Enhancing Technology transfer and diffusion

CA pillar of climate change mitigation

Technological diffusion is recognized as a key pillar of climate change mitigation in environmental agreements. Enhanced technology transfers within a 'climate club' would have sizeable positive effects on GDP in a 2° scenario.

Large gaps in current policies and diffusion patterns

Existing international policy measures such as the Clean Development Mechanism only had an impact on north-south diffusion and have mainly been directed to large emerging economies, mostly China, India, and Brazil. There exist major gaps in the network of technological diffusion, between and within developing world regions.

Policies to reshape technological diffusion routes

Technology diffusion routes are much more influenced by long term trade relationships existing between countries and by the level of technological development than by sectorial policy measures such as renewable support policy. In order to foster technological diffusion, climate clubs must target a major shift in the structure of international trade and economic integration.

Building a technological base in developing countries

In developing countries, the build-up of a supply base of certain low-carbon technologies is as important as the deployment of the technologies per se.

PARIS SCHOOL OF ECONOMICS
ÉCOLE D'ÉCONOMIE DE PARIS

GREEN WIN

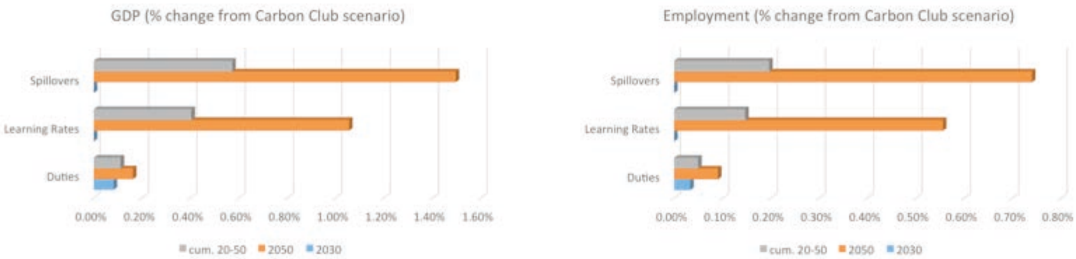
A pillar of Climate Change Mitigation

The importance of technological diffusion processes for the achievement of climate policy objectives has been emphasized at least since the Kyoto Protocol (see e.g., Blackman, 1999). Within the scientific community, the Intergovernmental Panel on Climate Change (IPCC) has repeatedly put forward its central role for climate policy and sustainable development (see e.g., IPCC, 2014). In the policy debate, technology transfers are strongly emphasized in the INDCs prepared for the COP21 and their relevance is recognized in the Paris Agreement, which puts forward in its preamble "the urgent need to enhance the provision of finance, technology and capacity-building" and devotes a full section to its decisions on "technology development and transfer", hence putting it on an equal footing with mitigation and adaptation.

Technological diffusion is also put forward as a key element in the design of 'climate clubs'. Such clubs would bring together countries willing to implement ambitious climate policies if associated with the benefits of a "club good". Notable candidates for such club goods are: enhanced access to low-carbon technologies, trade agreements or access to low-cost climate finance (see e.g Grubb et al., 2015; Keohane and Victor, 2016). Macro-economic simulations performed with the GEM-E3 model for the Green-Win project show that technological diffusion can play a major role in increasing economic performance within a climate club in a 2° scenario (see figure 1 below). This impact is notably larger than trade agreements. e.g. increased/decreased duties for countries outside/within the club in relation to the carbon content of goods (see e.g. Nordhaus, 2015).

Enhancing technological diffusion would have substantial macro-economic benefits

Figure 1: GDP and Employment impacts (in % change) of enhanced technological change (learning), technological diffusion (spillovers) and trade advantages (duties) for a set of countries forming a climate club. The countries forming the club are China, Europe, India, Japan, South Korea and Argentina. These countries are assumed to implement INDC commitments consistent with a 2° scenario while the remaining countries solely implement their Cancun pledges. In the baseline scenario, there are no co-benefits in participating in the club. The results reported for spillovers, learning rates and duties correspond to the increase in GDP and employment provided to club countries if the corresponding "public goods" are added to the club, that is if the rate of technological diffusion between countries is increased (spillovers), if a higher rate of endogenous technological change is enabled (learning) or if duties are imposed/lifted on countries outside/within the club (see Paroussos et al. 2017 for details).



Large gaps in current policies and diffusion patterns

Policy measures to foster technological transfers

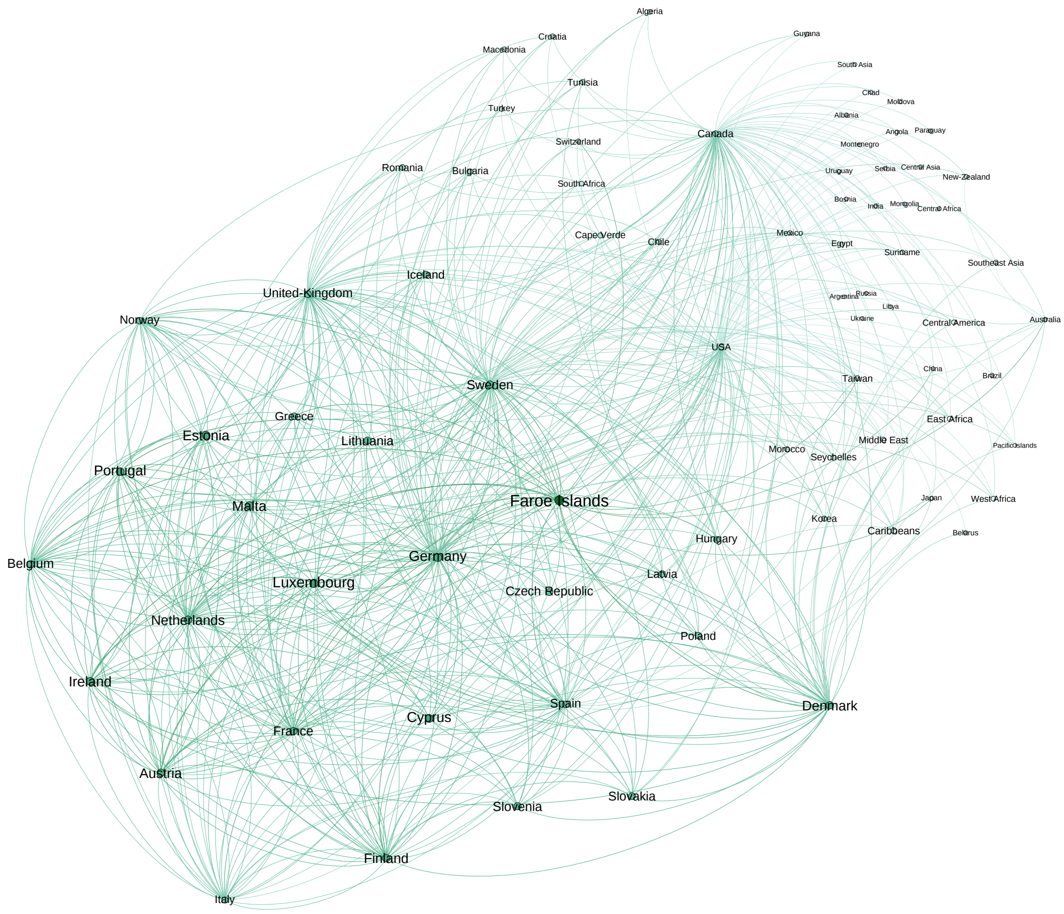
The strong emphasis on technological transfers in international climate agreements, which convey a notion of appropriability of the technology by the recipient country, suggest that such transfers can be heavily influenced or even controlled by governments. This might be true in some very specific industries such as defence and aerospace. Yet, for most of the technologies that are of concern for climate policy, notably renewable energy, the diffusion process is the outcome of firm-level decisions and interactions. Moreover, transfers take a wide variety of forms (e.g. material or immaterial) and employ a variety of vehicles (e.g. international trade in intermediate goods, foreign direct investments, licensing). Finally, technological diffusion is not a simple bilateral process but might involve strong network effects. In this complex landscape, it is much less clear what policy can do and how it can operate.

Clean Development Mechanism mainly reached China and India and neglected South-South

The Clean Development Mechanism (CDM) is probably the most important policy measure that has been implemented in view of fostering technological transfers. It should be stressed, however, that technology transfer was only a secondary focus of CDM projects whose main objective rather was to reduce GHG emission abatement costs. In particular, it should be noted that not all CDM projects entail an actual international technology transfer; in fact, it has been shown that transfers take place in less than half of CDM projects (see Dechezleprêtre et al., 2008). Another important caveat of the CDM approach is its sole focus on the relationship between developed and developing countries. Thus, it neglects the potential of south-south transfers and the role of network effects. This led to a narrowing of the scope of the CDM market, with most projects being directed to the large emerging economies, mostly China, India, and Brazil (see Rahman et al., 2016).

In order to understand the requirements for developing policies with a global perspective, the Green-Win project has constructed maps of the current patterns of technological diffusion using machine learning techniques for network reconstruction and micro-level datasets on technological adoption in wind energy, solar energy and electro-mobility (see Mandel and Halleck, 2017).

Figure 2: network of technological diffusion for wind reconstructed from adoption data (see Halleck-Vega and Mandel, 2017)



There are large gaps and long lags on the current technological diffusion routes

This allows the development of network maps of technological diffusion routes, such as the one reproduced in figure 2. The analysis of the inferred networks reveals a number of inefficiencies in current diffusion patterns. First, the distance between source and recipient countries can be large, implying long lags in the diffusion process to a large number of developing countries. Second, except in the core of developed countries, the technological interconnections within and between regional clusters are weak. Third, there lacks clear regional or global centres that could play the role of hubs in the diffusion process and hence increase its efficiency. In this context, simulations show that the most efficient policy to ensure a rapid diffusion of technologies at the global scale is to develop new hubs and links among developing countries. The development of CDM-like frameworks for south-south cooperation seems to be a minimum requirement from this perspective.

Policies to reshape technological diffusion routes

Policies should target both the extensive and the intensive margins of technological diffusion

The development of new technological diffusion routes thus appears as a major policy challenge. An econometric analysis of the determinants of technological transfers (Halleck-Vega et al. 2018) sheds light on potential policy levers. Two dimensions of the problem must be distinguished à priori: the extensive margin of technological diffusion, i.e. the extension of the scope and of the paths of technological diffusion, and the intensive margin, i.e. the increase in volume of technology diffusion and usage. A range of specific policy measures appear to have an impact on the intensive margin of diffusion: reduced tariffs on low-carbon technologies, renewable portfolio standards, participation in the Clean Development Mechanism or, more broadly, in international environmental agreements. Once a technology is strongly established in a country, this country is also likely to contribute to its further diffusion. However, the initialization of the technology adoption process, i.e. the development of the extensive margin of technological diffusion, seems to rely on much more fundamental and structural features. The two main determinants of initial adoption are, according to our analysis, the level of integration of the recipient country in international trade and its level of technological development or technological capabilities (e.g. skills/knowledge base as measured by the ArCo index, see Archibugi et al. 2004). Both are independent of sector specific policy measures.

Climate clubs must target trade routes with mitigation objectives

These results provide some insights to the current debate on climate clubs. They indicate that, if they ought to function autonomously, such clubs cannot be designed in an ad-hoc manner to foster the diffusion of certain technologies. They must rather target a major shift in the structure of international economic and trade integration in order to ensure that the mainstream commercial routes are aligned with the objectives of climate change mitigation. The mainstream flow of trade must deliver the most advanced low-carbon technologies to countries with large mitigation potential. A major concern in this respect is to increase the integration of non-BRIC developing countries through the development of new north-south and south-south routes.

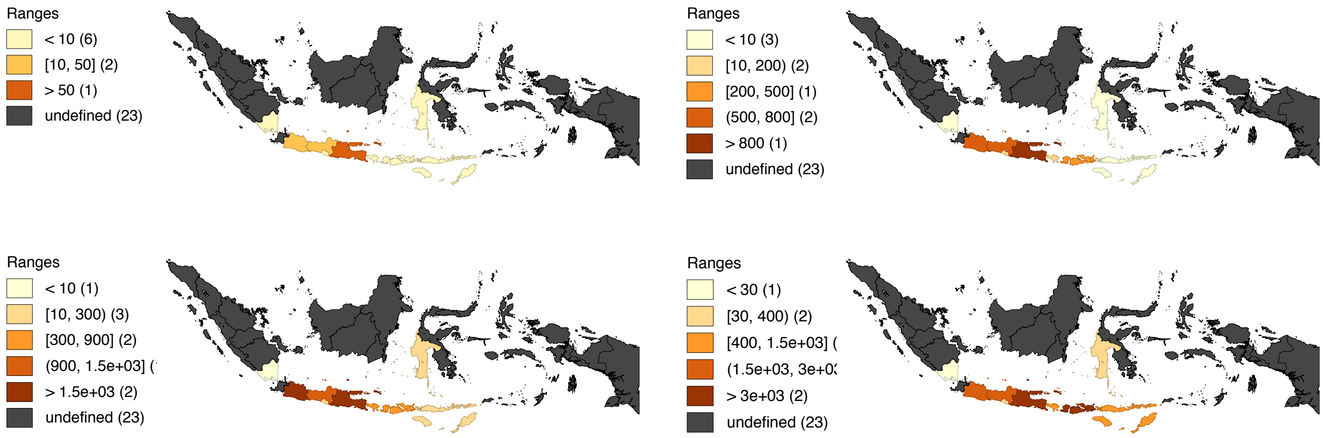
Building a technological base in developing countries

An example of a win-win strategy is the diffusion of biogas in Indonesia through the creation of a local industry

On top of the challenges present at the global scale, technological diffusion might also be an issue at the domestic level in absence of a mature market for low-carbon technologies. Indeed, if there are no organized markets in the sector in which low-carbon technologies ought to be deployed, e.g. if there is no organized energy market, conventional policy measures such as price and quantity support measures can hardly be implemented. The usual alternative is to rely on foreign aid and development programs but these do not allow the technology base to build that will ensure autonomous scale-up and further diffusion. The Green-Win project is performing a case study of an approach to overcome these barriers in the field of biogas in Indonesia. The Indonesian domestic biogas program (BIRU) targets the development of a domestic biogas sector rather than the deployment of the technology per se. This approach involves the build-up of a strong supply base, identification of the demand and the design of trading and financing schemes. Beyond a good performance in terms of scale and speed of diffusion (see Figure 3),

these developments then allow the domestic market to scale-up autonomously and possibly to spillover at the regional scale. This case study echoes the global outlook. Both at the local and at the global scales, the efficient policies to foster technological diffusion are those that target structural change and aim at aligning the objectives of low-carbon technology deployment with mainstream trade and investment flows.

Figure 3: the success of the Indonesian domestic biogas program is illustrated by the rapid diffusion of this technology between 2009 and 2012 in the nine Indonesian provinces where the BIRU program has been implemented in order to foster the creation of a local biogas industry. The colour scale indicates the volume of adoption and more specifically the sum of plant size in m3 (Biodigester plant sizes range from 2-20 m3, where most installations are 4-8 m3). Undefined denote the 23 provinces not covered yet by the BIRU program.



References

Archibugi, D., & Coco, A. (2004). A new indicator of technological capabilities for developed and developing countries (ArCo). World development, 32(4), 629–654.

Blackman, A. (1999), The economics of technology diffusion: Implications for climate policy in developing countries, Resources for the Future, Washington D.C.

Dechezleprêtre, A., M. Glachant, M., and Y. Ménière (2008), The Clean Development Mechanism and the international diffusion of technologies: An empirical study, Energy Policy, 36(4), 1273–1283.

Grubb, M., de Coninck, H. C., & Sagar, A. D. (2015). From Lima to Paris, Part 2: Injecting Ambition. Climate Policy, 15, 413–416.

IPCC (2014), Climate Change 2014: Synthesis report, Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (Eds.)], IPCC, Geneva, Switzerland, 151 pp.

Halleck-Vega, S. and Mandel, A. (2018), Technology Diffusion and Climate Policy: A Network Approach and its Application to Wind Energy, Ecological Economics, Vol. 145, pp 461–471.

Halleck-Vega, S., Mandel, A. and Millock, K. (2018), Accelerating diffusion of climate-friendly technologies: a network perspective, forthcoming

Keohane, R. and Victor, G.D. Cooperation and discord in global climate policy. Nature Climate Change, 6(6): 570–575, 2016.

Nordhaus, W. (2015), Climate clubs: Overcoming free-riding in international climate policy, American Economic Review, 105(4), 1339–1370.

Paroussos, L. Fragkiadakis, K. and Panagiotis, F. Mitigation and adaptation pathways and their macroeconomic impact, deliverable 3.3 of the Green-Win project, available online at www.green-win-project.eu

Rahman, S., A. Dinar, and D.F. Larson (2016), The incidence and extent of the CDM across developing countries, Environment and Development Economics, 1, 1–24

Green growth and win-win strategies for sustainable climate action (GREEN-WIN)

The GREEN-WIN Project identifies, develops and critically assesses win-win strategies, green business models and green growth pathways that bring short-term economic benefits, while also supporting mitigation and adaptation goals within the broader sustainable development agenda.

Work programme

↘ At national levels, GREEN-WIN analyses win-win opportunities that arise through integrating policies across different sectors, and advances state-of-the-art macro-economic models in order to identify green growth pathways.

↘ At local levels, GREEN-WIN carries out action research case studies to develop green business models and enabling environments in the following three areas: i) coastal flood risk management in Jakarta, Kiel, Rotterdam and Shanghai; ii) transformations in urban systems in Barcelona, Istanbul, Shanghai and Venice; and iii) energy poverty and climate-resilient livelihoods with case studies in India, Indonesia and South Africa.

↘ Cutting across both levels, GREEN-WIN investigates financial products and policies, as well as financial system reforms that redirect financial flows towards sustainability and climate action.

↘ All of these activities are embedded in an open dialogue between research institutes, international organisations, business, and civil society that co-develops shared narratives around win-win strategies, business opportunities and green growth pathways

Project partners

Global Climate Forum (GCF), Germany (coordinator) | The Institute of Environmental Sciences and Technology, Autonomous University of Barcelona, Spain | E3-Modelling, Greece | Environmental Change Institute, Oxford University, UK | Ecole d'Economie de Paris, France | University College London, UK | The Ground_Up Association, Switzerland | Stichting Deltares, The Netherlands | Institute for Advanced Sustainability Studies, Germany | Global Green Growth Institute, Republic of Korea | Jill Jaeger, Austria | European Centre for Living Technology at Università Ca' Foscari Venezia, Italy | Institute of Environmental Sciences at Boğaziçi University, Turkey | Universtitas Udayana, Udayana University, Indonesia | University of Cape Town, South Africa | 2° investing initiative, France | Sustainability and Resilience, Indonesia

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642018, and the Swiss State Secretariat for Education, Research and Innovation (Project No 15.0216)

Project duration:
01.09.2015 – 31.12.2018 (40 months)
Project resources: 3.9 million Euros

Contact

Jochen Hinkel (project coordinator),
Global Climate Forum (GCF), Germany
mail: greenwin@globalclimateforum.org
twitter: @greenwinproject
web: www.green-win-project.eu