



Working Paper Series

*Green-oriented Knowledge Transfers in global markets:
technologies, capabilities, institutions*

by

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Green-oriented Knowledge Transfers in global markets: technologies, capabilities, institutions

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Abstract. The development of green technologies represents a key driver in the transition towards environmentally sustainable societies. Among environmental challenges, the implementation of national climate policies and international efforts to face the threat of climate change has been particularly effective at triggering the production of climate-friendly innovation in developed countries. This effectiveness has been acknowledged by several studies which observed that, for example, the production of patents related to renewable energy technologies has sharply increased over the last decades. However, the battle against climate change is far from being over. As the share of greenhouse gases emissions in developing countries is sharply growing, how to promote the transfer of available green technologies to these countries is one of the main challenges that policymakers are facing in recent years. Understanding the mechanisms behind technology transfer of “environmental” knowledge and how such transfer happens among countries with heterogeneous economic conditions and different capabilities is a complex exercise. In this report we provide an overview of the literature on green knowledge transfer and, more importantly, on how such literature can be strengthened to deepen the understanding of the interactions that are at stake. The conceptual analysis is aimed at offering a platform to set in-field projects with stakeholders (research/business oriented), to concretely implement the elaboration and general best practice identification for knowledge and technology transfers in the green economy transition.

Keywords: Knowledge transfer, sustainability, inclusive growth

JEL: O31; O35; O19

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1. Knowledge transfer, technology and catching up. Investments and cooperation

Previous literature in the international and innovation economics & management fields discusses that in the presence of an international technology transfer, home countries players are able to access and absorb host countries' knowledge and transfer it into their own production processes. This process opens new opportunities for both host and home-countries' players, in a possible two ways interaction rich of feedbacks in a dynamic setting. While in the short run the relationship is more unilateral, it might evolve into a closed knowledge exchange loop while the set of interactions moves on.

As far as the technology transfer from host to home countries' agents is concerned, be it formal, i.e. depending on an explicit contract (e.g. for technology exchange) or informal, still it results in potential knowledge flows (spillovers) in favour of the host country.

Such technology transfer is facilitated by (Amighini and Sanfilippo 2014; Crespo & Fontoura, 2007; Narula & Driffield, 2012):

Technology transfer channels	Description
Foreign trade	Exposes domestic firms to competition leading them to be more efficient and to adopt new technologies
Foreign direct investment (FDIs)	Allow foreign firms to enter in the host country and to bring towards advanced technologies and capabilities which are sources of technological spillovers
Patent protection	IP rights address, at least partially, knowledge externalities deriving from imperfect appropriability of knowledge (see Section 2 for details)

Figures 1 and 2 offers an overall picture of worldwide GHG trends¹ based on a decomposition analysis (taking as theoretical reference the IPAT or Kaya Identity, Mazzanti and Zoboli, 2009) that focuses on both production and consumption based perspectives. Striking differences appear globally across the four different income groups of countries. Firstly, we note that "Industrialized" countries are the only group associated with a negative trend for CO₂ emission in the analysed period (1995-2013), while the other three groups registered a significant increase in emissions.

Among the three components, the wealth effect has always a positive impact on total emission with the exception of the "Least Developed" countries, where it is negative.

The composition effect has, on the contrary, a similar and negligible impact on the four-income group, while the technical effect shows some important heterogeneity. In particular, technical improvement has reduced total emissions in all income groups with the exception of "Least Developed" countries, in which the emission associated with this effect, have increased in the analysed period.

¹ Elaboration based on EORA dataset. Additional overviews and analyses of environmental trends based on the decomposition of efficiency/innovation, structural change/composition and scale effects are present in the recent UNIDO IDR report (UNIDO, 2015), that was presented in many world institutions by UNIDO during 2016. UNIDO will publish in 2017 a new report specific with an eye on Manufacturing and sustainable consumption issues,

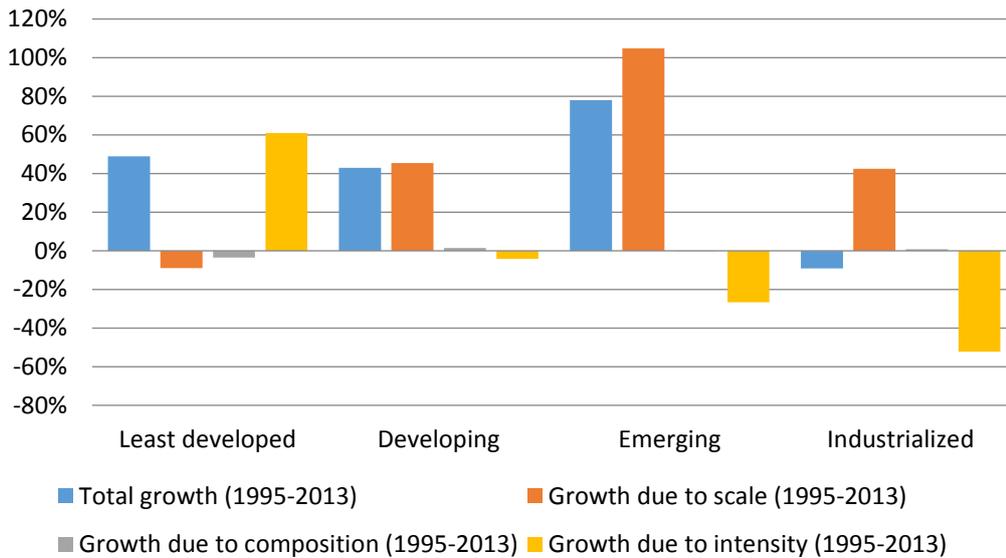


Figure 1. Production-based CO2 emissions

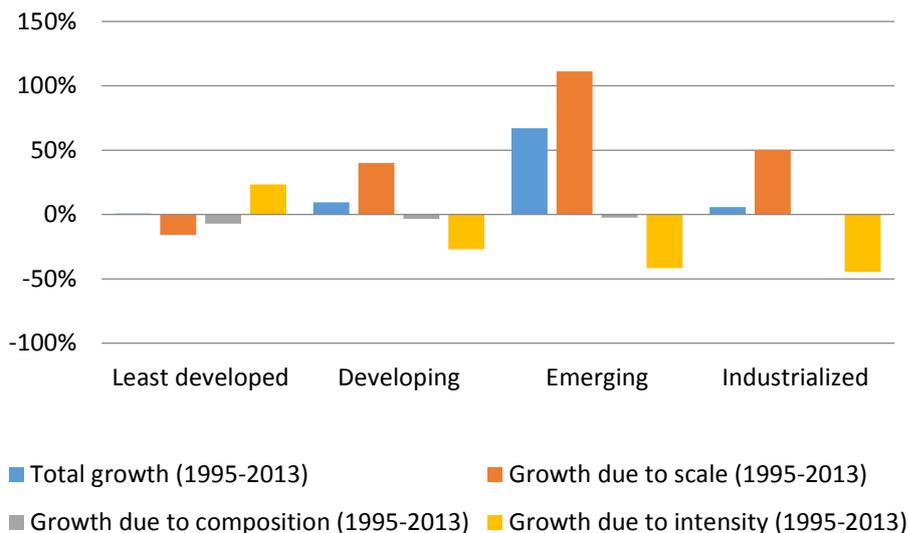


Figure 2. Consumption-based CO2 emissions

Even though it is empirically evident that the environmental production efficiency (e.g. GHG/GDP) of poor countries is lower with respect to that of more advanced countries, the ultimate consequence is not only a necessity for a North South bilateral transfer (e.g. CDM in the climate change arena). Knowledge should be transferred through various north-south, south-south channels, where the emphasis is on the co-creation of knowledge and mutual feedbacks from the involved parties.

The key element is the necessary extension of 'innovation' meaning, if we aim at understanding the real innovation phenomenon. Innovation is well beyond (patented) technology and technology itself. Innovation is about (i) tangible and intangible knowledge flows, (ii) complementarity among technological adoptions, organizational change, training – in terms of human capital formation, skill redevelopment, etc. Thus, better social, environmental and economic performances, namely higher well-being and enhanced capabilities to create welfare and income, arise from the complementary use of diversified forms of innovations. Small innovations are as important as big scale innovations:

the effect of the innovation is crucial to understand its value for society and people. The central factor of interest is the context where the set of innovations is adopted and the synergies/complementarities that are present. Those are highly context dependent as well – by geography, sector, etc. Which Innovation(s), how it is adopted and where it is adopted are all relevant questions that need to be conceptually and empirically addressed. Within the set of innovations, a special space is occupied by education/training. Though it is often overlooked, the formation of (new) skills and competences is always a complement to techno-organizational innovations, and a central pillar, given the primary relevance of human capital across development levels. Human capital is the necessary factor that is needed to achieve a sustainable society where technology is transformed into social values and capabilities – in terms of enhanced access to 'resources' – are increasing.

The aforementioned definition of the innovation environment as a diversified, multiple, rich framework gives relevance to and makes necessary three realms that are more specific. First, Innovation is often led by end users (public transport in Indian city), and not only by R&D through linear innovation model (supply driven). Demand and supply sides are equally important. Policy levers act in the background to sustain the overall innovation system. Second, Open innovation systems (suppliers, customers, social capital type of relationships) are crucial. Even if top down innovation generation might remain relevant in some cases. Sustainable innovations need knowledge transfers to flow through open innovation systems, in their sector and geographical characteristics. Innovation adoption is thus highly characterised by cooperation, spillovers, social capital accumulation. Practical knowledge, business models, 'relative capabilities' hugely drive the transfer: a key point is the capacity of absorption of recipients and the coherence between innovation and the socio-economic, institutional and technological context. The adoption and transfer of Innovations is to be coherent with system of values and techno-economic infrastructures. It is thus necessary to study and understand the coherence among the various involved parties and sides of the innovation adoption and knowledge transfer,

The diversity of innovations needs to be analysed by various and flexible methods. Surveys, case studies, small labs, etc. are necessary ways to understand the variegated layers and features of innovations in firms, sectors, and also between firms and sectors, given the crucial role of spillovers and knowledge cooperation².

What favours knowledge transfer?

Given that a) knowledge can also be not readily transferable (even more when it is tacit) and b) technology³ can imply costs to become accessible to any firm (even more in the absence of an adequate absorptive capacity) the likelihood to observe an international technology/knowledge transfer depends on three characteristics:

Factors affecting technology transfer

The nature of the technology under scrutiny e.g. in terms of its complexity, novelty, speed of change, level of applicability (product or production process).

The characteristics and capabilities of the agent buying/acquiring/ imitating the technology as firms are characterized by different technological capabilities and skills.

The existence of a national policy. It favours or contrarily limits the entrance of FDI in the country.

A confirm of this is outlined in a study by Luo et al. (2011) on BRIC cases: the emerging economies analysed have even been able to develop their own technologies (Brazil in aircraft, electronics and

² This paragraph has integrated the outcomes of discussion that occurred during the Table 5 world café at the Green.EU INNO4SD symposium in Cyprus, November 2017 (especially regarding the issues *where do we stand with regard to Innovation & Technology Transfer? What knowledge has been generated to date? What could improve in terms of the research process of past projects*).

³ General note. Throughout the report the definition of innovation is broad: we refer to knowledge as an integrated realm where technology, human capital and organizational changes are always integrated and possible complements. Even when we refer to 'technology', the meaning is broader.

computers; India in computers; Malaysia in electronics) thanks to a combination of foreign capital (FDIs) together with firms national capabilities and governmental policies in building national development strategies able to adapt imported technologies.

The transfer of green technologies

All in all, we argue that this picture holds even when the focus is on a peculiar type of technology transfer, i.e. the one directed towards technologies leading to a reduction in environmental pressures, namely environmental or Green Technologies (GT). GT and broader green/environmental/eco innovations (for conceptual definitions and discussions see Carrillo-Hermosilla et al., 2010; Rennings, 2000; Kemp, 2010; Kemp and Pontoglio, 2010; Kemp and Pearson, 2007⁴) differ from usual innovations to the extent that:

- public good component of the innovation benefit (largely environmental) is larger,
- concrete appearance of both economic and environmental gains is occurring over a longer medium-long term time-path (Corradini et al., 2014; Gilli et al. 2014).

The probability to observe an international transfer of GT is still depending on:

- nature of the specific knowledge entailed in each technology,
- capabilities of the recipient agent to absorb such green knowledge and
- institutional set up.

Furthermore, the limited amount of resources available for firms operating in developing countries for building own knowledge makes them substantially dependent on external sources of technology, namely through technology transfer (Amsden and Chu, 2003). Resource constraints faced by such firms, defined as “resource-poor late entrants” (Mathews, 2002; Bell and Figueiredo, 2012; Lee et al. 2015) make them enter a value chain that is already established and dominated by firms from advanced countries, such that the market segment they are able to enter is mainly a sub-contracting one, devoted at producing goods that fit the buyer’s requirements. Hence, in absence of a green technology transfer these countries might not possess the necessary capabilities and resources to create and diffuse green knowledge. However, opening to external trade has also counter – effects, as they will be explained in the following paragraphs.

Notably, such a conclusion stands true while adopting a conceptualization of technology transfer&diffusion finalized to lead to a type of growth aligned with that of OECD economies, characterized by industrialized processes, global value chains and knowledge transfer conceived according to privatistic rules. Alternative conceptualizations of knowledge transfer, including green technology transfer, are possible while addressing developing or low-income countries that, on the one hand may refer to a different system of knowledge generation (less hierarchical, profit-driven and marketable), as stated by Gupta (2012) and, on the other hand, may need to first reform the socio-institutional framework to then successfully innovate within the techno-economic paradigm typical of North-South knowledge transfer (as for the case of Thailand reported by Intarakumnerd et al., 2002). More on that will be presented in chapter 4.

Box 1.1 FDI, trade and CO2 emissions

In a study conducted on China’s economy Ren et al (2014) found that trade surplus is an important source of rapidly increasing CO2 emissions. Whereas China’s trade surplus grew from \$102 billion to \$181.76 billion, net CO2 exports has experienced an increase from 2130.5 MT to 2821.6 MT showing that a significant share of China’s CO2 emissions are related to commodities that are consumed by foreigners. In addition, the authors provide evidence that FDI inflows in China came at a price, as they are responsible of a rise in its CO2 emissions. On the one hand, trade openness and foreign investments spur China’s economic development and, on the other hand, contributes to increase the levels of pollution. This finding provides a confirmation of the existence of a pollution haven in China, an issue which links to the necessity

⁴ Work package 2 in the Green.eu project aims at providing discussions over and definitions of green innovations.

to analyse the consumption and production sustainability perspectives (EEA, 2014)⁵. See Figure A for a sketch on the embodied emissions in import flows coming to the EU.

Requirement of GHG emissions to satisfy EU final demand - top 5 non-EU countries

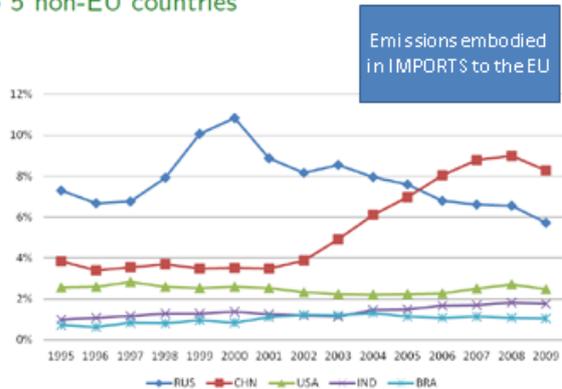


Figure A - Emissions embodied in Imports to the EU (source: own calculations on WIOD dataset)

It has been acknowledged that trade liberalization may also lead to a reduction of emissions, especially in the manufacturing sector. Recently Shapiro and Walker (2015) have highlighted the role of environmental regulation as a key driver of pollutant emissions of US manufacturing. The paper also emphasises that the increase in pollution tax faced by US manufacturers has been much more relevant than changes in productivity and trade, in tackling emission reduction. In contrast, Cherniwchan (2017), focussing on individual plant levels, suggests that trade liberalisation (NAFTA agreement) had a pivotal role in explaining the reduction of emissions in the US manufacturing sector. Nearly two third of PM₁₀ and SO₂ emission reduction can be attributed to the effect of NAFTA agreement and that the main mechanisms at the base of this process are: increased access to foreign markets and in intermediate inputs (from Mexico) and, to a less extent, increased import competition.

Foreign trade and environmental effects

Starting from the Grossman and Krueger (1991) contribution, the linkage between foreign trade and environmental effects has been investigated by several authors, who analyzed the existence of a so called Environmental Kuznets curve (EKC). EKC postulates this link takes the functional form of an inverted U shape, and relates economic growth to an initial phase of increasing environmental pressure and then to a turning point after which environmental pressure gets de-linked from economic growth. In such a broad framework of analysis, having a better natural environment can become a good in advanced economies, whose demand tend to increase, thus making advanced economies face stricter environmental regulation than poorer economies. In such a scenario a reaction to stricter environmental regulations might be of a Porter-like one (Porter and van der Linde, 1995) thus enhancing competitiveness, but it can also be that of relocating part of all production activities in those countries with weaker regulations.

In this last respect, pollution abatement can be seen as an additional cost domestic firms have to bear that can potentially hamper their competitiveness at the advantages of firms located in countries with no or weak environmental standard. In the case of such re-localization past literature used the term "pollution haven hypothesis" PHH (Copeland and Taylor, 2003).

All in all, both EKC, Porter Hypothesis and PHH have received consistent amount of research and contribution, but no universally accepted position has been found so far. Copeland and Taylor (1994, 1997) for instance found that free trade improves the developed countries' environment at the expensed of the developing countries' environmental pressure and a similar support of the PHH

⁵ See Figure 1 for a sketch on the embodied emissions in import flows coming to the EU. Other calculations of embodied emissions and jobs are available area by area and country by country.

came from Cole (2004), Pao and Tsai (2011) for BRIC countries and more. Rejection of the PHH are however also available in the literature (e.g. Eskeland & Harrison, 2003; Dong et al., 2010; Cole and Fredriksson, 2009; Perkins and Neumayer, 2009).

Not largely investigated is the connection between the role of trade openness for driving technology transfer and at the same time for creating a sort of green catching up for those countries that are exposed to green knowledge and are able to use such knowledge to avoid the rise of a “pollution haven” in their boundaries. In other terms, the role of trade openness and FDIs on green knowledge generation and diffusion in host countries and its environmental effect would be of crucial interest, rather than focusing directly on FDIs’ environmental outcomes, in order to understand whether such openness can be beneficial for the uptake of GTs and environmental innovations which may result in a reduction of the environmental pressure of production in such countries. Figure 3 below reports the intuition.

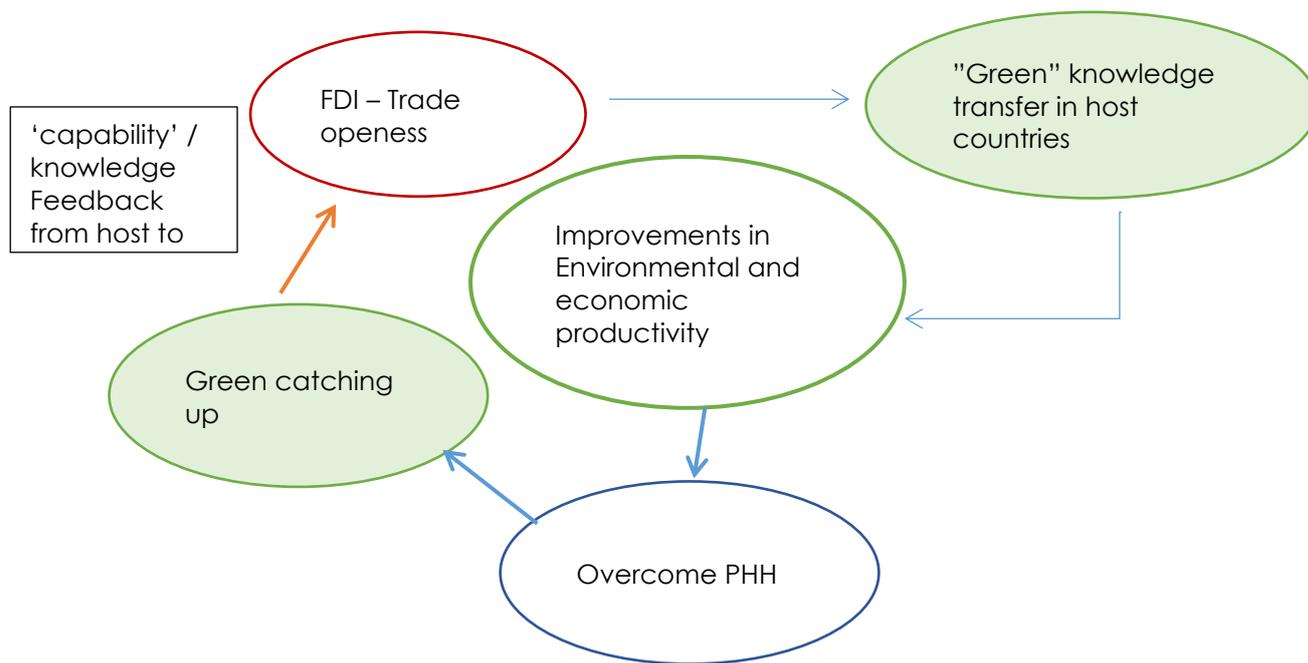


Figure 3 – Technology transfer and its channels

Implications from Section 1

- Whether international “green” technology transfer through FDIs can help developing countries to a) catch up and b) to contextually reduce the rise of “pollution havens” deserves further investigation.
- It depends on the nature of the technology considered, as well as on the capabilities of the buyers and on the national set-ups.
- The industrial composition of the country and its knowledge base will play a role: being characterized by science-oriented sectors rather than tacit-knowledge based ones makes the difference in terms of entry barriers.
- Science-oriented sectors are characterised by high entry costs such as acquisition of qualified green human resources and high amount of R&D (green or not) expenditures

2. Patent protection and climate change-related technology transfer towards developing countries

As discussed above the channels through which broad knowledge transfer occurs are trade in goods, FDI and licensing. These channels involve human interaction, new technology, its technical characteristics and bureaucratic system and they may trigger or inhibit technology transfer (Greiner and Franza, 2003). Indeed, it has been acknowledged that these elements may also raise barriers to transfer efforts. Guilfoos (1989) categorised these barriers into three main groups, i.e. technical, people and regulatory barriers. Whereas the first two barriers mainly refer to the capabilities of new technologies and its equivocality - i.e. more understandable technologies are easier to transfer (Smilor and Gibson, 1991), those involving laws and procedures include, among others, intellectual property (IP)-related regulations.

Green technologies and Intellectual property rights

As far as GTs are concerned, the presence of a double externality, i.e. environmental externality related to pollution and non-excludability and non-rivalry of knowledge, increases the complexity of this framework, especially when these two externalities interact (Jaffe et al., 2005; Barbieri, 2015). IP rights address, at least partially, knowledge externalities deriving from imperfect appropriability of knowledge. When the challenge concerns the development and transfer of energy or GTs from industrialised to developing countries, the extent to which the regulatory system for IP protection should be strengthened or weakened to promote technology transfer is at forefront of policy agendas worldwide. Developing countries support the creation of an IP right regime specifically designed to promote international transfer of GTs, whereas developed countries are committed to reinforce IP right protection to increase the benefits derived from their inventions.

Would technology transfer from developed to developing countries be enhanced by stronger patent protection?

Enforced IP protection in developing countries enhances the transfer of GTs through import of capital goods, foreign investments and licensing, although this effect is hampered in lowest income countries (Hall and Helmers 2010)

Patent issues do not represent barriers for the transfer of GTs towards emerging countries (Barton 2007; Ockwell et al. 2008).

A stronger patent regime may stimulate technology transfer from developed to developing countries especially when the risk of imitation by domestic firms in the host country is higher (Maskus, 2010).

In addition, Hall and Hemlers (2010) highlights that the heterogeneity of climate change technologies in both reliance on IP rights and patenting propensity suggests that "it is highly unlikely that a single, universal mechanism characterises the nexus between IPRs and the generation and diffusion of green technologies across countries" (Hall and Hemlers, 2010: 28).

Green technology transfer and the Kyoto Protocol

The transfer of GTs is a primary goal to reduce inequality in the consequences of climate change between developed and developing countries. Indeed, GTs are primarily developed in industrialised countries and urgently required in developing countries to reduce GHG emissions. North-South transfer of environmental technologies increases the capability of developing countries to decouple economic growth and environmental burden. Therefore, the transfer of GTs and the design of policy instruments to foster it, are central discussion points in climate negotiations (Popp et al., 2010, Popp, 2011).

Technology development and transfer are pivotal in the Kyoto Protocol and are also at the core of post-Kyoto discussion on mitigation and adaptation to climate change. Therein, three main mechanisms are acknowledged to bring about technology transfer, i.e. the Clean Development Mechanism (CDM), Joint Implementation (JI) and Emission Trading (ET). CDM and JI are designed to trigger projects that target emission reduction where the economic and social context is more

convenient. Indeed, more industrialised countries (Annex I) are awarded emission credits in exchange for the development or financing of projects that reduce GHG emissions in other Annex I countries (JI) or in developing countries (non-Annex I) (CDM).

Although not primarily introduced to trigger technology transfer (it does not have technology transfer requirements), it has been acknowledged that the CDM boosts North-South transfer of GTs (Figure 4 and 5) (e.g. Schneider et al, 2008).

Country	Rank	Average % of world's inventions	Average % of world's high-value inventions	Top 3 technologies (decreasing order)
Japan	1	37.1 %	17.4 % (2)	All technologies
USA	2	11.8 %	13.1 % (3)	Biomass, insulation, solar
Germany†	3	10.0 %	22.2 % (1)	Wind, solar, geothermal
China	4	8.1 %	2.3 % (10)	Cement, geothermal, solar
South Korea	5	6.4 %	4.4 % (6)	Lighting, heating, waste
Russia	6	2.8 %	0.3 % (26)	Cement, hydro, wind
Australia	7	2.5 %	0.9 % (19)	Marine, insulation, hydro
France†	8	2.5 %	5.8 % (4)	Cement, electric & hybrid, insulation
UK†	9	2.0 %	5.2 % (5)	Marine, hydro, wind
Canada	10	1.7 %	3.3 % (8)	Hydro, biomass, wind
Brazil	11	1.2 %	0.2 % (31)	Biomass, hydro, marine
Netherlands†	12	1.1 %	2.1 % (12)	Lighting, geothermal, marine
Total	-	87.2 %	77.2 %	

† Note: Together, EU27 countries represent 24% of the world's inventions.

Figure 4 - Top green technology inventors (from Dechezlepretre et al. 2011)

Dechezleprêtre et al. (2008) emphasises that technology transfer occurs in almost half of the CDM projects examined and it often concerns the transfer of knowledge and skills instead of equipment alone. This reinforces at micro level the fact that the human capital share is largely the greatest among natural, handmade, human stocks of capital, across country income level. Its relative share is larger in high income countries but is also the highest in many poor countries. Sustainability in itself is a path characterised by increasing investments and stocks of capitals, wherein human capital plays a pivotal role.

Equipment transfer appears to be frequent in larger projects whereas the transfer of both knowledge and equipment (or knowledge alone) is more likely in small CDM projects (Haïtes et al., 2006). Thus, bottom up project based sustainable development, which is of high relevance where the economy is based on SMEs and micro-firms, strictly links technology and knowledge (skills).

Moreover, the Dechezleprêtre et al. (2008) work shows that the likelihood of transfer is influenced by the type of technology involved in the CDM project. Indeed, data confirm that the majority of CDM projects concern end-of-pipe technologies for HFC, CH4 and N2O reduction and wind power, suggesting that these kind of technologies are more easily transferred from developed to developing countries. Finally, as discussed above, technological capabilities in the host countries represent a barrier to technology transfer.

Similar findings are provided by Dechezleprêtre et al. (2009). The paper investigates the transfer of climate change-related technologies in CDM projects in Brazil, Mexico, India and China and emphasises the presence of large differences in the number of CDM projects in these countries and in the type of technology involved. In addition, there is heterogeneity on the main factors driving technology transfer. That is, in some countries such as Mexico and Brazil the involvement of foreign partners in the host countries and technological capabilities seem to play a central role. On the other

hand, in fast growing countries (China and India) the main driver seems related to the opportunities opened by rapid economic growth. Finally, Murphy et al. (2015) highlights that among other factors, complementary policy in the host countries that enhances technological capabilities, positively influences technology transfer by CDM projects.

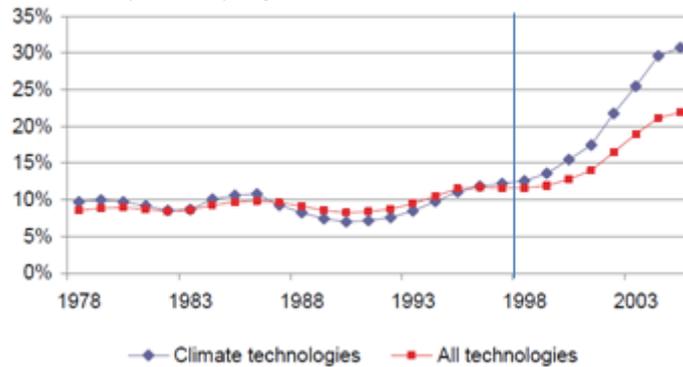


Figure 5 - Technology flows OECD- non OECD countries (Dechelezpretre, Glachant et al, 2011)

Implications from Section 2

- The literature related to the impact of CDM projects on the transfer of GT suggests that size of the project, presence of foreign participants, type of technology and technological capabilities influence the likelihood of technology transfer from developed to developing countries.
- End-of-pipe technologies for HFC, CH₄ and N₂O reduction and wind power are more likely to be transferred from developed to developing countries through CDM
- It is easier to develop green technologies in developed countries since environmental regulation is more effective at spurring technological improvement. Developing countries are unlikely to enact policy requiring huge emissions reductions at this time.
- Complementary policy implementation in the host countries aimed at enhancing technological capabilities, positively influences technology transfer by CDM projects.
- Efforts and activities within Green.eu should be devoted to:
- Identification of main knowledge opportunities related to the introduction of foreign technologies in emerging and developing countries
- The effect of those technological 'opportunities' on skills and human capital creation, and the overall complementarity among knowledge based practices
- The role of complementary (environmental) policies in the host countries.
- How knowledge transfer impacts recipient countries in terms of emission/resource use reductions and economic performances
- How the development of knowledge in the host country then generate bilateral and multilateral feedbacks in a dynamic and self-sustainable process of knowledge creation
- Those are among the key routes on which Green.eu WP4 should base the identification of specific research / business best practice identification through specific case studies and projects (geo-referenced and sector specific).

3. Knowledge transfers: cooperation, open innovation and systemic eco-innovations

Recent research has revealed the systemic nature of eco-innovation. Systemic thinking concretely places at the heart of the reasoning inter-firm, inter-sectors and geographically related links and spillovers, Networking and cooperation compensate for the lack of internal economies of scale of eco-innovators, particularly SMEs ones (Mazzanti and Zoboli, 2009; Antonioli et al. 2016; Cainelli et al. 2015). Recently, the relevance of knowledge sources that are external to the firm boundaries has attracted an increasing attention. The fact that eco-innovators have to deal with different techno-economic problems, making their endeavours even more complex than in the case of "standard" innovation, entails the need to acquire, master and operationalize different types of knowledge. As noted by Carrillo-Hermosilla et al. (2010) eco-innovations imply four types of changes, related to design, user-involvement, product-service and governance dimensions. Coping with these changes implies having information and skills which, in many cases, are distant from the traditional industrial knowledge base in which firms operate. Evidence shows that to cope with these requirements, knowledge interactions, in the form of cooperation with external partners, are more important for eco-innovators than for standard innovators (De Marchi, 2012). Specific type of partners have been shown to be particularly relevant: for instance KIBS, research institutions and universities or suppliers (Cainelli et al., 2012; De Marchi, 2012; De Marchi and Grandinetti, 2013).

Cooperation and knowledge transfer

Modalities of knowledge transfer that extend beyond formal interactions in the form of cooperation are observed. In this regard, Ghisetti et al. (2015) analyse the effect of the "breadth and depth" of information sourcing on eco-innovation performance, finding positive returns on both of them, with the impact of broad knowledge sourcing being bounded by redundancy and inconsistent signals arising from too dispersed sourcing strategies and, at the same time, more dependent on absorptive capacity. Studies have mainly concerned developed countries.

Relevant questions

Can developing / emerging countries benefit from transfer of knowledge related to eco-innovation in the form of cooperation and open innovation?

Which are the peculiarities of international knowledge transfer practices that involve organizations (e.g. firms, private and public research organizations) from developing/emerging countries?

To address these relevant issues at least a couple of points are still to be addressed. First and foremost, a more complete understanding of the eco-innovation knowledge base is required, as different typologies of knowledge can be transferred more easily than others over geographical and technological/cognitive distances (Boschma, 2005), which characterize actors with dissimilar capabilities.

A starting point could be the distinction between synthetic and analytical knowledge. The former is typically acquired through interactions with business partners and relies on tacit knowledge related to concrete technological know-how and practical skills. On the contrary, analytical knowledge concerns the creation of new knowledge, relies on scientific knowledge and formal models, benefit from the interactions of firms with research organizations and is dominated by codified knowledge (Asheim and Gertler, 2005; Asheim and Coenen, 2005). Recent evidence, limited to a single EU country, suggests that both the resort to synthetic and analytical knowledge benefits firm's eco-innovation, with the prevalence of the former (Marzucchi and Montresor, 2015) especially for eco-innovation that do not alter the nature of the production processes, but rather pertain to new products and end-of-pipe solutions.

- This type of exercise could be replicated in the case of developing/emerging countries, and with an emphasis on international interactions.

In principle, synthetic knowledge could be less subject to absorption problems related to technological gaps; however as it is based on tacit knowledge, its transmission relies on context-specific conditions (e.g. face-to-face interactions and geographical proximity) that are difficult to replicate in the case of international interactions. On the contrary, interactions aimed at exchanging analytical knowledge, being based on up-to-date scientific knowledge, are likely to exacerbate knowledge absorption problems; however, its codified nature makes it more likely to travel over geographical distance and to be less subject to context-specific transfer conditions. A second relevant point concerns in fact the capacity of organizations to absorbing external knowledge. Ghisetti et al. (2015) argue that the exploitation of external knowledge for the sake eco-innovations, even more that standard ones given the higher technological and non-technological (e.g. organizational, institutional) complexity, relies on absorptive capacity (a concept introduced by Cohen and Levinthal, 1989). This is found to be triggered by R&D and organizational mechanisms that facilitate the internal transmission of externally-sourced knowledge. In the specific case of knowledge transfer practices that involve organizations in developing and emerging countries, the lack of sufficient absorptive capacity could be a serious barrier for the effective exploitation of knowledge coming from more technologically advanced sources. Unfortunately, to date, no insight is available on the specific mechanisms that can enhance the absorption of knowledge in these contexts. This is an aspect that deserves attention.

Box 3.1 Green technology cooperation in the Euro-Mediterranean

The case of the Euro-Mediterranean (EU-MED)⁶ renewable energy cooperation provides an illustration on how the probability of observing an international transfer of green technology depends not only on the institutional set up, but also on the capabilities of the recipient agent to absorb such green knowledge.

Since the early 2000s, the EU-MED renewable energy cooperation has been framed in a comprehensive institutional framework, mainly structured on the European Neighbourhood Policy (ENP) and on the Union for the Mediterranean (UfM).

In 2003 the Trans-Mediterranean Renewable Energy Cooperation (TREC) initiative was started, with the aim of unlocking the renewable energy potential of the region through cooperation as if there were no borders. Between 2007 and 2009, this initiative evolved into the Desertec project, which was specifically focused on tapping into the potential of North African and Middle Eastern deserts to supply clean power (solar and wind) to those regions and to Europe. Desertec was politically backed by the EU, and also gathered support from European companies and banks. However, Desertec failed to deliver. By 2014, 47 of the 50 initial Desertec shareholders had left the consortium, de facto marking the end of the project.

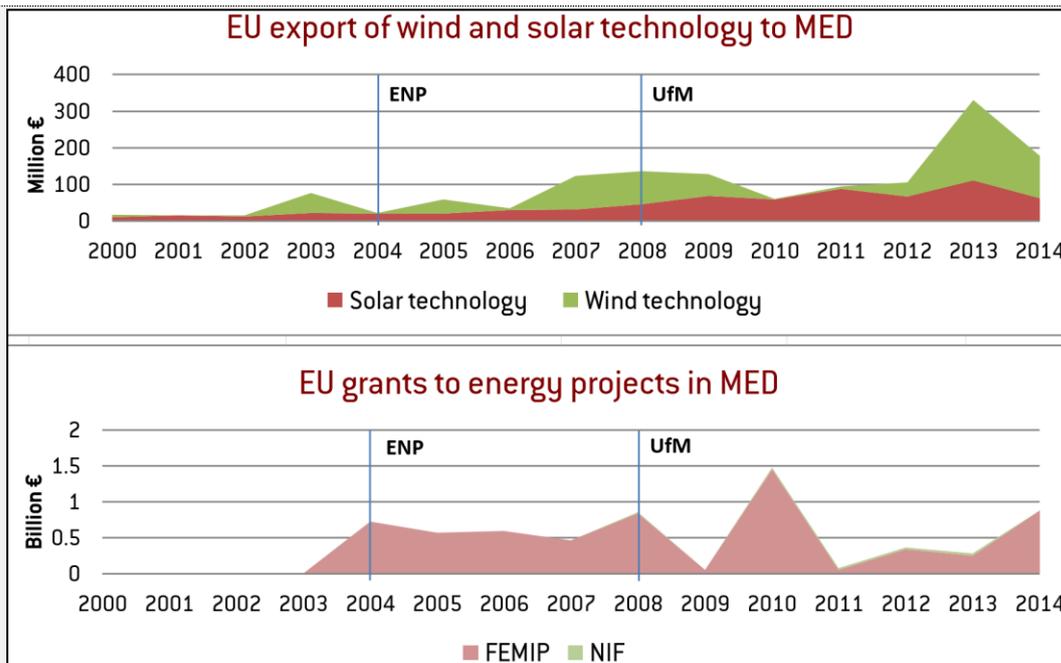
The Mediterranean Solar Plan (MSP) initiative suffered the same fate. Started in 2008 as a UfM flagship initiative, this project also aimed to export solar and wind power to Europe. The MSP was supported by the European Commission, which also promoted cooperation between this project and Desertec.

Both these projects were framed into the wider European Neighbourhood Policy. In 2003, a 'Memorandum of Understanding for the progressive integration of electricity markets of Algeria, Morocco and Tunisia and in the EU electricity internal market' was signed. In 2007 the Mediterranean association of energy regulators (MEDREG) was created, while in 2012 the Mediterranean association of transmission system operators (MED-TSOs) was also launched. Both these institutions were aimed at facilitating the conditions for energy cooperation in the EU-MED.

However, the history of EU grants to MED energy projects and of EU exports of solar and wind technologies to MED countries (Figure B) indicates the lack of concrete impact of all these institutional settings on the key renewable energy technologies: solar and wind.

Figure B: EU grants to energy projects and export of solar and wind technologies to MED

⁶ For the purposes of this case study, the following countries are considered as MED: Algeria, Egypt, Israel, Jordan, Lebanon, Libya, Morocco, the Palestinian Authority, Syria, Tunisia and Turkey.



Source: author's elaboration based on European Investment Bank and UN Comtrade database.

Note: FEMIP = Facility for Euro-Mediterranean Investment and Partnership; NIF = Neighborhood Investment Facility.

The main reason of this lack of impact lies on MED countries' absence of capabilities to absorb green knowledge. In particular, four are the main barriers to this transfer: commercial, regulatory, infrastructural, financial.

- The commercial barrier: the extensive use of universal energy subsidies in MED countries lead to an inefficient allocation of resources and market distortions that, among other things, also limit the competitiveness of renewable energy sources vis-à-vis conventional energy sources;
- The infrastructural barrier: MED countries lack an adequate electricity infrastructure. Electricity transmission systems need to be enhanced at both the national level and between MED countries. Furthermore, the electricity connections between the countries and the EU also need to be expanded/constructed in order to allow future potential "green" electricity exports from the MED to the EU;
- The regulatory barrier: the MED region lacks a stable and harmonized energy regulatory framework. Such a framework would represent a fundamental prerequisite for the deployment of solar and wind energy, particularly considering these technologies' long payback period. The current fragmentation of the regional regulatory landscape needs to be fixed in order to allow international investors to be fully committed in developing projects in the region;
- The financial barrier: also because of the three previous barriers, the region lacks an adequate financing scheme for the renewable energy. Government investment and finance from various international institutions -mainly Europeans- continue to represent the cornerstone of the regional renewable energy financing. This situation is not sustainable, as a large-scale deployment of renewable energy in the region must rely on a much more solid financing scheme in order to be fully successful.

In order to be able to absorb green technologies, MED countries have to first tackle these four challenges. This indeed represents the fundamental prerequisite to allow international transfer of green technology in the framework of the established EU-MED regional institutional set up.

Collaboration and technology transfer

It has been acknowledged that external sources of knowledge are important to exploit technological opportunities. A huge body of literature has emphasised that collaboration between university and industries triggers the creation and adoption of new knowledge, favouring a two-way technological knowledge transfer.

As observed by Guimón (2013) the main barriers that affect collaboration between university and industry in developing countries are:

- Lack of financing and low levels of human capital, such as poor quality of education, in universities. This affects the capacity to be involved in industry-related projects
- Managerial capacity and limited experience in these type of projects
- Informal collaborations aimed at mobilise university researchers to the private sector

Implications from Section 3

- Knowledge interactions, in the form of cooperation with external partners, are more important for eco-innovators than for standard innovators
- Interactions aimed at exchanging analytical knowledge, being based on up-to-date scientific knowledge, are likely to exacerbate knowledge absorption problems
- The exploitation of external knowledge for the sake eco-innovations relies on absorptive capacity, even more than standard one
- Absorptive capacity can be a serious barrier for knowledge transfer practices from developed to developing countries

Box 3.2 and 3.3 present two international case study applications that could be taken as opportunities to develop new cooperation and knowledge transfer's activities within Inno4SD.

Box 3.2 Private and public collaboration in the Chinese low emission automotive industry (from Jin et al. 2016⁷)

Over the last decades, China's government spent effort to stimulate the market of pure electric and plug-in hybrid vehicles in order to reduce air pollution released by the transport sector. The creation of a new energy vehicle industry, defined as a strategic emerging industry by the State Council of China in 2010, is among the priorities of the Chinese government. The government has implemented the National High Technology and Research and Development Program aimed at financing R&D activities to develop new energy vehicles. Furthermore, the development of alternative vehicles became a pivotal strategy for the automobile industry due to its inclusion since the 10th Five-Year Plan. The Chinese government highlighted the need to increase market size, volume of production and improve infrastructure related to alternative propelled vehicles in order to achieve the target. The interaction between infrastructure development, market formation and industrial growth seemed to be effective at stimulating the creation and diffusion of low emission vehicles. Indeed, the alternative vehicles market grew from 7.200 cars sold in 2010 to a more than 300.000 cars sold in 2015. However, the share of these vehicles over the national fleet remained relatively low, approximately 1.5% in 2015. Hangzhou, the provincial capital of Zhejiang Province, implemented strategic niche policies to achieve government goals and favour the emergence of a new energy vehicle industry. Some of these policies concerned the development of hybrid buses and taxis; improvement in battery-charging technologies; creation of a battery-charging station network and the implementation of a renting and sharing service for alternative vehicles.

Collaboration in the form of private and public partnership has been particular useful for the emergence of the alternative vehicle industry. Indeed, collaborative innovation is seen as an effective instrument to spur the development of emerging industries (McKelvey et al. 2015). A battery-charging regime has been implemented in Hangzhou. Private companies such as Zotye collaborated with universities to develop a changeable battery technology for low emission taxi. The collaboration between private and public sectors favoured also the development of the micro-bus model which enabled alternative car sharing and renting and provided sustainable urban mobility solutions. Moreover, companies, institutions and universities collaborated to develop information systems and sharing station technologies.

The case study provides insights into the effectiveness of policy intervention to stimulate the creation of an alternative vehicle market. Policy implementation incentivised the demand for alternative vehicles through sustainable public transportation in the form of hybrid buses and taxis and rental and shared low emission vehicles. As a consequence, Hangzhou's new energy vehicle industry grew over the period, with about 20.000 vehicles sold. In addition, more than twenty companies specialised in the development of low emission vehicle core technologies. The infrastructure which involved 90 charging stations and 100 car-sharing stations, favoured the creation of the market and technical niches. Finally, technological and financial resources played a pivotal role in the emergence of the industry. The former has been enhanced by national programs to develop electric vehicle core components which acted as platforms for collective innovation. The latter has been triggered by the access to local and national government funds to carry out R&D as well as financial subsidies to purchase or rent low emission cars.

Box 3.3 Eco-efficient practices in the Brazilian transport sector

The transport sector in Brazil is responsible for 30% of all energy consumption in the country. Given this context, it becomes relevant to adopt eco-efficient practices starting from the use and development of technologies that can reduce environmental impact. Thus, all efforts endeavoured in the segment of mobility deserve highlight. The Itaipu Hydroelectric Power Plant is the largest generator plant in the

⁷ The authors agreed to contribute through an abstract of their paper. This case study may be further developed within the INNO4SD network.

world, and has been developing since 2006 a mobility program based on the use of electrical vehicles.

At first, the intention of the Itaipu team was to evaluate the use of turbinable poured energy turning it into hydrogen. This would be a low cost energy and could be applied in shuttle buses used for tourist circuits inside the plant. At that time, KWO (Kraftwerke Oberhasli AG) was consulted and asked to join in this enterprise. This company was developing an electrical vehicle in Switzerland and was already Itaipu's partner in other projects. As they considered the use of hydrogen a farther technological step in the project, KWO suggested Itaipu should consider splitting this Project into phases: first, focusing on developing electric vehicles powered by batteries, and further focusing on hydrogen fuel cells, using the poured turbinable energy. Given these guidelines, and once at the time KWO's partner for the vehicles was FIAT, the latter company was also invited to partake the Project.

Early on, the challenges faced by the companies were the size and weight of the battery to be used in the electric vehicle, and its storage capacity, besides the matter of governmental incentives to enable the production of the different needed electronic components in an industrial scale, efficient air conditioning, and high performance traction motors. Research laboratories were invited to participate in the project, with the objective of developing technologies that could guarantee higher performance and durability to the required battery. At the same time, several government agencies aimed at financing technical research in strategic sectors in Brazil, like FINEP, joined the Program. These secured the necessary financial resources for the continuity of the research and fostered new partnerships with interested hydroelectric plants, battery manufacturers, and other correlated sectors. The premise was that a technology does not work alone and in isolation, and that when the electric vehicle showed the defined technological trajectory behind it, research and development of complementary assets would gain effectiveness.

It should be added that the electric vehicle program also underwent some very practical tests. One of the most emblematic was the loan of an electrical vehicle built in partnership with FIAT for driving in Fernando de Noronha archipelago. It was observed at the time that going around the island on gasoline costed around R\$ 670.00, whereas running on electricity this cost could be reduced to R\$ 67.00, besides cutting on CO₂ emissions and noise pollution.

Itaipu Binational and Kraftwerke Oberhasli AG (KWO) opened in 2012, in Meiringen, Switzerland, a laboratory for the development of a new advanced 100% recyclable sodium battery, with high energetic density. To do away with the high costs of importing the batteries (a factor considered a financial impediment to the project), a cadenced process of technological transfer was started, gradually enabling Itaipu to develop the new battery, using Brazilian technology, and at a lower cost. This fact allowed for the licensing of companies in Brazil and abroad for its production.

By this time, the electric vehicle project already had consolidated the following research lines: (a) studies of a new high-capacity sodium battery, (b) smart grid concept applications to improve energy performance, (c) connection impact studies of the electric vehicle to the power supply network, (d) the adaptation of new models of vehicles with electric drive, (e) and the 100% recyclable sodium batteries bank, being used both to provide electric vehicles fast charge as for energy accumulators for use in isolated communities, hitherto without electric supply. In 2013, studies for the production of an electric vehicle on rails, as well as for an electric airplane in partnership with ACS Aviation, were initiated. The expertise of ACS allowed for the reduction of the prototype's weight, by using lightweight and highly resistant composite materials. The first flight of the new electric plane took place two years later. In 2014 and 2015, the main action fronts of the program were the development of new hybrid buses running on ethanol; the proposal to make viable an energy storage system in the Fernando de Noronha archipelago, in partnership with an hydroelectric plant from São Francisco River and the Electric Energy National Agency; the continuation of the electric vehicle on rails project; and the development of the sodium battery. Another highlight was the establishment of a cooperation agreement with French Renault. This agreement foresaw the assembly of 32 Twizy vehicles, and the

expansion of the Itaipu Binational Electric Vehicle Research, Development and Assembly Centre in the city of Foz do Iguaçu, Parana State. Besides the transfer of technology, another purpose of the partnership was to take advantage of Renault's technical expertise in electric vehicles to help develop the parts suppliers segment in Brazil. The last company to join the project was the German BMW, which produces the I3 electric models. These models have been used for impact studies of the vehicle to the power grid. The technological alliances with KWO and FIAT in the first stage, and RENAULT and BMW subsequently proved to be fundamental to make the electric mobility project viable, particularly as regards the flow of transfer of the most needed technical knowledge. Based on contracts involving the transfer of materials and equipment, the required expertise allowed for the operation and maintenance of the electric vehicles. As challenges in the macroeconomic sphere, the fact that there are no tax incentives for the development of electric vehicles also deserves a highlight. Quite the contrary, taxes on batteries for electric vehicles are approx. 500% higher than for small commercial vehicles.

4. Profit sector for Green Technology Transfer: Inclusive and Frugal approaches

One of the most agreed conditions for enabling the global diffusion of innovation has always been the availability of resources, especially financial means, through which investing in R&D activities to design new products or services targeting the global market. This assumption has been historically seen as the pre-requisite for credibly starting any innovation process, privately or publicly supported. Consequently, the concept of scarcity was never associated to that of innovation, as the lack of resources was in itself the main obstacle to innovation diffusion at all levels.

In the field of International Development, this assumption particularly addressed public institutions, whose reduced financial availabilities minimized their potential of pro-development actors, progressively reducing their funds for International Development Aid, thus decreasing their role of enablers of technological transfer benefiting low-income communities worldwide (Easterly, 2006). Seemingly, innovation processes were never perceived as possible were scarcity was an endemic socio-economic condition, namely in least developed countries or developing countries where poverty interested the vast majority of the local population.

Contrary to that, since the early years 2000 academics and economists begun noticing that, as a consequence of the downsized role of public institutions in dealing with development processes, the latter were going through a process of re-shaping due to the engagement of entrepreneurs investing their own funds to design new solutions for poverty issues, namely combining new models of intervention with traditional forms of development aid (WBCSD, 2006; Bais, 2008). As reckoned by Prahalad and Hart (2006), companies were just discovering the potential of low-income markets in terms of new consumers, new business partners and new hubs for product development (Karamchandani, 2009; Viswanathan and Sridharan, 2012). Public Institutions' reduced budgets, hence, did not impede the diffusion of new forms of development initiatives thanks to the private sector's took over of the traditional International Development's public mandate, so to become a new powerful actor with a strong vocation on product and process' innovation (Hart and Christensen, 2002).

At the same time, other academics and economists questioned the idea that scarcity was a structural obstacle for the diffusion of innovation processes and begun theorizing the concept of Frugal Innovation. This has to do with the idea of innovating in conditions of scarcity, meaning in a condition of poor availability of monetary and infrastructural resources. Frugal innovation is a type of growth's strategy claiming that resource constraints are opportunities instead of limitations (Radjou et al., 2012). Amongst the main protagonists of Frugal Innovation there are marginalized and low-income communities, able to experience innovation processes according to grass-root logics (also known as Jugaad) prioritising product's affordability, usefulness, usability and sustainability. According to such criteria, Frugal Innovation posits that social impacts can sprout even in poor contexts, to the point that increased business and social value can finally be paired thanks to scarcity as a driver of development and innovation's diffusion (Radjou and Prabhu, 2012).

Concluding, the traditional assumption that scarcity was an insurmountable limit to innovate within International Development models was contradicted by the increasing interest of the profit sector in development issues, which counterbalanced the decreasing role of public institutions and unleashed the potential of corporations in dealing with innovation processes targeting untapped markets and unheard needs in low-income communities. Additionally, scarcity ceased to be associated to rudimentary forms of innovation for people in poverty, yet, it started being conceived as a different driver for a new form of innovation typical of low-income communities: Frugal Innovation. Both processes had tremendous impacts in Development studies, policies and initiatives, demonstrating that scarcity was no longer a passive condition hampering growth's possibilities, yet a catalyst for innovating the panel of actors dealing with development purposes and for unknown forms of grass-root innovation flourishing from collective ingenuity within low-income communities (Gupta, 2012).

Innovation for Development vis à vis Scarcity: examples

The conceptualization of scarcity as a catalyst for spreading innovation at a macro-level, through the engagement of the profit sector in Development issues, and at a micro-level through the importance given to frugal innovation's dynamics in low-income communities, led to the definition of two complementary approaches:

- Inclusive Business (and its theoretical underpinning, known as “The BOP theory”): Inclusive Business models are commercially viable and replicable business models that include low-income consumers, retailers, suppliers, or distributors in core operations. They are correlating positive business growth with business models that offer goods, services and job-opportunities to low-income communities (IFC, 2014). **Keywords:** *co-creation, ecosystem approach, participative design.*
- Frugal Innovation: (aka *Jugaad* Innovation): Frugal Innovation is a strategy to develop useful technology solutions that aim to do “better with less”, that is, generate greater economic and social value while minimizing the use of scarce resources. Contrary to the general practice to innovate for the top of the pyramid (as there lies the greatest purchasing power and abundant resources) with eventual trickle down effects, Frugal Innovation is practised in emerging markets and then makes its way up to other levels to benefit all users. It represents a new kind of innovation process that leverages institutional voids and resource constraints achieving profitability from BOP consumers (Hart and Sharma, 2004). Frugal technology solutions can range from healthcare to finance to agriculture to energy. **Keywords:** *collaborative consumption, circular economy, grass-root innovation, social innovation.*

The above mentioned approaches share a common aspect, which is the understanding of scarcity as an empowering condition for innovating development processes addressing low-income communities. Moreover, both Inclusive Business and Frugal Innovation concur to reinforce a new model of development that is intrinsically sustainable as it relies on inclusive co-creation practices and, in most cases, low environmental impacts thanks to a circular process of resources' exploitation. In order to clarify further how inclusiveness and circularity may lead to diffuse a type of innovation more sustainable and impactful, three initiatives will be further illustrated.

Kokono®

Description⁸: Kokono® is a brand new product consisting in a rigid shell to protect infants from 0 to 12 months. Thanks to its plastic structure, covered with natural fibres, Kokono® isolates the baby from the direct contact with the ground, reducing the probability of infections due to the permanence of the baby on the floor exposed to infectious agents and dangerous animals during day-time and night-time. Kokono®'s rigid structure is also protecting the baby from random bumps happening during night-time when rooms, in off-grid rural villages, are completely dark. Last but not least, the insecticide treated nets covering Kokono®'s shell, protect the baby from mosquitos and other flying insects. Adding to that, the handle permits to transport Kokono® from one place to another, allowing mothers and other caregivers to carry out any kind of domestic activity close to their babies, which would not always be possible while holding the infants on mother's back.



Figure 5: Kokono® shell.

Eco-innovation features: Kokono® has been conceived by sharing knowledge and insights with end-consumers, located in low-income communities in Central Africa, and by listening to local experts in maternal care and expats' experiences. The product, therefore, resulted from a process of co-creation that engaged the company and trickled down to be co-designed by local people living in

⁸ Source: XXI Triennale Exhibition, “Rethinking work in a digital society” session.

those communities where the innovative product may be delivered and diffused. More on that, Kokono® is thought to be co-produced and assembled by people living in the low-income community according to local traditional knowledge, as for the external part of the shield that is made out of natural fibres following the traditional methods of waving natural fibres and contributing to its recyclability. More on that, once its main function becomes irrelevant, Kokono® can be used as a basket to transport goods. Notably, ensuring a second-life to the product is aligned with the need of circular and multi-tasking features required by sustainable development projects targeting low-income communities.

14 Trees

Description⁹: 14Trees is a joint-venture between LafargeHolcim and CDC Group plc ('CDC') that aims to accelerate the production and commercialization of Durabric - an environmentally-friendly, affordable alternative to traditional clay burnt bricks. Already used in Malawi, Rwanda, Tanzania and Zambia, 14Trees will enable Durabric to be commercialized in other countries, particularly in sub-Saharan Africa. More than 3 million of these bricks have already been produced in Malawi since 2013, and have been used in around 500 buildings. A new Durabric production plant is being built in Malawi and will open in the third quarter of 2016.



Figure 6: Initiative's logo.

Eco-innovation features: many African countries face the effects of climate change as a result of widespread deforestation that is driven by the demand for wood used in the production of clay burnt bricks. An expanding construction sector boosted by population growth and urbanisation also puts pressure on resources and increasingly fragile ecosystems. Durabric offers a solution to address these challenges, as the bricks are produced from a mixture of earth and cement, compressed in a mould, and left naturally to cure without firing, in the process saving up to 14 trees per house. By avoiding this firing phase, Durabric reduces greenhouse gas emissions tenfold compared to traditional fired bricks. In addition, 14Trees will market a comprehensive range of innovative building solutions, including for screeds and roofing, reducing total construction costs by nearly 25 percent compared to traditional solutions.

gThrive

Description¹⁰: is a wireless sensor designed like a plastic ruler that farmers can stick in different parts of their field and start collecting detailed data on soil conditions. This GPS-enabled dynamic data helps farmers optimize the use of water, energy, and fertilizer and increase output and product quality. This solution is easy to set up and pays for itself within one year. It started its diffusion from fragile regions California, regularly facing major water shortages. It does not require a professional installer and it can be easily moved from one field to another by the owner.

⁹ Source: <http://www.lafargeholcim.com/cdc-and-lafargeholcim-launch-14trees-joint-venture-bring-low-carbon-affordable-housing-materials>

¹⁰ Source: <http://www.gthrive.com>

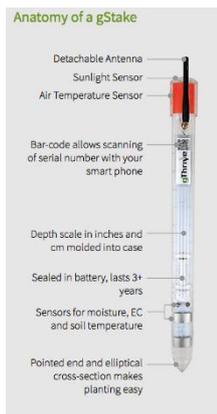


Figure 7: gThrive's components.

Eco-innovation features: from California to Central America, many farmers began using the system. Growers of a range of crops in these countries are using the gThrive system to control water, reduce power consumption, and manage crop production. Particularly in Central America, water management is critical as villages are located on well water, depleting faster than replenishment can occur in extremely dry areas where they are growing strawberries and fresh vegetables. gThrive enables farmers to reduce consumption and its portability provides an unexpected benefit as growers 'migrate' equipment from California to Arizona to Mexico following the growing cycle. Besides the obvious water and power savings benefits, growers can also manage crop production for market timing. By increasing or decreasing water availability, they can control plant growth, flowering and fruiting to better meet market needs and contracted requirements. All this can be done remotely rather than flying down from the US to check on operations and staff activities.

Implications from Section 4

- **For the profit sector:** to envision social and environmental impacts as part of their business returns on investment (i), to rely on participative and co-creation methods to support R&D investments (ii), to work together with intermediary actors such as consultancies and NGOs specialised in social dynamics within income poor communities (iii), to include qualitative indicators to assess the social and environmental impacts of innovative solutions targeting poor countries (iv), to adopt a LT perspective to define the investments' cost-opportunity.
- **For Public Institutions (National and Multilateral Institutions):** to collaborate proactively with the profit sector creating enabling conditions for inclusive and frugal investments such as: administrative clarity (i), open debates gathering all the engaged actors to share different expertise (ii), specific subsidies for supporting the front end costs of products' prototyping (iii), a repository of traditional knowledge in order not to lose track of sustainable local practices over generations (iv).
- **For the civil society:** increase the number of academic courses on inclusive business and frugal innovation (i), create international partnerships with universities located in the Global South for implementing inclusive and frugal innovation projects (ii), go beyond philanthropy as a way to engage the private sector into socially-oriented initiatives (iii), rely qualitative and quantitative indicators to assess the transformative impacts of development projects (iv).

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