INTRODUCTION

Technology plays a crucial role as a practical instrument to address climate change. The development of less greenhouse gas (GHG) intensive technologies and the diffusion of innovations for mitigation of and adaptation to climate change is crucial for the reduction of emissions in developing and developed countries.[1] For this reason, technology innovation and its subsequent diffusion are at the core of current negotiations about the post-Kyoto climate governance.[2] While efforts in this direction have to be undertaken primarily by developed countries as part of the "common but differentiated responsibilities and respective capabilities", the potential role developing countries can play as a source and vehicle for climate-related technologies should not be underestimated.

Developing and emerging countries are facing increasing international pressure to make serious efforts to combat global warming, and especially to reduce emissions of GHGs.[3] The key difficulty hampering the efforts of developing countries to limit global warming consists in their limited access to climate friendly technologies[4], and the problems this causes. Article 4.5 of the United Nations Framework Convention on Climate Change (UNFCCC) suggests a mechanism of North–South technology transfer as a possible solution which would allow developing countries to deal with the challenges of climate change. It asks developed country signatories to "*promote,facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties*". The UNFCCC, however, falls short of sufficiently considering the potential of South–South technology transfer; and other fora such as the WTO framework give equally little attention to it. This thesis aims at exploring this gap by considering the potential of technology flows between developing countries as a complementary and interesting paradigm to address climate change. Indeed, South–South technology transfer constitutes an interesting alternative to the traditional pathway of North–South transfer of technological innovation through financial flows, emphasising the role of developing countries as sources and not only as recipients of international technology innovations. Several developing countries are emerging as world leaders in some key climate-related technologies, involving other developing countries in numerous projects, and spreading clean technology through trade and investments flows.

Furthermore, South–South technology transfer is relevant from a broader development perspective. The implementation of a mitigation and adaptation strategy, at a national or international level, cannot be analysed without considering the framework of sustainable development and without taking into account the possible impact on economic growth, equity and poverty alleviation. South–South technology transfer has the potential to increase the "*development dividend*", the social and developmental benefits that are associated with adaptation measures and the implementation of policies on GHG emissions in developing countries.[5]

Until now, the effective achievement of the transfer of climate-related technologies has not been an easy and immediate process, but has faced the challenge of needing to respond to the specific economic situation of the different recipient countries with regard to the efficient diffusion and assimilation of new technologies. Moreover, the transfer of technologies should also involve a long-term capacity building goal tailored to the particular situation of the host developing country, a process sometimes too burdensome for regular development assistance. These reasons have contributed to the lack of progress in technology transfer under formal mechanisms (UNFCCC's Clean Development Mechanism) or along the traditional North–South pathway. The South–South approach to technology transfer may overcome some of these difficulties, as foreign direct investments transmit technological innovations between developing countries, which share some similarities, and thus may have a better mutual understanding of their markets, financial and social situations.

The phenomenon of technology transfer is defined as "*he process originating from the countries*

and the companies that developed and produced the innovation technology to the countries and subjects that will receive and facilitate their effective implementation and dissemination".[6]
Except where the information traded is available within the public domain, technology transfer consists in a very costly process of learning,[7] where the costs are essentially related to how the information is traded between the partners.[8] Technology transfer refers, in fact, to a comprehensive notion, including the tacit knowledge[9] and *„a broad set of processes covering the flows of know-how, experience and equipment''*[10] following different pathways, where different entities intervene and influence these processes.[11]
The transfer of technology is embodied in a wide range of activities;[12] however, there are three main ways in which it is possible to exploit and acquire technology across national boundaries: trade, licensing and foreign direct investment (FDI). Trade in goods and services, through the purchase of equipment and knowledge not commercially available in the recipient country, represents a channel for the international diffusion of technology together with technology licensing that typically consists in the purchase of the technical information, know-how, production and distribution rights on the innovation, within firms or between unrelated firms. By contrast, the technology transfer through FDI – defined as investments by foreign companies in the productive assets of local companies – encompasses not only the horizontal and vertical linkage between firms, thanks to the supply of intermediate goods and services, or between firms at the same phase of the production chain, but also cross-border movement of personnel and the process of the internalization of research and development (R&D) activities.[13] In this paper, I concentrate on the diffusion of technology via trade and investments, which is by far the most common channel for flows of technologies across countries.
Due to the complexity of the process of the transfer of technologies for addressing climate change,[14] it can be analysed by looking at the different actors and the specific modalities to finance the technology diffusion which are involved in the actual flow of technology.[15] For example the diffusion of technologies can be supported by a public sector contribution in the form of finance and investment. The traditional paradigm of this type of technology transfer is represented by North–South technology and financial flows, essentially employed in bilateral and multilateral official development assistance (ODA) programmes for supporting climate change projects and it has been adopted in the context of UNFCCC within the technology transfer projects associated with the Clean Development Mechanism. Alternative means for spreading technological innovation related to climate change emerge in the context of international agreements establishing the cooperation between public and private sectors in a specific project on specific environment-friendly technologies.
Currently, these technology-specific arrangements, involving not only governments but also firms and industry associations, are being promoted and developed by the European Union (EU) in its bilateral agreements with China and India and by the US, for example in the Asia Pacific Partnership on Clean Development and Climate.[16] Nonetheless, it is unclear whether the role of effective diffusion of technology through public–private partnerships is subordinate to, and for this reason undermined by, the political priorities of the countries involved in the partnership.[17]
A third possible means of transfer of technology is through multinational firms that operate on the sole basis of their market and competitive business strategies, but are effective vehicles of technology diffusion, particularly through trading flows in goods and services and FDI.[18] In my research, I focus on private-sector technology transfer because "*when considering means to enhance investment and financial flows to address climate change in the future, it is important to focus on the role of private-sector investments as they constitute the largest share of investment and financial flows*".[19] This private paradigm of international technology diffusion is particularly interesting because this is the mode of technology transfer that exploits the role of developing countries as sources not only of private investment but also of climate-friendly technologies. It is this paradigm that draws attention to the current changes in the traditional geography of technology transfer in the form of South–South technology transfer, since until now attention has

been focused on the North–South flows disregarding the fact that developing countries are becoming increasingly relevant sources of climate friendly technologies.

The transfer of environmentally sound technologies between developing countries is not only an attractive suggestion for possible evolutions of the current exchange of knowledge but it represents an important reality in the technological cooperation across countries. Some developing and emerging countries are casting themselves, on the international stage, in the role of leading exporters of climate friendly technologies, transferred from South to South and from South to North. The level of innovation across countries has changed rapidly in recent years, in particular the geographical distribution of climate mitigation innovations and their international diffusion. Patent data represent a good indicator of the geographical and temporal trends of innovative activities, allowing cross-country comparisons.[20]

For this purpose, the results collected in the European Patent Office/Organisation for Economic Co-operation and Development (EPO/OECD) World Patent Statistical Database (PATSTAT) concerning patent applications filed from 1978 to 2005 in 13 climate-mitigation fields are particularly interesting[21]. In terms of geographical distribution of innovations, the PATSTAT database clearly shows that the level of innovation is highly concentrated: the top 12 countries account for nearly 90% of the world's climate-related inventions.