Rethinking Borders of National Systems of Innovation: Austrian Perspectives on Korea's Internationalization of Green Technologies †

Philipp Olbrich* & Nina Witjes**

Abstract

The recent decades have seen a growing rate of international cooperation in science, technology, and innovation (STI) including in the field of green technologies. However, current approaches to national systems of innovation (NSI) have not kept up with this development. International aspects are rather treated as external conditions within which policymakers operate and respond but not influence. This paper tackles this problem by applying a refined NSI concept that includes an international dimension and complements past frameworks by focusing on those Korean government policies, actors, and activities relevant for the internationalization of STI. Austria and Korea have both formulated differing strategies to acquire international leading positions in the field of innovation and the development of green technologies. In the first step, the paper assesses Korea's international activities within the field of green technologies that transcend national boundaries and establish international connections. The government has still a strong influence on selecting technology areas for strategic funding but our findings show that international STI actors have difficulties in identifying the appropriate point of contact to initiate cooperation or apply for related funding. Second, an external perspective on Korea's international collaborations in the field of green technologies is offered. Austria has tentatively identified the East Asian country as a second-priority cooperation partner for its future STI internationalization activities. Interviews with Austrian stakeholders in the field of green technologies indicate a high interest in cooperation with Korea that is facilitated by a similar business culture based on personal networks. Moreover, researchers and policymakers referred to a shared need of small countries for intelligent decision-making processes regarding potential cooperation partners abroad. However, in order to enhance awareness, visibility and demand for Korean STI cooperation in European countries, more long-term funding programs featuring a more permanent point of contact should be introduced.

Keywords
national system of innovation, STI-internationalization, Korea, green technology, Austria, socio-technical imaginaries, bioenergy

† This research paper was made possible through the Science and Technology Policy Institute's 2014 Fellowship Program. We owe special thanks to Ruediger Frank for his support, to two anonymous reviewers for helpful comments, and to all interviewees for their participation.

* Researcher, Austrian Institute for International Affairs, Vienna, Austria, philipp.olbrich@oiip.ac.at

** Researcher, Austrian Institute for International Affairs, Vienna, Austria, nina.witjes@oiip.ac.at

1. INTRODUCTION

The field of science, technology and innovation (STI) has experienced significant changes over the past decade and a multitude of international issues are now entangled with scientific or technological aspects. Nation states include STI in their global ambitions as a response to the urgent need for solutions to global challenges that require international cooperation due to their complexity such as climate change or food security. In many countries, these developments have placed the internationalization of STI high on national agendas (Boekholdt, Edler, Cunningham, & Flanagan, 2009; ERA Expert Group, 2008; Flanagan, Uyarra, & Laranja, 2011). This can be inferred from efforts to map the global distribution of national capabilities in science and technology (EC, 2013; OECD, 2013). Findings of these studies point to a changing geography of STI (Leadbeater & Wilsdon, 2007) as emerging countries have considerably increased their efforts and financial investment to improve their national systems of innovation (NSI).

Green technologies represent a field of increased public and private investment as well as strong support from the policy level. In fact, innovation in green technologies has been at the core of many national action plans and STI strategies because of their importance in economic development and sustainability. The development of green technologies is not only pursued to protect the environment, but also to promote job creation in innovative future industries that are highly internationally competitive and increasingly integrated into the global economy (Park, 2014).

This applies to both Austria and Korea, as both states claim a leading position in the field of innovation and development of green technologies and pursue green growth strategies even though they approach green technologies quite differently. However, this study does not aim to provide a comprehensive comparison of Korean and Austrian international efforts. Instead it will bring together Korea's STI internationalization in green technologies with an assessment of Austrian stakeholders of these efforts based on expert interviews. This will contribute to an understanding of how Korea's green growth policies are situated within a specific national setting and accordingly evaluated in an international context of STI collaboration.

The paper pursues two major objectives. First, a structured review of Korea's international activities concerning green technologies will be presented. The analysis will focus on Korea's STI internationalization in this area from 2008 onwards and employ a modified NSI approach. Thus far, most NSI approaches have in large part neglected activities that transcend national borders. Therefore, an international dimension is introduced that deliberately includes the international activities of firms, organizations and governments. More precisely, the modification is based on three distinct considerations: the review concentrates on Korean actors (*geography*) that are active within the field of green technologies (*sector*) and operate internationally by reaching out their domestic NSI (*international activities*).

Second, we provide insight into Austrian cooperation experiences with Korea. Using the field of biomass as a case study, an external view of Korea's international activities in green technologies is offered which is derived from expert interviews with Austrian stakeholders from science, business,

and government sectors.[1] Thereby, their experiences and expectations are outlined which allows for inferences about policy recommendations. An Austrian perspective on Korea is particularly interesting and relevant as both put a strong focus on sustainable growth, referring to themselves as front-runners in green technologies. Korea and Austria show a number of similarities and differences regarding their internationalization activities and the way they deal with concepts of and approaches towards green growth. The paper goes beyond an analysis of strategic goals and provides a first explorative study of Korea's STI internationalization in green technologies and Austrian stakeholders' views thereof.

After introducing the literature on national systems of innovation and related considerations on globalization, we offer an analytical framework that structures the empirical analysis. Following an assessment of Korea's government strategies of STI internationalization, we will focus on crucial Korean actors and activities in green technologies before turning to the Austrian perspective on cooperation with Korea in this area.

2. LITERATURE REVIEW & RELEVANT CONCEPTS

2.1. Approaches Towards National Systems of Innovation

The origins of the NSI approach go back to innovation studies of the OECD in the 1960s (Godin, 2009). However, it was Freeman's (1987) publication on the development of Japan's system of innovation that introduced the term into academic discourse (e.g. Edquist, 1997; Edquist & Hommen, 2008; Lundvall, 1992; Soete, Verspagen, & ter Weel, 2010).[2] Other early contributors include Lundvall (1992) and Nelson (1993) who each published an edited volume on NSI. These authors are commonly contrasted with each other (Dodgson, 2009; Edquist, 2005) in that they represent different understandings of the concept. Lundvall pursues a more theory-laden way of engaging the concept by highlighting the social relationships of interactive learning and the national institutional setup as main factors for affecting innovation. Nelson on the other hand is rather concerned about specific organizations—albeit in various sectors like finance, education, business, etc.—that are more directly involved in the production and diffusion of knowledge. Ultimately, both attempt to identify crucial forces primarily responsible for innovation in a national context, but differ in what these forces are (Edquist, 2005). Since this involves cultural, social, political as well as economic factors (Edquist, 2005), the analysis touches multiple disciplines from political science to economics to cultural studies. Against this background, Lundvall (1992) reasons that "a definition of the system of innovation must, to a certain degree, be kept open and flexible" (p. 13).

Even after another twenty years, the phenomenon's complexity has prevented the occurrence of an accepted definition that goes beyond the "systemic nature of innovation activity" (Filippetti &

[1] Since on-going and potential cooperation projects are discussed, all interviewees will be quoted anonymously by mutual agreement.
[2] However, Freeman (1995) himself disagrees and accredits Lundvall to have first used the expression.

Archibugi, 2011, p. 180). Instead there is an abundance of alternatives of which each highlights different aspects important for innovation processes. Broader approaches consider systems of innovations as all components and their relations that contribute to the production and dissemination of "new, and economically useful, knowledge" within a country (Lundvall, 1992, p. 2). In an attempt to narrow it down, others turned to the impact of national institutions to define NSI as they "determine the rate and direction of technological learning" (Patel & Pavitt 1994, p. 79; see also Mowery, 2001, p. 17). They argue that their specific structure provides the conditions for the creation, storage and transfer of knowledge, skills and technological artifacts (Metcalfe, 1994). Departing from the focus on the institutional setup, other approaches rather emphasize the role of certain organizations active in the production and dissemination of knowledge such as universities, think tanks, or companies (Nelson & Rosenberg, 1993). Lastly, Edquist and Hommen (2008) pursue a more dynamic perspective and turn to activities within a NSI as central determinants of innovation processes.

2.2. Globalization, National Boundaries and Internationalization of STI

Several studies have been conducted to analyze NSI in a comparative manner (Edquist & Hommen, 2008; Lundvall, Intarakumnerd, & Vang, 2006; Nelson, 1993), but research on international STI cooperation informed by a NSI approach is scarce. This might result from the facts (1) that it is a quite recent empirical phenomenon, (2) that the focus of national competition in a globalized economy is often interpreted as rivalry rendering collaboration unlikely and (3) that the theoretical concept is understood as excluding international relations between nation states.

With respect to accounting for the effects of globalization, the NSI approach is considerably constrained by the implied spatial dimension. The 'national' is mostly understood as a necessary delineation of the object of analysis and applied in accordance with political borders (cf. Carlsson, Jacobsson, Holmen, & Rickne, 2002; Fagerberg, 2005). As a corollary of that, globalization is rarely integrated into the NSI concept but rather treated as exogenous.[3] This might result from the fact that the concept of globalization lacks a clear definition and comes in various manifestations[4], which all are subject to much debate.

International collaboration is used as a strategy to cope with growing global competition and has "become commonplace in the knowledge-based economy" (Mandeville, 2005, p. 165) as a response to the danger of falling behind in the global race for innovation. Nevertheless, most NSI approaches do not deliberately include the growing international cooperation between firms, organizations, and governments into their analyses.

There have only been a few attempts to bring together the concept of NSI and globalization that

[3] Similarly, technological determinism (e.g. Heilbroner, 1967) assumes technology as outside of the social and only affecting it on different levels.

[4] Economic interdependence (Power, 1997); revolution of communication technology (Datta, Sikdar, & Chatterjee, 2013); cultural homogenization (cf. Jennings, 2010); risk society (Beck, 1992).

treat the latter as more than boundary conditions for national innovation (cf. Pietrobelli & Rabellotti, 2009). Previous analyses that dealt with globalization and NSI can be aggregated into two separate approaches.

In a *first approach*, the international dimension is often equated with external influence, understood as an "impact of changes driven by unprecedented global social and economic forces" (Sörlin & Vessuri 2007, p. 3) or a "set of challenges that the process of globalization has been posing to systems of innovation" (Borras, Chaminade, & Edquist, 2008). In short, research is limited to the effects of globalization on national innovation (see Edquist & Hommen 2008; Lundvall et al., 2006; Nelson, 1993). International aspects are rather treated as external conditions within which policymakers operate and respond to but not shape themselves. Hitherto, analyses of NSI stop short of examining those activities that reach out of the respective country's national boundaries, let alone systematically integrating it into the NSI approach.

A *second approach* questions the usefulness of the NSI concept altogether as "globalization trends […] might well have undermined much of the relevance of national innovation policies" (Soete et al., 2010, p. 29). As evidence, scholars cite increasing interdependence between industrialized economies and a constant growth in cross-border flows of knowledge, research, goods, and capital (Mowery & Sampat, 2005; Narula & Zanfei, 2005; Soete et al., 2010).

In contrast to these approaches, it is argued here that despite increasing cross-linkages, central STI actors and institutions are still rooted in their national contexts and boundaries. International competitiveness in innovation is highly dependent on country-specific factors including financial systems, education, or fundamental research institutions (Bozeman & Dietz, 2001; Edquist, 2005; Larédo & Mustar, 2001; Patel, 1997). It follows that although activities are transcending borders, it is national actors in charge, located in a country-specific context and guided by national policies and rules. Accordingly, policy making on a national level still exerts considerable power over innovation (Liu & White 2001).

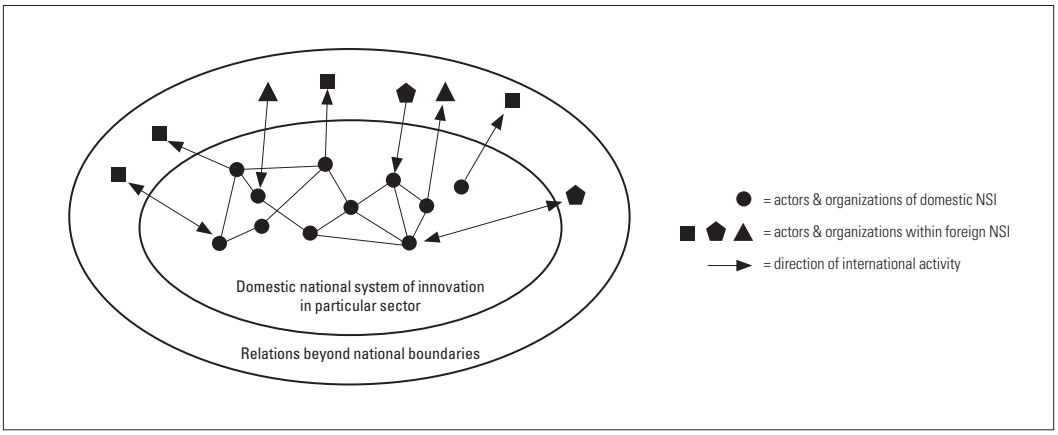
2.3. Integration of the International Dimension into NSI approach

In an attempt to integrate international activities into the NSI approach, this paper pursues a *third approach*. In doing so, the analysis is neither limited to the exogenous impacts of globalization (first approach) nor deems meaningless the importance of national boundaries and by association national policy making (second approach). As a matter of fact, we observe a growing number of STI cooperation on an international level that involves private as well as public actors, e.g. multinational corporations, universities, governmental research institutes, or ministries. Increasing cross-border exchanges, however, do not necessarily entail a proportional decrease in relevance of national borders or policies. Instead, it is argued, that every nation state's respective response to globalization in terms of STI internationalization is inevitably filtered through local organizational, political, and cultural frameworks, which results in significant differences.

In order to adequately grasp the international dimension of Korea's activities in green technologies, a refined NSI concept will be applied that complements past frameworks by focusing on those gov-

ernment policies, actors and activities relevant for the internationalization of STI. In this paper, the national system of innovation is conceived as constituted by several actors and organizations and their relations among each other, which are confined by their territorial boundaries that can be transcended in order to relate to actors from foreign NSI (see figure 1).

FIGURE 1. International Dimension of National Systems of Innovation



Source: Olbrich & Witjes 2014

For the purpose of reducing complexity of determinants of innovation processes, it is crucial to specify certain boundaries of the objects of analysis. This can be done along various lines: a spatial demarcation is inherent in any generic NSI approach that takes into account only those actors and activities within a country's territorial boundaries or local and regional industrial clusters (Hajek, Grebenicek, & Novosak, 2011; Saxenian, 1994). Other scholars like Malerba (2005) argue for the analysis of systems of innovation within the limits of certain sectors defined as "a set of activities that are unified by some linked product groups for a given or emerging demand and which share some common knowledge" (p. 385). Lastly, a definition of certain activities is proposed in order to set boundaries for the object of analysis and assess innovation processes within a certain system (Edquist, 2005). At times these approaches are juxtaposed (cf. Carlsson et al., 2002) although, as it is argued here, integration can be more fruitful. In order to enhance the validity of findings for the objective at hand and to sharpen the NSI approach as theoretical tool, three kinds of boundaries are drawn.

(1) On a *geographical basis*, the analysis is limited to the Korean context, taking into account organizations and institutions that fall within the jurisdiction of the country. Even though an international perspective is taken, the origin of activities (e.g. sending researchers) or the effects (e.g. receiving researchers) can be delimited to Korean territory.[5]
(2) A *sectoral demarcation* focuses on the green technologies sector, assuming that arguments can

[5] We are fully aware of the complexity of understandings of nation states and their borders. However, we refer to the national based on the assumption that STI policy is influenced by the respective state although responding to and being shaped by global and transnational developments at the same time.

only be made about a specific technology in a specific social and historical context (Hecht, 2001) and not about the role of technology in general. Furthermore, this contributes to a useful analysis as there are not only sharp differences in terms of actors, activities, and institutions between various countries but also across sectors (Malerba, 2005; Larédo & Mustar, 2001).

(3) In *terms of activities*, the paper will concentrate on those activities and actors that reach out the Korean NSI. This means the analysis considers activities that transcend the boundaries of Korea's innovation system and have an impact on the green technology sector.

3. ANALYTICAL FRAMEWORK & METHODOLOGY

3.1. Government Strategies Towards STI Internationalization

The NSI approach ascribes a central role to the state as coordinating actor. Therefore, we will provide an overview of Korea's governmental STI internationalization policies. They define the general direction of its NSI's international dimension and thereby frame all activities in the field of green technology. Additionally, an assessment of international STI policies and strategies is deemed necessary as public actions have a significant influence on technical change and innovation (Edquist, 2001; Soete et al., 2010) in that they can serve to promote or impede the innovation in different sectors, technologies, regions etc. and intervene to support and regulate market actors.

The examination of the central goals of the internationalization strategies in Korea's green technologies sector is based on an analysis of policy papers, publicly accessible official statements, speeches, websites, reports, and newspaper articles. After a characterization of the (1) government's position on R&D and (2) Korea's STI internationalization policy, the analysis focuses on (3) government efforts in the area of green technologies. This assessment allows for inferences about the direction of STI policy as well as the relevance and impact of specific actors within the country's internationalization activities.

3.2. Korea's International Activities in Green Technologies

In a second step, the analysis turns to the central activities and actors that are driving the internationalization processes in the Korean green technologies sector. In contrast to previous, mainly quantitative studies, we approach Korean internationalization in green technologies by complementing existing quantitative data with document analyses[6] and secondary literature. STI internationalization comprises a complex set of actors including universities, multinational corporations, venture capital organizations, public agencies, and research centers (Edler & Flanagan, 2009; Edquist, 2005; Metcalfe, 1994; Mowery & Sampat, 2005). As a part of the international orientation of a country's system of innovation, each actor fulfills a specific purpose by pursuing varying activities. Therefore, the focus of this section will be to identify the central actors of Korea's STI

[6] Government strategies, official statements, press releases, websites and newspaper articles.

internationalization and their specific activities. While most Korean collaboration activities in this area had been focused on Japan and the US, an increasingly intense cooperation with the European Union (EU) and its member countries can be observed in the recent past (Dall, Scheck, Steinberger, & Westphal, 2013). Due to this novelty, especially those actors and activities are considered that engage the EU and its member states.

Since it is nearly impossible to detach activities from the respective actor, both components are aggregated into one section and addressed simultaneously. In accordance with our suggested approach that integrates an international dimension into the NSI concept, those activities are considered that transcend Korea's national boundaries and have an impact on actors outside its own national system.

In order to make Korea's international STI activity in green technologies theoretically accessible, a structured catalogue is suggested which classifies the activities of STI actors. Based on literature review,[7] the international perspective of this paper requires a modification of previous collections. Despite the clear theoretical division into five distinctive categories, some activities may fulfill the criteria of two or more:

TABLE 1. Catalogue of International STI Activities

Research & development	International production of knowledge concerning green technologies (basic and applied research conducted abroad or domestically by foreign researchers); financed and executed by public as well as private actors.
Education	Universities as main actors; of special interest are topic-specific study and exchange programs and their strategic content orientation.
Introduction & modification of organizations	Political decisions to create new research organizations, agencies, coordination committees or ministries for the purpose of facilitating and engaging in international STI activities.
Assistance & consultancy	Government actors, foundations or other non-governmental organizations finance R&D, contribute to long-term cooperation, provide starting capital, or consultancy services for actors to support them in establishing international linkages
International networking	Bilateral and multilateral cooperation between Korea and other countries in the field of green technologies as they integrate knowledge and facilitate.

Based on this catalogue, each aspect will be addressed individually.

3.3. Assessing the Austrian Perspective on Korea's NSI

[7] See Edler & Flanagan (2009); Edquist & Chaminade (2006); Edquist (2005); Edquist & Hommen (2008); Kogan (2007); Liu & White (2001).

In order to assess the current Austrian perspective on STI cooperation with Korea in the field of green technologies, a two-tiered approach is applied. First, based on document analyses the paper will take a brief look at the broader context of European internationalization policies in which Austria is integrated. This will be complemented by an assessment of Austria's internationalization strategy and the role of green technologies therein. Second, we conducted six guided in-depth expert interviews[8] both in Austria and Korea as this method serves as access points to information difficult to explore otherwise. Austrian stakeholders were selected for interviews based on the condition that they were either involved in on-going cooperation projects with Korean actors in the field of green technologies or had substantial experience in international collaboration with Korea. As forestry management and bioenergy are two central fields of green technology cooperation between both countries, they are emphasized in this analysis. The sample includes experts from three different fields, i.e. government, science, and business. The interview data also allows for a reconstruction of how stakeholders relate green technologies to broader visions of national technological development by employing the theoretical concept of socio-technical imaginaries (Jasanoff & Kim 2009). Additionally, we will draw on the socio-technical imaginaries of Korea and Austria in order to see how concepts of green technologies are inscribed in the processes of STI policies and politics with respect to their specific national history and culture.

4. THE INTERNATIONAL DIMENSION OF KOREA'S SYSTEM OF INNOVATION

4.1. Government Strategies

4.1.1. Research & Development

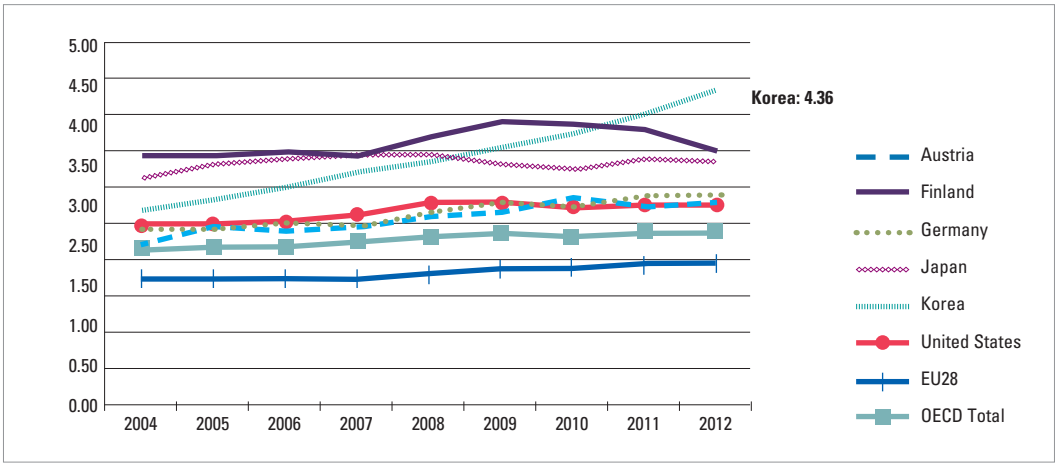
Following its successful economic development, which started under the authoritarian Park regime in the 1960s, Seoul has shifted away from labor and capital-intensive production and reorganized its economy to concentrate on knowledge-based technological development and innovation (Chung, 2001). For eight consecutive years, Korea's expenditures on R&D are increasing, which underpinned its development to become the eleventh largest economy within less than three decades (Bobe & Crehan, 2013).

In 2012 it invested a projected 4.36% of its GDP into R&D and the government announced further investment even though this figure already is the highest among all OECD member states (see figure 2). Research divisions of large firms (e.g. Samsung or Hyundai) together with government-sponsored research institutes mainly constitute Korea's innovation system and account for most of the expenditures (Edquist & Hommen, 2008, p. 21). The current government strongly supports its national STI sector as President Park has declared it a key priority to develop the country into a

[8] A systematizing expert interview ascribes less importance to the actual discourse or how views are expressed but more to what is thematically similar or different. Since the interviewees share a common field of expertise and probably also a fair amount of empirical knowledge, this, and the form of a guided interview, enhances the comparability of the data. As a consequence it is possible to extract supra-individual similarities and differences (Meuser & Nagel, 2005) that allow for more exact statements about the relations between each of the three fields.

world leader in science and technology as part of the government strategy to re-boost the economy in a sustainable way. This so-called "creative economy" policy aims for the creation of new markets and jobs by combining STI with information technology based on innovative ideas (MOFA, 2013).

FIGURE 2. Gross expenditure on R&D (GERD) as % of GDP



Source: OECD (2014)

With respect to Korea's political system, the executive branch, especially the president, outweighs the legislature in terms of political power and is in the position to make consequential strategic decisions during her one-time five-year term (Köllner, Flamm, & Olbrich, 2014). In accordance with that assessment, the preceding Lee government introduced the 577 Initiative that set the targets of an increase of gross expenditure on R&D (GERD) to 5% of GDP, promote seven selected technology areas and become one of top seven "STI powers" (MEST & KISTEP, 2008) in the world by 2020. Using a similar numerical slogan, his successor Park has introduced a Three-year Plan for Economic Innovation titled 474 Vision in early 2014. It aims for constant annual growth of 4%, a 70% employment rate as well as a future per capita income of US$ 40,000. Interestingly, just like Lee, her plan also includes to raise the GERD to the level of 5% of GDP.

Even nowadays the Korean government is actively engaging the STI sector to carry through its economic strategies. As opposed to merely creating institutions and a legal framework to have STI activities operate freely, it strategically sets targets, picks the winners, and distributes money accordingly.

4.1.2. STI Internationalization Policy in Korea

Korea's economy is strongly outward-oriented, as can be seen in the high share of exports as a percentage of GDP amounting to 57% in 2012. This corresponds with its high degree of integration in the global economy. As of 2014, there are ten free trade agreements (FTAs) in place, including with the United States and the European Union, while more are under negotiation. If they come to successful conclusion, Korea's bilateral FTA portfolio would cover markets that represent more than

70% of the global GDP. This internationalization strategy is also pursued within the area of STI, and Korea's access to the EU's 7th Research Framework Program (FP7) for research and innovation as well as its follow-up Horizon 2020 is representative of these efforts.

In her inauguration speech in 2013, President Park Geun-hye prominently promoted her idea of the creative economy and singled out science, technology, and ICT as main economic drivers before adding that she "will raise [Korea's] science and technology to world-class levels" (Yonhap, 2013). To this effect, STI are conceptualized as projections of national power and the government strives to increase the country's international recognition as an equal to other developed economies (Leadbeater & Wilsdon, 2007). Indicative for this understanding were efforts to have the Green Climate Fund's headquarters located in Incheon as well as to host the Global Green Growth Summit that was intended to strengthen cooperation in the field of green technologies and promote green growth strategy at the international level.

4.1.3. Green Innovation & Green Technologies in Korea

At first glance, Korea does not seem to have all the attributes necessary to become a world leader in green technologies. In 2010, the country was the 7th largest emitter of greenhouse gases only following China, the US, India, Russia, Japan and Germany—even though it merely has a population of roughly 50 million (MOE, 2013, p. 10). Moreover, the share of its new and renewable energy sources makes up only 2.61% (Statistics Korea, 2012).

On the other hand, from 2008 to 2010, Korea filed 1873 environmental patents under the Patent Cooperation Treaty, the three major areas being energy generation from renewable and non-fossil sources, general environmental management, and technology with contribution to emissions mitigation. Only Japan, the United States, and Germany have filed more patents in that area (OECD, 2013). In the wake of the global economic crisis, Korea identified green technologies as a promising source of sustainable future growth and dedicated 80% of its fiscal stimulus package to green growth projects (Mabey, 2009). With the help of massive investments by the Lee government in green technologies and industries, a growth paradigm change was pursued that should move away from expansionary quantity which entails widespread environmental degradation and depletion of natural resources.

The "Low-Carbon Green Growth" strategy was designed to connect environmental protection and sustainability to lasting economic growth and job creation. In doing so, the government has shown high-level commitment and is taking up an important coordinating role in promoting green growth through innovation in green technologies (Kang, Oh, & Kim, 2012). This commitment is reflected in the Korean government's goal to cut the nation's carbon emissions by 30% below the business-as-usual (BAU) level by 2020 even though it is not part of the Kyoto Protocol.[9]

While the government of Park Geun-hye is less outspoken on green growth policies than its prede-

[9] This is the highest reduction level recommended by the Intergovernmental Panel for Climate Change (IPCC).

cessor, the general strategy is maintained and "Korea remains determined to fight global warming by pushing through carbon reduction projects at home and boosting international cooperation" (Shin, 2013). The reason for the verbal restraint might partly originate from the fact that green growth was one of the most prominent trademark agendas of Lee Myung-bak. Challenges posed by global climate change are rendered as an opportunity. Korea wants to belong to the first-movers in a new market of green technologies by pushing for an "innovative model that tackles the issue as an opportunity to produce new growth engines" (Park, 2013). Accordingly, the government strategy to promote green technologies is not only informed by mitigating the effects of climate change and reducing greenhouse emissions but also framed as an industrial strategy that aims for sustainable economic growth and significant job creation (cf. Lee, 2010; Mathews, 2012). Corresponding to the previous government, the 474 Vision highlights future opportunities for the environment and energy sector[10] and commits to the further development of greenhouse gas emission reduction technologies (MOSF, 2014).

4.2. Actors & Activities

4.2.1. Research & Development

In contrast to its global production network and export orientation, Korea is in the bottom half in OECD rankings when it comes to international co-authorship and co-patenting (OECD, 2012). Similarly, merely 1.7% of its patents are based on international co-inventions, outperforming only Japan while the OECD average is 6.8%.[11] So even though Korea is heavily investing into R&D, this does not automatically translate into similarly high figures on indicators for international R&D cooperation and knowledge exchange, which calls for a more in-depth look into the country's internationalization efforts.

The National Research Foundation of Korea (NRF) has implemented several programs to enhance international research exchange between Korea and other countries. The Global R&D Networking Program provides US$ 11 million to engage in various internationalization efforts, e.g. the FP7 of the EU. The World Class University Program, on the other hand, aims at improving the research environment and international competitiveness of Korean universities, and is funded with about US$ 770 million over a period of five years. The funding is concentrated on research in strategic economic areas so that international collaboration in green technologies can be expected to benefit. The objective is to recruit renowned foreign scholars as (non) full-time professors or to establish all new departments at universities. Next to these specific programs there are also other forms of international cooperation such as international joint seminars, conferences, and researcher exchange based on memoranda of understanding (Dall et al., 2013). As a part of the 474 Vision's goal to increase R&D spending to 5% of GDP, President Park also announced a "Korea Research Fellowship" to attract world-class scientists to come to Korea and contribute to the country's economic growth and

[10] Several green technologies were mentioned for increased investments in technological development, i.e. clean thermal power generation, environment-friendly automobiles and carbon capture and storage (Park, 2014).

[11] In comparison, the same value for Austria is 13.1%, Germany 8.9%, USA 6.7%.

improve the research qualities of local universities (Park, 2014). A multitude of actors are involved in international R&D activities in green technologies ranging from firms, government-research institutes (GRIs), and universities.[12]

On the business side, large private conglomerates (*chaebols*) dominate Korean international R&D activities at the expense of small and medium sized enterprises (SMEs) (cf. Lim, 2008; Schüller, Conle, & Shim, 2012). Companies like Samsung, LG or Hyundai maintain global networks of R&D centers in various countries in order facilitate technology transfer and profit from local talents. Beside those long-term commitments, branches of *chaebols* engage in concentrated R&D cooperation with foreign companies on topics of complimentary expertise. Initiatives regularly follow agreements on the government level, as was the case with the Danish-Korean Green Growth Alliance.

With a few exceptions, Korean universities are outperformed by the business and GRI sectors in terms of R&D activities (Lim, 2008). KAIST, formerly known as the Korean Advanced Institute for Science and Technology, is a research university specializing in the field of science and technology. Currently, it has dedicated 6.6% of its research efforts to environmental technology. Its research is strongly supported by government initiatives which make up the largest share when it comes to contracted projects as well as research expenses. KAIST maintains a global network of 193 universities, ministries, laboratories, and institutes and is continuously internationalizing its publication record. This is indicated by the growing proportion of articles in international journals now amounting to more than 90% compared to roughly 73% in 2002 (KAIST, 2014). The research center on energy, environment, water and sustainability (EEWS) at KAIST is particularly active in the area of green technologies and has institutionalized an annual workshop series that brings together international researchers on about half a dozen occasions over each year in Korea. Moreover, the institute is engaged in university-industry cooperation: KAIST and Saudi Aramco have entered into a research partnership to build a CO2 Research Center that is jointly financed with US$ 10 million annually. Collaboration is set to focus on exchange of researchers and expertise as well as conducting joint projects (Saudi Gazette, 2013).

GRIs receive considerable portions of government R&D (Lim, 2008) and their research focus is adjusted to strategic goals. The Korea Institute of Science and Technology (KIST) was the first GRI in 1966 and supported government efforts to industrialize the country. Thirty years later it has established a European branch in Germany and built a dense cooperation network with other European universities and research institutes. Its main purpose is to internationalize Korean STI by (1) conducting research on its own, (2) promoting cooperation with the EU and (3) supporting the Korean industry. KIST Europe employs about sixty people from twelve different countries who concentrate on two research fields, i.e. nano-engineering as well as environment and biotechnology. Further-

[12] For a list of Korean R&D actors involved in FP7 research projects on green technologies, see Table 3.

more, the institute organizes international conferences to establish joint research opportunities between Korea and the EU, participates in global exchange programs, and is conducting research on the European STI environment. In addition to these broader cooperation schemes there were several more specific research projects funded within the FP7 of the EU that put forward international R&D on green technologies (see Table 3). Despite these efforts, Korean international R&D actors and funding programs are still not well known among European researchers, which have difficulties in identifying appropriate points of contacts (Dall et al., 2013).

4.2.2. Education

The main actors considered for education activities are universities, which are responsible for the enhancement and generation of human capital. Other relevant actors include research institutes or firms as soon as they implement in-house training based on visits of branches abroad (cf. Edquist, 2005). The relevance of universities varies widely among NSIs in different countries (Mowery & Sampat, 2005). There are not only differences in the content and methods of education but also in the role universities play as a direct contributor to processes of innovation. As stated above, the overall impact of R&D from Korean universities is not as meaningful as that of the business sector or GRIs. However, the Korean university system provides a large pool of human resources (Lim, 2008) and the proportion of individuals with a university degree has grown rapidly. While 64% of Koreans between twenty-five and thirty-four hold a tertiary degree, the OECD average is merely around 39%. Additionally, about one-third are graduates in science, engineering, manufacturing and construction, more than for example in the US (15.2%), Japan (23.2%), Austria (26.7%) or Germany (30.6%), which speaks for a strong base for research in green technologies and innovation (OECD, 2014).

The Korean government has put in place various initiatives on the university level to facilitate exchange with third countries: the Global Korea Scholarship Program comprises a large variety of scholarships that support incoming as well as outgoing students from the undergraduate to doctoral level (NIIED, 2013). The number of Koreans going abroad for studying is constantly on the rise and amounted to more than 120,000 by 2010, while the figure for incoming students is just about half of that, even though it doubled from 2007 to 2011 (OECD, 2014).

The government has pledged to increase education efforts in nurturing experts on climate change and green technologies (MOE, 2013). KAIST offers several graduate courses on the master as well as PhD level, set up to support the human resources production for the development of green technology on an international level, which are also open to foreign students. The Graduate School of Green Transportation is part of KAIST's College of Engineering and aims for research and education in the field of low-carbon transport technologies that help to generate economic growth through cooperation with the industrial sector.

Secondly, there is the Graduate School of Green Growth located at the university's Business College in Seoul. It was founded on grounds of international cooperation with universities abroad and to promote the development of green growth (Yonhap, 2012), which is why 90% of the programs' courses are taught in English. In total, it offers three distinct programs provided with significant

financial support that highlights their strategic relevance: first, a Green MBA of two years emphasizing global entrepreneurship based on green technologies; second, a research-oriented Green Business Program offering both a masters and PhD degree with a focus on green finance, economics and management; third, a Green Policy masters program established to promote domestic and international green policy experts. The two-year degree program especially seeks foreign students and combines business, policy, and technology aspects of green development.

In a response to recent government strategies (see above), international exchange and study programs as well as graduate schools were introduced on short notice. This speaks for the considerable institutional flexibility of Korea's educational system to react to policy demands; however, the quality and efficacy of those efforts can only be determined in the long run.

4.2.3. Modification & Introduction of New Organizations

The governmental interest in STI internationalization is rather new, which is why actors are still looking for suitable organizational setups beneficial for their purposes. While start-ups or private entrepreneurship are the most obvious ways, the creation of STI organizations can be a consequence of political decision-making (Edquist & Chaminade, 2006). In Korea, most notably, the introduction of a new STI ministry was one of the first major structural changes the Park government made to the NSI in concurrence with her creative economy paradigm. One of the central strategic tasks of the Ministry of Science, ICT and Future Planning (MSIP) is the promotion of international cooperation in research, technology and ICT. A particular focus lies on small and medium-sized enterprises (SMEs) in that it supports them to enter foreign markets. SMEs have recently gained ground on the R&D and innovation front that is still firmly controlled by large conglomerates in Korea (Lim, 2008; Schüller et al., 2012).

Other cases include the introduction of the Green Technology Center-Korea (GTC-K) or the establishment of research departments at universities and GRIs focused on green technologies. Furthermore, the founding of the Global Green Growth Institute (GGGI) can be ascribed to efforts of the Korean government. While a lot of initiatives to fight climate change hinge on international consensus, the GGGI was first established as a non-profit foundation under Korean law in 2010. The institute immediately took action in executing green growth policies in developing and emerging countries (O'Donnell, 2012, p. 1). Nowadays it is an accredited international organization with its headquarters in Seoul and three global branches holding Official Development Assistance (ODA) eligibility status by the OECD.

GGGI's main activities include (1) technical assistance and capacity building aiming at deriving and implementing green development strategies, (2) research on green growth in cooperation with international research institutes and organizations, and (3) facilitation of partnerships on an industry-government level to further sustainable development in emerging countries. This innovative approach to tackle the effects of climate change and development assistance at the same time is the result of the Korean initiative on green growth and is "unique for forging ahead and pursuing a bottom-up approach to green growth without waiting for a global, consensus-based organization to agree on what should be done" (O'Donnell, 2012, p. 8).

4.2.4. Assistance & Consultancy

R&D or innovation in science and technology requires financial backup. A great amount of financing for international STI activities comes from private actors (Edquist & Chaminade, 2006), but government actors, foundations, or non-governmental organizations can intervene to provide starting capital, contribute to long-term cooperation, or initiate research (Kogan, 2007). Additionally, there are several consultancy services for actors to support them in establishing international linkages.

In absolute numbers, Korea's total R&D expenditure in 2011 amounted to US$ 46.7 billion and is dominated by the business sector (see Table 2) (OECD, 2014). With respect to green technologies, the share of the government R&D budget increased from 6.5% in 2002 to 17.5% in 2010 or more than US$ 2 billion (Statistics Korea, 2012). The scope of green R&D includes among others environmental technologies, clean technologies, energy technologies, and marine environmental technologies.

TABLE 2. R&D by Sector of Performance

Business	Government	Universities	Non-profit actors
74.8%	12.7%	10.8%	1.7%

Source: OECD (2014)

Moreover, there is a strong emphasis on funding for natural sciences and engineering compared to social sciences and humanities across all sectors. Still, the R&D government sector is relatively large in international comparison and mainly consists of GRIs and national laboratories. Since research capabilities at universities are not as strong—arguably because of heavy teaching obligations, poor research facilities and insufficient incentives for research (Chung, 2001)—GRIs receive a large amount of state funding for R&D that is focused on strategic industries (e.g. green technologies) (Lim, 2008).

When it comes to consultancy, there are basically two targets groups: Korean actors looking for support in their internationalization of green technology and foreign actors, mostly in developing countries. The Ministry of Foreign Affairs has installed a Global Energy Cooperation Center (GECC) and the Global Economic Affairs Bureau. The GECC makes use of diplomatic missions abroad to facilitate cooperation of Korean energy companies with foreign businesses. Moreover, it will act as an information database on market trends, points of contact, and energy policy in potentially profitable markets (MOFA, 2012).

The Greenhouse Gas Inventory & Research Center of Korea (GIR) and the GTC-K also support domestic actors' cooperation activities but at the same time address foreign actors. The GIR operates capacity-building programs for developing countries by inviting researchers and government officials to seminars on greenhouse gas mitigation and organizing different fora and conferences on related topics. Cooperation with more advanced countries includes research collaboration as well as technology and knowledge exchange. The GTC-K promotes global green technology cooperation in collaboration with the GGGI for developing countries but is also involved in R&D and policy planning.

4.2.5. International Networking

In terms of networking, bilateral and multilateral institutionalized STI cooperation between Korea and other countries is examined. The traditional NSI approach pays great attention to relations among different components as they integrate knowledge and facilitate learning (Edquist & Chaminade, 2006). Similarly, international linkages bear the potential to acquire new knowledge and combine capabilities for common benefits.

In late 2013, in a common statement on the occasion of President Park's visit to the UK, she and Prime Minister David Cameron vowed to "enhance bilateral co-operation to lead the global transition to a low-carbon economy and to meet our respective greenhouse gas emissions reduction targets" (DOE/FCO, 2013). During several of her state visits, President Park has concluded similar joint declarations with leaders from the US (White House, 2013), China (FMPRC, 2013), and Denmark (MOFAD, 2013) to promote clean energy and environmental technologies which shows that Korea pushes for international cooperation in green technologies on the highest government level.

In terms of points of contact for international STI networking, the Korea Institute for the Advancement of Technology (KIAT)—with a focus on industrial technology—as well as the National Research Foundation (NRF) take important roles when it comes to cooperation programs with the EU. For energy cooperation, it is the Korea Institute of Energy Technology Evaluation and Planning (KETEP) that also houses an international cooperation R&D program. As a part of this, KETEP has funded forty-seven joint research projects on energy-related topics since the start of the program three years ago and enters cooperation with various actors from government and science to share information, exchange experts, or conduct joint research on green technologies. In recent years, strong governmental efforts have been made to enhance collaboration in science and technology between Korean and European researchers (see Table 3).

TABLE 3. EU's FP7 Green Technologies Research Projects with Korean Participation

Acronym	Title/Mission	Period	Coordinator	Korean Participant(s)
CITI-SENSE	Development of sensor-based Citizens' Observatory Community for improving quality of life in cities	2012-10-01 to 2016-09-30	Norsk Institutt for Luftforskning	Korea Institute of Construction Technology
CORFU	Collaborative research on flood resilience in urban areas	2010-04-01 to 2014-03-31	The University of Exeter	International Center for Urban Water Hydroinformatics Research & Innovation Foundation
EFENIS	Efficient Energy Integrated Solutions for Manufacturing Industries	2012-08-01 to 2015-07-31	The University of Manchester	Industry-University Cooperation Foundation Hanyang University
FOFDATION	The Foundation for the Smart Factory of the Future	2010-06-01 to 2014-05-31	Airbus Operations SAS	Pohang University of Science and Technology
IMPACT	Improved Lifetime of Automotive Application Fuel Cells with ultra low Pt-loading	2012-11-01 to 2016-04-30	Deutsches Zentrum für Luft- und Raumfahrt eV	Gwangju Institute of Science and Technology
LISSEN	Lithium Sulfur Superbattery Exploitating Nanotechnology	2012-09-01 to 2015-08-31	Consorzio Sapienza Innovazione	Industry-University Cooperation Foundation Hanyang University
MATISSE	Materials and Innovations for a Safe and Sustainable nuclear in Europe	2013-11-01 to 2017-10-31	Commissariat a l'energie atomique et aux energies alternatives	Korea Atomic Energy Research Institute
MEM4WIN	Ultra thin glass membranes for advanced, adjustable and affordable quadruple glazing windows for zero-energy buildings	2012-10-01 to 2016-03-31	Inova Lisec Technologiezentrum GmbH	Korea University Research and Business Foundation

Source: compiled from CORDIS (2014)

From 2009 to 2012, KIST Europe was the head of the coordination project KORRIDOR that promoted Korean research and technology development programs to European researchers and raised public awareness of the opportunities for Korea-EU cooperation. The research calls of this project especially covered topics of international cooperation in green technologies, e.g. effective usage and efficiency improvement of energy or renewable energy R&D. The same is true for KORANET—another Korea-EU R&D cooperation program—that issued project calls on green technologies. In the end, eleven projects were selected for joint funding that at least involved one Korean and two European participants within the areas of reduction of carbon footprint, technologies for sustainable development, renewable energies, and energy efficiency.[13] Lastly, following the conclusion of the cooperation project KESTCAP that provided a platform for Korea-EU STI cooperation in general, the NRF is coordinating another program called KONNECT and will operate from 2013 to 2016. The project budget amounts to US$ 2.7 million, which is allocated among four main fields of research, i.e. nanotechnologies, ICT, biotechnologies, green technology as well as secure, clean, and efficient energy.

5. AUSTRIAN PERSPECTIVES ON KOREA'S STI INTERNATIONALIZATION

5.1. The Broader Context of European Internationalization Policies

Since Austria's STI system is tightly linked and embedded into the European framework, it is necessary to briefly present this context. The subsequent section will provide an overview of Austria's STI system paying special attention to green technologies. Our empirical analysis concentrates on cooperation between Austrian and Korean actors in the field of bioenergy on the research, policy and business level. Bioenergy is one of the major cooperation areas between both countries. In doing so, the analysis not only provides information on Austrian experiences with their Korean counterparts but also a first empirical insight into perceived similarities and differences and their repercussion for green technology cooperation.

On the European level, goals and strategies of STI internationalization have been formulated as a response to intense global competition. In order to provide conditions conducive to international cooperation, the internationalization of STI has been pursued much more strategically on a policy level in the European context. The "International Strategy for Research and Innovation" (EC, 2012) is a visible demonstration of the effort to transform Europe into "the most dynamic and competitive knowledge-based economy in the world" (European Council, 2000) as explicated in the Lisbon Strategy. It builds on the idea that the European Union (EU) "is confronted with a quantum shift resulting from globalization and the challenges of a new knowledge-driven economy" (European Council, 2000). As a response, the 7th Research Framework Program and its follow-up Horizon 2020 have opened up and allowed for the participation of third countries, which has become an integral option in all funding schemes (EC, 2013). This provides promising opportunities and hith-

[13] For a complete list of the funded projects see here: www.koranet.eu/en/229.php

erto untapped potential for European actors to foster cooperation with Korea in the field of STI and vice versa. An online survey on drivers and barriers of transnational STI cooperation (KORANET, 2010) among European and Korean policymakers, program executive agencies and researchers shows that both sides argue in favor of further cooperation with each other. Survey participants regarded it as conducive for cooperation that "culture, size and type of markets combine well" (KORANET, 2010). However, they contended that a lack of knowledge about specific cooperation opportunities and partners as well as the geographical distance serve as main barriers (KORANET, 2010). Additionally, European participants were concerned about the relatively low priority on the policy level to intensify cooperation with Korea.

5.2. The Austrian NSI and Internationalization Policy

Austria represents a small but highly industrialized country that is strongly linked to the European Union. With a per capita income of over US$ 44,000, it belongs to the most economically developed countries in the EU. Similarly to other European countries, like e.g. UK, Germany, or Sweden, STI are considered important drivers in the global competition and central means to increase national productivity. The last decade was characterized by a substantial catching-up process of Austrian investment in R&D during which total expenditures have nearly doubled. In 2011, the country's total investment in R&D amounted to € 8.3 billion or 2.75% of GDP, significantly higher than the EU average of around 2% (ERAWATCH, 2011). At present, Austria's innovation performance is ranked 9th among all European Union member states behind Belgium and the United Kingdom and is characterized as an innovation follower (EC, 2013).

Responding to this, Austrian STI policy aims to advance from this position and catch up with current European innovation leaders (Austrian Federal Government, 2011). In accordance with this aim, the Austrian government has issued the objective to increase its R&D investment to 3.76% of GDP until 2020. For this purpose, it is determined to put incentives in place that promote innovation in business and ultimately increase the participation rate of the corporate sector in the country's STI system to up to 66% of all R&D investments within the next six years.

Given these ambitions, the internationalization of STI became a stated aim of the federal government and was integrated into several fields of Austrian policy making. While a diverse range of activities and cooperation has already been set up on the European level, the building up of new bilateral cooperation beyond European borders has gained considerable attention since 2011. On a policy level, the federal government intends to create institutional structures and increase coordination and concentration of target-aimed measures in the on-going internationalization process (Austrian Federal Government, 2011). This seems particularly necessary since Austria has been cautious in setting up institutions on the national level and abroad to enhance international STI cooperation when compared to other European countries like Germany or the UK (Heidenwolf & Sigl, 2014): Over the past 13 years Austria has only opened two Offices of Science and Technology, namely in Washington (2001) and Beijing (2012).

The current national STI strategy envisions a place among the leading European STI nations for 2020. With respect to this objective, a working group concerned with internationalization policy

towards non-European countries was established consisting of a broad variety of stakeholders from science, research, policy, and business. Consensus exists among all stakeholders, that internationalization is especially necessary for small countries as these are not able to cover all the different aspects of a sound STI system (cf. Sigl & Witjes, 2014). Therefore, the expansion into new fields of knowledge, technology, human resources and markets made possible through international orientation was seen as a necessary precondition for successful development of the Austrian NSI. In the 2013 published policy paper "Beyond Europe" (Federal Ministry for Transport, Innovation and Technology, Federal Ministry of Science and Research, Federal Ministry of Economy, Family and Youth & Austrian Foreign Ministry, 2013), five main goals were named and future cooperation countries identified. The stated objectives are *excellence of the research system, access to emerging markets by STI cooperation, optimizing resources through participation in international networks*, *contributing to solve global challenges and to use science diplomacy to enhance foreign relations* (Federal Ministry for Transport, Innovation and Technology et al., 2013).

5.3. Austrian Approaches to Green Technology Cooperation with Korea

When it comes to the strategic selection of potential partner countries for increased STI cooperation, Austria has mainly followed international trends by identifying the USA, China, and Russia as such. However, Korea, too, was identified as a second priority country together with South Africa, Brazil, and Israel (Federal Ministry for Transport, Innovation and Technology et al., 2013). General measures for enhanced cooperation with Korea address the following activities: further development of scientific and technological collaboration through joint calls and targeted use of EU programs, development of alumni networks, investigation of new opportunities for cooperation between Austria and Korea regarding the low carbon economy, and the development of common PhD and postdoc programs (Federal Ministry for Transport, Innovation and Technology et al., 2013).

Differences between Austria and Korea are salient in the structure of their respective NSI. Austrian interview partners (IPs) stated that Korea seems to be less interested in international cooperation in R&D than Austria because of stronger ties between GRIs and the domestic private R&D sector, which might be difficult to be transferred abroad. Asked for their cooperation experiences, however, interviewees from the business sector often referred to "a similar business culture" (IP 2; 4; 5) by which they meant the importance of personal contacts in both countries as a conducive factor for the initiation and carrying out of successful collaborations. A presumed language barrier was not confirmed by most interviewees and English language skills were perceived as more than sufficient, in particular in the field of academic collaborations.

Researchers and policymakers alike referred to a shared need of small countries for intelligent decision-making processes regarding potential cooperation partners abroad. Austrian IPs considered this as a promising entry point for enhanced cooperation between both countries and as an effective strategy to avoid competition with their respective great neighbors, e.g. China or Germany.

Positive experiences and further interest in STI cooperation with Korea were reported for the field of green technologies and in particular with regard to biomass (bioenergy). This is partly due to the Austrian federal government's focus on "climate change and scarce resources" (Federal Ministry

of Science and Research, Federal Ministry for Transport, Innovation and Technology & Federal Ministry of Economy, Family and Youth, 2013) as a means to improve Austria's position in STI in Europe and to contribute to solutions of global challenges. In the past couple of years, the country has shown high performance in the field of green technologies while it was notably also strong in the sectors of energy efficiency, renewable energies, e-mobility, and ecological construction. In support of green technologies, the "Climate and Energy Fund" is a primary government project to push Austrian research and innovation in this field; from 2007 to 2013 it had a combined budget of over € 850 million. By federal law[14] the fund concentrates its efforts in three main areas, i.e. R&D of sustainable energy technologies, initiation of model projects especially in the areas of transport and infrastructure, and the promotion of marketable green energy solutions.

The Austrian environmental industry is considered highly competitive in global markets as documented by high growth rates and an increasingly positive trade balance in that area amounting to € 1.1 billion in 2011 (Federal Ministry of Science and Research et al., 2013). Renewable energies constitute a large share of Austria's energy mix and make up almost 75% of its electricity production (E-control, 2013, p. 12). In particular with respect to low carbon energy, Austria expressed a strong interest in international cooperation (Federal Ministry of Science and Research et al., 2013, p. 16-17). The majority of interviewees referred to both countries' need to invest in bioenergy and saw one of the main opportunities for cooperation in the field of forestry management and the use of biomass as energy source.

> I think one of the most important commonalities is that both countries have a very high potential for the production of bioenergy using the natural resources of their forests. Cooperation may benefit from both countries' similar landscapes and climate conditions. This creates similar preconditions for the use of biomass as source of sustainable energy (IP 3).

Calling it promising preconditions for cooperation, all interviewees referred to the similarities between Austria and Korea regarding geography in general ("small countries surrounded by powerful neighbors") and in particular both countries' approach towards their forests as cultural and economic resources. A ministerial staff member with cooperation experiences with Korea in the field of forestry management and education highlighted the notable similarities between Korean and Austrian forests (IP 1).

Other Austrian IPs, too, extensively referred to the cultural and spiritual importance of forests in both countries and had profound knowledge about the history of forestation in Korea. All IPs referred to the deforestation during to the Korean War as key experience, some assumed that this led to an understanding of the forest as a symbol for national independence and a renewed interest in how to make use of it as one source of energy independence.

[14] Federal law on the introduction of a climate and energy fund (KLI.EN-FondsG)

Another similarity between both countries often cited was their dependence on human capital as they both lack substantial natural resources. This has resulted in a shared status as advanced knowledge economies in search of alternative energy sources by investing in science, technology and innovation. As a consequence, biomass was seen as one of the preferred areas of cooperation. Building on the empirical material, we argue that the specific focus on bioenergy in cooperation between Austria and Korea is not only rooted in both countries' specialization in this field. Instead, bioenergy is also a promising interface of both countries' different approaches towards nuclear energy, resulting from their respective socio-technical histories.

The concept of socio-technical imaginaries as proposed by Jasanoff and Kim (2009) helps to understand the different starting points of Austria and Korea to invest in green innovation. Originally developed within the context of cross-national comparison of the roles of nuclear technologies in Korea and the United States, Jasanoff and Kim (2009) defined national socio-technical imaginaries as "[…] collectively imagined forms of social life and social order reflected in the design and fulfillment of nation-specific scientific and/or technological projects. Imaginaries, in this sense, at once describe attainable futures and prescribe futures that states believe ought to be attained" (p. 120). The authors developed the concept based on the assumption that, in order to make sense of national policies of science and technology, it is necessary to invoke not only the material and organizational resources that states deploy but also the imaginative resources by that they relate such policies to broader societal objectives (Jasanoff & Kim, 2009; Müller & Witjes, 2014).

Although nuclear energy is still part of Austria's energy use—it is imported from neighboring countries, e.g. from the Czech Republic—the gross share of nuclear energy has decreased in recent years and the construction or operation of nuclear power plants on Austrian territory is prohibited by federal constitutional law. This strong refusal of nuclear energy is part of an Austrian sense of national identity and contrasts Korean perceptions. In order to understand the strong focus of Austrian policymakers on green technologies, it is important to turn towards the techno-political culture and history of Austria. Austria is the only country worldwide in which civil society movements rejected a ready-built nuclear power plant in 1978, which as a consequence never went into operation, serving now as a national monument for civil society's engagement in (energy) politics (Schleicher, 1999).

In the international context, Austria strongly represents itself as "an ecological and sustainable nation committed to preserving 'nature' as well as acting as a pioneer in biocompatible technologies, e.g. in the area of 'green energy'" (Müller & Witjes, 2014). In a study by Müller & Witjes (2014) on STI cooperation between Austria and China, the authors have empirically analyzed how Austria emerges in the discursive negotiations by STI stakeholders as bio-pioneer, a green country, in which 'nature' is enabled rather than disturbed by (the right) technologies and an "alternative innovation space" (Felt, 2013) devoted to green technologies and sustainable energy. In this narrative, its "intact" nature becomes a symbol of its technological capacities (Müller & Witjes, 2014).

How Korea deals with energy displays considerable differences from Austria as the country early on embraced nuclear technology with the first reactor being operational in 1978. Different from the territory of today's North Korea, the southern part of the Korean peninsula does not hold any con-

siderable amount of natural resources suitable for energy production so that Korea imports more than 90% of its fuel. This meaningful dependence is countered by a high share of domestically produced nuclear power amounting to about one third of the country's electricity production which is planned to be expanded to 59% by 2030 (Holt, 2013). Moreover, Korea has initiated an ambitious nuclear power plant export program aiming for a global market share of 20% by 2030 or an equivalent of eighty reactors that has started successfully by selling four reactors to the United Arab Emirates worth $20 billion (World Nuclear Association, 2014). For the Korean government, this focus on nuclear energy does not contradict its ambitious green growth strategy as Seoul considers any technology as green as long as it does not come with carbon emissions (Shim, 2010).

Interviewees stated that since nuclear energy is rejected on the public as well as the policy level in Austria, experience in alternative energy sources is comparatively high. Their perspective on the initiation process of Korean-Austrian cooperation alternated: while some put emphasis on the role of Austria as the more experienced partner with the Korean partner in search for advice or counseling (especially within the field of forest management and education), others expected Korea to rise further towards global top positions in the field of green technologies, particularly in materials research, rare earths, biomass production and high technology—sooner or later overtaking Austria.

Lastly, Austrian IPs offered diverging views on the issue of Korean practices of adapting technologies: while policymakers and business stakeholders (IP 1, 4, 5) had the impression that Korean firms might copy Austrian innovations without having their own experiences, interviewed scholars saw no evidence for this from current research results or their own cooperation experience (IP 2, 3, 6). Still, Austrian IPs held favorable views regarding further bilateral cooperation but conceded that knowledge about potential partners and institutions as well as about funding schemes is still relatively low on both sides.

5.4. Findings from Interviews with Austrian Stakeholders

With respect to the paper's second objective to offer an Austrian perspective on Korea's international cooperation in green technologies, it was shown that both countries are already linked through EU research programs. However, Austria has also unilaterally identified Korea as a priority country for further STI collaboration with a focus on low-carbon technologies. Against this background, expert interviews were conducted with Austrian stakeholders who were involved in green technology cooperation with Korean actors. Results suggest that both countries share a similar business culture based on personal networks, which is rated as facilitating international cooperation. Further conducive factors included comparable geographical circumstances such as relatively powerful neighboring countries and a lack of natural resources, which results in a shared emphasis on R&D and human capital for economic development.

There was special interest in increased cooperation within the green technologies sector, and bioenergy was identified as a common field of expertise. While Korean actors were ascribed great interest in foreign technologies and know-how, Austrian IPs were divided on whether Korean partners partly enter cooperation with the motivation of copying Austrian innovations. However, Austrian stakeholders acknowledged that Korean STI capabilities are rising rapidly especially in the areas of

material research, ICT, rare earths, biomass production, and high technology, which would mitigate this problem in the midterm. Contrary to initial assumptions based on literature review, interviewees did not rate communication problems as negatively affecting cooperation.

As major obstacle to Austrian-Korean cooperation, IPs cited the lack of knowledge of Korean funding programs and relevant points of contact. This also corresponds with our results from the review of Korea's international STI activities, which revealed frequent and rapid changes of its NSI's institutional structure in the area of green technologies.

6. CONCLUSION

Past approaches of national systems of innovation have to a great extent neglected the international dimension. The paper has tackled this problem by focusing on those activities of domestic STI actors that transcend national boundaries and establish international connections. In doing so, it was argued that despite a growing economic interdependence and increasing international STI cooperation (Mowery & Sampat, 2005; Narula & Zanfei, 2005; Soete et al., 2010) the "national" still maintains high theoretical value. A nation's STI internationalization is significantly affected by its political, economic, and cultural conditions that account for differences in international R&D collaboration. By means of policies and funding decisions, governments exert a great deal of influence on their country's STI internationalization policies and sectoral priority settings. Essentially, this affects how and in which technology sectors actors enter into international cooperation. Against this background we offered an analytical framework that clearly delimits the object of analysis in terms of (1) geography, (2) sector, and (3) activities. Consequently, future studies of NSIs should consider these boundaries and assess the extent and nature of international STI activities reaching out of the domestic sphere.

In the Korean context, the national government's influence is reinforced by the fact that the president is equipped with considerable political power and only serves for a one-time five-year term during which she can pursue her government agenda. In their respective government STI strategies, Presidents Lee as well as Park have identified key strategic investment areas and prescribed economic as well as technological targets. In order to reach these goals, Korea has invested more in R&D than any other OECD economy and strategically allocated funds according to its internationalization strategies. In support of that, the government has also introduced new organizations and committees and even reshuffled the ministerial structure.

A total of ten effective FTAs and an economy largely dependent on exports are indicative for Korea's economic outward orientation. This corresponds with its participation in the EU 7th Research Framework Program and Horizon 2020. However, the government's motives for STI internationalization are at least two-dimensional. Next to economic aspects, Korea strives for international recognition as a leading nation in science and technology as formulated by Presidents Lee and his successor Park.

The same logic is applies to the case of green technologies. Lee Myung-bak has made green growth one of his trademark policies and laid the foundation for promoting development in green technologies and their internationalization. Although the Park government is less outspoken on the issue and has made some cuts—partly to dissociate herself from her predecessor—her government has still identified it as a major policy and economic issue. This is hardly surprising given that Korea relies on energy imports to cover more than 90% of its demand (Yoo, 2006) and measures of energy efficiency and fossil fuel substitution would directly contribute to national energy independence and potentially decrease costs. Accordingly, green technologies and climate change are framed as an opportunity to create jobs and kick-start the economy (Park, 2013). At the same time, however, the commitment to green growth is promoted to enhance the country's international visibility and prestige analogous to its contributions to international security and development assistance (cf. Olbrich & Shim, 2012). In an attempt to increase its reputation and influence on international politics, Korea hosts summits and sponsors initiatives on issues of tackling climate change and low-carbon technologies. Essentially, government efforts to promote the internationalization of green technologies can be placed between the poles of industrial as well as foreign policy.

With respect to international R&D activities, these efforts have led to mixed results in terms of quantitative output. While Korea shows a strong record in environmental patents, this is qualified by a weaker performance when it comes to international co-authorship and co-patenting (OECD, 2012, p. 337). The composition of international R&D actors is fairly diverse and includes universities, GRIs, and the business sector. The latter is largely dominated by *chaebols*, such as Samsung, Hyundai or LG, which operate international R&D networks and clearly outperform SMEs. Other forms of international R&D cooperation of Korean companies often follow agreements on the government level. While universities perform weaker, GRIs receive considerable government support for international R&D activities. This supports swift adjustments of research foci in accordance with government strategies so that green technologies were quickly put on the agenda. There are also several funding programs in place, e.g. by the NRF, to enhance international cooperation in R&D. However, our results suggest that the difficulty of becoming aware of these opportunities and to identify the crucial points of contact hampers the realization of cooperation. This can at least partly be explained by continuous institutional and organizational changes ensued by broader government policies.

To a lesser extent, this also applies to international activities in education. The rapid introduction of graduate schools on green growth is a case in point where institutional reorganization quickly followed government programs while its persistence is still unclear. Overall, the Korean university system has produced a large pool of graduates, especially in science-related subjects, and surpasses other industrialized economies on both indicators.

Similarly, the creation of new organizations to support the internationalization of green technologies followed familiar patterns in that the Korean government was quick to establish new committees, research departments, or whole ministries such as the MSIP. The Global Green Growth Institute on the other hand represents a new type of actor creation as it was first formed under the Korean jurisdiction before transitioning into a full-fledged international organization with ODA eligibility status.

As stated above, Korean gross R&D expenditure ranks among the highest in the OECD and 17.5% of the government's share was spent on green technologies (Statistics Korea, 2012). By international comparison, state assistance in R&D is relatively large and rather concentrates its funds on natural sciences and GRIs than social sciences and universities. Still, the business sector is financially the most important R&D performer in Korea as it represents about three quarters of expenditures. It should be noted, however, that this can mainly be attributed to large conglomerates.

The government's significance in international networking is reflected in recent joint declarations with leaders from several countries that emphasized international research and technology cooperation in environment and sustainability issues. Other relevant actors include Korean multinational enterprises through their global R&D networks but also semi-governmental organizations like KIAT or KETEP that both feature international R&D cooperation programs. Furthermore, Korea and the EU have several high-value programs in place in order to enhance cooperation in green technologies.

Using the concept of socio-technical imaginaries, differences in the respective countries' approach to green growth were presented. While Austria pictures itself as a traditionally ecology-minded society and has rejected the use of nuclear energy in a public referendum, the situation in Korea is different. Seoul pursues a rather unique strategy with respect to nuclear energy, which is actually considered "green" since it is associated with low greenhouse gas emissions (Shim, 2010).
It was shown that Korea is dedicated to enhancing the internationalization of its green technologies sector and that there are already various initiatives in place that provide funding opportunities as well as newly created organizations to facilitate cooperation. This is strongly supported by the Korean government, which exerts great influence on the direction of the country's NSI. In accordance with that, Austrian stakeholders acknowledge Korea's rising STI capabilities and declare an increased interest in green technology cooperation. However, there are problems with the identification of the relevant points of contact and funding programs, which complicates potential cooperation. This can partly be explained by the frequent shifts of institutional arrangements. To tackle this problem, more long-term funding programs should be created that focus on a specific technology area and come with a constant institutional affiliation.

Furthermore, to increase the awareness of Korea as an attractive STI cooperation partner, a permanent international contact group could be installed to serve as a first source of information for organizations and researchers interested in cooperation and to promote Korean funding schemes within the European research community. Lastly, this study was designed as a first explorative attempt to complement quantitative work on Korea's internationalization activities and bilateral cooperation in green technologies. Further research is necessary to more clearly identify factors that are obstructive or conducive to international cooperation, how it is affected by the countries' techno-political history and if so, how it varies among different technology sectors. We suggest, that in order to tackle these questions, it can be fruitful to combine existing quantitative data with in-depth qualitative analysis and to pursue this research in the context of bi- or multilateral research cooperation between the countries involved.

REFERENCES

Austrian Federal Government (2011). *Potenziale ausschöpfen, dynamik steigern, zukunft schaffen: Der weg zum innovation leader.* Vienna: Strategie der Bundesregierung für FTE..

Beck, U. (1992). *Risk society, towards a new modernity*. London: Sage Publications.

Bobe, B. & Crehan, P. (2013). *A review of the S&T agreement between the European Union and the Republic of Korea.* Luxembourg: Publications Office of the European Union.

Boekholdt, P., Edler, J., Cunningham, P. & Flanagan, K. (2009). *Drivers of international collaboration in research: Report to European Commission* (Eds.). Brussels: European Commission.

Borras, S., Chaminade, C. & Edquist, C. (2008). The challenges of globalisation: Strategic choices for innovation policy. *Circle Lund University, 9.*

Bozeman, B. & Dietz, J. S. (2001). Research policy trends in the United States: Civilian technology programs, defense technology and the deployment of the national laboratories'. In P. Larédo & P. Mustar (Eds.). *Research and innovation policies in the new global economy* (pp. 47-78). Cheltenham: Edward Elgar.

Carlsson, B, Jacobsson, S., Holmen, M. & Rickne, A. (2002). Innovation systems: analytical and methodological issues. *Research Policy, 31*(2), 233-245.

Chung, S. C. (2001). The research, development and innovation system in Korea. In P. Larédo & P. Mustar (Eds.). *Research and innovation policies in the new global economy* (pp. 115-156). Cheltenham: Edward Elgar.

Community Research and Development Information Service [CORDIS]. (2014). *EU research projects*. Retrieved from http://cordis.europa.eu/projects/rcn/110368_en.html

Dall, E., Scheck, H., Steinberger, M. & Westphal, H. (Eds.) (2013). *Korea and Europe – meeting through science: Exploring the opportunities of R&D cooperation with KORANET* (2nd ed.). no place: Koranet.

Datta, D., Sikdar, S. & Chatterjee, S. (2013). Telecommunications industry in the era of globalization with special reference to India. In S. Banerjee & A. Chakrabarti (Eds.), *Development and sustainability* (pp. 277-305). Heidelberg: Springer.

Department of Energy & Climate Change/Foreign & Commonwealth Office [DOE/FCO]. (2013). *United Kingdom – Republic of Korea joint statement on climate change*. Retrieved from www.gov.uk/government/news/united-kingdom-republic-of-korea-joint-statement-on-climate-change

Dodgson, M. (2009). Asia's national innovation system: Institutional adaptability and rigidity in the face of global innovation challenges. A*sia Pacific Journal of Management, 26*(3), 589-609.

E-control. (2013). *Stromkennzeichnungsbericht* 2013. Retrieved from www.e-control.at/portal/page/portal/medienbibliothek/oeko-energie/dokumente/pdfs/Stromkennzei chnungsbericht2013.pdf

European Commission [EC]. (2012). *Enhancing and focusing EU international cooperation in research and innovation: A strategic approach*. Retrieved from http://ec.europa.eu/research/iscp/pdf/com_2012_497_communication_from_commission_to_inst_en.pdf#view=fit&pagemode=none

European Commission [EC]. (2013). *Horizon 2020 – the EU's new research and innovation programme*. Retrieved from http://europa.eu/rapid/press-release_MEMO-13-1034_en.pdf

Edler, J. & Flanagan, K. (2009). *Drivers of policies for STI collaboration and indicators: Key themes from the literature*. Retrieved from http://ec.europa.eu/research/iscp/pdf/drivers_sti_annex_1.pdf.

Edquist, C. (1997). Systems of innovation approaches – their emergence and characteristics. In C. Edquist (Ed.). *Systems of innovation: Technologies, institutions and organizations* (pp. 1-35). London: Pinter.

Edquist, C. (2001). Innovation policy – a systemic approach. In D. Archibugi & B.A. Lundvall (Eds). *The globalizing learning economy* (pp. 219-238). Oxford: Oxford University Press.

Edquist, C. (2005). Systems of innovation: Perspectives and challenges. In J. Fagerberg, D. C. Mowery & R. R. Nelson (Eds.). *The Oxford handbook of innovation* (pp. 181-208). Oxford: Oxford University Press.

Edquist, C. & Chaminade, C. (2006). Industrial policy from a systems-of-innovation perspective. *European Investment Bank Papers, 11*(1), 108-133.

Edquist, C. & Hommen, L. (2008): Comparing national systems of innovation in Asia and Europe: Theory and comparative framework. In C. Equist & L. Hommen (Eds.), *Small country innovation systems: Globalization, change and policy in Asia and Europe* (pp. 1-28). Cheltenham/Northampton: Edward Elgar.

ERA Expert Group. (2008). *Opening to the world: International cooperation in science and technology*. Brussels: European Commission.

ERAWATCH. (2011). *Country profile: Austria*. Retrieved from http://erawatch.jrc.ec.europa.eu/erawatch/opencms/information/country_pages/at/country?section=Overview&subsection=BasicChar

European Council. (2000). *Presidency conclusions: Lisbon European Council*. Retrieved from www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/00100-r1.en0.htm

Fagerberg, J. (2005): Innovation: A guide to the literature. In J. Fagerberg, D. C. Mowery & R. R. Nelson (Eds.). *The Oxford handbook of innovation* (pp. 1-26). Oxford: Oxford University Press.

Federal Ministry for Transport, Innovation and Technology, Federal Ministry of Science and Research, Federal Ministry of Economy, Family and Youth & Austrian Foreign Ministry. (2013). *Beyond Europe: Die Internationalisierung Österreichs in Forschung, Technologie und Innovation über Europa hinaus. Empfehlungen der AG 7a an die FTI-Task-Force der Bundesregierung* (Eds.), Retrieved from www.zsi.at/object/news/2786/attach/FTI_AG7a_Brosch__re_Druck.pdf

Federal Ministry of Science and Research, Federal Ministry for Transport, Innovation and Technology & Federal Ministry of Economy, Family and Youth. (2013). *Österreichs Forschungs- und Technologiebericht 2013*(Eds.). Retrieved from www.bmwf.gv.at/uploads/tx_contentbox/FTB_2013.pdf

Felt, U. (2013). *Keeping technologies out: Sociotechnical imaginaries and the formation of a national technopolitical identity*. Retrieved from http://sciencestudies.univie.ac.at/fileadmin/ user_upload/dep_sciencestudies/pdf_files/Preprints/Felt_Imaginaries_preprint.pdf

Filippetti, A. & Archibugi, D. (2011). Innovation in times of crisis: National systems of innovation, structure, and demand, *Research Policy, 40*(2), 179-192.

Flanagan, K., Uyarra, E. & Laranja, M. (2011). Reconceptualising the 'policy mix' for innovation, *Research Policy, 40*(5), 702-713.

FMPRC [Ministry of Foreign Affairs of the People's Republic of China]. (2013). *President Xi Jinping: Comprehensively promote mutually beneficial cooperation push forward China-ROK relations for greater development*. Retrieved from www.fmprc.gov.cn/eng/wjdt/wshd/t1054787.shtml

Freeman, C. (1987). *Technology policy and economic performance: Lessons from Japan*. London: Pinter.

Freeman, C. (1995). The 'national system of innovation' in historical perspective. *Cambridge Journal of Economics, 19*(1), 5-24.

Godin, B. (2009). *The making of science, technology and innovation policy: Conceptual frameworks as narratives, 1945-2005*. Montreal: Centre Urbanisation Culture Société.

Hajek, O., Grebenicek, P. & Novosak, J. (2011). Regional innovation strategies in the Czeck Republic. J*ournal of Competitiveness*, *2*,11-19.

Heidenwolf, C. & Sigl, L. (2014). Scientists as ciplomats?! On the challenges of researching international science, technology and innovation policies. In C. Günay & J. Pospisil (Eds.), *Global shifts and Europe. ADD-ON 13 / 14. yearbook oiip*

(pp. 45-60). Vienna: Facultas.

Heilbroner, R. (1967). Do machines make history? *Technology and Culture, 8*(3), 335-345.

Holt, M. (2013): *U.S. and South Korean cooperation in the world nuclear energy market: Major policy considerations.* Retrieved from http://fas.org/sgp/crs/row/R41032.pdf

Jasanoff, S. & Kim, S. H. (2009). Containing the atom: Sociotechnical imaginaries and nuclear power in the United States and South Korea. *Minerva, 47*(2), 119–146.

Jennings, J. (2010). *Globalization and the ancient world*. New York: Cambridge University Press.

KAIST. (2014). *Research statistics*. Retrieved from www.kaist.edu/html/en/research/research_0403.html

Kang, S. I., Oh, J. G. & Kim, H. S. (2012). *Korea's low-carbon green growth strategy.* OECD Development Centre, Working Paper No. 310. Paris: OECD Publishing.

Kogan, M. (2007). Modes of Knowledge and Patterns of Power. In S. Sörlin & H. Vessuri (Eds.), *Knowledge society vs. knowledge economy: Knowledge, power, and politics* (pp. 35-31). New York: Palgrave Macmillan.

Köllner, P., Flamm, P. & Olbrich, P. (2014). Südkoreas politisches System seit der Demokratisierung. In E. J. Lee E. J & H. B. Mosler (Eds.), *Länderbericht Korea*. Bonn: Bundeszentrale für Politische Bildung (forthcoming).

KORANET (2012). *SWOT analysis of patterns of cooperation (drivers and barriers)*. Retrieved from www.koranet.eu/_media/D1.2.3_SWOT_analysis_web_final.pdf

Larédo, P. & Mustar, P. (2001). General Introduction: A Focus on Research and Innovation Policies. In P. Larédo & P. Mustar (Eds.), *Research and innovation policies in the new global economy* (pp. 1-13). Cheltenham: Edward Elgar.

Leadbeater, C. & Wilsdon, J. (2007). *The Atlas of Ideas: Europe and Asia in the new geography of science and innovation* (Eds.). London: Demos.

Lee, J. S. (2010). *Green growth: Korean initiatives for green civilization*. Seoul: Random House.

Lim, C. S. (2008). Towards knowledge generation with bipolarized NSI: Korea. In C. Edquist & L. Hommen (Eds.), *Small country innovation systems: globalization, change and policy in Asia and Europe* (pp. 113-155). Cheltenham/Northampton: Edward Elgar.

Liu, X. L. & White, S. (2001). Comparing innovation systems: a framework and application to China's transitional context. *Research Policy, 30*(7), 1091-1114.

Lundvall, B.A. (Ed.) (1992). *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Pinter.

Lundvall, B. A., Intarakumnerd, P. & Vang, J (Eds.) (2006). *Asia's Innovation Systems in Transition*. Cheltenham: Edward Elgar.

Mabey, N. (2009). *Delivering a sustainable low carbon recovery*. Retrieved from www.e3g.org/docs/E3G_Delivering_a_Sustainable_Low_Carbon_Recovery.pdf.

Malerba, F. (2005). Secotral systems: How and why innovation differs across sectors. In J. Fagerberg, D. C. Mowery & R. R. Nelson (Eds.), *The Oxford handbook of innovation* (pp. 380-406). Oxford: Oxford University Press.

Mandeville, T. (2005). Collaboration and the network form of organization in the new knowledge-based economy. In D. Rooney, G. Hearn & A. Ninan (Eds.), *Handbook on the knowledge economy* (pp. 165-177). Cheltenham/Northampton: Edward Elgar.

Mathews, J. A. (2012). Green growth strategies – Korean initiatives. *Futures, 44*(2012), 761-769.

Metcalfe, J. S. (1994). Evolutionary economics and technology policy. *The Economic Journal, 104*(July), 931-944.

Ministry of Education, Science and Technology [MEST] & Korea Institute of S&T Evaluation and Planning [KISTEP]. (2008). *Becoming a S&T power nation through the 577 Initiative*. Science and Technology Basic Plan of the Lee Myung Bak Administration. Seoul: MEST; KISTEP.

Meuser, M. & Nagel, U. (2005). ExpertInneninterviews – vielfach erprobt, wenig bedacht: Ein Beitrag zur qualitativen

Methodendiskussion. In. A. Bogner, B. Littig & W. Menz (Eds.), *Das Experteninterview: Theorie, Methode, Andwendung* (2nd ed.) (pp. 71-111). Wiesbaden: VS Verlag.

Ministry of Environment [MOE]. (2013). *Ecorea: Environmental review 2013*: Korea. Seoul: Ministry of Environment.

Ministry of Foreign Affairs of the Republic of Korea [MOFA]. (2012). *Energy: Global Energy Cooperation Center (GECC)*. Retrieved from www.mofa.go.kr/ENG/policy/energy/issues/ index.jsp?menu=m_20_130_20

Ministry of Foreign Affairs of the Republic of Korea [MOFA]. (2013). *Foreign Minister proposes the realization of creative economy through cooperation between Asia and Europe at the ASEM Foreign Ministers' Meeting*. Retrieved from www.mofa.go.kr/ENG/press/pressreleases/index.jsp?menu=m _10_20&sp=/webmodule/htsboard/template/read/engreadboard.jsp%3Fboardid=302%26typeID=12%26tableName=TYPE_ENGLISH%26seqno=313055

Ministry of Foreign Affairs of Denmark [MOFAD]. (2013). *Joint press statement on the occasion of the official visit to Denmark by H.E. Prime Minister Chung Hong-won*. Retrieved from http://sydkorea.um.dk/~/media/Sydkorea/Documents/Joint%20statement%2020-22%20october%202013/Joint%20Statement%2020-22%20October%202013.pdf

Ministry of Strategy and Finance [MOSF]. (2014). *3-year plan for economic innovation*. Retrieved from http://english.mosf.go.kr/popup/13_PolicyFocusBanner_20140128/popup.html

Mowery, D. C. (2001). The United States national innovation system after the Cold War. In P. Larédo & P. Mustar (Eds.), *Research and innovation policies in the new global economy* (pp. 15-46). Cheltenham: Edward Elgar.

Mowery, D. C. & Sampat, B. N. (2005). Universities in national innovation systems. In J. Fagerberg, D. C. Mowery & R. R. Nelson (Eds.), *The Oxford handbook of innovation* (pp. 209-239). Oxford: Oxford University Press.

Müller, R. & Witjes, N. (2014). Of red threads and green dragons: Austrian sociotechnical imaginaries about STI cooperation with China. In M. Mayer, M. Carpes & R. Knoblich (Eds.), *The global politics of science and technology – vol. 2* (pp. 47-66). Heidelberg: Springer.

Narula, R. & Zanfei, A. (2005). Globalization and innovation: The role of multinational enterprises. In J. Fagerberg, D. C. Mowery & R. R. Nelson (Eds.), *The Oxford handbook of innovation* (pp. 318-345), Oxford: Oxford University Press.

Nelson, R. R. (1993). *National systems of innovation: A comparative study* (Ed.). Oxford: Oxford University Press.

Nelson, R. R. & Rosenberg, N. (1993). Technical innovation and national systems. In R. R. Nelson (Ed.), *National systems of innovation: A comparative study* (pp. 3-21). Oxford: Oxford University Press.

National Institute for International Education [NIIED]. (2013): *Corse Business, NIIED*. Retrieved from ww.niied.go.kr/eng/contents.do?contentsNo=78&menuNo=349

O'Donnell, J. K. (2012). The Global Green Growth Institute: On a mission to prove green growth. *Green Growth Quarterly*, Update II-2012. New York: Council on Foreign Relations.

Organization for Economic Co-operation and Development [OECD]. (2012). *OECD Science, Technology and Industry Outlook 2012*. Paris: OECD

Organization for Economic Co-operation and Development [OECD]. (2013). *OECD Science, Technology and Industry Scoreboard 2013*. Paris: OECD

Organization for Economic Co-operation and Development [OECD]. (2014). *Main Science and Technology Indicators, OECD.StatExtracts*. Retrieved from http://stats.oecd.org/Index.aspx?DataSetCode =MSTI_PUB

Olbrich, P. & Shim, D. (2012). South Korea's quest for global influence. *Global Asia, 7*(3), 100-107.

Park, G. H. (2013). *Remarks* by President Park Geun-hye at the opening ceremony of the headquarters of the green climate fund. Speech held on December 4, 2013.

Park, G. H. (2014). *Address to the nation* by President Park Geun-hye on the three-year plan for economic innovation. Speech held on February 25, 2014.

Patel, P. & Pavitt, K. (1994). National innovation systems: Why they are important, and how they might be measured and compared. *Economics of Innovation and New Technology, 3*(1), 77-95.

Patel, P. (1997). Localized production of technology for global markets. In: D. Archibugi & J. Michie (Eds.), *Technology globalisation and economic performanc*e (pp. 198-214). Cambridge: Cambridge University Press.

Pietrobelli, C. & Rabellotti, R. (2009). The global dimension of innovation systems: linking innovation systems and global value chains. In B. A. Lundvall, K. J. Joseph, C. Chaminade & J. Vang (Eds.), *Handbook of innovation systems and developing countries: Building domestic capabilities in a global setting* (pp. 214-238). Cheltenham: Edward Elgar.

Power, G. (1997). Globalization and its discontents. *Development, 40*(2), 75-80. .

Saudi Gazette (2013). Aramco-KAIST CO2 *Management Center launched in South Korea*. Retrieved from www.saudigazette.com.sa/index.cfm?method=home.regcon&contentid=20130227154690.

Saxenian, A. (1994). *Regional advantage: Culture and competition in Silicon Valley and Route 128*. Cambridge: Harvard University Press.

Schleicher, S. P. (1999). *Wirtschaftliche innovation durch eine umweltorientierte wirtschaftspolitik.* Die Transformation der österreichischen Umweltpolitik auf dem Weg von Zwentendorf bis Kyoto. Retrieved from www.accc.gv.at/pdf/sts9901.pdf

Schüller, M, Conlé, M. & Shim, D. (2012). Korean innovation governance under Lee Myung-Bak – a critical analysis of governmental actors' new division of labour, In J. Mahlich & W. Pascha (Eds.), *Korean science and technology in an international perspective* (pp. 109-128). Berlin: Physica-Verlag.

Shim, D. (2010). Green growth: South Korea's panacea? In R. Frank, J. E. Hoare, P. Köllner & S. Pares (Eds.), *Korea 2010 – Politics, Economy and Society* (pp. 165-188). Leiden: Brill.

Shin, H. H. (2013). *Korea eyes era of 'green growth 2.0'*. Retrieved from www.koreaherald.com/view.php?ud=20131110000342

Sigl, L. & Witjes, N. (2014, September). I*nternationalization of national science, technology and innovation policies: De- or re-enactment of the nation state?* Paper presented at the Science in the Nation-State: Historic and Current Configurations in Global Perspective Conference, University of Tübingen, Germany.

Soete, L., Verspagen, B. & ter Weel, B. (2010). *Systems of innovation*. (CPB Discussion Paper, No. 138). The Hague: Netherlands Bureau for Economic Policy Analysis.

Sörlin, S. & Vessuri, H. (2007). The democratic deficit of knowledge economies. In S. Sörlin & H. Vessuri (Eds.), *Knowledge society vs. knowledge economy: Knowledge, power, and politics* (pp. 1-33). New York: Palgrave Macmillan.

Statistics Korea. (2012). *Korea's Green Growth based on OECD Green Growth Indicators*. Retrieved from www.oecd.org/greengrowth/Korea%27s%20GG%20report%20with%20OECD%20indicators.pdf.

White House. (2013). *Joint Declaration in Commemoration of the 60th Anniversary of the Alliance between the Republic of Korea and the United States of America*. Retrieved from www.whitehouse.gov/the-press-office/2013/05/07/joint-declaration-commemoration-60th-anniversary-alliance-between-republ.

World Nuclear Association. (2014). *Nuclear Power in South Korea.* Retrieved from www.world-nuclear.org/info/Country-Profiles/Countries-O-S/South-Korea

Yonhap. (2012, October 23). *Korea to launch graduate school on green growth.* Retrieved from www.koreatimes.co.kr/www/news/nation/2012/10/116_122939.html.

Yonhap. (2013, February 25). *Full text of Park's inauguration speech*. Retrieved from http://english.yonhapnews.co.kr/national/2013/02/25/95/0301000000AEN20130225001500315F.HTML.

Yoo, S. H. (2006). Causal relationship between coal consumption and economic growth in Korea. *Applied Energy, 83*, 1181-1189.