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Catering to Cleantech's Resource Needs: The Strategic Importance of Board Networks in an Emerging Green Industry

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Date of publication: March 30th, 2013

To cite this article: Heemskerk, E.M., & Mans, U. (2013). Catering to Cleantech's Resource Needs: The Strategic Importance of Board Networks in an Emerging Green Industry. *International and Multidisciplinary Journal of Social Sciences, 2*(1), pp. 52-87. doi: 10.4471/rimcis.2013.13

To link this article: http://dx.doi.org/10.4471/rimcis.2013.13

RIMCIS – International and Multidisciplinary Journal of Social Sciences
Vol. 2 No. 1 March 2013 pp. 52-87

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Abstract

This paper explores the role of elite networks in shaping business strategies in the cleantech industry. In order to do so, we investigate whether and if so how boards of directors cater to the resource needs of the innovative and expanding cleantech industry. We create a new dataset of the board network of leading cleantech firms that allows us to show how cleantech directors are integrated into the worlds of government, banking, and research. The strategic merits of board networks considered are 1) the need for operational resources 2) the need for conducive policies; and 3) the need for market access. We find that Finance and Innovation are most sought after, and domestic networks remain dominant. While larger firms are well embedded in big business and finance, smaller corporations seek ties with innovation and policy networks. Cleantech firms currently show no significant capacity to reduce dependencies in terms of access to future cleantech markets. The findings suggest that the 'classic' resource needs, such as finance, are much better 'covered' through the board's network structures than those resources that would enable a firm to improve its long-standing needs, such as a favourable policy environment and access to future markets.

Keywords: cleantech, social network analysis, resource dependency theory, board of directors, corporate elite

ISSN 2014-3680
DOI: 10.4471/rimcis.2013.13

RIMCIS – International and Multidisciplinary Journal of Social Sciences
Vol. 2 No. 1 March 2013 pp. 52-87

Atendiendo la Necesidad de Recursos de las Tecnologías Limpias: La Importancia Estratégica de las Redes de Juntas Directivas en la Industria Verde Emergente

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Resumen

Este artículo explora el rol de las redes directivas en la conformación de estrategias empresariales en la industria de las tecnologías limpias. Con este fin, investigamos en qué medida las juntas directivas responden a la necesidad de recursos de la innovadora industria de las tecnologías limpias en expansión. Creamos una nueva base de datos de las redes de juntas directivas de las empresas de tecnología limpia, lo que nos permite mostrar cómo éstas juntas están integradas en las redes de gobiernos, bancos y grupos de investigación. Los méritos estratégicos de las redes de juntas directivas son 1) la necesidad de recursos operativos, 2) la necesidad de políticas adecuadas, y 3) la necesidad de acceso al mercado. Encontramos que la financiación y la innovación son lo más buscado, y que las redes locales permanecen dominantes. Mientras que las compañías más grandes están convenientemente insertas en las grandes finanzas y negocios, las compañías pequeñas buscan lazos con las redes de innovación y de diseño de políticas. En la actualidad, las empresas de tecnologías limpias no muestran significativamente capacidad de reducir dependencias en términos de acceso a los futuros mercados de tecnologías limpias. Los resultados sugieren que las necesidades "clásicas" de recursos, como las finanzas, se hallan mejor "cubiertas" con las estructuras de redes de juntas directivas que aquellos recursos que permitían a una compañía mejorar sus necesidades habituales, como las políticas ambientales favorables y el acceso a futuros mercados.

Palabras clave: tecnologías limpias, análisis de redes sociales, teoría de la dependencia, junta directiva, élite corporativa

ISSN 2014-3680
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Resource Base and Strategic Board Networks in the Cleantech Industry

The rise of the clean technology industry (Cleantech) is difficult to ignore. Global investment in renewable energy technologies for example increased five-fold between 2004 and 2010 (DIREC, 2010, p.20). Official figures from Bloomberg New Energy Finance cite a total of US$ 35 billion in 2004, up to US$ 186.6 billion in 2009 and US$ 243 billion in 2010. In 2009, revenue from the solar, wind and biofuel sectors alone grew by 11.4 per cent, reaching a total of US$ 139 billion. Almost all renewable energy industries experienced manufacturing growth in 2009, despite the continuing global economic crisis. A look at the level of investments in non-renewable energy confirms this trend. 2008 was the first year that investment in renewable technologies was more than the investment in fossil-fuelled technologies (UNEP & New Energy Finance, 2009, p.11). Beyondd this trend in renewables, Cleantech as a whole is expected to grow significantly in the coming decade. As a recent report from the Roland Berger Consultancy projects: "[t]he market for clean technology […] is booming, and was in 2007 larger than the pharmaceutical industry. It will be the 3rd industrial sector in the world in 2020 (EUR 1600 billion)" (Roland Berger, 2009, p. 2).

As is the case with many up-and-coming industries, cleantech is marked by rapid expansion. Growth rates are impressive and individual businesses are continuously looking for new opportunities. In such a fast-paced business environment, reducing key dependencies is a priority for businesses looking to stay in the game. Any given company needs to safeguard its access to those resources it needs in order to create, sell and distribute its products or services. And many times those resources are acquired through another company. Resource dependency theory (RDT) investigates the possibilities for corporate players to minimize existing dependencies in order to sustain its business. The RDT literature includes five key strategies for companies to do so: 1) mergers; 2) joint ventures; 3) political action; and 4) executive succession; and 5) boards of directors; (Hillman, Withers, & Collins, 2009, p. 1405-1414). The studies that focus on boards of directors show

how boards play a role in the corporate affairs beyond their management, monitoring and control task (Hillman, Withers, & Collins, 2009, p. 1408). Pfeffer and Salancik's seminal work on corporate boards is authoritative in this regard. They argue that boards are composed in a way that matches the skills and networks provided by the board members on the one hand with the resources needed by the firm on the other (Pfeffer & Salancik, 1978). As a consequence, "board size and composition are not random or independent factors, but are, rather, rational organizational responses to the conditions of the external environment" (Pfeffer, 1972, p. 226). For cleantech companies, these inter-personal linkages between its board members and business leaders, political decision-makers or other relevant broker figures can make the difference between boom and gloom. This perspective is gaining momentum with the "increased recognition that the leveraging of inter-organizational [networks] is a strategic resource that can be shaped by managerial action" (Huggins, Johnston, & Thompson, 2012, p.207).

Yet, despite a burgeoning literature on inter-organizational networks (e.g. Bergenholtz & Waldstrøm, 2011), little attention is given to how the ubiquitous networks of boards of directors cater to the resource needs of innovative and expanding industries such as the cleantech industry. The aim of this article is to take a first step in closing this gap. To what extent do boards cater for the resource needs required for a successful cleantech company? In order to answer this question, we build a new empirical dataset of the board network of a set of leading cleantech firms, covering the cleantech directors' additional board memberships elsewhere. This allows us to explore and improve our understanding of a structural feature underpinning the elite network of the fast-growing cleantech business.

So why is it important to look at the issue of resource dependency? For corporate directors it is common practice to sit on a number of other boards (Kogut, 2012; Stokman, Ziegler, & Scott, 1985). When a director sits on at least two boards, an interlocking directorate is created. In this way boards link the organization with its external environment by establishing important contacts and providing access to timely information through these personal networks (Van Ees, Gabrielsson, & Huse, 2009, p. 310). And there are strong connections made in the literature between interlocks and resource dependency (Mizruchi, 1996,

p. 274). Corporations that are interlocked with strategically related firms have been found to receive better advice, counsel and other business-related information, all of which are positively related to the performance of the firm (Westphal, 1999).

Board interlocks may occur for a number of reasons, stemming from both a firm's strategy and any given director's personal career path (Mizruchi, 1996). But once a network of interlocking directorates is in place, it is consequential. Huggins et al (2012) make a useful distinction in this respect between social capital and network capital. Network capital refers to the more calculative ties held by organizations as distinct from social capital's focus on the social interrelations of individual board members. Board networks as social capital are empirically established pipelines for the diffusion of corporate governance practices and innovation (Davis, 1991; Geletkanycz & Hambrick, 1997; Gulati & Westphal, 1999; Haunschild, 1993; Rao & Sivakumar, 1999; Stearns & Mizruchi, 1993). Here however we are interested in network capital: strategic networks that accrue advantages for firms (Huggins, Johnston, & Thompson, 2012, p.207). We expect that the cleantech firms are particularly keen on engaging in board ties with organisations that can help to increase access to crucial resources. In the next section we discuss this resource base in more detail. We then analyse how interlocking directorates create the cleantech industry's network, and to what extent the network's structure confirms what we would expect from a network capital perspective. This means we will focus on the potential access to, and not the actual use of strategic resources.

The remainder of the paper is organised as follows. The next section first elaborates on the key resource dependencies that cleantech firms may have. From this, a number of expectations will be derived. Next, we introduce the research methods and describe the dataset we created for the purpose of this paper. We use network analysis tools to investigate the set of the world's leading 77 cleantech companies. Interpreting this dataset represents a first attempt to create a more comprehensive understanding of how well cleantech elite networks are positioned to deal with resource dependencies. Section 4 shows the main results; section 5 discusses the findings and suggests future orientation for resource dependency theory research. Our contribution to

literature is twofold. We add empirical knowledge about the board networks that are responsible for the management decisions driving the largest companies in the emerging cleantech sector. The dataset we create is original both in scope (cleantech industry) as in its aim (mapping resource bases). Second we evaluate the relevance of three theoretical perspectives to the strategic use of board networks and advance the theoretical debate about RDT by using social network analysis and economic geography tools. By exploring the booming cleantech industry in this way, we contribute to an improved understanding of emerging business sectors and how they deal with resource dependencies.

Resource Dependency and Board Interlocks

The corporate board network of cleantech firms can cater to its needs in three distinct ways. The literature suggests that the board network can be used to reduce 1/ the need for operational resources (in particular finance and innovation); 2/ the need for conducive policies; and 3/ the need for market access. First, cleantech needs operational resources. According to classic RDT, board interlocks are used to secure preferential access to these (Pfeffer & Salancik, 1978). For the cleantech industry, the two main operational resources are finance and innovation. Finance is key, as many of the industry's advances are capital-intensive and potential returns on investments can take a long time – a long time without profits to cover payback for loans. Often being newcomer companies, these corporate outfits are generally not well-positioned to secure standard loans from commercial banks. "Loan financing is more difficult for early stage companies to attract, as traditional commercial banks are typically unwilling to lend to companies who have not yet generated revenues and do not yet have substantial assets to pledge as collateral" (Epstein, Berg, & Morello, 2010, p. 1). Good, reliable access to capital is therefore a major challenge for cleantech companies. In addition, cleantech is technology-driven, and requires a constant flow of innovation in order to survive in a competitive market. In fact, much of the innovation relevant to cleantech is driven by academic institutions (Ragnitz, Schmalholz, Triebswetter, & Wackerbauer, 2009, p. 7). This

calls for a well-established network that can generate (access to) research knowledge in the field of cleantech. Henriques and Sadorsky point out that the renewable energy sector provides a clear example of the cleantech sector's link to innovation. The renewables industry shares more characteristics with the innovation-driven technology sector than the energy sector (Henriques & Sadorsky, 2008). The reasons for this are twofold: On the one hand renewable energy still has to prove that it offers a valid alternative to current, well-consolidated energy technologies, such as oil and gas. On the other hand, clean energy can only become a lasting success story if costs continue to decrease (Arent, Wise, & Gelman, 2011). The latter, industry experts agree, is contingent on innovation.

Second, as a device for elite formation (Domhoff, 1967; Scott, 1997) board interlocks constitute a policy-network through which cleantech firms can engage in lobbying efforts for conducive policies (Carroll & Carson, 2003; Culpepper, 2009). Here board interlocks do not operate through direct intervention but through their ability to set the parameters of the corporate environment within which all cleantech firms have to operate (Scott, 1997, p.188). After all, cleantech is dependent on a conducive regulatory environment. The (national) policies in place that support, or hinder, the industry's economic vitality are critical success factors for individual companies. This is the case for both sides of the push-pull spectrum: technology push policies (i.e. research grants) and market pull policies (i.e. procurement guidelines, tax credits for consumers of cleantech products) (Dowlatabadi, 1998; Grubb, Haduong, & Chapuis, 1995). Most agree that corporate decision-making highly depends on whether existing policies are 'loud, long and legal' in order to minimise investment risks (UNEP SEFI & New Energy Finance, 2007). In fact, countries that have offered the greatest consistency in supportive policy - particularly in renewable energies - have scored highest both in terms of stimulating corporate growth and economic efficiency (Buerer & Wuestenhagen, 2009, p. 4999). Mendonca et al point out that, based on renewable energy experiences in Denmark and the United States, "[l]ong term, stable support schemes which allow a multiplicity of actors to invest in the sector will provide a secure basis for development of the industry in a decentralised way. Another prominent example is Germany, where the feed-in-tariff

scheme has stimulated innovation and led to significant cost reductions particular in the solar PV technology. This can be supported by ownership restrictions which direct investment opportunities to the communities closest to the installation themselves" (Mendonca, Lacey, & Hvelplund, 2009, p.294). In contrast, government policies can be an important barrier to development in the cleantech industry: "the uncertainty and discontinuity of energy policies are the main causes of small development of renewable energy [in the Netherlands and Sweden]" (Marques & Fuinhas, 2011, p. 1603). Without a conducive policy environment, cleantech offers a much more limited outlook on achieving significant and lasting growth. Board members who tap into relevant policy networks can clearly be an asset in this respect.

Third, it has been increasingly recognised that effective inter-organizational networks do not only create local but also global networks. Global connections can be thought of as pipelines that are "essential complements to the 'local buzz' that is produced and reproduced in agglomerated centres where innovative activity is concentrated" (Bathelt, Malmberg, & Maskell, 2004; Gertler & Levitte, 2005, p.489). For cleantech firms, global connections are especially relevant as sources of access to and information about new markets. Companies can use the network of their board members to ensure what could be called 'indirect' market access. Board members with additional functions in companies operating in other markets (whether or not that company is part of the cleantech sector) de-facto offer valuable insights about new markets. International experience brought in through the board of directors can thus be an important source of information – as for example a board member's Canadian business experience to a US-based start-up. However, at a time when international business is undergoing a massive shift from developed to emerging markets, this type of market access is particularly relevant for getting a foot in the door in the growing, and less-consolidated, consumer markets of for example Eastern Europe and Asia.

In sum, we expect that the cleantech firms are particularly keen on engaging in board ties with organisations that can help to increase access to the three resource bases: finance & innovation, access to policy influence, and access to new markets. In addition, if the perspective of network capital is indeed apt, we would also expect that

different cleantech firms will pursue different network strategies. After all, the network configuration should be – at least to a certain extent – a reflection of the particularities of the corporation. We will therefore investigate to what extent we can discern different network strategies among the cleantech firms, for example, between the larger and smaller corporations.

Data and Methods

We used the cleantech company ranking as published by the authoritative cleantech website www.cleantech.org as a basis for the selection of firms. The index is comprised of corporations that are considered global leaders in cleantech across a broad range of industry sectors, from alternative energy and energy efficiency to advanced materials, air & water purification, eco-friendly agriculture/nutrition, power transmission, and more. Firms are included in the list based on their perceived "staying power and the ability to exploit rapidly growing and evolving markets". It does not list every company in the sector or companies recently re-branded as "green" but is an expert-picked list of promising cleantech firms. For the purpose of this paper we included all 77 firms in the list (30 September 2010). The firms are distributed over four categories: Energy Efficiency (46%), Renewable Energy (30%), Sustainable Management (17%) and Waste Management (7%). Although the 77 cleantech firms have home bases across the globe, they are not distributed evenly. The majority of the organisations (60%) are based in North America, followed by Europe (28%) and Asia (12%). No firms from Africa or South America are included in the list.

For all 77 firms we identified the members of the boards of directors using annual reports, the Financial Times website and the Amadeus database of Bureau van Dijk. Countries differ in the way corporate governance is organised. In some countries the executive board and the supervisory board are separate entities (two-tier system), in other countries there is one board with board executives and non-executives (one-tier system). In all cases we included both executive and non-executive directors. However, we did not include the managerial cohort below the level of the board.

For each of the individual members we subsequently listed all other organisations they are affiliated with through directorships and board memberships. These additional memberships and affiliations were taken from the annual reports and of corporate websites. Cross-checking multiple sources per person often showed that information in the biographies was not fully complete. The list of memberships and affiliations for the same person might differ across various annual reports. We have been as inclusive as possible. Using the publicly available records means that we are able to distil networks of the cleantech firms through those affiliations and board memberships that are explicitly mentioned. Because outside directorships add to the status of the cleantech directors and hence to that of the firm, we can expect that functions and memberships with relevant organisations are all included. The final database includes 723 cleantech directors and 1662 additional organisations with which the cleantech directors are affiliated. The total number of organisations in the database is therefore 1739. The dataset is available for further analysis at the first author's website.

We included each separate, unique board in the database. This allows to capture market access through board networks but also allows mapping the interpersonal meeting network and social capital of the cleantech directors. We used a relational database as the main repository for the network information, which also allowed retrieving the basic descriptives and statistics on firms and directors. In addition, the software package UCINET was applied for calculating network measures and the package NETDRAW for building the related sociograms (Borgatti, Everett, & Freeman, 2002). (Note that the network we analyse here is a subset of a larger network of interlocking directorates. We did not include the links between firms that are created by board members who are not a member of a cleantech corporation. Therefore we refrained from applying network-wide topological indicators such as average distance or eigenvector and betweeness centrality).

In order to map the resource bases, we placed all affiliations of cleantech directors into one of seven categories. First there are the three resource bases: finance, innovation and access to policy networks. Banks and venture capital firms are categorised under finance.

Conducive policies include access to think tanks, lobby groups and interest organisations. Innovation includes research institutes, universities, and corporations with a clear Research & Development orientation. In addition to the three resource bases we discern a number of additional categories. The fourth category is the broad set of organisations in Industry & Services. Basically, it represents the business community except for high-tech, energy, and finance. It also includes general ICT firms without a dominant R&D orientation, pharmaceuticals and health care. Although arguably innovation takes place in these types of organisations, we do not regard this as important for the resource base from the perspective of the cleantech firms. Fifth, we distinguish a separate category, energy, because of its close links to the cleantech industry. Finally, a small set of institutions such as museums and cultural institutions are part of the set 'public'. For a small number of organisations we were not able to determine their activities; they are listed as unknown.

In order to map the board network access to markets, we have assembled the relevant geographic office location data for those private companies where cleantech executives serve on the board. The geographic distribution of office networks is widely used in relational economic geography as an indicator for global economic developments across different territorial scales (e.g. Godfrey & Zhou, 1999; Neal, 2008; Taylor et al., 2011). Because non-executive directors are not part of the day-to-day management of the firm, it is useful to zoom in on the network of the executive directors for this part of the analysis. We scored each of the corporations linked to cleantech executives in terms of access to foreign markets. Having offices in another country means that specialist regional information, offices and other infrastructures are in place, and that staff members are familiar with domestic regulations, business culture and society. Through their board membership at such firms cleantech directors can tap into these resources. Therefore we measure a given firm's level of market access by the number of countries in which it has an office location.

Empirical Results

The Board Network of the Cleantech Elite: Architecture and Properties

We are not aware of a previous study that mapped the board network of the cleantech industry. Therefore it seems worthwhile to investigate the general properties of the interconnections. Together the boards of the 77 cleantech firms consist of 730 seats, an average of 9.5 directors per corporation. This is comparable to board sizes in the USA, which increased from 8.9 in 2001 to 9.3 in 2009 (Chu & Davis, 2011). Table 1 gives some board and network descriptives. For three-quarters of the members of the cleantech elite (545), we were able to identify additional board memberships and organisational affiliations. This group of interlocking directors can be denoted as the inner circle of the cleantech elite (Useem, 1984). Together the cleantech inner circle spans a network of 6833 interlocks through their 1810 additional board memberships and affiliations at 1662 distinct (non-cleantech) organisations. Interestingly, cleantech firms hardly interlock among themselves: there are only seven direct interlocks that connect the boards of the 77 cleantech corporations. In this, they differ from financial sectors, for instance, where direct board interlocks have been very common in a multitude of countries such as the USA (Davis, Yoo, & Baker, 2003), the Netherlands (Heemskerk, 2007), Germany (Windolf, 2002) and many others (Kogut, 2012; Stokman, Ziegler, & Scott, 1985).

It is a well-known feature of complex networks, including networks of board interlocks, that the network ties are not evenly distributed over the nodes of the network. Typically, a small group of nodes, be it directors or organisations, attract a large proportion of the network ties (Schweitzer et al., 2009; Watts, 1999). One implication of this is that average indicators of network centrality often disguise important properties of the network. Figure 1 therefore shows how the network ties are distributed over the directors and organisations in the sample. The pronounced leftward bias in Figure 1 indicates that the large majority of organisations and directors make only a limited contribution to the overall network. For most organisations we see a peak in the

distribution at two to four network ties (interlocks). These firms are moderately connected within the network. What follows is a rather steep decline to about ten interlocks per firm. Here we see a steady group emerging with ten to twenty board interlocks. A select group of firms make a disproportionate large contribution to the network with more than 30 board interlocks. For the board members we see a somewhat similar distribution. A fair share of the cleantech directors only have one board position and are not part of the inner circle. The directors with at least two positions create board interlocks. With still a fair share of directors with three interlocks, there is a rather steep decline from four interlocks onwards that is followed by a long tail of directors who each contribute considerably to the network because they occupy many board positions.

Table 1

Board positions and network ties of cleantech firms

Nr of Cleantech Firms	77
All Board Position	730
executive positions	206
non executive positions	524
Average board size	9,5
executive	2,7
non executive	6,8
Number of additional board positions	1810
Number of connected non cleantech organisations	1662
Number of cleantech directors	723
Board network ties (lines)	6833
Average number of network ties per director	9,5
Average number of network ties per organisation	7,9
Number of cleantech directors with additional board positions (inner circle)	545
executive	105

The structure of the network reflects the way in which the data collection was organised. First we collected 77 separate (ego) networks of the cleantech firms. These separated components can become connected when two cleantech directors meet each other at another organisation. We call this an indirect interlock. Of all cleantech firms, 39 are connected with each other through indirect board interlocks. The network divides into a number of components: nine pairs and one large component where 21 cleantech firms are connected. The dominant component of the cleantech network extends to a much larger network, connecting a total of 527 firms (see Figure 2). The board networks of the cleantech firms are further illustrated in Figure 3. It shows one pair (not part of the dominant component) between French Schnyder Electric and Ansys from the USA. The two firms are connected through four indirect interlocks. In addition, they are both entrenched in board networks with a wide range of organisations, which we will analyze below. The cleantech firms are well embedded in larger organizational network structures. But among themselves, the cleantech corporations

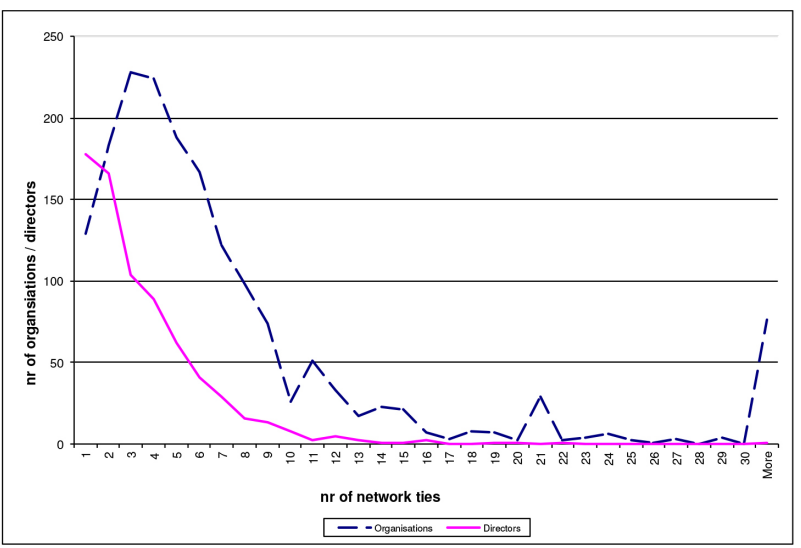


Figure 1. Distribution of positions and interlocks over directors and organisations

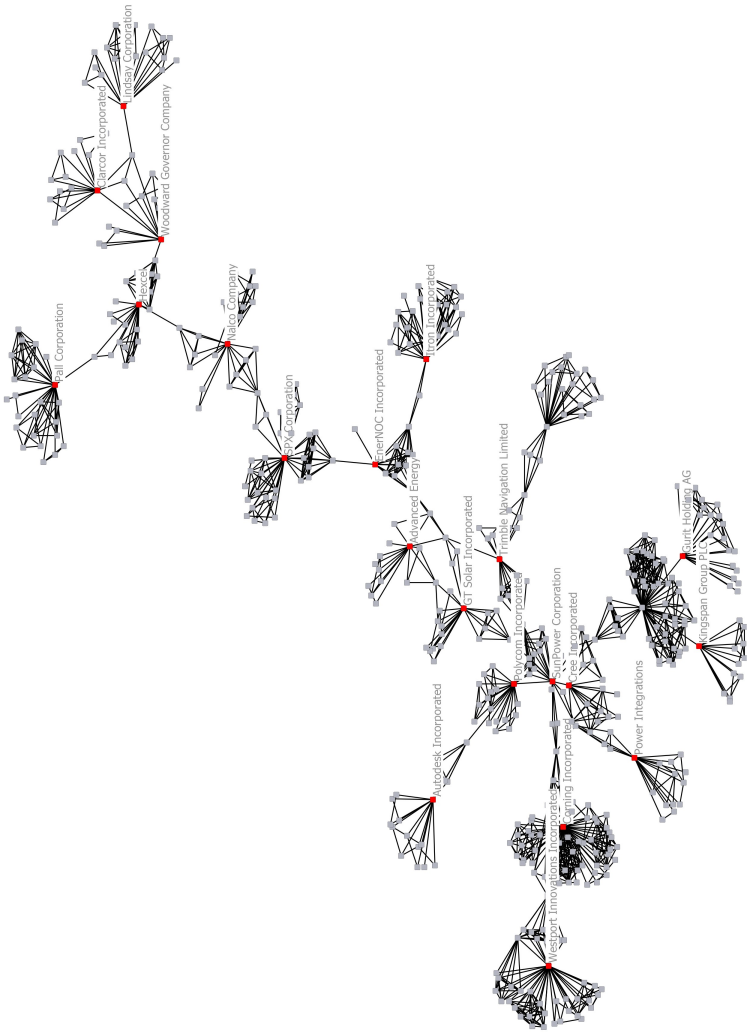


Figure 2. The dominant component of the Cleantech Network

remain sparsely interconnected. This suggests an external network orientation. The next section therefore investigates how the network makes use of these external linkages: Do they allow firms to tap into valuable resources that can support their business activity?

Network Access to Operational Resources and Conducive Policies

Table 2 below shows the resource base of the network of the 723 cleantech directors. The first column lists how many of the organisations in the cleantech network belong to each of the seven categories. Clearly, the cleantech firms are well embedded in the larger business community. As a group, the cleantech directors connect to all six categories. The second column shows which part of the cleantech directors' network connects to each category. How many of the 77 cleantech firms connect with each resource base is shown in the third column. Of all 1662 organisations in the cleantech network, 42.8 percent fall in the broad 'Industry & Services' category. 'Finance' ranks second with 16.8 percent of all firms, followed by 'Innovation' with 15.6. Just under eleven percent of the organisations in the cleantech network are within the 'Policy' category; 6.8 within 'Energy' and 4.6 are found within 'Public'. If we look at the number of interlocks the cleantech firms create with each of the categories, we see that this closely resembles the overall Distribution (see column 2 in Table 2. Innovation and Energy receive a slightly more board interlocks, the other categories a little less).

A first glance at these figures reveals that the cleantech firms have an extensive network through their board members. Next to ties with the business community, the operational resources (finance and innovation) are best catered for, with over sixteen percent of all ties (column 2). More than 90 percent of all cleantech firms have a direct board tie with a financial institution, and 83 percent connect with innovative organisations. This confirms our expectation that the financial resource base remains most important for cleantech firms. However, innovation is almost as important for cleantech as finance. Access to policy influencing bodies, on the other hand, seems a less important part of the board network. With just over ten per cent of all ties, it remains sparsely

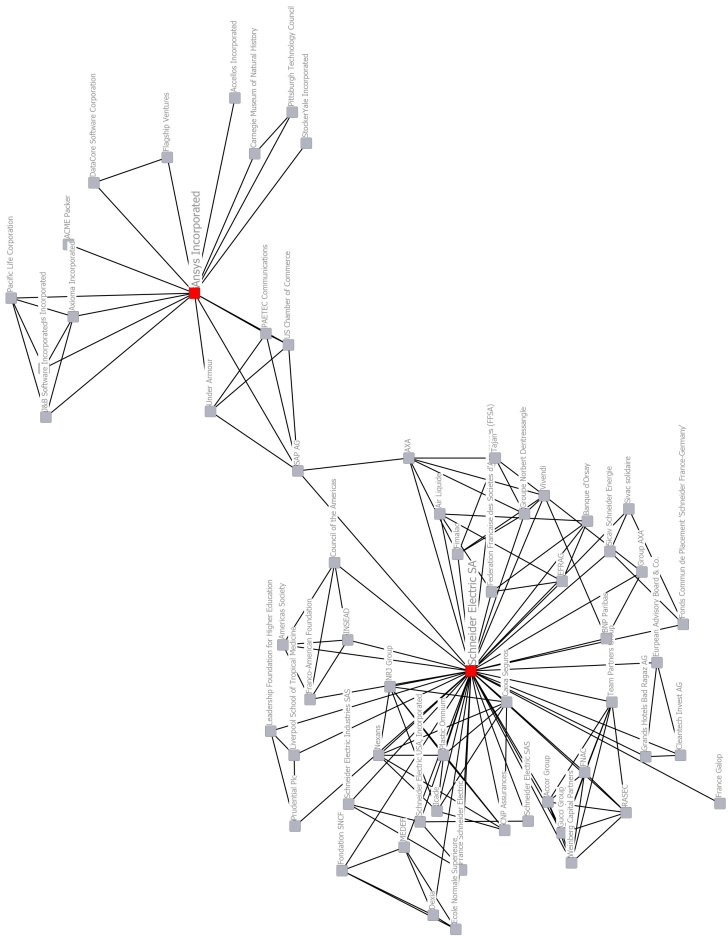


Figure 3. The Schnyder - Ansys component

connected to this group of organisations, although still over 63 percent of all cleantech firms include policy influencing bodies in their board network. Energy is only marginally connected. Finally, public organisations hardly play a role in the network. While in some sections of the corporate elite the relatively informal setting of charity and other civil society oriented organisations present themselves as excellent venues for networking (Heemskerk, 2007), cleantech directors hardly take part in this.

As officers of the firms, executive directors typically have much fewer additional positions because of time constraints. When they do choose to invest time and energy into additional positions they do so with consent from the rest of their board and typically choose organisations that can be beneficial to their primary affiliation. Non-executive, or outside directors on the other hand are typically recruited on the basis of their (network) profile and often include officers from other firms. Columns 4 and 5 in Table 2 show the subset of the network that is created by the 206 cleantech executives only, columns 6 and 7 the subset of the 524 non-executives. As the table shows, executives and non-executives have a markedly different network. First, and perhaps most pronounced, the interlocks with finance are clearly divided between the two groups of directors. Only 5.8 percent of the network of cleantech executives connects with finance, while for non-executives, finance constitutes over nineteen percent of their network. The dominance of non-executives in the financial part of the network suggests that these ties serve as a monitoring device: financial institutions link with cleantech firms through non-executive directorates in order to have direct access to information and strategic decision-making. This kind of monitoring tie can be seen as the reverse indication of a resource dependency and have been very common in early networks of interlocking directorates (Fennema, 1982; Stokman, Ziegler, & Scott, 1985).

A second observation is that, next to the overall group of Industry & Services, executives invest most in ties with lobby work and the energy sector, while these categories are only moderately covered by the entire board network. With both comprising just under twenty percent of their ties, it is clear that cleantech executives care for good network ties with energy businesses, as well as with ties to policy influencing bodies such

as lobby organisations, industry associations or political advisory bodies. Non-executives, on the contrary, only devote a modest part of their network to these two categories. In fact, all of the connections cleantech firms have with organisations in the energy domain are created by a cleantech executive and are only sometimes strengthened by additional interlocks of non-executives (as shown by the 53.2 percent reach of the executives). Finally, innovation remains an important part of the network for both executives (16.9%) and non-executives (15.9%). Being present at other innovative organisations is clearly an asset for cleantech directors, which confirms the expected link between operational resources and network access.

Table 2

Resource base of CT firms through board interlocks

	1	2	3	4	5	6	7
	All directors			*Executives*		*Non executives*	
Resource Base	*Firms connected to resource base as % of all Firms*	*ties to resource base as % of all network ties*	*% CT firms with ties to resource base*	*executive ties to resource base as % of all network ties*	*% CT firms with executive ties to resource base*	*Non-executive ties to resource base as % of all network ties*	*% CT firms with non-executive ties to resource base*
Industry & Services	42.8	42.2	97.4	34	45.5	44.1	97.4
Finance	16.8	16.6	90.9	5.8	18.2	19.1	89.6
Innovation	15.6	16.1	83.1	16.9	32.5	15.9	79.2
Policy	10.9	10.3	63.6	18.6	28.6	8.4	55.8
Energy	6.8	8.2	53.2	18.3	9.1	5.9	53.2
Public	4.6	4.5	41.6	4.4	9.1	4.6	36.4
Unknown	2.2	2	26	2	7.8	2.1	20.8

In line with our expectations, the cleantech directors maintain an extensive network with other organisations in the domains of finance and innovation. These ties can help the cleantech firms to reduce their resource dependencies. These findings suggest that non-executive directors have a more externally oriented role, bridging with resources

such as finance. Cleantech executives on the other hand have, as officers and representatives of the firm, a network that is geared towards the nearby sectors of energy and reflect their responsibility for a successful lobby strategy.

Market Access Through Executive Networks

A cleantech firm sells a particular range of products and needs favourable conditions that allow for potential growth in terms of production, export and domestic sales. However, not every country has an interesting market in which it is worth investing (be it time or capital). We therefore use four indicator categories to determine whether or not a country offers a market for cleantech. First, companies are looking for relevant, conducive (macro-)policies. A country's national commitment to reduce CO_2 emissions for example stands for a consistent climate policy, which in turn makes corporate investments in cleantech more promising. Second, the level of CO_2 emissions (both absolute and in relative terms) indicate how much can actually be saved when introducing cleantech solutions and products (which is independent from the political commitment to CO_2 reduction). Third, we can look at a country's overall levels of energy consumption in order to determine the need for cleantech products. For assessing future potential, the current and projected growth figures of energy demand are of particular interest. A possible fourth indicator is directly related to the cleantech sector's current performance. When looking at the actual cleantech product sales per country, it is possible to determine whether or not a cleantech firm could expect to do good business in a given market. Table 3 provides an overview of these four indicator categories, and the six related quantitative indicators used for the analysis. In total, the four categories led to a list of 52 countries, whereby each country had to be included as a top scorer in at least one of the lists. For example, Latvia has a political commitment to reduce its CO_2 emissions by eight per cent, and does not feature in any of the other rankings. Indonesia in contrast has no political commitment under the Kyoto Protocol, but has a relatively high score on energy consumption growth (six per cent) in 2009-2010 within the G20.

All four categories can be linked to the level of market access that is offered to cleantech firms through their board networks. When cleantech executives sit on the board of other corporations they have access to information and the infrastructure about those countries in which the company is present. The 206 cleantech executives hold board positions at 167 distinct corporations (non-corporate organisations such as foundations, research institutes and the like are not included for this part of the analysis). The 52 national markets represent nearly 80 per cent of all office locations counted in the 167-company sample. Hence, the cleantech firms' linkages to international markets generally match today's most interesting cleantech markets.

Table 3

Four selected categories to define relevant markets for the cleantech industry[1]

	Category	Quantitative indicator	Year	Source	Total countries covered by data
1	Political Commitment	Commited CO_2 reductions by 2020 as ratifyed through Kyoto Protocol	2011	United Nations Framework Convention on Climate Change	26 (-8% to +8% commited CO_2 reduction)
2	National CO_2 emissions	Total CO_2 emissions	2008	Energy Information Agency	20 (ranking)
		Weighted CO_2 emissions (annual CO_2 emissions per capita and cumulative figure 1900-2006)	2011	Maplecroft	20 (ranking)
3	Energy Demand	Growth in energy consumption 2009-2010	2011	Enerdata	14 (representing 90% of G20 consumption
4	Industry Volume	Total clean energy technology product sales	2008	Roland Berger Strategy Consultants	20 (ranking)
		Relative clean energy technology	2008	Roland Berger Strategy Consultants	20 (ranking)

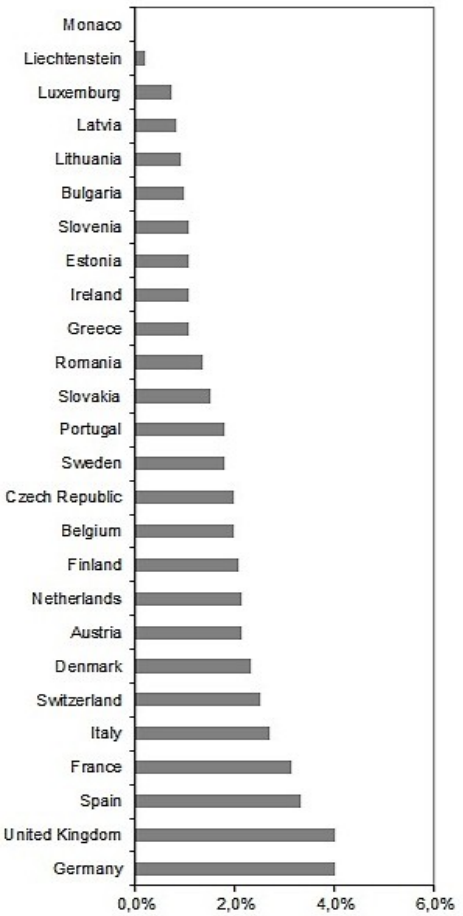
Of these 167 companies in the cleantech network 40 per cent provide access to international markets; the remaining 60 per cent have a distinctively domestic outlook. This confirms Gertler and Levitte's argument that local inter-organizational networks remain important in

innovative industries (Gertler & Levitte, 2005), despite the fact that many cleantech firms have international access through their board network offers cleantech firms access to 111 countries (through a total of 1532 country presences). Out of the set of 77 cleantech firms, 30 have access to up to ten other national markets. As we are interested in the market access by the cleantech sector in general, we are not using company specific, but sector specific figures. For example, the cleantech network creates indirect access to the German market through 45 country presences (there are 45 distinct companies in the cleantech network that have at least one office location in Germany). This represents four per cent of the 1120 office locations included in the sample. Using this method we can determine for each of the four indicators whether or not on an aggregate level, the cleantech firms have access to the most relevant markets.

In terms of political commitment, we chose to limit the assessment to those 26 countries with an eight per cent CO_2 reduction target (all EU-27 countries except for Poland, Hungary, Cyprus and Malta, plus Switzerland, Monaco and Liechtenstein). This way, it is possible to compare the relative number of office locations with those countries that share the highest commitment to CO_2 reductions. The 27 countries receive in total 46.5% of all country presences. The results as displayed in Figure 4 show that the largest countries score relatively high, such as Germany, the United Kingdom (four per cent of the total office locations), as well as Spain and France (more than three per cent). Some smaller countries score relatively high (more than two per cent), including Netherlands, Denmark, Finland and Switzerland. Some other small markets on the other hand score relatively low, such as Latvia, Luxembourg and Lithuania. This suggests that current cleantech networks provide indirect market access to those countries where there is a combination of political commitments to high CO_2 reductions and sizable markets.

When relating CO_2 emissions to office locations, the cleantech network offers varied levels of access to countries with high CO_2 emissions (see Figure 5). On the one hand, the United States has the highest score in terms of office locations in the network, and presents an interesting market because of its high CO_2 ranking. This is also true for China, where there is a coupling of high CO_2 emission and a high score

for office locations. Access to the Spanish and French markets is also relatively good for their respective section of the ranking. India and Japan in contrast have much lower office counts yet have some of the highest ranking in terms of emissions. Also, market access to Iran, Saudi Arabia and Ukraine is very low in relative terms.



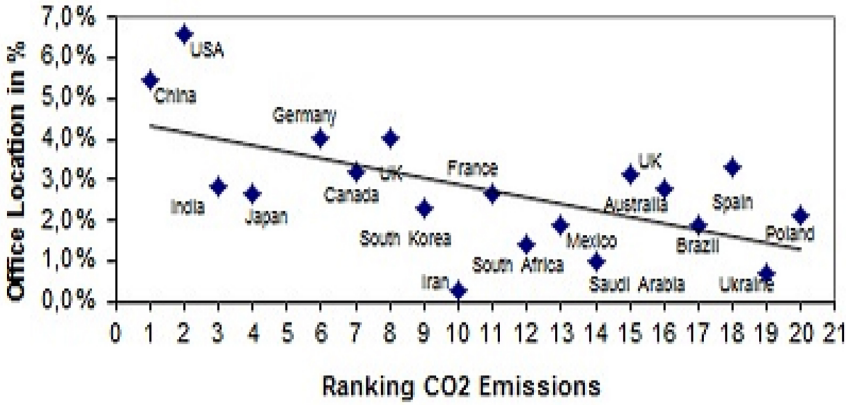
Source: UNFCC, 2011

Figure 4. Board access to markets with 8% CO_2 reduction target

Third, energy consumption growth in the period 2009/2010 also shows a picture of weak association (see Figure 6). While market access to major developed economies such as Germany, France and the United States is well established, the cleantech network does not offer significant access to those markets that have major energy consumption growth, such as Brazil and the Russian Federation (ten and eleven per cent respectively). Interestingly, market access to three of the four countries that had positive growth levels throughout the financial crisis (Indonesia, India and South Korea) also remains limited (1.2 and 3.0 and 2.4 per cent respectively).

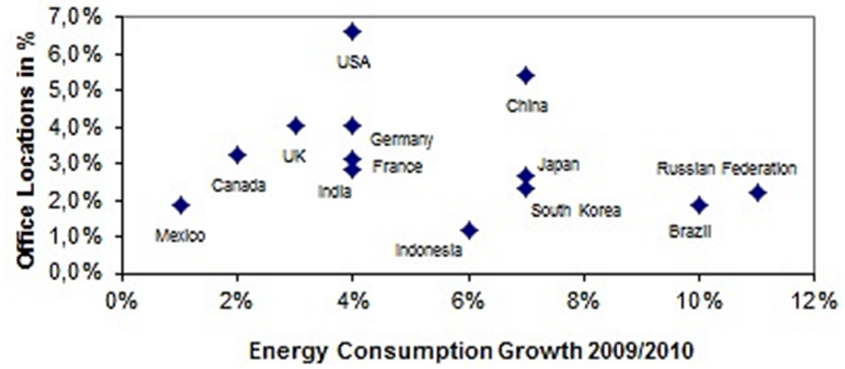
Lastly, there is the cleantech industry itself (see Figure 7). The absolute numbers reveal a clear correlation between office locations and the top 20 countries in terms of product sales per country. Exceptions to this correlation include Germany (1st), Japan (3rd), Denmark (5th) and Brazil (6th). Despite their impressive cleantech sales figures, market access by cleantech companies for those four countries stay below the average. In contrast, market access to the United Kingdom (9th) and Italy (17th) score high above average in our sample.

The data suggest that the cleantech network offers access to those main international markets that are generally considered important to global business. The relation between global office distribution across the network and absolute product sales figures remains the most visible link between cleantech markets and what cleantech firms can expect from board membership in terms of reducing market access dependencies. When looking in more detail at where low-carbon technologies could make a difference, the data does not support a strong correlation, be it with policy commitment, CO_2 emissions or increasing energy demand. This indicates that the cleantech sector resource dependencies that can be reduced through elite networks are more or less limited to major current markets (where cleantech already generates revenue), but does not cater for potentially more interesting new markets (where future revenue growth in the cleantech industry can be expected).



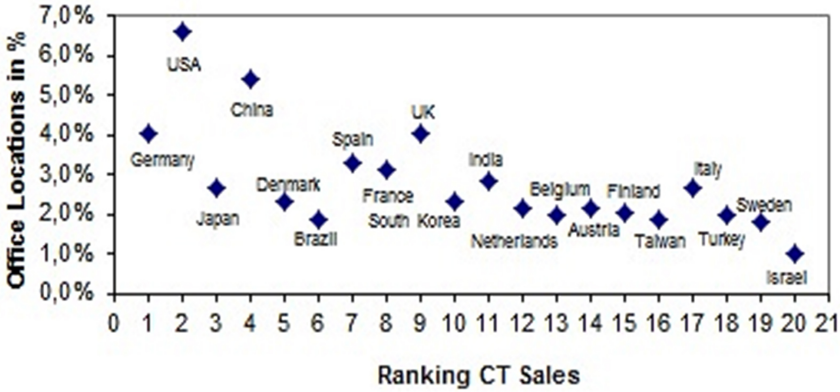
Source: Energy Information Agency (2008)

Figure 5. CO_2 emissions versus market access offered by the cleantech elite network



Source: Enerdata (2011)

Figure 6. Energy consumption growth versus market access offered by the cleantech elite network



Source: Roland Berger (2009).

Figure 7. Cleantech industry volume versus market access offered by the cleantech elite network

Cleantech's Network Strategies

Given the heterogeneity in size, scope and business, it can be expected that the cleantech sector is composed of sets of corporations with different network strategies. In order to get a sense of how the variables are related we calculated how the resource bases embedded in the board network relate to the size of the firm, measured by market capitalization. This helps us to see if large firms have a different network strategy from small firms. A correlation analysis shows some interesting results about the relationship between the resource bases. Figure 8 illustrates the relations of significant correlation (at least 0.05). First of all, there are strong and highly significant relationships between size, market access and business community. The larger the firm, the more the cleantech executives have access to alternative markets through their board networks. This is in line with the findings that market access is mostly created through networks with the larger business community, and in particular with executive interlocks with large multinational

organisations. As such, market access seems more a corollary of ties with the business community than a result of a network strategy oriented towards reducing resource dependencies. Size also correlates strongly with Finance (.418). This indicates that the larger cleantech firms in our sample predominantly create network ties with finance. Above we already found that non-executives, rather than executives at the cleantech firms create the ties with finance. Also, we expected that cleantech firms would create board interlocks with the financial sector in order to secure resources, and that this would be less the case for larger companies with a consolidated business portfolio. As it turns out, this is not the case; it is the larger firms that relate to finance. Furthermore, the network strategies of the cleantech executives as discussed above translate into a significant correlation of Finance with the category Conducive Policies. And firms who are oriented towards the energy sector also invest in ties with organisations that can provide conducive policies. Both of these resource bases do not correlate with size. In addition, firms that invest in conducive policies are also the firms with a network investment in innovation (.484). This indicates that smaller firms' network strategies are not based on isolated sectors. Instead they merge to form 'clusters' such as finance/conducive policies or energy/conducive policies. Put differently, cleantech firms apply a network strategy which allows them to using their board to reduce a set of selected resource dependencies: larger firms focus on market access, finance and business networks, while smaller ones seem to target resource 'clusters'.

The correlation analysis suggests that firms differ in their network strategy depending on size. Therefore we split the set of firms in two by the median market capitalization and did a similar correlation analysis on both sets. The set of the 38 largest firms show by and large similar correlations throughout the entire set. Some relationships lose their significance, such as those between Market Access and Innovation, and Conducive Policies with Finance and with Innovation. Among the 39 small firms however, the correlations between the two resource bases Conducive Polices and Innovation appear as a dominant feature. Apparently, it is the cleantech firms with a smaller market capitalisation that combine network ties with conducive policies and innovation. We could therefore consider these smaller cleantech firms being less

consolidated and geared towards stimulating growth in the overall cleantech industry. It is not finance that they need; it is on-going innovation and conducive policies which can ensure new products and a growing market size. Comparing the means of the larger and the smaller cleantech firms further corroborates these findings. The larger cleantech firms have significantly more network ties with Industry and Service (t=2.331) and with Finance (t=2.229).

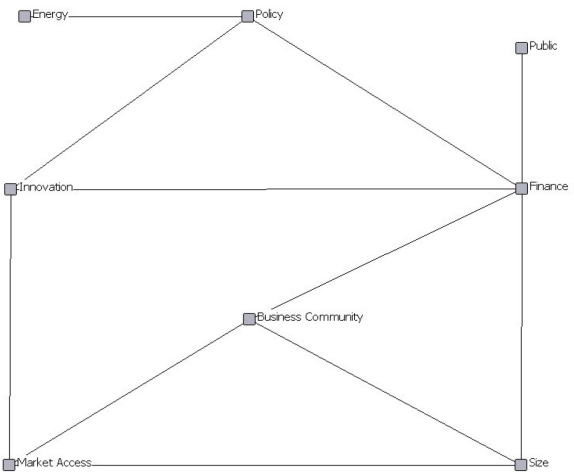


Figure 8. Correlations between resource bases and company size

Conclusion and Discussion

As a relatively new addition to the international business community, cleantech is a fast-moving part of the global economy, with significant prospects for sustained growth over the next decades. In this paper we investigated to what extent the network of board members is a strategic asset for the reduction of key dependencies for this growing sector. We formulated three theoretical perspectives on how the board network could benefit the cleantech firms: through its access to operational resources (finance and innovation), policy networks and foreign

markets. Our findings confirm that board networks in the cleantech business indeed reflect the strategic needs to reduce external dependencies. This holds particularly true for reducing dependencies on financial resources.

Network linkages to finance are a dominant part of today's cleantech board networks, even though larger firms tap much more into the boards of financial institutions than smaller ones. Closer scrutiny however revealed that the board ties that cleantech firms have with financial institutions are part of the existing linkages with the business community in general. Especially the larger firms have directors on their board with an extensive network in the business community covering finance, as well as industry & services.

Cleantech firms are also well connected to the boards of innovative firms. Both executives and non-executives build these ties, underscoring the importance of innovation for the cleantech industry. Especially the smaller Cleantech firms seem to focus on network ties with innovation rather than finance, in combination with network ties to policy networks.

In terms of policy networks, board interlocks serve to uphold the ties of business communities and relevant decision-making circles. Overall we did not find a strong network presence of cleantech board of directors in policy networks. Closer inspection however revealed that executive directors, quite contrary to the non-executive directors, have a more pronounced orientation towards policy planning forums. In a similar vein, executives steer their network towards the energy sector, which is in sharp contrast with the non-executive directors. In the cleantech board network, executives and non-executives have different network strategies, which cater for distinctive needs. This suggests that similar studies on board networks would benefit from paying more attention to the differences in network orientation between different types of directors. Executives can be seen as the officers whose task it is to insource crucial resources. Non-executives tie the cleantech firms into the wider corporate and financial business community. An interesting thought here is that the cleantech directors might also act as carriers of a sustainable economy underlying the cleantech industry to the wider business community. The extent to which they are 'agents' of change, in terms of sustainability in the business community, warrants

separate research though.

Looking at market access, the results showed how the cleantech executive network offers access to many of the most important international markets. This is particularly the case for large companies. It is noteworthy that the network offers limited access to those markets that could be considered interesting potential markets for cleantech products. Political commitment to CO_2 emission reduction, CO_2 emission levels and energy growth figures in countries do not correlate with the linkages board networks offer today. Some future opportunity to enter a promising market might have to be done through other business connections/networks. In contrast, today's largest cleantech markets do correlate with the highest access resources throughout the network. From a theoretical perspective the combination of social network analysis and economic geography tools proved useful in investigating the relationship between board networks and potential market access. In particular when looking at the current debates in the field of global production networks, this approach promises interesting insights into the role of firm actors as key drivers behind a globalising economy. At the same time, refinement is needed in order to develop more detailed indicators for measuring market access through elite networks.

Our analysis underscores the RDT argument that there is more to corporate governance than monitoring and controlling management. Corporations are not unrelated atoms that operate on anonymous markets, but are intrinsically embedded in a number of inter-organizational networks. At the apex of corporate power, cleantech firms have ample access to crucial resources. Our findings also support the view that networks of corporate directors are not merely passive conduits for the spread of information or building blocks of social capital: they are indeed network capital with direct strategic value to the firm and its board members, and that this approach promises interesting insights when it comes to emerging business sectors such as the cleantech industry.

With this explorative study we have shown that scholars in social network analysis would benefit from broadening their analytical toolbox. In order to develop the research agenda in this direction, next steps could centre on three issues.

First, the scope should be broadened. Corporate directors typically have a much larger network, including previous appointments. These previous board positions and affiliations can provide for access to resources in a similar way as we analyzed the current positions and these previous career paths act as important building blocks of the corporate elite network. Many of the corporate directors may have been colleagues on boards before, adding to the cohesion of the cleantech elite. For this paper, we studied the network from a resource dependency perspective, disregarding many of the important questions that can be asked from a social (elite) cohesion perspective. A second issue to test is how consequential and beneficial these network ties are for the cleantech firms. Are firms with strong board networks in finance indeed more successful in securing loans and investment, do ties with innovative organisations spur innovation in the focal firm, and does a well-balanced director network add to the overall survival changes and success of the cleantech corporations? As we deal with an emerging sector, some of these questions can only be answered in a few years' time. A third opportunity is to expand this line of research by looking beyond the cleantech companies themselves and focus instead on cleantech directors as ambassadors of sustainable investments and business practice. For instance, one might expect that organisations that have cleantech directors on their board, in particular cleantech executives, would be relatively active in reducing their carbon footprint and in general more sympathetic towards sustainability, corporate social responsibility and renewable energy. From this perspective the board network of the cleantech directors is not only a device to secure resources, but also a social structure that helps to build and disseminate the very ideas and practices on which the sector builds. Scholars in the field of social network analysis, corporate governance and economic geography are invited to contribute to the further development of such a research agenda.

Notes

[1] Due to lack of full data for all countries, we chose to use the rankings in order to 'score' each indicator. This makes comparison less technical, as it only refers to countries as scoring 1st, 2nd etc. This makes reading easy and suffices for the purpose at

hand: testing the concept of using geographical data for measuring market access from a resource dependency perspective. However, follow-up research could make an attempt to gather primary data for all relevant countries in order to provide a more exact assessment.

References

Arent, D. J., Wise, A., & Gelman, R. (2011). The status and prospects of renewable energy for combating global warming. *Energy Economics, 33*(4), 584-593. doi: 10.1016/j.eneco.2010.11.003

Bathelt, H., Malmberg, A., & Maskell, P. (2004). Clusters and knowledge: Local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography, 28*(1), 31-56. doi: 10.1191/0309132504ph469oa

Bergenholtz, C., & Waldstrøm, C. (2011). Inter-organizational network Studies—A literature review. *Industry and Innovation, 18*(6), 539-562. doi: 10.1080/13662716.2011.591966

Borgatti, S. P., Everett, M. G., & Freeman, L. C. (2002). *Ucinet for windows: Software for social network analysis*. Harvard: Analytic Technologies.

Buerer, M. J., & Wuestenhagen, R. (2009). Which renewable energy policy is a venture capitalist's best friend? Empirical evidence from a survey of international cleantech investors. *Energy Policy, 37*(12), 4997-5006. doi: 10.1016/j.enpol.2009.06.071

Carroll, W. K., & Carson, C. (2003). The network of global corporations and elite policy groups: A structure for transnational capitalist class formation? *Global Networks, 3*(1), 29-57. doi: 10.1111/1471-0374.00049

Chu, J. S. G., & Davis, G. F. (2011). Who killed the inner circle? The breakdown of the American corporate elite network, 1999-2009. *Proceedings of the 4th Political Networks Conference*, Paper 1. doi: 10.2139/ssrn.2061113

Culpepper, P. D. (2009). *Why business wins. Corporate control and public policy in Europe and Japan*. Book Manuscript.

Davis, G. F. (1991). Agents without principles? The spread of the poison pill through the intercorporate network. *Administrative*

Science Quarterly, 36(4), 583-613.

Davis, G. F., Yoo, M., & Baker, W. E. (2003). The small world of the american corporate elite, 1982-2001. *Strategic Organization, 1*(3), 301-326. doi: 10.1177/14761270030013002

DIREC. (2010). *DIREC report 2010 for up scaling and mainstreaming renewables*. New Delhi: Delhi International Renewable Energy Conference.

Domhoff, G. W. (1967). *Who rules America*. Englewood Cliffs, New Jersey: Prentice-Hall.

Dowlatabadi, H. (1998). Sensitivity of climate change mitigation estimates to assumptions about technical change. *Energy Economics, 20*(5-6), 473-493. doi: 10.1016/S0140-9883(98)00009-7

Epstein, M., Berg, B., & Morello, T. (2010). *Venture debt - another tool for cleantech*. Boston: Mintz, Levin, Ferris, Cohn, Glovsky and Popeo P.C.

Enerdata (2011), Global Energy Statistical Yearbook 2011. Available online: www.enerdata.net.

Energy Information Agency (2008), International Energy Statistics. Available online at: http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=90&pid=44&aid=8.

Fennema, M. (1982). *International networks of banks and industry*. The Hague: Martinus Nijhoff Publishers.

Geletkanycz, M. A., & Hambrick, D. C. (1997). The external ties of top executives: Implications for strategic choice and performance. *Administrative Science Quarterly, 42*(4), 654-681. doi: 10.2307/2393653

Gertler, M. S., & Levitte, Y. M. (2005). Local nodes in global networks: The geography of knowledge flows in biotechnology innovation. *Industry and Innovation, 12*(4), 487-507. doi: 10.1080/13662710500361981

Godfrey, B. J., & Zhou, Y. (1999). Ranking world cities: Multinational corporations and the global urban hierarchy. *Urban Geography, 20*(3), 268-281. doi: 10.2747/0272-3638.20.3.268

Grubb, M., Haduong, M., & Chapuis, T. (1995). The economics of changing course. *Energy Policy, 23*(4/5), 417-432. doi:

10.1016/0301-4215(95)90167-6

Gulati, R., & Westphal, J. D. (1999). Cooperative or controlling? The effects of CEO-board relations and the content of interlocks on the formation of joint ventures. *Administrative Science Quarterly, 44*(3), 473-506. doi: 10.2307/2666959

Haunschild, P. R. (1993). Interorganizational imitation: The impact of interlocks on corporate acquisition activity. *Administrative Science Quarterly, 38*(4), 564-592. doi: 10.2307/2393337

Heemskerk, E. M. (2007). *Decline of the corporate community. Network dynamics of the dutch business elite*. Amsterdam: Amsterdam University Press.

Henriques, I., & Sadorsky, P. (2008). Oil prices and the stick price of alternative energy companies. *Energy Economics, 30*(3), 998-1010.

Hillman, A. J., Withers, M. C., & Collins, B. J. (2009). Resource dependency theory: A review. *Journal of Management, 35*(6), 1404-1427.

Huggins, R., Johnston, A., & Thompson, P. (2012). Network capital, social capital and knowledge flow: How the nature of inter-organizational networks impacts on innovation. *Industry and Innovation, 19*(3), 203-232. doi: 10.1080/13662716.2012.669615

Kogut, B. (2012). *The small world of corporate governance*. Boston: MIT Press.

Marques, A. C., & Fuinhas, J. A. (2011). Drivers promoting renewable energy: A dynamic panel approach. *Renewable and Sustainable Energy Reviews, 15*(3), 1601-1608. doi: 10.1016/j.rser.2010.11.048

Mendonca, M., Lacey, S., & Hvelplund, F. (2009). Stability, participation and transparency in renewable energy policy: Lessons from Denmark and the United States. *Policy and Society, 27*(4), 379-398. doi: 10.1016/j.polsoc.2009.01.007

Mizruchi, M. S. (1996). What do interlocks do? An analysis, critique, and assessment of research on interlocking directorates. *Annual Review of Sociology, 22*(1), 271-299. doi: 10.1146/annurev.soc.22.1.271

Neal, Z. P. (2008). The duality of world cities: Comparing networks,

hierarchies, and inequalities in the global economy. *Global Networks, 8*(1), 94-115.

Pfeffer, J. (1972). Size and composition of corporate boards of directors: The organisation and its environment. *Administrative Science Quarterly, 17*(2), 218-228.

Pfeffer, J., & Salancik, G. R. (1978). *The external control of organizations: A resource dependency perspective*. New York: Harper & Row.

Ragnitz, J., Schmalholz, H., Triebswetter, U., & Wackerbauer, J. (2009). Cleantech in ostdeutschland: Bestandsaufnahme und entwicklungsperspektiven. *IFO Dresden Berichtet, 16*(3), 3-10.

Rao, H., & Sivakumar, K. (1999). Institutional sources of boundary-spanning structures: The establishment of investor relations departments in the Fortune 500 industrials. *Organization Science, 10*(1), 27-42. doi: 10.1287/orsc.10.1.27

Roland Berger. (2009). *Clean economy, living planet: Building strong clean energy technology industries*. Amsterdam: Roland Berger Strategy Consultants.

Schweitzer, F., Fagiolo, G., Sornette, D., Vega-Redondo, F., Vespignani, A., & White, D. R. (2009). Economic networks: The new challenges. *Science, 325*(5939), 422-425. doi: 10.1126/science.1173644

Scott, J. (1997). *Corporate business and capitalist classes*. New York: Oxford University Press.

Stearns, L. B., & Mizruchi, M. S. (1993). Board composition and corporate financing: The impact of financial institution representation on borrowing. *The Academy of Management Journal, 36*(3), 603-618. doi: 10.2307/256594

Stokman, F. N., Ziegler, R., & Scott, J. (1985). *Networks of corporate power.* Cambridge: Polity Press.

Taylor, P. J., Penfei, N., Derudder, B., Hoyler, M., Huang, J., & Witlox, F. (2011). *Global urban analysis. A survey of cities in globalization*. London: Earthscan Publishers.

UNEP SEFI, & New Energy Finance. (2007). *Global trends in sustainable energy investment 2007*. Paris: UNEP.

UNEP SEFI, & New Energy Finance. (2009). *Global trends in*

sustainable energy investment 2009: Analysis of trends and issues in the financing of renewable energy and energy efficiency. Paris: UNEP.

UNFCC, United Nations Framework on Climate Change (2011). *Kyoto Protocol*. Available online at: http://unfccc.int/kyoto_protocol/items/3145.php.

Useem, M. (1984). *The inner circle: Large corporations and the rise of business political activity in the US and UK*. New York: Oxford University Press.

Van Ees, H., Gabrielsson, J., & Huse, M. (2009). Toward a behavioral theory of boards and corporate governance. *Corporate Governance, 17*(3), 307-319. doi: 10.1111/j.1467-8683.2009.00741.x

Watts, D. J. (1999). Networks, dynamics and the small-world phenomena. *American Journal of Sociology, 105*(2), 493-527.

Westphal, J. D. (1999). Collaboration in the boardroom: The consequences of social ties in the CEO/board relationship. *Academy of Management Journal, 42*(1), 7-24.

Windolf, P. (2002). *Corporate networks in europe and the united states*. Oxford: Oxford University Press.

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