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Contents

How to Reap the Benefits of the "Digital Revolution"? Modularity and the Commons

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Abstract

A significant potential of the digital revolution has not been fully realized. A contextual shift has to take place to build institutions that would harness the power of a fundamental aspect of digital technologies: modularity. I show why modularity lies at the heart of digital technologies and describe its strengths and drawbacks. Further, I discuss an emerging mode of production premised on modularity, which may point towards a more sustainable and inclusive digital transformation yet to come.

Keywords: innovation, commons, technological change, industrial organization, manufacturing, sharing economy

1. Introduction

Capitalism is a creative-destruction process that revolutionizes the economic structure from within, destroying the old structure while creating a new one (Schumpeter 1950). Studying the economic history since the first industrial revolution, Perez (2002) suggests that capitalism reinvents itself every 40-70 years. In each reinvention, there is a pattern of a new common sense coupled with a new set of complementary and pervasive technologies (Perez 2002). This new common sense permeates the way people produce, the way they consume, and the way their institutions are organized (Perez 2002).

Perez (2002) argues that capitalism has experienced five technological revolutions[1]:

1. the first industrial revolution based on machines, factories, and canals (initiated in 1771; birthplace: Britain);
2. the age of steam, coal, iron and railways (1829; birthplace: Britain);
3. the age of steel and heavy engineering (1875; birthplace: Britain, USA, and Germany);
4. the age of the automobile, oil, petrochemicals and mass production (1908; birthplace: USA);
5. and the age of information and communication technology (ICT) (1971; birthplace: USA).

Each technological revolution evolves "from small beginnings in restricted sectors and geographic regions" and ends up "encompassing the bulk of activities in the core country or

1 I use the notion of "technological revolution" in the way Carlota Perez and other neo-Schumpeterians use it; meaning "a set of interrelated radical breakthroughs, forming a major constellation of interdependent technologies; a cluster of clusters or a system of systems" (Perez 2010, 189).

countries [birthplaces] and diffusing out towards further and further peripheries, depending on the capacity of the transport and communications infrastructures” (Perez 2002, 15). Each technological revolution leads “to structural changes in production, distribution, communication and consumption as well as to profound and qualitative changes in society” (Perez 2002, 15).

At the beginning of a technological revolution, new technologies erupt in an economy that includes old, maturing and declining industries. The rapid development of such new technologies requires a great deal of finance. This is when a frenzy of investment creates financial bubbles and turbulent times arrive – that is, collapse, recession, and instability (Perez 2002, 2009, 2010). Reflecting on Hegelian dialectics (Hegel 2018), the first period, i.e. the installation period of the revolution, is too “abstract” and thus needs a “negative”, i.e. a process of contextual shift or what Perez (2002) calls a “turning point”. The essential potentialities of the new technologies need to be identified, the fallacies and the unsustainability of the dominant practices need to be recognized, and institutional innovations to occur. The best parts of the installation period need to be rescued and the “negative” to be absorbed.

This contextual shift enables economies to take advantage of the new technologies across all sectors and spread the benefits of the new wealth-creating potential across society. Echoing Hegel (2018), after the “negative” comes the “concrete”: what Perez considers the deployment period that includes synergies among many societal stakeholders. In this period, the governments, entrepreneurs, and the civil society have a clearer understanding of the policies and the changes that need to take place.

So, according to Perez (2009, 2010), since the introduction of the microprocessor (California, November, 1971), and after a nearly four-decade-long paroxystic culmination of market experimentation, we are in the aftermath of two major bubbles (the NASDAQ collapse in 2000 and the financial crisis of 2007-2008) and amid a systemic crisis. The world is at the turning point and needs to reap the full benefits of the digital revolution, create the new fabric of the economy and overcome the tensions that led to two major bubbles (Perez 2002, 2009, 2010) (Figure 1).

This article argues that independently of whether one aims to build a green growth, degrowth, social democratic, communist or any future, one should be aware of a fundamental aspect of the digital technologies: modularity. Modularity is a property that describes the degree that standardized parts or independent units are used to construct a more complex system (Oxford Dictionaries 2019). A system can be an artifact, a structure or even a process. So, such a system is broken into modules of varying degrees of interdependence and independence based on predetermined abstractions and a set of rules or standards.

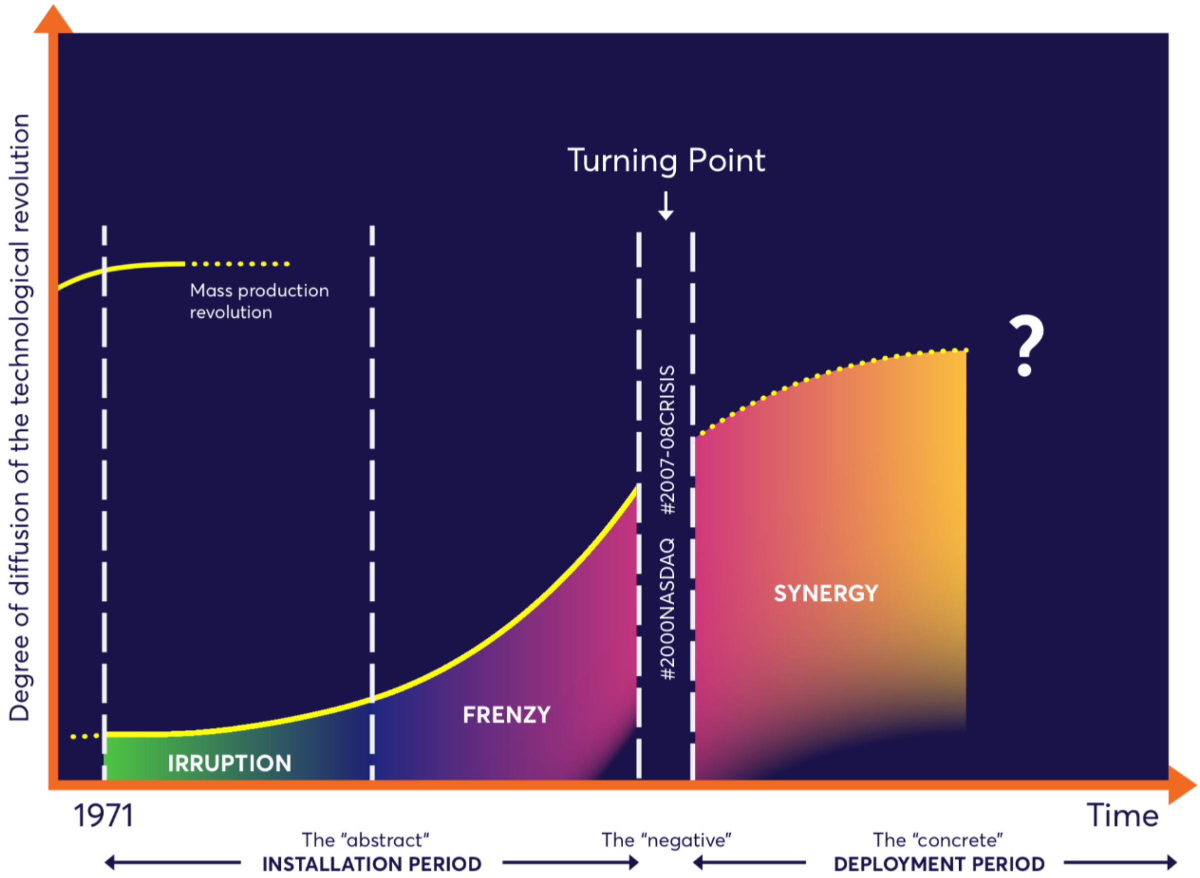

Figure 1: The techno-economic paradigm brought to the fore by the digital revolution is at a turning point, and a contextual shift is necessary.

The digital revolution has engendered radical changes in the production processes in almost all industries (Perez 2010; Kattel et al. 2009). Significantly enhanced technological and organizational capabilities have introduced modularity into production processes and networks (Berger 2006; Kattel et al. 2009). The industry that epitomizes the ICT-driven paradigm is the computer industry. It is thus within the computer industry that such new organizational forms and production processes more effectively taking advantage of the digital technologies have emerged. As discussed below, modularity empowers the leading organizations of the digital revolution.

To spread the benefits of the digital revolution across society, much modularity-oriented institutional innovation is necessary. However, the way that modularity-infused policies and practices are implemented is not politically neutral. This paper argues for commons-based modularity that may reap the benefits of modularity towards a more inclusive and environmentally sustainable paradigm.

Section 2 focuses on the essence of being digital and shows why modularity lies at the heart of digitalness. Section 3 discusses the strengths of modularity, drawing insights from the organizational and industrial ecology literature. Section 4 brings examples that demonstrate an alternative technology model to the profit-maximizing one, to argue that the former can make the best out of digital technologies if the goal is to build institutions that will be inclusive and environmentally sustainable. The last section concludes by summarizing the main messages of this article.

2. Demystifying digital technology

What is digital? Etymologically the word is derived from the Latin "digitus", which stands for finger or toe, and arose from the practice of counting on the fingers (Wiktionary 2019; Oxford Dictionaries 2019). An abstract practice in which each finger is a module. Counting on the fingers is a modular system composed of modules "designed independently but still function as an integrated whole" (Baldwin and Clark 2003, 151). The fingers (modules) are combined, and they compose a set of values. For example, three fingers stand for three and two palms stand for ten. And by using more levels of abstraction, it is even possible to count on the fingers to 99 (see the Chisanbop method from Korea).

Nowadays, digital "describes electronic technology that generates, stores, and processes data in terms of two states: positive and non-positive" (Jansen and James 2002, 130). It can thus be considered a property of representing values as distinct digits rather than a continuous spectrum. The positive and the non-positive values are two discrete digits: 1 and 0. The abstract decision to represent values as 1 and 0 enables modularity. 1 and 0 are modules that contain information: 1 stands for high voltage and 0 for low voltage. When combined they create more complex meaningful structures, using prior infrastructures for organizing and interpreting threads of these two digits. To be digital is therefore to be modular.

So, how digital (or modular) are the technologies that are considered as such? For example, let us compare the digital clock, which displays the time in numbers, to the analogue clock, which indicates time by the positions of rotating hands. In this case, digital refers only to the display. The drive mechanism can either be mechanical or electronic, modular or integrated. Therefore, the digital clock may be partly digital technology. Further, 3D printing is considered a digital fabrication process (Gershenfeld 2012; Kostakis and Papachristou 2014) because, first, some of the drive mechanisms are electronic and, second, a digital 3D model guides the 3D printer. The former contains discrete binary digits translated by the 3D printer's software into a digital object. In this way, the 3D printer builds a physical object. But is 3D printing a digital technology? And if yes, how digital is it?

Gershenfeld (2012; Gershenfeld et al. 2017) compares the assembling of Lego bricks with 3D printing. A child assembles the Lego bricks more accurately than its motor skills would allow. The Lego bricks (modules) are designed to snap together in alignment; they contain information embedded in their design. The Lego bricks are also available in different colors and materials and can be disassembled and reused. On the other hand, 3D printing accumulates errors, has a limited ability to use dissimilar materials, and the 3D printed artifacts cannot be disassembled (Gershenfeld 2012; Gershenfeld et al. 2017). Therefore, 3D printing involves integrated manufacturing that draws upon digital files. Lego demonstrates how processes and structures can be simplified into discrete and interoperable modules.

Hence, when one uses the term "digital", one should be aware of the (co-)existence of various degrees and understandings of digitalness. Being digital is context-specific. So is technology. Technology may not only refer to artifacts, such as the 3D printer, the clock or the Lego bricks. Technology also entails processes, such as designing the technological artifact, and the relevant knowledge, such as the know-how regarding the manufacturing, use, and maintenance of a technological artifact (MacKenzie and Wajcman 1999; Giotitsas 2019). Not only are the technological artifacts that define the current technological revolution less digital than many may think, but their production, use, and maintenance may be less digital, too.

3. The power of modularity

In nature, modularity has been ubiquitous for billions of years – from the construction of the DNA and the RNA by joining together nucleobase modules (adenine, cytosine, guanine, uracil, thymine) to the hexagonal cells in a honeycomb. Modularity has also been ubiquitous in the history of human design and construction: from the neolithic shelters and the pyramids of Egypt to the aqueducts of Rome and the Chinese Great Wall (Gentile 2013).

However, it is in the ICT-driven technological revolution that humanity reached such a level of innovation by building complex products from smaller subsystems, designed independently yet functioning together as a whole (Baldwin and Clark 2000, 2003). Baldwin and Clark (2000) use the computer industry as a case to address the power of modularity because it has the highest degree of modularity compared to other sectors. The degree of modularity describes the degree of coupling between different modules (Persson and Åhlström 2006). Thus, 100% modularity in design means that one function is allocated to one single module while 0% means that all functions are allocated to all different modules (Erens and Verhulst 1997; Ulrich 1995).

The computer includes a perplexing cluster of rapidly changing elements (hardware and software) that function in concert. Modularity enables the handling of this increasingly sophisticated technology. Once a product is broken up into modules, designers, producers, and users gain flexibility while different organizations can work on separate modules knowing that their autonomous efforts will result in a functional artifact (Baldwin and Clark 2000). Modularity, backed-up by ICT, is also increasingly used in other industries, such as in the automotive industry by Toyota and Volkswagen (Pandremenos et al. 2008; Baldwin and Clark 2003), in aircraft manufacturing by Airbus and Boeing (Buergin et al. 2018; Tang et al. 2009), in housing (da Rocha et al. 2015; Priavolou 2018), or in home appliances by Haier (Hamel and Zanini 2018).

Modularity enables different groups to work independently on modules, push deeper into their processes and thus boost the rate of innovation (Baldwin and Clark 2003). The module participants are free to engage in parallel experiments with a wide range of approaches, under the condition that they follow the design rules that allow the modules to fit together (Baldwin and Clark 2003). Therefore, a modular system may offer flexibility and variety in its use and improvement, provided everybody agrees to the overarching rules (Ulrich 2003). This makes complexity manageable by enabling autonomous experimentation in unforeseen ways (Baldwin and Clark 2003). In addition, commonly mentioned benefits of modularity include cutting down the communication or transaction costs due to distributed problem-solving, enhanced reusability, easier and longer maintenance of the artifact, and advanced customization (Jose and Tollenaere 2005; van Liere et al. 2004; Pekkarinen and Ulkuniemi 2008; Gentile 2013; Garud et al. 2003).

Nevertheless, if technology entails the artifact, the production processes, and the knowledge about the use and the maintenance of the artifact, how can modularity be conceived? Building on Bask et al. (2010) and Baldwin and Clark (2003), four types of modularity can be distinguished:

- Modularity in artifact design: It refers to the decomposability of an object into smaller subsystems that may be designed independently but still function together as a whole. For example, see the desktop personal computer that includes the motherboard, the processor memory, the case/chassis, the power supply, the floppy disk etc.
- Modularity in production processes: It refers to the way that the artifact is produced. Production includes the whole value chain of an artifact, from its design to its manufacturing and distribution. Modularity in production is often a result of increased modularity in design (Brusoni and Prencipe 2001). Modularity in design is connected to the outsourcing of tasks; however, it is not clear which begets the other (Campagnolo and Camuffo 2010). For example, see how the parts of an iPhone are produced by several suppliers from Japan, China and Korea to Italy and the USA.
- Modularity in use: It refers to the possibility that the users may have to mix and match modules so that the artifact suits their needs as well as their ability to maintain them. For example, see the modular shelving systems of IKEA that allow the users to build their bookcases by combining various shelves, using glass or wooden covers, adding lighting or substituting a broken shelf with a new one.
- Modularity in services: It refers to a "system of components that offers a well-defined functionality via a precisely described interface and with which a modular service is composed, tailored, customized, and personalized" (Tuunanen et al. 2012, 101). For example, see the Assisted Living Facilities of the Dutch mental healthcare institutions that customizes the residential care people receive to their needs for self-development (Soffers et al. 2014). The healthcare service is decomposed into parts that can be mixed and matched in various ways and thus form a functional whole (Soffers et al. 2014). The modularity in services is an emerging, more complex and context-specific manifestation of modularity (Bask et al. 2010) and may be approached on a case-by-case basis (for a list of diverse case studies of modularity in service see Brax et al. 2017).

So, modularity is not limited to design, but it can also or instead encompass processes of the value chain of an artifact. An organization, an institution or an individual can employ or combine any of these types of modularity. The leading organizations of the digital revolution have arguably gained their competitive advantage, among other reasons, because of the effective integration of modularity into their business models. Modularity allows for-profit firms such as Apple, Samsung, and Amazon to outsource the manufacturing of their products and, in addition to the already stated benefits of modularity, to profit from cheap labor. They may hide the modularity from end-users, and sell the product as a new whole. This enables them to have control over how the modules are integrated into the final product making it hard to swap modules independently.

Further, IBM, Google, and Facebook benefit from crowdsourcing part of their value chain to freelancing or voluntary labor (e.g. the Android ecosystem, the free and open-source software, or the community-based content creation) (Kostakis and Bauwens 2014; Bauwens et al. 2019). Moreover, Haier, the world's largest appliance maker, has adopted a modular form of organization orchestrating a network of hundreds of interconnected micro-enterprises (Hamel and Zanini 2018). Airbnb benefits from modularity, too (Han et al. 2018), offering its customers customized and tailored services (apartment renting, tourist guiding, etc.).

Modularity has also enabled commons-based organizations to scale-up and even outperform their for-profit competitors (e.g. Wikipedia vs. Britannica and Microsoft Encarta, the Apache HTTP Server vs. the Microsoft ISS). Building on Benkler (2006), von Hippel (2016), and Baldwin and von Hippel (2011), I argue that the commons-based initiatives may frequently demonstrate the most effective ways to reap the benefits of the digital revolution. Their commons orientation allows for cooperation beyond the constraints of time and place. A modular understanding of digitalness enables us to explore the deployment of the digital revolution under different political economies. The next section discusses the transformative power of the commons and how they may overcome some of the shortcomings of modularity.

4. The emergence of commons-based peer production: opportunities and challenges

The increasing availability of ICT has made information sharing and grassroots cooperation possible on such a scale that a new mode of production has been emerging: commons-based peer production (Benkler 2006). Commons-based peer production (CBBP) involves Internet-enabled structures that allow people to communicate, self-organize and co-create a commons, i.e. a shared resource, co-governed by its user or productive community according to the rules and norms of that community (Ostrom 1990; Bollier 2014). In CBPP, participants govern the work through participatory practices and create public value that can be used in new iterations (Bauwens et al. 2019).

There is a growing ecosystem of CBPP initiatives. For example, see the free encyclopedia Wikipedia, which has displaced the corporate-organized Encyclopaedia Britannica and the Microsoft Encarta (Silverman 2012; Cohen 2009) or the free and open-source software projects, such as the GNU/Linux that drives the top 500 supercomputers (Top500 2018) or the Apache HTTP Server that is the leading software in the web-server market (Netcraft 2018). While the first wave of CBPP included knowledge and software projects, the second wave seems to be moving towards design, which, when linked to the production of open hardware, can impact manufacturing (Rifkin 2014). For example, see the production of a wide range of artifacts: from low-cost 3D printers that have shaped a multi-billion-dollar market (Reprap 2018; SmartTech 2016; McCue 2018), to agricultural machines for small-scale farming (Giotitsas 2019), to low-cost prosthetic arms, and to off-grid wind and hydro-electric power generators (Kostakis et al. 2018).

One organizational and production configuration for CBPP has been described as "design global, manufacture local" (Kostakis et al. 2015; 2016; 2018). It reverses the industrial logic of restrictive intellectual properties and global supply chains feeding into economies of scale. Instead, intellectual property is, as a commons, accessible to everyone, with knowledge production taking place openly on a global scale. Manufacturing takes place locally by communities or enterprises, often through shared infrastructures and with regional biophysical conditions-needs under consideration. It embraces the idea of circular economies rejecting the decontextualization of inputs-outputs and related externalities. Therefore, the production seems to be oriented towards sustainability and well-being rather than economic growth. Hence, in addition to the large-scale CBPP initiatives such as Wikipedia and GNU/Linux, small-scale initiatives can also be influential on a larger scale as nodes in a commons-based global network of local networks. Grassroots initiatives, which are organized around shareable informational modules, can have both a local and a global orientation.

Modularity is a core characteristic of CBPP (Benkler 2006). For example, on Wikipedia, the content is broken down into smaller components: entries, sections, or paragraphs. People can contribute from one word to thousands of words (or figures). So, the modules allow for any size of the contribution to match different levels of contributors' motivation and time availability – a property called "granularity" (Benkler 2006). Further, it is easy to put the various contributions into the final product. Similar design properties characterize the free and open-source software and the open hardware realm. Modularity enables sharing and human creativity through asynchronous and synchronous collaboration, going beyond the limitations of time and space. To quote Manzini (2013), "the small and the local, when they are open and connected, can, therefore, become a design guideline for creating resilient systems and sustainable qualities, and a positive feedback loop between these systems". Hence, in addition to "scaling-up", CBPP initiatives are "scaling-wide".

To illustrate, from a modularity perspective, the relations forged by the emergence and the interaction of diverse CBPP ecosystems, I use the case of Farm Hack. The reason is that Farm Hack is about agriculture and is thus related to all three economic sectors (primary: production of raw materials; secondary: manufacturing; tertiary: services). Moreover, it is directly and indirectly connected with a wide range of different CBPP initiatives. Hence, it is a paradigmatic case (Mills et al. 2010). The information regarding this initiative is drawn from Giotitsas (2019; personal communication), who did an in-depth study of Farm Hack, as well as from the openly available material on its website (Farm Hack 2019).

Farm Hack is a community of farmers which promotes tools and machinery designed and developed following the open-source principles. It emerged as a collaborative effort of farmer activists in the USA to brainstorm and produce ideas for various tool-related problems on a farm. Since 2011, Farm Hack has grown to include a large and decentralized community comprised mostly of farmers. The Farm Hack community built a digital platform based on free and open-source software. The platform functions as a communication, coordination, dissemination, and technology-development tool. It is primarily a database of tools that have been built, modified and shared by the community. The tools are available under a Creative Commons license for everyone to freely use and modify, under the condition that they will release the designs under the same license.

Farm Hack also brings together farmers, designers, engineers, academics and activists in events to engage in dialogue; skill development; tool design, building and demonstration. Farmers from all over the world have contributed to the Farm Hack platform, which, at the time of this writing, contains more than 500 tools. Several of these tools involve the use of other CBPP projects, such as a Fido Cellular[2] (includes an Arduino microcontroller) or a Seeder

2 https://farmhack.org/tools/fido-temperature-alarm-sends-text-messages

Roller[3] (printable by a RepRap 3D printer). The content (along with the platform itself) is open to improvement or modification from whoever joins the platform.

The Farm Hack community has a local orientation and impact while it shares its intangible resources as a global digital commons. Thus, we observe the emergence of synergetic collaborative networks such as those described by Manzini above (2013; and for a detailed discussion see his 2015 book). For example, Farm Hack is connected with another similar community from France, L'Atelier Paysan. L'Atelier Paysan is a cooperative that develops commons-based farmer-driven technologies and practices. Together, Farm Hack and L'Atelier Paysan improve the same digital commons. Further, more communities from other parts of the world have been joining this network, which is not officially established but mostly works in an asynchronous collaborative manner. Each initiative has its unique characteristics, as each is born in and is influenced by its context-specific environments, although all may be oriented towards similar goals (for an in-depth discussion of Farm Hack's and L'Atelier Paysan's culture and characteristics, see Giotitsas 2019).

So, the Farm Hack platform is based on and consists of the following modules produced by other CBPP initiatives (the list is indicative):

- Software produced by CBPP communities: Drupal (which integrates a Wiki), Wordpress, Apache Web Server.
- A license produced as a commons by the Creative Commons community.
- Designs, bill of materials, manuals and software of tools for small-scale agriculture, from sensors to cultivating machines, produced as a commons by the Farm Hack community and other CBPP communities, such as L'Atelier Paysan.
- The Web and the Internet infrastructure that, in no small extent, is a commons.

Following the four types of modularity, Farm Hack may exhibit:

- Modularity in design: Some of the tools follow a modular design, others follow an integrated design strategy. This may depend on which strategy is the most appropriate for the producer/user to achieve their goals.
- Modularity in production: The design and manufacturing capacities for building the tools are distributed (commonified) and thus modularized. This distribution differs from a mere distribution of tasks across the supply chain (e.g. cases of globalized assembly of parts), which alone does not necessarily lead to a high degree of modularization. The critical factor is frugal and transparent design, which provides agency to various levels and qualities of technical capacities and expertise to participate in the production.
- Modularity in use: The user is free to improve the design and adjust the manufacturing to their needs and resources, also considering the local biophysical conditions and materials. The technological artifact may serve more than one purpose at the same time with the necessary adjustments. Also, its maintenance is arguably easier, as all knowledge is open, and the user, maybe with the help of an expert, can freely study its inner workings and thus maintain the tool without being locked in.
- Modularity in service: The Farm Hack platform provides support and community-building services, which facilitate the building-up of social relations (social commons). It offers

3 https://farmhack.org/tools/seeder-roller-generator-jang-seeders

varying degrees of utility, e.g. people can participate in workshops to learn how to build tools; they can organize them and build their tools; but they can also buy pre-assembled parts or whole tools ready to use. They can thus benefit from the Farm Hack value chain at will. The platform also includes a shop, which promotes entrepreneurial activity in line with the Farm Hack spirit and ideology.

One key difference of CBPP initiatives, such as Farm Hack, from traditional for-profit ones is that the former primarily produce use-value for their communities (von Hippel 2016; Benkler 2006; Bauwens et al. 2019). Their aim is not to maximize profits, but to maximize the sharing and impact of the community-built value. The commons orientation has the potential to address some of the shortcomings of modularity as identified by studies of for-profit implementations.

First, CBPP products are not intentionally designed to become obsolete (Kostakis et al. 2018); of course, one may want to create a product to last as long as possible but eventually fail to do so. The motivation to design for sustainability may address the negative environmental impact of certain modular products due to the planned obsolescence coming from the continual introduction and replacement of modules. To increase profits, some companies may adopt such practices (Agrawal and Ülkü 2013). This depends on the incentives of the producer and the over-arching political economy.

Further, another challenge is that a modular product is easy to be copied or imitated by competitors. Hence, some companies may choose to follow an integrated product architecture to keep the relevant knowledge inside the company and avoid imitation (Persson and Åhlström 2006; Seliger and Zettl 2008; Lau 2011). In the for-profit-maximization setting, critical design knowledge and expertise may also be transferred to suppliers (Shamsuzzoha et al. 2008), with whom the outsourcing company may stop cooperating. In CBPP, all knowledge is commonified, thus, such dangers do not exist. Knowledge is not a rival but an anti-rival resource because sharing enhances its value (Bauwens et al. 2019; Benkler 2006; Baldwin and von Hippel 2011). Shared knowledge may enable designers, who are also the users of the product, to have a thorough understanding of the inner working principles of the overall product or process. So, learning may be faster and product development less expensive as a result of permissionless collaborative efforts.

Moreover, Sonego et al. (2018) highlight the need for user-driven design so that the users become more engaged in the maintenance of the product and the producers understand when and how to implement modularity. In CBPP, users are often actively consulted in every step of the technological development process or are the ones developing the artifacts (von Hippel 2016; Giotitsas 2019).

Besides, modularity may hinder optimization (Gershenson et al. 2003; Lau 2011; Pandremenos et al. 2012). By containing redundant physical structure, modular designs may not exploit as much function-sharing as is possible (Ulrich and Seering 1990; Ulrich 1995). For instance, in an automobile, if the alternator and the engine are designed as separate modules, more physical structures (e.g. support bracket, alternator housing) associated with the alternator are needed. In an integrated design, the former would be enclosed in the engine block (Ulrich 1995). In CBPP, shared knowledge and designs create a broader spectrum of options for module functionality and association, while common "protocols" guide their fixation in the integrated structure. Also, the possibility for localized manufacturing with the freedom to adapt and adjust the knowledge into the local setting (desirable product architecture, culture, environment, needs, materials) may allow for further functional and cultural optimization and customization. Hence, the integrated design optimizes “at the center”, i.e. focusing on the pre-engineered function of the artifact; CBPP delegates optimization processes “at the edges”, following the user perspective rather than engineering requirements. The abovementioned “design global, manufacture local” configuration bears such a dynamic (Kostakis et al. 2015; 2016; 2018; Giotitsas 2019).

CBPP is an emerging phenomenon, and thus more research is needed to provide robust evidence and a deeper understanding of its dynamics and limitations. Kreis, Finn and Turner (2011) discuss the limits of CBPP and highlight unaddressed issues of the phenomenon. For example, under which conditions may CBPP be a subtly coercive expansion of the workplace into everyday life? Does CBPP develop institutional mechanisms that secure bureaucratic values such as inclusion and accountability? What is the power or influence of the emerging charisma-driven clans?

Moreover, so far, CBPP does not directly address the criticisms and problems of ICT regarding resource extraction, exploitative labor, energy use or material flows (Kostakis et al. 2018). Even the argument that CBPP does not include planned obsolescence rests on poor empirical data (Kostakis et al. 2018). In addition, CBPP currently cannot, and probably will not, substitute all production processes nor work better than centralized infrastructures in specific contexts (Kostakis et al. 2015).

Further, some of the shortcomings of modularity, such as path dependence and inertia that may discourage innovation (Gärtner and Schön 2016; Bonvoisin et al. 2016) or increased assembly errors (AlGeddawy and ElMaraghy 2013), were not discussed in the context of CBPP. There is not enough evidence even to identify a tendency for or against these shortcomings. Last, this article did not address the cultural aspects of technology, for instance the acceptance or varying meanings of certain artifacts, shapes, processes, or functionalities (a treatise of the cultural and social aspects of CBPP technologies can be found in Giotitsas 2019).

5. Conclusion

Modularity is a fundamental aspect of digitalness. It has existed since the creation of ancient human-made artifacts; however, it is in the digital era that the division of human labor is increasingly infused with modularity. Much discussion has been taking place around new technology-focused buzzwords and concepts, arguably without paying enough attention to the organizational potentialities of modularity. CBPP exemplifies one of these potentialities.
CBPP presents dynamics that harness digital technologies by promoting non-coercive cooperation. CBPP questions the basic mainstream economics mantra that humans seek individual profit maximization when engaging in productive activities. It also challenges the conventional organizational structures of property-based, market-regulated organizations.

To take advantage of “clean” and more “inclusive” modularity, we need major institutional innovations that require tremendous political support both top-down and bottom-up. The CBPP communities are already here, so are the prefigurative forms of a new mode of production. If the goal is the deployment period of the digital revolution to be democratic, innovative, and environmentally sustainable, CBPP appears as a qualitative leap that could inspire policy-makers, scholars, and practitioners to build institutions for the deployment period and a new paradigm yet to come.

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Impact of Climate Discourse on National Scientific Networks in Energy Technologies: The Case of Estonian Science and Industry Linkages

PIRET TÕNURIST, KAIJA VALDMAA, RINGA RAUDLA

Abstract

This article examines how the global climate change discourse influences the implementation of national science policy in the area of energy technology, with a focus on industry and science collaborations and networks. We develop a set of theoretical propositions about how the issues in the global discourse are likely to influence research agendas and networks, the nature of industry-science linkages and the direction of innovation. The plausibility of these propositions is examined, using Estonia as a case study. We find that the global climate discourse has indeed led to the diversification of research agendas and networks, but the shifts in research strategies often tend to be rhetorical and opportunistic. The ambiguity of the global climate change discourse has also facilitated incremental innovation towards energy efficiency and the potentially sub-optimal lock-in of technologies. In sum, the Estonian case illustrates how the introduction of policy narratives from the global climate change discourse to the national level can shape the actual policy practices and also networks of actors in a complex and non-linear fashion, with unintended effects.

Keywords: climate change, environmental technologies, clean technologies, energy technologies, science policy, innovation, policy feedback

1. Introduction

In the scholarly literature on climate change, the discursive construction of problems and the ensuing policy changes have received increasing attention (Dayton 2000; Lorenzoni and Benson 2014; Reusswig 2010). In particular, using the insights from discursive institutionalism (e.g. Schmidt 2008; 2010), it is argued that in order to understand and explain policy change, we have to examine the effects of discourse and the role it plays in bringing about changes (e.g. Lorenzoni and Benson 2014; Hope and Raudla 2012). According to discursive institutionalism (DI), the term "discourse" covers the substantive content of ideas and also the interactive processes in which the ideas are construed and communicated (Schmidt 2008; 2010). While a variety of approaches in social sciences have explored the role of discourse in politics and policy (see, e.g., Leipold and Winkel 2017 for an overview), DI also pays attention to how policy discourses become *institutionalized*. Although the role of discourse in explaining policy change has been examined in many studies by now, there are fewer studies that look at how discourse affects policy *implementation* at different levels of governance (for exceptions, see, e.g., den Besten et al. 2014). This paper hence seeks to contribute to the DI discussions about how a discourse that has evolved at the global level can influence the implementation of a policy in a specific policy domain at the national level.[1]

In particular, the goal of the article is to analyze the effects of the global climate change discourse on the implementation of national policies. As the solutions to climate change are high-technology-centered (Wesselink et al. 2013), we selected the science policy domain for our analysis (Shackley and Wynne 1995; Demeritt 2006). Within the broader *domain* of science policy, we zoom in on the specific policy *field* of energy technologies, since it is regarded to be the most important sub-field of climate-related technologies (e.g. Kuehr 2007; Ekins 2010). Given that the global climate change discourse entails competing sub-discourses – with one narrative focusing on environmental problem-solving and another being more business-oriented – it would be insightful to examine how these competing approaches influence the actual policy implementation in a specific country. Our paper argues that the introduction of policy narratives from the global climate change discourse to the national level can influence the actual policy practices and also networks of actors in a complex and non-linear fashion, with various unintended effects.

When looking at the effects of the discourse on policy implementation it is important to explore how different aspects of the discourse influence the *networks* of actors involved in the policy domain, since it is the interactions within those networks that can play an important role in influencing the eventual policy outcomes. This is particularly pertinent in the domain of science policy due to the high inter-dependence between industry and R&D facilities. The existing studies that have looked at the effects of the climate change discourse on science policy have primarily focused on climate technology transfer as part of low-carbon, renewable technology diffusion (Karakosta et al. 2010) but have ignored the effects on the dynamics of networks, which encompass a broad range of actors engaged in these climate-related technologies (policy makers, enterprises, research institutes, universities etc.) and are responsible for the actual innovative activities (Taylor 2008). Studies in evolutionary economics (Schmidt et al. 2012) have tried to address parts of this research gap, but the interdependence of R&D goals and the direction of innovation have not received enough attention. Also, these studies have not focused on the role of discourse in shaping the developments. Furthermore, when it comes to energy technologies they are usually studied from a technology-centric approach by innovation scholars (e.g. technology innovation systems, e.g. Gallagher et al. 2012), which does not fit the multi-disciplinary logic of climate-related technologies. Especially regarding clean technologies, multi-disciplinary scientific networks are rarely studied, and more emphasis has been put on company collaborations (Caprotti 2012).

Thus, in this paper we will focus on the dynamics of collaborative scientific networks (in particular industry and science collaboration (ISC) or industry-science linkages (ISL)). In the theoretical part of the paper we will develop a set of propositions about the effects of the global climate change discourse on the implementation of science policy in the field of energy technologies. The plausibility of these propositions will then be examined by looking at the case of Estonia. The case study of Estonia presents an opportunity to explore the effects of the changes in the global policy discourse in a small-country context that, first, had no significant environmental policy prior to the 1990s; and, second, had, until the beginning of the 2000s, a mono-technological energy sector with a very high GHG impact. Thus, it would allow us to

1 "A policy domain" is "a component of the political system that is organized around substantive issues" (Burstein 1991, 328).

trace the effects of the global climate change discourse on local policy implementation in a particularly pure form.

The paper proceeds as follows. In section 2, we identify the main trends in the global climate policy discourse that are relevant for the scientific networks in the field of energy technology and develop a set of propositions about how the discursive elements are likely to affect the implementation of science policy in energy technologies. In section 3, we present the methodology used for the Estonian case study (descriptive network analysis, structured interviews, analysis of documents and projects), followed by the empirical analysis in section 4. Section 5 provides a concluding discussion.

2. Global climate change discourse and shifts in the implementation of national science policy

2.1 Global climate change discourse: relevant aspects for science policy in energy technologies

According to the global climate change discourse, human activities (including the burning of fossil fuels and clearing of forests) have led to the concentration of green-house gases (GHGs) in the atmosphere, which, in turn, is affecting the global climate (for overviews, see, e.g., Dayton 2000; Reusswig 2010). Thus, according to the global discourse, which has become institutionalized in the Kyoto Protocol, governments should take steps to reduce the emission of GHGs. There are, by now, numerous studies which discuss the emergence, institutionalization and impacts of the global climate change discourse (Caprotti 2012; Wittneben et al. 2012). In this paper, we zoom in on those aspects of the global climate change discourse that are likely to affect the implementation of science policy in the field of energy technologies.

A core element of the global climate change discourse is advocating for the development and adoption of more energy- and other resource-efficient technologies that have a reduced or zero effect on the environment. There are, however, several issues with the dominant global climate change discourse that are likely to influence the implementation of science policy in the field of energy technologies.

First, the problem of climate change has been framed as a “global issue”, in need of “global solutions” (Miller 2004) and rethinking the whole system (Johnson and Suskewicz 2009). Such discursive constructions, however, have increased ambiguity on the national policy level in terms of the course of actions that should be taken (see Figure 1 for the core elements of the global climate change discourse).

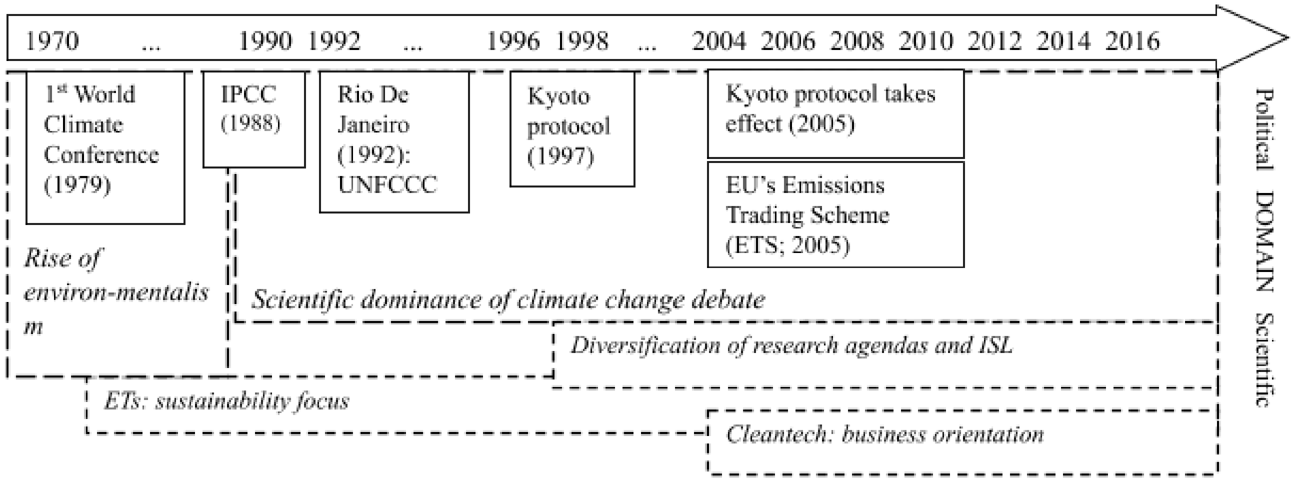

Figure 1: **Climate change: main political agreements and evolution of trends/elements in the global climate change discourse**

Second, one of the main deficiencies in the dominant discourse is the fact that through the Intergovernmental Panel on Climate Change (IPCC) and the Kyoto Protocol it has become a very linear discourse concentrated around science policy (e.g. Pielke 2010; Beck 2011), as opposed to also encompassing technology policy (and interactions between science and technology). The dominant narrative is that since it is scientifically proven that some technologies produce more greenhouse gases that have a clear effect on the climate, if we change the technologies it is possible to reduce the emission of GHGs. In other words, it has been argued that a simple “technical fix” is possible from an objective, value-neutral scientific approach (Wesselink et al. 2013), and too little attention has been paid to various policy goals, political commitment, and allocated means. The various policy goals can encompass more socially oriented objectives, like cleaner environment or equal resources for all (including future generations), or more business-focused goals, like fostering new innovative and clean energy technology sectors for boosting the implementation of basic science, or supporting fossil fuel power plants for the stability of the energy system. All of these policy directions can have either a short- or a long-term focus (depending on the level of political commitment) and can receive direct or indirect financial support, short- or long-term investment security – which all influence science, technology and innovation policy around energy technologies.

Although the time period of this analysis covers 1998 to 2012, a more recent development, the Paris Agreement (UNFCCC 2015) adopted in 2015 under the UNFCCC for tackling climate change beyond 2020, deserves special attention as it is one clear result in the long line of the Conferences of the Parties (COPs) of UNFCCC comparable to the Kyoto protocol and, for example in the context of EU strongly related with the Energy Union priority, making energy more secure, affordable and sustainable for all (European Commission 2017). Even more remarkable is the new EU energy legislative framework – the Clean Energy for All Europeans package – which has been concluded on all aspects, and the updated 8 legislative acts will be formally adopted in the first part of 2019 (European Commission 2019). The main aim of the package is to facilitate the clean energy transition of the 21st century, make a significant step towards the creation of the Energy Union and deliver on the EU’s Paris Agreement commitments.

Third, although the global climate change discourse includes clear social goals – at least when it comes to GHG-reduction – it also entails considerable ambiguity with regard to what technologies would fall under climate-related technologies and climate-crisis led innovation (see Figure 2). Specifically, we can encounter terms like "clean", "green" or even "eco" and "sustainable" technologies (e.g. UNCED 1992; OECD 1995; Kuehr 2007). Within the "climate crisis"led innovation debate these terms are sometimes used interchangeably (Kuehr 2007; Carrillo-Hermosilla et al. 2010; Schiederig et al. 2012), while they may actually signify very different technologies, in terms of their nature (high vs low tech), maturity level and investments required. This ambiguity of the global discourse, in turn, is likely to influence the implementation of energy technology policy at the national level.

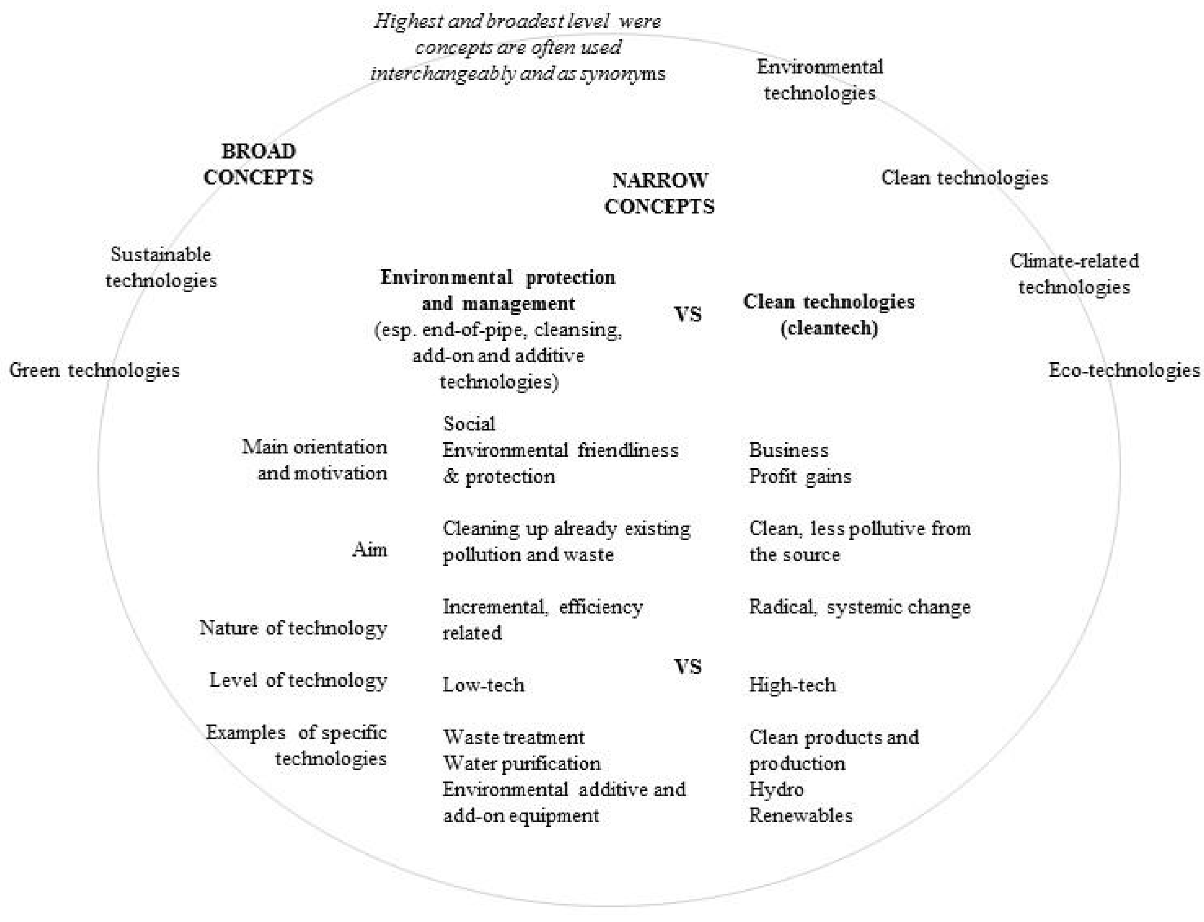

Figure 2: **Links between different concepts of environmental technologies, their level of technological intensiveness, radical and incremental innovation, etc**.

Fourth, the global climate change discourse entails competing sub-discourses: one narrative focuses on environmental problem-solving and another is more business-oriented (Caprotti 2012; Okereke et al. 2012; Kuehr 2007; O'Rourke 2009). These narratives, in turn, have different implications for what kind of innovations should be fostered. Following the environmental problem-solving narrative would mean that the focus should be on social goals and the development of *environmental protection and management technologies* ("environmental protection technologies" from now on) and more precisly *end-of-pipe* type (aimed at cleaning already existing pollution and waste), while the business profit-centered narrative would favor the focus on technologies that are already clean from their source – *clean technologies* or *cleantech* in short. Due to the ambiguity of terminology pertaining to the different technologies (as explained in the previous paragraph), these different narratives, with their different underlying logics, may not necessarily be explicitly acknowledged in national level policy-making, which may lead to ambiguity in what kind of innovations and research should, in fact, be fostered to combat climate change. However, these different approaches can lead to very different results of innovation, both in terms of cost efficiency and ethical concerns (e.g. equity across generations in terms of available energy resources).

In the existing studies, only limited attention has been paid to how the global climate change discourse would influence the implementation of science policy. Some find that the global climate change-led discourse has not changed the academic world formally to a large degree, maintaining that environmental innovation research is still in its infancy (Andersen 2008, 3), while others argue that the climate-crisis debate has increased the role of so-called sustainability science (Komiyama and Takeuchi 2006), which is more the case in the fields of *environmental protection technologies* rather than *cleantech.* In the following, we will discuss in more detail what the implications of the above-mentioned issues in the global climate change discourse are likely to be for scientific networks/ISL in the field of energy technologies.

2.2 Diversification effects and shifts in research strategies

The ambiguity of the broad terms like "climate-related", "sustainable", "green" or "environmental" technologies (which are used interchangeably as broad synonyms in this article) and not defining specific technologies under these loose areas in the global climate change discourse can lead to the same ambiguity in designing and implementing technology programs at the national level. Specifically, the ambiguity problem of "clean" vs "environmental protection and management" technologies in the global climate discourse (described above) can carry over to the policy field - as technology programs are also usually concentrating on broad areas like "climate-related" technologies. Such a broad approach, however, can become a challenge for the traditionally mission-oriented government policies like science policy (and science funding). The mission-oriented nature of policy means that it sets specific goals and outlines concrete activities to achieve these goals.

More specifically, we can make the following predictions about the effects of the global climate change discourse on the implementation of science policy in energy technologies. Due to the ambiguity in the global climate change discourse about what technologies should be fostered to combat climate change (UNCED 1992; OECD 1995; Kuehr 2007; Ekins 2010), most technological innovations are assumed to lead to higher efficiency and some environmental benefits. In practice this means that researchers usually define their own industry and technology categories to describe the "green" or "clean" sector. We can also observe that fields like ICT, chemistry, and material sciences have moved closer to environmental sustainability with the rise of green chemistry, green ICT, and green material technologies. Our first set of predictions is, hence, that the discursive ambiguity at the global level would lead to the *diversification of research agendas and ISL* at the national level. Due to the multi-disciplinary nature of the technologies under the "umbrella" of climate change, there is likely to be a diversification effect in the research areas of energy technology (Proposition 1.1). This means that a very wide range of research in terms of fields, but also levels (from basic to applied), can be undertaken under the broad area of climate change and environmental sustainability. The research topics can range from low-tech environmental protection technologies like end-of-pipe and additive technologies to totally pure high-tech clean technologies like hydro technologies. In addition to the diversification of research topics, we would also expect a diversification effect in the collaboration networks and ISL (Proposition 1.2). The diversification effect means that collaboration networks and ISL can have very diverse structures and working logics: basic vs applied, low vs high tech, short- vs long-term, close to the market vs far from the market. What structures and logics are used in specific ISLs (also what business model and direction of innovation is taken) depends on the research areas of ISL (social orientation vs business focus and incremental vs radical innovation direction taken) (see further explanations in sections 2.3 and 2.4).

Second, the global climate change discourse is likely to influence the priorities expressed in the national level science policy – i.e. the funding programs would specifically emphasize that funding is provided for research that helps to mitigate or combat climate change (Bailey et al. 2011; Bailey and Wilson 2009). In the implementation of science policy, in turn, this can lead to the adoption of different strategies by the research groups. On the one hand, we can expect that research groups genuinely change their research agenda and also form new research networks, according to the research funding priorities expressed in national policies, which emphasize the development of technologies that help to combat climate change (Proposition 2.1). On the other hand, we can expect that the existing research groups respond strategically to the funding incentives and try to show, rhetorically, that the research they are doing is connected to climate change (thus, for example, traditional energy research groups would adjust their activities, at least nominally, to show that they are doing research on environmental or clean technologies) (Proposition 2.2).

2.3 New business models and corporate influence: social vs business focus

It is important to differentiate the newest concept that has been used above – “*cleantech*” - from other environmental technologies (focused mainly on environmental protection and ethics) due to its business-model orientation (see Caprotti 2012). Its main idea is that the end result should be qualitatively “cleaner” and more resource efficient, which may not be the case of traditional ETs first popularized in the 1970s and 1980s (Schot 1992). Examples of traditional ETs include environmental protection technologies like end-of-pipe technologies (pollution treatment) (Yarime 2003) or environmental additive equipment[2], which may actually speed up resource depletion (Frondel et al. 2007).

The rapid emergence of the concept of *cleantech* in the US at the beginning of the 2000s can be linked to purposeful activities of a small range of institutional entrepreneurs within the global climate change discourse, promoting a “business model” that pulls together a range of technologies that have both economic and environmental value (Cleantech Group 2007; O’Rourke 2009; Cleantech.org 2015). Since this new sector is multi-disciplinary and relies strongly on networks and different interdependent institutions, it has significant implications for the implementation of science policy.

2 Under environmental additive equipment or environmental additive technology we mean add-on measures and solutions that do not reduce resource use and/or pollution at the source by using cleaner products and production methods (like cleantech does) but instead curbs pollution emissions by implementing add-on measures – this is what end-of-pipe technologies do (Frondel et al. 2007).

Consequently, if we look at the members of ISL and recall the difference in the global discourse about business-oriented cleantech vs socially motivated environmental protection, there may be very different firms taking up "greening" activities (e.g. cleantech vs environmental protection) responding to the climate change discourse, signaling their own interests to policy makers and bringing in specific goals, motivation and technical capabilities to ISL (Kemp and Foxon 2007). This leads us to our third set of propositions, which argue that the nature of ISL can vary considerably, depending on the motivation and nature of the collaborating company (i.e. whether it comes from environmentally motivated "traditional" environmental protection technology or the more recent, business-model-based *cleantech*).

Especially during the last decade, a firm-centric and market-driven approach to value capture has emerged in the global discourse, which is a highly profit-oriented approach ("do well by doing good", Richtel 2007). From the social perspective, it is not important which reasons are behind the adoption of clean technologies in response to climate change (whether they are purely environmental or more profit-oriented); thus, regularly the motivations of firms are not discussed in analyses of eco-innovations (Berkhout 2005). However, from the perspective of potential policy feedback and influence on science policy/direction of R&D (e.g. from the perspective of ISL, the incentives to invest, technologies and time-frames), the different motives (environmental protection vs business orientation) can play a considerable role. On the one hand, ISL with the *cleantech* sector can be expected to be *longer* and more durable due to the more complex, transformative investment into high-tech (Proposition 3.1). On the other hand, an opposite effect could be expected due to the strong *business nature* of *cleantech* ventures – meaning a push for ready-to-market collaboration with research units and, thus, short-term contracts between research units and industry (Proposition 3.2). When the ETs in question within an ISL are additive and efficiency-related (especially in the case of end-of-pipe technologies), collaborations close to the market can be expected because additive (also add-on) technologies are more incremental and do not need as much R&D and innovation as radical *cleantech* (Proposition 3.3) (links between incremental and radical innovation and ET-s are explained in the next section).

2.4 Direction of innovation: incremental vs radical change

The energy sector depends on complex and often very expensive technologies for which it is hard to make adoption decisions before acquiring the technology (Cowan and Daim 2011). It is not characterized by rapid technological change, but is among one of the lowest innovation-intensity sectors in the world (Jamasb and Pollitt 2011), where similar technologies have dominated the sector over a century. This makes the long-term direction of R&D (its transformative nature) more essential than the rate of innovativeness (market adoption, etc.) that is generally analyzed in connection to ETs. The problem with translating radical changes from basic science into workable solutions in a sector with many network barriers is substantial.[3] Yet, due to the "linear" and "value-neutral" technical approach of the global climate change discourse (Wesselink et al. 2013) and the multi-disciplinary nature of ETs, far more attention has been paid to the *rate* of innovation rather than the overall *direction* or the transformative[4] nature of innovation (Johnstone 2005, 21) in the global climate discourse.

3 The multitude of systemic problems of technology diffusion in the energy sector is well described in Negro et al. (2012).

4 Incremental innovation entails step-by-step additive improvements that do not distrupt the underlying system. Radical innovation disrupts the system and thus, in most cases gives it a new technological, organisational or other direction (Garcia and Calantone 2002). The rate of innovation does not refer to incremental or radical change but the level of activity taking place (Popp et al. 2010, 878); it often includes measures such as new products reaching the market, yearly patent volumes or market penetration rates. It would be, however, important to also look at how transformative the underlying technologies are: do they really switch the overall value chain to carbon neutrality or not, do they have the potential to distrupt the status quo (i.e. provide a new direction for the functioning of the energy system)?

However, a distinction between *incremental* and *radical* innovations should be made in assessing the change in the direction of overall innovation produced by the policy momentum related to the global climate discourse. It plays a significant role in discussing ETs in the energy sector, especially when technological solutions for the reduction of carbon emissions are considered. As such, environmental technologies can encompass both product innovations (Ekins 2010) and simply additive (end-of-pipe) and process-integrated technologies (Hemmelskamp 1997). In other words, the innovation can range from more radical cleantech, where new and cleaner or totally clean (from their source) technologies are introduced, to more incremental environmental protection and end-of-pipe technologies, which are add-on or additive technologies that clean up already existing waste and pollution (also called cleansing technologies), but they do not have to be "cleaner" in their essence. Whether science policy is focusing on cleantech or end-of-pipe technologies may have very different effects on the long-term direction of innovation. Thus, for example, end-of-pipe technologies in energy technologies such as the carbon capture and storage (CCS) may be reinforcing lock-into fossil fuels (Unruh and Carrillo-Hermosilla 2006; Markusson 2011). Also, if policy implementation focuses only on incremental innovation and low-ambition end-of-pipe and additive technologies there might be no chance for radically new energy technologies to emerge.

Coming to our last set of propositions, as innovation activities differ depending on the specific conditions of existing competition, market strategy and on the maturity of the technology involved, and most importantly, depending on the nature of technology researched – end-of-pipe technology focused on incremental and cleantech on more radical innovation (Kuehr 2007; Markusson 2011; Hellström 2007) – also different directions of innovation can be expected of ISLs in the *energy sector*. On the one hand, in the implementation of science policy in the field of energy technologies, in cleantech, totally new ISLs might emerge that have a radical direction of innovation (Proposition 4.1). On the other hand, ISLs in traditional cleansing, efficiency-related and additive end-of-pipe energy technologies are likely to have an incremental innovation direction (Proposition 4.2). Radical changes in innovation directions have a higher probability to produce new products and processes that are cleaner in their essence, while incremental changes in direction are likely to contribute to "sailing effects" of traditional energy technologies. The "sailing effect" creates a situation where the threat to the traditional technology of being displaced by new technology triggers investments in the old established technology, increasing its performance (De Liso and Filatrella 2008). This, in turn, can also lead to lock-in of technologies and non-optimal solutions for the energy sector.

The distinction between incremental innovation (end-of-pipe technology focus) and radical innovation (cleantech focus) under the broad range of ETs is important to understand because radical innovation – clean technologies – may require large up-front investments. As such, it should present more lucrative business opportunities, but it would also be much more capital intensive and there would be longer time frames connected to such investments, which can be far from commercialization. Hence, since it is radical in nature, many *cleantech* start-ups are university spin-offs (e.g. van Geenhuizen and Soetanto 2012). This, moreover, means that non-emitting technologies (being also a synonym of clean technologies) have far steeper learning curves (Junginger 2010), and support measures are needed to catch up with the profitability of current technologies (Azar and Sandén 2011).

3. Research methods

In order to examine the effects of the global climate change discourse on the implementation of science policy in the field of technology policy in Estonia - specifically on research topics, collaboration and networks, and ISL - we adopted the research strategy of a case study. Using a case-study approach to explore our research question is appropriate given that it allows us to explore a range of different factors at play in a holistic way and also to take into account the country context (del Río González 2009; Yin 2013). A variety of data sources also helps to describe economic and social relationships between firms and R&D units and the change in the direction of technologies that is central to our research interest. In line with the case-study approach, we used a variety of data sources in our analysis, including existing studies, secondary data, structured interviews, media articles, policy and project documents, and network analysis. Our analysis covers the time period from 1998 to 2012.[5] As more rigorous environmental goals strongly entered the Estonian energy sector with joining the EU in 2004 (Tõnurist 2015), the change in policy paradigm is best captured by the aforementioned timeframes. In addition, as Estonia achieved its renewable energy goal of 2020 (25% in gross final energy consumption) already in 2011 (Eurostat 2019) it created additional academic interest in how the dynamics in the ISL reflect the statistics. For the structured in-depth interviews, the 11 most salient research groups in energy technologies and their collaboration networks with companies in the ETs/clean technology sector in Estonia were chosen. 11 interviews with representatives from energy-technology research groups were conducted from April to May 2013; 4 interviews were carried out with the representatives of the R&D departments in the three main technology universities[6] in Estonia in October 2013; 20 interviews with Estonian cleantech companies were conducted in June and July 2011. The length of the interviews was 1-3 hours. The research groups were selected on the basis of one criterion: they all had received public funding at some point between 1998 and 2012. The interviews included questions about research areas and ISL (including other contacts with companies, such as internship programs, lectures, board membership etc.), the strength of ties, and changes in the strategic behavior and the content of research activities. The network analysis was carried out based on personal and project records of the largest technology-oriented universities in Estonia from 1998 to 2012. A network was created on the basis of all research collaboration: the nodes illustrate individual scientists and firms and the edges R&D projects and contracts between them (see the descriptive Figures A.1-A.5 in the Appendices). This makes the networks bipartite or two-mode as it is important to keep the data about researchers at the individual level, because changes in the composition of research groups are not uncommon. Networks were later weighted for the monetary value and length of contracts to control for the strength of ties. This consolidated the networks and diminished the significance of very small contracts, while the main structure and trends of the network remained. Since the strength of ties and informal communication are difficult to analyze through project data alone, we used the interview data to triangulate the information gathered

5 The empirical data for this analysis was collected under different research projects in 2011 and 2013: 1) the project of "Public funding of research activities in Estonia" under the national Research and Innovation Policy Monitoring Programme initiated by the Estonian Ministry of Education and Research between 2011 and 2015; 2) the Central Baltic INTERREG IV A project "Enabling a Global Vision for the Baltic Clean-tech industry" (Global Vision) from 2011 to 2013.

6 Our study covered the largest technology oriented universities in Estonia – TalTech, Tartu University (TU), the Estonian University of Life Sciences (EULS) – and a separate research institute (National Institute of Chemical Physics and Biophysics). TalTech is the main contributor of energy technologies in Estonia, while in other universities singular RE-centered research units have emerged during the 1990s.

from documents. In the interviews, we found that monetary value was not the best measure to describe collaboration strength as the former was more linked to the size of the private partner. Thus, we relied more on the self-reported information of scientists to determine the strength of relationships. In addition, document analysis was carried out to compose a profile for each research group. The documents included government funded research proposals, project reports, co-publication analysis and career data from the electronic database, the Estonian Science Information System (ESIS). These profiles were created to have a more in-depth view on the strategic activities of research groups and also to account for shifts over time, which is difficult to outline solely through network analysis.

4. The case of climate-change discourse and energy technologies in Estonia

4.1 The Estonian energy policy context

Estonia is the only country in the world where the principal source of electricity (up to 80%) is the burning of oil shale (kukersite) (see Table 1). The country has been the largest oil shale producer and consumer in the world since the 1960s, but it has come with a considerable environmental impact, which was the largest in the 1980s and has declined since (Raukas and Punning 2009; Mõtlep et al. 2010; Blinova et al. 2012). The energy sector is the main source of GHG emissions in Estonia (see Figure 3).

Table 1: **Energy balance sheet in Estonia** (TJ) (Statistics of Estonia, 15 May 2013)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production of primary energy	132389	131999	140265	162400	154123	160563	155265	180852	175374	172995	205080	208863
… oil shale	108330	106183	111103	132096	124121	129423	125022	146747	142956	134455	161401	166731
… oil peat	3345	3427	6416	3531	2678	3550	4726	4405	2174	3492	3680	3308
… fire wood	20617	22279	22608	26592	27132	27170	25044	29119	29593	34060	38668	36154
… other fuels	76	82	112	113	84	150	150	176	82	169	237	178
… hydro and wind	21	28	26	68	108	270	323	405	569	819	1094	1433

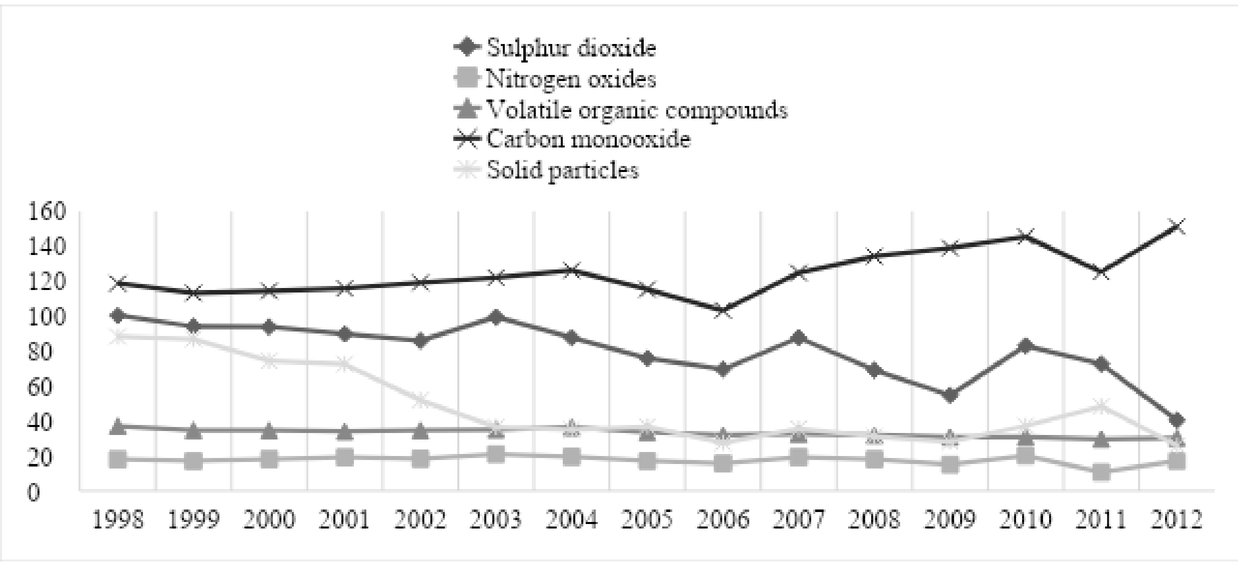

Figure 3: **Air pollution by pollutant from stationary sources** (tons) (Statistics Estonia, 9 March 2019)

On the whole, Estonia has been implementing environmental policies since the late 1980s. Environmental issues entered the policy debate first with the fight against the opening of new mineral mines for heavy industry (e.g. the so-called Phosphorite War, 1987-1988) through which calls for environmental sovereignty developed hand in hand with the general independence struggle of Estonia. This inspired the early adoption of the first environmental protection law in 1990, and environmental pollution levies were established; however, they were not substantial enough to change the energy sector, which was under the control of the government (Valdmaa 2014). In 1995, the country ratified the United Nations Framework Convention on Climate Change (UNFCCC), but legally the year 1998 marked the change in climate policy. As part of the accession process to the EU, the Integrated Pollution and Prevention Control Directive (IPPC) and the EU's clean air policy (Directive 96/62/EEC) were adopted in Estonia in 1998, but the former only took effect later. Also the Kyoto protocol was signed by the country in 1998 and ratified in 2002. However, as indicated in the energy-related policy documents in 1992-2002, the government was mainly concerned with energy security and pricing – rendering environmental concerns secondary. Only with joining the EU in 2004 did the climate change based policy discussion become more prevalent: in April 2004, the National Program of GHG Emission Reduction for 2003-2012 was adopted, and it was the first document that also included the Kyoto target as its main objective. Estonia imposed a CO_2 tax in 2005 and in 2006, and the new Environmental Charges Act was enforced. Feed-in tariffs for RE were introduced based on electricity prices, although at first with low coefficients in the closed market situation (Streimikiene et al. 2007). Several other fiscal measures (including excise duties on fossil fuels) and subsidies were also created by the government after 2004 (an overview of which is available in the Estonia's Fifth National Communication to the UN (Estonian Environmental Research Centre 2009)). While measures aiming at the renewable energy sources diversified, the largest investments in the energy sector remained in oil shale as concerns over energy security prevailed. The government has subsidized heavily the oil shale based electricity production to reduce GHGs: second-generation units with higher efficiency rates have been built, and fluidized bed combustion (CFB) technology (which this expected to minimize environmental pollution) has been implemented (e.g. Dementjeva and Siirde 2010).

The possible future decline in the proportion of oil shale in electricity production could be facilitated by the rise in the use of wind energy, natural gas and biomass (Roos et al. 2012). This would have to be supported by scientific research and public research funding. During the time under review basic research funding measures have been available for the sector; however, there has been a gap in support measures for proof of concept and prototyping in the Estonian R&D system. Thus, the measures have been fragmented in their mission orientation towards climate change, giving more support to high technologies rather than applied innovations needed in the local context.

4.2 Change in ISL in energy technologies

There are approximately 15 considerable research groups in energy technology in Estonia. Our network analysis showed a heavy concentration of influential research groups in energy technologies in TalTech (see Figure A.1 in the Appendix describing the whole network by Eigenvector centrality). The network analysis also showed that the competence regarding the *traditional* energy technologies (oil shale combustion and chemistry) lie with TalTech.

The traditional energy research groups are located in three departments (Faculty of Power Engineering, Chemical and Materials Technology and Mechanical Engineering). In other universities, including Tartu University and EULS, energy technology research groups were not found to be closely linked to the field of traditional energy studies – these research groups were based on strong basic research in *other* fields (material sciences and life sciences) that were found to have *applications* in the field of energy (in Tartu, photovoltaic elements and in EULS, biomass).

Coming to energy technology ISL, there is one general remark that should be made before we examine the propositions. When we look at how the cooperation with the industry and enterprises has generally changed, then based on the network analysis and the content analysis of project reports, we can see that for most traditional energy technology groups their ties with the industry weakened from the 1990s onward, and especially during the period of interest (1998-2012). On the one hand, this is because before the 1990s, the ISL were linked with Soviet Union public enterprises. On the other hand, the research groups needed time to adapt to the new collaboration logics of ETs (described in sections 2.2-2.4), which will be explained below. In the following, we will examine whether the propositions developed in section 2 hold true in the case of Estonia.

First, we can observe a clear diversification effect in terms of research areas (confirming Proposition 1.1) as the central research groups in energy technologies (also in oil shale technologies) have started to include climate change, RE and ETs-related projects in their agenda after the beginning of 2000s, when the multi-disciplinary ETs (discussed in section 2.2) emerged in the climate change discourse (see Figures A.1 and A.2 in the Appendices, which visualize how research groups start to concentrate and traditional fossil fuel based research groups start to integrate RE and ET narratives in their research areas). This is more apparent among research groups that have been more actively involved in industry contracts. This development also reflects the popularization of ETs in the business sector since the beginning of the 2000s, with the increasing initiative of solving environmental problems (but with profit orientation) coming from the companies. Also, the collaboration networks have diversified (confirming Proposition 1.2): for example, the central research groups (also in oil shale technologies) have started to involve more smaller, private companies with short-term contracts, more applied and close-to-the-market projects, in addition to long-term, far-from-the-market projects with a single state-owned energy company, which had previously been the trend.

Though the analysis of research project applications and reports showed clear diversification effects in research topics and networks, the conducted interviews also indicated considerable inertia in research fields and groups (disconfirming Proposition 2.1): even though ETs-related activities received more attention and new funding opportunites compared with the agendas before the 2000s, *no* totally new research groups in areas of "pure" clean technologies as a reaction to funding based on "climate change" emerged. In addition, while many research groups in more traditional energy technology fields perceived a bias in funding towards RE, the interviewed research group leaders emphasized that ISL collaboration projects were led by companies and their restriction-based demand for ETs (see Propositions 3.2 and 3.3), but no significant RE R&D goals or preferences were put in place by funding programs. Instead, the interviews showed that research groups, especially in traditional energy fields (oil shale technology), who incorporated ETs goals to their agenda, did not change their core research areas (confirming Proposition 2.2). This can be expected from research groups dealing with technologies at the end of their life cycles, and it contributes to paradoxes that stand in the way of fundamental changes in the energy sector.

The analysis of the research project applications and reports from 1998 to 2012 and the dynamics of the topics and group members indicates that during the early part of the covered period, some current core research groups grew out of basic research in material technology, with possible applications in the photovoltaic industry. These groups were the main parties that could be seen as working towards clean energy before the 2000s. However, most RE-related research before 2004 was fundamental in nature, and in terms of ISL, the collaboration between industry and universities was clearly one-dimensional – undertaken with one or few familiar partners and including only traditional, efficiency and some environmental projects. After 2004, however, it changed and became multi-dimensional (see the descriptive Figures A.4-A.5 in the Appendices). As the goals of the Estonian environmental policy and also the national level discourse changed between 1998 and 2004, research projects also started to include more environmental concerns about emission reduction and pollution avoidance. According to project reports and interviews there was new interest from the industry (also oil shale based production facilities) to start collaborations with research groups solely based on ETs (in accordance with Proposition 2.2), confirming that traditional energy research groups changed their activities to include ETs (if not fully clean technologies) to respond to funding incentives.

Another interesting finding is that when we look at the proportions of R&D funding between clean/environmental technologies and traditional fossil fuel focused energy technologies, then the top few research groups now receive proportionally more financing then the rest. This may be largely coming from the bias in the Estonian research funding system, which prefers basic science to applied science and gives preference to high technology. Consequently, research groups that focus on applied research have become weaker and rely on short-term private funding, especially in the energy sector. By concentrating on broad areas and defining no clear specific R&D goals in energy technologies in Estonia, the normative weight was put on the value-neutral scientific endeavor, very much in accordance with the main trends in the global climate change discourse discussed in section 2.

The third set of propositions developed in section 2 argued that the qualitative nature of the emerged networks in scientific collaboration differs depending on the motivations and nature of the collaborating company, which in turn is influenced by the technology at hand (cleantech vs environmental protection and especially end-of-pipe technologies).

According to the interviewed scientists, only the dominant companies in the market (in the Estonian case the state-owned enterprise Eesti Energia and the Viru Chemistry Group) or university spin-off companies were interested in the application of basic science also in the traditional, fossil fuel based fields. However, substantial R&D collaboration in the core areas of the energy companies in general was very rare and occurred mainly in the field of *cleantech* (for example in photovoltaic batteries). To some degree this supports Proposition 3.1 in terms of longer and durable transformative investment in *cleantech* (as explained before, there were only few radical cleantech ISL with some state-owned enterprises and university spin-offs, who had better access to resources and were closer to the universities), but as we had only few cases to describe such long-term relationships, it is not possible to fully confirm Proposition 3.1.

However, as understood by the interviewed scientists, and also found by Valdmaa and Kalvet (2011), most of the companies that have contracts with Estonian research groups want simple environmental impact assessments or solutions that need to be worked out fast and can be easily integrated into the previous technology. The interviewed companies made maximally six months to year-long contracts and wanted immediate results and market applicability or introduction to the production process (supporting Propositions 3.2 and 3.3). Similarly to Proposition 3.1, due to only few cleantech cases, and as the projects were implemented in a very short time (maximum 5-6 years in RE), no clear assessment of Proposition 3.2 can thus be made: the business-oriented *cleantech* approach with strong push for ready-to-market corporations with research units and short-term contracts was not clearly observed. Still, when ISL based on additive projects were concerned, the collaboration took a very short-term, close-to-the-market format, clearly confirming Proposition 3.3.

The interviews additionally showed that while industry giants want to keep themselves informed about the work of Estonian scientists in their related energy area, the companies are not willing to pay for basic research that cannot be implemented in the short term (see additional information about the Estonian energy sector in Tõnurist 2015). Research groups that have been working with and for the industry usually have continued this trend. Only in cases when they have not managed to get public funding have some groups started more active cooperation with the industry. However, this was only the case if they previously also had some contacts with the industry.

Furthermore, in non-traditional energy technology fields, the application of technology remains far from the market due to the dominance of smaller firms in the field and the scale on which the sector requires solutions, not to mention systemic barriers incumbents have put in place. Cleantech firms lack the necessary investment needed to test the R&D on scale. Consequently, local research in areas outside of traditional energy production may remain on a theoretical level, or wider international networks have to be used to popularize or sell the results of this more theoretical research. As such, there were some university spin-offs that contributed to radical cleantech ISL (e.g. photovoltaic technologies and ultracapacitors energy-storing technologies), but they were still an exception to the rule (thus providing only partial support to Proposition 4.1). There was more clear evidence in support of Proposition 4.2: when ISL based on additive projects were concerned, the collaboration took a very short-term, close-to-the-market format, in turn contributing to the "sailing effects" of traditional energy technologies, potentially leading to lock-in of non-optimal solutions for the energy sector, making it more difficult to radically change the energy sector and reduce GHG in a considerable amount. Clearly more cooperation is related to incremental innovation and rudimentary analyses/testing done for the companies. In general, one can expect a direct influence from the structure of the energy sector of the country to the direction of research. Research groups that are mainly dealing with basic research and with more radical innovations are less attractive to the industry because of the long development period, capital intensiveness and high uncertainty (also found by Valdmaa and Kalvet 2011). The summary of whether the theoretical propositions held in the Estonian case are presented in Table 2 below.

Table 2: **Summary of main findings**

Propositions	**Findings**
Prop.1 Diversification effects	
Prop. 1.1 Diversification of research areas	Corroborated
Prop. 1.2 Diversification of ISL	Corroborated
Prop. 2 Shifts in research strategies	
Prop. 2.1 Emergence of new research groups	Not corroborated*
Prop. 2.2 Opportunistic adjustment of research agendas by research groups in traditional energy technology	Corroborated
Prop. 3 Qualitative difference in subsequent collaborative ties between science and industry: social vs business orientation	
Prop. 3.1 *Cleantech* ISL is longer and more durable	Not corroborated*
Prop. 3.2 *Cleantech ISL has a strong business nature and short-term contracts*	Not corroborated*
Prop. 3.3 Incremental ETs projects (efficiency and additive nature) imply projects close to the market	Corroborated
Prop. 4 Direction of innovation: incremental vs radical	
Prop. 4.1 New cleantech ISL has radical innovation direction	Not corroborated*
Prop. 4.2 Efficiency related and additive environmental protection technologies have an incremental innovation direction contributing to "sailing effects" and lock-in of technologies	Corroborated

* More research needed.

5. Discussion and conclusions

The global climate change discourse has influenced policy-making at all levels of governance. However, the impact of the global discourse on national policies, real practices, and the interactions of involved actors has been under-researched. Our paper brings these issues to the forefront and maintains that policy changes based on a broad and high-level global discourse can have unintended and multi-directional effects in the implementation of science policy and, more specifically, in the domain of energy technology. This argument is elaborated through an overview of the main issues within the global climate change discourse and how these issues are likely to influence science and industry collaboration and also the direction of innovation. We argue that while the broad-based policy discourses and policy changes may be easily transferrable from country to country and from sector to sector (meaning the spread of ETs to different countries and to various technology sectors), they can also accommodate diverging, almost contradictory approaches (e.g. *cleatech* vs *environmental protection and especially end-of-pipe technologies*) due to feedback from different interested parties (researchers, companies, investors, etc.).

In the theoretical framework we explained how the global discourse relates to policy practices and how issues with the discource can influence the implementation of science policy in the domain of energy technologies. Based on a review of the global climate change policy discourse we developed four main groups of propositions connected to the change in the research activities in both firms and research institutes, and we examined the applicability of these propositions in the case of Estonia. The propositions and their applicability have been outlined in Table 2. First, we show that the global climate change discourse has led to the *diversification effect of research agendas and ISL* (corroborating Propositions 1.1 and 1.2). Second, in terms of *shifts in research strategies in response to the global climate change discourse,* we found no evidence of the emergence of totally new groups in cleantech (not confirming Proposition 2.1), while the traditional energy technology research groups have adjusted their research, at least formally, and included the ETs agenda in their research (confirming Proposition 2.2). Third, we expected that the form, quality and motivation of collaboration networks depends on the technology researched: i.e. whether it addresses the socially-oriented environmental protection or the business-focused cleantech part of the global climate change discourse. Based on the Estonian case, however, Proposition 3.1, arguing that cleantech ISL is longer and more durable, and Proposition 3.2, stating that cleantech ISL has a strong business nature and short-term contracts, were not corroborated because of the small number of examples under study. But Proposition 3.3, claiming that environmental protection ISL (efficiency-oriented and additive in nature), have collaborations close to the market was clearly corroborated. Forth, with regard to the *possible direction of innovation – incremental vs radical* – our expectation that cleantech has a radical innovation direction (Proposition 4.1) could not be corroborated due to the limited number of cases under study. However, Proposition 4.2, which emphasized that efficiency-related and additive environmental protection technologies have an incremental innovation direction, contributing to sailing effects and lock-in of technologies and non-optimal solutions for the Estonian local energy sector, was corraborated.

Thus, our analysis shows that when examining the effects of the climate change discourse, it is important to zoom in on the policy implementation level, as well. Even though the national level policy makers have adopted the global climate change discourse in terms of the goal of long-term low-carbon energy production, when we look at the actual implementation of science policy, R&D has not moved hand in hand with the discursive goal. Although the broad global climate discourse has influenced funding decisions in science policy, the impact has not been as profound as expected: value-neutral scientific policy has strengthened some more basic science research groups but also left some more applied groups dependent on industry investment. If more applied research teams are solely dependent on industry contracts, they can function with outside-industrial funding only for a short period, and this is not sustainable regarding the development of the research field. Doing more applied, short-term research hollows out the basic research competences of the group, and in the long run this also reduces the research groups’ value to the industry. Successful applied research has to be grounded in profound basic research capabilities – a core competence of universities.

As shown in the case of Estonia, with no clear mission-oriented energy technology financing, the applied research groups and ISL are left to compete within the general science funding system that favors basic research. While this funding system has given precedence to new *cleantech* fields (e.g. photovoltaic and storage technologies), this is not the result of active state policy in the field of energy, and it is very uncertain whether the local GHG-emission output will diminish (the technology can of course be applied elsewhere with global net benefit, but also domestic investment to carbon reduction is essential for reducing GHG). In many cases the willingness of companies to implement R&D becomes the central concern of the actual goals of climate change related policy goals. If companies are not motivated to do R&D and tend to focus more on incremental than radical innovation, there are also limited effects to GHG emission reduction. Here the nature, magnitude, quality and direction of ISL become very important. As investment decisions are not managed centrally, incentives to individual electricity utilities in the market for advancing technologies become more important. Some of these projects may not attract investment from the private sector, and the companies and their collaboration networks with research groups – as shown above – may enforce different dynamics altogether (short-termism, incrementalism, etc.). This indicates that differentiation in terms of policy is needed to capture both short-term solutions (as outphasing of traditional energy technology takes time), but also greater use of renewable, "clean" energy, which is needed for long-term energy security. In order to make a change from oil shale based electricity production towards clean energy, more long-term commitments from policy and funding programs are necessary. Here the correct policy mix becomes the key in addressing many of the problems not only in R&D but also within the industry that take into account the actual effects of the influence of discource in implementation. Hence, the highly scientific/high-technology-oriented and linear understanding has not produced the desired effect in Estonia. Due to the lack of clear and specific R&D funding goals, a radical decrease in GHG emissions has not ensued.

To conclude, our analysis shows the importance of accounting for long-term and multi-directional effects of discursive policy changes and the need for an adequate policy mix depending on the technologies in question and the structure of the economy. The economic structure and the composition, nature and capabilities of the companies in the local industry, as policy feedback mechanisms, may play a significant role in what discourse translates into during implementation.

In future research, more studies are needed to describe the business-model aspect of *cleantech* and its influence on the direction of innovation. Also, it would be useful to undertake comparative studies in order to explore how the global climate change discourse has influenced policy implementation in different countries and to analyze whether the local interpretations of global discourses are different, whether the effects on energy technology ISL and other issues follow similar patterns in different science system, and whether there are also differences in effects in the various sub-fields of energy technologies. Besides, since major restructurings have taken place in all Estonian universities from 2013 onwards, it would also be highly interesting to analyze how these changes have influenced research topics and ISL.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article

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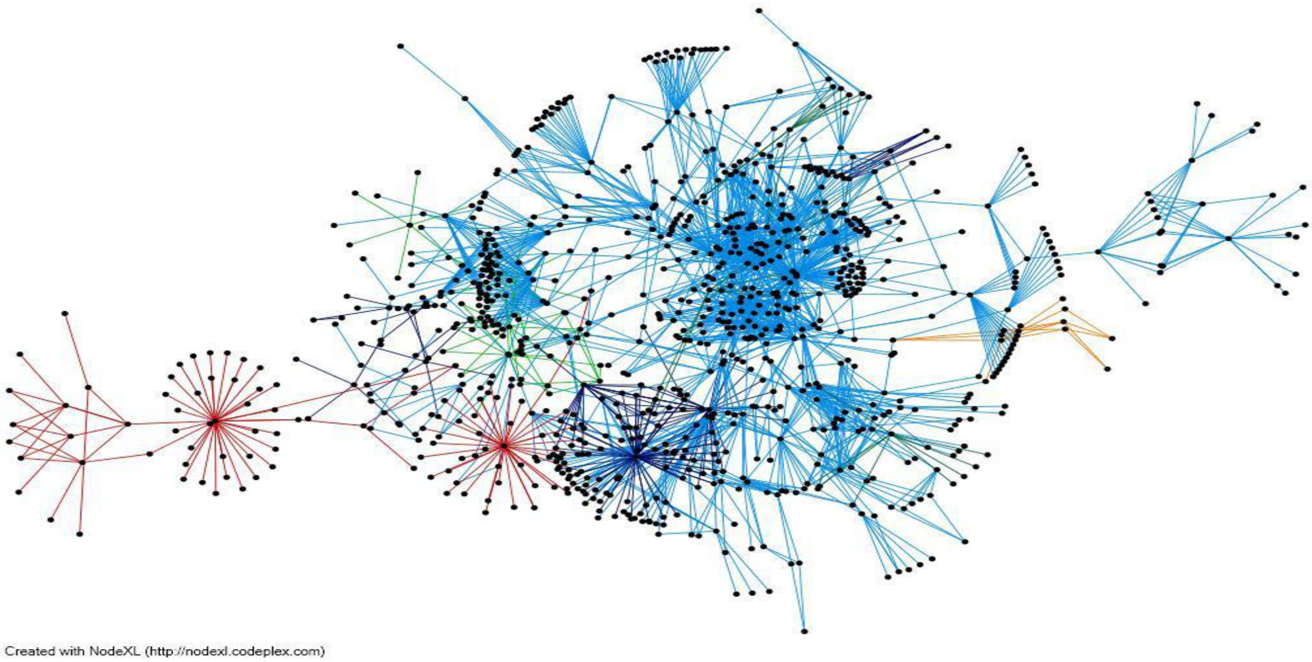

Appendix Figure A.1: Energy technology network in Estonia 1998-2012 (based on project information)*

Source: Authors, NodeXL.*Within the descriptive figure the edge color denotes the university (blue and green TalTech (an institute joined the university later); dark purple Tartu University; maroon EULS and brown National Institute of Chemical Physics and Biophysics). The size of the vertices is dependent on Eigenfactor centrality, thus making it dependent on the influence of a vertex within the network (see Yu et al. 1965). The figure has been created with the Harel-Koren Fast Multiscale algorithm.

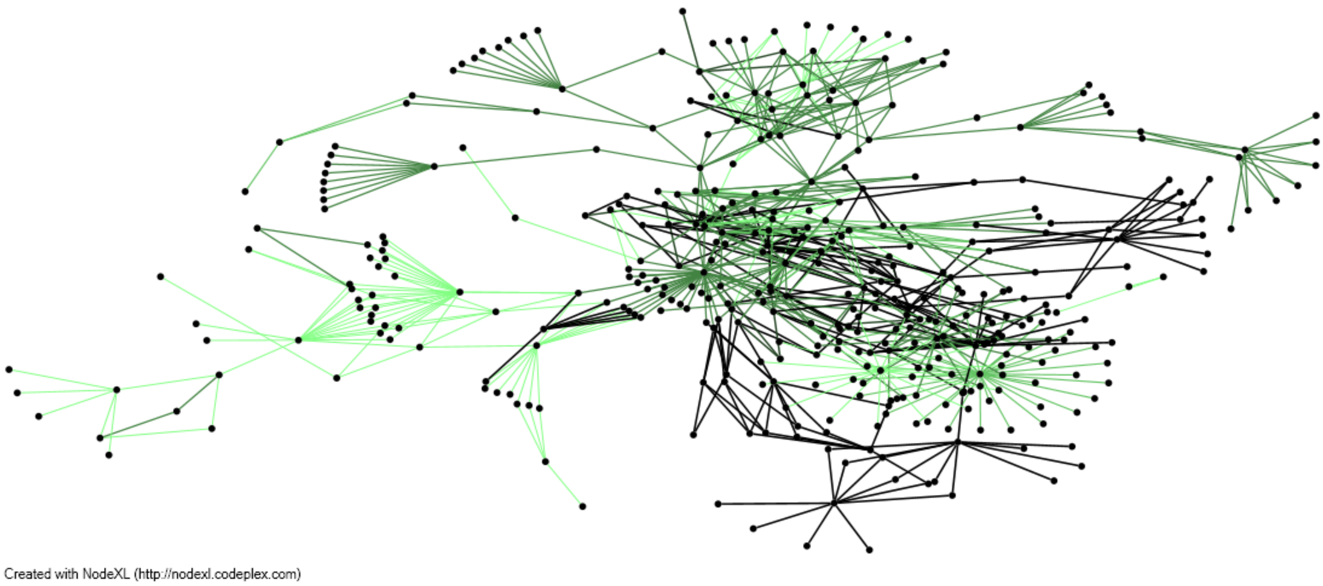

Figure A.2: Energy technology network by type of technology 1997-2004 (public and private funding).

**From here onward the color coding is a spectrum from black to light green that are collated in the following manner: “black” denotes traditional energy technologies (1), sailing technologies (extending traditional projects) (2), efficiency projects (3), environment-centered projects (4) and RE projects “light green” (5). All the figures has been created with the Harel-Koren Fast Multiscale algorithm.

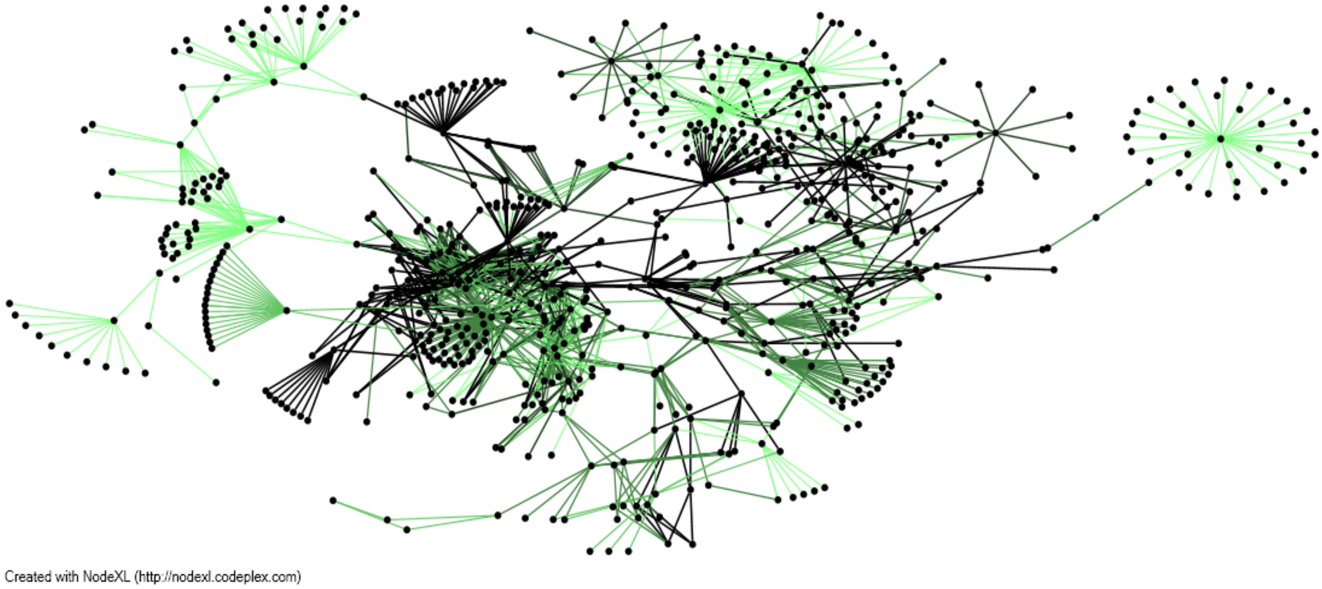

Figure A.3: Energy technology network by type of technology 2005-2012 (public and private funding)

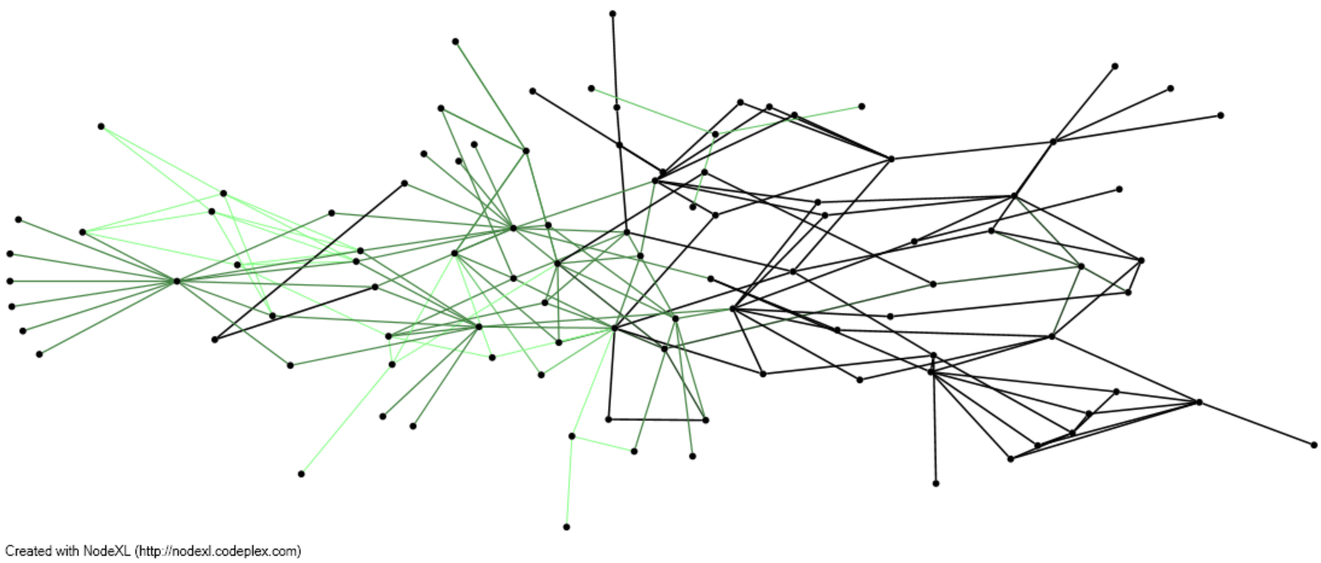

Figure A.4: Energy technology network (contracts with private companies) by type of technology 1998-2004

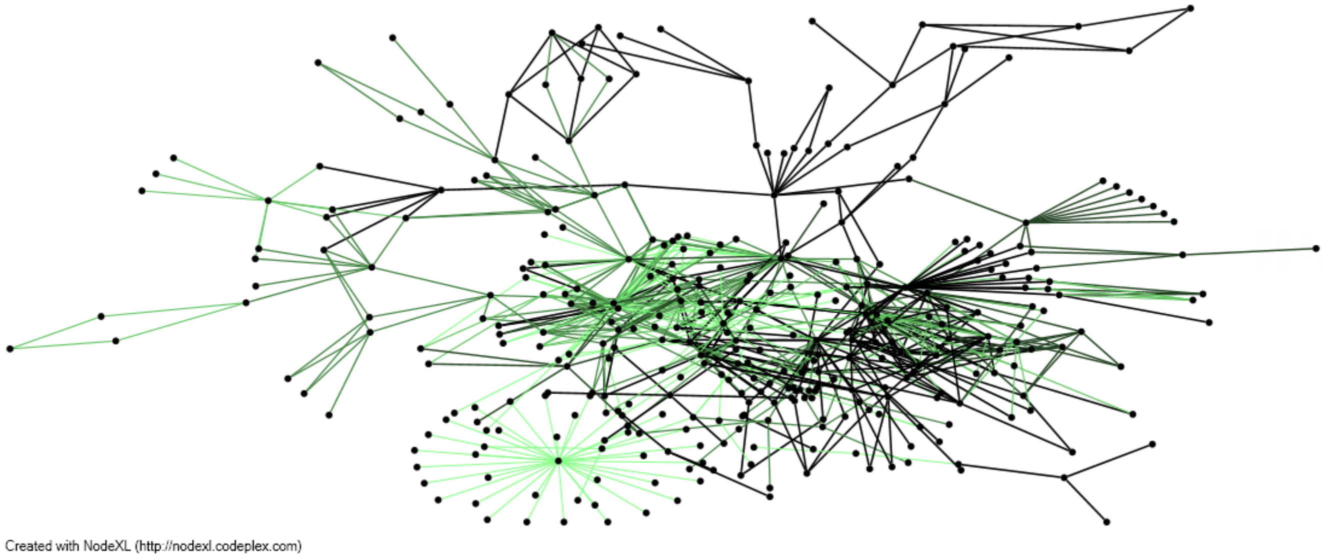

Figure A.5: Energy technology network (contracts with private companies) by type of technology 2005-2012

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Examining the Collaborative Process: Collaborative Governance in Malaysia

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Abstract

This article identifies and examines factors important to the collaborative process. It does so by treating Malaysia's performance and management delivery unit (PEMANDU) – which is an agent that played a central role in economic and government transformation programmes – as a prism from which to identify essential components of collaboration. By examining PEMANDU's various initiatives together with descriptions of two cases on collaboration, the article concludes that facilitative leadership and one-of-a kind organizational design are necessary but not sufficient conditions for a successful collaborative-governance endeavor. Institutionalizing collaborative governance remains problematic. This is because even though collaborative governance is nested within the country's larger development concerns, the issues of trust, legitimacy and regime change have made collaborative governance a still nascent tool for public-sector reform effort.

Keywords: Collaborative Governance; Collaborative Process; Delivery Unit; PEMANDU; Malaysia

Introduction

Collaborative governance is increasingly viewed and adopted by governments as a possible remedy to address various bureaucratic concerns. The recursive and iterative nature of the collaborative process and the promotion of horizontal and vertical integration in collaborative governance are viewed as essential qualities for bureaucracy to deliver the public good as well as navigate the close nexus between politics and administration (Meier and Bohte 2007). Collaborative governance is also increasingly seen as the best method for bureaucrats to overcome rigid adherence to traditional axioms of implementation (Hill and Hupe 2014), especially at a time when public policy demands quick and effective policy delivery. Collaborative governance is also associated with the ideas of adaptability and flexibility, two qualities that are viewed as capable of producing better policy design and execution (Thomson et al. 2007: Ansell et al. 2017).

Besides facilitating public-policy delivery, collaboration is also seen as encouraging democratic governance. Collaboration can act as a powerful tool to resolve a dispute and empower participatory governance (Fung 2004; Fung et al. 2003). Collaboration is also found to be an effective tool to overcome adversarial democracy and for the state to reclaim its administrative trust and legitimacy (Newman et al. 2004; Innes and Booher 1999; Ansell and Torfing 2014; Sabel and Zeitlin 2008; Dorf and Sabel 1998).

But despite the qualities of collaborative governance, identifying the collaborative process is highly problematic. Gaining access to the collaborative process is difficult, especially when bureaucracy is highly impermeable to outsiders. Wood and Gray (1991) describe the collaborative process as a "black-box", where gaining access to collaborative factors remains difficult and challenging for outside observers. Identifying factors that go into a collaborative process is also onerous because they do not come in neat packages given various factors like the nature of the bureaucracy, leadership, the near opaqueness of the process and the iterative nature of policy formulation (Meier and Bohte 2007). While identifying and examining factors in a collaborative process remains a challenge, this paper takes the view that one best way to understand the collaborative process is to adopt a second-best approach, that is by treating an agency – which is involved or tasked to promote the state's administrative reform effort – as a prism from which to identify and examine factors that contribute to a collaborative process. This paper will do so by examining the operation of a significant change agent in Malaysia, the Performance and Management Delivery Unit (also called PEMANDU). PEMANDU was a change agent that was tasked with instituting Malaysia's economic and government transformation programs. Besides examining PEMANDU's organizational design and operations the article will also highlight two case studies – which PEMANDU was involved in – to shed further light on the collaborative process.

The effort to understand the collaborative process and collaborative governance is also timely because collaborative governance is relatively new in non-Western contexts. Work on collaborative governance in Malaysia is rather limited, perhaps due to the newness of the idea. Up until now, there has been one work that discusses this – and a very recent one at that. Using Ansel and Gash's (2008) collaborative governance framework, Ramadass et al. (2018) identified transformational leadership, governance, and relational capital as important to collaborative success. This work is important as it highlights the significance of leadership and relational capital in collaborative governance. The work, however, does not provide specifics on the collaborative process. Other than highlighting that leadership and relational capital are statistically significant, it does not describe the extent to which leadership and relational capital operate within a particular institutional structure. Also it does not discuss the nature of organizational design and how it can facilitate collaboration. The work also does not elaborate on the dynamics of leadership or describe issues of trust, legitimacy, and reciprocity that may be essential for a more complete picture of collaboration. This paper hopes to address these concerns. Using interviews and case studies the paper will provide a thick description to highlight the relevance of institutional design, trust, leadership, shared motivation and how they operate within idiosyncratic conditions. It will address the following questions. First, what is the nature and extent of Malaysia's collaborative governance design? Second, what are the distinctive features of the collaborative process? Finally, what are the factors that contribute to the workability or unworkability of the collaborative process?

We obtained data from various sources. The sources include PEMANDU annual reports, various reports on PEMANDU conducted by the World Bank and other secondary materials like published articles and newspaper write-ups. We also conducted five interviews with people who have worked closely with PEMANDU. Two of them are very senior officers in the bureaucracy. One officer was directly involved with PEMANDU when she was seconded to it. Another was a high-ranking senior official who on various occasions had direct dealings with PEMANDU. As for the two other experts, one was a special officer in a ministry who had the opportunity to be involved in lab sessions conducted by PEMANDU. The other was one of the few officers who had the opportunity to see how PEMANDU was first set up. This expert gave a detailed account of the early days of PEMANDU and its objectives. One of the authors also had the chance to chat with a prime officer of PEMANDU at one social event. During the chat, the officer gave a brief but important insight on PEMANDU. He gave a philosophical insight to PEMANDU and highlighted how PEMANDU's organizational design and collaborative processes had been adopted in many countries outside of Malaysia. Indeed, the interviews highlighted some major issues confronting PEMANDU. They were helpful as they gave clarity to the case studies as well as the secondary reports and highlighted conceptual terms that are important to collaborative governance, such as trust, legitimacy, resources, leadership and institutional design.

The paper is divided as follows. The first part will provide various definitions and discussions on collaborative governance. The next part will discuss the role of PEMANDU and how its various processes have unintentionally laid down the importance of collaborative governance in the Malaysian bureaucracy. The third part of the paper will describe the two case studies. The fourth part of the paper will provide brief discussions of the findings on collaborative governance.

Collaborative Governance and Collaborative Process

With rapid technological advancement and increasing social complexities, it has become increasingly difficult, perhaps even impossible, for bureaucracies to operate within information silos and deliver agency-centric policies. Not many scholars were initially convinced that a collaborative model of governance can deliver better public good. Bardach (1998) emphasizes that collaboration can only be useful if it "produces better organizational performance or lower costs that can be had without it."(Bardach 1998, 17). But the rapid advancement in information technology, scarce resources and the wicked nature of policy problems increasingly demand a multidisciplinary approach to public policy, which saw collaborative governance gaining traction as an attractive administrative tool. Collaborative governance is seen as a response to the rise of "permeable structures", one where people are linked across organizational functions and boundaries (McGuire 2006).

There are many definitions of collaborative governance. It is largely described as an integrative exercise involving various parties. The difference between the many definitions of collaborative governance lies in the qualification of actors involved in the collaborative process. Gray (1998), for instance, defines collaborative governance as an integrative exercise where "parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible" (Gray 1998, 5). Emerson et.al (2012, 2015) gave a broader and more inclusive definition, describing collaborative governance as one that involves "processes and structures of public policy decision making and management that engage people … across the boundaries of public agencies, levels of government, and/or the public, private and civil spheres to carry out a public purpose that could not otherwise be accomplished.. Ansell and Gash (2008), however, provide a narrower definition, describing collaborative governance as an "arrangement where one or more public agencies directly engage non-stakeholders in a collective decision-making process that is formal or consensus-oriented and deliberative and that aims to make or implement public policy or manage public programs or assets" (Ansell and Gash 2008, 544). We find this definition to fit the Malaysian case. Its reference to collective decision-making, consensus, deliberation and the formal nature of the collaborative process is highly relevant to Malaysia, a plural polity where policies have always been a product of intense negotiation, compromises, and consensus.

But a more central concern of this study is the collaborative process. Wood and Gray (1991) argue that while there are many discussions on antecedents and outcomes of collaboration, there is little explanation on the "process" segment of collaborative governance. They argue the need to be attentive to the collaborative process, arguing the importance of administration, government, organizational autonomy, mutuality and norms of trust and reciprocity. Ring and Van de Ven (1994) added to Wood and Gray's (1991) explanation, describing the collaborative process as cyclical and iterative in nature. They also pose a caveat stating that the non-linear and unstructured qualities of the collaborative process could inadvertently pose a challenge to policy implementers and decision-makers. Since the work of Wood and Gray (1991) there have been more efforts at identifying essential qualities of the collaborative process. Besides understanding formal structures, evaluating collaborative processes also requires understanding informal structures (Thomson and Perry 2006). Some of these considerations include factors like commitment, communication, and trust (Huxham and Vangen 2000a), as well as leadership and governance (Currie et al. 2011; Hui et al. 2011; Siddiquee 2007). While getting insights into informal structures in collaborative transactions is indeed a challenge, it is necessary because variables like personal relationships, psychological contracts and informal understanding and commitment of different stakeholders can provide a more complete insight into delivery-level behavior (Thomson and Perry 2006, 22). Thomson et al. (2007) also give a more elaborate explanation of the collaborative process saying that it involves five important elements – governance, administration, organizational autonomy, mutuality and norms of trust. In coming up with their collaborative governance model, Ansell and Gash (2008) give centrality to the collaborative process, emphasizing the importance of variables such as trust, mutual recognition, participatory inclusiveness as well as leadership styles. They also highlight the importance of institutional design as well as starting conditions like political, legal, socio-economic features, leadership and bureaucratic environment (Ansell and Gash 2008). More recently, Emerson et al. (2012) produced an equally comprehensive model of collaborative governance that gives further insight into the variables that are important when examining the collaborative process. Called the integrative framework, the model pivots on the need to understand the system context – political, legal, socioeconomic – as well as other essential issues like leadership, incentives, and interdependence. The model also highlights the need to understand the "sets of implicit and explicit principles, rules, norms, and decision-making procedures around which actors' expectations converge in a given area" (Emerson et al. 2011, 5).

The above discussions on collaborative governance gave important insights into the variables that one needs to look out for when examining the collaborative process. Identifying the variables that go into a collaborative process, however, is indeed a challenge given the near impermeability of the bureaucratic processes. The process is made more challenging when we take into account countries' different political, socio-economic and legal environments. If you are an outsider with no access to core people in the bureaucracy, the near opaqueness and impermeability of the bureaucratic process can make examining the collaborative process even more difficult. Recognizing such difficulty we have attempted to understand the collaborative process by using a second-best approach. We chose PEMANDU because it incorporated a collaborative approach in its numerous projects and hence provided us the prism from which to understand processes and elements that are essential to the collaborative process. We now describe PEMANDU.

About PEMANDU

PEMANDU (the Performance Management and Delivery Unit) was established in 2009. The inspiration for having a delivery unit came from the United Kingdom's Prime Minister Delivery Unit (PMDU). PEMANDU was part of the state's effort to promote better accountability, legitimacy and governance following the then ruling regime's heavy defeat in the 2008 general election, where it won the election but secured less than two-thirds of total parliamentary seats. In its design, PEMANDU was not a typical public agency. It was a pseudo-public organization that did not conform to the general operational standards of other agencies within the Malaysian bureaucracy. Unlike other government agencies, PEMANDU did not come under the direct control of the head of the civil service, which is the chief secretary to the government, but rather under the direct charge of the Prime Minister. This arrangement – which will be explained below – allowed PEMANDU the autonomy to recruit personnel, the ability to plan for its own budget and the ability to have direct access to the Prime Minister. PEMANDU offered the facilitative leadership required of a collaborative process. By facilitative leadership we mean the ability to bring various stakeholders together and get them to engage in a collaborative spirit (Ansell and Gash 2008; Chrislip and Larson 1994; Reilly 1998). Such leadership involves exercising a number of functionalities, which include maintaining the ground rules, building trust and facilitating dialog between stakeholders (Ansell and Gash 2008, 544). There are also those that describe facilitative leadership as one that embraces, empower, mobilize stakeholders (Ansell and Gash 2008; Vangen and Huxham 2000a, 2003). One description that bears close proximity to PEMANDU's role is Ryan's (2001) definition that an effective collaborative leader must have three essential components: adequate management of the collaborative process; maintaining "technical credibility; ability to empower different stakeholders to make credible and convincing decisions that are acceptable to all" (Ryan 2001, 241).

But unlike Ansell and Gash's (2008) elaboration of what constitutes facilitative leadership, PEMANDU's leadership role had an added dimension. It was given a broad mandate; assuming the role of a facilitative leader as well as taking charge of delivering the state's economic and government transformation programs. PEMANDU's positioning in the Malaysian bureaucracy reflects this broad mandate; a position in the hierarchy that was unprecedented in Malaysia's administrative reform history. It was a unit within the Malaysian bureaucracy, yet it did not exactly operate like other agencies within the bureaucracy. For instance, despite it being an administrative unit under the Prime Minister Office – PEMANDU's Chief Executive Officer reported directly to the Prime Minister and not to the head of the Malaysian civil service, the Chief Secretary of State. In its operation, PEMANDU was given the flexibility to manage its resources. PEMANDU had its own human-resource department, which was in charge of hiring and talent management. About 80 percent of PEMANDU's officers came from the private sector. These officers were given remuneration packages that were different from the ones enjoyed by other civil servants. Structure-wise, PEMANDU had several divisions, with each division taking charge of a particular NKRAs. Each division was headed by a director. When it came to reporting, PEMANDU's CEO reported directly to the Prime Minister and not to the chief secretary of the civil service (Xavier et al. 2016). This ministerial appointment lent him the legitimacy and gravitas to advise other ministers. In sum, even though it operated in the public-sector realm, PEMANDU was an autonomous unit, just like a unit that operates within the private-sector space. The idea of having a delivery unit that lies outside the mandate of the civil service is indeed a departure from Malaysia's previous administrative reform efforts.

It is not surprising that PEMANDU's unique organizational positioning plus its broad mandate and special access to the highest chief executive, the Prime Minister, invited a mixture of envy and skepticism from civil servants. One strong criticism by civil servants was that PEMANDU only added to a bloated bureaucracy. All the senior civil servants we approached said that PEMANDU's role was duplicitous to that of other prominent agencies. These officers defended their views justifying that the civil service had equally competent officers who were able to carry out the tasks mandated to PEMANDU and at a much cheaper cost. They added that there were existing agencies that were equal to the tasks that PEMANDU was delivering – agencies like the Economic Planning Unit (EPU), the Ministry of Finance, the Malaysian Administrative and Modernisation Planning Unit (MAMPU) and the Implementation and Coordination Unit (ICU). In response to the criticisms, PEMANDU's chief executive Idris Jala made known that PEMANDU was not duplicating the roles of any government agencies. In trying to appease his critics, Idris reiterated that PEMANDU merely served as a facilitator to coordinate efforts to realize the government transformation plans and that its life span was fixed. Also, the criticism against PEMANDU carries little merit because PEMANDU could be a response to a public-service delivery problem. The bureaucracy's strict adherence to the civil service code, for example, could somehow work against collaborative tendencies. There is also every possibility that the existing structure of the bureaucracy will continue to see agencies working in silos. Indeed, the bureaucracy needed a fresh injection of new ideas and PEMANDU's design and its organizational positioning within the bureaucracy gave it the capacity to be an active agent of collaboration – one that other agencies in the bureaucracy might find hard to emulate.

Regardless, the importance of collaboration was heavily built into PEMANDU's operational design. To facilitate the collaborative tendency in the bureaucracy, one of PEMANDU's major steps was to win over the confidence of political masters and bureaucrats. One method that PEMANDU adopted to make bureaucrats and political executives accept the merit of collaboration was to involve cabinet ministers in co-creating policy design. We discuss this next.

Winning over key actors

One of the key highlights of PEMANDU initiatives was in organizing a workshop that involved cabinet ministers. The workshop was an important foundation of PEMANDU's role as a collaborative agent. By having this workshop PEMANDU achieved two things; first it promoted buy-ins from cabinet ministers to PEMANDU's various initiatives and second, the workshop forged inter-ministerial cooperation, a feature that is important in the collaborative process.

Convincing cabinet ministers of the merits of the workshop was difficult but necessary; without the buy-ins from the minister, PEMANDU would face stiffer resistance from the bureaucracy in running its programs. During the workshop, the cabinet ministers were asked to map a comprehensive plan and identify key areas that could improve public-service delivery. At the start of the workshop, obtaining buy-ins from cabinet ministers was a huge challenge; the ministers, understandably, were not convinced of the value of the collaborative project and how issues relating to one ministry could be tied to other ministries. To help ease the process, PEMANDU provided facilitative leadership. PEMANDU officials provided the ministers with information obtained from surveys and dialog sessions to help them have a firmer grasp of the issues. With the aid of such information, ministers were then cajoled by consultants to look beyond their individual ministry's concerns and identify critical policy concerns and goals that cut across ministries. To facilitate collaborative tendencies the conveners asked the ministers to employ a "backward" strategy when evaluating policy issues. Such a backward strategy required participants to first identify policy goals and then to work backward and search for ways that could best achieve the policy goals. The backward strategy intuitively nudged the ministers into designing a collaborative solution because it induced participants to look at issues from various dimensions for optimal policy solutions.

Another highlight of the workshop was the heavy presence of the prime minister. Such presence was helpful as it sent a signal to ministers on the seriousness of the workshop and the need for greater collaboration. The presence of the chief executive was especially helpful considering Malaysia's bureaucratic culture, where there is deference for authority and high power distance. Indeed the heavy presence of the prime minister underlined the seriousness of the collaborative project that could well help encourage reciprocal commitment from cabinet ministers.

PEMANDU understood the Malaysian bureaucratic structure and employed a tool that best responds to such a culture. The Malaysian bureaucratic culture is seen as high on collectivism (Hofstede 1980), one in which bureaucrats tend to display in-group cohesiveness, collective distribution of resources and collective action (Kennedy and Mansor 2000). There could also be the tendency for group members to exercise "perverse equalitarianism", where members tend to forego openness and keep to a conformist culture because being too direct or forthright is seen as insensitive or rude. To overcome such possible infringement to collaborative tendency, PEMANDU introduced a "blind" voting system, where new ideas – which were initially raised and deliberated – were put up for blind voting. This method safeguarded confidentiality, overcame self-censorship, helped elevate policy choices that are most in need of attention and highlighted the collaborative imperative (Iyer 2011a). The "blind voting system" – which was executed during the cabinet ministers' workshop – was one among the process designs that PEMANDU employed to promote the collaborative process.

By the end of the six-week-long workshop, the cabinet ministers began to buy into the idea of collaboration; the ministers began to appreciate that the change agenda cut across the ministries. One evidence of this was when the ministers became champions of PEMANDU's numerous social labs that involved multiple stakeholders. When asked to submit officers to attend PEMANDU's various social labs, the ministers asked department heads of respective ministries to send their very best officers. The ministers sanctioned those laboratories and on occasion attended the lab sessions. There were other designs that PEMANDU introduced in order to facilitate the collaborative process. We turn to this below.

Designing the collaborative process

To settle disputes and resolve bottleneck issues on agreed-upon policies, PEMANDU designed mechanisms that incorporated elements of collaboration while at the same time taking into account Malaysia's bureaucratic culture. One of the first initiatives was setting up the Delivery Management Offices (DMOs), which are housed in each ministry. The DMOs act as coordinating agencies to ensure the delivery of the National Key Results Areas (NKRAs) as planned. The NKRAs were 7 socio-economic issues that needed immediate attention for Malaysia's development, and they included: reducing crime; fighting corruption; improving urban transport; raising the income of low-income households; improving rural infrastructure; improving student outcomes; and addressing cost of living. The DMOs acted as the first touchpoint in settling bottleneck issues that arose as a result of competing interests or due to institutional constraints. And, in true collaborative mode, the DMOs are made up of PEMANDU officials as well as officials from the various Ministries, Departments, and Agencies.

Besides DMOs, PEMANDU also designed administrative layers to escalate outstanding issues that are heavy in collaborative elements. Issues that remain unresolved by DMOs were first brought to a technical working group for resolution. This working group mainly comprised members from the leading ministry and members from institutions relating to the issue with PEMANDU assuming the advisory role. Should the problem remain unresolved, the issue would then be brought to a steering committee comprising relevant ministers, secretaries-general, directors-general and CEOs from important ministries and agencies. Unresolved issues were also brought to the Prime Minister in his meetings every seven weeks (one week each for one NKRA), and this meeting included the minister in charge of the NKRA, the prime minister and PEMANDU's CEO. If the issue still remained unresolved, the matter would be brought to the Problem-Solving Meeting (PSM). The World Bank report suggests that this meeting was held twice a year and was chaired by the Prime Minister. We cannot confirm the exact timing of these six-eye meetings (Minister concerned, Prime Minister and CEO of PEMANDU), but usually the issues would be resolved at the steering-committee stage; only rarely was the issue brought to the PSM (World Bank 2017).

We must add that one feature of PEMANDU's dispute or debottlenecking mechanism is taking into consideration Malaysia's bureaucratic culture, a culture that is not naturally predisposed to inter-ministerial collaboration. PEMANDU had to negotiate serious issues of group dynamics among bureaucrats – e.g. "face-saving" or members' avoidance of group conflict. This feature of group dynamics was well understood by PEMANDU's CEO, Idris Jala. When he chaired meetings, Idris ensured that PEMANDU officials played a non-intrusive role. To get people to think of solutions, Idris drove the message to participants that the solution to issues were already there with them, reiterating that "the good ideas are already there, and people know these ideas, but the reasons we don't move from ideas to results is because there are technical, political, administrative, process, system hurdles" (Iyer 2011, 9). In essence, PEMANDU understood the group dynamics and merely nudged participants to resolve issue using their collective resources.

To make for better monitoring of projects, meetings every week, every month as well as twice yearly were organized, and these meetings were chaired by the Prime Minister. The weekly meetings – involving each of the NKRA team, delivery management office staff and other key members of the delivery chain – were meant to enable team members to be on the same page when it comes to outstanding issues and goals. The twice-yearly meeting included a six-eye meeting involving the Prime Minister, the minister leading the specific project and Idris Jala, PEMANDU's CEO. In such meetings, the progress was reviewed using data compiled by DMOs. A dashboard system was employed, where project performances were assessed using a green, yellow and red rating; with green signaling that progress has been made while red signifies the opposite. The meetings acted as important tools to consolidate the collaborative framework, monitor the progress made and iron out outstanding issues. In commenting on the meetings, one PEMANDU officer said that "although PEMANDU engages with the ministries on a daily basis, these weekly problem-solving meetings with the higher management and the monthly sessions with the PM meant that little would fall through the cracks" (Iyer 2011, 10).

To sum up, the design of PEMANDU's delivery process portrayed the many challenges as well as the idiosyncratic techniques used to promote collaborative governance. One important lesson is that PEMANDU's design of the collaborative framework took into account Malaysia's institutional quality, one that is characterized by a high disposition toward silo thinking, high power distance, collective thinking, perverse equalitarianism, and bureaucrats' non-confrontational disposition. There was another tool that PEMANDU employed in the collaborative process. We discuss this next.

PEMANDU, collaborative design, and Social labs

The establishment of PEMANDU's social labs – as part of its "eight-step transformation programme" – demands attention. The social labs were intended to translate the broad targets spelled out in the NKRAs – aimed at operationalizing the National Key Result Areas (NKRAs) – into concrete projects (World Bank 2017). The social labs drew officers from various ministries and agencies. These officers were handpicked and deemed to be the best of their cohorts. They were selected by cabinet ministers – who at this point bought into the idea of collaboration. In fact the ministers gave clear orders to various agencies to send their best officers to participate in the lab sessions.

The lab sessions were intensive and inclusive. Officers were told to look beyond the immediate concerns of their respective ministries and come up with solutions that cut across ministerial boundaries. The labs forced officers to adopt a holistic approach to policy problems that induced collaboration. The intensity of the lab sessions and the fact that the sessions lasted between six and eight weeks also gave officers sufficient material to appreciate the imperatives of collaborative work. The labs allowed them to view policy problems and prescriptions from multiple perspectives. To make for an effective collaborative effort and better policy prescription, participants were provided with views collated from the public – from interviews, online feedback and text messaging (Iyer 2011).

In the end, the labs became more than sites to develop tangible targets and mobilize resources from different government agencies; the labs became sites for stakeholders to bond and make a realistic assessment of each agency's strengths and weaknesses. In fact, participating officers admitted that the lab sessions trained them to decide on socially desired outcome from a collective standpoint. One officer from the Ministry of Transport mentioned that the incremental, piecemeal and collaborative approach adopted helped officers to develop a more holistic appreciation of the problem discussed.

The officer also mentioned that the tools employed by PEMANDU facilitated the collaborative process. During the sessions, participants were told to move from broad policy goals to more specific targets, a process that PEMANDU's CEO Idris Jala described as "going from 3,000 feet to 3 feet." This involved "starting with the big picture and sharpening the focus to inspect its smallest detail" (Iyer 2011, 6). To help them make specific targets, participants were told to adopt an iterative and recursive approach. This involved revisiting old assumptions, raising new information and reconfiguring earlier targets and plans (Sabel and Jordan 2015). PEMANDU officials were on hand to assist the process. Acting as facilitators they encouraged participants to start their propositions with a blank canvas and to revisit initial plans, which led to lively and open discussions among the participants. The whole process effectively induced collaborative tendencies as "participants come to know and trust one another, they bring to the fore, knowledge of problems or solutions that, at the outset, they may have held closely to themselves" (Sabel and Jordan 2015, 19).

For more effective collaborative work, participants in the lab sessions were made to present their detailed plans to senior officials from two key agencies – the Ministry of Finance (MoF) and the Economic Planning Unit (EPU) – for a more realistic assessment. Called the "stress test" the presentations were meant to impress on participants that policy plans would have to be weighed against the state's many priorities and resource limitations. The "stress test" sessions, which at times were attended by ministers, saw senior government officials querying participants on the rationale and details of their plans. After listening to the presentations, the senior officials would brief participants on the feasibility of the projects when measured against financial and administrative limitations. At the end of the sessions, modifications were made after participants weighed in on the various concerns.

Indeed, the social labs added to the collaborative process as they did away with hierarchical concerns, promoted lateral network settings and encouraged the co-creation of policy design. PEMANDU's adoption of the recursive and iterative approach to policy prescription and the informal nature of the lab sessions encouraged members to come up with new policy possibilities. They helped participants make realistic judgments of policies and forced them to look at issues from a multi-sectorial perspective that cut across ministerial concerns. The interactive dialogs and the iterative approach also helped in promoting buy-ins from stakeholders (Sabel and Jordan 2015, 32). In fact, the collaborative process saw 50 percent of original solutions be revised, and this was due to the new pieces of information raised by participants. One director of the education NKRA team said that the

> lab is an environment where hierarchy is set aside. We encourage participants to leave their 'organisational hats' outside the door. It empowers civil servants, giving them a chance to voice ideas that may have been in the works for years (Iyer 2011, 7).

But how much has PEMANDU's collaborative endeavor permeated the bureaucracy? Has collaborative governance become a central organizing principle in the conduct of Malaysian bureaucracy? To demonstrate the extent to which PEMANDU's processes and ideas on collaboration have pervaded bureaucratic thinking, we describe two examples. The first involves PEMANDU in a collaborative project with different agriculturally related agencies, and the second involves PEMANDU providing its expertise in setting up a "delivery unit" within a particular ministry that is tasked with promoting collaboration.

PEMANDU and improving Paddy Productivity in the Muda Region

The Muda Paddy project demonstrates the successes of as well as challenges to collaborative governance. The project involved the collaboration of several agencies – PEMANDU as the facilitator, the Ministry of Agriculture (MoA), the Muda Agricultural Development Authority (MADA) and the farmers' association called *Persatuan Peladang Kawasan (PPK)* – and aimed to improve productivity in paddy farming in the Muda region, a rice farming area in Northern Peninsular Malaysia. In fact, the Muda project was one of PEMANDU's many initiatives under its Entry Point Projects (EPP), projects whose aim was to turn traditional agriculture activity into agribusiness activity by incorporating the latest technology to improve output and earnings. There were in total 16 EPPs, and these projects involved existing farmers as well as new entrants and covered a range of agricultural activities – from seaweed farming, herbal production, farmed fishing, and livestock to rice production (Adnan and Nasirruddin 2016).

The Muda region paddy project was aimed to promote commercial-scale farming, improve irrigation density and accelerate the use of new technologies. The project attempted to do so by aiming to amalgamate some 50,000 hectares of paddy fields – about 51 percent of total paddy fields in the country – involving some 27,500 small-time farmers. The amalgamated land would then be run like a paddy estate and centrally managed by a private management entity. Under the scheme, paddy farmers were given the choice to either work their own land or lease their land to the management company, which would provide the labor. Either way, the management company would provide assistance by way of levelling the land and providing technical assistance to farmers, which includes activities like treatment of soil by controlling water and acidity levels. In return for the management assistance, farmers must agree to implement good agricultural practices, which involved precision in planting and harvesting, treatment of soil quality, efficient water use and pest control. Farmers who opted for the scheme were also trained to adopt the latest technologies, and this involved incorporating the latest knowledge across all paddy and rice production chains. They were also taught methods to improve irrigation density and they were introduced to large-scale farm mechanization. In choosing the scheme, farmers were given RM 10,000 per hectare as an incentive, and this is disbursed over 5 harvesting seasons.

The Muda region project intended to increase average yields to 8 tonnes per hectare and to increase farmers' annual income to RM 48,000 by 2020 from a current income of about RM 24,000 per annum in 2011. To ensure that targets were met, PEMANDU worked closely with the MoA and MADA to monitor the performances of the PPKs. The collaboration – between PEMANDU, MoA, and MADA – involved making sure that farmers kept to the proposed plan. Lands were inspected regularly by agricultural officers from the MoA and MADA. These officers followed the "rice check manual" to assess the performance of rice production and provided necessary feedback to farmers. PEMANDU's principles and processes were also incorporated in the project, and this came in the form of Standard Operating Procedures (SOPs), which were meant to ensure that farmers adhered to common best practices in farming methods and adopted new technologies. A chain of processes was also put in place that mirrors PEMANDU's delivery process. They include monitoring, problem-solving and learning (Sabel and Jordan 2015). In the collaborative effort, the PPKs acted as "delivery units" by performing the task of a conduit between PEMANDU, the Ministry of Agriculture and the farmers. These stakeholders would monitor their progress against the one set by PEMANDU. Indeed, the Muda project provided steep learning lessons for small farmers as it aimed to promote capacity-building, specifically improving local learning through self-monitoring. Thus far, a total of RM 2.7 billion had been invested in the Muda project, out of which RM 2.2 billion went to the intensification of irrigation infrastructure.

The World Bank Report (2011) describes the collaborative effort as "one of the most inventive and audacious of PEMANDU's reform undertakings" (Sabel and Jordan 2015, 37) given the magnitude of the amalgamation and the short time frame given to achieve the goals. Work, however, was still in progress as far as the amalgamation of land is concerned. There had been a setback in its implementation, which is discussed below. But overall, the results show that on average "participants' income rose by 11 percent and in the strongest performing PPKs yields rose to more than 20 percent" (Sabel and Jordan 2015, 38).

Setting up a PEMANDU-like agency within an agency

Another project to demonstrate the extent of the incorporation of PEMANDU's delivery processes was the setting-up of a PEMANDU-like unit within the Ministry of Education. The "Performance and Delivery Unit" (PADU) is a unit within the education ministry that was tasked to carry out PEMANDU's "deliverology" philosophy to reform Malaysia's education policies. The unit's mandate involved taking charge of implementation and managing the interdependencies involving the different units in the education ministry to ensure ongoing improvements in providing quality education. On its website, PADU describes itself as a unit to "facilitate, support, and deliver the ministry's vision in transforming Malaysia's education system", specifically achieving the targets set out in Malaysia's national blueprint for 2013-2025. The unit also describes that it "collaborates with the ministry to develop remedial action plans."

The Ministry of Education sought PEMANDU's advice in setting up PADU. In its design, PADU mirrored PEMANDU's. Just like PEMANDU, PADU was headed by a chief executive officer who had some years of working experience in the private sector. PADU's CEO was aided by seven executive directors. When it came to policy delivery, PADU incorporated PEMANDU-like processes, for instance having PEMANDU-like dashboard indicators to measure the performance of individual units and carrying weekly meetings involving PADU's CEO and other stakeholders. But unlike PEMANDU's case – where its CEO held weekly meetings with the Prime Minister and cabinet ministers – PADU's weekly meetings involved its CEO, the second education minister and the various heads of units to discuss the progress made.

In delivering its targets, PADU worked closely with the various units in the education ministry as well as with various state education departments. One project involved PADU organizing a collaboration effort among senior education officers in the state of Perlis. Working closely with Perlis' state education department (*Jabatan Pelajaran Negara* (JPN)) PADU officials held a series of consultations and in-depth interviews with the state education officers to help them identify the difficulties and roadblocks they faced in achieving the National Education Blueprint and in overcoming Perlis' poor national examinations scores. The meetings with the education officers involved reflection sessions. These were similar to PEMANDU's social labs, but this time, it involved PADU officials, who aided the discussions by orienting participants to deliberate on issues of high impact that would affect performance delivery. At the end of the sessions, officers identified four key success factors in driving change – collaboration among JPN officers, school leadership, quality teaching and learning in the classroom and student attendance – which were then translated into actionable items. PADU's sessions with the Perlis education officers produced results. In its 2015 annual report, the Ministry of Education detailed how the collaborative efforts between schools in Perlis saw the state recording its biggest improvement in the national primary-school examination in 2015. An interesting point to note is that when describing PADU's work, the report makes heavy use of vocabulary like "maximum impact", "success factors", "actionable items", "targeted intervention" and "quick wins", vocabulary that is often used by PEMANDU to describe its processes. Indeed, the words reflect PADU's attempt to emulate the inner workings of PEMANDU.

The two cases – the Muda Paddy Project and PADU – provided contrasting aspects of collaborative governance. In the end, the two projects gave mixed results, indicating that collaborative governance is never isomorphic. The two examples depicted invite obvious concerns: what are the essential features for collaborative governance to work in Malaysia, and could collaborative governance be an institutionalized feature of the Malaysian bureaucracy? We elaborate this below.

Whither collaborative governance?

The details above underlined the essential features of Malaysia's collaborative process. PEMANDU's unique operational positioning in Malaysian bureaucracy – the autonomy to manage its resources, easy access to the chief executive, the ability to employ sophisticated and idiosyncratic techniques in promoting collaboration tailored to the bureaucratic culture and the ability to organize various social labs – all had the right formula to make for a successful collaborative project. However, the two cases demonstrate that it takes more than just the above qualities to make for the successful execution of collaborative governance. What was clearly missing from the equation were the issues of trust and legitimacy.

Malaysia's introduction of collaborative governance was more of a project initiated by the state to improve governance and restore trust and legitimacy to the then ruling regime after the regime suffered a huge drop in popularity in the 2008 and 2013 general elections. Trust in government initiatives was clearly low. Such was the extent of the trust deficit and legitimacy problems that then Prime Minister Najib Abdul Razak remarked that "I must execute [government and economic transformation programmes] or be executed" (Comin and Peng 2012). He also remarked that "his future and that of his government is in jeopardy unless public frustration with the poor state of service delivery and other governance issues are tackled urgently" (Siddiquee 2014, 25).

In spite of the World Bank's impression of PEMANDU as having the best arrangement for collaborative governance, the Muda region paddy project and PADU demonstrate that issues of trust and legitimacy remain a huge challenge to successful collaborative governance. Indeed, the two cases indicate that the institutionalization of collaborative governance remains in doubt due to issues of trust and legitimacy. The Muda region paddy project and PADU showed that a trust deficit fostered public apathy and non-cooperation that saw citizens prefer to be passive participants in the public-policy process. The psychological contract between the governed and the government – manifested by way of trust and legitimacy in government – were absent, which made the collaborative endeavor a challenge. The lack of trust was demonstrated from farmers' unwillingness to amalgamate land despite the project reporting an increase in national rice sufficiency from 63 percent in 2010 to 71 percent in 2015 (National Transformation Programme Report 2015, 284). In fact, PEMANDU's employment of the state-of-the-art management rubric to encourage collaboration among farmers was not enough to convince farmers of the benefits of economies of scale that could be reaped from land amalgamation. Farmers were not enthused by the project despite seeing their income improve and yields increase. Some who joined the scheme opted out after they no longer enjoyed the financial incentive of RM 2,000 per hectare after five seasons. For non-amalgamated farmers there were no reasons to join the project after they saw their yields increase from using new technology. Only 20,000 hectares of land were amalgamated in 2015, and this is 40 percent of the target of 50,000 hectares to be reached by the year 2020 (Adnan and Nasruddin 2016).

Trust and legitimacy deficit issues were alluded to in PEMANDU's annual report. In the report PEMANDU acknowledged the administrative challenges to the implementation of the Muda paddy project, highlighting the difficulty in persuading farmers to employ best practices and urging farmers to use new technologies. The report also mentioned that despite MADA's (Muda Agricultural Development Agency) effort at introducing standard operating procedures (SOPs), not all farmers "enjoyed these benefits [higher income] as they did not implement the SOPs" (Pemandu 2016, 241). In another statement that underlines issues of trust and legitimacy, PEMANDU also mentioned problems in constructing irrigation infrastructure because of the issue of land acquisition with farmers, citing legal and administrative problems. The lack of enthusiasm on the part of farmers was also reflected when PEMANDU admitted that it was putting on hold the introduction of a special purpose vehicle to manage the industry’s entire value chain because the “state of operational readiness is yet to be established”, which, the report admitted, could “hinder fruitful collaboration” (Pemandu 2016, 241). It is indeed a tragedy that efforts at collaborative governance that are so necessary for dealing with an increasingly complex system are impeded by political imperatives and deep mistrust in institutions.

The projects demonstrate both the huge potential that can be reaped from the collaborative effort and the amount of work needed to institutionalize collaborative governance. Institutionalizing collaborative governance remains. PEMANDU ceased operations in May 2018, days after Malaysia experienced a change of government. The Barisan Nasional (BN), who had ruled Malaysia for 61 years, lost its hold of power. This new chapter in the country’s political history naturally saw the newly installed government making it clear that it would do away with major projects of the previous government. Given that the collaborative-governance project is nested within Malaysia’s larger development goals designed by the previous regime, there is little to believe that collaborative governance, in the manner that it is carried out now, will continue. The newly installed government had made known during its campaign trail that it would remove PEMANDU, which it did, saying that PEMANDU had failed to deliver in its main Key Performance Indicators, failed to be accountable to parliament and had ensnared itself in possible conflict-of-interest situations. PEMANDU is now a private consultancy firm called PEMANDU Associates. The firm has retained the original name for reasons of goodwill and the track record that PEMANDU had garnered over the years.

Can there be an alternative unit that can replicate PEMANDU’s role as a collaborative agent? This would be difficult mainly because PEMANDU’s unique organizational design had provided it with the ability to deliver collaborative performance between various stakeholders. Its special position in the bureaucracy – its direct access to the prime minister, its independence in terms of recruiting the best from the private sector, its attractive remuneration packages that are outside the civil-service pay structure – was path-breaking, as far as Malaysia’s administrative arrangement is concerned. PEMANDU’s unique positioning within the bureaucracy provided it with sufficient power to convene the different stakeholders (Huxham and Vangen 2000b). Such a positioning had provided PEMANDU with greater latitude to manage its agenda and not be bound by institutional compliance expected of a public bureaucracy. To appreciate PEMANDU’s unique value proposition – its organizational design and mandate – one only needs to compare PEMANDU’s ability to effect change with that of PADU, the unit that attempts to mirror PEMANDU. PADU could not produce the same collaborative arrangement with its stakeholders as PEMANDU had done. What is missing from PADU’s delivery process is the direct access to the top leadership, the Prime Minister or even the Minister of Education; PADU’s CEO reports to the Second Minister of Education, not to the Prime Minister or the Minister of Education. PADU’s position within the hierarchy also makes the execution of collaborative work a challenge. Hierarchy-wise, PADU is one of 37 units in the ministry, so despite assuming the position of Chief Executive Officer, PADU’s chief is of similar rank and authority as other department heads. This limited span of control in the organization and its embeddedness within the ministry of education and the civil-service structure are PADU’s Achilles heel. It is hard for PADU to be a facilitator for change because Malaysia’s bureaucratic politics, cultural code, and presence of high power distance – where grades and positions define the individual’s mandate or scope of work – could result in occasions when heads of departments would refuse to take the advice of PADU officers who are of lower rank. In their assessment of PADU’s performance, officers in the education ministry expressed doubts about PADU’s ability to deliver the education blueprint. One of the officers we talked to raised the concern that PADU directors were new recruits to the civil service with little or no background in educational services. The officers expressed the assumption that the new PADU recruits might not know much of on-the-ground operations. They also expressed concern that PADU is a small unit and that it may be overwhelmed by the scale of the blueprint. PADU’s inherent challenges to institute change are not unlike the experience of many change agencies within the Malaysian bureaucracy. One case in point was the challenges faced by Malaysia’s Administrative and Modernisation Planning Unit (MAMPU), an agency that is tasked with carrying out administrative reform. Taking the view of Malaysia’s bureaucratic code, MAMPU officers were not able to initiate change because they are still guided by the fear that a perceived act of insubordination would jeopardize their promotional prospects (Noh and Tumin 2013, 97). There is, of course, the possibility to replicate PEMANDU’s role in the civil service, but without PEMANDU’s unique line of authority, there is a possibility of conflicting agency goals and missions, inflexible administrative and legal procedures and constrained financial resources (Purdy 2012). Indeed, a diffuse authority structure can hamper the collaborative process because it affects the extent of participation, cooperation, and representation (Huxham and Vangen 2000a). PEMANDU’s organizational arrangement had proven to be critical in obtaining buy-ins and mobilizing collaboration. One officer we interviewed, who was a special officer to a minister, mentioned how one critical government agency “dropped everything in their path” to give priority to PEMANDU-led initiatives every time there was a visit by PEMANDU officials.

Conclusion

This article describes the collaborative process as well as highlights that understanding the process remains a challenge. In its attempt to circumvent the difficulty of understanding the collaborative process it has adopted a second-best method, that is, by using an important change agent as a prism to observe the collaborative process.

What are some of the lessons that can be drawn from PEMANDU’s collaborative process? One obvious take away is the importance of organizational design. While it is true that PEMANDU fell short of its objectives, its organizational design is worth noting. PEMANDU’s organizational design is hard to replicate. PEMANDU’s positioning in Malaysian bureaucracy was unprecedented in Malaysia’s administrative history; a unit within the Malaysian bureaucracy, yet it did not exactly operate like other agencies within the bureaucracy. In the initial years, its CEO was appointed a senator in the upper house and made a cabinet minister. This arrangement allowed PEMANDU the autonomy to recruit personnel, the ability to plan for its own budget, the privilege of having direct access to the Prime Minister and the ability to liaise directly with ministers and the different ministries – factors that facilitated collaboration. The case of social labs, the cabinet workshop and the adoption of various bureaucratic mechanisms to ensure better delivery are some of the examples of how PEMANDU’s organizational design facilitated the collaborative process. It must be said, however, that PEMANDU’s organizational design is not without its risks. Its ready access to public funds, its close nexus with the highest political authority, its autonomy when it comes to operation suggests the need to put in place safeguards to protect the public good. Without such safeguards, this organizational design can easily succumb to governance issues of accountability, conflict of interest and abuse of power, which ultimately affects the perception of governance and costs the regime its legitimacy.

A second lesson that can be drawn from PEMANDU's experience is the importance of buy-ins from key actors in policy execution. By putting in place mechanisms to convince important actors of policy objectives, obtaining buy-ins from key appointment holders in government would result in lesser resistance and avoid policy distortion. A case in point is the workshop for cabinet ministers. PEMANDU's organization of the workshop was difficult but one that was completely important; without the buy-ins from the ministers PEMANDU's collaborative endeavor would have faced greater resistance from the bureaucracy. This is especially relevant in high power-distance settings, like Malaysia. In a place where hierarchy and positions are viewed as important qualities to execute policy successfully, having the cabinet ministers promote difficult policies was indeed crucial. Also, the heavy presence of the prime minister was helpful at the initial stage because it sent signal to ministers on the seriousness of the workshop and the importance of greater collaboration.

PEMANDU's employment of the blind voting system also needs mentioning. The blind voting system fits a Malaysian bureaucratic culture that is high on collectivism. In a setting where bureaucrats tend to display in-group cohesiveness, indulge in collective action and promote "perverse equalitarianism", where members tend to stick to a conformist culture for fear of being too direct, insensitive or rude, the blind voting system gave members the security that their views would be held in confidence. Indeed, PEMANDU's blind voting system was a novel idea, a clever way of negotiating Malaysia's bureaucratic structure and culture to get optimum policy outcomes.

PEMANDU's collaborative design in settling disputes and resolve bottleneck issues also stands out. Such mechanisms at dispute settlement came from an appreciation of a bureaucratic culture that is not naturally predisposed to inter-ministerial collaboration. PEMANDU's incorporation of group dynamic techniques that took into account bureaucrats' "face-saving" or "avoidance of group conflict" tendencies eased inter-ministerial interactions and produced collaborative tendencies between bureaucrats.

But the Malaysian experience also highlights many concerns. The first is that the design and performance of collaborative governance remains a function of the state-society structure. As the World Bank report pointed out, it is hard to replicate the Malaysian experience because PEMANDU was designed and executed in the context of Malaysia's state-society structure. Second, state-initiated collaborative design may not be enough for a successful collaborative exercise. The state's heavy involvement in the collaborative design and the state's nurturing of an ecosystem to facilitate the collaborative process is necessary but not sufficient to make for successful collaborative governance. The Muda Project and PADU show that although there were small wins in the collaborative process, these were not enough to remove the more systemic issue of trust deficit and lack of legitimacy for the ruling government. Indeed, the examples showed that issues of trust, legitimacy and regime coherence could throw off the best collaborative organizational design and state's intentions. Trust and regime legitimacy can interfere with ideas of shared motivation and collaborative governance. The Malaysian example demonstrates that trust, legitimacy and regime quality are important, perhaps necessary, to make collaborative work. Such loss of legitimacy was ultimately reflected in May 2018, when the then ruling regime lost its hold of power for the first time in 61 years.

This article does not pretend to present a formula for collaborative governance. Rather, the article only raises a lot more questions than it answers. While the likes of Ansell and Gash (2008) and Emerson et al. (2012) provide parsimonious models that have included various factors that are important to the collaborative process, the process of instituting collaborative governance does not come in neat packages. This article demonstrates that understanding the collaborative process remains a huge challenge due to the multitude of considerations.

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