PROSPECTIVE VOLUNTARY AGREEMENTS TO ESCAPE CARBON LOCK-IN

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Abstract

The paper looks for co-evolutionary policy responses to carbon lock-in – a persistent state that creates systemic market and policy barriers to carbon low technological alternatives. We address the coordination role for authorities rather than the corrective optimisation and analyse experiences from environmental voluntary agreements and foresight activities. The paper argues that combining the virtues of these tools into a new policy tool, named *Prospective Voluntary Agreement* (PVA), can help facilitate an escape from carbon lock-in and provide policy resources for addressing lock-in related issues. The merit of PVA lies with the enhancement of collaborative policy culture and inter-sectoral and interdisciplinary stakeholder learning that creates commitment to desired action for escaping lock-in.

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INTRODUCTION

In recent years, environmental authorities have recognized the limitations of conventional command-and-control based instruments and expert driven technocratic planning practices and they have develop more flexible and participatory approaches (European Commission, 2004; OECD, 2003). Based on the use of market incentives and voluntary measures, authorities have introduced alternative methods such as eco-taxes, voluntary agreements, negotiated licenses and eco-labelling. These methods pledge to reduce the need for intervention on the part of authorities and to bring about change in a more cost-effective way. Discussion on the policy rationales of alternative methods has largely focused on comparing them with conventional legislative-type instruments within the optimisation of present production systems in terms of environmental and economic impacts (OECD, 2000, 2003). Here, we go with the work of a number of authors (e.g. Ayres, 1991; Carraro and Siniscalco, 1994; Kline, 2001; Smith, 2000), who admit that it is unlikely that optimisation-oriented policy approaches alone are able to bring about sufficient change, in particular in relation to the challenge of curbing climate change. We provide alternative viewpoints by building upon evolutionary and institutional theories that consider technological advance as knowledge accumulation and emphasise learning within innovation processes (Dosi et al., 1988). Thereat, the study is also part of increasing efforts to create linkages between environmental and innovation policy (e.g. European Commission, 2004).

This work contributes to the literature by elaborating the notion of Techno-Institutional Complex (TIC) (Unruh 2000; 2002), a concept which builds upon recent efforts at rejoining evolutionary and institutional economics (e.g. Hodgson, 2002; Nelson, 2002). More specifically, the paper argues that industrial economies have been locked into fossil fuel-based energy systems. This condition is termed *carbon lock-in*, a persistent state that creates systemic market and policy barriers to carbon low technological alternatives. Instead of policy attempts to optimise eco-efficiency of present production systems, our focus lies with the inducement of path-dependent structural changes (Carrillo, 2004; Llerena and Matt, 1999; Mulder & Van den Bergh, 2001). The role assigned to authorities is not corrective but *coordinative*, and is more concerned with influencing the process than imposing a particular result (Metcalfe, 1995). The emphasis is on learning and coordination in the combined use of regulatory, economic and voluntary policy tools. Among alternative methods of environmental policy, we focus on environmental voluntary agreement (EVA), defined as *"an agreement to facilitate action with a desirable environmental outcome, which is encouraged by government, to be undertaken by the participant based on the participant's self-interest"* (Storey et al., 1997). In particular, we examine and elaborate EVA practices designed to accelerate radical technological changes. EVA are typically negotiated between industry and government as alternatives to environmental regulation in an effort to generate faster environmental results and greater economic efficiency, but also criticized as lacking inclusiveness and having poorly defined targets, resulting in lower environmental standards, unenforceability and ineffectual monitoring (Makuch, 2003). Makuch suggests that an enhanced dialogue *process* between authorities and industry can help identify potential obstacles before an agreement is created.

Stakeholder dialogue process is inherent in the field of innovation policy and technology futures analysis (Technology Futures…, 2003), particularly in technology assessment and *foresight* activities. While technology assessment (Hay & Noonan, 2004) recognises the potential impacts of existing technological choices, foresight emphasises learning and vision-building for creating the desirable and even radically different future. Foresight is typically employed to enhance long-term sectoral, regional or national innovation activities (Salo, Könnölä & Hjelt, 2004). Recently, foresight activities have paid increasing attention to effective communication and extensive stakeholder participation. The High Level Expert Group appointed by the European Commission crystallised these trends by defining foresight as follows (European Commission, 2002): *"A systematic, participatory, future intelligence gathering and medium-to-long-term vision-building process aimed at present-day decisions and mobilising joint action"*. At its best, foresight process creates common vision for systemic change towards sustainable development. However, difficulties often arise in transferring vision into action.

Integrating the virtues of EVA and foresight provides opportunities to overcome their individual shortcomings. EVA are designed to curb negative impacts of technology and polluting industrial activities, whereas foresight activities focus traditionally on technological advance improving long-term economic competitiveness. Combining these distinct view points, authorities can use the threat of environmental regulatory actions as well as innovation oriented economic incentives to connect even confrontational stakeholders into a mutually beneficial learning and action towards an escape from carbon-lock-in. Thus, the paper argues that combining the virtues of EVA and foresight methods into a new policy tool, named *Prospective Voluntary Agreement* (PVA), can help facilitate an escape from carbon lock-in and provide policy resources for addressing lock-in related issues.

The remainder of this paper is structured as follows. In Chapter 2, we discuss the dynamics of carbon lock-in and, in Chapter 3, elaborate corresponding co-evolutionary policy objectives. In Chapters 4 and 5, experiences from EVAs and foresight activities are examined and, in Chapter 6, integrated in a new policy tool, named *Prospective Voluntary Agreement* (PVA). Finally, in Chapter 7, the paper discusses implications of the proposed tool on environmental and innovation policy-making.

2 CARBON LOCK-IN

Most of the explanations for failures of the diffusion of environmental technologies tend to focus on barriers to adoption within micro-economic decision-making (Jaffe, Newell & Stavins, 2000; Lohani & Azimi, 1992) giving limited attention to institutional and macro-level context. However, institutional theorists make clear that macro-level norms and rules constrain micro-level decision making (North, 1981). To understand this broader context, we consider both evolutionary and institutional economics. Evolutionary economics[1] focus largely on the role of technological advance in the

[1] Evolutionary approaches depart from the (aggregate) production function used by neoclassical economists (Dosi et al., 1988). Given that uncertainty is intrinsic to the process of technological change, the neoclassical assumption of rational maximizing behaviour is replaced by a search for profit "in the dark" (heuristic search routines); as a result, there is no single welfare maximizing equilibrium, but rather a plurality of possible equilibria: evolution of historical events thus determine which equilibrium is reached or approached at any given time; the structure, including the economic, social and political institutions, is often made explicit in evolutionary approaches (Carrillo, 2004).

economic development, whereas institutional economics emphasises institutional context in which technological decision are taken. Scholars within both disciplines have seen benefits in integrating evolutionary and institutional theory-building (e.g. Hodgson, 2002; Nelson, 2002).

In the domain of climate change policy, Unruh (2000, 2002) links evolutionary and institutional economics in an interdisciplinary framework termed a *Techno-Institutional Complex* (TIC), which is used to explain the failed diffusion of carbon low technologies. Thus, *Carbon lock-in* is a persistent state that creates systemic market and policy barriers to carbon low technological alternatives and occurs through combined interactions among technological systems and governing institutions. Such lock-in arises through path dependent co-evolution driven by increasing returns to scale, which Arthur (1989, 1990, 1994) has classified as scale economies, learning economies, adaptive economies and network economies. Increasing returns mean that the earlier superiority and emergence of dominant design (Nelson, 1995) is no guarantee of long-term suitability (David, 1989; Cowan, 1990; Nelson, 1994). Apparently inferior designs can become locked in to the production system through a historically dependent process in which circumstantial events in the techno-institutional context can determine the winning alternative (David, 1985, 1997).

A techno-institutional complex is a highly co-evolved, self-referential system where the members of the system create rules and practices to guarantee its self-perpetuation. Importantly government ministries and regulatory agencies are part of the TIC and are active participants in its perpetuation. Governments become involved in the establishment and extension of technological systems like road ways and electricity grids for a variety of reasons including universal service, national security, public safety, etc. Co-evolution among the private owners of technology and regulatory institutions creates a stable system that aims to provide needed services to society. However, as is frequently the case, negative externalities associated with a given technology are belatedly discovered after the system is well established. This is currently the case for many energy, transportation, industrial and also agricultural technologies and the basis of many current environmental challenges. Overcoming these problems requires changes to the underlying technological systems. Such change, however, is impeded by techno-institutional lock-in.

The limits of technological change lie generally not with science and technology, which tend to evolve much faster than governing institutions, but with the organisational, social and institutional changes that facilitate or inhibit the diffusion of new technological solutions (Unruh, 2000). Within different classifications, we identify two generic types of technological change: *continuity changes*, which are incremental, sustaining changes or additions to components that preserve the overall technological architecture, or *discontinuity changes* which seek the replacement of the existing systems (Dosi et al., 1988). Historically, environmentally related change has been of the continuity type, such as end-of-pipe technologies that leave the production system basically intact and add pollution control equipment onto the end of the process. These types of changes account for 70 to 90% of environmental technology expenditures (OIG, 2000). However, it is becoming increasingly clear that some environmental problems cannot be effectively solved through continuity approaches. Dealing with global climate change, for example, will require nearly 90% reductions in carbon dioxide emissions by industrialized countries, something that currently appears to be beyond the scope of continuity approaches in the energy sector.

Given this internally generated stability, breaking the lock-in situation often requires exogenous pressures originating outside of the techno-institutional complex such as major crises or external shocks (March & Olsen, 1989; Hughes, 1987). Some examples of exogenous pressures include technological breakthroughs, social movements or environmental disruptions (Unruh, 2002). However, waiting for exogenous forces to initiate change can be an inefficient way to resolve environmental problems created by techno-institutional lock-in. In fact, our foresight abilities tell us that many of these problems are irreversible, such as massive species extinction or a dramatic abrupt shift in global climate, and that precautionary actions are needed to prevent them. The challenge lies in generating forces for discontinuous change in the TIC. Escaping carbon lock-in in the absence of exogenous shocks requires mutual understanding about future problems and some level of consensus among TIC members about technological alternatives. It is argued here that generating these mutual understandings on actions can be facilitated through PVA.

3 CO-EVOLUTIONARY POLICY OBJECTIVES

In policy approaches addressing techno-institutional co-evolution, the main question is not optimisation and equilibrium, but endogenous path-dependent change and long-term co-evolution of environmental, social and economic processes and complex systems characterised by irreversibility and uncertainty (Carrillo, 2004; Llerena and Matt, 1999: 4, Mulder & Van den Bergh, 2001). The locus of attention moves from the neoclassical market failure (Arrow, 1962) towards the improvement in competitive performance and the promotion of structural change (Mowery and Rosenberg, 1989). Thus, the role assigned to authorities is not corrective but *coordinative* (Metcalfe, 1995); thus, authorities are more concerned with facilitating processes towards technological and structural changes than imposing a particular result. This evolutionary policy approach is especially important within a techno-institutional complex (TIC), where existing government policy is partially responsible for inertia to technological change. In this case an emphasis on mutual learning and coordination in the combined use of regulatory, economic and voluntary policy tools can help to escape lock-in. Additionally, actors from outside the TIC are important in providing new alternatives and motivations and thus play a role in PVA: The ultimate goal is a shift away from public and private policies that reinforce the lock-in conditions, to mutually defined policies that foster an escape from lock-in. Thus, we elaborate three fundamental objectives that can facilitate an escape from lock-in, including the creation of i) radical technological options, ii) vision for the implementation of technological alternatives, and iii) changes in both the physical and social networks themselves.

3.1 Radical Technological Options

Escaping lock-in requires as a starting point a variety of *radical technological options* that meet and shape market needs in ways that correct identified negative externalities. These options are both physical technologies in the form of technological artefacts and infrastructures, and social technologies (Nelson & Sampat, 2001) in particular, search for their creative combination in a systemic innovation process (e.d. integration of technology push and market pull approaches). In addition to ongoing research efforts in environmental technologies, cross-disciplinary and cross-sectoral collaboration is required to expand the variety of options both in supply and demand.

Given bounded rationality and imperfect information it is impossible to identify in advance what technologies and organisational responses are most desirable for society (Kline, 2001). Technological development should be understood as a process of evolution in which alternative technologies compete with one another and with the dominant technology, resulting in selection of winners and losers, with considerable uncertainty at the outset about their social merits (Nelson and Winter, 1982). Thus, in order to both prevent and escape lock-in conditions, authorities need to encourage stakeholder actions to expand the variety of options and respective technological trajectories, and along these processes engage in learning about their social merits (Carrillo, 2004; Kemp, 1997; Metcalfe, 1994).

3.2 Vision for Implementation

Techno-institutional co-evolution is complex, irreversible, and uncertain. The impacts of technology on environment and society are multi-faceted and may be noticed much later than in the emergence of technology, e.g. detrimental impacts of CFCs on the ozone layer. Thus, Unruh (2002) calls for attention of policy makers to take into account and create a flexible policy regime that allows continuous evolution. By initiating processes for creating the foresight and systemic understanding of techno-institutional co-evolution we can begin to formulate pathways to carbon low technology arrangements. Vision building entails the creation of future oriented scenarios that envision the new technologies, new systemic interconnections and new institutional arrangements. This vision can then guide the physical and organizational changes needed to escape a lock-in condition.

The co-evolutionary vision-building is crucial, especially because of fragmented sectoral policy-making structures originating, in particular, from the application of positivist social sciences. Typical sectoral policy responses to lock-in are fragmented optimisation efforts with command-and-control and market-based instruments, which may lead to inefficient and counterproductive policy actions. This creates uncertainty in the market and hampers the creation of discontinuity changes. Instead of short-term co-optimisation efforts between various policy sectors – which easily escalate to a policy debate characterised by fixed positions and claiming value (Raiffa, 1982) – we posit that emphases need to be placed on creating value through continuous stakeholder learning and common vision-building for discontinuity changes. Here, we turn our focus in innovation policy and, in particular, foresight practices developed for improving understanding of entire innovation systems and creating common vision for future actions.

3.3 Changes in Physical and Social Networks

The efficient exploitation of technological options and concepts requires a redefinition of stakeholder roles and institutional structures, as well as actual changes in the technological systems of concern. Both policy-makers and other stakeholders tend to shape institutional context through their strategic actions of creating and claiming value (Powell & DiMaggio, 1991), for example by building new coalitions. These new social networks and agreements, in turn, open up possibilities for lock-in breaking innovations spurring typically from new technology-based start-up companies within distinct value networks from those of incumbent industry. In line with this approach, in the rigid energy sector, companies such as Shell and BP have set up spin-offs and subsidiaries to develop renewables and hydrogen technology. This type of responses to carbon lock-in can be seen as strategic actions to anticipated market changes, but also to improve corporate image. Whereas collaborative action can create new physical and social networks for disruptive radical innovations, it can also be used for enforcing TIC (Beder, 1998). Thus, authorities need to initiate future-oriented and facilitated processes that direct possibly counter-productive stakeholder actions towards collaboration, persuading industry to engage in learning processes, reassess their value networks and commit to desired action. Here, experiences on EVA provide insight how to commit industry to desired action by building on incentives and collaboration, without ruling out regulatory actions in case of non-compliance.

We examine EVA and Foresight activities in relation to the above three objectives. Both EVA and Foresight are participatory collaborative policy tools, which represent distinct viewpoints; EVA are designed to curb negative impacts of technology and polluting industrial activities, whereas Foresight activities focus traditionally on technological advance improving economic competitiveness. Here, we consider these distinctions as starting points for elaborating PVA by combining EVA and Foresight to overcome their individual shortcomings.

4 ENVIRONMENTAL VOLUNTARY AGREEMENTS

Environmental Voluntary Agreements (EVA) are typically designed as alternatives to environmental regulation in an effort to generate faster environmental results and greater economic efficiency. Thus, research on EVA tends to focus on environmental *results* and economic efficiency within a specific institutional context (OECD, 2000). Our interests, however, lies particularly in the collaborative mechanism of EVA that can be conducive for the development of innovative solutions, which authorities and companies would have been unlikely to develop alone. OECD (2000) has classified EVA in three categories, including i) unilateral agreements initiated among industry, ii) public voluntary programmes devised by regulators and iii) negotiated agreements drafted between regulators and industry. Next, we follow this triadic categorisation and outline some of the experiences from each of them in relation to the co-evolutionary policy objectives.

4.1 Unilateral Agreement

Unilateral agreements are commitments by industry to reduce pollution. Thus, these commitments do not necessitate the evolvement of authorities (OECD, 2000). Typically unilateral agreements emerge as a response to stakeholder pressures to gain legitimacy and to avoid stricter regulation, for example, the Responsible Care Program in the chemical industry (Howard et al., 2000) and the Declaration on Global Warming Prevention adopted in 1996 by German industry and trade. The former represents intensive collaboration in a specific sector facing growing stakeholder pressures, where as the latter a loose coalition among different sectors to avoid the implementation of an energy tax. Thus, unilateral agreements tend to induce incremental and sustaining advances in physical and social networks and disregard the creation of radical technological options and vision for their implementation.

4.2 Public Voluntary Programme

Public voluntary programmes are devised by authorities, who establish the frame for the programmes and define basic requirements for participation. These programmes usually provide technical assistance and positive public recognition to participating companies (OECD, 2000). Most of EVA in U.S. are public voluntary programmes, as these programmes do not necessitate sectoral industry coalitions or agreement negotiations with authorities. For example, through Design for Environment Program (DfE), U.S. Environment Protection Agency (EPA) developed and provided companies with information how to incorporate environmental issues into the design of products, processes and management systems (Delmas & Terlaak, 2001a). The programme emphasised information dissemination and coordination of research and technology development (RTD) efforts. This industry-research collaboration may create radical technological options and changes in social networks among participants, but does not enforce their application, as it does not contain environmental targets or sanctions. For example, in the case of EPA's Climate Wise Programme, most corporate level targets do not require radical technological change, but can be achieved through improved housekeeping (Delmas & Terlaak, 2001b). Furthermore, as public voluntary programmes tend to be designed by authorities with limited stakeholder interaction, visions for implementation of technological alternatives remain fragmented.

4.3 Negotiated Agreement

Negotiated agreements differ from unilateral agreements and public voluntary programmes, because they require negotiation between industry and authorities (OECD, 2000). The success of negotiated agreements to prompt changes in physical and social networks relies largely on credible regulatory commitment, which may be diminished by the fragmentation of decision-making power among different authorities and the open access of stakeholders in negotiations (Delmas & Terlaak, 2001b). When stakeholders are included, transaction costs may become excessive. For example, in U.S. EPA's Project XL (excellence and Leadership), stakeholder involvement entailed lengthy and costly negotiations (Blackman & Mazurek, 2000). Thus, wider stakeholder engagement is typically seen as a burden rather than a learning opportunity. Still, stakeholder participation and transparency of negotiations remain important for achieving legitimacy and efficient implementation of an agreement (European Commission, 1996).

Negotiated agreements may promote radical technological options and changes in social networks. For example, the French End-of-Life-Vehicle Agreement spurred from too complex problem to be handled by a single company or industry. Collaboration was needed to create coordination mechanism, which promotes learning and exploratory action. Furthermore, the targets of the agreement asked for changes in technological trajectories and learning and mutual knowledge formation between companies. (Delmas

& Terlaak, 2001a.). However, in negotiated agreements limited attention is paid to stakeholder learning and vision-building for implementation of technological alternatives.

5 FORESIGHT ACTIVITIES

In recent years, national, regional and sectoral foresight studies have been conducted in many countries, in order to define research priorities, look at the future from a broad range of complementary viewpoints and create common vision for RTD activities (Gavigan, 2002; Hjelt *et al.*, 2001). The locus of foresight activities has tended to shift from positivist and rationalist technology-focused approaches towards the recognition of broader concerns that encompass the entire innovation system, including the challenge of sustainable development (Gavigan, 2002; Schomberg, 2002). Along this development, increasing attention has been paid to communication and stakeholder engagement, which is inherent in the definition of foresight given in the introduction of the paper. Salmenkaita and Salo (2004) categorise foresight activities in three traits, including i) emergent foresight driven by stakeholder interests to align RTD activities, ii) embedded foresight conducted within instruments of innovation policy and iii) explicit foresight initiated by policy-makers to align innovation policy actions. Subsequently, we discuss these practices in relation to the co-evolutionary policy objectives.

5.1 Emergent Foresight

Salmenkaita and Salo (2004) define emergent foresight as collective and competitive processes through which future-oriented analyses are iteratively produced, revised and evaluated, in response to a recognized need to align interdependent RTD agendas with opportunities that are perceived and shaped by stakeholders who share overlapping interests. Emergent foresights emerge typically within industry clusters with no necessary involvement of authorities. For example, the work of the Wireless World Research Forum (WWRF) – which sought to promote the conception, development and diffusion of wireless communication technologies – evolved from the establishment of a think-thank into a forum consisting of open calls for proposals, open meetings and workshops.

In this kind of networking process participants synthesise through iterative discussions their competing and complementary views into increasingly comprehensive visions of the future that may accelerate changes in physical and social networks and the development of even radical technological options for shaping future markets (Salmenkaita and Salo, 2004). Because emergent foresight is often initiated around existing industry coalitions, claiming value and power plays are typical features, in which institutional changes for implementation of radical technological alternatives may receive limited attention.

5.2 Embedded Foresight

Embedded foresight refers to individual and collaborative processes through which prospective information about relevant technological, commercial and societal developments is acquired, produced, refined or communicated within RTD programmes, in order to generate shared vision for RTD activities (Salo and Salmenkaita, 2002). For example, foresight activities embedded in Finnish RTD programmes in electronics and telecommunication have been considered highly relevant, especially because the sectors are characterised by rapid technological advance (Salo and Salmen kaita, 2002). Foresight activities embedded in steering group meetings and project reviews induce changes in social networks among the funding agencies, the recipients of RTD funding and the consulted experts and, t hus, also accelerate the development of new technological options. However, embedded foresight often is limited to the areas of existing RTD activities in terms of a time horizon and vision-building and, thus also in terms of the scope of changes in physical and social networks.

5.3 Explicit Foresight

Explicit foresight exercises in support of innovation policy-making exhibit considerable variety within the used methods. Salmenkaita and Salo (2004) consid er explicitly managed foresight projects where (i) the setting of research priorities is among the key agenda items, (ii) the work is intensively systematic and analytic, and (iii) participants are consulted mainly due to their expertise in specific fields. Often, such exercises are run by appointing parallel expert panels, for example The UK T echnology Foresight Programme 1994-1995 depended on 15 sector pa nels (Keenan, 2003). Even though the process itself may not ensure that steps towards the implementation of recommendations are taken, the results can be used to justify changes in S&T priorities, which in turn may create changes in physical and social networks and influence on the development of radi cal technological options. F or example, the UK Technology Foresight lead to the launch of several new LINK (academic-industrial collaborative RTD) programmes, e.g. waste minimisation through recycling, reuse and recovery in industry (Georghiou, Loveridge & Street, 1998).

In explicit foresight, sustainable development is gener ally viewed as a ke y future need to which science and te chnology should be direct ed. However, explicit foresights tend to emphasise opportunities and to neglect threats related to technological advance (Hjelt et al., 2001), thus disre garding the viewpoint i nherent in environmental technology assessment (Hay & Noonan, 2004). As a promising exception, an ex plicit foresight initiated by the Dutch Ministry of Housing, Physical Planning (Borub, 2003) discussed future technologies[2] as opportunities for s ystemic changes but also as pote ntial sources for new environmental problems. In explicit foresight, especially the selection of participants plays an important role in order to induce cr eative discussion and challenge the existing TIC.

6 PROSPECTIVE VOLUNTARY AGREEMENT

Interestingly, the identified three categories both in EVA a nd foresight activities correspond in terms of the level of authorities' eng agement. Unilateral a greement and emergent foresight are both industry lead activities in which authorities have limited access and possibilities to a ssure desired actions. Public voluntary programme and

[2] Examples of the identified technological systems included: Advanced separation; Cultivation of biological raw materials; Coal gasification; New generation of photovoltaics cells; Hydrogen for driving vehicles; Intermodal goods transport; Domestic communication systems; Novel protein foods; Optimisation of horticulture behind glass; Industrial waste as building material.

embedded foresight are designed and initiated by authorities but with limitations in terms of time and scope. In negotiated agreement and explicit foresight, authorities, in turn, have a major role in the design and management of the process together with stakeholders. Thus, these triadic categorisations own a promise for integrating EVA and respective foresight activities. As the co-evolutionary policy approach calls for authorities to actively engage in the coordination of stakeholder processes, we focus on combining negotiated agreement and explicit foresight. Despite the wide variety of both negotiated agreements and explicit foresights, we typify their archetypes and identify their virtues and shortcomings. *Archetypal negotiated agreement* is characterised with following dimensions:

- *Collaboration:* The parties engage in negotiations in order to achieve better outcomes than through competition or coercive actions. For the efficient and manageable negotiations, issues are defined and limited in number at the out-set of the process. As negotiated agreement focuses on environmental protection and costs, it often disregards other policy areas, thus limiting also the scope of decision-making.
- *Stakeholder engagement:* Negotiations tend to be limited between industry and authorities for the sake of efficient and manageable process. This approach is based on the experiences that extensive stakeholder participation increases threat of leakage of competitive and proprietary information and power struggle through media actions, thus also transaction costs and free- riding (Blackman & Mazurek, 2000; Weber & Khademian, 1997). However, ensuring some level of stakeholder engagement is considered important, in particular for the legitimacy and implementation of an agreement (European Commission, 1996).
- *Process management:* The negotiation is supported by mediation, which helps the parties to work out their own mutually agreeable targets (Raiffa, 1982). However, constrained by current institutional pressures negotiations are prone to become a political debate of claiming value or suffer from regulatory capture, thus contributing to the self-perpetuation of the TIC.
- *Outcomes:* Negotiations lead to an agreement and the commitment of parties to the implementation of the agreement. The objective is to create commitment to efficient environmental improvements, but difficulties often arise with poorly defined targets, resulting in lower environmental standards and free-riding (Makuch, 2003).

There also is a huge variety of explicit foresights, thus the identification of the typical characteristics is intricate. For the purpose of this paper, we typify the virtues and shortcomings of *archetypal explicit foresight* as follows:

- *Collaboration:* Through a stakeholder learning process, the objective is to create supporting knowledge for decision-making, in particular, for the setting of research priorities and look at the future from a broad range of complementary viewpoints. However, the opportunities of technological advance tend to be emphasised, whereas threats underestimated (Hjelt et al., 2001).
- *Stakeholder engagement:* Participants – especially from industry, research and public sector but also from civil society – are engaged in order to acquire expertise in specific fields. Extensive stakeholder participation, for example through panels working, becomes challenging as various stakeholders bring in

the process too many issues to be resolved and unclear interests (Hjelt et al., 2001; Salo, Könnölä & Hjelt, 2004).

- *Process management:* Facilitated future-oriented learning process helps participants to explore, identify, define and stay focused on working toward foresight objectives. Because the analytic and systemic work is meant to create support for decision-making on policy and stakeholder actions, explicit foresight is a learning rather than decision-making process. This reduces the need for lobbying and claiming value and helps participants even with contradictory history to work together (Raiffa, 1982).
- *Outcomes:* The explicit foresight process creates codified information such as recommendations for research priorities, but also accumulated tacit knowledge and common vision for future action among participating stakeholders. It often is, however, difficult to deliver into action consensus driven abstractions of identified solutions. The implementation of foresight recommendations may also suffer from lack of commitment and policy measures available for decision-makers (Salmenkaita and Salo, 2004).

Based on these typified archetypes of negotiated agreement and explicit foresight we consider combining their virtues to provide opportunities to overcome their individual shortcomings. Thus, we propose the development of a new integrated policy tool, *Prospective Voluntary Agreement* (PVA). Based on the definitions on EVA and Foresight in Chapter 1, we crystallise the definition for PVA as follows:

a systematic, participatory, future intelligence gathering and medium-to-long-term vision-building process aimed at creating an agreement between authorities and industry to facilitate desired action.

Recognising the challenge of integrating two different straits of practice, here, we limit our elaborations on the management of stakeholder learning process that supports the drafting a PVA, thus, giving limited attention to post-negotiation activities such as monitoring. In Table 1, we summarise the main determinants of archetypal negotiated agreement and explicit foresight and their respective combined determinants for archetypal PVA. PVA builds on extensive stakeholder learning process creating ground for the negotiation of an agreement between key stakeholders. Correspondingly, the activities of project coordinators evolve from facilitation to mediation. Instead of fixing issues at the out-set of the process, divergence and convergence of views on future challenges are looked for and elaborated through cycles of learning and negotiation. During this vision-building process key issues are identified for drafting an agreement that defines stakeholder commitment for future action.

Dimensions:	*Archetypal Negotiated Agreement:*	*Archetypal PVA:*	*Archetypal Explicit Foresight:*
Collaboration	Negotiation and Decision-making	Cycles of learning, negotiation and decision-making	Learning and support for decision-making

Stakeholder engagement	Limited to industry and authorities	Structured stakeholder engagement	Inclusion of industry, research, authorities and other stakeholders
Process management	Mediation	Facilitation and mediation	Facilitation
Outcomes	Commitment to action	Vision and commitment to action	Vision

Table 1 Determinants for archetypal negotiated agreement, explicit foresight and prospective voluntary agreement (PVA).

6.1 Cycles of learning and Negotiation

PVA process builds on stakeholder learning and facilitation methods used in explicit foresight in order to avoid the premature definition of issues typical to negotiated agreements. In negotiated agreement, the focus often lies with incremental improvements and optimisation of the economic and environmental performance of present production systems leading to claiming value characterised by fixed positions (Raiffa, 1982). To avoid such lock-in conditions, it is pertinent to begin with the comprehensive mapping of diverse view-points on current and future challenges, and only after creative formulation of various alternative technological pathways the process is directed toward the identification of key issues and focused negotiations for an agreement between key stakeholders. The design of creative learning and negotiation process calls for authorities to take an active role by bringing in the process their bargaining power and by providing needed infrastructure for conducting such a process. This asks for combined use of foresight and negotiation methods to balance analytic (i.e., production of factual future-oriented statements) and communicative (i.e., facilitation and mediation of dialogue processes among the stakeholders) approaches (Salo, Könnölä & Hjelt, 2004). Yet, the selection of these approaches and ensuing methodological choices is not an easy task, given that the different methods (e.g., Delphi-survey, critical technologies, expert panels, see, e.g. Porter et al. , 1991) have their specific advantages and disadvantages.

Thus, in the management of the PVA process, coordinators need to pay attention to *responsiveness* – by which Salo, Könnölä and Hjelt (2004) define as *purposely designed managerial controls for making warranted mid-course adaptations to objectives and implementation plans*. In effect, responsiveness requires *receptivity* vis-à-vis the interests and expectations of participating stakeholders, and *flexibility* in planning and implementation (Salo, Könnölä & Hjelt, 2004). In this setting, the defining feature of the responsive PVA process is that key stakeholders collaborate with the stakeholders from different societal sectors and scientific disciplines, in order to implement process cycles of learning and decision-making which, by design, contribute to the formulation of radical technological options, vision for their implementation and changes in both the physical and social networks themselves.

6.2 Structured Stakeholder Engagement

A shift away from public and private policies that reinforce the lock-in conditions to mutually defined policies that foster an escape from lock-in calls for wide stakeholder participation engaging actors also from outside the TIC to bring in new alternatives and motivations and external monitoring (Timmer, 1997). However, experiences both from negotiated agreement and explicit foresight address that wide stakeholder engagement may become too complex and controversial to manage (Blackman & Mazurek, 2000; Hjelt et al., 2001; Weber & Khademian, 1997). Therefore, responsive stakeholder engagement arrangements need to balance between *extensiveness* (e.g., which stakeholders are placed into contact with each other in the different phases of the process, in one way or another?) and *intensiveness* (e.g., how intensely are these contacts enacted in terms of information exchanges and common vision-building) (Barré, 2002; Salo, Könnölä & Hjelt, 2004). Based on the experiences from structured stakeholder engagement in a foresight study for the Finnish food and drink industries (Salo, Könnölä & Hjelt, 2004), we elaborate three levels of stakeholder engagement in PVA process with respective objectives:

- *Low engagement*: Stakeholders exchange ideas and perceptions on future challenges in seminars and individual interviews and comment on deliverables, thus contributing inputs to the process which, however, does not necessarily lead to notable changes in their value networks.

- *Medium engagement*: Stakeholders participate also in workshops and meetings engaging in collaborative learning processes and proactive development of radical technological options which also create shifts in participants' value networks (this, however, do not necessarily lead to participation in the agreement).

- *High engagement*: Key stakeholders are intensively involved in the collaborative management of the whole process. Through iterative process cycles of learning and decision-making key stakeholders create among them a common vision for drafting the workable PVA.

Figure 1 illustrates the above three levels of intensiveness in relation to extensiveness in stakeholder engagement. Within high engagement, key stakeholders – namely authorities and industry representatives who demonstrate interest in searching for a common ground for a PVA – design and manage together the cyclic and iterative learning and decision-making process. They invite extensively stakeholders in low and medium engagement. This enables the inter-sectoral and –disciplinary participation of experts and responds to the need for the inclusion of participants outside the TIC. High engagement, in turn, creates trust and commitment among the key stakeholders minimising the transaction costs of the agreement negotiations and the likelihood for free-riding.

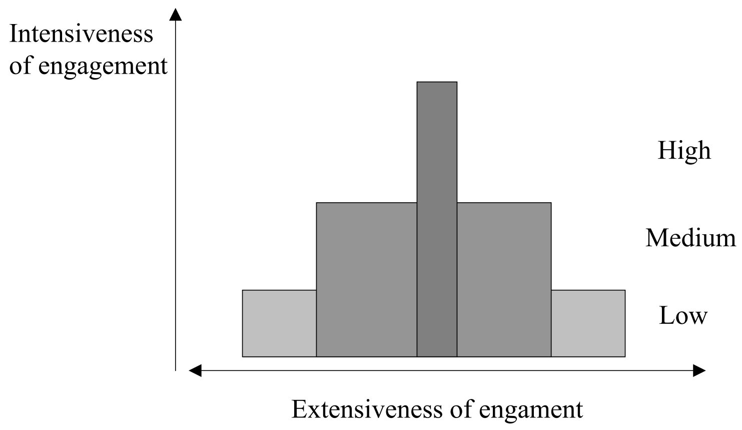

Figure 1 Three levels of intensiveness in relation to extensiveness in stakeholder engagement.

6.3 Facilitation and Mediation

PVA process begins with creating value through facilitated mutually beneficial learning on present and future challenges and common vision-building. Coordinators facilitate the iterative process cycles of mutual learning, which enables receptive and flexible process design in order to prepare key stakeholders for agreement negotiations. Fundamentally, postponing the negotiation of a PVA supports responsiveness and creativity by separating the creation and the evaluation of alternative technological and social options. Creativity for formulating radically new options can be further facilitated by encouraging participants to share ideas, interests and expectations, for example through the provision of small group work, anonymous feedback, ample time for reflection and information processing, and the acknowledgement of the plurality of values (Higgins, 1994). In agreement negotiations, the coordinators move from facilitation to mediation helping key stakeholders to identify and compare decision alternatives and work out their own a workable agreement. Combining experience from the mediation of negotiated agreements and from the facilitation of foresight activities may enable not only a creative learning process but also leading to commitment to action for an escape from lock-in.

6.4 Vision and Commitment to Action

Explicit foresight is designed to contribute to the creation of a common vision among stakeholders, but the implementation of visionary recommendations into action is often difficult, because of lack of commitment and policy measures available for decision-makers. Negotiated agreement, in turn, owns a promise for creating commitment, but lack of learning between parties tend to lead to loose targets. Thereat, combining explicit foresight and negotiated agreement provides, on the one hand, an open forum for stakeholder learning and the creation of systemic understanding of present and future challenges, and on the other hand, a common platform for key stakeholders to search for a common vision through iterative process cycles. The process culminates into a drafting of a PVA among key stakeholders committing them to desired action. The drafted agreement itself, however, is no more than a formal point in a process of governance within a specific type of cooperative arrangement. Thus, the agreement should be seen as a confirmation and reinforcement of the value of the emerged cooperation.

7 DISCUSSION

In this paper, we elaborated co-evolutionary policy responses to carbon lock-in, addressing the coordination role for authorities rather than the corrective optimisation. Within a techno-institutional complex existing government policy is partially responsible for inertia to technological change. Thus, escaping carbon lock-in in the absence of exogenous shocks requires continuous learning among stakeholders and the inclusion of actors also from outside the TIC. Thereat, we identified the need for authorities to initiate future-oriented stakeholder learning processes to facilitate an escape from techno-institutional lock-in and provide policy resources for addressing lock-in related issues.
We examined EVAs and Foresight activities in order to identify their individual shortcomings and to sketch a new integrated policy tool, PVA, in which authorities can use the threat of environmental regulatory actions as well as innovation oriented economic incentives to connect even confrontational stakeholders into a mutually beneficial creative learning process and commit them to desired future action. The merit of PVA process lies with the enhancement of collaborative policy culture and inter-sectoral and interdisciplinary stakeholder learning. Thus, in the application of PVA in a specific policy context, particular attention should be paid to the creation of a new collaborative arrangement that emerges from the existing institutional structures but recognises also the key role of actors outside the TIC and the plurality of viewpoints. At best, PVA process helps participants to position themselves in relation to TIC, allowing them to take informed decisions for the creation of radically new options and changes in physical and social networks. It also helps consolidate a shared vision for implementation of technological alternatives that supports the development of joint action plans.

We consider our exploratory work on combining the virtues of foresight and EVA providing a useful, although preliminary tool for the further development of participatory policy practices designed to synchronise environmental and innovation policy fields (European Commission, 2004). We suggest further development of PVA approach within the both fields of negotiated agreement and explicit foresight: within the former it calls for the inclusion of a future-oriented stakeholder learning process before fixing the scope and issues for agreement negotiations and within the latter it extends the locus from decision support towards decision-making, thus also committing key stakeholders to desired action. Therefore, we call for the creation of empirical evidence on PVA by initiating such processes and case studies for policy learning and further methodological development. We elaborated PVA as a response to carbon lock-in conditions, but it may well provide support also for addressing other environmental problems characterised with techno-institutional lock-in such as global agricultural-based issues such as water use or impacts on the nitrogen cycle. Finally, even though we focused on integrating the virtues of explicit foresight and negotiated agreement, we consider also combining the virtues of unilateral agreement and emergent foresight as well as public voluntary programme and embedded foresight as relevant areas for future work.

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