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THE INDUSTRY ROLE IN POLICYMAKING:
POLICY LEARNING IN CLIMATE POLITICS

Peter Stigson

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School of Sustainable Development of Society and Technology

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THE INDUSTRY ROLE IN POLICYMAKING:
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Peter Stigson

Akademisk avhandling

som för avläggande av teknologie doktorsexamen i energi- och miljöteknik vid Akademin för hållbar samhälls- och teknikutveckling kommer att offentligen försvaras måndagen 2 november, 2009, 13.30 i Zeta, Mälardalens högskola, Västerås.

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Akademin för hållbar samhälls- och teknikutveckling

Abstract

Climatic change has sparked a broad range of responses on all societal levels. New initiatives and negotiations, scientific findings, and technological developments, have established a novel framework for policymaking and industrial abatement investments. Lessons on the evolving framework should be analysed and utilised to handle the dynamic reality of climate policymaking processes.

Governments in the majority of economies only have an indirect and long-term influence on reducing industrial emissions, as they do not own the emitting operations. As representing one-third of the global carbon dioxide emissions, industry is therefore a key stakeholder group in whether or not the political agenda will be fulfilled. How industry perceives that obstacles and opportunities affect investment calculi are thus important. Hence, policymakers should facilitate policy learning (PL) to aid the creation of effective and efficient political agendas. This is important to acknowledge the policy and investment experiences of industrial actors and to deal with a number of plausible investment obstacles identified under the novel framework.

Taking stock of PL and other policy theories, this thesis is aimed to develop recommendations for facilitating PL and thus contributing to more effective and efficient climate policy frameworks. The results highlight the role of industry in abatement and political strategies where policymakers need to gain knowledge on how industries perceive abatement investment obstacles and how these may be bridged. The intrinsic learning values of government-industry negotiated agreements (NAs) are emphasised and a framework for operationalising PL through NA designs is developed. PL is furthermore identified as important, and NAs are recommended as a policy instrument, to fill knowledge gaps identified in two case-studies of promoting complex and novel industrial operations. This thesis also recommends a participatory policy evaluation tool that is sensitive to industrial competitiveness and establishes a forum for discussions on perceived investment obstacles and opportunities under different conditions. The results are not aimed to provide a blueprint for a comprehensive climate policy framework but as a contribution to literature and the incremental learning that this thesis strongly promotes.

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Taking stock of PL and other policy theories, this thesis is aimed to develop recommendations for facilitating PL and thus contributing to more effective and efficient climate policy frameworks. The results highlight the role of industry in abatement and political strategies where policymakers need to gain knowledge on how industries perceive abatement investment obstacles and how these may be bridged. The intrinsic learning values of government-industry negotiated agreements (NAs) are emphasised and a framework for operationalising PL through NA designs is developed. PL is furthermore identified as important, and NAs are recommended as a policy instrument, to fill knowledge gaps identified in two case-studies of promoting complex and novel industrial operations. This thesis also recommends a participatory policy evaluation tool that is sensitive to industrial competitiveness and establishes a forum for discussions on perceived investment obstacles and opportunities under different conditions. The results are not aimed to provide a blueprint for a comprehensive climate policy framework but as a contribution to literature and the incremental learning that this thesis strongly promotes.

Keywords: Climate policy; Policy learning; Participatory policymaking; Policy evaluation; Voluntary agreements; Negotiated agreements; Industry

Sammanfattning

Den utmaning som klimatförändringarna ställer samhället inför har resulterat i en politisk omvälvning. En utökad satsning på nya tekniker, menade att minska utsläppen av växthusgaser, ses som en viktig del i detta arbete. Detta kräver ett nytt politiskt ramverk för samarbetet mellan politiker och näringsliv, där båda parter måste bygga upp kunskap kring nya styrmedel och tekniker.

En viktig ståndpunkt i denna avhandling är att regeringar endast indirekt och på lång sikt kan minska utsläppen av växthusgaser. Industrin själv är den part som har direkt kontroll över dess utsläppskällor, vilka står för en tredjedel av de globala koldioxidutsläppen. Därmed spelar industriella aktörer en mycket viktig roll i uppfyllandet av de klimatpolitiska ambitionerna. Som ett resultat kan industrin erbjuda en viktig återkoppling till politiker avseende vilka problem och möjligheter som identifieras för att investera i utsläppsminskande åtgärder.

Mot denna bakgrund belyses industrins roll i uppfyllandet av klimatpolitiken. Avhandlingens syfte är att ge förslag på politiska initiativ som främjar den återkoppling som industrin kan erbjuda och därigenom bidra till ökad effektivitet i klimatpolitiken. I avhandlingen identifieras specifika investeringshinder samt klimatpolitiska möjligheter att överbrygga dessa hinder. Detta inkluderar politiska initiativ ämnade att främja dialogen mellan politiker och industri.

Ett analysverktyg presenteras där dessa aktörer gemensamt analyserar hur olika styrmedel och deras respektive utformning påverkar industrins konkurrenskraft. Avhandlingen lyfter fram frivilliga avtal som ett fördelaktigt styrmedel tack vare dess designflexibilitet och möjlighet att stimulera kunskapsutbyte. Det senare har dock förbisetts i tidigare forskning och mot denna bakgrund rekommenderas ett ramverk för att utforma dessa avtal så att lärandet mellan stat och industri främjas. Avhandlingen exemplifierar situationen med nya tekniska lösningar genom att analysera situationen med koldioxidinfångning och deponering, där betydande informationsasymmetrier identifierats. En annan fallstudie görs på resurseffektiva produktionslösningar som strävar efter industriell symbios i Kina. Där rekommenderas frivilliga avtal för att kunna anpassas till varierande produktionsmönster och för att stödja en kunskapsfrämjande aktörsdialog.

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First and foremost, I would like to thank *my father* as the main contributor who has made it possible for me to carry out this research and ultimately conclude this thesis. Thank you, thank you, and thank you! And, I will even throw in an extra one for you – which rumour has it is previously unprecedented. Thank you! Your support has been valuable from every aspect and has allowed us to have some very interesting discussions – I guess to the families' frustration when happening too often and going on for too long. While we have mostly been in agreement, the disagreements have perhaps been most interesting.

Being a PhD candidate with *Prof. Jinyue Yan* as supervisor has been a very, very rewarding experience. The opportunities you have provided for me to participate in a number of research projects in different areas have been truly interesting and educative. It has been fantastic to experience so much of China and the Chinese climate agenda. You have continuously amazed me in that you have always responded to my questions and emails within a few hours, even though you have been travelling in different time zones. Thank you so much for all your efforts!

Adjunct professor Erik Dotzauer, thank you ever so much for all your inspiring words, careful reviews, and overall concern for my research. You really have contributed to my research and for that I am ever grateful!

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The gratitude I feel for the understanding and support from you, Elli, can only be expressed through loving you even more. I guess that within short we will no longer be colleagues at the home office and want you to know that I will miss looking over to my left just to see you sitting there! Samma sak gäller dig min Tilda-Tok! Pappa tycker att det har varit så mysigt när du kommit inspringande för att snurra på min stol och titta på roliga filmer på datorn. Jag hoppas bara att du inte tycker att jag valt bort dig och bara jobbat istället för att leka och gosa. Jag älskar dig massor och massor! Jag måste också tacka lilla ”Snorken” som är på väg om några veckor för att du tvingat pappa att lägga ner böckerna och bli klar innan du kommer till världen.

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Peter Stigson

Saltsjö-Duvnäs, September 2009

List of Papers

THIS THESIS IS BASED ON THE FOLLOWING PAPERS, WHICH ARE REFERRED TO IN THE TEXT BY THEIR ROMAN NUMERALS.

Journal papers

I. Stigson, P., Dotzauer, E., Yan, J., 2009. *Improving policy making through government–industry policy learning: The case of a novel Swedish policy framework.* Applied Energy 86: 399-406.

II. Stigson, P., Dotzauer, E., Yan, J., 2009. *Climate and energy policy evaluation in terms of relative industrial performance and competitiveness.* International Journal of Green Energy 6: 450-465.

III. Stigson, P., Dotzauer, E., Yan, J., 2009. *Voluntary agreements as a vehicle for policy learning.* Accepted for publication after revisions in the International Journal of Climate Change Strategies and Management. Current version in the Proceedings of the Global Conference on Global Warming 2009 (GCGW-09). Istanbul, Turkey: July 5-9, 2009. Forthcoming.

IV. Stigson, P., Bryngelsson, M., Hansson, A., 2009. *Obstacles for CCS deployment: An analysis of discrepancies of perceptions.* Submitted to the International Journal of Greenhouse Gas Control.

Conference papers

V. Stigson, P., Stigson, B., 2007. *Promoting Eco-Industrial Parks in China – Policy suggestions based on international experiences.* In: Proceedings of the 3rd International Green Energy Conference. Västerås, Sweden: June 18-20, 2007.

The author of this thesis is the main contributor to papers I-III and V. Papers I-III were written under the supervision of Jinyue Yan and Erik Dotzauer at Mälardalen University (Sweden) who provided useful input and comments. Paper IV was co-written with Mårten Bryngelsson and Anders Hansson, both at The Royal Institute of Technology (Sweden), who mainly contributed on the issues of storage and acceptance as well as providing input and comments on the other sections. Paper V was mainly written in cooperation with Björn Stigson at The World Business Council for Sustainable Development (Switzerland).

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RELATED PUBLICATIONS NOT INCLUDED IN THESIS

Theses

Stigson, P., 2007. *Reducing Swedish carbon dioxide emissions from the basic industry and energy utilities: An actor and policy analysis*. Licentiate thesis. Mälardalen University Press, Västerås, Sweden. 415 pp. (ISBN 978-91-85485-40-6)

Reports and other publications

Stigson, P. (Editor and Work Package Leader), Mouvet, C., Krahl, D., Na, L., Fay, J., 2009. *Financing of, and economic incentivisation mechanisms for CCS*. Report of Work Package 5 of the project "Support to regulatory activities for carbon capture and storage (STRACO2)". Forthcoming. Will be available online at http://www.euchina-ccs.org/

Dotzauer, E., Stigson, P., 2007. *Svenska klimatlagar i otakt med varandra (Swedish climate acts not aligned to each other)*. Letter to the editor. Dagens Industri, August 2, 2007. (In Swedish)

Stigson, P., Yan, J., 2006. *Questionnaire analysis of Swedish stakeholders on CDM and clean technology transfer*. Research report within the project "Clean Technology Transfer Opportunities through CDM for the Sweden-China Case" (P20386-2) to the Swedish Energy Agency.

Stigson, P., 2004. *Koldioxidutsläpp från industri och elproduktion i Sverige – Lägesrapport. En aktörs- och policyanalys för minskade utsläpp och en hållbar utveckling (Carbon dioxide emissions from the Swedish industry and electricity production – State of the art. An actor and policy analysis for reduced emissions and a sustainable development)*. Research report 2004:2. Department of Public Technology, Mälardalen University. (In Swedish).

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Acronyms and abbreviations

BAU	Business as usual
CCS	Carbon capture and storage
COP	Conference of the Parties (to the UNFCCC, see below)
EIP	Eco-Industrial Park
EU	European Union
EU-ETS	European Union Emission Trading Scheme
GHG	Greenhouse gas
IEA	International Energy Agency
IP	Industrial park
IPCC	Intergovernmental Panel on Climate Change
KP	Kyoto Protocol
NA	Negotiated agreement
NGO	Non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
PL	Policy learning
R&D	Research and development
RD&D	Research, development, and demonstration
RDD&D	Research, development, demonstration, and deployment
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VA	Voluntary agreement

1. Introduction

1.1 Background

The challenge of limiting climate change has resulted in a surge of interest in low-carbon technologies and political initiatives aimed to reduce anthropogenic emissions of greenhouse gases (GHGs). Reducing emissions of GHGs to levels that can meet policy targets and mitigate changes to the climate will have to entail a broad range of measures in all societal sectors.[1] This thesis however mainly focuses on the basic and energy industry sectors. The industry plays an important mitigation role, as the sector in 2004 emitted 36 % of the global carbon dioxide emissions (IEA, 2007) and 19.4 % of the global GHG emissions (IPCC, 2007b), as well as being a provider of technologies and goods that affect emissions in other sectors. The energy supply sector is a larger emitter and represented, in 2004, as much as 25.9 % of the global GHG emissions (IPCC, 2007b).

The major initiative on the global policy agenda is the processes within the United Nations Framework Convention on Climate Change (UNFCCC) to establish a successor to the Kyoto Protocol (KP). On national levels continuous work are ongoing to establish country-specific policy responses to regional challenges and conditions as well as supranational commitments. As such, the nature of climate politics is in a dynamic period. In addition, and largely parallel to the dynamic

[1] Regardless of being defined as a maximum +2°C average global temperature rise or stabilisation of carbon dioxide concentrations at commonly discussed carbon dioxide equivalent levels of 550, 450, or 350 parts per million.

climate politics, the current situation is uncertain as a result of whether, or rather when, the UNFCCC process will succeed to produce an agreement and regards to the specifics of such an agreement.[2] This includes, *inter alia*, the details of a continuous operation of global emissions trading, new scientific findings on climate change, and emerging technologies and engineering solutions.[3] It also includes the updating and amendments of policies that will be required due to these and other factors.

The multitude of recent political climate initiatives has been introduced within a limited timeframe and has resulted in novel policy frameworks in most nations.[4] As a result, business in general, and the carbon dioxide intensive industries in specific, now operates under more stringent conditions. Policymakers can however influence what effects that a more stringent policy framework imposes on the private sector through: the choice of policy instruments; the design of policy instruments; and, the management of policy instruments. Such considerations are under the abovementioned situation, as well as other factors, such as the globalisation of markets and international differences in regulatory stringency, becoming increasingly important.

From a technical dimension, the climate challenge includes a number of novel technologies as well as increased attention to present technologies that can facilitate the reductions. Novel technologies that are not yet mature include carbon capture and storage (CCS), fuel cells, solar photovoltaics, and other alternatives. Looking at policies and technologies in combination, demonstration and deployment goals have been established for a number of technologies. The business risk of research, development, demonstration, and deployment (RDD&D) investments in these technologies is however typically high due to uncertainties

[2] Politics refers to the political agenda and work of a government. Policies refers to political initiatives that establish development targets, such as emission levels and technology deployment, as well as the introduction of specific policy instruments aimed to promote the fulfilment of the former.

[3] Engineering solutions are hereinafter grouped together with technological developments.

[4] The term novel is used to distinguish the emergence of a type of activity or technology previously not present. A new tax may be introduced, although it is not novel if not levied in a way that a tax has not generally been levied before. Hence, while a fuel tax is generally not novel, a carbon tax is more likely to be novel, seeing that it is much more scarcely utilized. This can be compared to the production of a new boiler of an old model range, or a novel boiler type that has not been previously been known of. As a recently emergent and continuously strengthened policy area, climate policies are identified as novel.

of, *inter alia*, deployment costs, rewards from policy incentives, and operational reliability.

Previous research has shown that the costs of abating emissions to necessary levels are manageable, but also that postponing action will sharply increase the costs of combating climate change (Stern, 2007). Nonetheless, abating emissions according to the necessary long-term trajectory will entail expenses on all societal levels, which inevitably will cause inertia to instigate action. Recent research has also argued that climate sensitivity and irreversibility effects may be larger than previously estimated, which indicates that the levels that must be reached, and the timeframe within which these levels should be attained, are more stringent that previously perceived (Smith et al., 2009; Solomon et al., 2009). An imperative conclusion is therefore that climate policies must be effective and efficient, i.e. promoting emission reductions in the short, medium, and long-term, and in a cost-containing fashion.

In addition to this, the complexity that surrounds climatic change means that policies and policymaking must be adaptive to anticipated and unanticipated changes in the policy environment (Swanson and Bhadwal, 2008). On a somewhat similar note, although not relating specifically to climate policies, Papadopoulos and Warin (2007) argues that dynamic and complex policy environments increase the importance of participatory elements in policymaking in order to achieve high policy effectiveness and efficiency.

The above means that the dynamic nature of climate politics is likely to continue for an extended time-period. This includes designing new and updating existing policies, as part of policy design and management processes. While both these processes are important, this thesis emphasises management as a measure to utilise policy experiences of the novel policy framework in improving the policy designs. This is parallel to policy learning (PL) and participatory policymaking (PP) (Section 2).

However, the aforementioned risks as well as other policy and technology oriented obstacles impede industrial abatement investments and thus the success of the political climate agenda. This means that the current outlook points toward early opportunities for abatement activities being missed and consequently a need for increased emission cuts and investments in the longer-term.

This thesis will therefore argue that governments should engage in PL and PP activities with the industry as to acquire information on obstacles that impede abatement investments and suggestions for policy amendments to bridge such

obstacles. Not utilising this information fails to acknowledge the role of industry as the decision-makers determining whether emissions in the sector will be abated or not. This knowledge-sharing is however, at present, not possible to accomplish effectively and efficiently as there is a shortage of forums and a common language that can facilitate this dialogue. Also, government representatives within the UNFCCC process have clearly stated that business presence is not wanted within these processes.[5]

This demonstrates the context within which this thesis is written, namely a situation where the arena for working to combat climate change is novel for both governments and industries. Against this background, the author has carried out a number of studies with a focus on how improved learning can acknowledge and utilise industrial policy experiences as to increase policymakers' capacities to implement effective and efficient climate policy frameworks.

1.2 Scope

In terms of actors included in this thesis, the research targets policymakers and industries. The term policymaker refers to actors and institutions within the public domain which have responsibilities within the selection, design, operation, or evaluation of a policy (also see Section 3.1 below). As such, it encompasses agencies that are generally responsible for the operation of a policy instrument on a day-to-day basis. The policymaker can thus be made up of several actors in the main political domain as well as different sub-domains. Who plays the main role of policymaker therefore typically changes over time, although politicians have the legislative responsibility and remain ultimately responsible.[6] The other main stakeholder group, industries, are investors in RDD&D of abatement opportunities. Within this sector there is a focus on *carbon intensive basic industries*, which

[5] Anonymous (under Chatham House Rule, spring 2009).

[6] This definition is equal to that of the Millennium Ecosystem Assessment (Carpenter et al., 2005): "A person with power to influence or determine policies and practices at an international, national, regional, or local level." This compares to a decision-maker (ibid): "A person whose decisions, and the actions that follow from them, can influence a condition, process, or issue under consideration". I.e. a policymaker is a decision-maker within the political domain. The term decision-makers is within this thesis used to position actors in the private domain to indicate the industries' self-determination regarding investment decisions.

includes power companies, refineries, pulp and paper industry, as well as iron, steel, aluminium, and mineral (e.g. cement) producers (also see 3.2).[7] These sectors are jointly or individually referred to as the *policy environment* depending on which actors that are influenced by the policy that is discussed (also see Figure 2).[8]

This thesis includes policies that have a bearing on reductions of GHG emissions. It consequently targets both exclusive climate policies as well as energy policies that promote renewable energy or energy efficiency. Telling climate and energy policies apart can sometimes be difficult in terms of which of two that is the primary target. As to avoid any confusion, the text conclusively refers to the included group of policies as *climate policies*, with the general exemption of specific discussions about voluntary agreements (VAs). The term policy obstacle is frequently used and is referred to as a policy design element, or an effect thereof, that impedes investments in industrial abatement measures.[9]

[7] With basic industry the author means the energy and carbon intensive industry sectors. However, according to some definitions, basic industries refer to the industries that export the majority of their goods. While this applies to the sectors above, it may also apply to manufacturing industries in export intensive countries, such as the Chinese industry sectors included in Paper V. As to avoid misunderstanding, the latter group is referred to as manufacturing industry.

[8] This focus excludes, but does not neglect, the importance of other stakeholders in a joint effort to mitigate climate change.

[9] Again, this focus excludes, but does not neglect, the importance of adaptation to present and future effects of climate change.

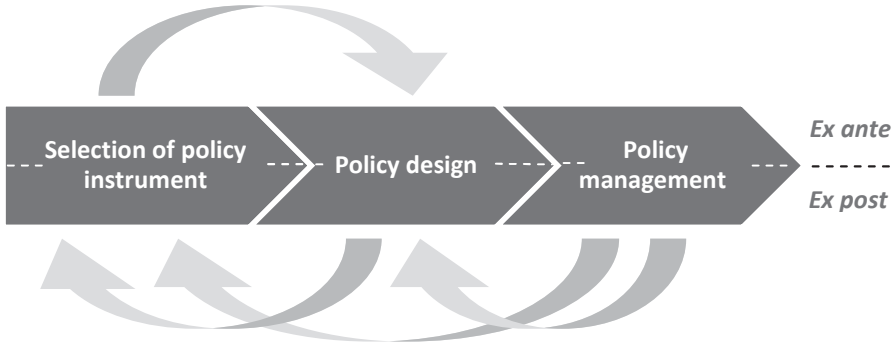

Figure 1 - Three policy processes stages with *ex ante* and *ex post* learning

Looking at policy arenas, the research focuses on climate policymaking. The specific focus is however on how policy experiences can feed into the different policymaking process stages and contribute to PL (Figure 1). These processes are divided into a three stage model. This interpretation of the policy cycle excludes the preceding processes where policymakers establish the political ambitions. As such, the research does not include the influence that industries, or industry representatives, may exert on politicians as they set the political agenda. The *ex ante* and *ex post* learning loops are based on evaluations of industrial perceptions of how to facilitate a policy framework that do not impede investments. Both cases of learning are discussed in most of the appended papers, although Paper II specifically targets *ex ante* evaluations (Section 4.2), and Paper III targets *ex post* evaluations (Section 4.3). While mainly targeting policy instruments, some of the findings are applicable also for other policies. One such example can be the declaration of technology deployment goals where industry experiences can be utilised to evaluate goal feasibility and viability. The main policy instrument group that is discussed is VAs, which is a result of its potential for utilising industry experience and competences, as well as PL (mainly see Paper I, III, and V).

This means that the *first* process of the policy cycle is where policymakers choose which policy instrument to implement to steer the public, such as the industry, in a certain direction. The *second* process is where policymakers decide on which design that the selected policy instrument will have. Separating these two is

important, as the choice of policy instrument in the first stage locks-in certain policy characteristics, hence limiting the design flexibility to influence policy characteristics (as is shown in Paper II). The *third* process includes the continuous management of a policy during the period that it is implemented.

This interpretation of the policy processes is different to, for example, that of Howlett and Ramesh (2003), who identify five stages (agenda setting, policy formulation, decision-making, policy implementation, and policy evaluation). Their model is however focused to explain public policymaking in general, while the model applied by the author is used as a framework to analyse which role that industry can play in exerting a positive influence during different stages of the policymaking processes. The model used in this thesis does not divide policy management into policy implementation and policy evaluation. This is done in order to acknowledge, and put emphasis on, the continuous and intertwined nature of these two policy processes (also see Section 4.3). Policy management, in this interpretation, includes feed-back loops where lessons feed back into the policy and may amend its design. It may also mean choosing a new policy instrument to achieve higher effectiveness and efficiency. Policy management from this perspective is important but much less discussed in literature. The appended papers mainly refer to the design and management processes, although Paper II specifically targets the selection and design processes with an emphasis on the former.

From a spatial perspective, the research has a slight focus towards the Swedish and European situation. This includes relatively progressive climate agendas of both policymakers and industry. It also includes the possibility that carbon leakage may occur as a result of stringent policies (Reinaud, 2008). In a Swedish context it furthermore includes an industry sector that has made significant improvements in terms of reducing specific emissions of carbon dioxide during the last 15 years (see Paper I). Paper V however targets China and the possibility to utilise VAs in a highly case-specific industry and developing country context. The international influence on the research is nonetheless both strong and inevitable due to the globalisation of markets and climate negotiations.

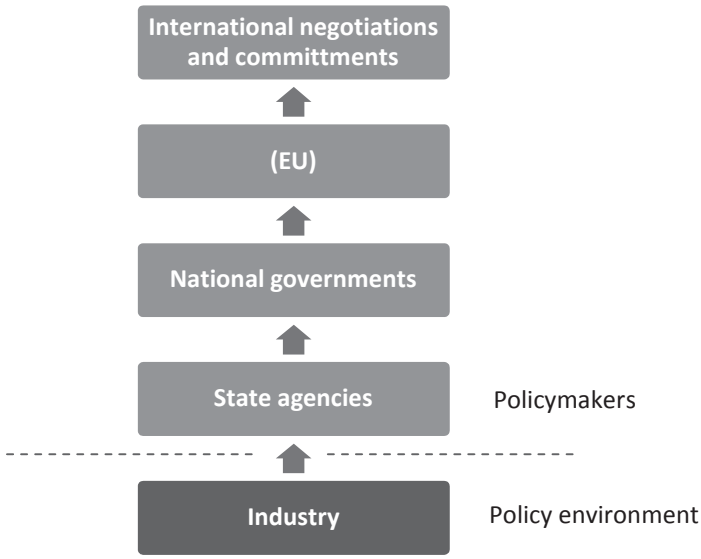

Figure 2 - Policy arenas and information dissemination in a bottom-up approach

This means that the policy arenas discussed in this thesis and how they relate are as depicted in Figure 2 (where EU only applies to Member States). The information flow is seen as originating from the industry as this is the source of information that is targeted in this thesis. Hence, the research does not in general make any distinction between which policymaking institutions or actors that processes the knowledge from the industries in the policy environment. The figure is simplified and in real life includes several sub-level institutions and actors, as well as local governments and committees at the different arenas. The purpose here is however to clarify the difference of policy environment and policymakers, as well as the latter being grouped together. It should be noted however that Paper II focuses more on politicians than actors at the agency level. From an industry perspective, the policy environment arena includes both industries and industry organisations.

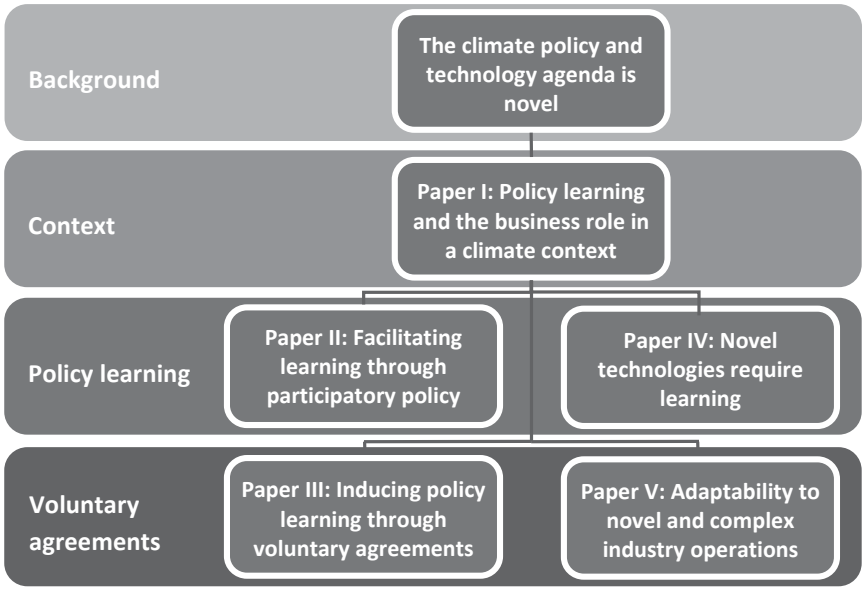

Figure 3 - Position of appended papers in relation to each other

Looking at the individual papers and how they relate to each other, the research stretches from positioning industry in a novel climate policy framework PL context, to reflections on specific policy contexts (Figure 3). The latter includes VAs as a recommended policy instrument, both from PL and flexibility perspectives, and the need for learning in relation to a novel technologies and production patterns. The two papers in the left column are more theoretical while the two to the right are more applied. The individual results also include some short backgrounds to the specific areas that are studied. For extended background, readers are advised to read the appended papers in their entirety.

Paper I establishes the two overarching theories – who can reduce emissions and which obstacles for this do a novel climate framework present – that establish the theses context (Results outlined in Sections 4.1).

Paper II introduces a decision analytical framework in terms of a participatory policy evaluation tool, which is aimed to improve policymaking processes (Section 4.2).

Paper III analyses how PL can be induced through VAs and how different design aspects thereof influence this potential (Section 4.3).

Paper IV critically analyses the need for learning among industrial stakeholders to jointly establish the existing playing field for adopting novel technologies under uncertainties (Section 4.4). This research was carried out within a project that strongly related to financing and incentivisation of CCS. While therefore including such results, these considerations are mostly excluded in this thesis's cover essay as to maintain the focus on learning and the policymaker-industry relationship.

Paper V analyses VAs from the perspective of novel production patterns in the form of Chinese Eco-Industrial Parks (EIPs). The contents of this paper is not put into a PL context as it was the first paper written of those appended to this thesis and seeing that the author's research interest for learning was in its infancy at the time. Due to this, Section 4.5 develops the learning aspects of Paper V in relation to PL theories.

1.3 Method and aim

The research focus originates from the author's previous work which included in-depth interviews with management level representatives from Swedish industries and organisations with responsibilities for the respective institutions' climate and energy work (Stigson, 2007).

The research in the appended papers is however mainly based on literature studies, although some research results are based on interviews (mainly in Paper I) and questionnaire surveys (Paper IV). The central main areas of analyses have been PL, PP, investment obstacles, and VAs. In terms of obstacles, the research has targeted how industries perceive investment obstacles and which implications that this has on a PL agenda. This has been used to argue how the identified obstacles can be overcome through utilisation of industries' experiences of factual investment conditions. This thesis thus argues for a bottom-up approach to policy analysis, which has the advantage identifying policy subsystems that are important to the policymaking processes (Howlett and Ramesh, 2003).

The research is aimed to highlight the policy advice that industries can provide to policymakers based on their experiences as investors, and that this potential is emphasised in light of the current situation with rapid changes in a complex climate policy and technical environment. This is turned into policy recommenda-

tions that are aimed to improve policy selection, design and management processes. To this end, the ultimate goal of the research is how policies can bridge these obstacles and contribute to a more effective and efficient climate policy framework.

Within this context, this thesis's theories boil down to the following research questions:

- How does the dynamic and novel climate framework situation affect policymaking processes?
- Which obstacles spring from this situation?
- Which role can the industry play in these processes?
- How can policies be designed as to further PL?
- How do novel technologies affect the need for PL?
- Which policy recommendations can be flexible and adaptable to novel technologies and operations?

1.4 Thesis outline

Section 2 provides information on PL as to provide the background on experiences in the policy environment benefiting policymaking. However, the concept is continuously developed throughout the sections as to put individual results into an appropriate context.

Section 3 looks more into the different roles of policymakers and industry and how these two actor groups and their respective work relate to each other.

Section 4 outlines the main results of the appended papers as well as some concluding remarks.

Section 5 highlights the policy implications of the research findings in terms of abatement investment obstacles, furthering PL, and benefits of certain VAs.

Section 6 provides the conclusions and summarises the answers the research questions above.

2. Policy learning

This thesis argues that policymakers should acknowledge and utilise the policy experience and expertise that the industry gains as policy subjects. Allowing such experience in the policy environment to feed into the policy processes is theorised as PL.[10] Arguing that the industry should be allowed to engage more thoroughly in the policy processes is also parallel to PP (or, interactive policymaking). The benefits of both these theories are supported by a strong body of literature, such as van Ast and Boot (2003), Driessen et al. (2001), Etheredge and Short (1983), Geurts and Joldersma (2001), and Szarka (2006). Importantly, however, the author (Paper I) agrees with past findings of Bennett and Howlett (1992), that the benefits of PL has lacked attention by policymakers. Furthermore, Schofield (2004) identify that while some literature refers to PL in terms of policy cycles, research is lacking in terms of procedural elements of implementing learning. This provides a gap within which the research is positioned (especially Paper III).

In general terms, PL means that knowledge in the policy environment – past experiences and expectations of the future – is utilised either to improve policymaking, contribute to enlighten policymakers, or both. Hence, PL argues for the benefits of bottom-up approaches in policymaking. Through incorporating

[10] Such processes can also be related to other concepts, such as neoliberalism and neocorporatism. The focus here is however limited to PL and PP as these theories are identified to provide the most suitable framework for the research focus. A benefit of PL, relative the theories above, is that the theory has no bias or preference in relation to industry as an actor in a learning environment.

exogenous knowledge, PL enables a larger group of stakeholders with policy knowledge to act as policy analysts. This means that the industry moves from an external and neutral position, to policy advisors who actively contribute to the policymaking processes. Due to this, governments act more as policymaking facilitators rather than single decision-makers (Geurts and Joldersma, 2001). PP is similar in theory and refers to a policy development process with a multitude of actors who contribute to the process and reach a collective outcome (Driessen et al., 2001). Joining these theories, it can be argued that increased participatory elements works as an effective catalyst for PL (see Paper II).

Literature hosts different schools of PL, which interpret actor relationships and learning capabilities differently.[11] Etheredge and Short (1983) discuss PL processes that result in improved governmental intelligence and effectiveness. This theory is referred to as government learning. With this focus, governmental learning is more exclusively focused on the political realm than other PL theories (Bennett and Howlett, 1992). According to Etheredge and Short, the analyses of which effects that policies have, should be analysed in collaboration with the actors in policy environment, i.e. those subjected to the policy.

Government learning is relevant to the scope of this thesis in that it is aimed to provide suggestions mainly to policymakers on how to improve policymaking processes. The theory's focus on political institutions is also suitable in that this thesis argues that PL should be facilitated and preferably operationalised by policymakers. The reason for not referring to government learning is however that parallel theories are of value due to, *inter alia*, a broader scope of learning agents, and that the normative values of PL is more commonly known.

Looking at whether PL should be interpreted as enlightening or improving policymaking, as mentioned above, it is emphasised that establishing arenas and efforts for learning must not necessarily mean that the industry ultimately influence planned decisions by policymakers. The theory however provides a distinct potential for improvements in doing so. This situation can be compared to findings by Schofield (2004), who identifies that exact policy effects are difficult to identify *ex ante*, and that a dialogue during implementation therefore should target which risks that the policy subject is willing to assume. The interpretation thus depends on which type of learning that occurs (see below).

[11] See, *inter alia*, Bennett and Howlett (1992) and Schofield (2004) for discussions on different interpretations and theories within policy learning.

PL is also parallel to organisational learning within which there are concepts that lends well to the scope of this thesis (also see Paper III). This learning theory generally distinguishes between three learning levels, which are increasingly impacting the fundamental basis of how the learning affects the learning organisation (i.e. policymakers in the case of this thesis). This is divided into single-loop, double-loop, and deutero learning (also see Section 4.3).[12] *Single-loop learning* occurs when the organisation become aware of an obstacle, or error, which is then simply corrected. This contributes to an increased knowledge-base within the organisation. *Double-loop learning* is more fundamental and results in the organisation questioning its management, policies, etc., based on what is learnt about the corrected obstacle. Besides widening the knowledge base, double-loop learning changes the management routines aimed to address the source of, and prevent, the problem. *Deutero learning* occurs when organisations learn about how to accomplish double-loop learning. This means that the organisation realises that learning needs to occur and that the competences for this needs to be created through developing new strategies for learning. This includes learning about which measures that is required to learn. Based on this, this thesis aims to contribute to all three types of learning through highlighting obstacles, available policy experiences, and how this learning can be operationalised. Ultimately, however, the thesis aims to induce deutero learning through highlighting the need and benefits of PL under current conditions.

Whether or not, or rather at which level, that PL occurs, logically differs. Hence, so does the need to induce learning and provide recommendations for doing so. Some factors that influence and result in learning variations, are differences between regions and policy areas, between which actors that learning occurs, developments over time, political cultures, party politics, crises, etc. For example, neo-corporatist or neo-liberal policymakers may be more active in allowing opinions from business to be heard. Green parties may be prone to listen to NGOs. Left governments learning from trade-unions and other left governments, etc. Nevertheless, this does not mean that learning occurs, however meaning that arenas for dialogue may be facilitated.

The varying levels of PL that is identified in literature do not provide a conclusive evidence of when PL occurs or not. Seeing that climate change is a recent emer-

[12] For more information on single and double learning loops, please see, e.g. Argyris (1976). A similar interpretation of single and double-loop learning are lower-level and higher-level learning (Fiol and Lyles, 1985).

gent policy area, identifying evidence of learning is even less obvious, due to limited time span of learning occurring and evidence thereof hence being provided. There are however some studies that are of interest. From a past perspective, Bennet and Howlett (1992) identified that while PL was well researched in the literature, it was less applied by policymakers. The author has studied the subject in Paper I (Section 4.1) where it is concluded that the evidence points toward a low level of PL taking place. Regardless, however, this thesis will point to a number of potential and plausible obstacles originating from a novel climate policy framework. As such, and due to other literature that is referred to in the results and appended papers, the need for PL is emphasised.

3. Policymakers and industry

This Section will provide a more comprehensive background into the roles and responsibilities of policymakers and industry. The purpose is to explain how these actor groups are viewed within the appended papers and thus to improve the reader's understanding of the subsequent sections. This Section also provides a more general view of how which investment obstacles that policies may establish. These should be seen as parallel and, to an extent, interlinked with the obstacles identified in the research (Section 4). They are included here to provide a more comprehensive view of how the policy framework affects industry investments. Seeing that this thesis deals with industry perceptions, this Section furthermore discusses the credibility of such perceptions and the consequences of knowledge asymmetries.

3.1 The role and responsibilities of governments

Governments and policymakers have the responsibility to guide the country's development towards the common good of society. This means, in the context of this thesis, to assert that the industry reduce their carbon dioxide emissions according to national climate targets and supranational commitments.[13] In order to accomplish this, governments may implement different policy instruments that

[13] It can also be argued that governments due to ethical responsibilities should go beyond current targets in light of scientific findings that more far-reaching short and long-term emission reduction targets than those currently established should be achieved to avoid severe impacts of climate change.

require, finance, or incentivise industrial investments in emission abatement measures. This includes balancing the risks and rewards of these investments, as well as removing both policy and other obstacles that impede investments.

The European Union (EU) has established the goal of limiting the global temperature increase as a result of climate change to +2°C (European Commission, 2007a). The IPCC (2007a) has identified that keeping the temperature increase to +2.0-2.4°C will require GHG emission reductions of 50-85 % to 2050 (compared to 2000 levels). This scenario means that emission must peak between 2000-2015. Adding to the urgency of acting, are the findings of the Stern Report that the costs of early measures will be significantly lower than dealing with higher GHG concentrations in the longer term (Stern, 2007). Delaying action now would mean that larger cuts would be needed in the future to curb the emissions trends and deal with a higher concentration of GHGs in the atmosphere. The magnitude of the abatement measures needed, means that they will be costly and thus difficult to implement, necessitating that climate policies promote these measures and investments at lowest cost (OECD, 2009). Hence, the current climate agenda should promote significant emission abatements as required in both the short and long-term future. And, this should be achieved in a cost-containing fashion.

However, industrial policy generally specifies that climate policies must not interfere with the national competitiveness. Swedish policies, for example, clearly stipulate that climate and energy policies must consider industrial competitiveness (Government Offices of Sweden, 2009a; 2009b). The situation is similar in the EU in relation to the Member States' industries (European Commission, 2005; 2006). From an international perspective, the UNFCCC also highlight that national climate policies should be cost-efficient (UN, 1994). Though, as Paper II discusses, there are other aspects, besides cost-efficiency, that are of equal importance in terms of how policies affect competitiveness (Section 4.2). Another reason to consider competitive effects is the risk for carbon leakage, i.e. relocation of production to less regulated regions, under stringent policy frameworks (Reinaud, 2008). Looking at the policymaker and industry intersection, there is consequently a question of how far policies should stretch in terms of reducing emissions before it interferes with other political goals. From this perspective this thesis mainly deals with the sensitivity of different policy options to comply both with a progressive climate agenda and industrial policies.

Moreover, the internationalised policy environment – a result of the global climate change agenda – means that national policymakers have restricted autonomy in designing the national climate policy framework. Besides UNFCCC

negotiations this applies, for example, in the EU where Member States abide under Union's legislative powers. There is, as a result, an increased pressure and urgency for national policymakers to design policies that protect the competitiveness of the domestic industries. This includes that policymakers has to be flexible to changes in the policy environment. This is emphasised by the uncertainties that surrounds the supranational agendas, such as whether the parties of the UNFCCC will come to an agreement at the COP15 in Copenhagen and the specific design of such an agreement. The situation is parallel in the EU, where the Energy End-Use Directive (2006/32/EC) stipulates that an energy efficiency certificates scheme may be forced if the Member States' fail to reach the established energy efficiency targets.

Against this background, the policymaking responsibilities also include monitoring and evaluating the function of the implemented policy framework and its effects, especially seeing the complex and changing policy environment. This means that an iterative learning process, evaluating potential and factual policy problems and solutions, should be part of the policymakers' agendas.

3.2 The role and responsibilities of industries

The industry sectors studied in this thesis are viewed as privately owned and listed on the stock exchange, as this is most common in market economies.[14] This means that the roles and responsibilities of industrial actors include that they are bound by legal stipulations to operate their businesses in an economically sound manner and must aim to provide a value for their shareholders. They are furthermore bound to operate within the legal framework, such as that established by climate policies. From this follows that one cannot expect industries to invest in abatement activities that do not make business sense. It however also means that any industry that does not live up to legal stipulations should face penalties of such a magnitude that perverse objectives to maximise profit to the cost of climate impact is deterred.

[14] Some listed industries may be state owned. It is however emphasised that policymakers have no decision-making power within the studied industries.

This feeds into an essential theory of this thesis, namely that governments cannot reduce emissions themselves.[15] As the majority of the world's industrial emissions originate from privately owned operations, the decision-making power in abatement investments lies outside of the public governance. This means that the governments are dependent on the industry, as well as other societal sectors, to accomplish their climate agenda. Moreover, industries play an important role not only as investors in abatement measures but also as providers of goods and technologies. Hence, the industry sector strongly influences emissions in other societal sectors.

The role that industry plays as abatement decision-makers means that they have factual information on how different obstacles affect investments in emission reductions. All obstacles will negatively influence industrial abatement measures through introducing a risk element into the investment calculus. This perspective is argued by Nilsson (2006) and Schofield (2004) to be important but nonetheless lacking attention in policy research.

Hence, policies should be designed to offer a balance between the different risks and rewards that investments face. This is a central element of policymaking and the following Section (3.3) provides some insight into general obstacles, commonly discussed in literature, which may form investment obstacles and hence need to be bridged.

The private sector has undoubtedly undergone a "greening" in the last two decades. Looking at how the business sector has developed parallel to a greater policy attention to climate change and GHGs, research indicates that business – though there are naturally differences within the sector – is increasingly concerned with climate policies in their investment decisions (Jones and Levy, 2007; McKinsey and Ecofys, 2006). Furthermore, the United Nations Environment Programme (UNEP, 2006) has identified that while the industry has made improvements from a general environmental and social perspective, this development is especially evident in terms of climate change. Moreover, anecdotal evidence indicates that this is even more accurate in terms of the majority of carbon intensive industries as they are heavier influenced by climate policies and where climate politics therefore has become a main part of the operational

[15] This is true in most market economies where the majority of businesses are privately owned and managed. The argument is less true for economies which are governed by the state to a larger extent, e.g. communist states.

situation analyses (or business intelligence). This is to an extent supported by reports on climate governance in businesses by, among others, Ceres, which identify a larger disclosure of how climate consideration affect business risks among heavy industry sectors than other private sectors (Cogan, 2006). It should be noted, however, that an increased attention to climate policies is to an extent a natural consequence of the political arena being novel.

Other studies, which have analysed how businesses view climate change within the corporate agenda, report that 81 % of the consulted companies in Sweden responded to include climate change on their corporate social responsibility agenda (VA Research, 2007). In an EU perspective, Kaptein et al. (2007) has shown that climate change in 2007 was of fifth (out of ten) most importance to the European business community's corporate social responsibility agenda. Moreover, their study revealed that the included companies expected that climate would rise to the top of the agendas within five years (i.e. before 2013).

This development can be assigned both to policy push and pull effects, as well as market expectations of businesses tending to their environmental and climate performance. Hence, it is concluded that sustainability and low climate impact has become part of the main business strategies and that the industry as such do not in general aim to impede a progressive climate policy framework (also see Paper I). Moreover, the author argues that this situation means that the industry realise that actions to abate emission will have to be taken and that they consequently favour a political framework to accomplish this effectively and efficiently. This can be summarized through the opinions of Stern when interviewed in a Swedish newspaper:

> *"I do not agree that they [the carbon intensive industries] are impeding the development towards a fossil lean society. However, I do not believe that they will stop asking governments for special rules. Not yet."* Sir Nicholas Stern (Translated from SvD, 2009)

3.3 Obstacles in promoting industrial abatement investments

Although, as Stern (2007) has pointed out, the costs of combating climate change can be significantly reduced by early action, the absolute value of the required abatement investments will still be extremely high. An estimate by the International Energy Agency (IEA, 2008) has concluded that halving the emissions to 2050 would cost about 45 trillion US dollars. And if the course of early action is not

followed optimally, which is inherently implausible, the costs will exceed the lowest estimate.[16]

In the industry sector, abatement measures are associated with investments that increase capital and/or operational expenses. Exemptions to this exist, such as energy and resource efficiency measures that may reduce costs. The longer-term industrial abatement potential cannot however be met through a single-focus strategy but is achievable only through technology investments (e.g. new process equipment and CCS) and other engineering solutions (e.g. improved process control and fuel switching). Hence, despite businesses and industries generally incorporating climate considerations and policies in their investment and business strategies, there is inertia to undertake the necessary investments actions due to the costs and risks they entail. Therefore policies should be in place that promote the necessary investments and balance the risk/reward calculi. A non-insignificant aspect of this is that high-risk investments may offer less favourable loan and third-party financing opportunities.

There is a strong body of literature that analyse how different policy obstacles negatively affect investment calculi and consequently reduce the effectiveness and efficiency of policies through increasing the inertia for abatement measures. Examples of policy characteristics that are commonly discussed as obstacles in literature are:

- a lack of long-term stability;
- uncertainty of regulation;
- complex regulation; and,
- low acceptance.

A lack of confidence in the regulatory framework due to short-term, uncertain, and complex policies may not only slow down, but also counteract policy objectives. Evidence for this can be found in research that identifies a lack of long-term policy stability to increase investment risks and hence reduce investment dynamics (Blyth et al., 2007). This is supported by Dinica (2006), who argues that short-term policies have reduced the diffusion of renewable energy technologies. Barbose et al. (2008) and Fuss et al. (2009) highlight uncertainty in terms of policy changes (i.e. the enactment or increased stringency) as a key risk factor in utility

[16] Scenarios are however often associated with significant uncertainties meaning that comparisons are difficult.

investment decisions. Decreased investments have also been identified due to complex and drawn-out environmental permissibility processes (Stigson, 2007). Cremer et al. (2007) identify, in a policy instrument oriented context, that uncertainties regarding the EU Emissions Trading Scheme (EU-ETS) in a post-2012 perspective establish a barrier for CCS investments. Another uncertainty is price fluctuations of market-based policy instruments that add to the investment risks (Section 4.1). The stakeholder acceptance of policies also has a bearing on their effectiveness and efficiency (Lucas et al., 2008). It should however be acknowledged that low acceptance is often a result of obstacles and as such the two are largely parallel. It nevertheless means that not only obstacles, but also other negative policy perceptions, should be bridged by policymakers.

It should be noted, however, that long-term policies may be argued as a utopian idea seeing that policymaking processes will inevitably have to be sensitive to, *inter alia*, the latest scientific findings, technological developments, and engineering solutions.

Due to these and other policy and non-policy obstacles, such as those outlined in the results below, there is a very strong plausibility that policies will have to be amended during the course of their implementation. While this contributes to policy uncertainty, the positive effects of the amendments may nevertheless supersede the negative (see Paper III).

3.4 Reflections on the credibility of industrial perceptions of investment obstacles

The research on how obstacles are perceived by industries is transposed into how these perceptions affect investments in abatement measures, as well as recommendations to amend the policy framework to overcome these obstacles. The papers appended to this thesis however do not reflect to any great extent on the accuracy and truthfulness of such perceptions and communications (some comments on the subject are however found in Paper I and III). The reason for this is that the research is aimed to argue for the positive effects of political measures that can contribute to establishing a functioning dialogue and knowledge-sharing between policymakers and industry. The author is also aware that many groups would question the legitimacy of allowing the industry a larger influence on policymaking decisions.

Against this background, a few words on the credibility of the industries' perceptions in the policymaking processes are justified as to problematise this focus. The author discerns two main categories of industries perceptions in the learning context:

1. The perceptions are based on sound analyses and as such reasonably accurate. This is communicated in a truthful manner and reflects a willingness to contribute to an improved climate policy framework parallel to a better business climate.
2. The perceptions are communicated in a truthful manner and reflects a willingness to contribute to an improved climate agenda and reduce GHG emissions, however poor background material or analyses means that the perceived obstacles are illusory.[17]

The difference between what industries know (category 1) and what industries perceive (category 2) is argued to be insignificant. If an industry knows that an investment has an elevated risk profile it will affect the investment risk calculi. However, the effect is no different if an industry perceives the same risk. This means that knowledge asymmetries (or knowledge gaps), where policies or other factors for sound reasons, or not, are perceived to increase investment, should feed into the policy processes.

[17] There are also situations where the communicated perceptions, whether accurate or not, are foremost used to argue for less stringent policies. Also, perverse incentives may mean that the communicated perceptions are aimed to disturb the policymaking processes for some reason and as such have no credibility. These are not included here due to the focus of positive aspects of a policymaker-industry dialogue and not the legitimacy of the industry in a policymaking context. Nonetheless, these two situations should be acknowledged by policymakers and all information should naturally be validated before feeding into policy processes.

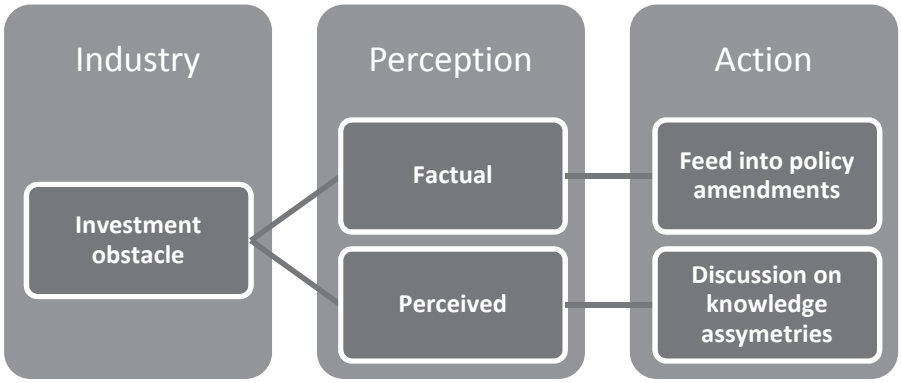

Figure 4 - Policymaker response to industrial investment obstacles perceptions

The learning framework however needs to validate whether the communicated message is true or not. In the former case it should feed back to considerations of amending the policies, and in the latter case it should form the basis for a discussion of knowledge asymmetries (Figure 4). The latter situation could be argued as less likely in the case of the large emitters included in this thesis where analyses of the climate policy situation are an essential part of operations and accordingly staffed. However, as Section 4.4 will point out, there are other forms of knowledge asymmetries that may impede technology developments.

A well-functioning dialogue is necessary and important in all cases as to evaluate which objective that the industry may have, and discern credible messages from flawed.[18] Nonetheless, the opinions voiced by the private sector should naturally not be perceived as the truth without being scrutinised. This thesis however points to the importance of reaching an effective dialogue where such evaluations can take place. Moreover, the communications from the private sector should be parallel to, and compared with, internal analyses as well as analyses by academia and non-governmental organisations (NGOs).

[18] This feeds back to the preceding footnote (17).

4. Results

The results outlined below are aimed to resolve a situation where a number of aspects, identified in the research and literature, indicate that the possibility for efficient PL is hampered. This includes the viewpoint by a government representative in the UNFCCC process, that business is not wanted in the dialogue. Another indicator is the view of a leading international industry organisation that governments and industry do not "speak the same language", do not understand each other's agendas, and lacking a forum for a dialogue. Other aspects include that climate change, being complex and dynamic, requires adaptive policymaking (Swanson and Bhadwal, 2008; Papadopoulos and Warin, 2007). Both policymakers and industry however agree that actions must be taken to abate emissions and mitigate climate change. Improving policymaking processes and policies therefore benefit both parties as well as the overall development.

4.1 Policymaking in a novel climate context

During the last decade, the implementation of climate policies has increased significantly.[19] These policies consist both of new climate policies as well as energy policies that provide attention to emissions of GHGs. Examples of the former group are carbon dioxide taxes, emissions trading, and GHG emission statutes. The latter group includes renewable energy (e.g. tradable green certifi-

[19] See, for example, the IEA Policies and Measures database at http://iea.org/textbase/pm/index_clim.html (Accessed August 24, 2009).

cates, feed-in tariffs, renewable energy subsidies) and energy efficiency policies. The development of environmental policies in general has also included an increased focus on market-based economic policy instruments. Taking Sweden as an example, the national climate policy framework has in the last six years implemented emissions trading, tradable energy certificates, and a VA on energy efficiency. Apart from this, the environmental code has undergone amendments and the carbon dioxide tax has yearly levy adjustments.

The level of novelty naturally differs globally, but the author argues that the climate policy frameworks in developed countries under current conditions are novel both to policymakers and industries. The reasons for this are not only that the policies are novel *per se*, but also that an increased use of market-based policy instruments contributes to this conclusion.

In terms of PL in this context, policy effects should be analysed in collaboration with the actors in policy environment, i.e. those subjected to the policy (Etheridge and Short, 1983). Paper I analysed, through interviews and literature, different aspects that can result in policy obstacles, which are related to the current novel situation, and thus should be included on this collaborative agenda, are that: (also see Paper I)

- the operational basics of novel instruments;
- the interaction between policies are not known;
- the commodity markets of market-based instruments (such as emission right and tradable green certificate markets) are immature;
- the final impacts of the policy is not known; and,
- novel policies are likely to require amendments which are not known.

The first point may seem mundane but is nonetheless important. Novel policy initiatives should be accompanied by informative efforts as to avoid knowledge gaps, such as a lack of information, in relation to the policy introduction. This requirement naturally increases with higher policy complexity and should be considered under the current situation where there is a focus on market-based instruments with detailed rules on monitoring, reporting, and trading. It should also be considered in terms of the policy recommendations given in Section 4.3 (Paper III).

When implementing several policies targeting similar goals and actors, they will influence each other. For example, if an emission rights price is high, the significance of a parallel subsidy may be reduced. Similarly, the interpretation of policy

effects becomes more difficult when policies may interact. One such case is where the tradable green certificate price comes down due to investments in renewable energy, which in turn is a result of high emission rights prices or high carbon dioxide taxes. This also highlights the situation where the effects of individual policies, as well as the interaction thereof, are more difficult to evaluate when implementing market-based policy instruments where the value of the traded commodity are dependent on several factors.

The larger influence of market-based instruments also adds to uncertainties in terms of novel and immature markets where fluctuations of commodity prices are typically high. An example of this is the EU-ETS where emission rights prices slumped from prices of 30 Euro/t to below 10 Euro/t in about a week (in April 2006). Later the prices dropped from a regained level of about 16 Euro/t to almost nil over the course of four months (September-December 2006).[20] This naturally makes investment calculi more difficult and therefore adds to the perception of abatement investments as risky.

All policy obstacles contribute to an increased possibility for amendments aimed to improve the policy. The resulting role of policy management includes that any amendments should be based on qualitative information on how the policy operates. Such information is difficult to attain *ex ante* (Schofield, 2004) and must consequently be learnt as the policy is implemented (*ex post*). At that point, the most updated information on how the policy factually affects investments and which obstacles that exists is held by the industry as being subjected to the policy. This is parallel to findings by Fouquet and Johansson (2005) and Geller et al. (2006) in that they have highlighted a stakeholder dialogue as an important measure to achieve high policy effectiveness. Not paying attention to the industry perspectives on policy obstacles logically risk reducing policy acceptance and thus policy effectiveness and efficiency.

In this context, the research highlights a positive initiative from Sweden in relation to the design and management of a VA for energy efficiency for energy intensive industries. This policy includes a business council that evaluates and directly provide industry perspectives to the responsible policymakers. This situation was found to be one of the contributing factors for a high policy acceptance among the interviewed industry representatives.

[20] For EUA price statistics, please see, e.g. the European Energy Exchange at http://www.eex.com/.

However, Sweden also provides negative lessons where the arrangement for PL has failed to heed the objections to the design of policies from the concerned stakeholders. This is highlighted in three cases in Paper I; namely, the former Swedish climate goal design, the carbon tax being levied on the industry parallel to emissions trading, and the permissibility process in the Environmental Code.

In the case of the Swedish tax system and applying a carbon dioxide levy for the Swedish trading sector included in the EU Emission Trading Scheme, there are reasons to criticise how the government acted from a PL theoretical perspective. Arguments to remove the tax for the industry, which were also subject to emissions trading, were at several occasions officially voiced by the industry itself as well as main concerned governmental institutions, such as the Official Committee on the introduction of emissions trading in Sweden. Despite this, the governments did not heed these recommendations for several years. When decided to act in line with the stakeholder opinions, the decision was later postponed (Ministry of Finance, 2006a; 2006b).

However, this does not mean that learning did not occur. The government may have increased their awareness and decided not to act on the recommendations for any number of reasons. A multitude of actors are generally invited to voice their opinions in comments to proposed legislative measures. As such there is also a high probability of diverse opinions on how to best design the policies. One should also remember the quote of Stern (in Section 3.2) that business is often asking for special rules and policy exemptions which cannot always be facilitated. Nonetheless, in this case there was a broad agreement between public, private, and academic bodies that the policy should be amended. As such, it is concluded that there are minor indications of learning in this instance.

These three instances has in previous research by the author been found to establish policy obstacles in that it caused frustration among the Swedish industry, which reduced policy acceptance and hampered investments (Stigson, 2007). These findings thus support Lucas et al. (2008) that low policy acceptance may affect investments negatively. Against this background, the author argues that PL is not appropriately addressed in Sweden today.

Moreover, the findings that the industry is increasingly attentive to climate policies in their investment decisions mean that policy obstacles are progressively influencing the success of the climate framework. Hence, investment obstacles should to an increasing extent form key points on a participatory and collabora-

tive learning agenda aimed to improve how an effective and efficient climate framework should be achieved.

While Paper I targets policy obstacles due to novel political initiatives, the novel conditions is strongly linked also to novel technologies. There are at present a number of technologies that are under development (e.g. CCS), being up-scaled (e.g. solar photovoltaics), and having recently reached commercial applications (e.g. wind power). Parallel to this, there are also new production patterns that focus on reducing resource intensities and emissions, such as EIPs. This establishes uncertainties of which technologies that will be favourable, which abatement potential that they will have, and consequently how they should be targeted under a climate policy framework. These uncertainties also establish risks that pose investment obstacles, as will be shown in Paper IV and V.

What this boils down to, is that the industry will gain important experiences after implementation due to being subjected to a policy while deploying or developing an abatement technology. This means that industry actors will be the first group to experience the factual effects of implementing the policy. An important point is that the operational conditions for a policy are not novel only for the industry but also for policymakers. The experiences gained by industry should thus be used as to improve the background material used to manage the policy framework towards higher effectiveness and efficiency. In conclusion, the implementation of a novel climate framework benefits from a policymaker-industry dialogue where operational details of policies and technology RDD&D investment perspectives can be discussed.

4.2 Participatory policy evaluation at management levels

While arguing the benefits of PL and PP as a tool for discussions, the interviews highlight that business and policymakers do not understand each other's work and institutional arrangements when discussing policy aspects (Paper I). Furthermore, there are also Swedish industry representatives who argue that the private sector representatives must be constructive and not only voice complaints in their dialogue with policymakers (Paper I). Moreover, the interviews in Paper I identified that the industry and agency representatives argue that a well-functioning arena for dialogue is important, with one representative highlighting that such arenas are lacking.

Along this line, Hammar (2006) concludes that research in this area of policy analyses of competiveness is important as to adequately analyse how policies can compensate vanguard actors that have higher costs for action, and thus contribute to more effective policy frameworks. Hammar furthermore argues that policies mitigating risks and costs can aid industries and other groups to assume forerunner positions. Moreover, Hammar highlights that adopting an effective climate framework should allow vanguard nations to have a strong voice in the design of policies. Through the focus of this thesis, the author argues the parallel for industries. Against this background, PL, and PP, Paper II aims to provide an arena for joint policy evaluations through a decision analytical framework. These evaluations are argued as becoming more important as policy stringency increases, as a result of developing nations taking a lead in reducing global emissions.

The background is that the industry has, from an international perspective, large differences in progression to reduce emission and energy intensities, and there are consequently large differences in emission and energy intensities (Silveira and Luken, 2008). Due to this, there are also national differences in the investment costs of realising further reductions of emissions or energy consumption (Criqui et al., 1999). Furthermore, the industry faces increasing internationalisation of their markets. This means that the spatial harmonisation of policy instruments between countries and regions is an important determinant of how policies affect actors in the private sector.

As a result of the above, policy compliance costs may also show large variations. These differences can establish negative competitive effects seeing that the markets for the non-power industry sectors included in this thesis are global (Bassi et al., 2009).[21] For this reason, in choosing policy instruments, policymakers should evaluate the relation of compliance costs and competitiveness. This is required to comply both with policy goals of a competitive industry (Section 3.1) and abating industrial emissions. This means that a progressive climate agenda should include evaluations of the possibility to choose policy instruments that are sensitivity to the relative performance of an industry compared to their equivalent competitors. Such evaluations are important in relation to a pre-design

[21] Eurelectric (2009) discusses harmonization and competitiveness issues due to differences in tax burdens in EU countries in a report that covers both electricity producers and consumers. Kuik et al. (2009) highlights that marginal abatement costs depend on, *inter alia*, the stringency of climate goals.

discussion on which policy instrument to implement, the specific design of the chosen policy, as well as policy amendments (such as updating of tax rates, changed allocation procedures, etc) (see Figure 1).

These policy processes should, as aforementioned, utilise industrial expertise to base the evaluation on experiences in the policy environment. Such learning processes should facilitate (Geurts and Joldersma, 2001):

- stepwise learning through stakeholder interaction from the policy environment; and,
- an enhanced policymaker-stakeholder dialogue.

Policy evaluation is however complex, and according to Nagel (1990):

> *"[…] relate to processing a set of societal goals to be achieved, alternative policies for achieving them, and relations between goals, and policies, in order to choose or explain the best policy, combination, allocation, or predictive decision-rule"*

Hence, most policy evaluation models are large-scale, comprehensive, and complex. As a result, they generally take a long time to produce results and require experienced staff to operate the software that is commonly associated with their use. From this follows, although they are important tools, that they are largely unusable for decision-makers of policy selection (i.e. government) and abatement investments (e.g. chief financial officers in the industry). The scale of modulation also limits the transparency and complicates the result interpretation.

Against this interview and literature background, the author has developed a tool – PAARP (Policy Analysis According to Relative Performance, see Paper II) – that can facilitate simple and robust evaluations of how different policy choices affect industrial competitiveness. The simplicity is meant to allow for the inclusion of a diverse stakeholder group and importantly those who are not experts in policy analysis. The author's aim is to assist participatory policymaker-industry policy evaluation dialogues on decision-maker levels. The tool is designed to: (1) provide simplicity to be widely and easily adopted; (2) rapid calculations which allows for higher transparency of results and subjectivity; and, (3) rapid feed-back of industry experiences.

Goulder and Parry (2008) argue that which policy criteria that is evaluated influence the appropriateness of policy choices. The focus on competitiveness is consequently important to evaluate climate policies relative the political agendas which prioritises a competitive industry sector. This does not mean to imply that

policymakers should avoid striving for a vanguard climate policy agenda; it however strongly argues that such an agenda has to be sensitive to how this affects other policy goals, such as the competitiveness of the industry sector.

There are four aspects which are included in the tool against their influence of how the policy affects competitiveness, namely:

- an industry's relative performance in terms of emission or energy intensity, etc., compared to its competitors;
- the policy compliance costs;
- the voluntariness to face the compliance costs (above); and,
- whether the policy is harmonised and provides comparable cost increases for all competitors.

Initially, the author did not intend to provide a policy evaluation tool but to analyse the literature on identify how these individual characteristics interact at different levels. However, it was found in the initial research phase that evaluations of compliance costs and voluntariness were associated with a low rate of agreement of estimates. Hence, the outcome was a tool where a participatory setting facilitates a relative evaluation of these factors.

The tool uses a simple equation (Eq. 1) to calculate an index that indicates to which extent that a policy is sensitive to how it may influence the competitiveness of the targeted industries.

$$Z = \frac{X(A+B)+C}{A_{max}+B_{max}+C_{max}} \cdot 100 \qquad (1)$$

where

Z = policy competitiveness index

A = compliance costs (0-3) 0 = highest costs, 3 = lowest costs

B = voluntariness (0-3) 0 = compulsory, 3 = voluntary

C = relative performance (0-3) 0 = poor, 1 = good, 2 = better, 3 = best

X = harmonisation (0 or 1) 0 = harmonised, 1 = non-harmonised

A_{max}, B_{max}, C_{max} represents the maximum values chosen for the value range (i.e. here equal to 3)

The *compliance costs* are calculated as partial equilibrium costs. The reason for this is that direct compliance costs excludes administrative costs and reduced operational flexibility, and general equilibrium costs also includes non-business costs that are imposed on the market (Pizer and Kopp, 2003). The *voluntariness* is important to evaluate whether the compliance costs are compulsory or can be avoided. In the latter case there need not be any negative competitive effects. The *relative performance* is at the core of the evaluations, as it determines whether abatement actions should be forced, incentivised, financed, or simply acknowledged by choice of different policies. This heeds differences in abatement and compliance cost due to varying progression in reducing emissions. If a policy is *harmonised* between different regions where the industries operate, the industries face similar regulation stringency.

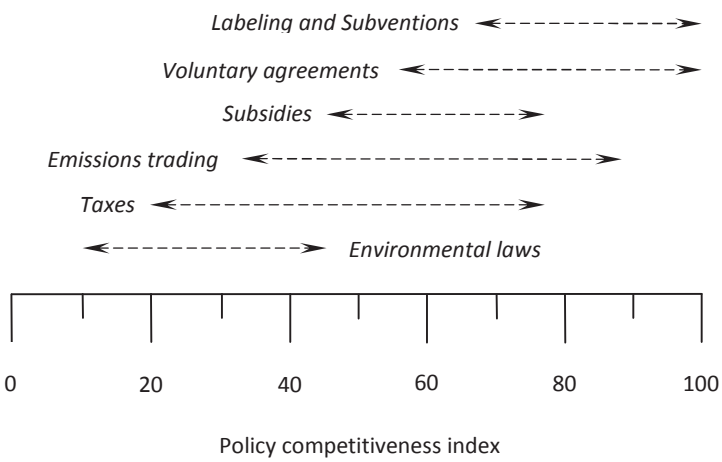

Figure 5 - Competitiveness index for different policy instruments

Depending on which values that are assigned to the included factors, it is possible to plot the analysed policy instruments along a policy competitiveness axis. Showing here (Figure 5) is the range of index values that applies for different *C* values (from 0-3) when the author has assigned fictive values for the other indicators (see Paper II). This signifies that policy design, perceived effects, and relative performance classification, have significant influence on policy competitiveness sensitivity. Looking closer at the specific design aspects of individual instruments then is provided here, a more detailed index picture allows compari-

sons of specific instrument design aspects. In the case of emissions trading, for example, one can discern that the different competitiveness impact of grandfathering versus benchmarking allocations is reduced with better relative performance (see Paper II). Another aspect worth highlighting due to this thesis's focus is the high competitiveness index of NAs. This is particularly important as the author argues that NAs should be used more extensively and is suitable to promote case-specific measures, seeing that these agreements typically would not be harmonised.

The influence of harmonisation can be exemplified in relation to allocation differences under the EU-ETS, where Cremer et al. (2007) identified that a 400 MW coal fired power plant could receive up to four times the allocated amount in one Member State compared to another. And, naturally, in other countries emissions trading may not apply.

While establishing the exact compliance costs are difficult and lacks research, biased views of the participants will influence which values that are perceived, or argued, as correct. This situation is aided by a participatory setting (also called group support systems or policy labs) which allows for discussions on relative, instead of absolute values. There are also differences in production characteristics that influence emission and energy intensities as well as abatement potential and costs, which will make broad sector comparisons difficult (much like there are problems to establish fair benchmarks in some industrial sectors). Evaluations that go into much detail therefore risk impeding discussions and agreements on results. It is therefore recommended that the values are kept in an integer number range of 0-3, as to provide less room for lengthy arguments of exact values.[22] Moreover, the tool allows for rapid calculations, which in turn allows for re-calculations and evaluating differences in outcome with different values/opinions.

An example for the applicability of the tool is a situation where a carbon tax provides an umbrella policy to provide broad incentives for emission reductions. Adding emissions trading for some sectors would add further incentives and plausibly increase emission target compliance in the included sectors. It is however questionable if emissions trading provides sufficient incentives for research, development, and demonstration (RD&D) of low-carbon technologies

[22] Such a low value range lacks detail but is argued as sufficient in terms of discussing relative values, which is the focus of the tool.

before proven to maintain stable and high emission rights prices (e.g. Groenenberg and de Coninck, 2008; Watson, 2008). Novel technologies, such as CCS and EIPs, therefore typically require additional support to be developed (Groenenberg and de Coninck, 2008; Paper IV-V). The competiveness index here provides a forum for discussion on how to push, or pull, the implementation of a novel technology that adds investment risks through increasing capital and operational expenses.

A current example of where the tool argues another policy design than suggested is the proposal for a new Industrial Pollution Directive (European Commission, 2007b). It is suggested in its Article 10, Paragraph 1, that "Where emissions of a GHG from an installation are specified in Annex I to Directive 2003/87/EC in relation to an activity carried out in that installation, the permit shall not include an emission limit value for direct emissions of that gas, unless necessary to ensure that no significant local pollution is caused." The tool would argue otherwise and recommend that limits should indeed be used to establish a minimum acceptable level. The writing should thus change to "Minimum emission levels based on an EU-wide baseline should be established for all industrial activities". This could be used to harmonise the baseline of carbon dioxide emissions in the EU and allow the EU-ETS to incentivise further emission reductions, providing a policy approach that is more sensitive to competitiveness.

Due to the limited amount of included factors and short value ranges, the tool is not meant to make other policy evaluation methodologies redundant. It is aimed to aid effective policy selection processes and policy designs through putting an emphasis on competitive considerations and aiming for PL and acceptance. As evaluating specific conditions, the results are furthermore not generally applicable. From this follows that policy effectiveness and efficiency would benefit from sectoral and more individual approaches. This highlights that increasingly complex technical operations and abatement solutions will benefit from policies that are adaptable to the case-specific context (also see Paper IV and V). The plurality of the climate challenge thus argues for an increased administrative function in climate politics as to govern a developed framework function.

van den Hove (2006) argues that participatory processes will predominately occur in an environment where a consensus of opinions does not exist. Nonetheless, the high transparency and collaborative outcome is argued by the author to aid consensus-building and policy acceptance, which in turn improves policy effectiveness and efficiency (Lucas et al., 2008). As such, while the tool could easily be used to gather input on the included factors on-line, this is not recommended as

the first-choice, due to reducing the close participatory contact that is seen as an essential element.

To put the tool recommended by the author in perspective, it should be compared with a 34 equation policy evaluation method developed by Sheriff (2009), which is presented as an approach that provides "policymakers an easily implementable" method. Parallel to policymakers, Sheriff also mentions researchers, i.e. hinting that he does not mean politicians but rather specialists in on government sub-levels, such as agencies, which may have the experience to utilise the method. This however highlights that the method presented here is aimed at decision-makers who in a meeting most likely do not have the time or experience to go through a 30+ equation simulation to reach a conclusion. Importantly though, these stakeholders are those that decide on the large operational investments that decide on long-term emission intensities.

4.3 Negotiated agreements as a vehicle for policy learning

The appended Paper I highlights that PL and VAs share common theoretical aspects due to the participatory nature of certain agreement designs. Against this background, and by means of a literature survey and metadata comparison, this thesis includes a more detailed analysis of this VA and PL nexus. This incorporates a focus on whether the additional learning values of VAs, as perceived by the author, had any support in literature. The literature sources were mainly scientific journals and policy papers of multilateral government organisations (e.g. OECD and World Bank). The latter to include an analysis of policymaker approaches.

This is transposed into the aim of the analysis to study:

- if literature identifies that VAs promotes PL and, if so, that this is seen as a value that supports the use of this policy instrument type; and,
- if available literature can provide input to a recommended design of VAs that promotes PL.

The purpose of this analysis was to contribute to the existing literature on the subject and highlight research results in this area as to develop policy recommendations for a VA design that utilises the PL potential. As mentioned in Section 2, literature identifies that PL lacks operationalising in literature (Schofield, 2004). This is further emphasised by Börkey and Lévêque (2000) in that they identify that learning has not been a driver for implementing VAs as a climate policy. The

analysis does not aim to provide a general guide to VA designs and should be interpreted from the abovementioned context.

To start, there are different types of VAs, where Börkey and Lévêque (2000) distinguish three groups:

- Unilateral Agreements: industry stakeholders commit to tasks formulated by themselves, and share this with the stakeholders they wish (i.e. employees, shareholders, customers, etc.).
- Public Voluntary Schemes: agreement stipulations are unilaterally designed by policymakers, which includes stipulations of, e.g. operational performance, monitoring, and reporting. As an incentive the industry may receive a benefit (e.g. research and development subsidies or technical assistance).
- Negotiated Agreements (NAs): bilaterally developed industry-policymaker contracts, which may be binding or not. Otherwise include similar characteristics as public voluntary schemes.

The main evaluation aspect here is which VA design that is most suitable to promote learning. In this context the two latter singles out as much more appropriate than unilateral agreements, as the author identifies significant differences in the potential for learning (Table 1).

Table 1 - Learning potential of different types of voluntary agreements

VA type	Policymaker-industry dialogue	Learning potential
Unilateral agreements	None	Low
Public voluntary schemes	Reporting	Intermediate – High
Negotiated agreements	Discussions on potentials for operational improvements, compliance economics, reporting, policy management, etc.	High – Very high

As such, the study mainly focused on NAs as having the highest learning potential through establishing new and potentially effective arenas for government-industry collaboration, dialogue, and knowledge-sharing. This is generally not

facilitated by other policy instruments that are implemented in a more unilateral fashion, such as taxes and administrative instruments. The author therefore argues this as a distinct value that should count towards NAs relative other instruments in *ex ante* as well as *ex post* policy evaluations. This value is potentially of such significance that the author argues that ten Brink's (2002) classification of NAs into three functions (bridging, supporting, and independent; see paper III) should be expanded by a parallel learning function.

Regardless of which type of VA that is analysed in literature, the author finds that the learning potential is largely overseen. This and other research, as well as policy papers by governmental organisations, however do not consider the focus at hand here. Learning is often referred to as industry-industry learning. Moreover, VAs are often discussed in general terms and there is thus no notion of which type of VA that is discussed. Furthermore, an increase in dialogue and knowledge-sharing is mostly referred to as a soft-effect and not learning. And, finally, if *learning* is mentioned it is very scarcely referred to as *policy learning*.

The current literature is therefore argued as only having touched upon this area and, as such, the analysis serves the purpose to acknowledge the PL values of specific VA designs (i.e. NAs). This is especially important in light of VAs having received criticism for not being effective and simply promoting business-as-usual (e.g. Ekins and Etheridge, 2006; OECD, 2003). However, other literature disagrees and argues values, such as flexibility and rapid implementation, especially when including stringent compliance mechanisms or incentives (e.g. Helby et al., 1999; Rietbergen et al., 2002). Paper III highlights that which type of VA that is implemented, and how it is designed and managed, has a significant bearing on the effectiveness and efficiency of the policy.

There is however some initial work on the subject, on which the study builds. Ramesohl and Kristof (2002), for example, identify that VAs can host the benefit of learning and that this may have a high value. Krarup and Ramesohl (2002) identify that in order for VAs to have positive effects on policymaker-industry learning, the agreements must be accompanied with explicit rules on agreement design and management. These two examples serve as a background for the second aim of the study; recommendations on how to operationalise VAs as to promote the benefit of PL.

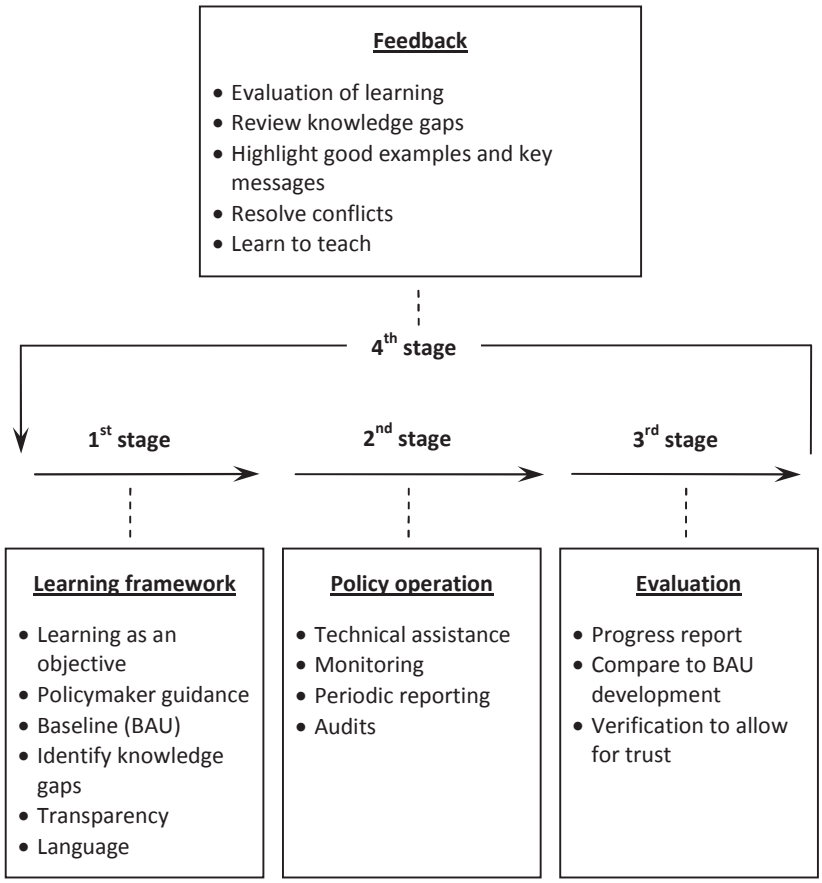

Figure 6 - Policy learning stages of negotiated agreements

The recommendations are based on policy cycle theory (see Figure 1) but are adapted to the main stages of designing and managing NAs. The cycle is therefore divided into four stages (Figure 6). The first (1) phase – learning framework – targets the learning agenda through establishing building blocks required for effective learning as well as, importantly, a mindset that PL is a central element of implementing the agreement.[23] Policy operation takes place during the second (2) stage, where important elements are monitoring and reporting. This stage can,

[23] For further explanations of each stage, please see Paper III.

inter alia, include technical assistance as an incentive aimed to aid industries on how to reduce emissions. If this targets the quality of the reporting, it benefits the learning material. The third (3) stage evaluates the progress made by the industries and is common practise in well-designed agreement scheme. The fourth (4) stage emphasises policy looping as a means to utilise the gained information as a policy management tool to continuously improve the policy. This stage could arguably be included in the previous stage but is separated here as to emphasise that PL is not part of common NA practices and should also be evaluated. In this sense, the task of learning to teach is important as both policymakers and industry should disseminate knowledge gained during the agreement that can improve the policy.

Through these stages, the recommended NA framework targets deutero learning as it recommends a new strategy for learning, which in addition evaluates the learning that occurs in stage 4. However, through a new arena for increased dialogue, NAs may also contribute single-loop learning through identifying solutions to identified, or perceived, obstacles. Effectively, through addressing learning failures, double-loop learning is also included.

A novel policy framework is likely to require updates to improve unforeseen effects that form investment obstacles, which means that there is a continuous need for learning during the entire policy cycle. This is incorporated in the recommended NA framework through the continuous reporting during the second stage and the looping at the fourth stage. At the same time, updates contribute to unpredictability which may reduce policy effectiveness. Carrying out amendments in conjunction with a dialogue with the industry is however argued to have the potential to reduce such negative effects.

The NA design and management processes that are recommended above may admittedly seem cumbersome and time-consuming. However most of the building blocks in the different stages are present in a typical NA and can often be utilised to promote PL by a change in mindset that learning will benefit both policymakers and industry.

4.4 Case-study: Deploying carbon capture and storage

The results above have analysed PL in terms of policy design and management processes from a theoretical perspective, targeting which role that the industry can play in these processes. The following results are more applied and analyse

the deployment of complex solutions to mitigate climate change. This begins with a view on CCS deployment obstacles and how learning can mitigate these.

CCS is important in the climate policy context as being a technology solution that is often assigned to hold one of the largest potentials for carbon dioxide abatement. This is evident in scenarios produced by IPCC (2005) where CCS represents 15-55 % of the total abatement potential by 2100. Another estimate is that CCS could reduce industrial emissions by 33 % globally and 53 % within the EU if deployed in all sectors (Stangeland, 2007). As such, CCS technologies – consisting of a group of different capture, transport, and storage steps – have received a lot of attention. This has been transposed into deployment goals where the G8 aims for 20 demonstration plants (>1 Mt/year) by 2010 (G8 Energy Ministers, 2008). The EU has set the goal to operate 12 demonstration facilities by 2015 (European Council, 2008).

Investments and deployment of CCS is however impeded by a number of obstacles associated with CCS as a novel technology, where the individual components as well as complete infrastructures are immature and yet to be proven (de Coninck et al., 2009). Due to this, both policymakers and industry, as well as other actors, lack robust knowledge on the economic, ecologic, and social aspects of deploying the technology. Based on a questionnaire survey[24], literature review, and CCS project analyses, the study aims to:

- identify industry opinions on engaging in CCS RDD&D[25];
- highlight discrepancies between these perceptions and available literature and first-mover project experiences (i.e. knowledge asymmetries); and,
- identify the policy implications of the results.

[24] Carried out within the STRACO2 project, see http://www.euchina-ccs.org/

[25] RDD&D and RD&D are differentiated in that the former includes commercial, or mature, applications that do not need any public support. This is seen as an essential part of bringing the majority of novel, or immature, technologies through pilot, demonstration (and possibly up-scaling) phases.

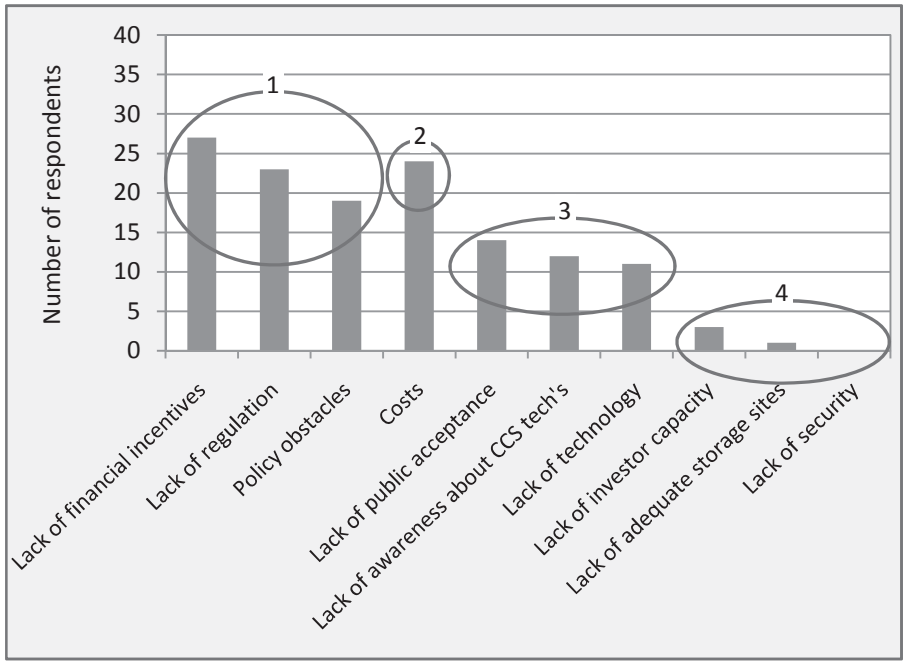

Figure 7 - Obstacles to the commercial success of CCS divided into four groups

Looking at the specific deployment obstacles for CCS, there are inherent risks associated with the novelty of the technologies, such as operational reliability, infrastructural challenges, lock-in in "non-winner" technologies, and large first-mover investments costs. Important information for policymakers in this situation is knowledge on the complete set of investment obstacles and how these rank against each other as to prioritise policy initiatives. This information is important to realise demonstration activities that can prove the technology and validate the projected abatement potential. This insight and background to further analyses is provided through the industry questionnaire responses to the question of "Which are the biggest obstacles to the commercial success of CCS at the moment?"[26] (Figure 7).

[26] Looking at investor capacity, the situation would most certainly have changed should the responses been able to take the full magnitude and consequences of the 2008/2009 financial slump into consideration, which is why we do not analyze this further here. The number or respondents were 55.

From these results it is possible to single out four main groups of obstacles. Most respondents are concerned about policies which belong to group 1. The second largest obstacle is costs which forms group 2. These two groups are closely linked in terms of financing and incentivisation policies that may bridge the cost gap and risks. Coming to group 3, the concerns are significantly lower and the aspects included in group 4 are the least important obstacles. In a short-term perspective, policies should thus balance risks primarily in groups 1 and 2 as this would improve industrial investment calculi most. However, as these risks are reduced, groups 3 and 4 become relatively more important, meaning that these also need to be on the policymaker agenda.

On the other hand, these arguments are purely based on realising investments through overcoming *perceived* obstacles. Here, the author distinguishes the difference in relation to the *factual* obstacles to deploy CCS as there may be discrepancies between these (also see Section 3.4). Hence, a comparison between the responses reflecting industrial perceptions on the one hand, and literature and factual project experiences on the other, can reveal discrepancies and provide an improved background for policymakers. Such an analysis shows that literature has a much more diverse outlook on obstacles that can impede or plausibly halt a broad dissemination of CCS, while also substantiating that policy and financial concerns are valid (Paper IV). The non-perceived obstacles that can be identified through this are, for example, environmental trade-offs through the use of chemicals in capture processes where utilising CCS is identified to strongly increase the human toxicity compared to a non-CCS case (Koornneef et al., 2008). Other such concerns are the use of solvents in post-combustion processes (da Silva et al., 2008). Looking at a perceived "non-issue" such as adequate storage potential, Anderson et al. (2007) highlight that storage potentials are highly uncertain. These concerns are shared with Boehringer (2009) who argues that German estimates are uncertain and that true potentials are probably in the lower range. A question herein is however which type of storage that different actors count towards the potential, seeing that there are differences in the expected permanence of different sites – some more suitable, and some less (IPCC, 2005).

Comparing this situation with a number of projects that has been restructured, postponed, or cancelled (RPC-projects), supports literature in that there are substantial evidence to argue that deployment obstacles are much more diverse than perceived by the industry (Table 2). Due to the risk of misdirecting funds and

resources to less promising RD&D, such a situation is problematic and should be improved as to provide a robust framework for investments.

Table 2 - Restructured, postponed, and cancelled CCS projects

Project	Location	Status	Reason
FutureGen	Illinois, USA	Restructured [a] (Jan 2008)	Construction cost increase
Halten CO_2 Project (Tjeldbergodden)	Tjeldbergodden, Norway	Cancelled [b] (June 2007)	Low revenues (i.e. costs)
Killingholme	England, UK	Postponed [a] (April 2008)	Policy changes increased costs
Kwinana	Western Australia	Cancelled [a] (May 2008)	Lack of storage
ZeroGen	Queensland, Australia	Restructured [c] (March 2008)	Technology uncertainties
BP Carson Hydrogen Power Project LLC	California, USA	Restructuring [d] (May, 2009)	Low acceptance

[a] http://sequestration.mit.edu/ (Accessed November 11, 2008)
[b] James (2008)
[c] http://www.zerogen.com.au/ (Accessed November 11, 2008)
[d] http://www.bp.com/genericarticle.do?categoryId=2012968&contentId=7014858, http://sequestration.mit.edu/tools/projects/bp_carson.html (Accessed March 11, 2009)

Apart from these obstacles there are also important interdependency issues when developing new and complex infrastructures with three major components. This is, for example, associated with risks of engaging in one sector before the infrastructure is fully developed. This can be related to the lead time before a full infrastructure is available, and the limited operational reliability of a restricted infrastructure. Chrysostomidis and Zakkour (2008) relates to the interdependency risk in the context of first-movers on gas transport, where benefits of transport projects is potentially small in relation to the financial risks, as full capacity usage cannot be guaranteed. The initial demonstration and full-scale operations will also face increased costs due to having to establish the infrastructure. In addition to this, Gale (2009) has raised concerns of the pipeline transport operations when

captured carbon dioxide streams of different composition are mixed. This means that there is a high industry interdependency between and within different stages of installing and operating a full infrastructure.

Admittedly, there are several reports that do not argue any negative influence of these and other concerns. The analysis here is however made from a critical perspective, and as such aims to highlight potential obstacles and how these can be bridged, rather than a problem-free situation. Regarding the latter, it should however be noted that the author identify CCS as a bridging technology for the power industry, and as a longer-term solution for industries with process related carbon dioxide emissions (e.g. cement, and iron and steel industries). From this argument follows that if the storage potential is limited, the usage thereof should be regulated as to provide guidance for operators and investors.

An agenda aimed to promote the implementation of a novel technology should furthermore safeguard that projects do not fail, as this can cause anchoring, i.e. increasing investments risks based on the perception that the projects have a possibility to fail. This can be related to CCS in terms of findings of the European Technology Platform for Zero Emission Fossil Fuel Power Plants (ETP ZEP, 2008), identifying that the EU deployment goal should be met as to "de-risk" investments through proving the viability.

To conclude, the abovementioned information asymmetries and interdependency mean that all stakeholders – from policymakers to business, academia, NGOs, and society – should be brought together to improve knowledge-sharing as to reduce the resulting obstacles. This is emphasised by CCS being a novel and complex technology where the stakeholders typically lack robust knowledge of important deployment aspects. This is highlighted in the questionnaire results through comments that any policy measures will likely require amendments as suggested and implemented policy initiatives are based on a largely non-existent technology. As a result of these the novelty-based uncertainties, some respondents highlighted the importance of feeding lessons from demonstration projects into policymaking processes (Paper IV).

This situation also means that what is perceived to be state-of-the-art knowledge today can be undermined by new findings tomorrow. A continuous and rapid feed-in of new knowledge is therefore important in proving the feasibility and viability of a novel technology option as to validate abatement potentials, remove RDD&D obstacles, update policies, and if needed steer away from an option that

is concluded as not recommendable. In this context, the importance learning was supported by some questionnaire respondents (Paper IV).

Due to knowledge asymmetries, as well as the complexity and highly case-specific operations, the author identify that the flexibility and learning values of NAs could contributing to bridging these obstacles and knowledge asymmetries in promoting CCS. In the case of CCS, Paper IV therefore agrees with de Coninck et al. (2009) and argues that a global CCS facility should be installed. Such a facility should acknowledge the large potential that CCS is commonly assigned, and should ideally be governmentally sanctioned as to provide legitimacy and a suitable PL arena. The agenda for such a facility should, *inter alia*, include:

- identified discrepancies between policies and obstacles (i.e. investment risks);
- identified discrepancies between deployment experiences and literature versus investor perceptions; and,
- interdependency aspects.

The results provide that a policy framework aimed to promote a novel technology must include information on other obstacles than mitigating costs and providing regulatory certainty. Perception discrepancies and interdependency obstacles provides a strong case for government-industry PL as well as other learning arenas, such as industry-industry learning to reduce infrastructural interdependency risks, as these can be mitigated through a well-functioning dialogue. This means that policymakers need to adopt a learning-by-doing agenda as the current situation poses a challenge for evidence based policymaking.

4.5 Case-study: Promoting Eco-Industrial Parks in China

China is one of the world's largest emitters of carbon dioxide and major air pollutants, which is a result of rapid economic development as well as low energy efficiencies and high carbon contents of the primary energy sources (Auffhammer and Carson, 2008; Fan et al., 2007; Yi et al., 2007). The recent economic development has caused negative effects in terms of resource depletion and environmental degradation, which has been acknowledged by the Chinese authorities (Kai, 2006). To meet this challenge the Chinese government has

stepped up their efforts to mitigate this situation. As a result, new policies targeting resource and energy efficiency has been introduced.[27] Many policies are however very general and the policy framework has been criticised for not being effective in promoting the political agenda (Fang et al., 2007).[28] At the time of writing Paper V, the same applied to promoting eco-industrial developments (Geng et al., 2007).

The Chinese industry represented in 2005 about two-thirds of the nation's energy consumption (Lin et al., 2006) and three-quarters of the electricity consumption (Yuan et al., 2007). Looking at the industrial infrastructure, a large portion of the Chinese manufacturing industry is located in approx. 1700 industrial parks (IPs) which represented, in 2006, approx. 11 % of the Chinese Gross Domestic Product and 30 % of the exports (China Knowledge, 2009; figures from 2006). IPs comprise industries as well as living areas and other services, and are present all over China in varying sizes. The IPs are highly diverse in terms of, *inter alia*, included industries, climatic conditions, and resources. As a concept where the industries and other services located on the same premises, the IPs provide a potential for symbiosis where park industries and other activities recycle each other's waste sources (heat, waste, etc.). This concept is referred to as Eco-Industrial Parks (EIPs). With an aim for increased economic, ecologic, and social benefits, they are highly aligned with the overall goals of China's development. EIPs started on a pilot scale in China in late 90s and are still a novel concept with few parks operating. The author thus identifies a number of similarities to the aforementioned results, in that EIPs operate under a novel policy environment due to low experience levels, rapidly growing economy, and a changed policy framework. Moreover, EIPs may implement novel technologies (e.g. adsorption coolers, biogasification, and water recycling) or combinations thereof which form complex technical solutions.

[27] It should be noted that China, in specific terms, has lacked a climate agenda as not stipulating any targets for GHG emissions or policies targeting carbon dioxide emissions. The Chinese policies have been much more focused on resource and energy efficiency as well as other environmental concerns which can be included in a climate framework.

[28] The policy framework has developed after writing Paper V and that new policies, such as the Circular Economy Promotion Law (entered into force January 1, 2009), has been introduced. Nonetheless, although including stipulations of recycling and eco-production, this law also need more detailed provisions to lay down the exact terms of its function. E.g. terms such as "the state encourages" are used.

Differing to the other papers, Paper V mainly concerns the Chinese manufacturing industry, rather than the basic industry as in the previous results. This is however natural as it provides a more level comparison with developed country industries as they to a larger share than heavy industries are privately owned and managed. Hence, as large basic industries and energy utilities are generally controlled by the government, they operate under different financial conditions.

Against this background the author has analysed literature and documentation from policy advisory forums with the aim to highlight the benefits of NAs in promoting EIPs.[29] This includes a focus on the specific conditions and obstacles that policy initiatives supporting EIP developments should handle. One of the most important aspects is that such policies should not limit the economic growth, seeing that this goal has an equally high priority on the national agenda. This focus however also include that policies should support a rapid development towards EIPs, rather than regular IPs, as to avoid a lock-in effects and more costly process changes at a later stage. Moreover, a general policy targeting EIPs should be flexible and adaptable to the specific operational contexts of different parks, as there are large differences in production, regional contexts, and eco-solutions. The novelty and complexity of the concept also means that knowledge asymmetries are likely to occur, such as the case with CCS (Section 4.4). This is supported by Chiu and Yong (2004), who identify that eco-industrial developments have been hampered by policies that do not keep up with technological innovation. A lack of suitable management systems which appropriately address the interdependency of park activities also establish an obstacle (Chiu and Yong, 2004). Other literature has highlighted that EIP park managers may not realise the value of the EIP concept (Esty and Porter, 1998). This is parallel to park managers often focusing on sales rather than resource and environmental concerns (CCICED, 2003). Also, following from Paper I (Section 4.1), policymakers should acknowledge the technical and economic expertise of the park management.

[29] This mainly included the China Council for International Cooperation on Environment and Development (see http://www.cciced.org/) and the ministerial-level Senior Policy Advisory Council meetings under the China Sustainable Energy Program (see http://www.efchina.org/). Also, in contrast to Paper III (Section 4.4), Paper V use the term VAs but do not specify which type of agreement. However, as the reader will notice it includes negotiations between policymakers and industry, hence referring to NAs.

Hence, besides common regulation and incentivisation aspects, there are a number of obstacles which relates to the need for a policy initiative that:

- has high adaptability and design flexibility;
- can be rapidly implemented;
- support a strengthened dialogue and knowledge-sharing in an industry-industry as well as PL setting;
- contribute to new management systems; and
- highlight EIP values.

Looking at the abovementioned situation for EIPs, the more collaborative nature of NAs compared to other policies offers such positive characteristics. As aforementioned, NAs provide a flexible policy solution which can bridge knowledge-gaps, be rapidly implemented, and promote PL. Similar to the case of CCS, however, learning is furthermore important not only in a policymaker-industry context but also between industries, as a result of the strong interdependency in EIPs. A NA should for these reasons preferably include shared goals that emphasises the park management's joint responsibilities. Goals for the individual park actors would however point to the individual responsibilities. On the other hand, this can also be accomplished through regular reporting which aids control of individual actor's keeping up with the joint goal. Negotiating a joint agreement, assuming a joint responsibility, and carrying out regular and transparent reporting, logically promote improved industry-industry learning. This in turn feeds into the development of appropriate management strategies based on the collective opportunities and barriers as well as providing improved knowledge-sharing. Developing these strategies also means that the communication with policymakers may provide learning against a better information material. The NA design also allows for different "add-ons", such as aid with developing appropriate management strategies, and energy and resource audits, which may further adapt the agreements to the specific EIP and target knowledge asymmetries. Amidst this dialogue and design considerations, good examples should be reported and communicated as to encourage IP managers to adopt the EIP concept.

These processes provide continuous learning that is important for the symbiosis between the park actors. If policymakers get involved in developing appropriate

management systems, it provides good-practice lessons to policymakers which may propel EIPs developments.[30]

To this can be added that policy advisors commonly argue for the introduction of a carbon dioxide tax and reduction of fossil fuel subsidies. If such policy developments come into effect, the policy framework will impose a growing financial burden for the industry. Seeing the goal of economic development, NAs may provide a suitable opportunity to subsidise the tax while also supporting the policy effectiveness.

There are consequently several reasons to recommend NAs in promoting EIPs in China. An important rationale for this would be the flexible nature thereof, and thus adaptability to a strengthening policy framework targeting the rapidly changing industry sector evolving under the high economic growth rate. Moreover, findings by Eichhorst and Bongardt (2009) that the policymaker-industry collaboration in NAs is aided by stringent energy policies as this established a common agenda for both parties to meet the central government's goals.

While the analysis has focused on EIPs, the findings are applicable to other multi-component industrial systems and varying ownership conditions. This can, for example, include chemical (kraft) pulp and paper plants with black liquor gasification and connections to district heating systems. It is also applicable to CCS where the conditions for operating the CCS system will be highly case-specific as dependent on type of capture facility, need for transport, and availability to reservoirs of differing quality.

[30] Noteworthy is that later research by Eichhorst and Bongardt (2009) has shown that the initial implementation of NAs has been positive and that government-industry relationships and learning have been among the main drivers.

5. Policy implications

Abatement opportunities in the industry are associated with common and case-specific obstacles that impede an effective and efficient promotion of investments. The research results in this thesis highlight theories and recommend practices that acknowledge how the industry can contribute to overcome these obstacles through improved policy processes and instrument designs that acknowledge PL benefits.

The purpose of this section is twofold. Firstly, it is aimed to provide a section for discussions on the results. Secondly, it highlights the main policy recommendations to policymakers. This includes: a summary of the obstacles present in the studied climate context; main arguments for policymakers to increase the attention to the positive potential of PL and hence to facilitate learning; and finally, to highlight benefits and designs of NAs that can contribute to bridging these obstacles and operationalise PL.

5.1 Overcoming obstacles to invest in abatement measures

As discussed, the industry is increasingly attentive to climate policies in their investment decisions. Hence, any existing obstacles related to policy initiatives, or a lack thereof, have become increasingly impeding a positive development towards abating emissions and reaching the established climate goals. The current situation, where science tells us that abatement efforts must be effective in the shorter term, emphasises the need to bridge any obstacles that limits the possibilities to reach such goals. Effective policies are also important to promote

early measures which can avoid lock-in in less efficient technologies that will affect abatement efforts during the operational lifetime. Moreover, the situation where the costs to mitigate climate change increases from an optimal development also tells us that the policy framework must strive to accomplish this not only effectively, but also efficiently, as to contain costs as much as possible. Any cost-increase will add inertia for action and thus limit the success of the political agenda and mitigating changes to the global climate.

Designing policies that can overcome the existing obstacles is however complex. They must, for example, acknowledge that the policy environment is enlarged due to the global nature of climate change and internationalisation of markets. Adding to this is the development of new technologies that establish increasingly diverse abatement opportunities. Moreover, the importance of considering competitive effects is likely to grow as a result of progressive political agendas striving for vanguard positions in dealing with climate change, as is the case in Sweden and EU as well as a number of other countries. In providing a robust policy framework, which can abide also by other political goals, policymakers should utilise the differences in policy instrument characteristics to abide by, for example, industrial policy objectives.

As to meet these challenges, governments have developed novel policy frameworks. This is inherently beneficial as regulations have to be in place to provide the fundamental elements of evaluating a technology's feasibility and viability, and thus provide a business case. However, the novel policies also bear with them uncertainties of how the new policies function and interact as well as how the novel markets of market-based instruments will behave. This can form obstacles for investments in RDD&D if the policy uncertainty and complexity lead to low acceptance or uncertain policy support, as proven in numerous studies.

Hence, the challenge for policymakers today is immense. Especially seeing that governments cannot reduce emissions themselves and as such will not have first-hand knowledge on how current and expected developments affect investment decisions in the industry. Adding to this is the situation where the industry develops technologies and thus has knowledge of when, and under which conditions, that different technical abatement options may become viable.

New policies need to be implemented to deal with novel technologies and industrial operations as well as other market and political failures. These policies, as well as previous policies, need to be monitored and adjusted. This includes updating the overall climate policy framework to new and plausibly unexpected

changes in the climate and scientific findings thereof. As to analyse which measures that can contribute to higher policy effectiveness and efficiency, this task should include a dialogue with the industry, which will have first-hand experience and knowledge about the factual effects of the policies.

An important aspect of this rapid development is that knowledge asymmetries, or information discrepancies, can easily occur. These form obstacles themselves as they can result in strategic planning being based on erroneous information. Such situations may mean that an obstacle is not identified or that a non-issue is perceived as an obstacle. It also relates to which technical and economic potential that technologies factually have. Not knowing this is a risk both for policymakers and industrial actors which develop and deploy abatement technologies. This can, for example, mean that public subsidies may be offered to a technology that seems promising in different abatement scenarios. However, a more careful analysis may provide that there are important obstacles that have not been acknowledged. This cause resulting obstacles if leading to a slowdown in reaching the objective of effective and efficient abatement of emissions. No actor in specific can be argued as responsible for the occurrence of these knowledge asymmetries. However, as responsible for policymaking and guiding the society, governments bear a responsibility to identify and close such cognitive gaps. As such, they should facilitate arenas for dialogue on investment perceptions.

An example of knowledge asymmetries is a participatory survey by the author at a CCS policy briefing. The survey was made against the background of the author's research which identified that there was not a common perception of the difference between CCS pilot and demonstration activities. The attendees (respondents) were a diverse group of policymakers, engineers, researchers, and other specialists within the field of climate, energy, and CCS – i.e. professionals with an impact on CCS developments. The short questionnaire asked which capture rate (Mt/year) and boiler size (MW) that would categorise an operation as a demonstration activity. This classification is essential as pilot plants are research and development (R&D) activities which commonly test storage *or* capture operations (e.g. capture and release). Demonstration activities need to adopt a full capture, transport, and storage infrastructure of larger sizes and thus at much higher costs. In addition, the regulatory aspects are diametrically different as pilot activities are commonly excluded from taxes and rigid permissibility approvals. This does not apply to demonstration activities. The common classification is that an operation close to, or above, 1.5 Mt/year and 300 MW, is a demonstration activity (Brockett, 2009). The responses however clearly proved

the author's initial perception of a knowledge asymmetry and need for a common language as they showed very large variations from 0.1-30 Mt/year and 5.0-600 MW. There requires little further arguments to conclude that this impairs discussions on which operations that CCS policies targets, how research budgets should be distributed, progress of the technological development and fulfillment of deployment goals, etc.

The time span before emissions needs to peak logically argues for thorough analyses of technical and economic potentials of a broad set of technologies that can abate emissions. As such, all obstacles and knowledge asymmetries, specific or general, must be dealt with rapidly as to provide an information background for sound policy decisions and to balance the risk/reward for private investments as not to delay investments. The alternative is increased emission cuts as well as mitigation and adaptations costs in the future, plus other negative consequences, such as the risk of carbon leakage.

Industries will not invest in technologies unless there is a sound business case, i.e. an acceptable balance of risks and rewards. Moreover, the business case is also dependant on this balance being fairly stable. This highlights an effective policy management regime as important. However said management processes must then be in place to deal with the plausible occurrence of obstacles during policy implementation with maintained acceptance.

There are different methods of reducing these investment obstacles and this thesis analyses how increased attention to industrial investment perceptions may contribute to policies and policy processes that can impel industrial investments in GHG emission abatement. This includes that policymakers should acknowledge and evaluate:

- which role that industrial investment perceptions and experiences play in a climate change context;
- how joint discussions on key policy characteristics can facilitate a common language and understanding of policy solutions;
- how the policy instrument group of VAs can be designed to incorporate learning and evaluated on the basis of providing positive soft-effects;
- how asymmetries in investment perceptions may complicate policy-making; and,
- how VAs can be adopted to case-specific situations.

5.2 Improving policy learning

Climate policymaking hence provides a policy environment that entails some special conditions and problems. The global nature, novelty, costs, competiveness, rapid economic developments, parallel policy objectives, and plurality of solutions and actors, indeed all add up to climate policymaking being a very complex and difficult puzzle.

Looking at the policymaker-industry intersection of this puzzle, these two groups share common agendas to work within this complex situation and to create solutions. As a leading business representative has said: "Business cannot succeed in a society that fails." As introduced in Paper I, governments cannot reduce industrial emissions due to not managing the emitting operations. Since the decision-makers of such investments lies at the industry, they are inherently experts in analysing how policies affect RDD&D in abatement technologies and measures. Moreover, the research indicates that policymakers mainly cooperate with actors within the political realm and that there is a lack of a common language and understanding of each other's agendas.

These factors impede the effectiveness and efficiency of efforts to abate emissions by, *inter alia*, not dealing effectively with investment obstacles, and must consequently be bridged. This can only come about through an increased dialogue. This is effectively sought by industry representatives, which now actively pursue a more participative role in the international climate negotiations, instead of being bystanders. In this processes, the industry strongly advocate for a developed public-private dialogue within the policy processes (World Economic Forum, 2008).

Hence, policymakers should engage resolutely in PL. Aiding this; PP has the potential to work as a catalyst for learning. Important in this context is that higher stakeholder participation, and logically attention to opinions, lead to higher acceptance, which in turn result in improved policy effectiveness.

It is important that learning does not only occur *ex ante* policy implementation but also as part of the policy management processes. What is state-of-the-art knowledge today may very well be turned over by tomorrow's developments.

The author would like to emphasise that the arguments for a larger inclusion of industry policy perspectives do not mean that they should assume a role as *policymakers*. This has no place in a democracy. Rather, the industry should be acknowledged as *policy analysts*, which means that their policy perceptions

should be acknowledged and evaluated. In this context, it is worth mentioning the research by Juntti et al. (2009), which has identified that value-based statements are gaining ground as legitimate arguments in environmental policymaking.

An increased analytical framework, through PL and participatory events, may potentially prolong policy implementation. Nevertheless, this thesis argues that this is worthwhile if this leads to higher policy acceptance and improved policy designs, especially in the long-term through capacity building. Also, including the policy subjects from the beginning could arguably speed up the policy processes as reducing the need for repeated referrals of proposed legislative measures.

There are consequently impelling arguments that the benefits PL under current conditions could provide essential benefits to meeting the specific challenges that policymaker face in light of climate change.

5.3 The benefits of negotiated agreements

Seeing that literature and current conditions emphasise the theoretical benefits of PL, it is naturally interesting to analyse if there is a policy instrument that can provide the same fit into climate policies. Even more interesting would be to provide a policy recommendation that can encompass and deal both with current conditions and PL.

Such an instrument would, against the obstacles identified above, ideally possess as many of the following characteristics as possible:

- effective;
- cost-efficient;
- flexible;
- rapidly implementable;
- high acceptance;
- long-term and predictable;
- sensitive to competitiveness considerations;
- participatory; and,
- furthering a policymaker-industry dialogue and knowledge-sharing.

This thesis argues that VAs designed in collaboration between policymakers and industry, i.e. NAs, can be designed as to offer that very opportunity.

Literature provides that NAs can be rapidly implemented and adapted to case-specific conditions. Börkey and Lévêque (2000), for example, highlight that NAs are recommended when policymakers face technological uncertainties. These are unquestionable values within the context of this thesis, seeing that a bridging technology, such as CCS, will have to be implemented rapidly or else missing the assigned abatement potential. Hence, the technology must be demonstrated and proven in a short timeframe. It also has the value that improved production patterns, such as EIPs, may come about sooner and thus contribute to a more short-term effective climate framework. Paper V identifies NAs as adaptable to highly case-specific operations. Börkey and Lévêque (2000) as well as Stigson (2007) have also identified that NAs may offer higher policy acceptance than other instruments. Glachant (1999) argues that the cost-efficiency of VAs is high under similar conditions as those posed by climate change abatement activities. Predictable and potentially long-term characteristics of NAs are highlighted in Paper I and V. The sensitivity that NAs can provide in pursuing a stringent climate framework is highlighted in Paper II. Paper III emphasises the PL values of NAs and identifies different design elements that can heed the literature which argues that learning requires operationalisation (Krarup and Ramesohl, 2002).

Moreover, literature argues that in terms of climate policy, learning has not been a driver for the implementation of VAs (Börkey and Lévêque, 2000). These findings are important in that it highlights yet another gap parallel to that of NAs' learning values where this type of policy instruments can make larger contribution to climate policy frameworks.

The link between NAs and PL has been largely overlooked in literature. The dialogue aspects of VAs have primarily been identified as a soft-effect and usually in an industry-industry context. However, as is shown in Paper V, this type of learning is recommended on the basis of creating a platform for, not only government-industry dialogue, but also industry-industry learning within the EIP management.

The arguments that PL bring about larger administrative efforts applies also to NAs. However, so does the conclusion that the benefits are of such magnitude that the trade-off is likely to be positive in terms of increased effectiveness and efficiency. As is argued in Paper III, the recommended operationalisation of NAs is not entirely additional to common NA practices. Most of the suggested design elements are in fact predominately present in general NA designs. A central element is thus to add an emphasis on the dialogue and learning aspects.

Against these findings the research argues for the benefits of NAs and that climate policy processes and frameworks would benefit from an increased utilisation thereof. The two key conclusions are that *ex ante* policy evaluations NAs should acknowledge the potential PL values and aim for designs that promoted learning. *Ex post* evaluations should evaluate if learning has taken place and recognise this value as well as underline design lessons which promoted PL. The author emphasises that the recommendations provided is not aimed to provide a blueprint for all design considerations of NAs but rather to stress design aspects that can increase the learning values thereof.

6. Conclusions

The significant and urgent challenges of mitigating climate change has resulted in policy and technology responses that have established novel conditions for policymakers and industry alike. Actions to reduce emissions have to be rapidly implemented and achieve substantial abatement. Policies promoting this consequently have to be effective and cost-containing. However, abatement is impeded by a number of obstacles.

Industries play a key abatement role as governments only have secondary influence on industrial investment decisions. As being the decision-makers of abatement investments, as well as providing technology to other societal sectors, the industry has large influence on reaching the abatement and technology deployment goals on the public climate agenda. This role means that the industries are those best informed on how policies and obstacles factually influence investments. This includes perceptions of whether policies provide a sound business case through balancing risks and rewards. Logically, as the policymaker is less informed of the individual effects of an implemented policy or technology, she lacks essential experiences on how to design, implement, and manage policies in a fashion that is beneficial for steering towards the desired goal. Failing to acknowledge the industries' perceptions is parallel to disregarding their role as the investors who largely will determine whether the political agenda will be successful or not. This establishes a risk that the policy framework will not tend to impediments for a positive development and possibly increase investment risk.

Looking at climate change from the context of this thesis, a few specific aspects emphasise the need for dialogue and learning. This is mainly attributable to the urgency and costs of acting to reduce GHG emissions, novel policies and tech-

nologies developed to abate emissions, as well as the plurality of meeting this challenge in terms of actors and technologies.

Under current conditions, new information and lessons are continuously learnt on various aspects, such as necessary emission cuts, how effective policies are and interact, and the technical and economic potential of different technologies. This means that knowledge asymmetries may become prevalent and obstruct effective and efficient strategies for policymakers and industries alike.

The policymakers should thus engage in policy learning to acquire knowledge of how the policy environment and policy subjects view the opportunities and barriers to act under the implemented agenda. This increases awareness and capacities and that aid effective policymaking. This is however, at present, not possible to accomplish effectively as there is a lack of forums and a common language for this dialogue. While facilitating the dialogue is seen as the responsibility of policymakers, there is evidence that the political will to engage in such processes with the industry is limited.

The learning agenda should permeate the choice, design, and management of policies. The choice of policy instrument is important as it locks-in specific policy characteristics and determines the level of flexibility and adaptability. The specific design thereof has obvious implications for the policy subject. Learning within the operation and management of the policy is equally important as novel conditions and rapid developments are likely to require the policy to be updated. This should also, as is argued in this thesis, possibly be initiated by the industry.

Looking at policy obstacles within the climate framework, the research has highlighted that the operational basics, interaction, and final impacts of new instruments are not known and that this is emphasised in terms of market-based instruments. Moreover, the novel framework is likely to require a number of unforeseen amendments in the short-term.

Looking at novel technical solutions to the climate problem, this thesis finds evidence that learning is required between a broader set of actors – i.e. government-industry as well as industry-industry learning. This springs from the uncertainties regarding the potential of different technologies and engineering solutions to abate emissions. Expenditures on abatement options that are not successful naturally have negative implications on the efficiency of the policy framework. It also falls back on the complexity of, for example, globalised markets as well as complex and immature technical abatement opportunities. These uncertainties and complexities mean that policymaking will have to be highly

adaptive. It also means that the information that is continuously made available in the policy environment should feed into the policy processes without delay. Utilising this information provides a robust knowledge base in the policy amendments that will inherently take place in any policy area, and even more so under the conditions studied here. Hence, the results argue for an increased administrative function within climate politics as to govern the necessary actions to abate emissions.

Specific measures to bridge this situation can however be facilitated by policy-makers and this thesis has found that negotiated agreements hold a significant potential to induce policy learning. They are also adaptive to specific investment conditions within a diverse and complex abatement potential environment, having high acceptance, and having the potential to acknowledge competitiveness where this is a concern. Such agreements are however not a golden key that makes other policy instruments redundant. This thesis however argues that the potential for this policy instrument under current conditions with benefit can be used more frequently. An essential aspect is the potential to bridge knowledge asymmetries. There are significant differences within voluntary agreements in how well they can reap the potential benefits. Through the negotiating and management phases of implementing negotiated agreements, policy learning can be operationalised.

Through taking stock of PL and NA theories, this thesis has against these findings answered the research questions that were outlined in Section 1.3. This thesis contributes to bridging some identified cognitive gaps in policy theory and implementation that are identified in the individual research papers. The author does not attempt to establish a new learning theory but rather to build on existing theories and literature. However, as mentioned in Paper I, the unprecedented policy challenge of combating climate change could very well be argued as requiring a new learning concept, based on the urgent, far-reaching, and global implications that the climate challenge have on mitigation and adaptation activities across all societal groups and all pillars of sustainability.

Seeing the vast challenge of climate change and the diverse stakeholder and technology relationships in abating emissions, further research should develop strategies that can bridge abatement investment obstacles and link the private and public interests and agendas. While this thesis has targeted the carbon intensive industry, there are other sectors that are of equal importance for an effective and efficient international climate agenda. Policy researchers should therefore study political initiatives that can facilitate forums for constructive

knowledge-sharing from a broad perspective. This includes policy recommendations for specific instruments, NAs and other, which can promote this dialogue. Importantly, this should also revisit existing policy interpretations to fully recognise the PL values that different policies have. Another area of research is the legitimacy issue and how policymakers view the credibility of industry policy perceptions and suggestions, hence evaluating obstacles for PL at that level. Continued research in these areas is important to provide policymakers with a comprehensive blueprint of how the political framework can benefit from measures that acknowledges this important aspect of climate policies.

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