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WEDGING THE GAP

AN ANALYSIS OF THE IMPACT OF EXISTING LARGE-SCALE BOTTOM-UP INITIATIVES FOR GREENHOUSE GAS EMISSION MITIGATION IN 2020

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SUMMARY

The international community has agreed on limiting global average temperature increase to 2°C above pre-industrial levels. Current country pledges are, however, insufficient to bridge the emissions gap between business-as-usual greenhouse gas emissions and pathways compatible with the 2°C target. Blok et al. (2012) have proposed an approach called 'wedging the gap' to bridge this emissions gap. The approach consists of 21 coherent major global bottom-up initiatives, called wedges , which together have an estimated potential of reducing 10 Gt CO_2e by 2020. However, this is a rough estimation based on many assumptions. In this research the commitments of existing large-scale bottom-up initiatives consistent with the 'wedging the gap' approach are analysed. This analysis is carried out for ten of the 21 wedges[1].

For these wedges an inventory of existing initiatives is created. If possible, the emission reduction commitments of the initiatives are quantified compared to business-as-usual emissions assuming the initiatives meet their stated targets. There are strong differences between the amount of currently existing initiatives and their ambition levels within the different wedges. For the six wedges 'Top 1000 companies', 'Major cities initiative', 'Cars and trucks', 'Boost solar photovoltaic energy', 'Boost wind energy', 'and 'Agriculture' large-scale bottom-up initiatives with quantifiable targets currently exist.

The combined emission reduction commitment of the initiatives in the six wedges that could be quantified is estimated to be in range of 3.2–4.5 Gt CO_2e in 2020, taking into account overlap between the wedges. This is about a quarter of the 14 Gt CO_2e emissions gap in 2020. The part of this commitment that is additional to high-ambition government pledges is estimated to be in the range of 2.3–3.5 Gt CO_2e in 2020. This is about one third of the 8 Gt CO_2e emissions gap between high-ambition country pledges and the emission level consistent with the 2°C target in 2020. The emission reduction commitment is quantified assuming the initiatives meet their stated targets. However, a preliminary assessment of the levels of commitments shows that only about one third of the stated commitments can be classified as 'strong'.

Although the estimated commitment of currently existing initiatives is substantial, it is not enough to bridge the emissions gap. To stay below a 2°C temperature increase above pre-industrial levels major efforts are needed in the coming years. Action has to be taken to start up initiatives in the wedges that are not yet covered and to strengthen and upscale the already existing initiatives. Additional wedges might be needed to be able to bridge the gap. Also, on-going monitoring is needed to assess the extent to which the initiatives fulfil their commitments.

[1] These ten wedges are: 'Top 1000 companies', 'Voluntary-offset companies', 'Voluntary-offset consumers', 'Major cities initiative', 'Cars and trucks', 'Boost solar photovoltaic energy', 'Boost wind energy', 'Phasing-out fossil-fuel subsidies', 'Reduce deforestation' and 'Agriculture'.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

ACCO	Association of Climate Change Officers
ADB	Asian Development Bank
AFP	Asia Forest Partnership
APEC	Asia Pacific Economic Cooperation
ASEI	Asian Solar Energy Initiative
BAU	Business-as-usual
BELC	Business Environmental Leadership Council
C2ES	Center for Climate and Energy Solutions
CBD	Convention on Biological Diversity
CCAFS	Research Program on Climate Change, Agriculture and Food Security
cCCR	carbon*n* Cities Climate Registry
CCI	Clinton Climate Initiative
CCX	Chicago Climate Exchange
CDM	Clean Development Mechanism
CDP	Carbon Disclosure Project
CEO	Chief Executive Officer
CERs	Certified Emission Reductions
CGI	Clinton Global Initiative
CH_4	Methane
CIAT	International Center for Tropical Agriculture
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
CPF	Collaborative Partnership on Forests
CSI	Cement Sustainability Initiative
EC	European Commission
EHCC	Earth Hour City Challenge
EISA	European Initiative for Sustainable Development in Agriculture
EPA	Environmental Protection Agency
EPIA	European Photovoltaic Industry Association
ESC	European Shippers' Council
EU	European Union
EU PVTP	European Photovoltaic Technology Platform
EVO	Dutch Shippers' Council
EWI	European Wind Initiative
FACCE-JPI	Joint Programming Initiative on Agriculture, Food Security and Climate Change
FAO	Food and Agriculture Organization of the United Nations
FCPF	Forest Carbon Partnership Facility
FFSR	Friends of Fossil Fuel Subsidy Reform
FSC	Forest Stewardship Council
FTA	Freight Transport Association
G20	Group of Twenty
G8	Group of Eight
GDP	Gross Domestic Product

GFAN	Green Freight Asia Network
GFE	Green Freight Europe
GFEI	Global Fuel Economy Initiative
GHG	Greenhouse gas
GMI	Global Methane Initiative
GPFLR	Global Partnership on Forest and Landscape Restoration
GSA	Global Solar Alliance
GSC	Global Solar Council
GSI	Global Subsidies Initiative
Gt	Gigatonnes
Gt CO_2e	Gigatonnes of carbon dioxide equivalent
GTP	Green Truck Partnership
GW	Gigawatts
GWEC	Global Wind Energy Council
HDV	Heavy-duty vehicle
HFCs	Hydrofluorcarbons
HHDT	Heavy heavy-duty truck
ICCA	International Council of Chemical Associations
ICCT	International Council on Clean Transportation
ICLEI	ICLEI - Local Governments for Sustainability (formerly named: International Council for Local Environmental Initiatives)
IEA	International Energy Agency
IFAP	International Federation of Agricultural Producers
IISD	International Institute for Sustainable Development
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IRU	International Road Transport Union
ITF	International Transport Forum
ITS	Institute of Transportation Studies
IUCN	International Union for Conservation of Nature
JRC	Joint Research Centre
kWh	Kilowatt-hour
LCRS	Logistics Carbon Reduction Scheme
LDV	Light-duty vehicle
LHDT	Light heavy-duty truck
LowCVP	Low Carbon Vehicle Partnership
MCPA	U.S. Conference of Mayors' Climate Protection Agreement
MICCA	Mitigation of Climate Change in Agriculture
MHDT	Medium heavy-duty truck
Mt	Megatonnes
Mt CO_2e	Megatonnes of carbon dioxide equivalent
N_2O	Nitrous oxide
NAMA	Nationally appropriate mitigation action
NGO	Non-governmental organisation
NREAP	National Renewable Energy Action Plan
PCFV	Partnership for Clean Fuels and Vehicles

PFCs	Perfluorcarbons
PV	Photovoltaics
R&D	Research & Development
R&D&D	Research, Development & Demonstration
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	Reducing Emissions from Deforestation and Forest Degradation, including conservation and sustainable management of forests and the enhancement of forest carbon stocks
SAI	Sustainable Agriculture Initiative
SAN	Sustainable Agriculture Network
SEAP	Sustainable Energy Action Plan
SEII	Solar Europe Industry Initiative
SF_6	Sulphur Hexafluoride
SLoCaT	Partnership on Sustainable, Low Carbon Transport
SRREN	Special Report on Renewable Energy Sources and Climate Change
TPWind	European Wind Energy Technology Platform
TTW	Tank-to-wheel
TWh	Terawatt-hour
UK	United Kingdom
ULCOS	Ultra-Low CO_2 Steelmaking
UN	United Nations
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
US	United States
U.S. DRIVE	Driving Research and Innovation for Vehicle efficiency and Energy sustainability
US DOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
VCM	Voluntary Carbon Market
VERs	Verified Emission Reductions
WBCSD	World Business Council for Sustainable Development
WEC	World Energy Council
WEF	World Economic Forum
WEI	Wind Energy Initiative
WEO 2012	World Energy Outlook 2012
WFO	World Farmers' Organisation
WMCCC	World Mayors Council on Climate Change
WTW	Well-to-wheel
WWF	World Wide Fund for Nature

1. INTRODUCTION

1.1 BACKGROUND

In Copenhagen in 2009 and in Cancún in 2010 the international community agreed on limiting global average temperature increase to 2°C above pre-industrial levels and considered lowering this temperature target to 1.5°C (UNFCCC, 2009) (UNFCCC, 2010). Since Copenhagen many countries have submitted pledges—proposals for emission reductions—for 2020 (UNFCCC, 2011a) (UNFCCC, 2011b). However, in Durban in 2011 the Parties noted with grave concern "*the significant gap between the aggregate effect of Parties' mitigation pledges in terms of global annual emissions of greenhouse gases by 2020 and aggregate emission pathways consistent with having a likely chance of holding the increase in global average temperature below 2°C or 1.5°C above pre-industrial levels*" (UNFCCC, 2011c, p. 2).

In a report called *The Emissions Gap Report 2012* published by United Nations Environment Programme (UNEP) major scientific studies on global greenhouse gas (GHG) emission estimates are synthesized. According to this report global greenhouse gas emissions have to peak before 2020 and the emission level should be around 44 Gt CO_2e[2] in 2020 (range 41–47 Gt CO_2e) in order to have a likely chance[3] of meeting the 2°C target. However, global greenhouse gas emissions in 2020 under business-as-usual (BAU) conditions are estimated to be 58 Gt CO_2e (range 57–60 Gt CO_2e) leaving an emissions gap of approximately 14 Gt CO_2e between business-as-usual and pathways compatible with meeting the 2°C target. In principle, it is possible to bridge this emissions gap—as the technical mitigation potential for greenhouse gas emissions is estimated to be 17 ± 3 Gt CO_2e by 2020—,but the current country pledges are insufficient to bridge this emissions gap. The emissions gap in 2020 between the emissions expected after implementation of the pledges and the emission level consistent with the 2°C target is estimated to be 8 to 13 Gt CO_2e, depending on how the pledges are implemented. Even in the most optimistic case, when all high-ambition pledges are adopted and strict accounting rules are applied, there will still be a gap of 8 Gt CO_2e (range 4–11 Gt CO_2e). However, many of the pledges are conditional and depend on the ability of national legislature to endorse the necessary laws, on action from other countries, or on financial or technical support. Therefore it is most probable that the emissions gap will be at the high end of the 8 to 13 Gt CO_2e range (UNEP, 2012).

Blok et al. (2012) have proposed a new approach called 'wedging the gap' to bridge the emissions gap. This approach consists of 21 coherent major global bottom-up initiatives to reduce greenhouse gas emissions which together have an estimated potential of reducing 10 Gt CO_2e by 2020. For all of these 21 initiatives the following requirements hold: (1) there is an existing starting position from which significant scaling up is possible; (2) significant additional benefits exist next to greenhouse gas emission reduction; (3) there is an organisation with the potential to lead the global initiative; and (4) the initiative has the potential to reach a significant emission reduction (of the order of 0.5 Gt CO_2e). Also, it is important that the actors are motivated by self-interest or internal motivation instead of external pressure. Actions by individual citizens, cities or companies will have negligible impact, but when scaled up into a large global coalition bottom-up initiatives driven by sub-sovereign and non-state actors have the potential to create sufficient momentum to bridge the emissions gap in 2020 (Blok et al., 2012) (Hare et al., 2012). In Figure 1[4] the estimated cumulative impact of the 21 wedges is shown, including the overlap between the different wedges and the overlap with the country pledges. In Appendix I an overview of all 21 initiatives and their assumed potential commitment is given.

[2] Gigatonnes of carbon dioxide equivalent. Unless otherwise stated all emissions in this report refer to the global warming potential-weighted sum of the greenhouse gases covered by the Kyoto Protocol, i.e. CO_2, CH_4, N_2O, HFCs, PFCs, and SF_6.

[3] More than 66% likelihood

[4] In this figure the emissions gap is 12 Gt CO_2e instead of the 14 Gt CO_2e stated before. This is because this figure is based on the 2011 UNEP *Bridging the Emissions Gap* report. In *The Emissions Gap Report 2012* the estimate of the emissions gap has increased.

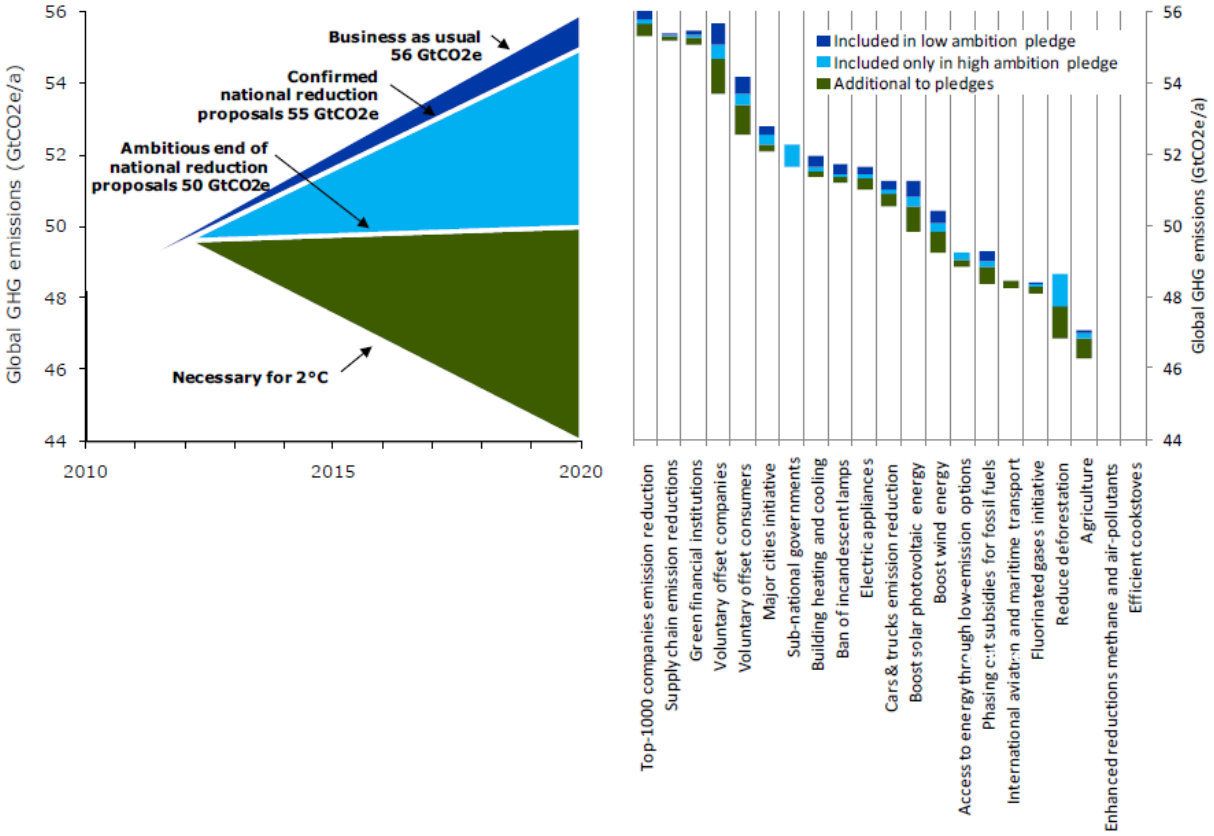

FIGURE 1 POTENTIAL CUMULATIVE IMPACT OF THE 'WEDGING THE GAP' INITIATIVES (HARE ET AL., 2012)

1.2 OBJECTIVES & RESEARCH QUESTIONS

The quantification of the impact of the 21 proposed initiatives by Blok et al. (2012) is a rough estimation based on many assumptions. Although the large-scale global initiatives proposed in the 'wedging the gap' approach do not currently exist, many bottom-up initiatives in line with this approach already have been started. It is however still very unclear what the actual impact of these existing initiatives is. The objective of this research is to create an inventory of the existing initiatives and to determine what the total expected impact of these initiatives is on greenhouse gas emission mitigation in 2020. This research is relevant from a scientific point of view. Considerable analysis exists to date on the impact of government targets and government initiatives (e.g. Climate Action Tracker, Climate Interactive and other modelling groups described in *The Emissions Gap Report 2012* (UNEP, 2012)). In contrast, the body of knowledge about existing bottom-up initiatives aimed at greenhouse gas emission reduction is still scarce (see as an exception e.g. the analysis of WWF's Climate Savers programme (Ecofys, 2012)). In addition, methodological development is needed to determine the expected contribution of these bottom-up initiatives to closing the emissions gap. It is also relevant from a social point of view as it shows how much more bottom-up action will be necessary to be able to close the emissions gap and limit global temperature rise to 2°C above pre-industrial levels.

The main research question of this study is:
"What is the total expected impact of existing large-scale bottom-up initiatives consistent with the 'wedging the gap' approach on greenhouse gas emission mitigation in 2020?"

To answer this research question, the following sub-questions have to be answered:

- Which large-scale bottom-up initiatives consistent with the 'wedging the gap' approach already exist?
- What are the ambition levels and other characteristics of these initiatives?
- What is the expected impact of these initiatives on greenhouse gas emission mitigation in 2020 compared to a business-as-usual scenario?
- How large is the overlap of these initiatives with country pledges and with other initiatives?
- What is the total expected impact of all these initiatives combined?

1.3 SCOPE & LIMITATIONS

The geographical scope of this research is global and the temporal scope is from now up to 2020. The research has some limitations. Enormous numbers of bottom-up initiatives exit throughout the world and it is impossible to investigate all these initiatives. Therefore the focus is on large-scale initiatives in which multiple actors combine their actions. Small individual actions are not considered. Furthermore, it is not possible within the time scope to assess for all initiatives whether or not they are likely to meet their stated target. It is thus investigated what the expected impact of these initiatives is, assuming they meet their stated 2020 targets. Within the time frame of this research it was not possible to analyse all 21 wedges. Therefore it was chosen to research the ten wedges with the highest expected impact (see Table 1).

TABLE 1 ESTIMATED IMPACT OF SELECTED WEDGES ACCORDING TO BLOK ET AL. (2012)

	Wedge	**Impact in 2020 (up to Gt CO_2e[5])**
1	Voluntary-offset companies	2.0
2	Reduce deforestation	1.8
3	Voluntary-offset consumers	1.6
4	Boost solar photovoltaic energy	1.4
5	Boost wind energy	1.2
6	Phasing-out fossil-fuel subsidies	0.9
7	Agriculture	0.8
8	Top 1000 companies	0.7
9	Major cities initiative	0.7
10	Cars and trucks	0.7

In Chapter 2 the general methodology of this research is described. Chapters 3 until 10 describe the ten researched wedges. These chapters include an introduction on the wedge and, if applicable, an overview of the initiatives consistent with the wedge, the specific methodology applied and the resulting expected impact on global greenhouse gas emissions in 2020. In Chapter 11 the results of all the wedges are combined and the overlaps of the wedges with other wedges and country pledges are assessed. Chapter 12 provides a discussion and in the concluding Chapter 13 the research question is answered.

[5] Because of the potential overlap between the initiatives the impact in 2020 is stated as 'up to'.

2. METHODS

This chapter describes the general methodology used in this research. The specific methodology applied to quantify the impact of the existing bottom-up initiatives within each wedge depends on the types of commitment of the initiatives as well as the availability of data. Therefore, the specific methodologies applied for each specific wedge are described in the corresponding chapters.

2.1 INVENTORY OF INITIATIVES

The aim of this research is to quantitatively assess the emission reduction that can be achieved in 2020 if existing large-scale bottom-up initiatives consistent with the 'wedging the gap' approach meet their current commitments. The first step in the analysis of the initiatives is to create an inventory of existing initiatives and to gather information about these initiatives. The main sources of information for compiling this inventory are publications and websites of the initiatives and other actors involved. The search for initiatives is stopped when no new initiatives can be found any more.

2.2 BUSINESS-AS-USUAL SCENARIO

To quantify the emission reduction commitment of the existing initiatives in 2020, business-as-usual emissions—the expected emissions without the initiatives being implemented—have to be determined. There are multiple ways to define a business-as-usual scenario. One of the possibilities is to define it as representing a likely pathway given currently implemented policies (UNEP, 2012). This approach is taken in this research and the International Energy Agency's (IEA) *World Energy Outlook 2012* (WEO 2012) Current Policies Scenario is used as a reference scenario. This scenario includes the effects of government policies and measures that were enacted or adopted by mid-2012 and does not take into account any other potential future policy actions. The projected 2020 greenhouse gas emissions in the WEO 2012 Current Policies Scenario are 56.0 Gt CO_2e (IEA, 2012a), which is consistent with the business-as-usual scenario used by Blok et al. (2012).

To determine the business-as-usual emissions for a specific sector multiple methods are possible, the choice of which depends on the available data. For the wedges directly related to energy generation (e.g. 'Boost solar photovoltaic energy') the WEO 2012 Current Policies scenario is directly applicable. For other sectors other scenarios with comparable assumptions are used (e.g. the International Council on Clean Transportation's (ICCT) Adopted Trajectory for the transport sector) or a business-as-usual scenario is constructed based on predictions for the sector growth and autonomous energy or carbon efficiency improvement. In case no specific data are available concerning a certain sector, the total overall emission growth rate in WEO 2012 Current Policies Scenario is applied to the sector.

2.3 EMISSION REDUCTION COMMITMENT

To quantify the emission reduction commitment of a certain initiative the target of the initiative is related to the emissions in the business-as-usual scenario. For example, when the target is to reduce emissions 20% below business-as-usual, the expected emission reduction is 20% of the defined business-as-usual emissions. And when the target is defined as a certain emission level in 2020, the expected emission reduction is the difference between the target and business-as-usual emissions. The impact is estimated assuming that the stated commitment of the initiatives is achieved in 2020. It is outside the scope of this research to assess the likelihood of the initiatives meeting their targets. The emission reduction commitment of an initiative can only be quantified if a quantifiable target is stated. Initiatives that do not have a target are therefore not included in the analysis of the expected impact of the initiatives. In case there are multiple initiatives within a wedge for which the commitment can be quantified, overlapping commitments of different initiatives are only taken into account once.

There are many uncertainties when dealing with projections of future emissions, for example uncertainties in growth rates and efficiency improvement rates. To deal with these and

other uncertainties, ranges are used in the calculations of the expected emission commitment of the initiatives. These ranges reflect the uncertainty in the result by showing what the influence of the assumptions and uncertainties in the data is on the result. The upper and lower values of the ranges reflect the best case and worst case emission reduction commitment, given the varied values and assumptions. Since for most of the used data no information about the uncertainty is available, the uncertainty ranges of the data are based on assumptions. The uncertainty ranges are, therefore, not a specific confidence interval, but rather an indication of the uncertainty in the result. When adding the commitments of different initiatives within a wedge, error propagation rules are used to determine the range of the total commitment.

2.4 OVERLAP WITH OTHER WEDGES & COUNTRY PLEDGES

The commitments of the initiatives within the different wedges cannot simply be added together. Overlap between the initiatives might exist. The assumptions used by Blok et al. (2012) are used as guidance for estimating the overlap between the initiatives. The assumptions are adjusted based on the number of wedges analysed in this research and the magnitude of the commitments of the existing initiatives. An uncertainty range for the overlap is applied.

To determine the overlap between the commitments of the initiatives and the high-ambition country pledges, the WEO 2012 New Policies Scenario is used as a reference. This scenario includes not only policy commitments and plans that have already been implemented, but also those that have been announced, even if the measures to implement those commitments are not yet introduced. Examples of those commitments are renewable energy targets and national greenhouse gas emission reduction targets. The greenhouse gas emissions in 2020 are expected to be 50.8 Gt CO_2e under this scenario (IEA, 2012a). This is a slightly higher projection than the 50 Gt CO_2e reported by Blok et al. (2012) for the ambitious end of national reduction targets, but slightly lower than the 51 to 52 Gt CO_2e range reported in *The Emissions Gap Report 2012* for the case with high-ambition pledges and strict reporting rules (UNEP, 2012). For some wedges the overlap with country pledges is determined using other scenarios with similar assumptions or based on information about specific country pledges. In case no usable scenario or aggregated information about country pledges is available, the assumptions used by Blok et al. (2012) are used as guidance for estimating the overlap.

After having assessed the impact of all initiatives and their overlaps with country pledges and other initiatives, the results are combined into one single answer to the main research question, which can be related to the emissions gap. When adding the commitments for the different wedges, error propagation rules are applied to determine the uncertainty range.

3. WEDGE 1: TOP 1000 COMPANIES

3.1 INTRODUCTION

At first, many large multinational companies opposed the Kyoto Protocol and put much effort into trying to influence their government's position in the debate. However, when government support for Kyoto turned out to exceed the initial expectations, an increasing number of companies ended their opposition and prepared to comply with the upcoming regulations (Kolk & Pinkse, 2004). Companies have many options to reduce greenhouse gas emissions, such as process improvements, product improvements, and substituting fossil fuels by renewable energy. Many companies have come to realise that apart from complying with regulations, reducing greenhouse gas emissions can also be seen as an opportunity and lead to a competitive advantage. Examples of advantages include new market opportunities, cost-savings due to efficiency improvement and enhanced corporate social responsibility leading to increased reputation, stakeholder acceptance, and investor confidence (Kolk & Pinkse, 2004) (Boiral, 2006).

Blok et al. (2012) have estimated that 0.7 Gt CO_2e[6] could be avoided in 2020 if 30% of the top 1000 largest greenhouse gas emitting companies would reduce their energy-related emissions 10% below business-as-usual and all companies would reduce their non-carbon dioxide greenhouse gas emissions by 50%. This initiative could potentially be led by the World Business Council for Sustainable Development (WBCSD).

3.2 DESCRIPTION OF INITIATIVES

Although one large-scale overarching initiative for companies wanting to reduce greenhouse gas emissions does not yet exist, there are a number of initiatives currently in place. Ten of these initiatives bringing together companies addressing climate change were identified, an overview of which is given in Table 3. In total 218 of the top 1000 largest greenhouse gas emitting companies are a member of one or more of these emission reduction initiatives (see Table 2). The top 1000 largest greenhouse gas emitting companies are taken from a database (de Jong, 2011).

TABLE 2 NUMBER OF PARTICIPANTS IN INITIATIVES FOR COMPANIES

Name	Number of companies involved	
	Total	Top 1000
ACCO	>100	≥11[7]
Caring for Climate	341	72
CSI	24	4
BELC	35	29
Haga Initiative	12	2
Responsible Care	152	45
The Clean Revolution	37	13
ULCOS	10	4
WBCSD	192	106
WWF Climate Savers	29	12
Total (accounting for multiple membership)		**218**

[6] In the calculation of this value the scope 1 and 2 GHG emissions of the energy producing sector and other sectors are added to give the total emissions. Therefore this number might be somewhat overestimated due to double counting.
[7] ACCO publishes its representative members only; therefore there could be more than 11 top 1000 participants.

TABLE 3 OVERVIEW OF COMPANIES INITIATIVES FOR GHG EMISSION MITIGATION

Name	Led by Starting year Region Sector	Description of the initiative (as described by the organisation[8])	Commitment
Association of Climate Change Officers (ACCO)	- 2008 Global Cross sectoral	ACCO aims to advance the knowledge and skills of those dedicated to developing and directing climate change strategies in the public and private sector, and to establish a forum for collaboration between climate change officers (ACCO, n.d.).	No clear commitment stated.
Caring for Climate	UNEP & UN Global Compact 2007 Global All Sectors	Caring for Climate is an initiative aimed at advancing the role of business in addressing climate change. The initiative helps companies to advance practical solutions, share experiences, and shape public policy as well as public attitudes (Caring for Climate, n.d.) .	By supporting the Caring for Climate Statement participants commit to setting voluntary targets to improve energy efficiency and to reduce their carbon footprint. Participants report publicly and annually on the achievement of those targets (Caring for Climate, 2010).
Cement Sustainability Initiative (CSI)	WBCSD 1999 Global Cement Industry	The CSI is an alliance of leading companies in the global cement industry. The CSI provides a platform for a shared understanding of sustainability issues, developing and distributing practical tools, facilitating effective stakeholder engagement, and providing sustainable solutions (CSI, 2012).	By signing the CSI Charter participants commit to developing a climate change mitigation strategy, setting reduction targets for CO_2, and reporting annually on their progress (CSI, 2012).
Business Environmental Leadership Council (BELC)	C2ES 1998 Global (focus on US) All sectors	BELC believes that business engagement is critical for developing efficient, effective solutions to the climate problem. BELC is the largest US-based group of corporations focused on addressing the challenges of climate change and supporting mandatory climate policy (C2ES, n.d.).	Companies adopt voluntary emission reduction targets (C2ES, n.d.).
Haga Initiative	- 2010 Global (focus on Sweden) All Sectors	The Haga Initiative is a network of companies with the aim of reducing carbon emissions from the business sector and highlighting the climate issue by showing that ambitious climate strategies lead to business advantages and improve profitability (Haga Initiative, 2011).	Participating companies commit to setting an emission reduction target of at least 40% by 2020. Participants report on their targets, progress, and planned actions (Haga Initiative, 2011).

[8] The descriptions of the initiatives in this report are (in most cases) based on the descriptions of the initiatives on websites or in publications of the organisations themselves. The descriptions have been summarized and slightly rephrased, but partly include direct quotes.

TABLE 3 OVERVIEW OF COMPANIES INITIATIVES FOR GHG EMISSION MITIGATION (CONTINUED)

Name	Led by Starting year Region Sector	Description of the initiative (as described by the organisation)	Commitment
Responsible Care	ICCA 1985 Global Chemical industry	Responsible Care is an environmental, health, and safety initiative to drive continuous improvement in performance of the chemical industry. This objective is achieved by meeting and going beyond legislative and regulatory compliance, and by adopting cooperative and voluntary initiatives with government and other stakeholders (Responsible Care, 2006).	Participants commit to continuously improving the environmental, health, and safety knowledge and performance of technologies, processes, and products over their life cycles so as to avoid harm to people and the environment. No clear targets are stated (Responsible Care, 2006).
The Clean Revolution	The Climate Group 2012 Global All sectors	The Clean Revolution is a partnership of international states and governments, business leaders and corporations, thinkers and opinion formers. It calls for a massive scale-up of clean energy and infrastructure and of smart technologies and design (The Climate Group, 2012).	No clear commitment stated.
Ultra-Low CO_2 Steelmaking (ULCOS)	ArcelorMittal 2004 Europe Steel Industry	ULCOS is a consortium of 48 European companies and organisations from 15 European countries that have launched a cooperative research & development initiative to enable strong reduction in CO_2 emissions from steel production (ULCOS, n.d.).	The aim of the ULCOS programme is to reduce the CO_2 emissions of today's best steel production routes by at least 50%. It is not stated when this target is to be reached (ULCOS, n.d.).
World Business Council for Sustainable Development (WBCSD)	- 1992 Global All Sectors	The WBCSD is a CEO-led organisation of forward-thinking companies that galvanizes the global business community to create a sustainable future for business, society, and the environment. Together with its members, the council applies its respected thought leadership and effective advocacy to generate constructive solutions and take shared action (WBCSD, n.d.).	No clear commitment stated.
WWF Climate Savers	WWF 1999 Global All sectors	WWF Climate Savers is a global leadership platform which positions multinational corporations at the forefront of the low-carbon economy. The programme acts as a sounding board, providing guidance for companies seeking to substantially reduce their carbon footprints. The member companies work with other companies, suppliers, and partners to implement innovative solutions for a low carbon economy (WWF, n.d. a).	Each participant sets a reduction target in absolute terms and within a defined timeframe. Targets and progress are reviewed on a regular basis and publicly communicated (WWF, n.d. a).

These initiatives vary strongly in scope and level of commitment. Some initiatives are open to all types of companies, whereas others (e.g. the Cement Sustainability Initiative (CSI)) focus on a specific sector. Most of the initiatives have a global scope, but some have members only from a specific part of the world (e.g. the European Ultra-Low CO_2 Steelmaking (ULCOS) initiative). The size of the initiatives also varies strongly; the smallest having only 10 participants, whereas the largest has 341 participants (see Table 2). But the most important difference between the initiatives is the difference in the level of commitment. About one third of the initiatives do not require any clear commitments for greenhouse gas emission reductions from their member companies. Most of the initiatives require their participants to adopt emission reduction targets and to report on these targets and their progress, however generally there is no minimum level of commitment required. Only the most ambitious initiative, the Swedish Haga Initiative, requires its members to set a reduction target of at least 40% by 2020 (Haga Initiative, 2011).

3.3 METHODS

Data on the greenhouse gas emissions in 2008 from the 2000 largest[9] companies have been collected from a database (de Jong, 2011). 218 of the 1000 largest greenhouse gas emitting companies in this database participate in one or multiple initiatives. The data from this database are used as a basis for calculating the business-as-usual emissions in 2020 for the participating companies. Since it is too time-consuming to determine the business-as-usual emissions for each company separately based on company-specific data, an aggregated approach is used. Neither global projections for the growth of the different industrial sectors nor global historical production data are available. Therefore, it is not possible to differentiate between the industrial sectors when calculating the business-as-usual emissions. The only exception is the energy producing sector, for which emission projections from the WEO 2012 Current Policies Scenario (IEA, 2012a) are used. Since there are strong differences in the projections for different regions in the world (e.g. a strong rise in emissions in Africa and non-OECD Asia, compared to a decline in emissions in Europe and the United States), for each company the projections for the region in which the company is operating are used. In case a company operates in multiple regions, the mean of these regions is used. Unfortunately, the emissions of the industrial sector are not reported separately in the WEO 2012. For all other sectors the business-as-usual emissions in 2020 are therefore estimated based on the industry energy use projections[10] in the WEO 2012 Current Policies Scenario (IEA, 2012a). An annual emission growth rate of 2.6% is thus assumed for all sectors except the energy producing sector. Since differences in emission growth rates between companies are more likely to be determined by sector than by geographical region, the global growth rate is applied to all companies. Due to the large number of companies, differences in sectorial growth rates are expected to cancel out when calculating the total business-as-usual emissions of all companies combined.

Since the initiatives have generally not stated an overall emission reduction commitment, the level of commitment differs for every participating company. It is beyond the scope of this study to research the level of commitment for each of the 218 participating companies individually. Therefore, a random sample[11] of 25 companies is chosen to be used as an indication for the commitment level of the participating companies. For these 25 companies the targets stated by the company are used to calculate the expected emission reduction compared to the 2020 business-as-usual emissions. As the targets of the different companies are stated in many different ways, using different time frames and baseline years, some assumptions have to be made to be able to calculate the expected impact in 2020. In case the commitment period of a company ends before 2020, it is assumed that the commitment stays at the same level after the end of the current commitment period (e.g. in case of a commitment of 2% emission reduction per year until 2017, the commitment is assumed to be also 2% reduction per year for the period 2017-2020). In case a target is stated for the emission-intensity instead of an absolute emission reduction target, it is assumed that a 1% autonomous efficiency improvement is already included in the business-as-usual scenario. When a

[9] In terms of turnover.
[10] The mix of energy sources in the industrial sector does not change significantly in the WEO 2012 Current Policies Scenario. Therefore, it is assumed that the emission growth rate is approximately equal to the growth in energy use.
[11] A random number generator was used to select the companies in the sample.

target is stated only for carbon dioxide emissions instead of all greenhouse gases, the same level of commitment is assumed for the other greenhouse gases. In case there is no quantifiable target stated, no emission reduction commitment compared to business-as-usual emissions in 2020 is assumed. In specific cases some other company-specific assumptions have to be made to be able to quantify the commitment in 2020.

The weighted average of the expected emission reductions from the random sample of 25 companies is assumed to be the average commitment for all 218 participating companies. Based on the calculated business-as-usual emissions for all companies and the expected average emission reductions, the expected impact on emission reductions of the ten initiatives is calculated. The uncertainty range of the result is determined by changing the underlying assumptions and analysing what the impact of these changes is on the result.

There might be an overlap between the scope 1[12] emissions of the energy producing companies and the scope 2 emissions of the other companies, since the energy producing companies deliver energy to other companies. This overlap is assumed to have negligible impact on the total emission reductions, since only part of the world largest companies participate in the initiatives. The participating energy producing companies deliver also to parties that are not a member of one of the initiatives and the participating companies will also receive part of their energy from non-participating energy producing companies.

3.4 RESULTS

The emissions of the top 1000 largest greenhouse gas emitting companies were 10.2 Gt CO_2e in 2008 (de Jong, 2011). 218 of these companies participate in one or more initiatives. 2008 emissions of these companies equalled 4.0 Gt CO_2e or 39% of the total top 1000 emissions. Based on the WEO 2012 Current Policies Scenario (IEA, 2012a), the business-as-usual emissions of these 218 companies are expected to increase to 5.0 Gt CO_2e in 2020, a 25% growth in emissions.

The commitments of 25 randomly chosen companies are used as an indication of the average commitment of the companies. For each of these 25 companies the expected emission reduction compared to business-as-usual emissions is calculated (see Appendix II). The commitments of these companies vary strongly, from no quantified target at all to a target of achieving net zero carbon dioxide emissions in 2020 (including some carbon offsetting[13]). In Figure 2 the expected emission reductions of the 25 companies are shown in relation to their 2008 emissions.

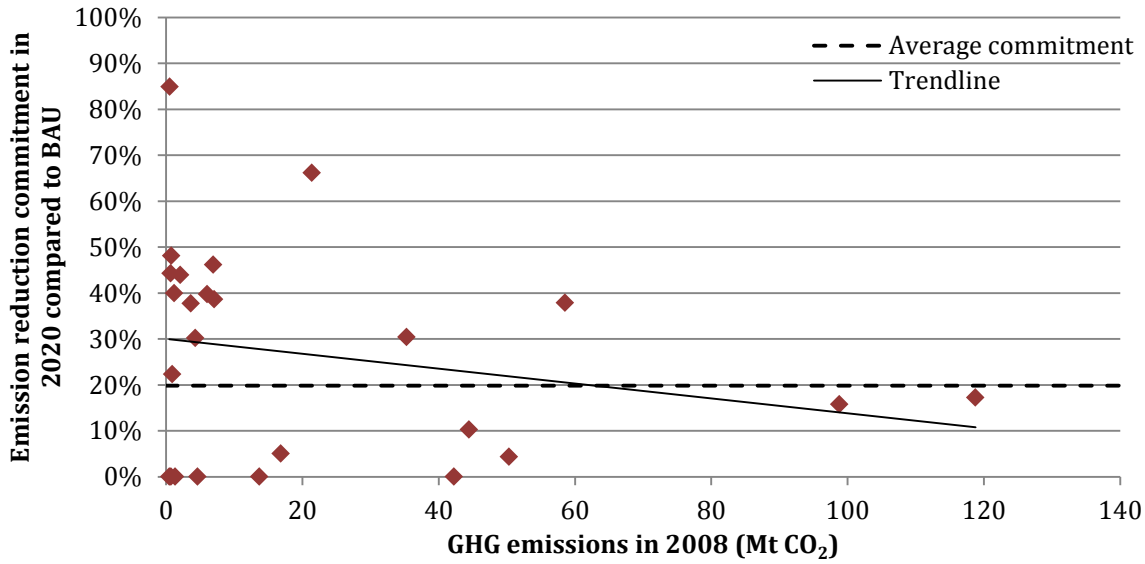

FIGURE 2 EMISSION REDUCTION COMMITMENT OF RANDOM SAMPLE OF 25 COMPANIES

[12] Scope 1 emissions are direct emissions, whereas scope 2 emissions are emissions from the generation of purchased electricity (WBCSD & WRI, 2004).

[13] Carbon offsetting is not included in the commitments calculated, since voluntary offsetting by companies is another wedge in the 'wedging the gap' approach (described in Chapter 4).

Although there is no strong correlation ($R^2 = 0.05$) between the expected emission reduction and the amount of emissions, it can be seen that the largest emitters tend to have lower commitment. Due to the weak correlation, the trend line shown cannot be used to adequately predict the commitments of the other participating companies. However, the trend that larger emitters have lower commitment is accounted for by using the weighted average of the commitments.

The weighted average of the commitments of these 25 companies is a reduction of 20% compared to business-as-usual emissions in 2020. Applying this average reduction to all 218 participating companies results in an estimated reduction commitment of 0.99 Gt CO_2e in 2020. To determine the uncertainty in this result it is analysed what the effect of changing the assumptions used for the calculations is on the end result. It has been analysed what the effect is of varying the following parameters; the assumed autonomous efficiency improvement (range: 0–2% per year), the emissions growth within the business-as-usual scenario (range: 2–3% per year; and similar for energy sector), and the average emission reductions commitment of the companies (range: 18–22% emission reduction compared to BAU[14]). It is also analysed what the effect is of assuming no new commitments after the current commitment period[15]. Based on this analysis it is concluded that the uncertainty in the result is ± 0.2 Gt CO_2e. The estimated emission reduction of top 1000 companies is thus 0.99 ± 0.2 Gt CO_2e below business-as-usual based on current commitments (see Figure 3).

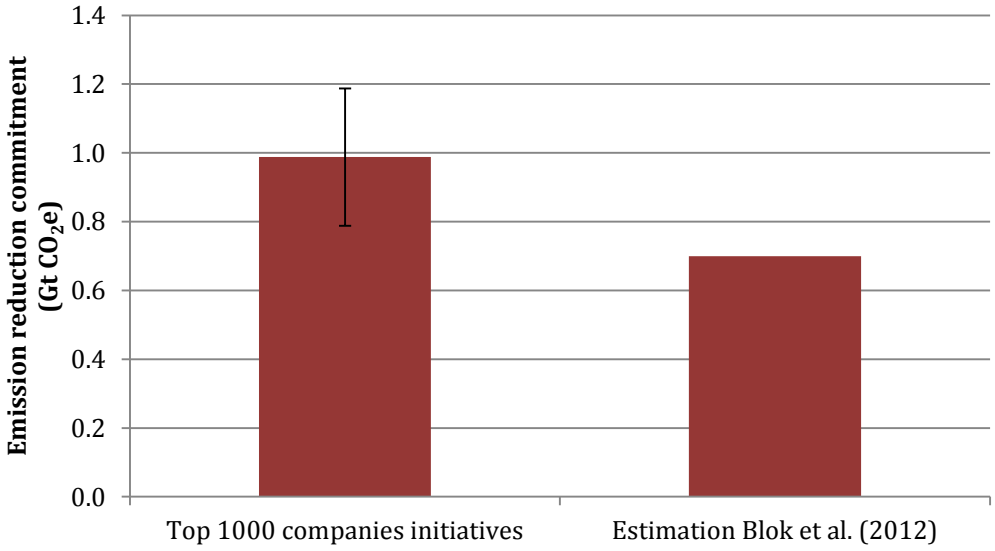

FIGURE 3 EMISSION REDUCTION IN 2020 BASED ON COMMITMENT OF TOP 1000 COMPANIES

This outcome exceeds the expected impact of up to 0.7 Gt CO_2e by Blok et al. (2012). Blok et al. (2012) assumed that 30% of the top 1000 largest greenhouse gas emitting companies would participate. It turned out that 22% of the companies are currently a member of a greenhouse gas reduction initiative, but these companies account for about 39% of the total top 1000 emissions. The current average commitment of the companies turns out to be more ambitious than the 10% reduction below business-as-usual as assumed by Blok et al. (2012).

[14] The weighted standard deviation of the average emission reduction commitment is 1%. This range is thus the 95% confidence interval.

[15] In this case the emission reduction commitment in 2020 is 0.94 Gt CO_2e.

4. WEDGES 2 & 3: VOLUNTARY OFFSETTING

A carbon offset can be used to compensate for greenhouse gas emissions by avoiding the release of an equivalent amount of greenhouse gases elsewhere or by absorbing emissions that would otherwise have remained in the atmosphere (Kolmuss et al., 2008) (Taiyab, 2006). Carbon offsets can be created through various types of projects, such as renewable energy and energy efficiency projects, reforestation and afforestation projects, and destruction of industrial gases (Taiyab, 2006). Offsetting of emissions is possible because greenhouse gases dissipate globally and the contribution to climate protection is the same no matter where in the world emissions are reduced (Kolmuss et al., 2008). By making it possible to reduce emissions where costs are the lowest, carbon offsets projects can reduce the overall costs of achieving a certain emission reduction target (Kollmus et al., 2010).

The global carbon market consists of a compliance market and a voluntary market. Compliance markets are created and regulated by mandatory carbon reduction regimes, such as the Kyoto Protocol and the European Union Emission Trading Scheme, whereas voluntary carbon markets (VCMs) allow companies, individuals, and other actors to buy carbon offsets on a voluntary basis. In the VCMs two types of carbon offsets are available; Certified Emission Reductions (CERs) originating from the compliance market and Verified Emission Reductions (VERs) created in the voluntary market (Kolmuss et al., 2008). The volume of the VCMs accounted for less than 1% of the total carbon market in 2011. The VCM is a highly fragmented market consisting of hundreds of offset suppliers. The market for voluntary carbon offsets is driven by purely voluntary as well as pre-compliance buyers. Pre-compliance buyers purchase VERs at a relatively low price either to use them for future compliance or to sell them with a profit under a future mandatory cap-and-trade system. Between 2004 and 2010 a significant part of the carbon offsets traded on the VCMs were conducted on the Chicago Climate Exchange (CCX) (Peters-Stanley & Hamilton, 2012). The CCX was a voluntary cap-and-trade system that ended in 2010. CCX members made legally-binding commitments to reduce greenhouse gas emissions. The VERs achieved by the members exceeded the commitments in each year of the program (CCX, 2011).

VERs have the advantage of having lower transaction cost than offsets generated in the mandatory market, but there have been concerns about the lack of quality control (Kollmus et al., 2010). A main point of concern is the issue of additionality; carbon offsets should come from projects that would not have been implemented under business-as-usual conditions. Research has pointed out that a significant amount of offsets have come from non-additional projects (Kollmus et al., 2010). Another point of concern is that the accounting methods for offsets might be too inaccurate to justify claims of emission compensation. These concerns have led to the development of over a dozen voluntary carbon standards (e.g. Gold Standard). These standards differ slightly in focus and none of them has so far managed to become the industry standard (Kolmuss et al., 2008). Fully fledged carbon offset standards have three components; (1) accounting and quantification procedures, (2) monitoring, verification and certification procedures and (3) registration and enforcement systems (Kollmus et al., 2010).

A growing number of companies claim to be 'climate neutral' by voluntarily offsetting their emissions and more and more individuals offset their travel emissions (Kolmuss et al., 2008). In 2011 the volume of transactions in the VCMs was 95 Mt CO_2e for immediate or future delivery. Almost all (98%) of these carbon offsets adhered to a third-party standard and 43% were on a registry. 92% of these offsets were bought by corporate buyers, whereas only 1% was bought by individuals. 81% of the offsets were sold to voluntary buyers and 13% to pre-compliance buyers[16]. The total trade volume is not equal to the emission reduction achieved by carbon offsetting. Carbon offsets do not compensate for emissions until they are voluntarily retired (i.e. they cannot re-enter the marketplace). In 2011 only 13 Mt CO_2e of the total trade volume of voluntary carbon offsets were reported to be retired, while half of the offsets were sold to end-users for the purpose of retirement (Peters-Stanley & Hamilton, 2012).

According to Blok et al. (2012) a coalition between an organisation with convening power and offset providers could lead to an emission reduction of up to 2.0 G CO_2e in 2020 by motivating 20% of the companies in the light industry and commercial sector to offset their remaining

[16] The motivations of the remaining 6% are unknown.

emissions after taking emission reduction measures. Similarly, environmental NGOs could encourage 10% of the 20% richest individuals to offset their personal emissions from electricity, heating, and transport, which could have an impact of saving up to 1.6 Gt CO_2e in 2020 (Blok et al., 2012). Unfortunately, no such large scale bottom-up initiatives motivating companies and individuals to offset their emissions exist at the moment.

While individual actors commit to offsetting their emissions, with the ending of the CCX there is no voluntary offsetting initiative that requires a commitment from its members. Therefore, it is not possible to assess the impact in 2020 of the current commitments to carbon offsetting, as it is impossible to identify all actors that have made an individual commitment. Figure 4 shows the development of the transaction volumes in VCMs from 2002 until 2012 based on data from Hamilton et al. (2007) and Peters-Stanley & Hamilton (2012). Until 2007 the VCMs experienced rapid growth, but due to the economic recession this growth has stagnated in recent years. It is difficult to predict how these markets will develop over the coming years.

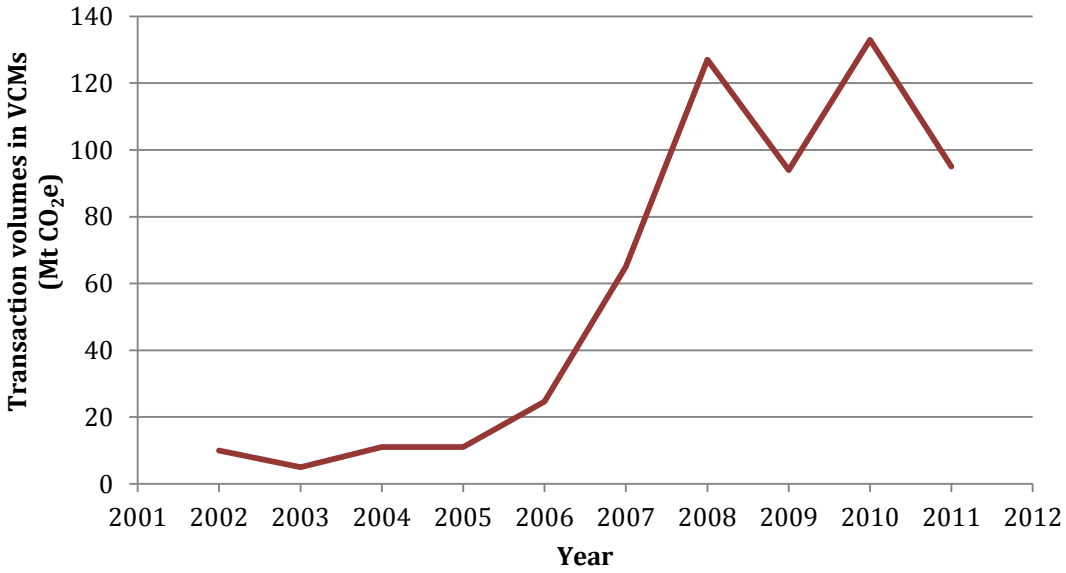

FIGURE 4 TRANSACTION VOLUMES IN VOLUNTARY CARBON MARKETS (BASED ON HAMILTON ET AL. (2007) AND PETERS-STANLEY & HAMILTON (2012))

Suppliers of carbon offsets have predicted in 2011 that the volume of transactions will grow to 0.6 Gt CO_2e in 2020, an estimate that is much more conservative than their 2010 projections of reaching a volume of 1.6 Gt CO_2e in 2020. However, it is currently unlikely that this predicted value of 0.6 Gt CO_2e will be reached in 2020, as the cumulative trade volume predicted in the period 2012-2016 (1.5 Gt CO_2e) is four times the volume reported by suppliers to be in their project pipelines (Peters-Stanley & Hamilton, 2012). In order to reach the emission reduction of up to 3.6 Gt CO_2e estimated by Blok et al. (2012) a 28-fold increase of the VCMs is needed, with all carbon offsets traded being voluntarily retired. Based on the current state of the VCMs this is highly unlikely. The emission reductions from voluntary offsetting in 2020 are more likely to be well below 0.6 Gt CO_2e. But since there are no voluntary-offsetting initiatives which meet the criteria for inclusion in 'wedging the gap' at the moment, there is no emission reduction impact expected based on current commitments for the two voluntary-offsetting wedges.

5. WEDGE 4: MAJOR CITIES INITIATIVE

5.1 INTRODUCTION

Urban areas cover less than 3% of the world's liveable land area, but were home to 52% of the world's population in 2011 and this is projected to increase to 67% in 2050 (UN, 2012) (Krause, 2011a).Urban areas are therefore the source of a substantial part of global greenhouse gas emissions and can be central to reducing these emissions. Estimates of the emissions from urban areas vary from 30% to 80% depending on the definition of urban areas as well as the allocation method used (Satterthwaite, 2010) (Krause, 2011a). At the same time, cities are particularly vulnerable to the adverse effects of climate change, such as sea level rise, extreme heat, hurricanes, and more frequent and intense floods and droughts. This is because the majority of cities are located in coastal areas or on river banks and the high density and concentration of people in cities (Krause, 2011a) (Krause, 2011b) (Rosenzweig et al., 2010).

Research has shown that cities experiencing a greater risk of adverse effects from climate change are more likely to increase climate protection efforts, even though reducing greenhouse gas emissions in one particular area will have virtually no effect on the threat of global climate change (Krause, 2011a). Due to this free rider effect, where all benefit from the actions of others, it would make little economic sense for municipal governments to spend resources on mitigating climate change (Betsill, 2001) (Kousky & Schneider, 2003). However, in the majority of cities, policies aimed at reducing greenhouse gas emissions are not primarily driven by climate protection, but justified by cost savings and other co-benefits (Kousky & Schneider, 2003). For example, replacing traffic lights with LEDs yields cost savings because of the lower energy use and maintenance costs compared to conventional traffic lights (Kousky & Schneider, 2003). One of the most important co-benefits is improving public health; reducing greenhouse gas emissions yields local public health benefits by reducing the effects of local air pollution, while on a global scale it decreases the possible health risks of climate change such as morbidity and mortality induced by heat, extreme weather events, food and water shortages, and waterborne infections (Younger et al., 2008) (Cifuentes et al., 2001). Policies aimed at improving mass transit and walking and cycling facilities have multiple co-benefits, including improved air quality, decreased congestion, reduction of accident related injuries, and improved public health due to increased physical activity (Betsill, 2001) (Younger et al., 2008)

Municipal governments have often considerable authority over land-use and transport planning, the operation of public buildings and vehicle fleets and waste disposal, and they are the level of government closest to the citizen. Therefore, they can play an important role in greenhouse gas emission mitigation (Betsill, 2001) (Krause, 2011b). Although there has been a lot of scientific research aimed at the motivations for cities to take action to reduce greenhouse gas emissions, there has been very little research on the actual and potential impact of local greenhouse gas emission reduction actions (Krause, 2011a). According to Blok et al. (2012) groups such as C40 or ICLEI could lead the C40 cities or an equivalent sample to reduce their emissions 20% below business-as-usual in 2020, which has a reduction potential of up to 0.7 Gt CO_2e.

5.2 DESCRIPTION OF INITIATIVES

In Table 4 ten initiatives for cities aiming to reduce their greenhouse gas emissions are described. Thousands of cities and municipalities participate in these initiatives worldwide.

TABLE 4 OVERVIEW OF CITIES INITIATIVES FOR GHG EMISSION MITIGATION

Name	Led by Starting year Region Number of participants	Description of the initiative (as described by the organisation)	Commitment
C40 Cities Climate Leadership Group (C40)	- 2005 Global 61	C40 is a global network of large cities taking action to reduce GHG emissions. The C40 Group provides its members with direct support, peer-to-peer exchange, and research and communication. The Clinton Climate Initiative (CCI) is the implementing partner of the C40 Group. The CCI works with participating cities on large-scale projects for reducing GHG emissions and improving energy efficiency (Román, 2010) (C40 Cities, 2011a).	Many participating cities have set GHG emission reduction targets (ARUP, 2011).
carbon*n* Cities Climate Registry (cCCR)	Carbonn/ ICLEI 2010 Global 232	Cities can report on their GHG emissions and reduction targets through cCCR and cCCR is now the world's largest global database of local climate action. cCCR has been developed under the auspices of the WMCCC and with support of among others ICLEI. Cities reporting to the cCCR include ICLEI member cities, Mexico City Pact signatories and WWF Earth Hour City Challenge candidates (Arikan & Yanchevskaya, 2012).	-
Climate Alliance	- 1990 Europe >1600	The Climate Alliance of European Cities with Indigenous Rainforest People is a European network of local authorities committed to the protection of the world's climate. The member cities and municipalities aim to reduce GHG emissions; therefore local climate strategies are developed and implemented. There are also measures taken to raise the public's awareness for the protection of the rainforest and to refrain from the use of tropical timber derived from destructive logging. Climate Alliance is related to the Covenant of Mayors. Climate Alliance runs the Covenant of Mayors Office and acts as a Covenant Supporter for Climate Alliance Members (Climate Alliance, 2013).	Member cities and municipalities are committed to reducing CO_2 emissions by 10% every five years, to halving per capita emissions by 2030 at the latest (from a 1990 baseline), to preserving the tropical rainforests by avoiding the use of tropical timber and to supporting projects and initiatives of the indigenous partners (Climate Alliance, 2013).

TABLE 4 OVERVIEW OF CITIES INITIATIVES FOR GHG EMISSION MITIGATION (CONTINUED)

Name	Led by Starting year Region Number of participants	Description of the initiative (as described by the organisation)	Commitment
Covenant of Mayors	- 2008 Europe 4748	The Covenant of Mayors is the mainstream European movement uniting local and regional authorities, voluntarily committing to increasing energy efficiency and use of renewable energy sources in order to improve the quality of life of their citizens (Covenant of Mayors, 2011).	Covenant signatories are committed to meeting and exceeding the European Union CO_2 reduction target of 20% by 2020 (from a 1990 baseline). Signatories also commit to submitting a Sustainable Energy Action Plan (SEAP) (Covenant of Mayors, 2011).
Earth Hour City Challenge (EHCC)	WWF 2011 Pilot Countries: US, Canada, India, Norway, Sweden, Italy 66	The EHCC is a competition amongst cities to adapt to the adverse effects of climate change and to take steps to transition towards a 100% renewable energy future. The EHCC aims to showcase diverse solutions and challenges for cities in different parts of the world and to identify options for collaboration between these cities (WWF, 2012).	A City Commitment is not required, but ideally commitments include: an absolute or BAU target for reducing CO_2 emissions, an absolute or BAU target for reducing CO_2 equivalent emissions, a reduction target of the carbon intensity per unit output, an improvement target for energy efficiency, and a target value of energy sourced from renewables (WWF, 2012).
ICLEI - Local Governments for Sustainability	- 1990 Global >1000	ICLEI - Local Governments for Sustainability is an association of cities and local governments promoting local action for sustainable development. Through the GreenClimateCities Initiative, replacing the Cities for Climate Protection programme, cities can receive guidance and technical support for setting up their GHG emissions inventory, identifying opportunities for emission reductions, developing a climate action plan and measuring, and reporting their progress to the cCCR (ICLEI, 2012) (ICLEI, n.d.).	No clear commitment stated, but participating cities adopt voluntary emission reduction targets.

TABLE 4 OVERVIEW OF CITIES INITIATIVES FOR GHG EMISSION MITIGATION (CONTINUED)

Name	Led by Starting year Region Number of participants	Description of the initiative (as described by the organisation)	Commitment
Mexico City Pact	- 2010 Global 268	The Global Cities Covenant on Climate "the Mexico City Pact" was launched on the World Mayors Summit on Climate in 2010. The Mexico City Pact establishes a set of voluntary commitments to promote strategies and actions aimed at mitigation of GHG emissions as well as adaptation to the impacts of climate change. The Mexico City Pact was the result of an alliance between among others WMCCC and ICLEI (Díaz, 2012).	By signing the Mexico City Pact, cities commit to 10 action points; including reducing their local GHG emissions voluntary, adopting mitigation measures to achieve their targets, and reporting their emissions and targets through the cCCR (Díaz, 2012).
The Clean Revolution	The Climate Group 2012 Global 16	The Clean Revolution is a partnership of international states and governments, business leaders and corporations, thinkers and opinion formers. It calls for a massive scale-up of clean energy and infrastructure and of smart technologies and design (The Climate Group, 2012).	No clear commitment stated.
U.S. Conference of Mayors' Climate Protection Agreement (MCPA)	- 2007 US >150	The MCPA is an agreement between US mayors that strive to meet or exceed the Kyoto Protocol target in their communities (MCPA, 2008).	Cities commit to meeting or exceeding the GHG emission reduction target suggested for the United States in the Kyoto Protocol; 7% reduction from 1990 levels by 2012 (MCPA, 2008).
World Mayors Council on Climate Change (WMCCC)	- 2005 Global 80	WMCCC is an alliance of committed local government leaders concerned about climate change. The aim is to strengthen political leadership on global sustainability and to be the prime political advocacy force of cities and local governments on global sustainability matters. The WMCCC receives technical and strategic support from ICLEI (WMCCC, 2010).	No clear commitment stated, but part of the WMCCC members have signed the Mexico City Pact.

These initiatives take various forms. The majority are networks of cities aiming to collaborate and share knowledge on greenhouse gas emission reductions, whereas the Mexico City Pact and the Mayors' Climate Protection Agreement (MPCA) are agreements between signatories committing to a certain greenhouse gas emission reduction. The WWF Earth Hour City Challenge (EHCC) takes the form of a competition between participating cities. The carbon*n* Cities Climate Registry (cCCR) is a global database to which cities can report their greenhouse gas emissions and reduction targets. Many of these initiatives are linked to each other and many cities participate in multiple initiatives. For example Climate Alliance is a Covenant Supporter of the Covenant of Mayors and the Mexico City Pact was the result of an alliance between among others the World Mayors Council on Climate Change (WMCCC) and ICLEI - Local Governments for Sustainability.

Other networks of cities for which greenhouse gas mitigation is not a main aim, such as Cities Alliance and United Cities and Local Government, are not included in this analysis nor are networks aimed at climate change adaptation, such as the Asian Cities Climate Change Resilience Network.

5.3 METHODS

Thousands of cities and municipalities participate in one or more climate change mitigation initiatives. It is impossible to assess the commitment of all these participants individually. Quantification of the commitment has to be done on an aggregated level. The emission reduction potential of only three of the initiatives described in Table 4 is quantified. These initiatives are C40, cCCR and the Covenant of Mayors. The other seven initiatives are either (partly) included in these three initiatives or omitted for various reasons. Participation in climate protection initiatives is sometimes rather an act of symbolic policy than an actual commitment to climate change mitigation, especially when membership requirements are relatively easy and there is a lack of monitoring (Krause, 2011b). Therefore initiatives that lack a clear commitment are omitted from the analysis and for some initiatives only the participants that report on their emissions and targets are included. The Clean Revolution is omitted because members do not make a clear commitment and the MCPA is excluded because there is no post-2012 target stated. 49 Mexico City Pact signatories, 82 ICLEI members, all 66 EHCC Candidates and some WMCCC members report to the cCCR (Arikan & Yanchevskaya, 2012), these reporting members are included in the analysis of the cCCR members. Only the reporting members of these initiatives are included in the analysis, since none of these initiatives demand a minimum commitment and cities reporting on their progress are likely to be more serious about their commitment. Climate Alliance is also omitted because Climate Alliance does not report on the progress of its members and is a Covenant Supporter of the Covenant of Mayors and therefore there is considerable overlap between the members of those initiatives.

The majority of the C40 Cities report their emissions to the Carbon Disclosure Project (CDP, 2012). These data are used as the basis for the business-as-usual scenario. Since no business-as-usual emission growth projections are available for cities, the business-as-usual emissions of the C40 Cities in 2020 are estimated based on the overall emissions growth in WEO 2012 Current Policies Scenario (IEA, 2012a). A 1.41% emission increase per year is thus applied. Only the cities that have stated an emission reduction target are taken into account in the analysis. Targets are stated as an absolute reduction compared to some baseline year. Since these baseline years differ per city and the emissions in the baseline year are not reported, the exact target for each specific city cannot be determined. Therefore, all emission reduction commitments are converted to a 10-year reduction target (assuming the same percentage emission reduction in each 10-year period), and the weighted average of these commitments is applied to the emissions of all cities with a target. Cities that have not reported a target are not included in the analysis, since these cities have not made a commitment.

The emissions of the cCCR reporting cities are reported in the *November 2012 update* (Arikan & Yanchevskaya, 2012) of the cCCR *2011 Annual Report* (Arikan, 2011).). To avoid overlap, the emissions of the C40 Cities also reporting to the cCCR are subtracted from the total emissions reported by cCCR. The business-as-usual in 2020 emissions of the cCCR reporting members are again based on the overall emissions growth in WEO 2012 Current Policies Scenario (IEA, 2012a). The average commitment of the reporting members is estimated based on the commitments reported in the cCCR *2011 Annual Report* (Arikan, 2011).

The analysis of the Covenant of Mayors is based on an assessment by the Joint Research Centre (JRC) (Cerutti et al., 2013). Since the baseline used by Cerutti et al. (2013) to determine the emission reduction in 2020 differs from the business-as-usual scenario used in this analysis, the results are adjusted based on an estimation of the business-as-usual emissions in 2020. For the analysis of the Covenant of Mayors the C40 and cCCR participants are again excluded to prevent double counting. Since emissions are not reported for each individual participant of the cCCR and Covenant of Mayors, the overlap is estimated based on the population of the participating cities.

There are different possible methodologies for determining the emissions of cities. The choice for a production or consumption-based methodology has a large influence on the result. Production-based methodologies allocate only the emissions coming from sources physically located within the city boundary to the city, whereas consumption-based methodologies allocate emissions to the city if they are a by-product of some good consumed in the city regardless of where they were physically emitted (Dodman, 2009) (Krause, 2011a). Unfortunately, in most cases it is not documented which specific methodology is used when reporting on cities emissions. However, since targets are stated in relation to reported emissions, this will most likely not be a problem when calculating the emission reduction potential.

5.4 RESULTS

In 2012, 45 C40 cities reported their emissions to the CDP and the emissions totalled 0.74 Gt CO_2e[17] (CDP, 2012). 34 of the C40 cities reported a greenhouse gas emission reduction target (C40 Cities, 2011b). The emissions reported by these 34 cities totalled 0.67 Gt CO_2e[18]. Under business-as-usual conditions these emissions are expected to grow by 18% to 0.80 Gt CO_2e in 2020 based on the overall emission growth in the WEO 2012 Current Policies Scenario (IEA, 2012a). Since cities use many different base and targets years, all commitments are converted to a 10-year reduction target. These reduction targets are shown in Figure 5.

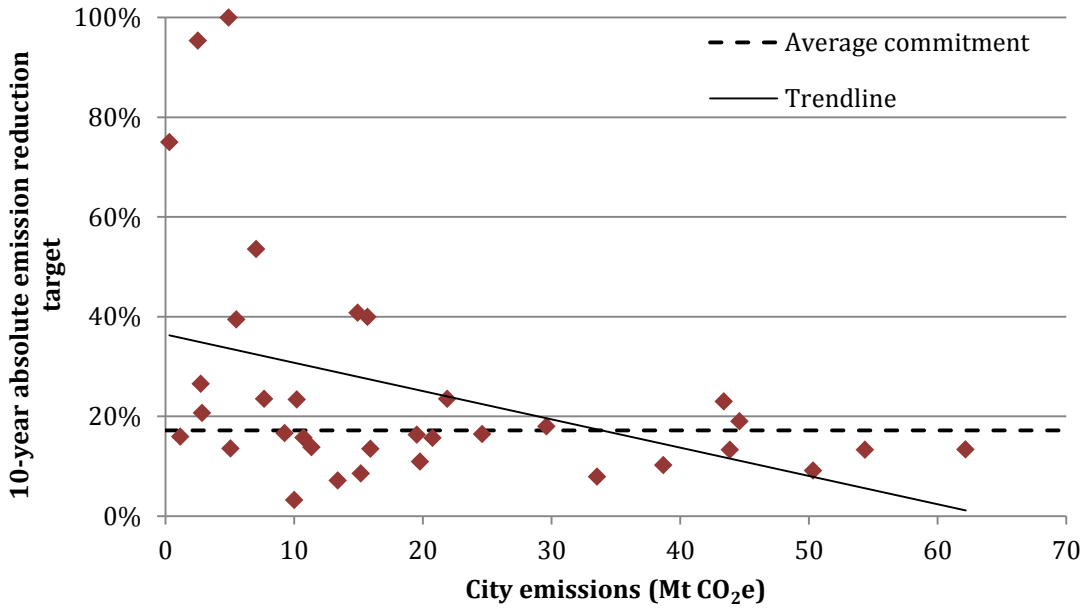

FIGURE 5 EMISSION REDUCTION COMMITMENT OF C40 CITIES

[17] Other values are also reported for the total C40 Cities emissions. C40 reports 1.7 Gt CO_2e (C40 Cities, 2012), while ARUP reports 2.9 Gt CO_2e (ARUP, 2011). However it is not documented how these values where determined. Since CDP reports emissions per participating city and these values are in accordance with the information on the C40 website, the values reported by the CDP are considered to be the most reliable.

[18] The cities did not report their emissions for the same year. For 25 of the cities the reporting year was given (C40 Cities, 2011b). These reporting years vary from 2003 to 2011. The average reporting year was 2008, the 0.67 is therefore assumed to be the 2008 value.

Commitment periods are in most cases long. Only five cities have a target year before 2020, while 12 cities have a target year between 2030 and 2050. The two values close to a 100% in Figure 5 are Melbourne and Copenhagen, which aim to be carbon neutral in, respectively, 2020 and 2025. The tendency for larger emitters to have lower reduction targets which is seen in companies can also be seen here, although the correlation is again weak ($R^2 = 0.17$). Therefore the weighted average of the commitments is taken. The weighted average commitment of the cities reporting an emission target is an absolute reduction of 17% per 10-year period (i.e. over 30% below business-as-usual emissions in 2020). If the 34 cities reporting a reduction target meet their commitment the impact in 2020 will be an emission saving of 0.26 Gt CO_2e. The uncertainty range of this result is 0.20–0.34 Gt CO_2e, based on varying the assumptions for the emission growth (range: 10–30%) and weighted average commitment (range: 16–18% per 10-year period[19]).

The 232 cities reporting to cCCR emit in total 1.5 Gt CO_2e[20] (Arikan & Yanchevskaya, 2012). Subtracting the emissions from the nine C40 cities with a target also reporting to cCCR leaves a total of 1.3 Gt CO_2e. These emissions are estimated to increase by 18% to 1.6 Gt CO_2e based on the overall emission growth in the WEO 2012 Current Policies Scenario (IEA, 2012a). The majority of the commitments reported to cCCR lie between 0.5 and 3.0% absolute reduction per year (Arikan, 2011). An average commitment of 1.5% reduction per year is assumed, taking 1.0 and 2.0% as the lower and upper values of the range. Based on these assumptions, the expected emission reduction by cCCR reporting cities, excluding C40 cities, in 2020 is 0.46 Gt CO_2e. The uncertainty range of this result is 0.28 –0.68 Gt CO_2e, based on varying the assumptions for the emission growth (range: 10–30%) and the average commitment.

The JRC analysed the Sustainable Energy Action Plans (SEAPs) of the Covenant of Mayors signatories (Cerutti et al., 2013). SEAPs are documents in which the Covenant signatories outline how they intend to reach their emission reduction target by 2020 (Covenant of Mayors, n.d.). According to Cerutti et al. (2013), the 1100 cities for with an accepted SEAP by March 2013 will reduce their emissions by 97 ± 2 Mt CO_2e by 2020 compared to their baseline emission inventories of 0.35 Gt CO_2e. This analysis is however not in line with the approach taken in this research, as the emission reduction is quantified in relation to historical emissions. The base year used for the baseline emission inventories varies among the SEAPs, with the majority of signatories using 2005 or 2007 (Cerutti et al., 2013). Due to the different base years, it is difficult to determine the business-as-usual emissions. The 2020 business-as-usual emissions are assumed to be 25% higher than the baseline emission inventories (range: 15–35%). The cities with an accepted SEAP that are also a C40 of cCCR member have a population of 10.9 million, which is 24% of the total population of 45.3 million covered by accepted SEAPs. Therefore the overlap between the C40, cCCR and the Covenant of Mayors is assumed to be 24% of the Covenant of Mayors commitment (range: 20–30%). Based on these assumptions, the expected emission reduction by Covenant of Mayors signatories with an accepted SEAP, excluding overlap with C40 cities and cCCR members, in 2020 is 0.14 Gt CO_2e, with an uncertainty range of 0.10 –0.18 Gt CO_2e.

In Figure 6 on the next page the results are summarized. The emission reduction commitments for all three initiatives are shown including their uncertainty range and the overlap between the initiatives. In total the emission reduction potential in 2020 is estimated to be 0.86 Gt CO_2e (range: 0.67–1.10 Gt CO_2e[21]). This estimate is somewhat higher than the 0.7 Gt CO_2e estimated by Blok et al. (2012). This is partly because Blok et al. (2012) only considered the C40 cities and in this analysis more initiatives are included. The main reason for the difference is that Blok et al. (2012) assumed more than 3-fold higher emissions for the C40 emissions, as reported by ARUP (2011). This higher estimation of the emissions leads to a higher estimation of the emission reduction commitment. However, since ARUP does not report how this higher value was obtained, the values reported by CDP are considered to be more reliable and are used in this analysis.

[19] Range chosen based on weighted standard deviation of 0.4%.

[20] Based on the latest available GHG inventories. 2008 is assumed to be the average reporting year based on (Arikan & Yanchevskaya, 2012) and (Arikan, 2011).

[21] Error propagation rules are used when combining the uncertainty ranges of the commitments of different initiatives.

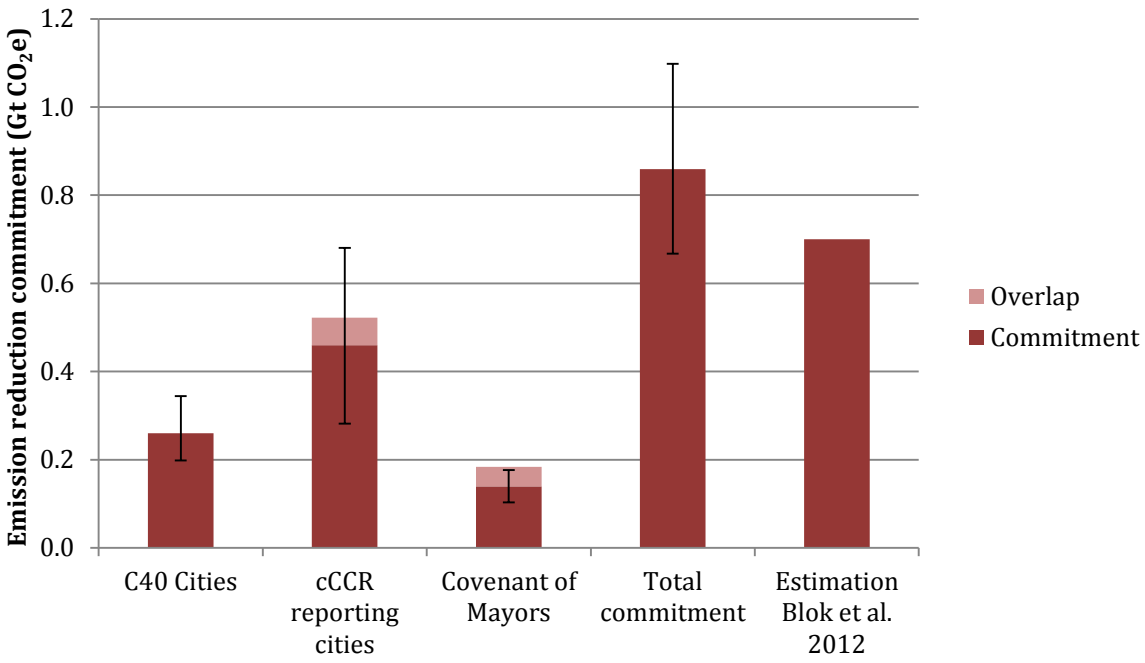

FIGURE 6 EMISSION REDUCTION IN 2020 BASED ON COMMITMENT OF CITIES INITIATIVES

6. WEDGE 5: CARS AND TRUCKS

6.1 INTRODUCTION

More than half of the worldwide oil use is for transport and three-quarters of the transport sector energy use is used by road transport. Without strong policies road transport fuel use is expected to double between 2010 and 2050 and improving the efficiency of road transport vehicles is one of the most cost-effective ways of reducing the growth in oil demand (IEA, 2012b). Vehicle technology has shown an efficiency improvement of around 1% per year over the last decades, however most of this improvement has been compensated by power and weight increases instead of improving fuel economy (FIA Foundation, 2009). Trends in new-vehicle fuel economy have varied from region to region, from minor improvement to worsening (Façanha et al., 2012). Many technologies for improving the fuel economy of vehicles are already commercial available, such as engine, transmission and drivetrain improvement, the use of lightweight materials and better aerodynamics and rolling resistance. Most of these technologies are cost-effective as the increase in vehicle purchase price will be compensated by fuel use savings (IEA, 2012b) (FIA Foundation, 2009). It is often argued that consumers and commercial truck operators would demand fuel-efficient vehicles, however, in reality this is often not the case. Market barriers, such as lack of information and uncertainty about future fuel prices, often prevent consumers as well as manufacturers from being willing to spend more on fuel-efficient technologies unless they have a pay-back time of less than two years (Façanha et al., 2012) (IEA, 2012b). Policies to overcome market failures could thus greatly benefit consumers and lead to other benefits such as significant reductions in oil expenditures as well as reductions in urban air pollution (IEA, 2012b) (FIA Foundation, 2009). In absence of these policies, bottom-up initiatives could also be a driver for the development and adoption of more fuel-efficient vehicles.

According to Blok et al. (2012) a coalition of manufacturers and NGOs joined by the UNEP Partnership for Clean Fuels and Vehicles (PCFV) could commit to saving one additional litre of fuel per 100 kilometres globally by 2020 for cars and equivalent reductions for trucks. This could lead to an emission saving of 0.7 Gt CO_2e compared to business-as-usual in 2020.

6.2 DESCRIPTION OF INITIATIVES

14 bottom-up initiatives aiming at greenhouse gas mitigation in the road transport sector have been identified, an overview of which is given in Table 5. The focus of the majority of these initiatives is on the emissions of the road freight industry, whereas very few initiatives aim at reducing the emissions of passenger cars. It is notable that only a very limited number of initiatives include partners from the manufacturing industry. The majority of initiatives do not have a clear and quantified commitment. The two most promising initiatives are the Global Fuel Economy Initiative (GFEI) and the International Road Transport Union's (IRU) "30 by 30" Resolution. GFEI is a partnership between six organisations[22] and aims to improve global average fuel economy of light-duty vehicles (LDVs) by 50% by 2050 by improving the fuel economy of new cars through incremental efficiency improvements and by additional measures such as eco-driving and improved vehicle maintenance (FIA Foundation, 2009). Studies have shown that these fuel economy improvements are indeed feasible (Eads, 2011). IRU represents truck, bus, coach and taxi operators in 74 countries worldwide and its 180 members have committed to reducing emissions by 30% by 2030 through means such as investments in innovative engine and vehicle technology, driver training and innovative logistic concepts (IRU, 2009).

[22] FIA Foundation, International Transport Forum (ITF), United Nations Environment Programme (UNEP), the International Council on Clean Transportation (ICCT) and the Institute of Transportation Studies (ITS).

TABLE 5 OVERVIEW OF TRANSPORT INITIATIVES FOR GHG EMISSION MITIGATION

Name	Led by Starting year Region Number of Participants	Description of initiative (as described by the organisation)	Commitment
"30 by 30" Resolution	IRU 2009 Global >180 members (road transport associations and industries with close ties with road transport)	The IRU "30 by 30" Resolution is a voluntary commitment of the road transport industry to reduce CO_2 emissions by 30% by 2030 through means such as investments in innovative engine and vehicle technology, driver training, and innovative logistic concepts (IRU, 2009).	IRU and its member associations voluntarily commit to reducing CO_2 emissions by 30% by 2030 from a 2007 baseline calculated as transport performance in tonne-kilometres and person-kilometres (IRU, 2009).
21st Century Truck Partnership	US DOE 2000 US 32 partners (industrial partners, federal government and national laboratories)	The 21st Century Truck Partnership is an industry-government partnership between heavy-duty engine, truck, bus and hybrid powertrain manufacturers, and four federal government agencies in the US. Specific technology goals have been defined that will reduce fuel usage and emissions and increase safety. The aim of the partnership is to support research, development and demonstration, which makes it possible to achieve these goals with commercially viable products and systems (US DOE, 2007).	No post-2012 targets stated.
Fleets for Change	CGI 2010 Global 36 companies	Fleets for Change is a Clinton Global Initiative (CGI) "commitment to action". Fleets for Change assists companies to determine baseline fleet emissions and to reduce emissions by increasing fuel efficiency, reducing miles travelled, utilizing low-carbon fuels and deploying technologically advanced vehicles. Member fleets provide emissions data and track progress towards overall reduction targets (Fleets for Change, 2010).	Member fleets commit to reducing commercial fleet GHG emission in absolute terms by 20% in the period 2010-2015 (Fleets for Change, 2010).
Global Fuel Economy Initiative (GFEI)	- 2009 Global 6 organisations	GFEI is a partnership between 6 organisations that promote further research, discussion and action to improve fuel economy worldwide. GFEI's core activities are data development and analysis of fuel economy potentials, support for national and regional policy-making efforts, and outreach and awareness raising to stakeholders (e.g. vehicle manufacturers) (FIA Foundation, 2009).	The initiative has a target of improving average fuel economy of 50% worldwide by 2050 from a 2005 baseline. The target for 2020 is a 30% average fuel economy improvement for new cars in OECD countries (FIA Foundation, 2009).

TABLE 5 OVERVIEW OF TRANSPORT INITIATIVES FOR GHG EMISSION MITIGATION (CONTINUED)

Name	Led by Starting year Region Number of Participants	Description of initiative (as described by the organisation)	Commitment
Green Freight Asia Network (GFAN)	- 2011 Asia 25 members (shippers, carriers, logistics providers and associations)	GFAN brings together shippers, carriers, logistics providers and associations to advance sustainable freight in Asia. GFAN aims to enhance collaboration to share best practice and jointly scale up green freight efforts, to ensure the active participation of the private sector in the development of national green freight policies and programme, to develop consistent methods for measuring and reporting fuel use and GHG emissions from road freight, and to establish a database with verified data (GFAN, 2012).	No clear commitment stated.
Green Freight Europe (GFE)	ESC & EVO 2012 Europe >65 members (multinational carriers, shippers and logistics service providers)	GFE is an independent voluntary programme for improving the environmental performance of road freight transport in Europe. The programme drives emission reductions by establishing a platform for monitoring and reporting of GHG emissions, promoting collaboration between carriers and shippers in driving improvement actions and monitoring progress, and establishing a certification system to reward shippers and carriers who fully participate in the programme (GFE, 2012).	Carriers commit to improving the fuel efficiency of their fleet over time and shippers commit to improving their GHG emission performance over time (GFE, 2012).
Green Truck Partnership (GTP)	Roads & Maritime Services 2009 Australia 11 partners	GTP is a collaborative initiative between Roads & Maritime Services and the Australian road freight industry. The aim of the partnership is to provide real-world information on the performance of alternative transport fuels and vehicle technologies. The GTP wants to disseminate the findings and create an industry dialogue about the future opportunities to reduce emissions and increase fuel efficiency of road freight vehicles (Rare, 2011) (Roads & Maritime Services, 2012).	No clear commitment stated.
Lean and Green	Connekt 2008 Netherlands, Belgium, Italy >250 organisations	Lean and Green is a Dutch initiative to support sustainable transportation by helping companies to reduce GHG emissions while increasing profitability. Companies that demonstrate that they are actively working towards improving their sustainability are rewarded with the programmes 'Lean and Green' Award. The performance of the award recipients is monitored and these companies are obliged to report on their emission savings twice a year (Rare, 2011).	Participants commit to reducing their GHG emissions by at least 20% within 5 years (Rare, 2011).

TABLE 5 OVERVIEW OF TRANSPORT INITIATIVES FOR GHG EMISSION MITIGATION (CONTINUED)

Name	Led by Starting year Region Number of Participants	Description of initiative (as described by the organisation)	Commitment
Logistics Carbon Reduction Scheme (LCRS)	FTA 2010 UK 72 commercial vehicle operators	LCRS is a voluntary industry-led initiative to record, report and reduce GHG emissions from freight transport in the UK. The LCRS collectively tracks emission reduction progress by industry and provides a platform to share best practices. The aim of the LCRS is to demonstrate to the government that the industry is contributing to climate change targets without the need for regulation or additional taxation (FTA, 2012) (Rare, 2011).	Participants have committed to reporting and reducing their GHG emissions from road freight transport and to collectively reduce the GHG emission intensity of their freight operations by 8% by 2015, compared to a 2010 baseline (FTA, 2012).
Low Carbon Vehicle Partnership (LowCVP)	LowCVP 2003 UK 200 organisations	The LowCVP is a public-private partnership that wants to accelerate a shift to lower carbon vehicles and fuels and create opportunities for UK businesses. Aims of the LowCVP are to develop initiatives to promote the sales and supply of low carbon vehicles and fuels, to provide input and advice on Government policy, to provide a forum for stakeholders to share knowledge, and to contribute to the achievement of UK Government targets for road transport GHG emission reduction (LowCVP, 2012).	Membership is dependent on active commitment to and engagement in the drive to low carbon road transportation (LowCVP, n.d.). However, no quantified targets are stated.
Partnership for Clean Fuels and Vehicles (PCFV)	UNEP 2002 Global >100 partners (government, international organisations, industry, NGO, and other partners)	The PCFV is a global initiative to promote cleaner fuels and vehicles in developing and transition countries. The PCFV helps developing countries to eliminate the use of leaded gasoline and to phase down sulphur in diesel and gasoline fuels and supports the development and adoption of cleaner fuel standards and cleaner vehicle requirements by providing a platform for exchange of experiences and successful practices in developed and developing countries as well as technical assistance (UNEP, n.d.).	Apart from the elimination of leaded gasoline and the reduction sulphur levels in fuel to 50ppm or below, there are no quantified targets stated (UNEP, n.d.).
Partnership on Sustainable, Low Carbon Transport (SLoCaT)	SLoCaT 2009 Global >50 organisations	SLoCaT is a global voluntary multi-stakeholder initiative with the goal of mobilising global support for reducing the growth of GHG emissions generated by land transport in developing countries by promoting more sustainable, low carbon transport. SloCaT improves the knowledge on sustainable low carbon transport and helps develop better policies and catalyse their implementation (SLoCaT, 2011).	No clear commitment stated.

TABLE 5 OVERVIEW OF TRANSPORT INITIATIVES FOR GHG EMISSION MITIGATION (CONTINUED)

Name	Led by Starting year Region Number of Participants	Description of initiative (as described by the organisation)	Commitment
SmartWay	USEPA 2004 Global > 3000 partners (freight shippers, truck carriers, logistics companies, multimodal carriers and rail carriers)	SmartWay is a voluntary partnership between the USEPA and the freight industry aiming to improve fuel efficiency and reduce GHG emissions and air pollution from transport. The SmartWay programme is comprised of five components. SmartWay Transport Partnership is a partnership between USEPA and the freight sector aiming to address GHG emissions, fuel consumption, air emissions and operating costs. SmartWay Finance Program supports fuel-saving equipment. SmartWay International Interests provides guidance and resources for countries developing freight sustainability programmes. SmartWay Technology Program helps freight companies to select equipment, technologies and strategies for reducing fuel use and emission. SmartWay Vehicles ranks cars and trucks and identifies the best performing with the SmartWay logo (USEPA, 2013) (Rare, 2011).	SmartWay Transport partners commit to measuring their current environmental performance, to develop a three-year plan to improve that performance, and to report on their progress. Fleet customers commit to increasing the amount or freight shipped with SmartWay carrier partners with 5% per year (USEPA, 2013) (Rare, 2011).
U.S. DRIVE	US DOE - US 11 partners (automotive, electric utility and fuels industry and federal government)	U.S. DRIVE stands for Driving Research and Innovation for Vehicle efficiency and Energy sustainability. U.S DRIVE is a non-binding, non-legal, voluntary government-industry partnership which aims to accelerate the development of pre-competitive and innovative technologies to enable a full range of efficient and clean advanced LDVs (U.S. DRIVE, 2012).	No clear commitment stated.

6.3 METHODS

Since the GFEI and IRU's "30 by 30" Resolution are the two most ambitious initiatives and together cover almost all global emissions from cars and trucks, only the commitments of these two initiatives are researched. GFEI is committed to improving the fuel economy of LDVs[23] worldwide, whereas IRU covers the emissions from heavy-duty vehicles[24] (HDVs) and some LDVs in 74 countries worldwide. Since the commitment of GFEI is stronger this commitment is applied to all LDV emissions. Since IRU's members do not cover all countries, IRU's commitment is only applied to the HDV emissions of countries in which IRU has members. Most of the other initiatives mentioned in Table 5 cover emissions that are also covered by GFEI and IRU, but have weaker commitments. The only exception is the Australian Green Truck Partnership (GTP), but since this initiative does not have a clear commitment it is not analysed.

The Adopted Global Transportation Emissions Trajectory from the International Council on Clean Transportation's (ICCT) *Global Transportation Energy and Climate Roadmap* (Façanhaet al., 2012) (ICCT, 2012) is used as the business-as-usual scenario in this analysis. This scenario includes the impact of all existing enforceable and finalized regulations adopted by governments from 2000 to 2012 (Façanha et al., 2012). Data from the ICCT's Roadmap is used because this roadmap provides the most comprehensive set of data and includes not only carbon dioxide emissions but also methane and nitrous oxide emissions from the transport sector. The roadmap covers well-to-wheel (WTW) emissions and is thus more complete than some other roadmaps which include only tank-to-wheel (TTW) emissions. The ICCT Roadmap provides data on expected emissions as well as vehicle activity for the period until 2050 in five-year increments for 16 world regions.

In the case of LDVs, the GFEI 2020 targets are new vehicle fuel economy targets. New vehicle fuel economy is an input variable to the *ICCT Global Transportation Roadmap Model* (ICCT, 2012). To determine the impact of the GFEI commitment the GFEI targets are used as input variables to this model. The difference between the resulting LDV emissions and the LDV emissions in the ICCT's Adopted Trajectory is the impact of the initiative. The GFEI has only stated an intermediate 2020 target for OECD countries. However, to achieve their worldwide 2030 target, fuel economy improvements are also necessary in non-OECD countries before 2020. Therefore, the improvement needed in 2020 to be on track for the 2030 target is applied to non-OECD regions.

In the case of IRU's commitment, the target is stated as an overall emission improvement of 30% by 2030 in terms of transport performance in tonne-kilometres and person-kilometres from a 2007 baseline (IRU, 2009). Therefore, the emission intensity (in g CO_2e per tonne-kilometre for heavy-duty trucks and in g CO_2e per passenger-kilometre for busses) in 2007 is calculated by combining vehicle activity and emission data. 2007 vehicle activity and well-to-wheel emission data are estimated by linear interpolating between 2005 and 2010 values from the *ICCT Global Transportation Roadmap Model* (ICCT, 2012). Since IRU's target year is 2030, the emission intensity improvement commitment in 2020 has to be estimated. The estimated intermediate target is applied to the 2007 emission intensity to determine the 2020 target emission intensity. The 2020 emissions from HDVs, if the target is met, are calculated assuming vehicle activity is the same as in the business-as-usual scenario. The difference between these emissions and the 2020 emissions in the ICCT's Adopted Trajectory is the commitment of the IRU "30 by 30" Resolution.

6.4 RESULTS

Based on the ICCT's Adopted Trajectory business-as-usual greenhouse gas emissions from LDVs are expected to be 4.4 Gt CO_2e[25] in 2020. Emissions are expected to increase by about 17% in the period 2010–2020, whilst vehicle activity is expected to increase by about 38% in the same period. The average global emission intensity of LDVs is calculated to decrease by 21% in the period 2005–2020 under business-as-usual conditions (ICCT, 2012). This is due to the fact that many countries have

[23] LDVs include passenger vehicles (e.g. cars, minivans, SUVs) and light commercial vehicles.

[24] HDVs include heavy-duty trucks and buses.

[25] Only CO_2, CH_4 and N_2O emissions are included in this chapter. ICCT does not yet report on PFCs, HFCs and SF_6 emissions.

already adopted ambitious emission targets for LDVs, which are included in the business-as-usual scenario (Façanha et al., 2012). However, there are substantial differences between the different regions in the world. While there are highly ambitious policies implemented in some regions (e.g. the United States and the European Union), there are no adopted policies in other regions (e.g. Mexico and Australia) (Façanha et al., 2012). The differences in the business-as-usual fleet average LDV[26] emission intensity trends in some regions are shown in Figure 7.

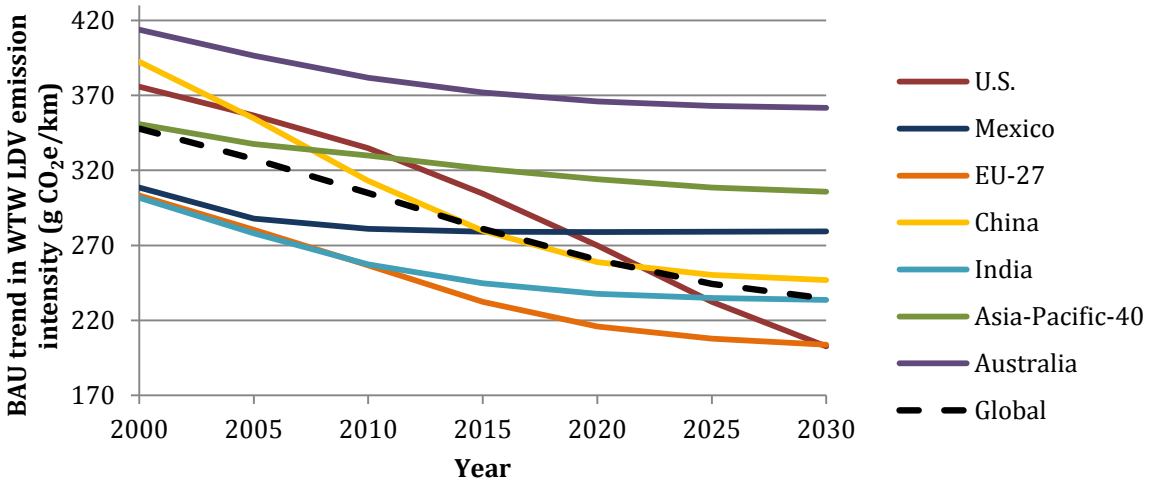

FIGURE 7 BAU LDV FLEET AVERAGE EMISSION INTENSITY TRENDS IN SELECTED REGIONS (BASED ON ICCT, 2012)

GFEI has a target of improving average fuel economy for new cars by 30% in OECD countries in 2020 from a 2005 baseline (FIA Foundation, 2009). Figure 8 shows the average new vehicle fuel economy in 2005 and in 2020 based on the ICCT's Adopted Trajectory (ICCT, 2012) as well as a 30% improvement target from the 2005 baseline in 2020 for OECD regions[27]. As can be seen in the figure, there are some regions (United Stated and Japan) for which the improvement in the business-as-usual scenario exceeds the GFEI target. However, for most regions the GFEI commitment will lead to emission reductions beyond the business-as-usual scenario.

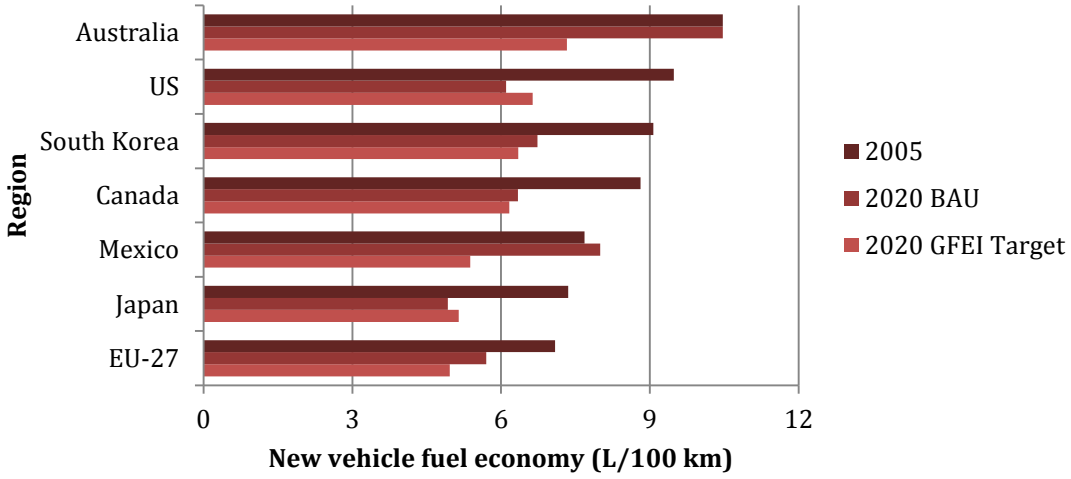

FIGURE 8 NEW VEHICLE FUEL ECONOMY IN 2005 AND 2020 IN OECD REGIONS

[26] LDVs include passenger vehicles (e.g. cars, minivans, SUVs) and light commercial vehicles.
[27] Regions in the *ICCT Global Transportation Roadmap Model* do not correspond to OECD and non-OECD Regions. The OECD target is applied to the region EU-27, although this region includes some non-OECD countries. The non-OECD target is applied to the regions Latin America-31, Asia-Pacific-40, Non-EU Europe and the Middle East, although these regions include some OECD-countries.

Although GFEI has not set a 2020 target for non-OECD countries, fuel economy improvement is necessary before 2020 in order to be able to reach the 2030 and 2050 targets. An improvement of 3.0% per year in average vehicle fuel efficiency per year is needed worldwide from 2012 onwards to reach these targets (Cuenot & Körner, n.d.). An average emission intensity improvement of 3.0% per year in the period 2012–2020 is therefore applied to the non-OECD regions. Since average fuel economy has not improved in the period 2005–2011 in non-OECD countries (Cuenot & Körner, n.d.), this implies a 22% improvement from a 2005 baseline. Figure 9 and Figure 10 show the resulting emission reduction commitments in 2020 in OECD and non-OECD regions.

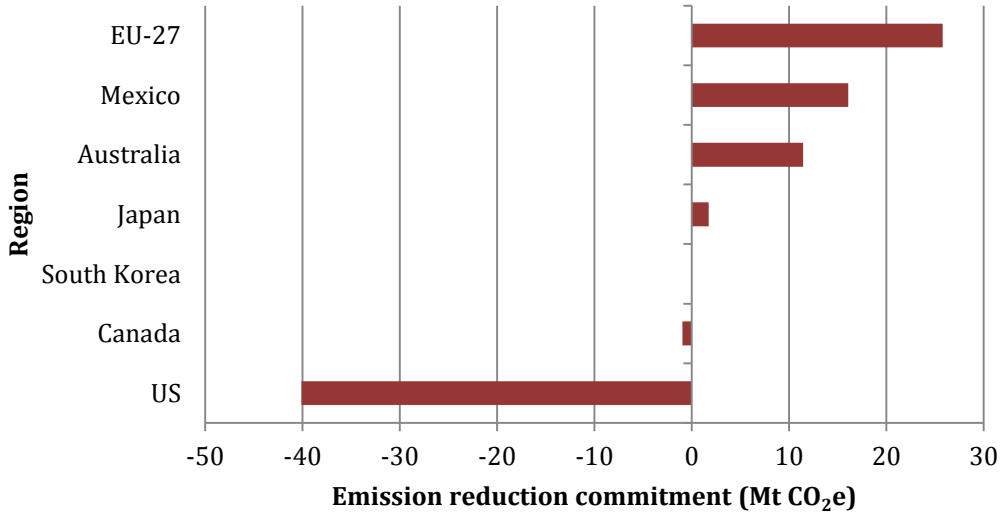

FIGURE 9 2020 EMISSION REDUCTION COMMITMENT GFEI IN OECD REGIONS

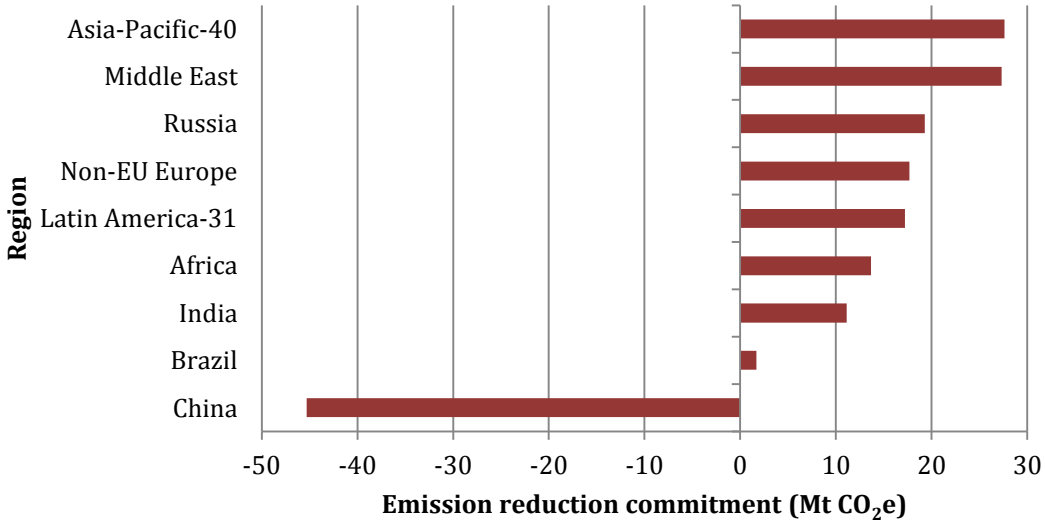

FIGURE 10 2020 EMISSION REDUCTION COMMITMENT GFEI IN NON-OECD REGIONS

For some regions this emission reduction commitment is negative, this indicates that the fuel economy improvement in the business-as-usual scenario exceeds the GFEI targets. It is assumed that this does not affect the effort the improve fuel economy in other regions. Therefore, these negative values are excluded when calculating the total commitment. The total emission reduction commitment of the GFEI in 2020 is estimated to be 0.19 Gt CO_2e (0.06 Gt CO_2e in OECD regions and 0.14 Gt CO_2e in non-OECD regions). The highest contributions in the OECD regions come from the European Union, Mexico and Australia. For Mexico and Australia, this is due to the large difference between business-as-usual and target new vehicle fuel economy in 2020 (see Figure 8). For the European Union, the difference between business-as-usual and target new vehicle fuel economy is

much smaller. However, due to the high vehicle activity in this region the total impact is large. The large contribution in the non-OECD regions is due to the large average fuel economy improvement compared to business-as-usual in most regions. Notable exception is China, were ambitious policies are already adopted.

Due to uncertainties in the business-as-usual scenario and the way the GFEI targets will be reached, the uncertainty in the result is estimated to be large. Since business-as-usual fuel economy improvement exceeds the GFEI targets in some regions and the fact that GFEI has only stated an interim target for 2020 for the OECD regions, the overall GFEI target could also be met with lower total emission reductions. Therefore the lower bound of the uncertainty range is therefore taken to be 0.05 Gt CO_2e. The upper bound is estimated to be 0.25 Gt CO_2e.

For HDVs there are much fewer adopted regulations, mainly because mandatory HDV regulations are much more complex than LDV regulations because of the enormous range of vehicle types and applications (Façanha et al., 2012). Based on the ICCT's Adopted Trajectory the business-as-usual emissions are expected to be 4.1 Gt CO_2e in 2020. Over the period 2010–2020 emissions are expected to increase by 23%, while vehicle activity is expected to increase by 30% (ICCT, 2012). As with LDVs, there are substantial differences in emission intensity between the different regions. Since IRU uses 2007 as a baseline, the emission intensity in 2007 is estimated by linear interpolation using 2005 and 2010 values. IRU has stated a target of reducing emission intensity by 30% by 2030 from a 2007 baseline. Based on this commitment a commitment of reducing emission intensity by 18% by 2020 is assumed (range: 16-20%). HDVs include four categories in the *ICCT Global Transportation Roadmap Model*: light heavy-duty trucks (LHDT), medium heavy-duty trucks (MHDT), heavy heavy-duty trucks (HHDT) and busses. IRU's commitment is applied to these four categories for all of IRU's member countries[28]. The result per region and vehicle type is shown in Figure 11. The emission reduction resulting from an 18% improvement target for all HDVs in 2020 in the countries covered by IRU's members is calculated to be 0.33 Gt CO_2e. Taking into account the 16-20% uncertainty range in the 2020 commitment of the IRU "30 by 30" Resolution, the range of this result becomes 0.27–0.40 Gt CO_2e. However, there are more uncertainties in the underlying data, such as uncertainties in the business-as-usual scenario. Therefore the uncertainty range in the result is expected to be wider and taken to be 0.2–0.5 Gt CO_2e.

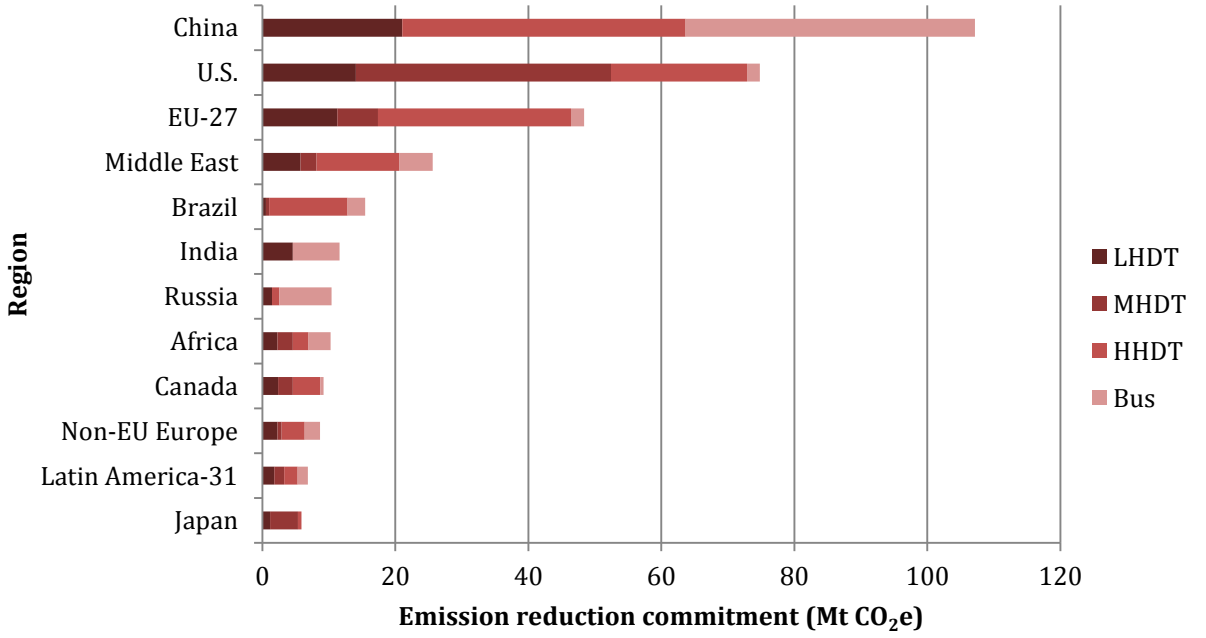

FIGURE 11 HDV EMISSION REDUCTION COMMITMENT IN 2020 IN DIFFERENT REGIONS BY VEHICLE TYPE

[28] The regions Africa and Latin America-31 include IRU members and non-members, therefore half of the emissions of these regions are included in the analysis.

The total impact of the commitment of road transport bottom-up initiatives is thus estimated to be to 0.53 Gt CO_2e (range 0.33–0.70 Gt CO_2e). The results are summarized in Figure 12. This expected impact of 0.53 Gt CO_2e is lower than the 0.7 Gt CO_2e estimated by Blok et al (2012). This is mainly due to the fact that there is a significant improvement in the fuel economy of LDVs in the business-as-usual scenario. In a few regions GFEI's commitment is even less ambitious than existing regulations. The commitment for LDVs is thus expected to be lower than expected by Blok et al. (2012). The impact of the commitment for HDVs is comparable to the estimation by Blok et al. (2012).

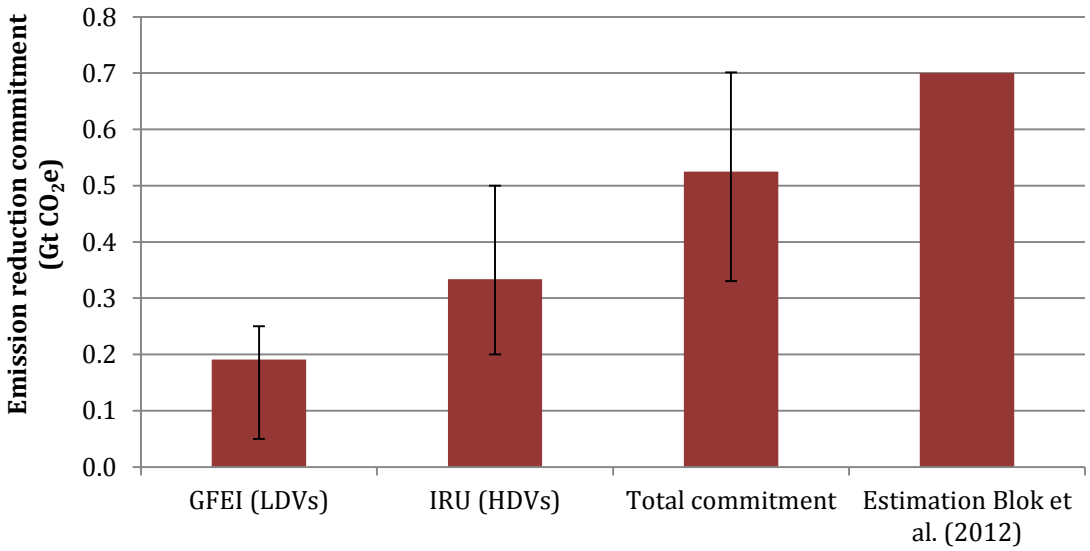

FIGURE 12 EMISSION REDUCTION IN 2020 BASED ON COMMITMENT OF TRANSPORT INITIATIVES

7. WEDGES 6 & 7: BOOST SOLAR PHOTOVOLTAIC & WIND ENERGY

7.1 INTRODUCTION

26% of global anthropogenic greenhouse gas emissions resulted from power generation in 2010 (IEA, 2012a). Replacing fossil fuel-based power generation with renewable power generation, such as solar photovoltaics (PV) or wind energy, has thus an enormous potential for abating greenhouse gas emissions. Renewable energy technologies do not only address climate change mitigation but also have a number of other benefits. Using renewable energy can, for example, increase the security of energy supply by diversifying energy supply and, for importing countries, by decreasing the dependence on fossil-fuel imports. Renewable energy generation also has health benefits due to reduced air pollution compared to fossil-based power generation. However, there are barriers that can hinder the implementation of these technologies. These barriers include economic barriers, such as high up-front investment costs and financial risk, socio-cultural barriers, such as local opposition to renewable energy projects, and institutional barriers, such as existing infrastructure and market regulation being favourable for conventional power generation (Moomaw et al., 2011a)

Although solar PV and wind energy only accounted for respectively 0.1% and 1.5% of global electricity supply in 2011 (IEA, 2012a), the technical potential of both these renewable energy sources greatly exceeds the current energy demand (Moomaw et al., 2011a). Solar PV is currently one of the fastest growing industries with yearly growth rates of production volume between 40 and 90% over the last decades (Jäger-Waldau, 2012). The global cumulative installed capacity was nearly 70 GW in 2011 (EPIA, 2012) (REN21, 2012) and reached 100 GW in 2012 (Montgomery, 2013). Wind energy has experienced average cumulative growth rates of about 28% over the last decade and the global cumulative installed capacity was almost 238 GW by the end of 2011 (GWEC, 2012).

According to Blok et al. (2012) a coalition of progressive governments and producers could remove barriers for solar PV energy by introducing good grid access and net metering rules, leading to an additional installed capacity of 1600 GW by 2020. This could have an impact of mitigating up to 1.4 Gt CO_2e in 2020. In the case of wind energy the Global Wind Energy Council (GWEC) could foster the global introduction of arrangements leading to risk reduction for investments in wind energy according to Blok et al. (2012). This could lead to an additional installed 650 GW, which would have an impact of saving up to 1.2 Gt CO_2e in 2020. Because the methodology used for assessing the impact of initiatives boosting solar PV and wind energy are similar, these two wedges are discussed in one chapter.

7.2 DESCRIPTION OF INITIATIVES

Many local bottom-up initiatives exist aimed at installing additional wind or solar PV capacity. For example in the Netherlands the Foundation Wij Willen Zon [We Want Sun] collectively purchases solar PV systems for private individuals and the initiative ZonVast [Fixed Sun] enables consumers to lease solar PV systems (Verhees et al., 2013). In the case of wind energy community ownership initiatives are common in Germany and Denmark (Toke, 2005). These initiatives are however generally very small and will not lead to significant emission reductions on a global scale. Also, it is impossible to identify all these initiatives worldwide. Therefore the focus is only on large scale initiatives with either a global scope or aimed at capacity increase of at least 1 GW. Initiatives such as the Solar for All initiative, which aims at making solar energy affordable for the 1.4 billion people without access to electricity (SfA, 2013), are also not included in the analysis. The reason for this is that this type of initiative will not lead to emission savings, as the renewable energy generation resulting from it will lead to additional electricity generation instead of replacing fossil fuel-based electricity generation. These initiatives are consistent with another wedge in the 'wedging the gap' approach, 'Access to energy through low-emission options', which is not analysed in this research. Table 6 shows an overview of the identified large-scale initiatives aimed at boosting solar PV energy. Table 7 provides an overview of the initiatives aimed at wind energy deployment.

TABLE 6 OVERVIEW OF SOLAR PV INITIATIVES

Name	Led by Starting Year Region	Description of the initiative (as described by the organisation)	Commitment
300 GW/a	pv magazine & Solarpraxis AG 2012 Global	The 300 GW/a initiative aims at raising awareness of the possibilities for the global PV industry, which could form a key pillar of the global energy supply by 2025. pv magazine is engaging with experts from the industry, politics and academia to determine what can be done to achieve the goal of 300 GW additional installed capacity per year by 2025 (Gifford, 2012). pv magazine is a montly trade publication covering the latest PV news (pv magazine, n.d.). Solarpraxis AG is a leading consulting and service company in the renewable energies industry (Solarpraxis AG, 2013)	300 GW per year globally additional installed capacity by 2025. This requires a 20% annual growth rate of the PV market (Gifford & Ali-Oettinger, 2012).
Asia Solar Energy Initiative (ASEI)	ADB 2010 Asia & the Pacific	Many developing countries in the Asia and Pacific region have ideal conditions for the use of solar power, but the steep up-front costs of solar projects, high borrowing costs, and the lack of access to long-term capital are stalling solar energy growth. ASEI aims to overcome these constraints by boosting the development of enough grid-scale projects and to accelerate the downward trend in the cost of solar energy. Apart from financing solar energy projects, ASEI also hosts the Asia Solar Energy Forum, an international knowledge-sharing platform (ADB, 2011).	ASEI made a commitment to increase the amount of new solar power generation in the Asia and Pacific region to 3 GW by 2013 (ADB, 2011).
Global Solar Alliance (GSA)	- 2012 Global	GSA is a worldwide network initiative comprised of leading solar energy exhibitions and conferences, global-oriented companies from the solar energy sector and solar industry associations. The aim of GSA is driving the global development of the solar markets and industry. It strives to spread awareness, information and advocacy among the professional community, the decision makers and the general public (GSA, n.d.).	No clear commitment stated.
Global Solar Council (GSC)	- 2012 Global	GSC is a CEO-level industry coalition, founded by 7 international companies representing the whole value chain of solar PV. GSC engages with policymakers to promote the use of solar energy and to emphasise the importance of a supportive policy and trade environment (Williamson, 2012).	The goal of GSC is to increase the deployment of cost-competitive solar energy worldwide (Stuart, 2012).

TABLE 6 OVERVIEW OF SOLAR PV INITIATIVES (CONTINUED)

Name	Led by Starting Year Region	Description of the initiative (as described by the organisation)	Commitment
Solar Europe Industry Initiative (SEII)	EPIA & EU PVTP 2010 EU	The SEII is an industry-led initiative which has developed a Research, Development and Demonstration (R&D&D) roadmap for PV in Europe. The SEII is a joint initiative between the European Photovoltaic Industry Association (EPIA) and European Photovoltaic Technology Platform (EU PVTP), in collaboration with the European Commission and Member States (EU PVTP, n.d.). The SEII is a part of the European Commission's Strategic Energy Technology Plan. The SEII has three strategic objectives: to bring PV to cost competitiveness in all market segments by 2020, to establish the conditions allowing high penetration of distributed PV electricity within the European electricity system and to facilitate the implementation of large scale demonstration and deployment projects (EPIA & EU PVTP, 2010).	The target is to supply 12% of the electricity demand in the EU with solar PV by 2020 (EPIA & EU PVTP, 2010).
SunShot Initiative	US DOE 2011 US	By driving research and development in PV, concentrated solar power, systems integration and balance of systems the SunShot wants to make the abundant solar energy resources in the United States affordable and accessible for all Americans. The SunShot Initiative aims to make solar energy cost-competitive with other forms of electricity by 2020, leading the way for rapid, large-scale adoption of solar electricity (US DOE, 2013) (US DOE, 2012a).	The target of the SunShot Initiative is to reduce the price of solar energy systems by about 75% between 2010 and 2020. This is expected to result in 50 GW cumulative installed capacity of solar PV in the US in 2020 (US DOE, 2012a).
Vote Solar Initiative	Vote Solar 2002 US	Vote Solar is a non-profit grassroots organisation working to foster economic opportunity, promote energy independence and mitigate climate change by making solar a mainstream energy source in the United States. Vote Solar works to overcome cost and regulatory barriers for both distributed and large-scale solar. Vote Solar works with policymakers, local advocates and individuals (Vote Solar, 2011).	No clear commitment stated.

TABLE 7 OVERVIEW OF WIND ENERGY INITIATIVES

Name	Led by Starting Year Region	Description (as described by the organisation)	Commitment
European Wind Initiative (EWI)	TPWind 2010 EU	The EWI is a R&D programme launched by the European wind industry together with the European Commission and Member States. The EWI is a part of the European Commission's Strategic Energy Technology Plan. The EWI is a roadmap to reduce the cost of wind energy, which will pave the way for the large-scale deployment of wind energy worldwide and secure long-term European technological and market leadership (EWEA, 2013).	The targets of the EWI are to maintain Europe's technology leadership in onshore and offshore wind power, to make onshore wind the most competitive energy source by 2020, to achieve a 20% share of wind energy in EU total electricity consumption by 2020 and to create 250,000 new skilled jobs in the EU by 2020 (EWEA, 2013).
Wind Program	US DOE - US	The US DOE Wind Program works with national laboratories, industry partners, universities and other federal agencies to conduct R&D activities and provide technical and financial support in order to accelerate the deployment of wind power technologies in the US by improving performance, driving down costs and reducing market barriers (US DOE, 2012b).	The target of the Wind Program is to achieve a 20% share of wind energy in the US electricity consumption by 2030 (US DOE, 2012b).
Wind Energy Initiative (WEI)	Iowa State University - US	The WEI aims to strategically drive heavy wind energy growth in Iowa and the US through leadership in research, education and outreach. The goal of the combined WEI research and education advances is to make wind energy competitive with other energy sources. This will be achieved by reducing capital costs, minimizing operation and maintenance costs, increasing output through efficiency and system design and improving grid operation for wind energy (Iowa State University, 2013).	The WEI aims to facilitate the nation's achievement of 20% electricity from wind energy by 2030 (Iowa State University, 2013).

Seven large-scale initiatives aimed at boosting solar PV energy and three large-scale wind energy initiatives have been identified. Only one of these initiatives, the 300 GW/a initiative, has made a global commitment. Both wind and solar energy initiatives with a clear commitment exist in the European Union and the United States.

Apart from the initiatives listed in Table 6 and Table 7 many solar energy associations and wind energy associations exist worldwide. These also aim at boosting the use of renewable energy, but they have no clear commitments stated and are therefore not included in the analysis.

7.3 METHODS

Three of the solar PV initiatives are included in the analysis; 300 GW/a, the Solar Europe Industry Initiative (SEII) and the SunShot initiative. The other initiatives do not have specified targets or, in the case of the Asia Solar Energy Initiative (ASEI), do not have a post-2013 target. The 300 GW/a initiative is the most ambitious initiative and has a global scope and this initiative thus overlaps with the other two initiatives. While the impact of SEII and the SunShot initiative will be determined as well, only the impact of the 300 GW/a initiative will be counted for the total commitment of the solar PV wedge. In the case of wind energy all the initiatives listed in Table 7 have a clear commitment and are included in the analysis. The Wind Energy Initiative (WEI) has the same commitment as the Wind Program and therefore these initiatives are treated as one in the analysis.

To estimate the emission savings in 2020 from these initiatives, it is calculated how much additional electricity generation from solar PV or wind energy will result from the initiatives. The WEO 2012 Current Policies Scenario (IEA, 2012a) is used as the business-as-usual scenario. In case the commitment of an initiative is stated as a cumulative capacity or total amount of electricity generation, the cumulative installed capacity or electricity generation from solar PV or wind energy in the WEO 2012 Current Policies Scenario is subtracted from this amount to determine the additional capacity or generation. If the commitment is specified as an amount of installed capacity, the electricity generation resulting from this installed capacity is determined using the ratio between installed capacity and electricity generation in 2020 from the WEO 2012 Current Policies Scenario. The WEO 2012 Current Policies Scenario provides global data as well as data for specific regions. In case an initiative aims at a specific region, data for that region are used for the calculations. A 20% uncertainty margin is applied to the data from the WEO 2012 Current Policies Scenario, to account for uncertainties in this projection.

It is assumed that the additional electricity generation from renewables replaces electricity generation from fossil sources. Wind and solar PV technologies are generally free from greenhouse gas emissions during operation. However, emissions do occur during other phases of the life-cycle such as manufacturing, transportation, maintenance and decommissioning (Peng et al., 2013) (Dolan & Heath, 2012). Therefore, when comparing conventional electricity generation with electricity generation from renewables the greenhouse gas emissions arising during the entire life-cycle should be accounted for for all technologies (Dolan & Heath, 2012) (Weisser, 2007). Data from the *Special Report on Renewable Energy Sources and Climate Change Mitigation* (SRREN) of the Intergovernmental Panel on Climate Change (IPCC) are used for this analysis. This report contains a review of published life-cycle assessments of electricity generation technologies based on 2165 references of which 296 passed the screening for quality and relevance (Moomaw et al., 2011b). There are strong variations in the emissions reported for a specific technology. These differences result for example from differences in plant efficiency, mode of operation and mode of fuel extraction (Weisser, 2007). The mean value reported in the IPCC SRREN is used for the calculations, taking the range from the 25th to the 75th percentile as the uncertainty range. There is one exception, for solar PV the range from the minimum to the mean value reported by the IPCC is used. This is done to account for the effect that solar PV is a fast-improving technology and emissions are likely to decrease further in the near future (Hsu et al., 2012) (Weisser, 2007). Also, the emissions from thin-film solar PV technologies are lower than emissions from conventional crystalline silicon solar PV technologies and the market share of thin-film based solar cells is expected to increase in the future (Arvizu et al., 2011). For wind energy, greenhouse gas emissions have been stable over time and scale and given the already low emissions significant reductions are not expected (Dolan & Heath, 2012). Therefore the mean value reported is used for wind power.

The data from the IPCC SRREN (Moomaw et al., 2011b) are combined with the fuel mix for electricity production in 2020 from the WEO 2012 Current Policies Scenario (IEA, 2012a) to calculate the average life-cycle emission intensity of electricity from fossil fuels. The regional fuel mix is used for initiatives operating in a specific region. The emission savings from electricity generated from renewables are calculated by subtracting the emission intensity of solar PV or wind power from the emission intensity of electricity from fossil fuels. By combining this with the electricity generation commitment of the initiatives, the impact on greenhouse gas emissions of the initiatives can be calculated.

7.4 RESULTS

7.4.1 EMISSION SAVINGS FROM RENEWABLES

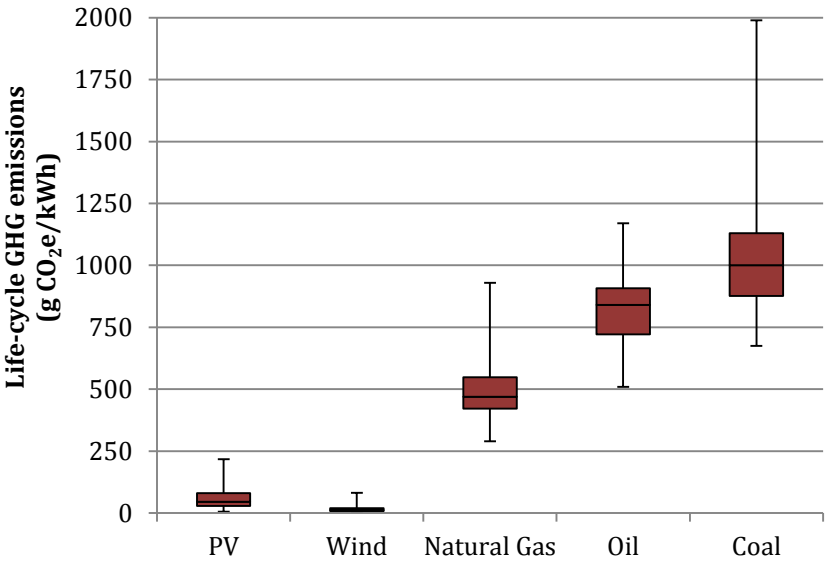

FIGURE 13 LIFE-CYCLE GHG EMISSIONS FROM ELECTRICTY GENERATION BY SOURCE

Figure 13 shows the life-cycle greenhouse gas emissions from electricity generated from solar PV, wind, natural gas, oil and coal based on data from the IPPC SRREN (Moomaw et al., 2011b). Combined with data on the electricity fuel mix in 2020 from the WEO 2012 Current Policies Scenario (IEA, 2012a) these data are used to calculate the life-cycle emission intensity from fossil electricity generation and the emission savings by replacing electricity from fossil sources by solar PV or wind power. Error propagation rules are applied to determine the uncertainty range. The global average results as well as the data for the European Union and the United States are shown in Table 8.

TABLE 8 EMISSION REDUCTIONS FROM REPLACING FOSSIL-BASED ELECTRICITY WITH SOLAR PV OR WIND ENERGY IN SELECTED REGIONS

Region	**Emission reduction solar PV (g CO_2e / kWh)**		**Emission reduction wind energy (g CO_2e / kWh)**	
	Mean	Range	Mean	Range
World	791	691–903	808	709–918
European Union	715	626–822	732	645–836
United States	784	685–897	801	704–912

7.4.2 SOLAR PV ENERGY

Three initiatives aimed at boosting solar PV are analysed. The 300 GW/a initiative aims at reaching an additional installed capacity of 300 GW per year by 2025 and this requires a 20% increase in added capacity per year (Gifford & Ali-Oettinger, 2012). Starting from an added capacity of 30 GW per year in 2012 this would lead to an added capacity of about 129 GW in 2020 and a cumulative global installed capacity of 694 GW in 2020. This is 467 GW more than in the business-as-usual scenario. The global average ratio between installed capacity and electricity generation is 1.24 TWh/GW in 2020 in the WEO 2012 Current Policies Scenario (IEA, 2012a). Applying this ratio to the additional installed capacity results in an additional electricity generation by solar PV of 580 TWh in 2020. Achieving this commitment leads to emission savings of 0.46 Gt CO_2e, with an uncertainty range of 0.25–0.77 Gt CO_2e. The uncertainty range is based on uncertainties in the additional capacity to be achieved by the 300 GW/a initiative, the emissions from electricity generation, the cumulative PV capacity in the WEO 2012 Current Policies Scenario, and ratio between installed capacity and electricity generation capacity in the WEO 2012 Current Policies Scenario.

SEII has a target of supplying 12% of the electricity in Europe by Solar PV in 2020 (EPIA & EU PVTP, 2010). The electricity demand in Europe in 2020 in the WEO 2012 Current Policies Scenario is 3588 TWh (IEA, 2012a). SEII thus aims at supplying 431 TWh by solar PV in 2020, which is 319 TWh more than in the business-as-usual scenario. The emission savings resulting from this commitment are 0.23 Gt CO_2e. The uncertainty range for this result is 0.16–0.31 Gt CO_2e, taking into account uncertainties in the emissions from electricity generation, and the cumulative PV capacity and electricity generation in the WEO 2012 Current Policies Scenario.

The SunShot initiative has a target of reaching 50 GW cumulative installed capacity in the United States in 2020 (US DOE, 2012a). This is 23 GW above the business-as-usual level, leading to an additional electricity generation by solar PV of 36 TWh in 2020. The emission savings resulting from this commitment are 28 Mt CO_2e, with an uncertainty range of 15–48 Mt CO_2e. The uncertainty range takes into account uncertainties in the emissions from electricity generation, the cumulative PV capacity in the WEO Current Policies Scenario, and the ratio between installed capacity and electricity generation capacity in the WEO 2012 Current Policies Scenario.

The results are summarized in Figure 14. Since the 300 GW/a initiative has a global scope this initiative overlaps with the other initiatives and therefore only the impact of the 300 GW/a initiative is counted for the total impact of the existing initiatives in the 'Boost solar PV energy' wedge. The commitment of 0.46 Gt CO_2e is considerably smaller than the estimation of 1.4 Gt CO_2e by Blok et al. (2012). This is because the commitment of the existing initiatives is much less ambitious than the 1600 GW additional installed capacity assumed by Blok et al. (2012).

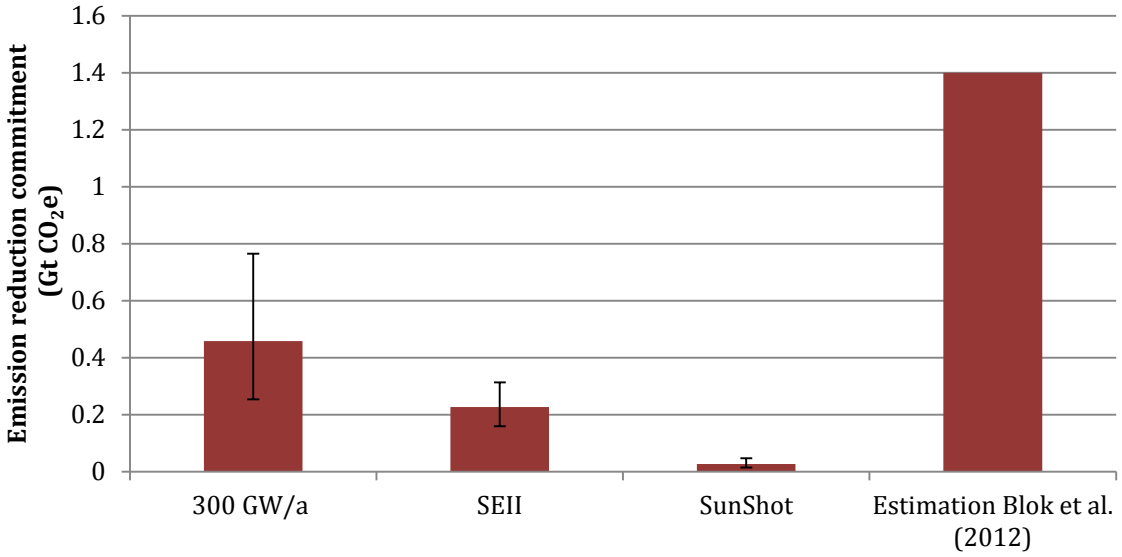

FIGURE 14 EMISSION REDUCTION IN 2020 BASED ON COMMITMENTS OF SOLAR PV INITIATIVES

7.4.3 WIND ENERGY

The EWI has a target of supplying 20% of the electricity in the European Union by wind energy in 2020 (EWEA, 2013). The electricity demand in Europe in 2020 in the WEO 2012 Current Policies Scenario is 3588 TWh (IEA, 2012a). EWI thus aims at supplying 367 TWh by wind energy in 2020, which is 351 TWh more than in the business-as-usual scenario. This additional generation from wind energy will lead to emissions savings of 0.26 Gt CO_2e, with an uncertainty range of 0.18–0.35 Gt CO_2e. The uncertainty range includes uncertainties in the emissions from electricity generation, and the cumulative wind power capacity and electricity generation in the WEO 2012 Current Policies Scenario.

The Wind Program and EWI have committed to supplying 20% of the electricity demand in the United States by wind energy in 2030 (US DOE, 2012b) (Iowa State University, 2013). The cumulative installed wind energy capacity needed in 2020 to be on track for this 20% by 2030 scenario is 150 GW (US DOE, 2012c). Based on the ratio between electricity generation and installed capacity in the Unites States in 2020 in the WEO 2012 Current Policies Scenario (IEA, 2012a), this 150 GW installed capacity is expected to generate 377 TWh of electricity. This is 146 TWh over the business-as-usual scenario. The emission savings from this additional generation are 0.12 Gt CO_2e, with an uncertainty range of 0.08–0.19 Gt CO_2e. The uncertainty range takes into account uncertainties in the emissions from electricity generation, the electricity generation from wind power in the WEO 2012 Current Policies Scenario, and the ratio between installed capacity and electricity generation capacity in the WEO 2012 Current Policies Scenario.

Figure 15 shows the results for both wind energy initiatives and the combined commitment of those initiatives, which is 0.37 Gt CO_2e in 2020 (range: 0.29–0.50 Gt CO_2e). This estimate is much lower than the 1.2 Gt CO_2e estimated by Blok et al. (2012). This is because there are currently only initiatives in the European Union and the United States. There are no large-scale global initiatives aimed at boosting wind energy yet. The combined commitment of the existing initiatives is thus much lower than the commitment of 650 GW additional capacity expected by Blok et al. (2012).

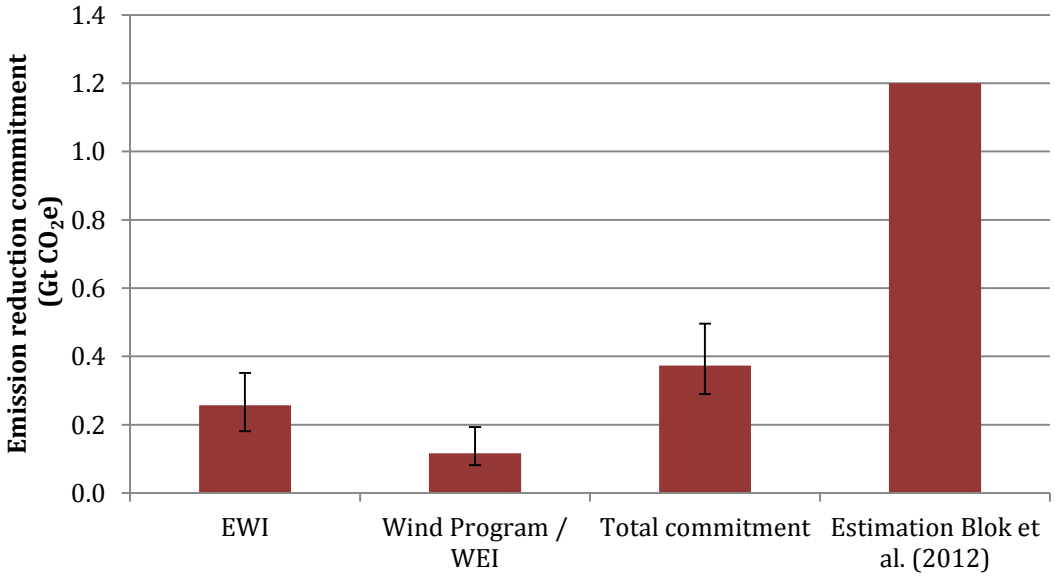

FIGURE 15 EMISSION REDUCTION IN 2020 BASED ON COMMITMENTS OF WIND ENERGY INITIATIVES

8. WEDGE 8: PHASING-OUT FOSSIL-FUEL SUBSIDIES

8.1 INTRODUCTION

An energy subsidy is defined by UNEP as "any government action that influences energy market outcomes by lowering the cost of energy production, raising the price received by energy producers or lowering the price paid by energy consumers" (UNEP, 2008, p. 8). Energy subsidies can take various forms, either directly or indirectly influencing costs or prices. Examples include grants, tax exemptions, regulations that favour a particular fuel and government-sponsored R&D (UNEP, 2008). Because of differences in definitions, methodologies and the transparency of fiscal systems, it is difficult to estimate the total size of global fossil-fuel subsidies (UNEP, 2008). Recent estimates range from at least US$ 750 billion to over US$ 1 trillion in 2012 (Bast et al., 2012). According to the International Monetary Fund (IMF) global subsidies are as high as US$ 1.9 trillion or 2.5% of global GDP on a post-tax basis (i.e. including negative externalities from energy consumption) (IMF, 2013).

Reasons for subsidising fossil fuels include protecting domestic industry against international competition, promoting jobs, and reducing dependency on energy imports for energy-security reasons (UNEP, 2008). But the most common justification for fossil-fuel subsidies is that they are necessary to help the poor gain or maintain access to essential energy services. However, fossil-fuel subsidies are an inefficient means for reaching this objective due to significant benefit leakage to higher income groups. Without precise targeting, richer households benefit more from the subsidy than poor households, as they are able to use more fuel (IEA, 2011) (Bast et al., 2012) (Del Granado et al., 2012). According to Del Granado et al. (2012), the richest 20% of households capture six times more subsidies than the poorest 20% in absolute terms.

Fossil-fuel subsidies keep energy prices artificially low, thereby providing a disincentive to energy-efficiency and encouraging additional and often wasteful energy consumption, and with the prospect of international high fuel prices fossil-fuel subsidies could act as a drain on government finances (IEA, 2011) (UNEP, 2008). Eliminating fossil-fuel subsidies can thus further the goal of climate change mitigation in two ways. First, a fossil-fuel phase-out would lead to a significant cut in greenhouse gas emissions. Second, this phase-out would free up the finance needed for climate change mitigation measures (Bast et al., 2012) (Cochet & Buckle, 2012). Although phasing-out fossil-fuel subsidies has environmental as well as economic benefits, these subsidies still remain common and large in many countries (IEA, 2012a).

In recent years many countries have already pledged to phase-out fossil-fuel subsidies. In September 2009, the G20 member states, comprising the world's largest economies, made a commitment to phase-out inefficient fossil-fuel subsidies over the medium term. This commitment is also supported by the G8 nations and the Friends of Fossil Fuel Subsidy Reform (FFSR), a group of eight non-G20 countries. In November 2009 the members of the Asia Pacific Economic Cooperation (APEC) made a similar commitment to phase out fossil-fuel subsidies. In official submissions and presentations, a large number of Parties to the United Nations Framework Convention on Climate Change (UNFCCC) also support fossil-fuel subsidy reform (Bast et al., 2012) (Koplow, 2012). These groupings of countries cover in total 134 countries that support fossil-fuel subsidy reform (Koplow, 2012). However, progress towards the goal of phasing-out global fossil-fuel subsidies has been very slow (Bast et al., 2012). So far no subsidies have been phased-out as a result of the G20 commitment and many countries have opted out of reporting on their fossil-fuel subsidies (Koplow, 2012).

Estimates of the impact of phasing out fossil-fuel subsidies in greenhouse gas emissions vary considerably. According to the IEA, global primary energy demand would be reduced by nearly 5% and carbon dioxide emissions by 5.8% or 2.6 Gt if fossil-fuel subsidies were completely phased-out by 2020 (Bast et al., 2012). Burniaux & Chateau (2011) estimate that greenhouse gas emissions will decrease by only 2.5% in 2020 in the same situation. According to Blok et al. (2012), the impact of phasing-out half of all fossil-fuel subsidies could lead to mitigating up to 0.9 Gt CO_2e in 2020.

8.2 DESCRIPTION OF INITIATIVES

In Table 9 an overview of three initiatives aimed at phasing-out fossil-fuels subsidies is given. These three initiatives all support research into fossil-fuel subsidies in order to increase transparency and work together with other organisations to encourage governments to phase-out fossil-fuel subsidies. Apart from these structural initiatives there have also been one-time actions aimed at convincing governments to phase-out fossil-fuel subsidies in recent years. In May 2012 a large coalition of NGOs representing millions of citizens worldwide called on world leaders to fulfil their promises and phase-out fossil-fuel subsidies as soon as possible (Koplow, 2012). During the Rio+20 Earth Summit in June 2012, 350.org organised a twitterstorm and delivered a petition signed by over one million people calling for an end to fossil-fuel subsidies (350.org, 2012a) (350.org, 2012b). Although these actions did not lead to increased government commitments, they did succeed in drawing public attention to fossil-fuel subsidy reform.

While all of the initiatives strive for a complete fossil-fuel subsidy phase-out, none of them have a clear commitment or target stated. Therefore, the commitment of the initiatives cannot be quantified. None of these initiatives or actions has any direct control over fossil-fuel subsidies and the only way they can accomplish a fossil-fuel subsidy reform is by encouraging governments to phase-out fossil-fuel subsidies. Many governments have already made commitments to do so and these commitments, including the G20 and APEC commitments, are included in the WEO 2012 New Policies Scenario (IEA, 2012a). Because of the lack of control and commitment of the initiatives it is unlikely that the initiatives listed in Table 9 will lead to fossil-fuel subsidy phase-out beyond the current country pledges. Thus, these initiatives are not expected to contribute to the bridging of the emissions gap. However, since progress towards phasing-out global fossil-fuel subsidies has up to now been very slow (Bast et al., 2012), these initiatives and actions drawing attention to fossil-fuel subsidy reform might play an important role in encouraging governments to actually fulfil their current pledges.

TABLE 9 OVERVIEW OF INITIATIVES AIMED AT PHASING-OUT FOSSIL-FUEL SUBSIDIES

Name	Led by Starting Year Region	Description (as described by the organisation)	Objective
Earth Track	- 1999 Global	Earth Track works to make government subsidies that are harmful to the environment easier to see, value, and eliminate (Earth Track, 2012a). Earth Track is working to establish a combination of research programmes and partnerships with like-minded organisations and individuals around the world in order to improve the information base on which important energy and environmental policy decisions are made. Earth Track also has an educational role, helping people to understand how subsidies work and informing about government interventions through its website and reports (Earth Track, 2012b).	Earth Track's objectives are to strengthen and standardize subsidy data in an unbiased way, to show a holistic picture of the impact of government policies on resource use and investment decisions, to provide educational materials, and to improve subsidy valuation tools and quantify the value of existing subsidies (Earth Track, 2012a).
Global Subsidies Initiative (GSI)	IISD 2005 Global	The GSI is devoted to analysing subsidies and how they support or undermine progress towards sustainable development. The GSI has received funding from governments, United Nations agencies, and foundations. The GSI's research into fossil-fuel subsidies is supported by the governments of Denmark, Norway, New Zealand, Switzerland and the United Kingdom (IISD, 2013).	The GSI aims to encourage individual governments to undertake subsidy reforms where these would deliver economic, environmental and social benefits and to generate a consensus in the World Trade Organization and in other forums on the necessity of reducing or eliminating subsidies that are trade-distorting and undermine sustainable development (IISD, 2013).
Oil Change International	- 2005 Global	Oil Change International is a research, communication, and advocacy organisation. Oil Change International works with partners around the world to make sure that fossil-fuel subsidies are phased-out as quickly as possible, by pushing for increased transparency, support for the poor and vulnerable, global coordination, and a phase-out deadline. Oil Change International contributes to the phase-out of fossil fuel subsidies by engaging in forums to push for a shift of public finances away from fossil fuels and towards clean energy, providing experience and leadership in organizing resistance to the political influence of the fossil-fuel industry, and bringing unique industry expertise (Oil Change International, 2013a) (Oil Change International, 2013b).	Oil Change International aims to expose the true costs of fossil fuels and to facilitate the transition towards clean energy (Oil Change International, 2013a).

9. WEDGE 9: REDUCE DEFORESTATION

9.1 INTRODUCTION

The current global forest[29] area is estimated to be about 4 billion hectares, covering 31% of the total land area (FAO, 2010) (FAO, 2012a). The worldwide cumulative loss of forest area over a period of 5000 years until 2010 has been estimated to be 1.8 billion hectares (FAO, 2012a). In the 1990s around 16 million hectares of forest per year were converted to other uses or lost through natural causes. This rate of deforestation has decreased to around 13 million hectares per year over in period 2000–2010, but remains very high (FAO, 2010) (FAO, 2012a). The global net loss of forest area is significantly lower, due to afforestation and natural expansion of existing forests in some countries. The global net loss of forest area decreased from an estimated 8.3 million hectares per year in the period 1990–2000 to 5.2 million hectares per year in the period 2000–2010 (FAO, 2010). However, considerable differences exist between the different regions in the world as can be seen in Figure 16. Most of the net loss of forests occurs in tropical regions whereas most of the net gain occurs in the temperate and boreal zones, in very different types of forests (FAO, 2010) (FAO, 2012a). The only region which shows a trend of increasing forest loss is Oceania, which is due to severe droughts and forest fires in Australia. The notable change in Asia from a net loss of 0.6 million hectares per year in the 1990s to an average net gain of over 2.2 million hectares per year in the period 2000–2010 is mainly due to large-scale afforestation in China (FAO, 2010).

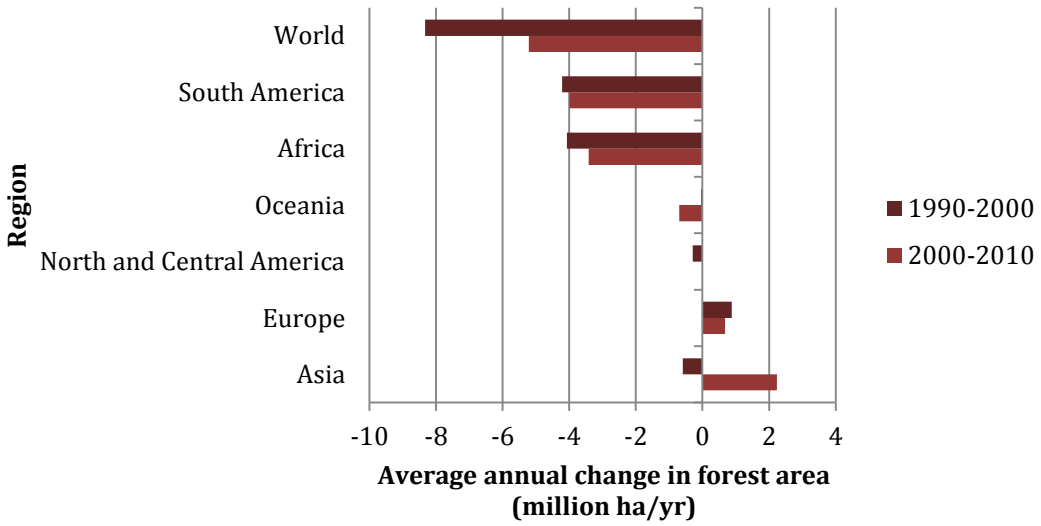

FIGURE 16 AVERAGE ANNUAL CHANGE IN FOREST AREA BY REGION (BASED ON FAO, 2010)

The direct driver for 80% of deforestation worldwide is agriculture. The clearing of land for other purposes, such as mining, infrastructure and urban expansion, is also an important driver. The main reasons for forest degradation are timber extraction, fuel wood collection, charcoal production, and livestock grazing (Kissinger et al., 2012). Many governments foster deforestation by providing subsidies and incentives for agriculture and by failing to value the important ecosystem services provided by forests. The external costs associated with forest clearing and degradation worldwide are estimated to be between US$ 2 trillion and 4.5 trillion per year (FAO, 2012a).

According to Nicholas Stern *"any climate change deal that does not fully integrate forestry will fail to meet the necessary targets"* (Stern, 2008, p. 25). Forests store over 650 Gt of carbon in biomass,

[29] FAO defines forest as *"Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use"* (FAO, 2010, p. 209).

soil, and dead wood and litter, which is more than the amount of carbon in the entire atmosphere (FAO, 2010). Therefore, forests play an important role in the carbon balance of the earth and hold significant climate change mitigation potential (FAO, 2012a). There is large uncertainty in estimates of emissions from land-use change (Harris et al., 2012). According to the IPCC the most likely estimate of net emissions from deforestation in the 1990s is 5.8 Gt CO_2 per year (Nabuurs et al., 2007).

Forest mitigation options include reducing emissions from deforestation and forest degradation (REDD), afforestation, reforestation and sustainable forest management. If properly designed and implemented, these forest mitigation options can be a low-cost method of meeting greenhouse gas emission targets, providing significant co-benefits in terms of employment, biodiversity, watershed conservation, and local livelihoods (Nabuurs et al., 2007) (Baker et al., 2010). The core of sustainable forest management is that harvested trees are replaced by new trees. As long as new trees are planted to replace those that are harvested, the amount of atmospheric carbon dioxide will in general decrease. However, there are many differences between different types of forests. Planted forests cannot fully compensate for the deforestation of natural or primary forests, especially concerning biodiversity (FAO, 2012a).

Many countries are already acting to reduce emissions from deforestation and forest degradation, and international agreements on REDD exist. In 2007, the Member States of the United Nations Forum on Forests (UNFF) adopted the 'Non-legally binding instrument on all types of forests' and reaffirmed their commitment to reverse the global forest loss and increase efforts to prevent forest degradation (UN, 2007). In 2008, delegates from the Convention on Biological Diversity (CBD) representing 67 countries pledged support for WWF's target of net zero emissions from deforestation and degradation in 2020. In 2010 the parties of the CBD adopted the Aichi Biodiversity Targets, including the target to at least halve forest loss and where possible bring it to zero by 2020 (WWF, 2011) (CBD, 2010). In 2010 the Conference of the Parties to the UNFCCC adopted a decision on REDD+, which lists safeguards to ensure multiple benefits and prevent negative spill-over effects from REDD+ activities. REDD+ goes further than REDD and also includes sustainable forest management and conservation and enhancement of forest carbon stocks (FAO, 2011). Also in 2010 at the Oslo Climate and Forest Conference, the REDD+ Partnership was launched. High-level government representatives from 50 countries agreed on a framework for the rapid implementation REDD+ measures. These countries pledged around US$ 4 billion for measures to reduce greenhouse gas emissions from deforestation and forest degradation in developing countries (FAO, 2011) (REDD+ Partnership, 2013).

Although considerable progress has already been made in reversing the global trend of deforestation, substantial efforts are still needed to stabilize or increase forest area in all regions of the world (FAO, 2010). According to Blok et al. (2012) global deforestation could be halved by 2020, if action is taken, led by an individual with convening power, in all the major countries with high deforestation emissions. This could have an impact of reducing up to 1.8 Gt CO_2e in 2020 (Blok et al., 2012).

9.2 DESCRIPTION OF INITIATIVES

Table 10 provides an overview of 13 initiatives aimed at REDD, REDD+ or sustainable forest management. Most of these initiatives are partnerships or networks bringing together different stakeholders (e.g. governments, international organisations, businesses, and local communities). Some of them are aimed at assisting countries with REDD+ activities at the government-level, whereas others focus on strengthening the position of local forest communities. The vast majority of initiatives do not have a clear commitment or quantifiable target stated. Exceptions are WWF, Greenpeace, and the Global Partnership on Forest and Landscape Restoration (GPFLR). In 2011, GPFLR launched the Bonn Challenge; a commitment to restore 150 million hectares of lost forests and degraded lands worldwide by 2020 (IUCN, 2011). By the end of 2012 one third of that target, 50 million hectares restored, was already within reach (IUCN, 2012). WWF campaigns for zero net emissions from deforestation and forest degradation by 2020 (WWF, n.d. b). Greenpeace strives for completely halting deforestation by 2020 (Greenpeace, 2013).

TABLE 10 OVERVIEW OF FOREST SECTOR INITIATIVES FOR GHG EMISSION MITIGATION

Initiative	Led By Starting Year Region	Description (as described by the organisation)	Commitment
Asia Forest Partnership (AFP)	- 2002 Asia & the Pacific	AFP is a regional multi-stakeholder forum launched at the World Summit on Sustainable Development. The partnership has currently 42 partners. AFP has set itself the task of information sharing, dialogue and joint action to promote sustainable forest management in Asia and the Pacific. By bringing them together AFP can enhance the efforts of individual forest stakeholders to promote sustainable forest management (AFP, n.d.).	No clear commitment stated.
Collaborative Partnership on Forests (CPF)	- 2001 Global	The CPF is an interagency partnership on forests comprising 14 international organisations, institutions, and secretariats with have substantial programmes on forests. The CPF was created to support the work of the UNFF and its member states and to improve cooperation and coordination among CPF member organisations. CPF's objective is to promote the management, conservation and sustainable development of all types of forests and to enhance long-term political commitment (CPF, 2013).	No clear commitment stated.
Cool Earth	- 2007 Global	Cool Earth is a charity that works with local communities to protect some of the world's most endangered rainforests from being destroyed. Cool Earth helps these communities to take legal control of their forest, to defend their trees and to get better prices for their products. Cool Earth does not buy land, but secures the land ownership for the local communities. Cool Earth makes a difference by protecting rainforest that would otherwise be destroyed within the next eighteen months and which has high levels of biodiversity. Cool Earth strategically chooses to protect areas of forest that form a protective blockade for millions of acres of neighbouring forest (Cool Earth, n.d.).	No clear commitment stated.
FERN	- 1995 EU	FERN is a NGO keeping track of the EU's involvement in forests and coordinating NGO activities at the European level. FERN focusses on forests and forest peoples' rights and the issues that affect them. FERN's mission is to improve environmental and social justice in the policies and practices of the EU. In striving to achieve this mission, FERN aims to be collaborative, evidence-based, independent, challenging and inclusive. All of FERN's work is done in close collaboration with social and environmental organisations and movements worldwide (FERN, n.d.).	No clear commitment stated.

TABLE 10 OVERVIEW OF FOREST SECTOR INITIATIVES FOR GHG EMISSION MITIGATION (CONTINUED)

Initiative	Led By Starting Year Region	Description (as described by the organisation)	Commitment
Forest and Climate Change Programme	FAO - Global	The Forest and Climate Change Programme works to increase national and international action on forests and climate change adaptation and mitigation. It aims to raise awareness, strengthen technical capacities and create enabling policy environments for action. The programme collaborates with many partners and stakeholders to raise awareness, enhance technical capacity, and create supporting policy environments for action (FAO, 2013).	No clear commitment stated.
Forest & Climate Initiative	WWF - Global	WWF's Forest & Climate Initiative is working to enhance support for a global policy framework for REDD+ and to ensure major REDD+ initiatives adopt and implement strong social, environmental and governance safeguards. The initiative works with forest countries and with local communities to build capacity and ensure programmes, standards, approaches and technologies for REDD+ produce real and verifiable emissions reductions while enhancing biodiversity and human well-being (WWF, n.d. b).	The goal of WWF's Forest & Climate Initiative is to achieve zero net emissions from deforestation and forest degradation by 2020 (WWF, n.d. b).
Forest Carbon Partnership Facility (FCPF)	World Bank 2008 Gobal	FCPF is a global partnership of governments, businesses, civil society, and Indigenous Peoples aimed at REDD+, including 37 tropical and sub-tropical developing countries. The objectives of the FCPF are to assist countries in their REDD+ efforts by providing them with financial and technical assistance, to pilot a performance-based payment system for REDD+ activities, to test ways to sustain or improve livelihoods of local communities and to conserve biodiversity within the approach to REDD+, and to disseminate the knowledge gained in the process. To achieve these objectives the FCPF has two separate complementary funding mechanisms, the Readiness Fund and the Carbon Fund (FCPF, 2013).	No clear commitment stated.
Forest Stewardship Council (FSC)	- 1993 Global	FSC is a global non-profit organisation promoting environmentally, socially and economically responsible forest management worldwide. Through certification FSC creates an incentive for forest owners and managers to follow best social and environmental practices and enables businesses and consumers to choose products that come from well managed forests (FSC, n.d. a) (FSC, n.d. b).	No clear commitment stated.

TABLE 10 OVERVIEW OF FOREST SECTOR INITIATIVES FOR GHG EMISSION MITIGATION (CONTINUED)

Initiative	Led By Starting Year Region	Description (as described by the organisation)	Commitment
Forest Trends	- 1998 Global	Forest Trends is an international non-profit organisation created by leaders from conservation organisations, forest products firms, research groups, multilateral development banks, private investment funds and philanthropic foundations. Forests Trends' mission is to expand the value of forests to society, to promote sustainable forest management and conservation through creating market values for ecosystem services, to support projects and companies that are developing these markets, and to enhance the livelihoods of local communities living in and around forests. Forest Trends analyses strategic market and policy issues and develops new financial tools to help markets work for conservation and people (Forest Trends, 2013).	The goal of Forest Trends is to have a meaningful impact on a global scale (Forest Trends, 2013). No quantified commitment stated.
Global Partnership on Forest and Landscape Restoration (GPFLR)	IUCN 2003 Global	GPFLR is a proactive network that brings together governments, organisations, communities and individuals with a shared goal. The priorities of the GPFRL are to catalyse support for forest and landscape restoration, to map and analyse restoration potential, and to enhance knowledge and networks on forest landscape restoration. Through active engagement, collaboration and the sharing of ideas and information GPRFL promotes an integrated approach that aims to ensure that forests and the functions they provide are effectively restored and conserved to help secure sustainable livelihoods and ecological integrity for the future (GPFLR, 2009a) (GPFLR, 2009b).	In 2011 the Bonn Challenge was launched; a commitment to restore 150 million hectares of lost forests and degraded lands worldwide by 2020 (IUCN, 2011).
Greenpeace	- - Global	Greenpeace is an independent global campaigning organisation acting to protect and conserve the environment. Greenpeace is campaigning for zero global deforestation by 2020. Greenpeace wants to achieve this by challenging industries to change their destructive practices, inspiring consumer action to demand products that aren't linked to forest destruction and lobbying politicians to take the co-ordinated international and local political action needed to protect the world's forests, the people who depend on them, biodiversity and the climate. Greenpeace works with indigenous communities at the frontline of forest destruction to investigate, document, expose and take action against forest destruction (Greenpeace, 2013).	Greenpeace campaigns for zero global deforestation in 2020 (Greenpeace, 2013).

TABLE 10 OVERVIEW OF FOREST SECTOR INITIATIVES FOR GHG EMISSION MITIGATION (CONTINUED)

Initiative	Led By Starting Year Region	Description (as described by the organisation)	Commitment
Prince's Rainforest Project	- 2007 Global	The Prince's Rainforests Project was set up by The Prince of Wales in order to find practical solutions to slow tropical deforestation and combat climate change. The project aims to help the world community recognise the true value of forests by identifying ways to value and then pay for the ecosystem services rainforests provide. The Prince's Rainforests Project is part of the International Sustainability Unit (Prince of Wales, 2013).	No clear commitment stated.
UN-REDD Programme	UN 2008 Global	The UN-REDD Programme is the UN's collaborative initiative on REDD+ in developing countries. The programmes mission is to support countries' efforts to reduce emissions from deforestation and forest degradation. The programme supports nationally-led REDD+ processes and promotes the involvement of all stakeholders in REDD+ implementation. The UN-REDD Programme has 46 partner countries (UN-REDD, 2010).	No clear commitment stated.

There are large differences in the estimates of the greenhouse gas emissions from deforestation from different sources. The estimates vary strongly because of basic uncertainty in the data and differences in assumptions and methodologies. There are major uncertainties in the actual deforestation rate, the biomass and soil carbon content of different forest types, the rate of carbon loss of for deforested areas, and the rate of re-growth of deforested and abandoned forest areas (Achard et al., 2004) (Ramankutty et al., 2007) (Baker et al., 2010). Estimations of deforestation emissions are further complicated by the fact that there are more than 90 definitions of forest area being used throughout the world (Lepers et al., 2005).

According to FAO the world's forests are a net source of emission, since forest area has decreased while carbon stock per hectare has remained nearly constant over the period 1990–2010. FAO estimates the loss of global carbon stock in forests in the period 2000–2010 to be 8.4 Gt C (FAO, 2010). Based on these data net carbon dioxide emissions from deforestation and forest degradation were 3.1 Gt CO_2[30] per year in the period 2000–2010. However, according to Pan et al. (2011) the world's forests are a carbon sink instead of a carbon source. Tropical forests are estimated to be almost carbon-neutral, since gross emissions from deforestation are almost equal to carbon uptake in tropical forests. With temperate and boreal forests acting as a net carbon sink, global net forest emissions are estimated to be negative. The total net forest sink is estimated to be 4.4 ± 3.1 Gt CO_2[30] per year in the period 2000–2007 (Pan et al., 2011).

Due to these considerable differences in the estimates of historical emissions from deforestation, it is difficult to define a reliable business-as-usual scenario for the forest sector. Even if it a reliable scenario had been available, estimating the emission reduction would be complicated by the fact that abatement potential can exceed business-as-usual emissions in the forestry sector. UNEP (2012) estimates an abatement potential in the forestry sector of 1.3–4.4 Gt CO_2e in 2020 at costs below 100 US$/t$CO_2$e, whereas McKinsey & Company (2009) predicts an abatement potential of 5.9 Gt CO_2e in 2020 at costs below 28 US$/t$CO_2$e.

Most of the initiatives identified do not have a target stated. Two of the initiatives, however, have very ambitious stated targets. WFF aims to achieve zero net emissions from deforestation and forest degradation by 2020 (WWF, n.d. b) and Greenpeace campaigns for zero global deforestation in 2020 (Greenpeace, 2013). These targets are, however, more likely to be aspirational targets than actual commitments.

It is not possible to quantify the emission reduction potential of the initiatives because of lack of strong quantifiable commitments. However, based on the number of initiatives aimed at reducing deforestation a significant impact can be expected from this wedge. Based on the abatement potentials estimated by UNEP (2012) and McKinsey & Company (2009), an impact of the order of a few gigatonnes can be expected from the initiatives within this wedge.

[30] Calculated from to Gt C to Gt CO_2 using the molecular weight of carbon and carbon dioxide (1 Gt C = 44/12 Gt CO_2).

10. WEDGE 10: AGRICULTURE

10.1 INTRODUCTION

Agricultural greenhouse gas emissions exist mainly in the form of methane and nitrous oxide, rather than carbon dioxide[31] (Smith et al., 2007). The agricultural sector accounts for the largest share of anthropogenic emissions of these two gases (Smith et al., 2008) (USEPA, 2012a). Methane is produced when organic materials decompose in anaerobic conditions (e.g. enteric fermentation by ruminant livestock, stored manures, and flooded rice paddies). Nitrous oxide emissions result from the microbial transformation of nitrogen in soils and manures. The main cause for the increase of agricultural nitrous oxide emissions is the application of nitrogen fertilizers and animal manures (Johnson et al., 2007) (Smith et al., 2008). The main sources of agricultural emissions are shown in Figure 17.

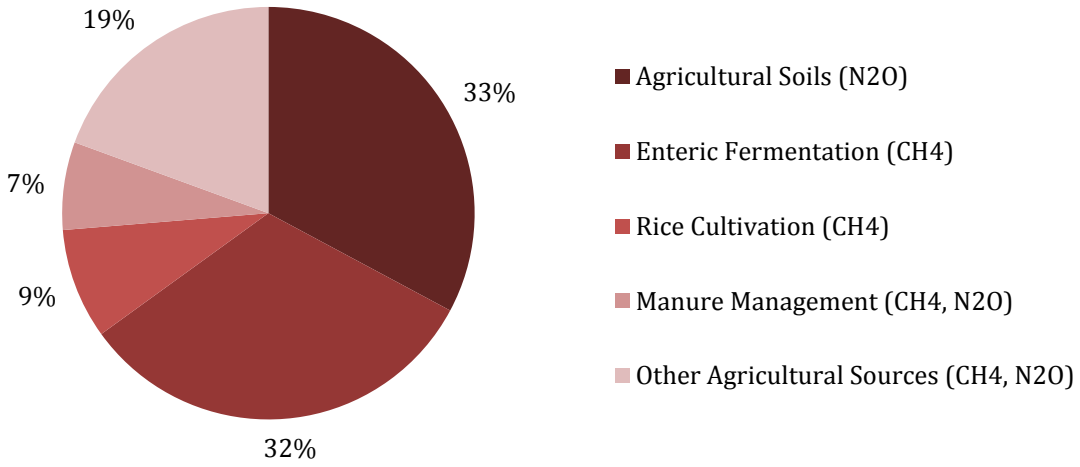

FIGURE 17 SOURCES OF EMISSIONS IN THE AGRICULTURAL SECTOR (BASED ON USEPA, 2012A)

Agricultural methane and nitrous oxide emission amounted to 6.0 Gt CO_2e in 2010 and are expected to increase to 6.5 Gt CO_2e in 2020 under business-as-usual conditions[32] (USEPA, 2012a). Developing countries are responsible for the majority of these emissions (Smith et al., 2007). The emissions from agriculture are expected to increase due to an increase in the demand for agricultural products driven by population growth, increasing per capita income, and a shift of diet preferences towards higher per capita meat consumption (Smith et al., 2007) (USEPA, 2012a).

There are many options for abating greenhouse gas emissions in the agricultural sector, such as improved cropland and grazing land management, restoration of degraded lands and cultivated organic soils, improved livestock management, and improved manure management (Smith et al., 2007) (Smith et al., 2008). According to UNEP (2012) the emissions reduction potential in the agricultural sector in 2020 is between 1.1 and 4.3 Gt CO_2e, at marginal costs below 100 US$/t$CO_2$e. McKinsey & Company (2009) estimates a reduction potential of 2.7 Gt CO_2e in 2020, a considerable part of which could be abated at negative abatement costs. For example nutrient management has negative abatement costs, due to a reduction in fertilizer use (McKinsey & Company, 2009). Mitigating climate change in the agricultural sector can have several co-benefits, such as increasing efficiency and trade competitiveness, reducing deforestation, enhancing food security and reducing water pollution (Wilkes et al., 2012).

[31] There are also substantial CO_2 fluxes both to and from agricultural land, but the *net* flux is small. CO_2 emissions from the conversion of forest land to agricultural land are allocated to the forestry sector (Smith et al., 2007).

[32] USEPA's BAU scenario is not consistent with the BAU scenarios used throughout this report, since future mitigation actions are only included if either a well-established programme or an international sector agreement is in place. Other commitments made by countries to reduce agricultural emissions are not taken into account in this scenario. Future changes in emission factors due to technological development are also not accounted for in USEPA's projections (USEPA, 2012a).

Many countries have made commitments to reduce their greenhouse gas emissions from agriculture (USEPA, 2012a). For example, 55 non-Annex I countries responded to the invitation in the Copenhagen Accord by submitting nationally appropriate mitigation actions (NAMAs) to the UNFCCC. At least 21 of these submissions include mitigation actions in the agricultural sector and many more NAMAs are being developed (Wilkes et al., 2012).

According to Blok et al. (2012) the International Federation of Agricultural Producers (IFAP) could help to realize 30% of the technical mitigation potential, with an estimated impact of mitigating up to 0.8 Gt CO_2e. The IFAP does, however, no longer exist[33]. A possible actor that could lead the climate change mitigation efforts in the agricultural sector is the World Farmers' Organisation (WFO), launched in 2011. WFO represents farmers' organisations and agricultural cooperatives with the objective of developing policies which support farmers around the world (WFO, 2013a). Although the WFO has not made any commitments regarding greenhouse gas emission mitigation, the organisation acknowledges the importance of climate change mitigation and encourages farmers to participate in the development of sustainable agricultural practices (WFO, 2013b).

10.2 DESCRIPTION OF INITIATIVES

Table 11 provides an overview of ten initiatives aimed at sustainable agriculture. There are various types of initiatives. The majority of the initiatives are research initiatives aimed at researching and developing sustainable agricultural practices. These research initiatives are not likely to have a significant impact on agricultural emissions in the short-term. Only two initiatives, the New Vision for Agriculture initiative and the Sustainable Agriculture Initiative (SAI) Platform, are led by companies committed to sustainable agriculture. Most initiatives are focused on sustainable agriculture in general, with the exception of AgSTAR and the Global Methane Initiative (GMI). These two initiatives aim specifically at reducing methane emissions from agriculture by promoting the conversion of methane to biogas.

Unfortunately, only one of the identified initiatives has a stated target. The New Vision for Agriculture initiative aims at reducing emissions per tonne of production by 20% each decade (WEF, 2010). All other initiatives do not have a clear commitment.

[33] The IFAP was dissolved by a court judgement on 4 November 2010, which ordered the judicial liquidation of the IFAP (ILO, 2012).

TABLE 11 OVERVIEW OF SUSTAINABLE AGRICULTURE INITIATIVES

Name	Led By Starting Year Region	Description (as described by the organisation)	Commitment
AgSTAR	USEPA - US	AgSTAR Programme is a voluntary outreach and educational programme aimed at reducing methane emissions from animal manure by promoting the use of biogas recovery systems. Biogas recovery systems are anaerobic digesters that capture and combust biogas to produce electricity, heat or hot water. AgSTAR provides information and tools to assist producers in the evaluation and implementation of these systems (USEPA, 2012b).	No clear commitment stated.
European Initiative for Sustainable Development in Agriculture (EISA)	- 2001 Europe	EISA is an alliance of national organisations of six European countries (France, Germany, Luxembourg, Sweden, United Kingdom, and Austria) aimed at developing and promoting sustainable farming systems. EISA has set up a network of demonstration farms to demonstrate Integrated Farming and promotes Integrated Farming throughout Europe. EISA aims to establish the EISA Framework as the European farming guideline for sustainable agriculture (EISA, n.d.).	No clear commitment stated.
Global Research Alliance on Agricultural Greenhouse Gases	- 2009 Global	The Global Research Alliance on Agricultural Greenhouse Gases is a Research Alliance based on voluntary, collaborative efforts of over 30 member countries. The Alliance is aimed at research, development and extension of technologies and practices that will help to produce more food without increasing GHG emissions. The Alliance supports three research groups (croplands, livestock and paddy rice) and two cross-cutting teams (soil carbon & nitrogen cycling and inventories & measurement) (Global Research Alliance, n.d.).	No clear commitment stated.
Global Methane Initiative (GMI)	- 2004 Global	GMI is a voluntary public-private partnership that aims to reduce global methane emissions and to increase recovery and use of methane as an energy source. GMI focusses on five sectors, one of which is agriculture. The Agriculture Subcommittee focuses on promoting the reduction of methane emissions from livestock manure and agro-industrial wastewater and residues through conversion into biogas by anaerobic digestion (GMI, n.d.).	No clear commitment stated.

TABLE 11 OVERVIEW OF SUSTAINABLE AGRICULTURE INITIATIVES (CONTINUED)

Name	Led By Starting Year Region	Description (as described by the organisation)	Commitment
Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI)	- 2010 Europe	FACCE-JPI is a Joint Programming Initiative of 21 countries committed to building an integrated European Research Area addressing sustainable agriculture, food security and impacts of climate change. FACCE-JPI provides and steers research to support sustainable agriculture and economic growth and to contribute to a European bio-based economy. In the summer of 2013 an implementation plan will be launched, setting out short-term and mid-term priority actions to implement the FACCE-JPI strategic research agenda (Hemonin, 2013).	No clear commitment stated.
Mitigation of Climate Change in Agriculture (MICCA) Programme	FAO 2010 Europe	The MICCA Programme is a multidisciplinary programme funded by Finland, Germany and Norway. The MICCA Programme aims to improve the livelihoods of farmers in developing countries and to enable these farmers to contribute to climate change mitigation. Among other activities, the MICCA Programme monitors and assesses GHG emissions and mitigation potential in the agricultural sector and puts climate-smart agriculture into practice in pilot projects (FAO, 2012b).	No clear commitment stated.
New Vision for Agriculture	WEF - Global	The New Vision for Agriculture is an initiative led by 29 global partner companies that addresses the major challenges of global food and agricultural sustainability. The initiative works to develop a shared agenda for action and to enhance multistakeholder collaboration in order to achieve sustainable agricultural growth through market-based solutions. The initiative has started four major public-private partnerships, including country-level initiatives in Mexico, Vietnam, Indonesia, and India, as well as the regional partnership platform Grow Africa which includes seven African countries. At the global level, the initiative enables public-private dialogue with the G20 (WEF, n.d.).	The New Vision for Agriculture aims to increase production by 20% while decreasing emissions per tonne of procuct by 20% and reducing the prevalence of rural poverty by 20% each decade (WEF, 2010).
Research Program on Climate Change, Agriculture and Food Security (CCAFS)	CIAT 2011 Global	CCAFS is a research initiative of the CGIAR (a global agriculture research partnership) and Future Earth (a research initiative for sustainability). CCAFS joins together the world's best researchers to identify and address the most important interactions, synergies and trade-offs between agriculture and climate change and to address agriculture in the context of climate variability, climate change and uncertainty about future climate conditions (CCAFS, n.d.).	No clear commitment stated.

TABLE 11 OVERVIEW OF SUSTAINABLE AGRICULTURE INITIATIVES (CONTINUED)

Name	Led By Starting Year Region	Description (as described by the organisation)	Commitment
Sustainable Agriculture Initiative (SAI) Platform	- 2020 Global	SAI Platform is a global food industry initiative with over 40 members aimed at supporting the development of sustainable agriculture worldwide. SAI Platform involves all food chain stakeholders willing to play an active role in the development and implementation of sustainable agricultural practices. The SAI Platform collects and develops knowledge on sustainable agriculture, which it communicates to all interested parties (SAI Platform, 2010).	No clear commitment stated.
Sustainable Agriculture Network (SAN)	- 1984 Global	The SAN is a coalition of leading conservation groups that promotes efficient and productive agriculture, biodiversity conservation and sustainable community development. The SAN aims to establish its sustainable agricultural standards as respected and recognized around globally by all actors along the value chain (SAN, 2010).	No clear commitment stated.

10.3 METHODS & RESULTS

Only one initiative, the New Vision for Agriculture initiative, has a stated target. The target of this initiative is to reduce emissions per tonne of production by 20% each decade (WEF, 2010).

Data from the USEPA's publication *Global Anthropogenic Non-CO_2 Greenhouse Gas Emissions: 1990–2030* (USEPA, 2012a) are used as the basis for determining the business-as-usual emissions of the agricultural sector in 2020. The previous edition of this publication was the main source of information on agricultural emissions in the IPCC's *Fourth Assessment Report* (Smith et al., 2007). The USEPA (2012a) data include only methane and nitrous oxide emissions for the agricultural sector. Carbon dioxide emissions are not included in the current analysis, since the net flux of carbon dioxide from agricultural land is small (Smith et al., 2007).

According to the USEPA (2012a) agricultural methane and nitrous oxide emissions were 6.0 Gt CO_2e in 2010 and are expected to increase to 6.5 Gt CO_2e in 2020 under business-as-usual conditions. Based on the 95% confidence intervals for agricultural emissions reported by Tubiello et al. (2013), the uncertainty in the emission scenario is estimated to be -10% to +30%. The uncertainty range for the 2020 emissions is thus estimated to be 5.8–8.4 Gt CO_2e. However, USEPA's definition of the business-as-usual scenario is not comparable to the business-as-usual scenario as defined in this report. USEPA (2012a) includes future mitigation actions only if either a well-established programme or an international sector agreement is in place. The business-as-usual scenario might thus not include some already adopted policies. Also, no future changes in emission rates due to technological development are included in USEPA's business-usual-scenario (USEPA, 2012a). Due to these reasons, the USEPA business-as-usual emissions are an overestimation of the business-as-usual emissions as defined in this report.

To account for this overestimation the USEPA business-as-usual scenario is adjusted. Based on the gross production index of the agricultural sector reported by FAO (2013) and historical agricultural emission data reported by USEPA (2012a), the historical emission intensity improvement in the agricultural sector is estimated. For the period 1990–2005 the emission intensity improvement is estimated to by 1.9% per year and for the period 2000–2005 this is estimated to be 1.0% per year. Since decreasing returns from further technological progress are expected in the future (Smith et al., 2007), the emission intensity improvement in the business-as-usual scenario in the period 2010–2020 is assumed to be 0.75% per year (range: 0.5–1.0 % per

year). Applying this assumption to the USEPA business-as-usual emissions, in which no technological progress is taken into account, results in an estimation of the business-as-usual emissions in 2020 of 6.0 Gt CO_2e (range: 5.3–8.0 Gt CO_2e).

Since no future changes in emission rates due to technological development are included in USEPA's business-usual-scenario, the 20% emission reduction target of the New Vision for Agriculture initiative is expected to have an impact of reducing emissions 20% below the USEPA projection. Relating this target of the New Vision for Agriculture initiative to the adjusted business-as-usual scenario leads to an estimated of 0.8 Gt CO_2e (range: 0.6–1.3 Gt CO_2e). This is comparable to the estimation by Blok et al. (2012) (see Figure 18). The large uncertainty range is due to the uncertainty in the business-as-usual scenario. The estimated commitment is lower than the abatement potentials of 1.1–4.3 Gt CO_2e given by UNEP (2012) and 2.7 Gt CO_2e estimated by McKinsey & Company (2009). Thus, the target of the New Vision for Agriculture initiative seems to be technically and economically feasible.

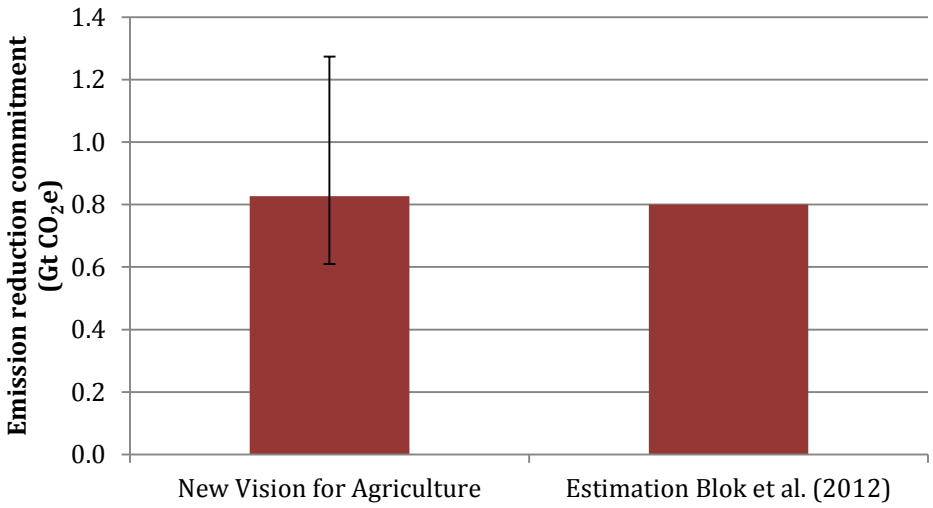

FIGURE 18 EMISSION REDUCTION IN 2020 BASED ON COMMITMENT OF NEW VISION FOR AGRICULTURE INITIATIVE

11. RESULTS & OVERLAP

11.1 RESULTS

In Figure 19 the results for all of the ten analysed wedges are shown compared to the estimations of the emission reduction potential of the wedges estimated by Blok et al. (2012). There are strong differences between the amount of currently existing initiatives and their ambition levels within the different wedges. There are no existing large-scale bottom-up iniatives aimed at voluntary offsetting, either for companies or consumers. There are a few initiatives aimed at accelerating the phase-out of fossil-fuel subsidies, but these are not expected to lead to emission savings beyond the current country pledges and could not be quantified due to lack of clear commitments. For the wedge 'Reduce deforestation' the commitments could also not be quantified, due to lack of quantiable commitments as well as large uncertainty in the baseline emission data for the forest sector. Within the wedges 'Cars and trucks', 'Boost solar PV energy', and 'Boost wind energy', multiple initiatives exist but their ambition levels are lower than the potential estimated by Blok et al. (2012). The commitment of the existing iniative in the wedge 'Agriculture' is comparable to the estimation by Blok et al. (2012). For the wedges 'Top 1000 companies' and 'Major cities initiative' the commitments of currently existing initiatives exceed the estimations by Blok et al. (2012).

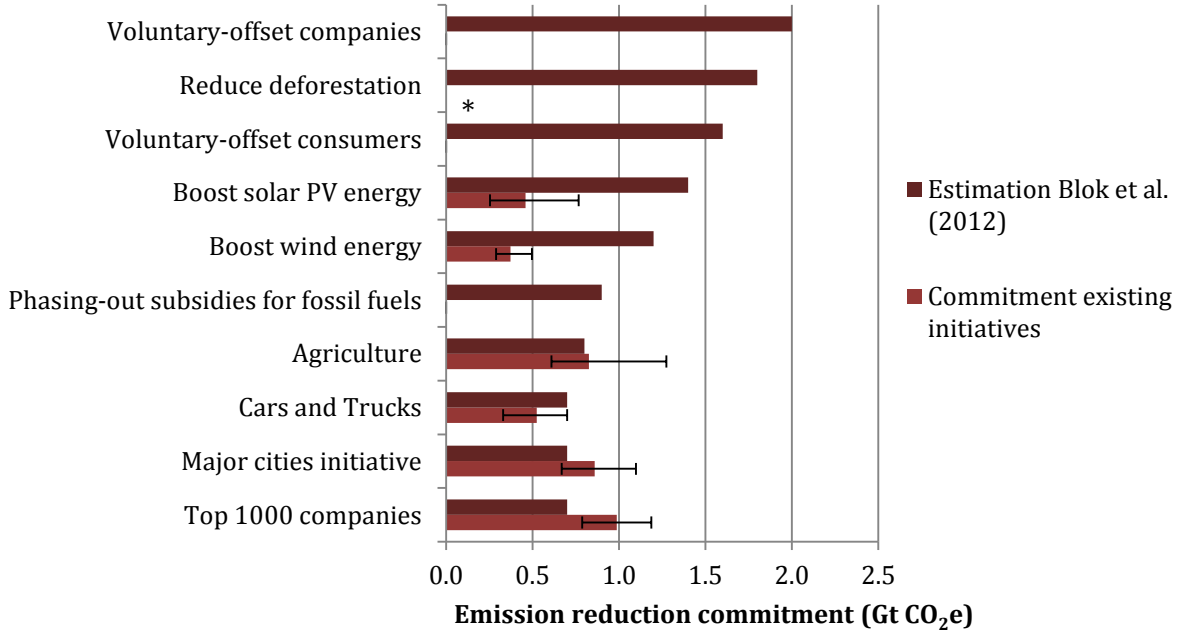

FIGURE 19 2020 EMISSION REDUCTION COMMITMENT OF EXISTING INITIATIVES COMPARED TO ESTIMATED POTENTIAL BY BLOK ET AL. (2012) FOR ALL 10 WEDGES
*) EMISSION REDUCTION COMMITMENT OF INITIATIVES COULD NOT BE QUANTIFIED

11.2 OVERLAP WITH OTHER WEDGES

Adding all the commitment of the six wedges for which the commitments could be quantified together, leads to a total commitment in the range of 3.6–4.7 Gt CO_2e[34]. However, overlap exists between the different wedges. For example, an increase in the share of renewable energy influences the emission reduction from energy savings. The assumptions for the overlap between the wedges are based on the estimates made by Blok et al. (2012). Since this research only covers part of the

[34] Error propagation rules are used for determining the uncertainty range of the combined commitment of the wedges.

wedges and for some wedges no emission reduction commitment could be quantified, the overlap between the commitments is likely to be smaller than the estimates by Blok et al. (2012). The total commitment of the existing initiatives covered in this research is about a quarter of the total impact estimated by Blok et al. (2012). Therefore, the overlap is estimated to be a quarter of the overlap estimated by Blok et al. (2012). For the lower limit of the uncertainty range, no overlap is assumed. For the upper limit, half the overlap values assumed by Blok et al. (2012) are used. The values used are shown in Table 12.

TABLE 12 ASSUMPTIONS ON OVERLAP BETWEEN WEDGES

Wedge	Overlap with initiatives above	Lower value	Upper value
Top 1000 companies	0%	0%	0%
Major cities initiative	7.5%	0%	15%
Cars and Trucks	7.5%	0%	15%
Boost solar PV energy	12.5%	0%	25%
Boost wind energy	12.5%	0%	25%
Agriculture	7.5%	0%	15%

Figure 20 shows the results of the overlap calculations, including the uncertainty range of the result. Uncertainty ranges are not shown for the individual wedges, as this would make the figure unclear. The combined commitment of the initiatives for which the emission reduction is quantified in this research is expected to be in the range of 3.2–4.5 Gt CO_2e in 2020. This figure does not include the wedge 'Reduce deforestation', since it was not possible to quantify the emission reduction commitment of this wedge. However, there are ambitious initiatives within this wedge and emission reductions of the order of a few gigatonnes can be expected.

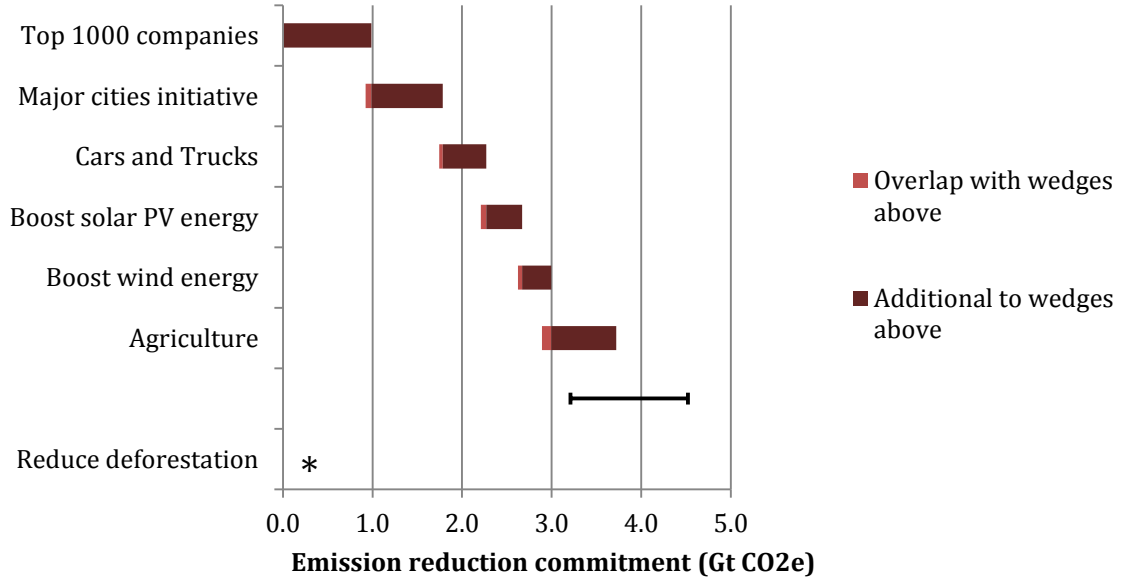

FIGURE 20 COMBINED COMMITMENT ACCOUNTING FOR OVERLAP BETWEEN WEDGES
*) EMISSION REDUCTION COMMITMENT OF INITIATIVES COULD NOT BE QUANTIFIED

11.3 OVERLAP WITH COUNTRY PLEDGES

The emissions reductions achieved when all initiatives meet their stated targets will overlap with emission reduction pledges made by countries. To determine the overlap with high-ambition country pledges the WEO 2012 New Policies Scenario is used as a the reference scenario instead of the WEO 2012 Current Policies Scenario (IEA, 2012a) for the wedges 'Top 1000 companies', 'Major cities initiative', 'Boost solar PV' and 'Boost wind energy'. For the wedges 'Boost solar PV' and 'Boost wind energy', the data from the WEO 2012 New Polices Scenario are combined with data from the National Renewable Energy Action Plans (NREAP) provided by Member States of the European Union[35] (Beurskens et al., 2011). The data from the NREAPs are taken as the primary source to determine the overlap for the European Union, whereas the data from the WEO 2012 New Policies Scenario are used to determine the uncertainty range. For the 'Cars and trucks' wedge, the ICCT's Pipeline Trajectory is used as the reference scenario for determining the overlap with country pledges. Unfortunately, the ICCT (2012) does not yet supply the full dataset for this trajectory. Therefore, the Adopted Trajectory (ICCT, 2012) is adjusted based on the proposed reported by Façahna et al. (2012). For the wedge 'Agriculture' no emission scenario including country pledges is available, therefore the estimation of the overlap with country pledges is based on the assumptions by Blok et al. (2012). The overlap is thus assumed to be 0.24 Gt CO_2e. Figure 21 shows, for the six wedges for which quantification of emission reduction commitments was possible, which part of the commitments is additional to country pledges.

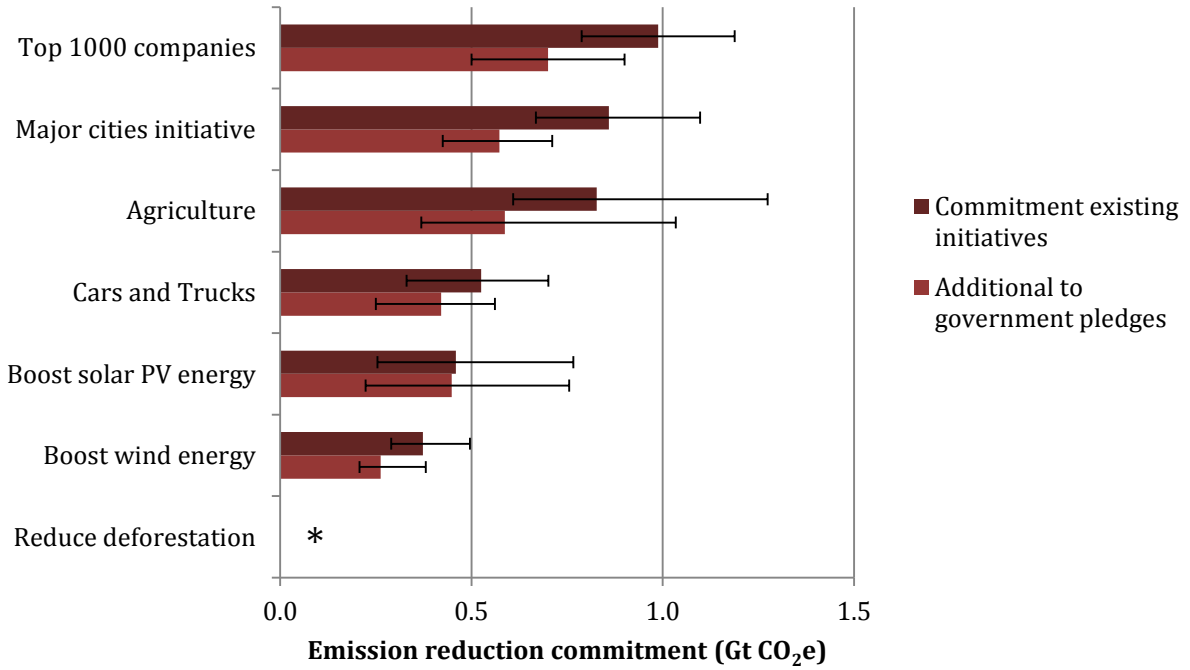

FIGURE 21 PART OF 2020 EMISSION REDUCTIONG COMMITMENT ADDITIONAL TO COUNTRY PLEDGES
*) EMISSION REDUCTION COMMITMENT OF INITIATIVES COULD NOT BE QUANTIFIED

[35] Beurskens et al. (2011) predict a lower solar PV capacity and a higher wind energy capacity in the EU in 2020 compared to the WEO 2012 New Policies Scenario (IEA, 2012a).

In Figure 22 the combined commitment of the six wedges accounting for overlap between wedges and overlap with country pledges is shown. The combined commitment additional to high-ambition country pledges is estimated to be 2.3–3.5 Gt CO_2e in 2020.

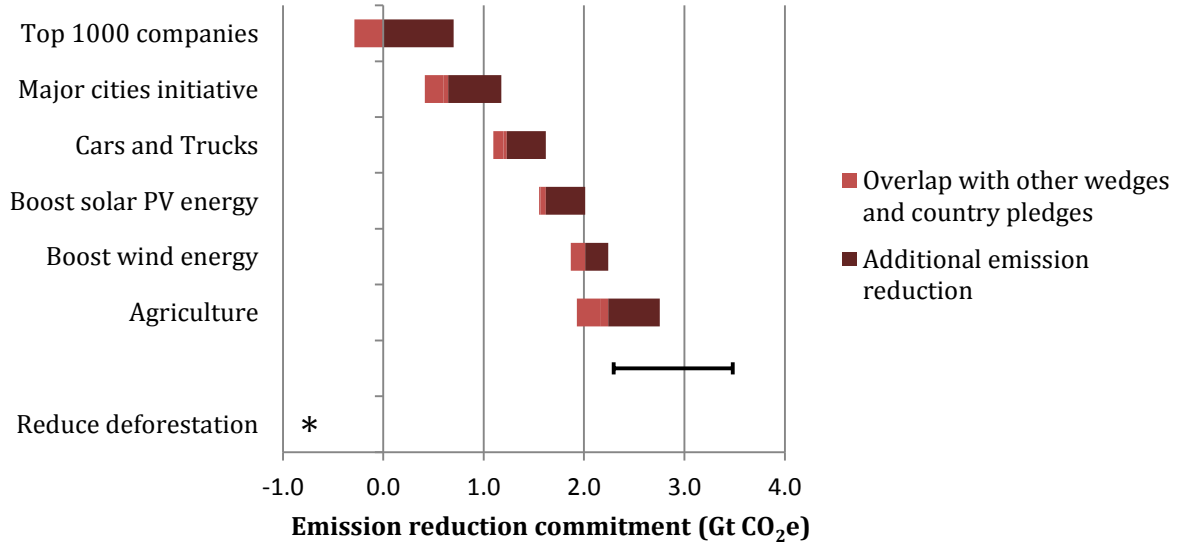

FIGURE 22 COMBINED COMMITMENT ACCOUNTING FOR OVERLAP BETWEEN WEDGES AND OVERLAP WITH COUNTRY PLEDGES
*) EMISSION REDUCTION COMMITMENT OF INITIATIVES COULD NOT BE QUANTIFIED

12. DISCUSSION

12.1 SCOPE & LIMITATIONS

In this research the impact of large-scale existing bottom-up initiatives aimed at greenhouse gas emission mitigation and consistent with the 'wedging the gap' approach is assessed. Due to time limitations this analysis is only carried out for the ten wedges with the highest expected impact. Additional research is needed to assess the impact of existing initiatives within the other wedges.

There are enormous numbers of bottom-up initiatives throughout the world and it is not possible to analyse all of these initiatives. The focus in this research is on initiatives with sufficient scale to have a significant impact on global greenhouse gas emissions. Small-scale initiatives and individual commitments are not taken into account. However, while small-scale initiatives will not have a visible impact on global emissions, they might have significant impact on the national or regional level. All small-scale initiatives worldwide combined could potentially also have a considerable impact on global emissions. However, these initiatives are outside the scope of this research. Much effort has been made to identify all the large-scale existing initiatives that are consistent with the wedges analysed in this research. However, it cannot be ruled out that some initiatives that could be relevant have not been identified. For example, large-scale regional initiatives without a website in English might be missed.

An important limitation of this research is that the impact of initiatives was only assessed for the initiatives that have a quantifiable target stated. The majority of initiatives identified and described in this research do not have such a quantifiable target. It is however impossible to quantify the commitment, if no target is stated. Nevertheless, this does not mean that the efforts of those initiatives will not lead to emission reductions. The total calculated combined commitment of the initiatives could thus be an underestimation of the total commitment of the initiatives. However, for most of the wedges, the initiatives that do have quantifiable targets seem to be the most ambitious initiatives. The other less ambitious initiatives are thus likely to overlap considerably with the commitments of the initiatives that are quantified.

12.2 UNCERTAINTY IN RESULTS

The uncertainty in the results of this research is large, due to the uncertainty in the underlying data as well as the many assumptions made. Therefore, the results of this research should not be regarded as an absolute answer to the question what the impact of existing bottom-up initiatives will be. Instead, the results should be interpreted as a first estimation of the order magnitude of the emission reduction commitment of existing initiatives. Further research and additional data are needed to quantify more precisely the expected impact of the emission reduction commitments.

An important source of uncertainty is the use of a business-as-usual scenario. A business-as-usual is a hypothetical scenario predicting what would happen if the initiatives did not exist. Since this scenario will never actually occur, it is not possible to determine with certainty whether the business-as-usual scenario is correct (Kolmuss et al., 2008).

Uncertainty ranges are used to display part of the uncertainties. However, for most of the data used in this research, the uncertainty ranges are not reported. The uncertainty ranges of the results are thus based on estimations of the uncertainty in the data and varying some of the assumptions. Although the uncertainty ranges do not display the full range of possible outcomes, they are expected to give an adequate indication of the level of commitment of the existing initiatives.

It is important to note that within the uncertainty ranges no uncertainty in the amount or ambition level of initiatives is taken into account. Uncertainty in the commitment is only taken into account in cases where the 2020 target is estimated based on a stated target for another year. The resulting total commitment for emission reductions in 2020 is based only on the commitments of the specifically mentioned initiatives for which the commitment could be quantified.

12.3 LEVEL OF COMMITMENT

In this research it is analysed what the impact on greenhouse gas emissions in 2020 of existing large-scale bottom-up initiatives will be, assuming they meet their stated target. However, making a commitment does not necessarily mean that the commitment will be achieved. It is outside the scope of this research to assess for each initiative the likelihood of the target being met. However, the levels of commitment of the various initiatives vary. Some initiatives are led by organisations that have direct control over the emission sources being addressed, whereas others depend on convincing other parties to take action. Also, some initiatives are led by more influential organisations than others and the ambition levels vary. Additional research is needed to assess the level of commitment of the various initiatives and to monitor the progress made toward achieving the stated targets.

For the initiatives for which the emission reduction commitments could be quantified an initial classification of the levels of commitment is made. In Table 13 the levels of commitment of the initiatives are classified as weak, medium or strong and an explanation for the classification is given. Figure 23 shows how the emission reduction commitment is distributed among those categories. The emission reduction commitment is displayed here as an 'up to' value, as overlap with county pledges and other wedges is not taken into account. As can be seen in the figure, only about a one third the commitments can be classified as 'strong' and the majority of initiatives have a 'medium' commitment. This implies that the actual impact of the initiatives analysed in this research might be significantly lower than the emission reduction commitments. The commitments classified as strong are the commitments in the wedge 'Top 1000 companies' and part of the commitments in the wedge 'Cars and Trucks'.

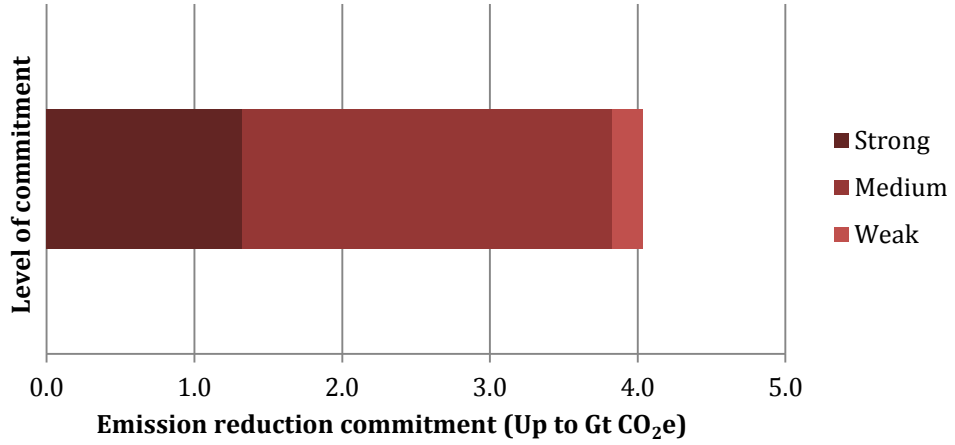

FIGURE 23 INDICATION OF LEVEL OF COMMITMENT OF ANALYSED INITIATIVES

TABLE 13 INDICATION OF LEVEL OF COMMITMENT OF INITIATIVES

Wedge	Initiative	Level of commitment			Explanation
		Weak	Medium	Strong	
Top 1000 companies	-			x	Most of the initiatives aimed at emission reductions in companies do not have overall commitments that all members should comply with. Instead, many companies adopt their own voluntary emission reduction targets. Since companies have strong control over their own emissions they are likely to be strongly committed to reaching their self-imposed targets.
Major cities initiative	C40		x		Cities participating in one or multiple of these three initiatives adopt their own voluntary emission reduction targets. Cities have considerable control over part of their emissions (e.g. emissions from public transport and municipal waste management), but they cannot completely control the emissions within their area.
	cCCR		x		
	Covenant of Mayors		x		
Cars and trucks	"30 by 30" Resolution			x	The "30 by 30" Resolution was unanimously adopted by the General Assembly of the IRU, with 180 members representing truck, bus, coach and taxi operators worldwide (IRU, 2009). Transport operators have strong control over their own emissions. The large amount of other freight transport initiatives without clearly stated targets will likely also contribute to achieving the "30 by 30" Resolution targets.
	GFEI		x		GFEI will engage with governments, the fuel and vehicle industry, civil society, and international organisations to achieve their goals (FIA Foundation, 2009). However, the GFEI partners do not have direct control over transport emissions.
Boost solar PV energy	300GW/a	x			This initiative does not have an approach to reach their ambitious target outlined yet. The initiative is led by a magazine, which does not have control over energy supply.
	SEII		x		The SEII is a joint initiative between EPIA and EU PVTP, in collaboration with the EC and Member States (EU PV Platform, n.d.). Although these actors have considerable control over the adoption of solar PV energy in the EU, SEII is an R&D programme with a facilitating role.
	SunShot		x		The SunShot initiative is led by the US Department of Energy, which has considerable control over the US energy supply. However, SunShot is an R&D programme without direct control over policies.

TABLE 13 INDICATION OF LEVEL OF COMMITMENT OF INITIATIVES (CONTINUED)

Wedge	Initiative	Level of commitment			Explanation
		Weak	Medium	Strong	
Boost wind energy	EWI		x		EWI is an initiative of the European wind industry, in collaboration with the EC and Member States (EWEA, 2013). Although these actors combined have considerable control over the adoption of wind energy in the EU, EWI is an R&D programme with a facilitating role.
	Wind Program		x		The Wind Program is led by the US Department of Energy, which has considerable control over the US energy supply. However, the Wind Program is an R&D programme without direct control over policies.
Agriculture	New Vision for Agriculture		x		This initiative is led by 29 large global companies and engages with many stakeholders (WEF, n.d.). A roadmap is published outlining how the New Vision for Agriculture can be achieved (WEF, 2010). However, the initiative cannot influence all agricultural emission worldwide.

13. CONCLUSION

In this research the emission reduction commitments of large-scale bottom-up initiatives consistent with the 'wedging the gap' approach are quantified. This analysis is done for ten of the 21 'wedging the gap' wedges. For six of these ten wedges an emission reduction commitment could be quantified. For the other four wedges no emission reduction commitment could be quantified. For the wedges 'Voluntary-offset companies' and 'Voluntary-offset consumers' this is due to the fact that no existing large-scale initiatives could be identified. Many organisations are active in the trading of voluntary carbon offsets, but no initiatives through which companies or consumers commit to buying these offsets exist at the moment. In the case of the 'Reduce deforestation' wedge the reason that the emission reduction commitment could not be quantified was not lack of initiatives. No less than 12 initiatives have been identified within this wedge, two of which, WWF and Greenpeace, aim to completely end deforestation by 2020. However, this is more likely to be an aspirational target than an actual commitment. Also, the differences between the greenhouse gas emissions of the forest sector reported and projected by different sources are so extensive that no reliable business-as-usual scenario could be determined. Within the wedge 'Phasing-out fossil-fuel subsidies' there are three initiatives aiming to encourage governments to phase-out fossil-fuel subsidies. However, none of these initiatives has a target for the phase-out of these subsidies. Since many countries have already pledged to phase-out fossil-fuel subsidies, but progress so far has been slow, it is expected that these initiatives might play a role in encouraging governments to fulfil their pledges. They are, however, not likely to result in emission reductions exceeding the current country pledges.

For the remaining six wedges the emission reduction commitments of a subset of the initiatives could be quantified. For all these wedges there are multiple initiatives and in most cases there is not yet one major initiative that covers the entire wedge, as is the basis of the 'wedging the gap' approach. An exception is the New Vision for Agriculture Initiative for the wedge 'Agriculture'. For the wedge 'Major cities initiative', Blok et al. (2012) suggest that the wedge could cover the 40 cities in C40 or an equivalent sample. However, there are many more initiatives aiming at greenhouse gas emission reductions in cities and the scope of this wedge could thus include a greater number of cities. In the 'Cars and trucks' wedge there are two initiatives that combined cover almost the entire wedge. The Global Fuel Economy Initiative covers the fuel economy of light-duty vehicles worldwide, whereas the International Road Transport Union's "30 by 30" Resolution covers the emissions of heavy-duty vehicles in much parts of the world. Apart from these initiatives there are also numerous smaller initiatives aimed at reducing emissions from road freight transport, which do not have clear commitments. For the wedges 'Boost solar PV energy' and 'Boost wind energy' there are large-scale initiatives at the European Union and the United States level. In the case of solar PV energy there is also the very ambitious 300GW/a initiative and a few smaller initiatives without clear commitments. In the wedge 'Top 1000 companies', ten initiatives have been identified, most of which do not have overarching commitments. However, most of the member companies have adopted voluntary emission reduction targets.

The research question of this research is *"What is the total expected impact of existing large-scale bottom-up initiatives consistent with the 'wedging the gap' approach on greenhouse gas emission mitigation in 2020?"* Figure 19 on page 64 shows for each of the analysed wedges the estimated impact of the initiatives for which a commitment could be quantified compared to the potential of the wedge estimated by Blok et al. (2012). Adding up all these commitments in the six wedges for which an emission reduction commitment could be quantified, leads to a total emission reduction commitment in the range of 3.6–4.7 Gt CO_2e in 2020. Accounting for overlap between the different wedges, this range lowers to 3.2–4.5 Gt CO_2e in 2020. This is about a quarter of the 14 Gt CO_2e emissions gap in 2020. The part of this commitment that is additional to high-ambition government pledges is estimated to be in the range of 2.3–3.5 Gt CO_2e in 2020. This is about one third of the 8 Gt CO_2e emissions gap between high-ambition country pledges and the emission level consistent with the 2°C target in 2020. Due to the unknown uncertainty in the underlying data as well as the many assumptions made to reach this result, the results of this research should be seen as a first estimation of the order magnitude of the emission reduction commitment of existing initiatives. This estimate does not include the commitments of the initiatives aimed at reducing deforestation since these could not be quantified. However, this wedge could add emission reductions of the order of a few gigatonnes to the total. It should also be noted that the analysis is based on the assumption that

all the initiatives meet their stated targets. An assessment of the likelihood of the initiatives meeting their stated targets is, however, outside of the scope of this research. A preliminary assessment of the levels of commitments shows that only about one third of the stated commitments can be classified as 'strong', but additional research is needed. This implies that the actual impact of the initiatives analysed in this research might be significantly lower than the emission reduction commitments.

Although the estimated commitment of currently existing initiatives is substantial, it is much lower than needed to bridge the emissions gap. The ten wedges assessed in this research have according to Blok et al. (2012) the potential to bridge about two-thirds of the emissions gap. However, the combined commitment of the analysed existing initiatives is only sufficient to bridge about a quarter of the 14 Gt CO_2e emissions gap in 2020. This is due to the fact that no initiatives exist for some wedges and that the ambition levels of the initiatives of some of the wedges are considerably lower than the estimates made by Blok et al. (2012). To stay below a 2°C temperature increase above pre-industrial levels major efforts are needed in the coming years. Action has to be taken to start up initiatives in the wedges that are not yet covered and to strengthen and upscale the already existing initiatives. Additional wedges might be needed to be able to bridge the gap. Also, on-going monitoring is needed to assess the extent to which the initiatives fulfil their commitments.

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APPENDICES

APPENDIX I: OVERVIEW OF 'WEDGING THE GAP' WEDGES

TABLE 14 OVERVIEW OF 'WEDGING THE GAP' WEDGES (BLOK ET AL., 2012) (HARE ET AL., 2012)

Wedge	Assumed commitment in 2020	Emissions reduction in 2020 (up to Gt CO_2e)
Top 1000 companies' emission reductions	30% of the top 100 companies reduce energy related emissions 10% below BAU and all companies reduce non-CO_2 emissions by 50%	0.7
Supply-chain emission reductions	30% of companies require their supply chains to reduce 10% below BAU	0.7
Green financial institutions	The 20 largest banks reduce the carbon footprint of 10% of their assets by 80%	0.4
Voluntary-offset companies	20% of the light industry and commercial sector offset emissions	2.0
Voluntary-offset consumers	10% of the 20% richest individuals offset emissions from electricity use, heating and transport.	1.6
Major cities initiative	C40 (or equivalent) cities reduce emissions 20% below BAU	0.7
Subnational governments	Emission reduction of 15-20% below BAU	0.6
Building heating and cooling	Realize 30% of full reduction potential	0.6
Ban of incandescent lamps	Global ban of incandescent lamps by 2016.	0.2
Electric appliances	Use of the most energy efficient appliances on the market	0.6
Cars and trucks	Save one additional litre per 100 km	0.7
Boost solar photovoltaic power	Remove barriers by introducing good grid access and net metering rules	1.4
Boost wind energy	Risk reduction for investments in wind energy	1.2
Access to energy through low-emission options	All people without access to electricity get access through low-emission options	0.4
Phasing-out subsidies for fossil fuels	Phase-out half of all fossil fuel subsidies	0.9
International aviation and maritime transport	Realize half of the technical mitigation potential	0.2
Fluorinated gases	Realize half of the technical mitigation potential	0.3
Reduce deforestation	Halve global deforestation	1.8
Agriculture	Realize 30% of the technical mitigation potential	0.8
Enhanced reduction of air pollutants	Realize half of the technical mitigation potential	Outside definition of the gap
Efficient cook-stoves	Replace half of the existing cook stoves	Outside definition of the gap

APPENDIX II: COMMITMENTS OF 25 RANDOMLY SELECTED COMPANIES

TABLE 15 COMMITMENTS OF 25 RANDOMLY SELECTED COMPANIES

Company	ACCO	BLEC	Caring for Climate	CSI	Haga Initiative	Responsible Care	The Clean Revolution	ULCOS	WBCSD	WWF Climate Savers	Commitment	Expected reduction in 2020 compared to BAU	Assumptions used for calculations
FMC						x					FMC is has no quantified GHG emission reduction target, but is committed to increasing revenue derived from products that create a sustainability advantage and to minimizing the overall impact of FMC operations and supply chain (FMC, 2012).	-	No quantifiable target stated.
HSBC Holdings							x				HSBC Holdings is committed to reducing their annual employee carbon emissions by one tonne, from 3.5 to 2.5 tonnes, in 2020 (HSBC, 2012).	22%	Target of reducing emission to 2.5/3.5 = 71% in 2020. 1% emission reduction per year assumed in BAU scenario.
VALE			x						x		VALE is committed to reducing GHG emissions 5% below BAU in 2020 and to encourage the supply chain to follow the same path (VALE, 2012).	5%	-
Volkswagen									x		Volkswagen has an objective of achieving 25% reduction in energy consumption, waste accumulation, emissions, water consumption, and CO_2 emissions by 2018, setting 2010 as a reference year (Volkswagen, 2012).	39%	Reduction target of 3.53% per year in the period 2010-2018. Same commitment assumed for period 2019-2020.
Formosa Plastics						x					Formosa sets aggressive internal energy efficiency improvement targets each year. There are no long-term targets stated (Formosa Plastics, 2012).	-	No quantifiable target stated.

TABLE 15 COMMITMENTS OF 25 RANDOMLY SELECTED COMPANIES (CONTINUED)

Company	ACCO	BLEC	Caring for Climate	CSI	Haga Initiative	Responsible Care	The Clean Revolution	ULCOS	WBCSD	WWF Climate Savers	Commitment	Expected reduction in 2020 compared to BAU	Assumptions used for calculations
Nippon Telegraph & Telephone (NTT)									x		NTT has a target of reducing CO_2 emissions by 15% or more below 2008 level by 2020 (NTT, n.d.).	28%	Emission target for 2020 is 15% below 2008 level.
Rio Tinto		x	x						x		Rio Tinto has a target of reducing the emissions intensity of their products by 6% by 2013 and by a further 4% by 2015, compared to 2008 (Rio Tinto, 2012).	4%	Commitment of 6% assumed for 5-year period 2016-2020. 1% emission reduction per year assumed in BAU scenario.
DTE Energy Company		x									DTE has no post-2012 GHG emission reduction targets stated (DTE Energy, 2013).	-	No quantifiable target stated.
Komatsu Ltd.									x		Komatsu is reducing CO_2 emissions generated by its business activities. However, nopost-2012 GHG emission reduction targets are stated (Komatsu, 2012).	-	No quantifiable target stated.
Hitachi			x						x		Hitachi has a target of reducing annual CO_2 emissions by 100 million tonnes by 2025 through Hitachi products and services (Hitachi, 2012).	-	No quantifiable target stated for Hitachi's own emissions.
PepsiCo, Inc.			x						x		PepsiCo has a target of reducing fuel-use intensity by 25% per unit of production by 2015 compared to a 2006 baseline (PepsiCo, 2011).	30%	Fuel-use is about 84% of PepsiCo's energy demand (PepsiCo, 2011). 25% target of 9-year period. Same commitment assumed for 2016-2020 period. 1% emission reduction per year assumed in BAU.

TABLE 15 COMMITMENTS OF 25 RANDOMLY SELECTED COMPANIES (CONTINUED)

Company	ACCO	BLEC	Caring for Climate	CSI	Haga Initiative	Responsible Care	The Clean Revolution	ULCOS	WBCSD	WWF Climate Savers	Commitment	Expected reduction in 2020 compared to BAU	Assumptions used for calculations
News Corporation							x				News corporation aims in the long-term to grow their business without increasing their carbon footprint. 2015 targets are to reduce absolute GHG emissions as well as emission intensity by 15% (News Corporation, 2012).	37%	15% emission reduction target for period 2010-2015. Same commitment assumed for 2016-2020.
Sprint Nextel Corporation	x									x	Sprint has committed to reducing GHG emissions 20% below 2007 levels by 2017 (WWF, n.d. c).	35%	Reduction target of 20% in 10-year period. Same commitment assumed for 2018-2020 period.
EDP - Energias de Portugal S.A.									x		EDP has a target of reducing specific CO_2 emissions by 70% by 2020, compared with the 2008 reference year (EDP, 2009).	66%	1% emission reduction per year assumed in BAU scenario.
Lafarge			x	x					x	x	Lafarge has committed to reducing its net GHG emissions to 33% per tonne of cement below 1990 levels by 2020 (equivalent to a 14.4% reduction compared to 2010 levels) and to contribute to the design of 500 sustainable buildings by 2015 (Lafarge, 2013).	11%	63.9% of Lafarge's portfolio is cement. 1% emission reduction per year assumed in BAU scenario.
Diversey										x	Diversey has committed to reducing the emissions from their operation 25% below 2003 level by 2013 (Diversey, 2011).	40%	25% reduction target in 10-year period. Same commitment assumed in period 2014-2020.

TABLE 15 COMMITMENTS OF 25 RANDOMLY SELECTED COMPANIES (CONTINUED)

Company	ACCO	BLEC	Caring for Climate	CSI	Haga Initiative	Responsible Care	The Clean Revolution	ULCOS	WBCSD	WWF Climate Savers	Commitment	Expected reduction in 2020 compared to BAU	Assumptions used for calculations
CLP Holdings							x		x		CLP has a target of 30% of their generating capacity in non-carbon emitting sources in 2020 (CLP, 2012).	10%	Target of 30% of generating capacity in non-carbon emitting sources. 2012 level of 22% assumed in BAU scenario.
Duke Energy Corporation		x					x		x		Duke Energy aims to reduce or offset the CO_2 emissions from U.S. generation fleet 17% from 2005 by 2020 and to reduce the carbon intensity of their total generation fleet from 0.63 in 2005 to 0.50 by 2020 (Duke Energy, 2012).	16%	Target of reducing emissions 17% below 2005 levels.
Mondi plc									x		Mondi aims to reduce their CO_2e emissions and their carbon-based energy consumption per unit of saleable production from their mills by 15% by 2014, against a 2004 base year (Mondi, 2012).	30%	15% reduction target over 10-year period. Same commitment assumed for 2015-2020 period.
KAO Corporation						x					KAO has a target of reducing CO_2 emissions by 22% in 2015 compared to the reference year 1990 (KAO, 2012).	31%	22% reduction target over 15-year period. Same commitment assumed for 2008-2020 period.
DuPont		x	x						x		DuPont aims to reduce GHG emissions by 15% percent by 2015 from a base year of 2004 (DuPont, 2012).	29%	15% reduction target over 11-year period. Same commitment assumed for 2016-2020 period.

TABLE 15 COMMITMENTS OF 25 RANDOMLY SELECTED COMPANIES (CONTINUED)

Company	ACCO	BLEC	Caring for Climate	CSI	Haga Initiative	Responsible Care	The Clean Revolution	ULCOS	WBCSD	WWF Climate Savers	Commitment	Expected reduction in 2020 compared to BAU	Assumptions used for calculations
Dow Chemical Company		x	x			x			x		Dow aims to reduce energy intensity 25% by 2015 from a 2005 baseline and to maintain all GHG emissions below 2006 levels (Dow, 2013).	18%	GHG emissions assumed below 2006 levels in 2020.
Norsk Hydro									x		Norsk Hydro aims to reduce their environmental impact to a minimum throughout the entire life cycle of their products (Norsk Hydro, 2012).	-	No quantifiable target stated.
Alcoa Inc.		x									Alcoa aims to reduce is to reduce 2005 levels of total CO_2 intensity in their Global Primary Products business (refining and smelting) by 30% by 2020 and 35% by 2030 (Alcoa, 2012).	28%	30% emission intensity improvement in 15 year period. 1% emission reduction per year assumed in BAU scenario.
Royal KPN										x	KPN has committed to achieving net zero CO_2 emissions by 2020 (KPN, 2011).	83%	Net zero emissions in 2020. Remaining 0.11 Mt CO_2 are compensated by carbon offsets.