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Essential Elements of Robust MRV-Systems and Analysis of Their Relevance for Linking Emissions Trading Schemes

Final Report

For our Environment

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Essential elements of robust MRV Systems and Analysis of their Relevance for Linking Emissions Trading Schemes

Final Report

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Kurzbeschreibung

Das UFOPLAN-Forschungsvorhaben „Internationaler Vergleich oder Bestandsaufnahme der Methoden und Verfahren für Monitoring, Berichterstattung und Verifizierung in Emissionshandelssystemen“ (FKZ: 3712 41 505) untersucht und vergleicht die Vorgaben zu Überwachung, Berichterstattung und Verifizierung (MRV) von Treibhausgasemissionen in ausgewählten Emissionshandels- und Monitoingssystemen. Im Zentrum der Analysen stehen dabei die organisatorisch-operative Ausgestaltung des Berichtszyklus sowie die methodisch-technischen Vorgaben zur Herleitung der jährlich zu berichtenden Emissionsmengen. Auf Basis der gewonnenen Erkenntnisse werden zentrale technische und systemische Risiken bei der regelmäßigen Überwachung von Treibhausgasemissionen identifiziert und Minimumkriterien für die Ausgestaltung von MRV-Systemen definiert, die zur Risikominimierung beitragen und eine Vergleichbarkeit der Systeme hinsichtlich Transparenz, Genauigkeit und Vollständigkeit der Überwachung ermöglichen.

Insbesondere vor dem Hintergrund potentiell in der Zukunft angestrebter Verknüpfungen von Einzelsystemen zu einem gemeinsamen Markt (Linking), ist die spezifische Ausprägung dieser Kriterien entscheidend für systemübergreifende Akzeptanz der individuell etablierten Überwachungsstandards. Das Forschungsvorhaben liefert dabei fundierte Rückschlüsse, ob im Kontext von MRV qualitative und/oder quantitative Barrieren für ein erfolgreiches Linking von Emissionshandelssystemen existieren würden. Diese Publikation enthält die Studie, die in diesem Forschungsschwerpunkt entstanden ist. Das Forschungsvorhaben trägt vor diesem Hintergrund zu den umfangreichen Studien mit Blick auf Linking von Einzelmärkten bei, fokussiert sich dabei jedoch spezifisch auf das Thema MRV.

Abstract

The UFOPLAN-research project „Internationaler Vergleich oder Bestandsaufnahme der Methoden und Verfahren für Monitoring, Berichterstattung und Verifizierung in Emissionshandelssystemen“ (FKZ: 3712 41 505) examines and compares the requirements for monitoring, reporting and verification (MRV) of greenhouse gas emissions in selected emission trading schemes (ETS) and reporting systems. In this regard, the operational and organisational structure of the annual compliance cycle as well as the methodical and technical requirements for determination of emissions in numerous ETS is in the focus of the study. Based on the results of in total five working packages, it was assessed on a general basis which inherent risks in the context of regular monitoring and reporting of emissions exist and which minimum requirements should be at least defined within a MRV-regulation in order to minimize those risks and to guarantee a robust monitoring.

Especially with regard to a potentially upcoming linking of ETS, the adequate desing of essential MRV-elements in the systems to be linked is key for the mutual acceptance of a common market. The research project, thus, presents comprehensive conclusions on potential barriers for linking in the context of the qualitative and quantative requirements for the determination of emissions as well with regard to the organizational and operational architectures of ETS. This publication contains the study that has compiled in this research area. The project complements the research that has been done on the issue of linking but focusses specifically on the requirements in the context of MRV.

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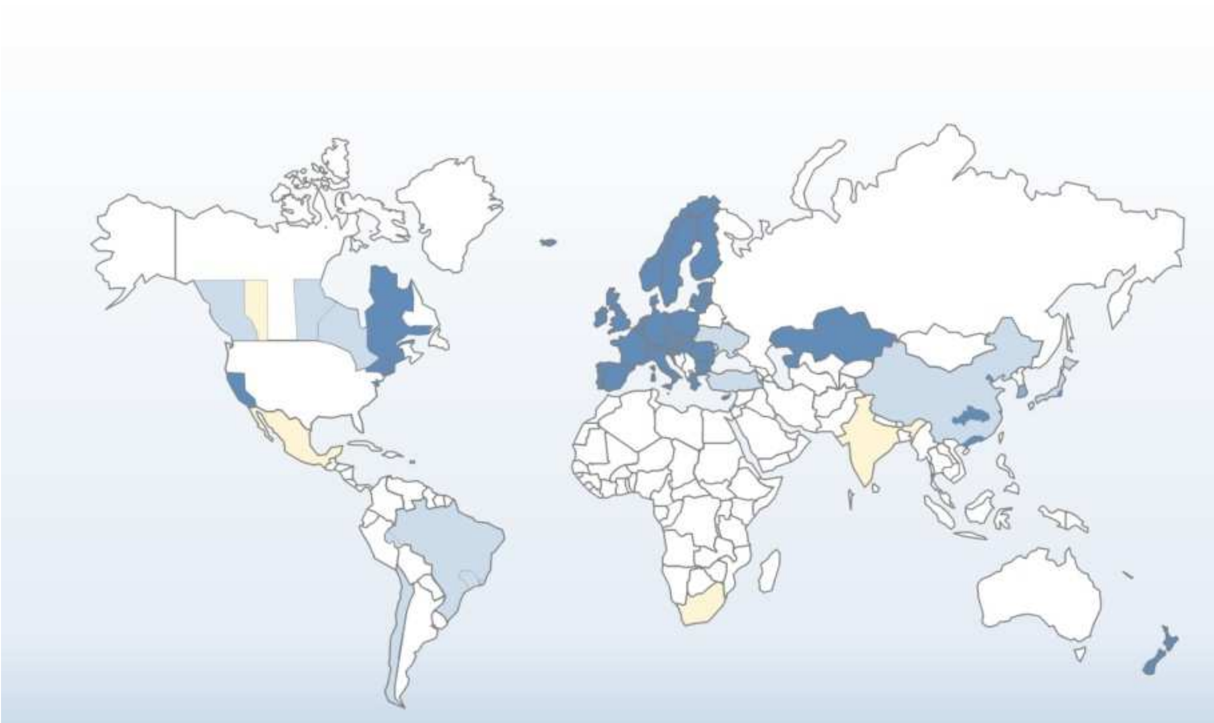
List of abbreviations

AB	Accreditation Body
AER	Annual Emissions Report
ARB	Air Resources Board
AUS	Australia
AVR	Accreditation and Verification Regulation
CA	Competent Authority
CAL	State of California
CAL CTP	California GHG Cap-and-Trade Program
Cal e-GGRT	California Electronic Greenhouse Gas Reporting Tool
CARB	Californian Air Resources Board
CC	Carbon Content
CCS	Carbon Capture and Storage
CE	Controlled Entity
CEMS	Continuous Emissions Monitoring System (CAL CTP) or Continuous Emissions Measurement System (EU-ETS)
CER	Clean Energy Regulator
CF	Conversion Factor
CFR	Code of Federal Regulations
CH_4	Methane
CPM	Carbon Pricing Mechanism
CTP	Cap and Trade Program
CV	Calorific Value
CY	Calender Year
EC	European Commission
EERS	Emissions and Energy Reporting System
EF	Emission Factor
EN	European Norm
EPA	Environmental Protection Authority

ETS	Emissions Trading Scheme
EU-ETS	European Union Emissions Trading Scheme
FIN	Finland
FMS	Formular Management System (Germany)
FY	Fiscal Year
GER	Germany
GHG	Greenhouse Gas
HFC	HydroFluoroCarbon
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
IT	Information Technology
kJ	kiloJoule
kt	kilotonne
MoE	Ministry of Environment (South Korea)
MP	Monitoring Plan
MRR	Monitoring and Reporting Regulation
MRV	Monitoring, Reporting and Verification
MW	Megawatt
N_2O	Nitrous Oxide
NDRC	National Development and Reform Commission
NGER	National Greenhouse Gas and Energy Reporting
NGMS	National Greenhouse Gas Management System
NIER	National Institute of Environmental Research
NIST	National Institute of Standards and Technology
OF	Oxidation Factor
PEMS	Periodic Emissions Measurement System
PFC	Perfluorcarbon
RAMS	Regulation on Accreditation and Market Surveillance
RGGI	Regional Greenhouse Gas Initiative

SDRC	Shanghai Development and Reform Comission
tCO_2e	Tonnes of CO_2 equivalent
tCO_2e/a	Annual tonnes of CO_2 equivalent
TMS	GHG & Energy Target Management System
UK	United Kingdom
US EPA	United States Environmental Protection Authority
UNFCCC	United Nations Framework Convention on Climate Change
VB	Verification Body
yr	year



Essential elements of robust MRV Systems and Analysis of their Relevance for Linking Emission Trading Schemes

Summary

A growing number of national and regional governments around the world plan or have decided to introduce Carbon Pricing Instruments, such as Emission Trading Schemes or Carbon Taxes, in order to create regulated frameworks for the mitigation of Greenhouse Gases. With regard to emissions trading, in the long term, linking those bottom-up schemes is seen as a promising option to further enhance efficiency of mitigation efforts and to decrease overall reduction costs.

While the ETS implemented and scheduled currently differ remarkably in their designs with regard to specific national/regional political and economic targets, a successful linking is dependent on the compatibility of the key design elements of the instruments. Especially in matters of MRV (MRV in the sense of all system elements, i.e. monitoring, reporting, verification and accreditation) a tonne of reported GHGs in one scheme must be a tonne in the schemes to be linked with, if consistency, transparency and credibility of the common market shall be guaranteed. The guiding question that forms the background of this study is, thus, “when is a tonne a tonne”?

The study at hand compares different approaches within MRV schemes in order to assess, whether barriers for linking (inherent risks) could arise due to differing provisions. It, therefore, aims at contributing to the international discussions regarding prerequisites for linking ETS by identifying and explaining MRV minimum requirements that should be addressed in the regulations of the ETS that are striving to link.

To this end, FutureCamp Climate GmbH and TÜV Nord Cert GmbH have analysed the MRV provisions in 13 ETS and monitoring schemes that are already running or scheduled for implementation. Special attention was paid to the MRV provisions of the Californian Cap-and-Trade Program, the South Korean Target Management System/ETS, the Shanghai ETS as well as the Australian Carbon Pricing Mechanism and the European Union (Emissions Trading Scheme). Those systems were chosen for analysis due to their level of elaborateness and diverseness, thus, offering a broad research basis.

The minimum requirements identified within this study were derived based on the assumption that a sound MRV scheme should rest upon the following principles: consistency, completeness, transparency, accuracy and comparability. Almost all of the reviewed schemes incorporate those principles in the regulation defined. However, besides different individual definitions of the principles it is the challenge during linking negotiations to assess whether the provisions in place guarantee the adherence to the principles.

The organisational and operational structure, the methodical and technical design as well as implemented regular evaluation and communication processes to improve the scheme have been identified as key pillars of MRV schemes. Each of those elements consists of various backbones that have been analysed within the last three years. However, depending on the design of those elements, four potential risks for linking have been identified:

- Weak implementation and enforcement of relevant regulations
- Differing uncertainty of reported emissions
- Inherent risks of double counting
- Existence of loopholes to transfer emissions out of the system

As a further result of the study, it was assessed which qualitative and quantitative factors determine the overall system risk. Thus, the impact of inter alia uncertainty requirements for the determination of activity data and calculation factors, of missing enforcement and sanctioning power as well as of unclear organisational and operational structures were analysed.

Zusammenfassung

In den letzten Jahren hat sich eine wachsende Zahl von nationalen und subnationalen Regierungen dazu entschlossen, Kohlenstoffemissionen mit Kosten zu belegen, mittels eines Emissionshandelssystems (EHS) oder einer Kohlenstoffsteuer, um einen verbindlich geregelten Rahmen zur Minderung von Treibhausgasemissionen zu schaffen. Insbesondere mit Blick auf die Einführung von Emissionshandelssystemen erscheint auf lange Sicht die Verlinkung dieser als eine vielversprechende Option, die Effizienz von Minderungsanstrengungen weiter zu erhöhen und Vermeidungskosten zu senken.

Während die derzeit bereits etablierten bzw. in Planung befindlichen EHS in ihrer spezifischen Ausgestaltung stark von den jeweiligen nationalen/subnationalen politischen und ökonomischen Zielen geprägt sind, ist es für ein erfolgreiches Linking unerlässlich, dass die zentralen Designelemente der betreffenden Systeme weitestgehend kompatibel sind. Speziell mit Blick auf die definierten Monitoring-, Reporting- und Verifizierungsvorgaben (MRV) innerhalb der EHS muss sichergestellt sein, dass die berichteten Emissionen in einem System mit den berichteten Emissionen in den zum Linking vorgesehenen EHS vergleichbar sind. Diese Bedingung ist eine unerlässliche Vorgabe für die Wahrung von Transparenz, Konsistenz und Glaubwürdigkeit in einem gemeinsamen Markt. Die der vorliegenden Studie zugrunde liegende Fragestellung ist daher: „Wann ist eine Tonne, eine Tonne?“.

In der vorliegenden Studie wurden die verschiedenen Ansätze für MRV-Systeme dahingehend analysiert, ob unterschiedliche Anforderungen zu Barrieren (inhärente Risiken) für ein Linking werden können. Sie zielt insbesondere darauf ab, einen Beitrag zu den internationalen Diskussionen über die Voraussetzungen für ein Linking von Emissionshandelssystemen zu leisten, indem Minimumanforderungen im Bereich des MRV identifiziert und erläutert werden, die in den Systemen der potentiellen Linking-Partner reflektiert sein sollten.

Dazu analysierten die FutureCamp Climate GmbH in Zusammenarbeit mit der TÜV NORD Cert GmbH die MRV-Vorgaben von insgesamt 13 EHS/Kohlenstoffsteuersystemen und reinen Monitoringsystemen, die bereits implementiert oder in ihrer Planung weit fortgeschritten waren. Besondere Aufmerksamkeit wurde den MRV-Anforderungen der Systeme in Kalifornien (California Cap-and-Trade Program), Südkorea (Target Management System/Korea ETS), Shanghai (Shanghai ETS), Australien (Carbon Pricing Mechanism) und der Europäischen Union (EU-ETS) gewidmet. Sie wurden für die Analyse ausgewählt, da sie einen hohen Reifegrad besitzen und darüber hinaus große Unterschiede aufweisen, so dass eine breite Forschungsbasis gegeben war.

Die im Ergebnis identifizierten Minimumanforderungen an MRV-Systeme im Kontext eines potentiellen Linkings wurden auf Basis der Annahme eruiert, dass ein solides MRV-System auf folgenden Prinzipien beruhen sollte: Konsistenz, Transparenz, Vollständigkeit, Genauigkeit und Vergleichbarkeit. Nahezu alle der untersuchten Systeme integrieren die genannten Prinzipien in die zugrunde liegenden Vorschriften. Doch zusätzlich zu den etwas unterschiedlichen individuellen Definitionen der Grundsätze besteht die Herausforderung darin, in Linking-Verhandlungen zu prüfen, ob die Vorschriften und die in der Praxis vollzogenen Regelungen die Einhaltung der Grundsätze gewährleisten.

In diesem Zusammenhang wurden die Aufbau- und Ablauforganisation, das methodische und technische Design der Überwachungsvorgaben sowie reguläre Evaluierungs- und Kommunikationsprozesse als wichtige Säulen eines MRV-Systems offenbar.

Jedes dieser Elemente ist ggf. anders strukturiert und lieferte umfangreichen Untersuchungsstoff für die Forschungsarbeit der letzten drei Jahre. Aufbauend auf den Ergebnissen der Analysen wurden in Abhängigkeit vom Design der MRV-Elemente vier potentielle Risiken für ein Linking identifiziert:

- Schwache Implementierung und Durchsetzung der einschlägigen Vorschriften
- Unterschiedliche Unsicherheit der berichteten Emissionen
- Inhärentes Risiko von Doppelzählungen
- Schlupflöcher, um Emissionen aus dem System zu transferieren

Als ein weiteres Ergebnis zeigt die Studie, welche qualitativen und quantitativen Faktoren das Gesamtrisiko beeinflussen. Zu diesem Zweck wurde unter anderem der spezifische Einfluss von Genauigkeitsanforderungen bei der Ermittlung von Aktivitätsdaten und Berechnungsfaktoren, von fehlenden oder schwach ausgeprägten Sanktionierungs- und Durchsetzungsmöglichkeiten sowie von unklaren organisatorischen und operativen Strukturen analysiert.

1 Methodology, background and objective

In the past ten years numerous carbon pricing instruments, such as carbon tax and emission trading schemes (ETS), have emerged or are under consideration to be implemented across the globe. In this regard, especially the introduction of emission trading schemes is widely recognized by policy makers as the most efficient way to reduce Greenhouse Gas Emissions (GHG) at the lowest possible economic costs.

However, the approaches regarding the institutional and operational designs chosen by the respective national, regional and local authorities differ remarkably, thus, reflecting specific national political and economic priorities.

Linking established markets could provide additional advantages with regard to inter alia mitigation potentials and costs, market liquidity and price stability. Differences in the individual political and economic targets, and in the design of ETS to be linked respectively, might, however, create barriers that hamper linking.

Generally speaking, ETS are built on numerous pillars, such as allocation rules, auctioning procedures, scope definition and Monitoring, Reporting and Verification (MRV) provisions that all together shape the character of the scheme by being designed and interconnected in order to support the overarching policy targets as well as possible. As a centrepiece of each system the MRV procedures implemented shall guarantee the transparency and credibility within the system. A sound MRV scheme creates the foundation for mitigation measures and ideally provides a framework in which a monitored and reported “tonne is a tonne”.

Thus, the study at hand displays the results of detailed analysis of numerous MRV schemes implemented around the globe. The aim was to study the differences in the definition of specific MRV features in the schemes under scrutiny and to evaluate advantages and disadvantages of the chosen approaches. The following schemes were analysed in detail by desk-review of the central MRV related regulations, interviews with representatives from authorities, verification bodies, think tanks and operators:

1. Australian Carbon Pricing Mechanism (CPM, repealed in June 2014)
2. Californian Cap-and-Trade Program
3. Shanghai ETS
4. South Korean ETS (data collected until October 2014 based on TMS)
5. European Union Emissions Trading Scheme [EU-ETS]

The above mentioned schemes were chosen as focus for the study with the purpose of gaining detailed insights of preferably highly diverse designs of MRV regulations. In addition to 10 further MRV schemes fact sheets on inter alia the scope of coverage, the applicable monitoring methodologies, basic requirements for the determination of calculation factors etc. were developed:

- New Zealand
- Quebec
- RGGI
- Guangdong
- Kazakhstan
- Shenzhen
- Turkey
- Tokyo
- National Chinese ETS (planned)
- US EPA GHG Reporting Program

Based on the results of the above mentioned analysis, the relevance of differences in the MRV approaches chosen was assessed in the context of the linking of carbon markets. In this regard the study shall contribute to the currently active discussions on linking and deliver specific information on the issue of MRV.

Hence, based on the guiding question **"when is a tonne a tonne",** the study at hand shall define and analyse those crucial design elements of MRV systems that ensure consistency, completeness, transparency, accuracy and comparability. This is seen as prerequisite for mutual acceptance during linking processes.

As a starting point for the assessment of potential relevance for linking five essential reporting principles – comparability, consistency, accuracy, completeness and transparency, which were defined by the United Nations Framework Convention on Climate Change (UNFCCC) as part of the reporting guidelines for annual GHG inventories [1] and are widely integrated in the different MRV schemes analysed – were used.

Incorporating those principles and based on good practice examples the relevant aspects for linking in the context of MRV are highlighted in the study at hand. This includes aspects on the regulatory level, qualitative and quantitative requirements for monitoring and reporting as well as provisions on enforcement and sanctioning mechanisms. As outcome result different approaches to the design of central MRV aspects are presented and minimum requirements on MRV in the context of linking are formulated.

[1] United Nations Framework Convention on Climate Change (2013a), FCCC/CP/2013/10/Add.3. Decision 24/CP.19: Retrieved 14.07.2015 from http://unfccc.int/resource/docs/2013/cop19/eng/10a03.pdf

2 General MRV principles

Regardless of the political, economic or environmental intentions behind the implementation of an ETS, the methodologies to monitor GHG emissions as well as their regulation usually claim to be in line with five general, underlying principles that are displayed below with their respective definitions within different institutions/ETS:

Completeness:

- IPCC: "Estimates are reported for all relevant categories of sources and sinks, and gases. Where elements are missing their absence should be clearly documented together with a justification for exclusion" [2]
- EU-ETS: "Monitoring and reporting shall be complete and cover all process and combustion emissions from all emission sources and source streams belonging to activities listed in Annex I to Directive 2003/87/EC..." [3]

Consistency, comparability and transparency:

IPCC [4]:

- **Consistency**: "Estimates for different inventory years, gases and categories are made in such a way that differences in the results between years and categories reflect real differences in emissions. Inventory annual trends, as far as possible, should be calculated using the same method and data sources in all years and should aim to reflect the real annual fluctuations in emissions or removals and not be subject to changes resulting from methodological differences."
- **Comparability**: "The national greenhouse gas inventory is reported in a way that allows it to be compared with national greenhouse gas inventories for other countries."
- **Transparency**: "There is sufficient and clear documentation such that individuals or groups other than the inventory compilers can understand how the inventory was compiled and can assure themselves it meets the good practice requirements for national greenhouse gas emissions inventories."

EU-ETS[5] :

- "Monitoring and reporting shall be consistent and comparable over time. To that end, operators and aircraft operators shall use the same monitoring methodologies and data sets subject to changes and derogations approved by the competent authority."
- "Operators and aircraft operators shall obtain, record, compile, analyse and document monitoring data, including assumptions, references, activity data, emission factors, oxidation factors and conversion factors, in a transparent manner that enables the reproduction of the determination of emissions by the verifier and the competent authority."

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[2] Intergovernmental Panel on Climate Change (2006): Guidelines for National Greenhouse Gas Inventories; 1.6f. Retrieved 12.07.2015 under http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/1_Volume1/V1_1_Ch1_Introduction.pdf

[3] Official Journal of the European Union (2012a): COMMISSION REGULATION (EU) No 601/2012 of 21 June 2012 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council; Article 5, retrieved 12.07.2015 from http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R0601&from=EN

[4] Intergovernmental Panel on Climate Change (2006): 1.6f.

[5] Official Journal of the European Union (2012a): Article 5

Accuracy:

IPCC[6]: “The national greenhouse gas inventory contains neither over- nor under-estimates so far as can be judged. This means making all endeavours to remove bias from the inventory estimates.”

EU-ETS[7]: “Operators and aircraft operators shall ensure that emission determination is neither systematically nor knowingly inaccurate. Operators shall identify and reduce any source of inaccuracies as far as possible and shall exercise due diligence to ensure that calculation and measurement of emissions exhibit the highest achievable accuracy.”

Even though almost all MRV regulations analysed somehow refer to the above displayed principles, there are differences in their interpretation and application. Whereas all relevant sources are counted in national inventories, **comparability** in the context of IPCC refers to the source categories (CRF codes)[8] and what is reported under these source categories in different countries (“external” comparability between different inventories). In contrast the EU-ETS definition highlights to aim for a **comparable** and **consistent** monitoring and reporting over time within one covered installation and also among all covered installations (“internal comparability”). In this regard, in EU-ETS in particular entities are part of the system due to a defined scope of the system.

Hence, comparability in the context of MRV is not a question of what is part of the scope, but refers to the qualitative and quantitative comparability of monitoring methodologies for determining emissions. In other words, there are design elements which are important to ensure the quality of the MRV system itself and have, therefore, an indirect effect on the amount of emissions that cannot be expressed in numbers. Other design elements have a quantitative effect on the reported tonne in a system. Accordingly, the practical implementation of those principles - especially comparability - has to be assessed on a more technical and methodical level.

To a certain extent **accuracy** is directly linked to the principle “a tonne must be a tonne”. Associating the emissions to a specific polluter or a particular entity is a key principle for the instruments of carbon pricing. Therefore, the evidence of predefined accuracies or -in practice- maximum uncertainties play a more important role than in the inventory context; in the case of ETS the determined emissions result in an installation or entity-related obligation to surrender certificates. The design of market-based instruments such as ETS takes into account the cost and the proportionality of measures; however, it should not lead to underestimating emissions.

Moreover, **transparency**, i.e. an appropriate documentation on all levels - in the rulemaking and the application of those rules -, is essential to the mutual understanding, the success of this analysis, the consideration of linking and the question whether a tonne is a tonne in linked systems.

As mentioned, the aim of the study is to identify and analyse crucial design elements of MRV systems in the context of linking. However, taking the above mentioned principles into account as reference it is to a certain extent necessary to broaden the scope of analysis on aspects that aren’t “part of MRV systems” by definition but are, nevertheless, strongly interconnected to MRV. These aspects are inter alia the scope of the ETS to be linked, different applicability criteria and installation categorization.

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[6] Intergovernmental Panel on Climate Change (2006): 1.6f.

[7] Official Journal of the European Union (2012a): Article 7

[8] United Nations Framework Convention on Climate Change (2015): Use of the 2006 IPCC guidelines for national greenhouse gas inventors and revision of the UNFCCC reporting guidelines for Annex I Parties to the Convention: Retrieved 23.09.2015 from http://unfccc.int/national_reports/annex_i_ghg_inventories/reporting_requirements/items/5333.php

In the following chapters the study will also discuss such aspects, if they are helpful for achieving the intention of the analysis.

In this regard, **complete monitoring and reporting** with respect to the scope of the ETS and to emission sources and source streams on installation or entity level are a prerequisite to guarantee for example that reduction targets are not weakened e.g. by loopholes. Moreover, enforcing the regulation to that end is essential to create a robust ETS. However, as mentioned above, the definition of the scopes to be linked in the ETS is not a specific MRV issue.

To sum up, the principles and their respective interpretation that are taken as a guiding frame for the study are:

- Completeness: all emission sources and activities within the scope shall be reported.
- Consistency: Consistent methodologies shall be used over time
- Comparability:
  a) Methodologies have to be internally comparable between the covered participants
  b) Monitoring methodologies have to be comparable between linked systems
- Transparency: Methodologies and assumptions are clearly explained, unambiguous and are documented transparently
- Accuracy: Uncertainties must be reduced as far as practicable

In the following chapters the study focuses on the organisational and operational structures of ETS as well as on the methodical and technical design with respect to MRV. The above mentioned principles are reflected in the sub chapters.

3 Organisational structure

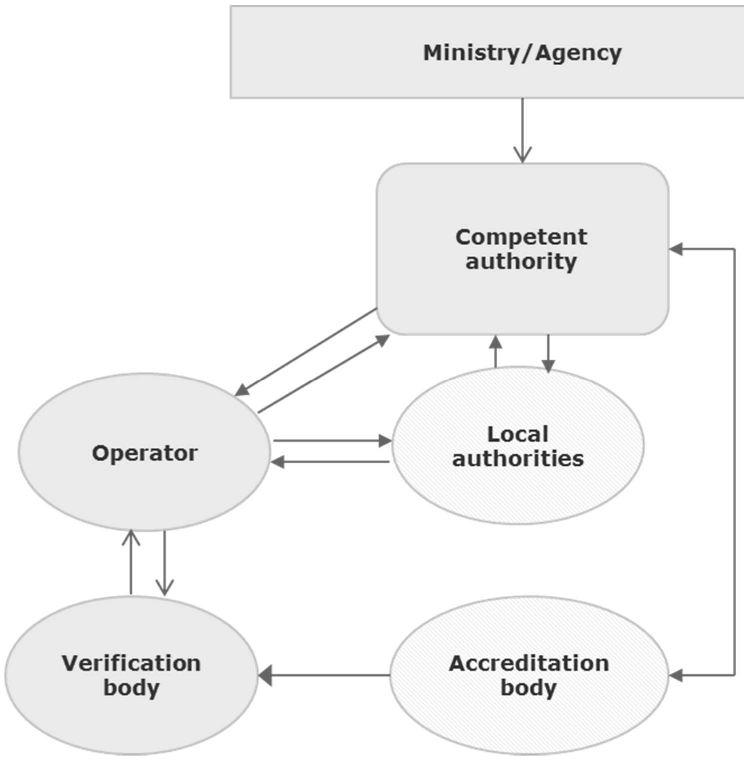
The robustness of an ETS is strongly dependent on the monitoring regulation it builds upon. Determination methods, quality and uncertainty requirements for measurement devices, the adequacy of applicable standard factors, appropriate and representative methods and frequencies for sampling and analysis as well as reporting requirements represent only one part of the fundamental provisions for a complete, accurate and transparent monitoring of GHG. However, the operators of covered entities need guidance and certainty that the chosen monitoring methodologies are in accordance with the regulation, probably at best by means of an approved monitoring plan. Furthermore, even the strictest rules need to be enforced in order to ensure full compliance.

In this regard, an organisational structure that clearly defines and specifies the individual responsibilities of all stakeholders involved in the MRV cycle is essential to guarantee the above mentioned principles. Thus, the organisational structure constitutes a qualitative framework that shall enable and ensure the robustness and transparency of the scheme.

In this context, it is necessary that the following aspects are defined unambiguously:

- Who is responsible for the administration of the ETS as “the lead institution”?
- Who is the relevant contact for operators?
- Who has the legally binding authority and administrative power to approve (e.g. monitoring plans) or to decide?
- What are specific responsibilities of other institutions that contribute (i.e. local authorities)?
- How is the information exchange organized and guaranteed?
- Who is able/has the authority to sanction in case of non-compliance?

Figure 1: Typical organisational structure



Source: FutureCamp

According to the project findings figure 93 illustrates roughly a typical structure of institutions involved in the MRV compliance cycle which is further explained in the following subsections of the study. However, the detailed institutional construct differs from system to system and an in-depth analysis of the institutional design that would hamper/facilitate linking of two ETS would be beyond the scope of the study at hand. Instead, it should be the focus of a separate detailed study.

Nonetheless, as essential components of an ETS, the following functions and tasks have been identified:

- Administration and Enforcement of the ETS and its regulations, usually performed by a Competent Authority (CA);
- validation/Verification of compliance, executed by VB;
- ensuring verifier's competence and independence/impartiality; establishing appropriate procedures at the verifiers and regular supervision of verification bodies and processes, performed by the Accreditation Body (AB);
- sanctioning in case of non-compliance through the Sanctioning Body , which is usually a part of the CA.

With regard to the credibility and robustness of the ETS it is, in principle, irrelevant whether the CA combines different tasks, such as the approval of monitoring plans, the final checking of emission reports, the accreditation of VB and sanctioning in case of non-compliance, under one umbrella. What matters is, whether a CA has enough financial resources, administrative power and expertise to perform those duties faithfully.

In the following parts usually performed duties and respective responsibilities are depicted with regard to each of the above mentioned institutions. The specific description of the different institution provides a holistic picture of a potential organizational structure. The identified minimum requirements for linking are systematically reflected in the scenarios provided at the end of the chapter.

3.1 Competent Authority

Depending on the governmental structure an ETS is implemented on a national, regional or local level. The hierarchies within the organisational structure vary. Typically, on the national or regional level, a cabinet-level agency/ministry politically backs the ETS and appoints a "Competent Authority" to administer the program on a centralized, (scientific), non-political basis. Such a structure is implemented e.g. within the EU-ETS in Germany[9] (and a lot of other member states), the Californian Cap-and-Trade Program (CTP)[10] and in Australia (CPM repealed June 2014).

The clear advantage of a centralized authority is that all relevant information is being gathered within a single institution. Thus:

a) the consistent interpretation, execution and enforcement of the regulations is guaranteed
b) the information exchange procedure could be sped up;
c) it allows for detailed data cross checks of all entities covered;
d) a consistent response on operator inquiries is facilitated;
e) all operators have the same address to contact in case of inquiries.

[9] Umweltbundesamt/Deutsche Emissionshandelsstelle (2015a): Die DEHSt: Retrieved 28.12.2015 from http://www.dehst.de/DE/Serviceseiten/Ueber-uns/ueber-uns_node.html

[10] California Environmental Protection Agency (2015i), California Air Resources Board: Cap-and-Trade Program: Retrieved 23.01.2016 from http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm

What matters is whether a CA has enough financial resources, administrative power and expertise to perform the above mentioned duties adequately. If a CA lacks the required internal expertise e.g. to approve new monitoring plans for operators covered, external expertise can be involved based on short-term assignments. It seems favorable for all parties involved to approve monitoring plans by a CA (EU-ETS[11], Shanghai[12] or RGGI[13]) as it strengthens the integrity of the scheme, provides additional legal certainty and, therefore, reduces the required effort for operators and verifiers to prepare and assess the annual emissions report. However, an officially approved monitoring plan is not required in all reviewed ETS. In some cases monitoring and reporting is done “directly” without a monitoring plan. In such cases, additional administrative effort will have to be put in to ensure a high quality of validation/verification services, especially regarding the required competence and independency/impartiality of VBs.

South Korea, for example, used to distribute under the South Korean Target Management System (TMS) some MRV related tasks and responsibilities (e.g. checking GHG data) between several ministries, each of them having expertise in specific sectors covered[14]. In this regard, the already existing expertise in the various institutions could be used and a potential redundancy could be avoided. However, it must be ensured, that enforcing the regulation is managed uniformly within the institutions.

As outlined above, in most of the analysed ETS, the competent authority (CA) is responsible for administering the program by enforcing the respective regulations, providing guidance for operators, checking/approving monitoring plans and GHG reporting data, carrying out on-site inspections as well as administering allocation procedures and the registry. CAs should also be entitled to carry out on-site inspections as an essential element for quality assurance of GHG monitoring and reporting.

Furthermore, an essential task is to define which installation fulfils the specific thresholds/pre-conditions to be covered by the program. In this regard, it is common to involve local authorities (see 3.2).

[11] Official Journal of the European Union (2012a): Article 12

[12] Shanghai Municipal Development and Reform Commission (SDRC) (2012a): Shanghai greenhouse gas emissions accounting and reporting guidelines (on trial), SH/MRV-001-2012, Retrieved 23.06.2015 from http://www.verifavia.com/bases/ressource_pdf/169/Shanghai-ETS-MRV.pdf (Chinese)

[13] Regional Greenhouse Gas Initiative (2013c), Model Rule, Part XX-CO_2 Budget Trading Program, Art. XX-8.5 (b): Retrieved 31.01.2013 from http://www.rggi.org/docs/ProgramReview/_FinalProgramReviewMaterials/Model_Rule_FINAL.pdf

[14] Greenhouse Gas Inventory and Research Center of Korea (2015b), Target Management System: Retrieved 28.12.2015 from http://www.gir.go.kr/eng/index.do?menuId=10#biz_con3

Table 1: Comparison of tasks and responsibilities of CA in different ETS.

	Centralized Authority?	Decision on compliance obligation	support by local authorities?	legally binding approval of MP	Authority to conduct site-visits?	Check of verified ER	Provision of guidance	Accreditation of VB	Authority to audit VB	Authority to sanction VB	Verifyer Supervisory Body	Authority to sanction operator	Management of the registry
California	x	x	x	-	x	x	x	x	x	x	x	x	x
EU-ETS (GER)	x	-	x	x	x	x	x	-	-	-	-	x	x
Australia	x	x	-	-	x	x	x	x	x	x	x	x	x
South Korea	-	-	-	x	x	x	x	-	x	x	x	x	-
Shanghai	x	x	-	-	x	x	x	x	x	x	x	x	x

Source: FutureCamp

Relevance for linking

The presence of a strong administration, either as a centralized authority or as a well-structured and functioning decentralized administrative system (as under the TMS in South Korea), is a prerequisite for the efficient and transparent operation of an ETS. It adds numerous qualitative aspects, as displayed above, which internally ensure the robustness of the ETS and enable external institutions/persons to evaluate and analyse the basic system characteristics and its respective developments. To that end, the consideration of this aspect is essential in the context of linking.

3.2 Local authorities

In some countries/regions, such as Germany (e.g. “Bezirksregierungen”)[15] or California (“Air Districts”)[16], independent local authorities are responsible for enforcing various regulations with respect to environmental issues (such as clean air or water laws) and for assessing physical boundaries and characteristics of facilities/installations. On that basis specific permissions are granted on installation level. In this context, those authorities are usually very familiar with the specific technical characteristics (such as number of boilers installed, the types of fuels used, amount of general emissions) and have the expertise to decide what technical components (flares, stacks, smelters, production lines etc.) belong, qua permission/license, to the installation.

Thus, those institutions could be very supportive in checking whether an installation exceeds respective thresholds that determine a potential compliance obligation (such as annual emissions [CAL[17]/AUS[18]], annual production or thermal heat input [EU] [19]) or that eventually covered emissions

[15] Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen (2013), Emissionshandel in der 3. Handelsperiode (2013-2020): Retrieved 28.12.2015 from http://www.lanuv.nrw.de/klima/klimaschutz/emissionshandel/ (German)

[16] California Environmental Protection Agency (2015j), California Air Resources Board: California Map for Local Air District Websites: Retrieved 10.07.2015 from http://www.arb.ca.gov/capcoa/dismap.htm

[17] California Office of Administrative Law (2012a), California Code of Regulations, §95810: Retrieved 16.06.2013 from https://govt.westlaw.com/calregs/Document/I197715E09A3011E4A28EDDF568E2F8A2?originationContext=document&transitionType=StatuteNavigator&needToInjectTerms=False&viewType=FullText&contextData=(sc.Default)

[18] Australian Government (2011a), Clean Energy Act [REPEALED]: Retrieved 25.09.2013 from https://www.comlaw.gov.au/Details/C2011A00131

[19] European Union (2003), DIRECTIVE 2003/87/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL – consolidated version from 30.04.2014, Annex I: Retrieved 23.07.2015 from http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02003L0087-20140430

are tried to be shifted out of the scheme. In Germany, the local authority grants the emission permits and, thus, decides on the inclusion of installations in the ETS.[20]

Prerequisites for this supportive function are:

- the local authority is familiar with the regulatory framework of the ETS and especially the respective inclusion thresholds;
- the information exchange between the involved authorities is guaranteed, regular and as holistic as possible;
- the operator is obliged to inform the local authority in case there are changes within the physical boundaries of the installation.

To sum up, in case a CA does not have the authority to perform onsite inspections or does not have access to adequate data to determine the compliance obligation, then the integration of relevant local authorities increases the consistency and completeness within the respective ETS. However, if additional authorities are involved, a uniform enforcement of regulations must be guaranteed. This can only be achieved, if a strong and regular information exchange is established and a joint interpretation of the legal basis is established.

Relevance for linking

As mentioned above, local authorities can provide additional qualitative insurance for the system by checking actual technical/physical and/or juridical conditions on installation level against the requirements of the regulation. The expertise and information local authorities usually have with regard to other environmental regulations has to be seen as a clear advantage in terms of knowing “what” (entity’s boundaries) has to be monitored. On the other hand, a large number of local authorities (possibly at different levels) causes a greater coordination effort to achieve a common interpretation of the rules and, thus, can be a disadvantage and can become a barrier for a harmonized enforcement.

3.3 Verification Body

In addition to the CA and, where applicable, to local authorities, independent verification bodies usually constitute an important institution within the organisational structure of an ETS. Verification bodies have the responsibility to prove data provided by the operator for reporting purposes either against an officially approved monitoring plan (EU-ETS)[21] or the regulation. Additionally, by checking the physical characteristics and the boundaries of an installation (e.g. via site visits) as well as the raw data for the respective annual emissions reports a third party verification ensures quality within the system by checking compliance.

In detail, during the verification process, the verifier evaluates conformance with the approved monitoring plan /the regulation[22] and to a certain extent (materiality level) the correctness of the information given by the operator. Site visits are usually part of the verification process and contribute to

[20] Landesamt für Natur, Umwelt und Verbraucherschutz Nordrhein-Westfalen (2013) (German)

[21] Official Journal of the European Union (2012b), COMMISSION REGULATION (EU) No 600/2012, of 21 June 2012 on the verification of greenhouse gas emission reports and tonne-kilometre reports and the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council, Art. 9: Retrieved 25.07.2015 from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:181:0001:0029:en:PDF

[22] The verification body primarily approves the full conformity of the emissions report with the established MP. However, in case there is no MP mandatory in the ETS or in the context of aspects not covered in the plan as a correct determination of the physical boundaries, the verifier is obliged to assess conformance with the regulation.

also check the practical compliance with the regulations, in order to detect potential loopholes and misstatements and evaluate the respective data management process.

Table 2: Verification requirements in different schemes

	Verification part of ETS	Verification threshold (only above x tCO2e/a)	Verification of the Monitoring Plan	Verification of the Emission Report
California	x		x	x
EU-ETS (GER)	x			x
Australia	x	x		(x)
South Korea	x			
Shanghai	x			x
Kazakhstan	x		x	x

Source: FutureCamp

In this regard, the role of the verification bodies could be summarized as follows:

- Providing an independent, impartial, accurate, transparent and authentic verification report including the total verified amount of emissions.
- Assessing compliance with the relevant regulation with regard to
  - emission numbers, energy production (if applicable) and energy consumption reported (if applicable);
  - the definition of installation boundaries
  - the requirements for identifying and measuring emissions sources, energy consumption and production points;
  - the requirements (e.g. appropriate procedures) established for accuracy, completeness and validity of reported subject matter including record-keeping requirements;
- Ensuring that the data reported by the operator is free from material misstatements in terms of
  - completeness and compliance with the requirements;
  - compliance with the monitoring plan and emission permit;
  - activities, control system and associated procedures to improve the performance regarding monitoring and reporting;

Verifiers are usually contracted and paid by the operator. However, in order to avoid any direct financial relationship between the operator and the verification body, it is also conceivable that the competent authority or equivalent institutions commission and pay the verification bodies for performing verification services. Such an approach could additionally increase the reliability and independence of verification services and, thus, the data reported. Nonetheless, the financial burden for the public budget is high, especially if each annual emissions report has to be verified regardless of the respective sum of emissions disclosed.

(Best) Practices

EU-ETS[23]:

- Accredited independent third party verification body commissioned and paid by operator
- Materiality:
  - 2% for installations > 500,000 tCO_2e/a
  - 5% for installations < 500,000 tCO_2e/a
- Level of assurance: reasonable
- Verification based on results of strategic and risk analysis
- Annual verification

California[24]:

- Accredited independent third party verification body commissioned and paid by operator
- Materiality: 5%
- Level of assurance: reasonable
- Each verification engagement is approved by CA regarding conflict of interest
- Triennial verification (with exceptions)

Australia[25]:

- Verification only in exceptional circumstances (>125,000 tCO2e/a, risk management, suspicion of fraud)
- Audits due to risk management: commissioned and paid by CA – other audits: commissioned and paid by operator
- Different audit types with different levels of assurance:
  - Reasonable assurance engagement
  - Limited assurance engagement
  - Verification engagement

South Korea[26]

- Designation by the Ministry of Environment after applying for a registration at the National Institute of Environmental Research
- Audits commissioned and paid by the operator

Shanghai[27]

- Verification by accredited independent third party verification bodies
- Verification guidance by CA does not include details like materiality, level of assurance etc.

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[23] Official Journal of the European Union (2012b), Art. 23 and 28

[24] California Environmental Protection Agency (2015d), California Air Resources Board; Verification of GHG Emissions Data Reports: Retrieved 12.12.2015 from http://www.arb.ca.gov/cc/reporting/ghg-ver/ghg-ver.htm and California Environmental Protection Agency (2013e), California Air Resources Board, California Code of Regulation Subchapter 10 Climate Change, Art. 95132: Retrieved 15.05.2014 from http://www.arb.ca.gov/cc/reporting/ghg-rep/regulation/mrr-2013-clean.pdf and Interview with David Kim (2014), Lead Verifier under the California Air Resources Board's (CARB) Mandatory Reporting Regulation with Environ, April 22nd 2014, San Francisco

[25] Australian Government (2015e), ComLaw; National Greenhouse and Energy Reporting (Audit) Determination 2009: Retrieved 27.12.2015 from https://www.comlaw.gov.au/Details/F2015C00875/Html/Text#_Toc336004486

[26] Ministry of Environment Republic of Korea (2011), Greenhouse gas, energy target management system operating guidelines, Notification No. 2011-29: Retrieved 25.03.2012 from http://eng.me.go.kr/board.do?method=view&docSeq=9168&bbsCode=new_infocus (Not available anymore)

[27] Shanghai Municipal Development and Reform Commission (SDRC) (2014): Management on Shanghai Third Party Verification on Carbon Emission (on trial): Retrieved 27.01.2015 from http://www.shdrc.gov.cn/main?main_colid=319&top_id=312&main_artid=23796

- Annual verification

Relevance for linking

A mandatory third party verification of the data disclosed by the operator provides reasonable assurance of compliance with the regulation within the ETS for all stakeholders. Especially in case the respective competent authority does neither have the financial resources nor the manpower to prove all data disclosed in detail and to check full compliance with the regulation, a third party verification adds a positive qualitative effect to the ETS. However, in the context of linking it is conceivable that there are different approaches with respect to mandatory verification requirements in the ETS to be linked which should not be seen as a barrier for linking. This could be true for constellations where:

- the competent authority is able to directly act as “a kind of verification body” and has the resources to prove compliance comprehensively (including site visits, cross checks and year to year comparisons of data disclosed)
- a specific verification threshold is implemented, which requires a mandatory verification only if a certain amount of emissions were reported - as is the case in Australia with >125ktCO_2/a[28]. However, it has to be calculated which share of total emissions covered by the ETS will, thus, be not subject to verification (less than 5% in Australia). The consequences with regard to potential uncertainties have to be included into the calculation of the full ETS uncertainty.

3.4 Accreditation Body

In order to ensure a high quality in verification services and to set certain standards for verification bodies that aim on performing services within the respective ETSverifiers are usually requested to obtain an official accreditation certified by the respective national Accreditation Body (AB). The step of officially accrediting a VB is seen as an important part of a reliable, transparent and comparable reporting system.

[28] Australian Government (2013d), Department of Foreign Affairs and Trade, Submission to the SBSTA May 2013 - Views on the Elaboration of a Framework for Various Approaches: Retrieved 26.04.2014 from http://dfat.gov.au/international-relations/themes/climate-change/submissions/Documents/Views-on-the-Elaboration-of-a-Framework-for-Various-Approaches.pdf

Table 3: Accreditation procedures in different schemes

	Same institution as CA	Accreditation of natural persons as verifiers mandatory	Accreditation of Verification Bodies
California	x	x	x
EU-ETS (GER)			x
Australia	x	x	
South Korea	(x)	x	x
Shanghai	x		x
Kazakhstan	(x)		x

Source: FutureCamp

In general, the AB is responsible for the following tasks:

- Assessment of verifiers’ competence to carry out the verifications in accordance to the relevant regulation
- Surveillance of VB/assessment whether verifiers perform services in accordance with the relevant regulations
- Assessment whether verifiers meet all requirements for being accredited
- Where applicable, approval of verifiers for individual verifications regarding possible conflict of interest
- Keeping a registry of accredited verifiers
- Sanctioning of VB and/or imposition of administrative measures (such as withdrawal of accreditation)

The AB themselves can be defined as per the international ISO 17011 norm, which regulates common rules for the process of accreditation of certification bodies and behaviour resp. virtues of the AB. However, the application of this ISO norm is not mandatory in all countries where ETS are developed. Therefore, national standards for the definition of AB are applied in parallel. Within the EU-ETS, ISO 17011 in combination with specific Accreditation and Verification Regulation (*AVR*)[29] and the Regulation on Accreditation and Market Surveillance (RAMS)[30] set the framework for the accreditation process.

The AB may be different from the competent authority, but can also be one institution. In this case, it is difficult to separate between tasks and responsibilities of the CA and the Accreditation Body.

[29] Official Journal of the European Union (2012b)

[30] Official Journal of the European Union (2008): REGULATION (EC) No 765/2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation No 339/93, retrieved 25.07.2015 from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:218:0030:0047:en:PDF

(Best) Practices

EU-ETS[31]**:**

- Accreditation body and competent authority are different entities (in each member state)
- Accreditation standard: International standard ISO 14065 + AVR
- Accreditation of verification bodies
- Witnessing activities by accreditation body in order to keep up accreditation for verifiers

California[32]**:**

- Accreditation body and competent authority are the same entity (ARB)
- Accreditation standard: individual standard similar to ISO 14065
- Accreditation of natural persons and verification bodies (each auditor needs individual appointment by ARB)
- Annual mandatory training of auditors and witnessing activities by CA/accreditor

Australia[33]**:**

- Accreditation body and competent authority are the same entity (Clean Energy Regulator)
- Accreditation standard: individual standard
- Accreditations for natural persons only
- Mandatory review of verifiers every 3 years (more frequently in case of suspicion of irregularities)

South Korea[34]

- Ministry of Environment acts as AB and central authority responsible for general ETS issues
- VB have to apply at the National Institute of Environmental Research (NIER) to perform verification services. After approval of NIER, the verification agency is designated and examined by the Minister of Environment
- A provisional verifier needs to have attended a course (>80h) set by the Ministry of Environment (MOE). To become a verifier one has to participate in three or five verification processes within two years, depending on the sector. The verifiers have to complete a refresher course (>24h) every two years

Shanghai[35]

- Accreditation body and competent authority are the same entities (NDRC, SDRC)
- Accreditation standard: individual standard by SDRC
- Accreditation of verification bodies

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[31] Official Journal of the European Union (2012b)

[32] California Environmental Protection Agency (2013e), California Air Resources Board, California Code of Regulation Subchapter 10 Climate Change, Art. 95132: Retrieved 15.05.2014 from http://www.arb.ca.gov/cc/reporting/ghg-rep/regulation/mrr-2013-clean.pdf

[33] Australian Government (2015h), Clean Energy Regulator; Greenhouse and Energy Auditor Registration Guidelines: Retrieved 28.12.2015 from http://www.cleanenergyregulator.gov.au/DocumentAssets/Pages/Greenhouse-and-Energy-Auditor-Registration-Guidelines.aspx

[34] Ministry of Environment Republic of Korea (2011)

[35] Shanghai Municipal Development and Reform Commission (SDRC) (2014): Management on Shanghai Third Party Verification on Carbon Emission (on trial): Retrieved 27.01.2015 from http://www.shdrc.gov.cn/main?main_colid=319&top_id=312&main_artid=23796 (Link not available anymore)

Advantages of CA and AB being the same authority:

- Improved information exchange
- Easier data access and data exchange
- Combination of competencies in personnel

Advantages of CA and AB being different authorities:

- Improved independence and less potential of conflict of interest
- Specialisation of personnel in a specific field (accreditation, review of technical issues in emission reports etc.), due to this a concentration of expertise

The table below shows the different requirements for verification bodies (blue) and individual verifiers (light yellow) in the context of the accreditation process.

Table 4: Comparison of accreditation requirements for verification bodies and individual verifiers

		California	EU-ETS (GER)	Australia	South Korea	Shanghai
Verification Body	Accreditation, using ISO 14065 and adding own requirements		x			
	Accreditation similar to ISO 14065 and adding own requirements	x				
	Using own accreditation standards				x	x
	certain amount of full-time staff members/qualified GHG auditors etc.	x	x		x	x
	minimum professional liability/ indemnity insurance	x	x			(x)
	fulfilling general independence requirements (conflict of interests)	x	x		x	
	procedures to provide relevant training/professional development	x	x		x	
	procedure to avoid conflict of interest	x	x		x	
	disclosure of judicial proceedings	x	x			
	minimum registered capital/minimum economic solvency		x			x
	proper internal quality management system		x			x
	location in the area of the ETS		x			x
Individual Verifier	specific standard for accreditation?			x		
	fit and proper person i.e. no offences against the law, no insolvency		x	x		
	knowledge of the relevant legislation	x	x	x	x	x
	knowledge of audit techniques	x	x	x	x	x
	independent professional testimonials from other experts			x		
	technical knowledge regarding at least one scope/technical area/methodology etc.		x			

Source: FutureCamp

Relevance for linking

The accreditation rules define what requirements independent verifiers need to fulfill to be involved in the verification process if independent verification is part of the ETS. Moreover, they regulate the interaction between verifiers and the accreditation body as well as the competent authority and the level of control the CA/accreditation body has over the verifiers. With regards to linking, this can be relevant in terms of the practical enforcement of the regulation. The accreditation rules and, therefore, the competencies of the accreditation bodies must be designed in a way to properly ensure that the verifier has the qualification and experience to enforce the verification requirements and a similar level of implementation of the ETS systems to be linked. If that is the case, details of accreditation and the organizational structure of the accreditation body (also its coexistence with the competent authority) can be seen as of secondary importance.

3.5 Sanctioning Body

The Sanctioning Body is responsible for the enforcement of sanctions due to non-compliance with the relevant legislation. In this regard, sanctions could be imposed on operators (in case of non-compliance) and verifiers (misstatements). Usually, the respective centralized competent authority has the administrative and regulatory power to act as the sanctioning body to sanction operators backed by respective laws and regulations. However, it is also conceivable that a different institution performs this task due to the lack of administrative power of the CA. In the context of sanctioning verifiers, usually the accreditation body has the authority to withdraw the accreditation. It is up to the specific regulatory basis whether the sanctioning body has a wide scope to react to potential offences, depending on the severity of the offence, the “offence track record” of the operator and the clear willingness to correct the error. Nonetheless, the authority to sanction potential non-compliance to an extent, that operators have the incentive to cooperate, is an element of utmost importance in order to ensure the robustness of the entire scheme. In the case of linking, the absence of substantial sanctioning mechanisms in one scheme is a clear obstacle for the entire linking process.

Relevance for linking

Enforcement and sanctioning is one key element to be evaluated in linking discussions. The Sanctioning Body must have the organizational structure, information access and legal power in order to ensure a proper implementation and enforcement of the regulation. The harmonization of all other parts of the regulations of two or more different ETS systems during linking discussions is obsolete in case these harmonized regulations cannot be similarly enforced in the linked ETS systems.

4 Operational structure

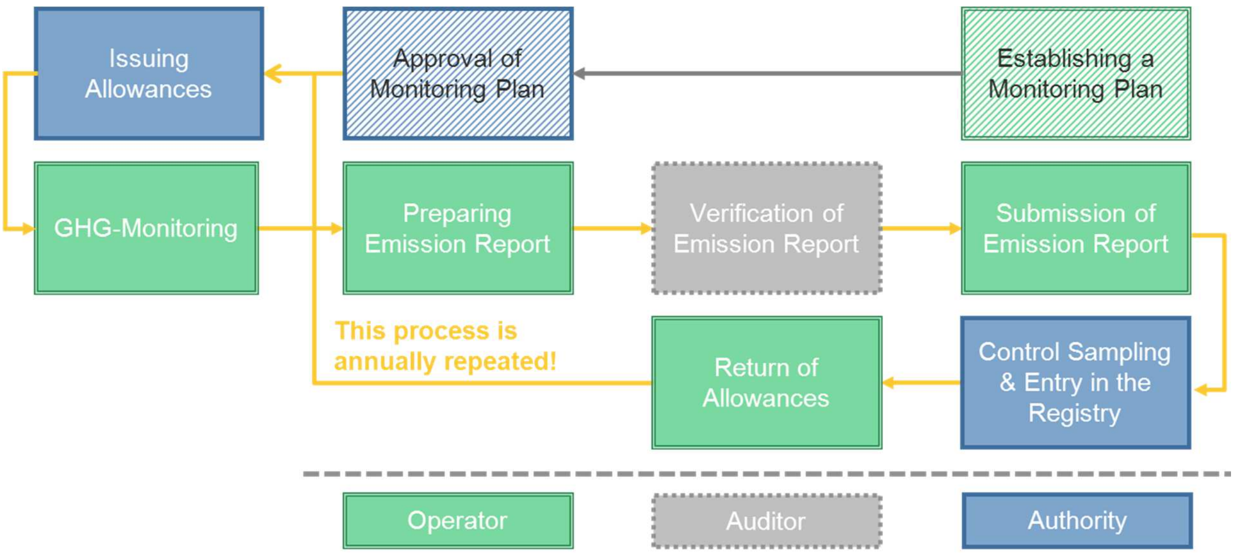
The operational structure of an ETS provides the framework for the technical and methodical design of the different pillars of the scheme. Usually backed by different regulations - such as the MRV, accreditation or auctioning regulation - the operational structure displays and clarifies the various tasks and responsibilities for the different stakeholders within the ETS as well as the (technical) vehicles for compliance. This includes the essential steps of the “compliance cycle” as well as the requirements with regard to the administrative elements of an ETS, such as standards for accreditation of verification bodies, standards for verification etc.

4.1 Compliance cycle

As indicated above, numerous different regulations usually determine the regularly recurring tasks and responsibilities of operators, auditors and the authorities involved in an ETS. Strict deadlines for compliance with the various regulations establish an annually repeated process - a “compliance cycle”.

According to the detailed studies on MRV regulation in different ETS, Figure 2 displays a compliance cycle that has been identified as the "average, typical” process which is annually repeated.

Figure 2: Typical compliance cycle



Source: FutureCamp

In the following list the essential MRV related elements of a typical compliance cycle are explained, different existing implementation approaches are displayed and identified essentials for linking are highlighted.

4.1.1 Preparation and maintenance of a Monitoring Plan

Usually, prior to the start of the first compliance period of an ETS, covered operators are obliged to develop a Monitoring Plan (MP) that describes in detail the monitoring methodologies and technical approaches chosen to comply with the respective regulations. The MP, thus, may depict inter alia:

- general description of the installation;
- all relevant emission sources and source streams;
- respective measurement devices installed to derive necessary data (type, location etc.); an evaluation of the instrument accuracy;

- information regarding quality assurance (calibration requirements, training practices for staff);
- respective sampling and analysis procedures to derive necessary calculation factors;
- data management processes.

Table 5displays different requirements with regard to the preparation of an MP in the schemes analysed. If changes to the above mentioned aspects appear, the operator will be obligated to update the MP. In general, it should not be allowed to reduce the accuracy of the chosen methodologies, except the changes are only for a defined, very limited period.

Table 5: Comparison of obligatory contents of MP in different ETS[36]

	Preparation obligatory?	Description of the installtion (type, main product, description of production processes)	Description of emission sources and source streams	Description of the monitoring methodologies chosen	Depictionof relevant measurement devices?	Description of specific device information (such as device type, number, location, technology) ?	Information regarding device accuracy?	Information regarding performed sampling and analysis?	Description of quality assurance processes	Information regarding the staff responsible for implementation	Information regarding data management and data flow	Information regarding treatment of data gaps
California	x	-	x	x	x	x	x	x	x	x	-	-
EU-ETS (GER)	x	x	x	x	x	x	x	x	x	(x)	x	x
Australia	-	-	-	-	-	-	-	-	-	-	-	-
South Korea	x	x	x	x	x	x	x	x	x	-	x	-
Shanghai	x	x	x	x	x	x	x	x	x	-	x	-

Source: FutureCamp

From an operator's point of view, the necessity to establish an MP before the compliance obligation starts may provide a number of benefits:

- the operator can develop a suitable monitoring approach step by step before legal requirements ultimately interfere and cause a possible sanctioning in case of non-compliance
- the final MP provides a roadmap and guidance for all staff members involved
- a clarification of responsibilities and duties – also with regard to update and adapt the MP – within the installation is fixed
- if applicable, the official approval of the MP through the CA provides the operator legal certainty with regard to the compliance with relevant regulations

Relevance for linking

If an operator is able to demonstrate compliance with the regulation to the complete satisfaction of the CA and/or VB, the presence of an MP will not have to be seen as a "must criteria" during linking negotiations. As seen in Australia with the "former" Carbon Pricing Mechanism, a credible and robust system could also be maintained without the requirement to establish an MP. A prerequisite for that is, nonetheless, clearly, that all applied monitoring methodologies as well as all used calculation fac-

[36] Official Journal of the European Union (2012b), Art. 12 and California Environmental Protection Agency (2012d): §95105 and Ministry of Environment (2011) Clause 42 and Shanghai Municipal Development and Reform Commission (SDRC) (2012a): 3.4

tors, measurement devices and integrated source streams are displayed in a transparent and unambiguous way (e.g. Australia: monitoring methodology is documented and submitted together with AER)[37] in order to enable the CA and/or the VB to check compliance with the regulation.

In any case, it is a prerequisite for linking, that the respective monitoring provisions are displayed in the regulation in a clear and unambiguous way so that compliance can be proven – with or without an MP.

4.1.2 Official check and/or approval of the Monitoring Plan

In some schemes, such as the EU-ETS, Shanghai or RGGI, the respective competent authority officially approves the MP submitted by the operator. It is regarded as strengthening the integrity of the scheme und provides additional legal certainty for the operator.

Besides the request for the initial approval of the MP, operators are obliged to notify the CA in case of changes in monitoring methodology, relevance of source streams (new fuels, different composition of process emissions) or technical approach (exchange of measurement devises). Thereby, a frequent assurance of monitoring quality within the installations is guaranteed.

Table 6: Current regulation on MP check and approval

	Preparation of MP obligatory?	Check of the MP performed by CA?	Official approval of the MP?	Checked by verification body during emissions reporting?
California	x	(x)	-	x
EU-ETS (GER)	x	x	x	x
Australia	-	-	-	-
South Korea	x	x	-	x
Shanghai	x	x	x	x
New Zealand	-	-	-	-
RGGI	x	x	x	-
Tokyo	-	-	-	-
Guangdong	x	x	x	x
Québec	(x)	-	-	x
Kazakhstan	x	-	-	x

Source: FutureCamp

In contrast, in schemes such as California, South Korea or Kazakhstan, the respective competent authorities have mainly outsourced the task of checking the MP regarding compliance with the regulation to the verification bodies involved. Under this scenario there is the clear advantage that the verifiers usually perform regular site visits and are specifically skilled in the respective sector. However,

[37] Dawes, Simon (2014): Measurement, Reporting, Verification - The Australian experience: Retrieved 23.03.2015 from http://mrv-conference.future-camp.de/pdf/day2_panel_02_s_dawes_linking_perspective_of_a_national_ets.pdf

in order to ensure the independence of the verification services and to ensure that potential misstatements or non-compliance within the MP are detected during reporting, it is seen as essential that, under such an approach, the MP and AER are verified by different verification bodies. In addition, the CA should still have the authority to request operators to submit the MP for cross-check and, moreover, regularly compare basic processes in different installations within the same sector.

Relevance for linking

With regard to linking, the step of officially approving the MP clearly goes hand in hand with an additional quality assurance and legal certainty for operators. However, if there is a detailed check of the MP and the AER performed by different verification bodies, this step should not be seen as an essential criterion during linking negotiations.

4.1.3 GHG-Monitoring

The elements of the regularly/continuously performed monitoring of GHG according to the MP/MRV regulation are described in chapter 5.4. In addition to that, chapter 5.1 also provides additional guidance on coverage and installation/source stream categorization.

4.1.4 Preparation of Annual Emissions Report

The Annual Emissions Report (AER) constitutes the basis for the annual compliance obligation on installation or entity level and provides, if applicable, together with the respective MP, all necessary information for the third party verification and the quality checks performed by the CA. In this regard, it displays the emissions numbers from the different relevant source streams or emissions sources, derived based on the methodologies set up in the Monitoring Plan (if applicable). The AER usually covers a period of one year, either the calendar year or the fiscal year. However, in case new installations enter the scheme during a reporting period, the AER only covers the respective period of time.

In order to ensure a high reporting quality and to prevent confusion with respect to the relevant installation/operator at least the following information ought to be included into an AER:

- Installation Identification Number
- Contact person
- Time period covered by the AER
- Corporate Parent Information
- All relevant source streams differentiated according to the relevant technical units or aggregated (if applicable)
- including respective activity data and
- calculation parameters
- Annual emissions (excluding biogenic) differentiated in all applicable GHG
- Annual emissions from biogenic CO_2

Relevance for linking

The AER is the core of each reporting activity within an ETS. Therefore, the focus should be to create an efficient framework for reporting to support operators submitting the correct data and to help the competent authority to effectively deal with the data in order to avoid inefficiencies during the reporting process.

In the context of linking, however, the structure and level of detail of the AER in the different schemes could differ without creating a risk for the envisaged common market. At the end, the relevant aspects are the number reported and the way they have been derived. In this regard, it is important that either in the monitoring plan or in the AER the methodologies used to derive the data reported are displayed in a transparent and clear way.

4.1.5 Verification process

After a verification body obtained an official accreditation to perform verification services within the respective ETS, the VB is usually allowed to verify the documents and data compiled by the operators in order to comply with the respective regulations.

However, in addition to the need of an official accreditation, in California for example, verifiers need to acquire an official approval by the CA for performing verification services for a specific operator. This step is especially related to the aim of avoiding/detecting potential conflicts of interest between verifiers and operators, and, thus, ensuring the independency within the verification process. In this regard, Californian VB (incl. all departments and subsidiaries of the company) must prove that it has not provided any other services to the operator for at least five years. Moreover, operators must change their VB at least once every six years and ensure a period of at least three years between two hires. With respect to linking, there are no substantial barriers implied in those different approaches. Fostering the independence of verification services definitely supports a high quality reporting but is no prerequisite for it.[38]

Generally, operators are requested by the respective regulation to get a positive verification statement for the annual emissions report. However, depending on the scope of the ETS and on country specific verification requirements, there are differences with regard to the thresholds in terms of annual emissions above which verification is mandatory. While within the EU-ETS all Annual Emission Reports have to be verified, in Australia only reports covering >125ktCO2 have to be verified by an independent third party. However, even though in this case only a small number of the liable entities covered has to get a verification statement, almost 95% of the emissions covered by the scheme are verified[39]. At the same time, compliance costs for small emitters are reduced significantly. The characteristics of the installations covered by the ETS are, thus, the relevant parameter in this regard.

Table 7: Overview on existing thresholds for mandatory verification[40]

	threshold for verification
California	all, according to scope >25ktCO_2
EU-ETS	all, regardless annual emissions
Australia	only installations above 125ktCO_2/a
South Korea	all installations covered
Shanghai	all installations covered

Source: FutureCamp

[38] California Environmental Protection Agency (2015d), California Air Resources Board; Verification of GHG Emissions Data Reports: Retrieved 12.12.2015 from www.arb.ca.gov/cc/reporting/ghg-ver/ghg-ver.htm

[39] Australian Government (2013d)

[40] California Environmental Protection Agency (2013e), §95103 (f) and Official Journal of the European Union (2012b), Art. 67 and Australian Government (2013d) and International Carbon Action Partnership (2015g): ETS-Map – Korea, Retrieved 25.09.2015 from https://icapcarbonaction.com/en/ets-map?etsid=47

Relevance for linking

With regard to linking it needs to be evaluated how the quality in reporting in systems with such different approaches could be ensured. Up to a certain extend, a detailed proof of non-verified Annual Emission Reports performed by sector specialists within the respective CA (provided the CA possesses enough administrative power and financial ressources, i.e. for pnsite inspections) might to this end pose a viable solution. Within the RGGI, "Authorized Account Representatives" that are responsible for submitting the ER (verification is not mandatory) have to certify under penalty of law "that the statements and information are to the best of his knowledge and belief true, accurate, and complete."[41] Thus, there are individual incentives, to ensure a high reporting quality backed by significant penalties for submitting false statements and information or omitting required statements and information, including the possibility of fine or imprisonment.

In general, main pillars of a verification process shall be:

- Site visits, in order to:
- validate correctness and completeness of the MP (if applicable) as well as of the emissions report with respect to the physical boundaries and the relevant technical components of the installations;
- analyse the data management system of the operators with regard to: potential gaps and weaknesses;
- interview the persons responsible for data collection and emissions calculation;
- inspect relevant measurement devices with regard to functionality and respective uncertainty requirements;
- validate primary data (activity data sheets, process information systems, analysis results etc.) on-site;
- approval of compliance with the respective regulation.
- Validation of data used to compile the emissions report during desk review to
- proof of calculation methodologies used in detail;
- detect inconsistencies within the data used for reporting;
- cross-check data on consistency with historic reports;
- evaluate overall materiality level
- Independent review of the verification statement performed by employees of the VB that are not responsible for the operator under scrutiny
- Issuance of a verification statement
- Corrective actions by the operator in case of non-compliance (if possible) or misstatements

4.1.6 Submission of the Annual Emissions Report

The deadline for submission of the AER to the CA shall be fixed and included in the respective regulation. In general, the available time period for preparation of the ER, also in the context of the potential availability of data (i.e. from energy supplier), and for verification, shall reflect both, the time needed on operator and on verifier level. Within the EU-ETS operators have to submit a verified AER until 31 March of the year following the reporting year.[42] In California, operators need to submit a preliminary AER without verification statement until 10 April. The final report including a verification statement needs to be submitted no later than 1 September of the year following the reporting

[41] Regional Greenhouse Gas Initiative (2013c): Art 4.1

[42] Official Journal of the European Union (2012b), Art. 67

year. [43] Thus, the time pressure to collect all relevant data, to hire a verifier and to conduct the verification is much lower then within the EU-ETS. In Australia there also used to be a split deadline for submission. Due to the reporting in the context of the fiscal year, an interim emissions number had to be submitted to the regulator no later than 15 June of the reporting year; the final number was due on 31 October.[44]

With regard to linking, merely evaluated in the context of MRV, differing deadlines for reporting within the schemes that aim on linking do not hinder a linking. However, there might be different implications in the economic or administrative context.

Table 8: Deadlines for preparation of ER and Verification Statements

	month available for preparation	
	ER	Verification statement
California	CY - until 10 April	CY - until 1 September
EU-ETS	CY - until 31 March	
Australia	FY - until 15 June (prelim.)	FY - 31 October
South Korea	CY - until 31 March	
Shanghai	CY - 30 April	
Kazakhstan	CY - until 1 April	
RGGI	CY - until 1 March	n. r.
Quebec	CY - until 1 June	

(CY=reporting based on calendar year; FY=reporting based on fiscal year)

Source: FutureCamp

With regard to linking, merely evaluated in the context of MRV, differing deadlines for reporting within the schemes that aim on linking do not hamper a linking. However, there might be different implications in the economic or administrative context.

Relevance for linking

In the context of pure MRV aspects, the specific provisions for the submission of the AER in each scheme do not have any relevance for a potential linking. However, this aspect might have implications for other aspects, such as allowance price development, auctioning calendars or allocation procedures.

4.1.7 Check of AER through CA and entry into registry

In order to establish an additional quality assurance within the reporting process, in most of the ETS which have been under scrutiny, the CA has the authority to check the already verified AER with focus on non-compliance or material misstatements. In this regard, the CA benefits from the holistic ETS information that is gathered on installation basis within the authority. Thus, there can be a comparison between similar installations and reporting years. Conclusions could be drawn and further

[43] California Environmental Protection Agency (2016), Air Resource Board, Key Dates and Activities for the Mandatory GHG Reporting Program - Update for 2016: Retrieved 20.01.2016 from www.arb.ca.gov/cc/reporting/ghg-rep/ghg-rep-dates.htm

[44] Australian Government (2015g), Clean Energy Regulator, Reporting Obligations: Retrieved 12.01.2016 from http://www.cleanenergyregulator.gov.au/NGER/Reporting-cycle/Report

clarifications requested. However, in the context of this clear advantage of additional checks, the CA must have sufficient financial endowment and appropriate staff.

Relevance for linking

With regard to linking, additional checks of the Annual Emission Reports performed by the CA in each of the systems are preferable, but should not be seen as a hindrance for linking. This is only true, if the mandatory presence of high quality verification services based on a strong accreditation system is included in the compliance cycle and if the independence of verification bodies is proven.

4.2 Cooperation and Information Exchange between CAs and ABs

The accreditation rules can regulate inter alia the interaction between the accreditation body and the competent authority. However, the tasks of the competent authority and accreditation body can be carried out by the same legal entity.

Being the only ETS system with two different authorities as CA and AB, the Accreditation and Verification Regulation of the EU-ETS[45] defines specific procedures of reporting and getting into contact between both authorities including annual reports and information transfer of critical issues detected during the CA's review of emission reports.

As accreditation bodies and verification bodies in the other analyzed systems are the same entities, the relevant legislation of those ETS systems does not include such formalized rules on communication or information exchange. However, it is observed that most regulations which involve more than one national or subnational authority (e.g. the TMS of South Korea) have implemented a more or less complex system of information flow between those entities and regulate the areas of cooperation.

Relevance for linking

When linking ETS systems, more and more national authorities are required to work together in a more complex environment than in a separate national system. This cooperation needs to be well-defined and -documented before linking ETS systems. However, the question of whether the AB and the CA are one or two entities can be estimated to be of secondary importance, if there are rules for information exchange and the understanding of accreditation and review of implementation of both ETS systems are similar.

4.3 Fields of application for IT

In numerous schemes, such as California, Australia or within the EU-ETS, specific web-based tools and integrated systems were developed in order to provide a digital basis for annual reporting (California, Australia, EU-ETS (GER, UK, FIN etc.)) and the preparation of monitoring plans (EU-ETS) or application procedures for emission allowances. The clear advantage of digital solutions is that they provide a fixed framework for reporting that assists operators in the documentation of all relevant data. Changes in monitoring methodologies due to physical changes within the covered installation could be displayed more easily and tracked over time.

Additionally, the application of IT provides instruments for:

- standardized reporting while increasing consistency and efficiency
- further assurance, security/confidentiality, and automatic checks
- an option for the CA to perform cross checks between similar installations

[45] Official Journal of the European Union (2012b)

- a balance between transparent reporting, ease of use and costs
- flexibility regarding confidentiality concerns – clear definition of rights
- retaining records (traceability)
- minimizing the risk of double counting through allowing “links” between installations or loopholes (i.e. in case of transfer of GHGs)
- transparent administration of registries

Moreover, the communication between CA, operator and VB is sped up and mostly documented. If changes of responsibilities within an operator’s team occur, new persons can easily assess the actual track record of the documentation.

Table 9: Examples for the use of IT within reporting process

Scheme	Issue	IT-Solution
EU-ETS (in general)	ER	Excel Template[46]
	MP	Excel Template[47]
EU-ETS (Germany)	ER, MP	Formular Management System (FMS), “Anlagendatenbank” (installation data base)[48]
	Communication	Via Virtual Post Office and FMS
California	ER	Californian electronic Greenhouse Gas Reporting Tool (Cal e-GGRT)[49]
Australia	ER	Emissions and Energy Reporting Tool (EERS)[50]
South Korea	ER	National Greenhouse Gas Management System (NGMS)

Source: FutureCamp

However, development and maintenance of such systems might be very costly and complex. Especially for complex sectors/installations as (in) the chemical sector, a web-based reporting system might not cover all potential constellations of complex installations. Nonetheless, the development of a transparent system of documentation is a prerequisite for ensuring complete, transparent and consistent reporting of data.

Relevance for linking

With regard to linking, it must be ensured that within both systems that are willing to link transparent reporting tools are implemented, whether they are automated IT systems or electronic templates.

[46] European Commission (2015a), Template No. 4: Annual emissions report for stationary source installations: Retrieved 28.12.2015 from: http://ec.europa.eu/clima/policies/ets/monitoring/docs/t4_aer_installations_update_2015_en.xls

[47] European Commission (2015b), Template No. 1: Monitoring Plan for the emissions of stationary source installations: Retrieved 28.12.2015 from http://ec.europa.eu/clima/policies/ets/monitoring/docs/t1_mp_installations_en.xls

[48] Umweltbundesamt/Deutsche Emissionshandelsstelle (2015b), Formular Management System: Retrieved 28.12.2015 from https://www.formulare.dehst.de/

[49] California Environmental Protection Agency (2015k), California Air Resources Board , ARB's electronic Greenhouse Gas Reporting Tool: Retrieved 28.12.2015 from https://ssl.arb.ca.gov/Cal-eGGRT/login.do

[50] Australian Government (2015f), Clean Energy Regulator, The Emissions and Energy Reporting System: Retrieved 28.12.2015 from http://www.cleanenergyregulator.gov.au/OSR/EERS/The-Emissions-and-Energy-Reporting-System

5 Methodical and technical design

The following chapter describes essential methodical and technical elements of a robust MRV scheme and evaluates their relevance for linking. However, as described in chapter 1 a few additional aspects that are not originally MRV, such as scope definition and inclusion thresholds, are analysed due to their strong interconnection to focal points of the study at hand.

5.1 Covered Sectors and Gases

Background

As shown below, the scope of an ETS can be very different depending on national economic circumstances and priorities and thus on the focus of the scheme. In that context, the most relevant issues of the scope definition within an ETS are:

- Greenhouse Gases included (e.g. compliance only for CO_2 or inclusion of further gases like N_2O or CH_4)
- Sectors included (e.g. energy, industry, transport, fuel suppliers, etc.)
- Inclusion of indirect emissions (e.g. emission reporting for consuming electricity or heat)
- Inclusion of upstream emissions (e.g. fuel suppliers report "theoretical" emissions inherent in the fuels sold)

(Best) Practices

EU-ETS[51]**:**

- CO_2 emissions; N_2O and PFC only for selected industries
- Pure Downstream approach
- Covers largest share of Energy and Industrial emissions (about 45 % of emissions)

California[52]**:**

- CO_2, CH_4 and N_2O emissions
- Combined Upstream / Downstream approach (upstream: suppliers of natural gas and refinery products)
- Mechanism to avoid double counting: Natural gas delivered to covered entities is subtracted from the emissions reported by gas suppliers
- Covers 85% of emissions

Australia[53]**:**

- CO_2, CH_4 and N2O emissions; PFC only for Aluminium
- Combined Upstream / Downstream approach (upstream: natural gas suppliers)
- Mechanism to avoid double counting: Liability could be transferred to the recipient (OTN system)

[51] European Commission (2016), Climate Action - The EU Emissions Trading System (EU-ETS): Retrieved 04.01.2016 from http://ec.europa.eu/clima/policies/ets/index_en.htm

[52] California Office of Administrative Law (2012a), California Code of Regulations, §95810: Retrieved 16.06.2013 from https://govt.westlaw.com/calregs/Document/I197715E09A3011E4A28EDDF568E2F8A2?originationContext=document&transitionType=StatuteNavigator&needToInjectTerms=False&viewType=FullText&contextData=(sc.Default) and International Carbon Action Partnership (2015c), ETS Map - California: Retrieved 28.12.2015 from https://icapcarbonaction.com/en/ets-map?etsid=45

[53] Australian Government (2011a), Clean Energy Act [REPEALED]: Retrieved 25.09.2013 from https://www.comlaw.gov.au/Details/C2011A00131

South Korea[54]

- CO_2, CH_4, PCF, SF_6, HFC and N_2O emissions
- Downstream approach (under TMS als energy consumption is reported)
- Covers about 66% of emissions

Shanghai[55]

- Only CO_2 emissions
- Direct and indirect emissions (purchased electricity and thermal energy)
- Covered sectors: apart from energy and industrial emissions also emissions from transport (ports, rail etc.) and commercial buildings incl. hotels (50% of emissions)

Relevance for linking

Generally it is not an MRV specific issue whether different schemes vary in terms of sectors and gases covered. However, the scope of an ETS has of course implications on the methodologies used to calculate emissions and should, thus, not be ignored in the context of that study. With regard to linking and focused on MRV, the scopes defined in the schemes that aim on linking could vary substantially without hampering a successful linkage. To that end it is important that a complete reporting of all emissions within the defined scope is provided (see 2 completeness). In systems where indirect emissions are included or where a mixture of upstream and downstream approaches is applied there should be provisions to avoid double counting on both ends - supplier and end users. In that regard it is of utmost importance that there are adequate surveillance and enforcement mechanisms to ensure that all relevant emissions within the scope of the scheme are reported.

5.2 Applicability criteria, Categorization of entities and source streams

Background

Within the scope of an ETS there can be several ways to define thresholds and applicability criteria for inclusion in the reporting or to set up different quality requirements. In principle, the following approaches in different constellations can be identified:

- Installation-based approach vs. entity-based approach
- Thresholds-based on technical parameters (e.g. capacity)
- Thresholds-based on yearly emission levels

The selection on the approach applied is generally dependent on the availability of data (e.g. availability of installation size from other permitting processes or availability of emissions data from pilot MRV phases).

A way to define the applicable monitoring requirements for each installation / entity is to categorize the installations and emission sources as follows, inter alia:

- Installation categorization based on total emissions or thermal rated heat input
- Categorization of source streams / emissions sources dependent on share of total emissions

[54] International Emissions Trading Association (2015a), Republic of Korea; An Emissions Trading Case Study: Retrieved 29.11.2015 from http://www.ieta.org/resources/Resources/Case_Studies_Worlds_Carbon_Markets/republicofkorea_case%20study_june_2015.pdf

[55] International Carbon Action Partnership (2015d), ETS Map – Shanghai: Retrieved 28.12.2015 from https://icapcarbonaction.com/en/ets-map?etsid=62

(Best) Practices

EU-ETS[56]**:**

- Installation based approach
- Thresholds based on capacity:
  - Combustion activities: Rated thermal input > 20 MW
  - Industrial activities: different production capacity thresholds
- Installation Categorization: A (<=50,000t/a), B (<500,000t/a), C (>500,000t/a)
- Lower requirements for minor source streams: 10% of total emissions or 5,000t/a (up to 100,000 t/a)
- Lower requirements (estimation) for de-minimis source streams: 2% or 1,000t/a (up to 20,000 t/a)

California[57]**:**

- Yearly emission threshold (25,000t/a):
  - exceeded in 2008 or any consecutive year
  - new installations: rough estimation by threshold guidance document
- No installation categorization in general but TIER-system that refers on the monitoring requirements for emissions from stationary combustion units according to their thermal rated heat input
- Lower requirements for de-minimis source streams: 3% of total emissions, 10% of annual heat input

Australia[58]**:**

- Yearly emission threshold (25,000t/a):
- calculation sheet with threshold test
- No installation categorization
- No reporting obligation for de-minimis source streams:
  - Below 1 tonne of combusted solid fuel
  - Below 1,000 cubic metres of gaseous fuel
  - Below 5 kilolitres of petroleum based oil

Shanghai[59]

- Yearly emission threshold exceeded in 2010 or 2011
  - 20,000 t CO_2/a for industry sector
  - 10,000 t CO_2/a for non-industry sector
- No simplified requirements for low-emission source streams and no tier-approach defined yet

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[56] Official Journal of the European Union (2012a) and European Union (2003), consolidated version from 30.04.2014: Annex I

[57] California Environmental Protection Agency (2013e), Art. 95132

[58] Australian Government (2013c), National Greenhouse and Energy Reporting (Measurement) Determination (2008, Version from August 2013): Retrieved 24.02.2014 from https://www.comlaw.gov.au/Details/F2013C00661

[59] CDC Climate (2013) Climate Report n°38: Retrieved 10.02.2013 from http://www.cdcclimat.com/IMG//pdf/13-01_climate_report_38_economic_tools_of_chinese_climate-energy_policies_cdc_climat_research.pdf

Relevance for linking

Generally, it is not a relevant linking issue whether the applicability criteria for entities and emission sources are different between schemes, because these criteria define what is subject and what is not subject to the system. However it is crucial that the criteria are designed in a way that allows the unambiguous identification of emission sources that have to be reported. Again, adequate surveillance and enforcement mechanisms are crucial to ensure that all relevant emissions within the scope of the scheme are reported.

The existence of any categorization (installation or source streams/emission source) is not a linking issue per se. However, it's a prerequisite to allow any estimation approaches and low uncertainty requirements only to installations / source streams that are of lower relevance for the system. In that way the categorization has indirect effects on the maximum uncertainty level of the total ETS system. The thresholds defined for categorization are relevant for the share of emissions which can be reported under lower tier approaches. (See chapters about calculation of emissions [5.4] and deviation from monitoring requirements [5.8]). To that end, a differing definition of categorisations and in this context a divergence in monitoring requirements could have a substantial quantitative effect on the total uncertainty in the system, depending on the emissions profile within the system on installation level.

5.3 Applicable monitoring methodologies

Background

The determination of emissions is usually based on one of the following methods:

- <u>Calculation-based approach</u> by multiplying the recorded volumes of relevant input streams (activity data; usually recorded in tonnes, liters or m^3) and respective calculation factors[60] - or as mass balance by multiplying activity data of input and output streams with the respective carbon content
- <u>Continuous Emissions Monitoring System (CEMS):</u> monitoring volume of flue gas and its inherent CO_2-concentration on an almost continuous basis
- <u>Mixture of calculation and CEMS:</u> if not all relevant emission sources are covered by the CEMS, a mixture of the two approaches can be applied.
- <u>Estimation:</u> as the approach with probably the lowest accuracy, estimation (on a qualified basis) could be applied. However, all other approaches described above are preferrable in order to generate the most accurate data.

(Best) Practices

EU-ETS[61]:

- Calculation is the dominating method
- CEMS mandatory for N2O-emissions and catalytic crackers in refineries
- Estimation only under the following conditions:
  - de-minimis source streams
  - Source streams with biomass fraction =>97%
  - Conservative estimation required

[60] See subchapter 5.4 - Calculation factors: such as oxidation factor, emissions factor, calorific value etc

[61] Official Journal of the European Union (2012a)

California[62]**:**

- CEMS in some cases under state regulation (e.g. Acid Rain Program) mandatory

Australia[63]**:**

- Definition of four methods applicable:
  - Method 1-3: calculation based
  - Method 4: CEMS

Shanghai[64]**:**

- Three defined accounting methods:
  - Emission factor method (calculation based)
  - Material balance method (calculation based)
  - Measurement Method

Relevance for linking

The application of different monitoring methodologies between different systems is not a critical issue in general as long as consistency and transparency about the methodology applied is guaranteed and accuracy or quality requirements are on a similar level in the end. However, a critical issue in the context of linking could be a missing comparability of qualitative requirements between different systems like standards for metering devices or for sampling and analysing (see following chapters).

5.4 Requirements for calculation of emissions

The following subchapters outline which approaches where found in the analysed schemes to determine quantities and calculation factors for regular reporting. In this regard special attention was paid to the requirements defined to ensure quality and accuracy of the data reported. Based on that, the relevance for linking of the determination of uncertainty as a key criterion for generating accuracy with the systems (to a certain extent) is evaluated.

5.4.1 Requirements for quantities

Background

As depicted in the previous chapter the calculation-based approaches incorporate the quantities, or activity data, of the relevant source streams into the calculation of the data reported. In this context, the uncertainty requirements for the determination of this data have a high impact on the accuracy of the data derived for reporting purposes.

The calculation of the overall uncertainty of the data recorded via e.g. metering devices is a complex issue. Since the classical quantitative uncertainty assigned to a calibrated device only refers to a snapshot in time under predefined conditions, uncertainty contributions of parameters (e.g. environmental temperature, temperature of the medium etc.) need to be considered reflecting that the uncertainty of the metering device is influenced while in service. Moreover, quality assurance aspects (e.g.

[62] Interview with Rajinder Sahota (2014), Chief Climate Change Program Evaluation Branch Stationary Source, Thursday, April 24th; Sacramento

[63] Australian Government (2013c), National Greenhouse and Energy Reporting (Measurement) Determination (2008, Version from August 2013): Retrieved 24.02.2014 from https://www.comlaw.gov.au/Details/F2013C00661

[64] Shanghai Municipal Development and Reform Commission (SDRC) (2012a), Shanghai greenhouse gas emissions Accounting and reporting guidelines (on trial), SH/MRV-001-2012, Retrieved 23.06.2015 from http://www.verifavia.com/bases/ressource_pdf/169/Shanghai-ETS-MRV.pdf (Chinese)

regular sealing of metering devices, specific standards for quality control of metering devices etc.) should be included, too. Finally, it has to be taken into account (by error propagation) that there can be more than one measuring device determining the quantity of a source stream. The use of a tier approach helps to differentiate the specific requirements dependent on the category of the source stream and the annual emissions of the installation and to create a balance between efforts to make and gain in certainty.

(Best) Practices

EU-ETS[65]**:**

- Uncertainty requirements linked to TIER approach
- Highest Tier requirement: maximum uncertainty 1.5%
- Uncertainty calculation simplified under the following conditions:
  - Devices under national metrological control
  - Calibrated devices
- Calibration standards and guidelines to calculate uncertainty of devices
- CEMS quality assurance according to ISO 14181

California[66]**:**

- For combustion processes, type of data source linked to TIER approach (no uncertainty values):
  - Tier 1 + 2: company records
  - Tier 3: calibrated flow meters, fuel billing meters or tank drops (gaseous and liquid fuels)
  - Tier 4: CEMS

Australia[67]**:**

- Uncertainty assessment based on the GHG Protocol guidance on uncertainty assessment
- Default uncertainties for Method 1 based on four criteria
- No absolute uncertainty thresholds defined

Shanghai[68]

- No Tier-approach or maximum uncertainty requirements
- Uncertainty needs to be assessed in the emission report according to specified criteria (i.a. missing data, measurement errors etc.)
- Reduction measures for lowering the uncertainty need to be stated in the emission report

Relevance for linking

As stated above, uncertainty is one of the key criteria to determine the overall accuracy of the reported activity data. In this regard, quantitative and qualitative requirements with respect to measurement devices and its respective quality control systems enable to estimate the uncertainty of the

[65] Official Journal of the European Union (2012a): Art. 26, Art. 28, Art. 59 and Annex II

[66] California Environmental Protection Agency (2013e) and United States Environmental Protection Agency (2009a), Code of Federal Regulations, Titel 40 Protection of Environment, §98.3: Retrived 02.02.2013 from http://www.ecfr.gov/cgi-bin/retriev-eECFR?gp=&SID=6f52ecf710ce431555b211a30e05b5cd&mc=true&n=pt40.21.98&r=PART&ty=HTML#se40.21.98_13

[67] Australian Government (2013c): Part 1.2 and 1.3

[68] Shanghai Municipal Development and Reform Commission (SDRC) (2012a)

reported data on a profound basis. For a comparison of the requirements to determine emissions on a source stream or installation basis in different systems it is essential that the definition of uncertainty in the systems to be linked is somehow comparable and that both systematic as well as incidentally occurring errors are considered.

To conclude, the allowed level of uncertainty ought to be on a similar level for schemes that shall be linked. The following approach can be applied for a rough assessment of the total uncertainty level in different systems, if uncertainty requirements are connected to certain criteria (i. e. via a tier approach including categories of source streams or installations, examples see chapter 5.2):

- Calculate share of installation categories / sector on total emissions of the scheme
- Determine allowed uncertainty level defined in the regulation
- Calculate overall uncertainty allowed in the scheme under consideration of all installation categories / sectors.

5.4.2 Requirements for calculation factors

Background

Applying the calculation-based methodology as outlined under 5.3 the following parameters (calculation factors) are of relevance for the determination of GHG emissions to be reported:

- Calorific Value (the amount of thermal energy released by a tonne, litre or cubic meter of a material during complete combustion expressed in kJ/unit)
- Emission Factor (average rate of a specific GHG produced in relation relative to the activity data utilised expressed in tCO_2e/kJ or tCO_2e/t)
- Oxidation Factor (fraction of carbon which is oxidized during combustion)
- Carbon content (fraction of carbon in a unit of a material expressed in tC/t)
- Conversion Factor (the numerical factor to convert Carbon to CO_2 according to the respective stoichiometry)
- Global Warming Potential Values (factor of how much heat a GHG traps in the atmosphere compared to CO_2)

(Best) Practices

EU-ETS[69]:

- Material specific analysis of relevant source streams to derive calculation factors is required for installations > 50,000t/a
- Minimum frequencies for sampling and analysis are defined for different types of source streams
- Strict quality requirements on laboratories (EN ISO / IEC 17025 or comparable standard)
- Establishment of an installation specific sampling plan is mandatory (to foster representativeness of the samples taken)
- Standard factors only for installations <=50,000t/a or minor /de-minimis source streams and commercial standard fuels:
  - Based on IPCC 2006 (Tier 1)
  - Country specific values (Tier 2a)
- DE: Oxidation Factor: Application of 1 for all categories required

[69] Official Journal of the European Union (2012a): Annex V, Annex VI, Annex VII

California[70]**:**

- Monthly material specific analysis of relevant source streams to derive calculation factors is required for process emissions (non-combustion)
- Fuel specific default values for combustion processes (TIER 1/partly TIER 2) allowed
- Minimum frequencies for sampling and analysis are defined for higher TIERs
- No requirements on laboratories but plausibility of factors used is checked during verification

Australia[71]**:**

- Method 2: industry standards for sampling
- Method 3: international standards for sampling and analyses
- Standard values for parameters:
  - Method 1: National default values
  - Method 1 is not restricted to small emitters

Shanghai[72]

- Measured Values
  - Compliance with national, industry or local standards for measurements (i.e. laboratory conditions etc.) is required
  - Measurements records need to be kept
- Default Values from Shanghai GHG accounting and reporting guidance

The requirements for the specific determination and use of calculation factors as part of the regular reporting have a large impact on the overall uncertainty of the respective emissions calculation. However, in contrast to the determination of the uncertainty of reported activity data, which could be based on quantitative numbers (maximal permissible error in service), it is more complex to determine the uncertainty of calculation factors.

The uncertainty of sampling and analyses is related mainly to sound requirements regarding the methods used to take representative samples and to analyse the respective source streams (i.e. by applying recognized standards) and define requirements regarding the quality of the laboratories involved (i.e. through accreditation or quality insurance measures)

Most of the schemes analysed, especially for small emitters as well as for standard materials, allow the use of default (standard) factors. In this regard, the origin of those values is of importance in case they are subject to comparison in the context of an envisaged linking. On the one hand, some schemes allow for the use of “IPCC Factors”. Those are derived from global data and display a mean average. Thus, they could lead to an overestimation in one region and to an underestimation elsewhere. On the other hand, as within the EU-ETS or in California, country (regional) specific factors (average mean) where derived from weighted historical data. Those values should not necessarily be considered as conservative but display the actual average mean (historic) data for a specific region.

70 California Environmental Protection Agency (2013e): for stationary combustion processes inter alia §95115 and United States Environmental Protection Agency (2009a): §§98.30 to 98.38, for process emissions inter alia California Environmental Protection Agency (2013e): §95117 and United States Environmental Protection Agency (2009a): §§98.190 to 98.198

71 Australian Government (2013c): standards are mentioned under various subparts

72 Shanghai Municipal Development and Reform Commission (SDRC) (2012a)

In case of linking it should, therefore, be analysed which criteria were used to derive the applicable default values in order to detect potential differences and to estimate differences in the quality of the factors used. Furthermore, it should be checked under which circumstances default factors could be applied and to what extend the overall uncertainty of the reported emissions is influenced by those requirements. The use of a tier approach helps to differentiate the requirements dependent on the category of the source stream.

Relevance for linking

Overall uncertainty of the emissions reported is one of the key criteria for characterising the design of MRV provisions. In his context, the choice of calculation factors is very relevant for the total uncertainty level within the scheme. The general relevance for linking is basically the same as described in chapter 5.4.1. It is critical to compare the methodology that was used to derive the applicable default values (i.e. the development method for national default factors, the reference state of the material like “wet” or “dry”) in order to detect potentials for a systematic over- or underestimation of emissions.

The application of standard values is not critical as long as those values could be compared with regard to the methodologies they were derived with. Regional and national factors should, in this context, be seen as the preferred sources. If such long-term average mean data is not available, standard factors that are defined in a way to ensure conservativeness of data reported (no underestimation) can be applied without hampering linking. In case of small emitters and minor source streams the application of default values such as IPCC factors should be acceptable.

5.5 Requirements for continuous emissions measurement systems

Background

In the case of using continuous emissions measurement systems (CEMS) for monitoring the emissions of a specific flue gas stream the quality of the determination of emissions is linked to the following two issues:

- The quality of flue gas flow measurement, mostly determined in cubic meter.
- The quality of greenhouse gas concentration measurement

Again the quality requirements of both parameters can be defined by one of the following approaches:

- Defining qualitative criteria, such as for the technical and procedural calibration requirements, explicit standards for quality control and management, as well as for the regular proof of the technical functioning of the used devices and (if uncertainty requirements are defined)
- quantifying the individual and combined uncertainty of the used devices according to defined and harmonized rules and defining respective uncertainty thresholds i.e. according to the size of the monitored source stream or the overall installations emissions

Within the EU-ETS or California, a mixture of qualitative and quantitative criteria for determining the overall uncertainty of the CEMS monitored source stream is applied.

(Best) Practices

EU-ETS[73]**:**

- Uncertainty requirements on flue gas flow and concentration measurement linked to a separate Tier approach
- Total maximum uncertainty for installations emitting more than 5,000t/a:
  - CO_2: 2.5%
  - N_2O: 5.0%
- Additional qualitative requirements on calibration: applying EN 14181
- Corroboration with calculation of emissions required

California[74]**:**

- CEMS integrated in Tier approach (Tier 4 = CEMS)
- Max. permissible error: 5% for each device, thus combined allowed uncertainty for the CEMS as a measurement system is 7.07%
- Specific requirements on data management and treatment of data gaps

Australia[75]**:**

- CEMS and/or Periodic Emissions Measurements System (PEMS) allowed to be applied in method 4
- CEMS: a corroborating calculation according to UNFCCC standards has to be handed in
- Uncertainty assessment according to section 7 of the GHG Protocol guidance

Relevance for linking

The general importance of qualitative or quantitative requirements on uncertainty as described in the chapter on the calculation based approach is also relevant for CEMS.

5.6 Transfer of GHGs

Background

CO_2 can be transferred out of the installation’s boundary either as part of a fuel mixture or as pure material. Waste gases in the chemical and in the steel industry often contain inherent CO_2. Pure CO_2 is a raw material for industrial processes, e.g. in the food and beverage industry. Often the transferred CO_2 is emitted within a short period of time. There might be other options with regards to binding CO_2 long-term. In the case of geological storage of CO_2 (CCS), for example, it can be assumed that the CO_2 will remain stored for a long period under clear provisions. Concerning other GHGs, the N_2O transfer between chemical installations in particular is another situation to be considered.

(Best) Practices

EU-ETS[76]**:**

- Transferred CO_2 can only be subtracted under the following conditions:
  - Transfer to another ETS installation as part of a fuel

[73] Official Journal of the European Union (2012a): Art. 42, Annex VIII

[74] California Environmental Protection Agency (2013e): §95115 and United States Environmental Protection Agency (2009a): §98.33 (a)(4)(iv)

[75] Australian Government (2013c): Part 1.3 and Part 8

[76] Official Journal of the European Union (2012a): Art. 49

- Transfer to a geological storage site with monitoring of pipelines and storage site

California[77]**:**

- Currently, transfer of GHG is only relevant in the context of:
    - CCS
    - Supply of CO_2 for further processing/utilization
- In the latter case, no subtraction allowed – pure upstream approach!

Australia[78]**:**

- transfer of CO_2 is only relevant in the context of carbon capture and storage activities
- in other contexts, it is of minor importance due to industry constellations

Shanghai

- No specific provisions on transferred CO_2 yet

Relevance for linking

The transfer of GHGs out of the ETS boundaries may generate loopholes as long as transferred emissions can be subtracted from the emissions reported. Therefore it is important to regulate under which conditions emissions can be subtracted.

5.7 Treatment of biomass

Background

The emission factor of biomass can be defined to be zero in an ETS. However, in that case the following aspects have to be considered:

- Definition of biomass possibly taking into account additional criteria like sustainability
- Provisions on the determination method of a biomass fraction
- Avoiding possible double counting, if biomass can either be considered in a physical way i.e. by sampling and analysis or e.g. in a contractual way

(Best) Practices

EU-ETS[79]**:**

- Emission factor of biomass is zero
- Biomass fraction has to be determined in mixtures by:
    - Laboratory analyses (highest Tier)
    - Estimation methods (conservative)
- Sustainability criteria are addressed for biofuels and bioliquids
- Biogas in natural gas grids:
    - Application of an appropriate guarantee of origin system; in that case analyses of the biomass fraction is not allowed for all installations connected to the grid

[77] California Environmental Protection Agency (2013e): §95123 and United States Environmental Protection Agency (2009a): §§98.420 to 98.428

[78] Australian Government (2013c): Part 3.4

[79] Official Journal of the European Union (2012a): Art. 38f

California[80]**:**
- Emission factor of eligible biomass is zero
- Eligible biomass is defined under the California Renewable Portfolio Standard

Australia[81]**:**
- Emissions from the combustion of biomass, biofuel or biogas are not accounted; Emissions Factor is zero
- No sustainability standards for the use of biomass exist

South Korea[82]**:**
- Emission factor of eligible biomass is zero
- For biomass mixed with fossil carbon a mixture ratio should be calculated determined via sampling and analysis
- The respective biomass share could be excluded from the emission report. If it is not possible to separate the share of biomass from the fossil carbon, no exclusion is possible
- No sustainability standards for the use of biomass exist

Shanghai
- Emission factor of biofuels and biomass is zero
- No sustainability standards for the use of biomass exist

Relevance for linking

The deductibility of emissions of biogenic origin (EF = 0) stimulates a preference for biomass. The general definition on biomass should hardly differ. But it can become important if -in one system only- (certain) biomass has to fulfil a selection of additional criteria (e.g. in the context of sustainability) to be exempted from the reporting obligation, whereas the same biomass without additional criteria would generate emission reductions in the other system. If this loophole is a relevant quantity or becomes one in the course of time, different definitions of biomass can damage the integrity of the system. In addition, the difference could also lead to biomass flows between systems, which cut short the steering effect by the statutorily privileged biomass with a certain quality (e.g. with certain sustainable criteria) and undermine other national environmental targets.

Another, double counting issue may occur, if the proof of biomass takes place by means of invoices or other documentations. It is, for example, important to have any mechanism to avoid double counting in systems where biogas that is fed into a grid can be treated as biomass even if it is not physically burned in an installation. The same is relevant in systems where electricity consumption is in the scope of an ETS and renewable electricity has to be considered in an appropriate way.

5.8 Deviation from monitoring requirements

Background

The definition of strict requirements (e.g. on maximum uncertainty) are essential on the regulatory level to secure reliability and credibility of the system. However, there will always be situations where not all requirements can be met either due to cost restrictions or to technical restrictions.

[80] California Environmental Protection Agency (2013e): Definition (37)

[81] Australian Government (2013c): Schedule 2 and Schedule 3

[82] Ministry of Environment Republic of Korea (2011): Clause 49

The definition of generally accepted simplifications and the definition for the acceptance of temporary and individual deviations in the regulation support the correct implementation process and increase the acceptance of the participants.

The following types of deviations have to be separated:

Generally accepted simplifications for small emitters, minor and de-minimis source streams, small emission sources (CEMS), or biomass or e.g. commercial standard fuels
Individual and temporary deviations for large emitters and major emission sources, source streams

(Best) Practices

EU-ETS[83]**:**

- Tier concept defines lower requirements for small installations and small source streams
- Deviations for relevant source streams at large installations (>50,000t/yr) are allowed only under the following conditions:
  - Technically not feasible
  - Unreasonable costs (comparison of the benefit of an improvement in accuracy at a fixed CO_2-price level with the costs of the improvement)
- All deviations are subject to the approval of the competent authority

California[84]**:**

- Only a few options to deviate but not on a regular basis:
  - If facility is operated in a continuous manner, calibration deadlines can be temporarily postponed
  - If other deviations, that are detected during verification, are still acceptable with regard to the materiality level, there will be no consequences within the relevant reporting year

Australia:

- It is also possible to drop back to a lower order method if a method is found to be non-compliant during an external audit. The liable entity has to confirm the case in writing to the CER

Relevance for linking

The treatment of deviations is relevant under two aspects:

- In cases where deviations are defined within the regulation the effect on the overall uncertainty shall not be high.
- In cases where the regulation does not define deviations there should be at least a procedure defined and an organisational responsibility that decides about acceptable deviations. Otherwise there’s a risk that the system may look good on the regulatory level but the implementation in reality is far from the actual requirements.

[83] Official Journal of the European Union (2012a): Art. 17f

[84] California Environmental Protection Agency (2013e): §95103 (k)(8) and Interview with David Kim (2014)

5.9 Data management and control: Treatment of data gaps, requirements for an internal control system

Background

Requirements on data management and control systems are essential elements for the successful implementation of MRV systems. Key elements are the following issues:

1. Documentation of data flow activities
2. Establishment of control systems
3. Procedures for quality assurance
4. Treatment of data gaps

Especially in the context of monitoring N_2O requirements for the treatment of data gaps should take account of the higher Global Warming Potential.

(Best) Practices

EU-ETS[85]:

- Written procedures required for:
  - Data Flow
  - Control Systems
  - Quality assurance of measuring equipment
- Requirement for risk analysis (except small installations < 25,000t/yr)
- Provisions on conservative closure of data gaps
- Germany: Treatment of data gaps, Toolbox defining 6 tracks[86]:
  - Reproducible without quality loss
  - Reproducible with quality loss
  - No reproducibility:
    - Substitution by lower tier approach
    - Substitution by estimation based on correlating parameter
    - Substitution by estimation based on historic records
    - Substitution by estimation including an expert opinion

California[87]:

- operator must include the substituted data in the GHG emissions data report and maintain all records, calculations and data used to estimated substituted data;
- under the limited circumstances of equipment breakdown, the operator may request approval of an interim data collection procedure at ARB
- provision in case a source is monitored via CEMS and for emission derived via calculation, inter alia if data capture rate in the context of fuel parameters is:
- >90% - use arithmetic average of the values of that parameter immediately preceding and immediately following the missing data incident

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[85] Official Journal of the European Union (2012a): Chapter V

[86] Umweltbundesamt/Deutsche Emissionshandelsstelle (2015c), Leitfaden zur Erstellung von Überwachungsplänen und Emissionsberichten für stationäre Anlagen in der 3. Handelsperiode (2013-2020), Art. 19.4: Retrieved 29.11.2015 from http://www.dehst.de/SharedDocs/Downloads/DE/Emissionsberichterstattung/stationaer/Emissionsbericht_Leitfaden.pdf?__blob=publicationFile

[87] California Environmental Protection Agency (2013e): §95129

- Between 80 and 90% - the highest valid value recorded for that type of fuel during the data year as well as the two previous data years
- <80% - the operator must then for each missed data point substitute the greater of either the highest value recorded (not limited to the reporting year) or the default values provided by the regulator

Relevance for linking

The avoidance of any kind of errors in the emission reports due to missing control systems is a relevant aspect for linking on a quality level.

Formal requirements on data management, i.e. on regular procedures in place for monitoring and reporting ensure the internal processes up to the final data collection and calculation for reporting and help to reduce the inherent and control risk. This is especially relevant in systems without any third party verification. However, if detailed formal requirements are missing in a system externally existing control mechanisms (like third party verification for MP or AER) may reduce susceptibility to errors.

The treatment of data gaps is an important MRV issue relevant for linking. The underestimation of emissions due to data gaps shall be avoided by providing general rules on the treatment of data gaps (e.g. based on the best data available possibly plus a safety margin).

6 Enforcement and sanctioning mechanism

The enforcement of the ETS regulation is basis for a functioning system. Along with the publication of guidance, maintanence of help desks or onsite inspections by the CA, sanctioning for non-compliance with the requirements of the relevant regulation is an important mechanism for enforcement of the ETS.

Sanctions may apply for any irregularities by the operators/entities and/or the independent verifiers. The provisions for sanctions can be part of the ETS legislation or the general criminal law of the relevant ETS country. This also implies that the entities in charge of prosecution can be different legal authorities i.e. the competent authority, the accreditation body or any other authority in charge of criminal prosecution.

<u>Reasons for sanctioning the operator can be, for example:</u>

- Untimely submission of report(s)
- Failure to submit the proper amount of certificates
- Emitted but not reported tonnes of CO_2
- Failures regarding data management/monitoring (e.g. incompliant monitoring plans)

<u>The following situations may also result in sanctioning of the verifier:</u>

- False or untruthful verification reports
- Gross mistakes in the verification reports
- Breach of confidentiality
- In case of conflict of interests

In case of non- or untimely reporting of emissions or failure to submit the correct number of emission allowances, the sanctions for operators can be linked to the actual amount of missing allowances or be imposed as a direct administrative fee for non-compliance independent from the missing number of allowances. If the regulator does not demand to submit the missing allowances after irregularities have been observed, the imposed fee will work like a price ceiling for the allowances.

<u>Further sanctioning options can include:</u>

- Operational ban of the installation/covered entity;
- Criminal prosecution of the operator’s personnel or imposing personal fees for the operator’s general management or other responsible employees;
- Occupational ban for responsible employees;
- Publication of non-compliant entities (“Naming and Shaming”)
- Blocking of registry account for trading
- Estimation of emissions by CA

Sanctions for verifiers can result in a direct liability for non-reported or non-submitted allowances. Another approach for sanctioning verifiers are the withdrawal of their accreditation or an occupational ban.

Relevance for linking

With regard to MRV, that means the definition of one tonne CO_2e, the sanctioning regime has a limited influence on the linking of ETS.

However, as mentioned before, sanctions for both operators and verifiers are essential for linking with regards to the enforcement of the harmonized rules and costs for compliance with the ETS regulations for operators in the linked systems.

7 Evaluation and communication on regular level

An important component of a functioning MRV cycle, also in linked schemes, is the regular evaluation of the core legislation implemented and to communicate and address the lessons learnt in order to improve the quality and efficiency in the system. The evaluation of the policy designs chosen and their implementation "on the ground" should aim at assessing strengths and weaknesses of the regulation in place in light of its efficiency and practicability, thus, enabling iterative improvements.

In this regard, it has to be checked on a regular basis whether requirements are technically useful over time and whether the level of effort necessary to fulfil defined MRV requirements is chosen in a balanced way in light of the volumes of emissions to be reported. This is true for the regulation relevant for reporting entities as well as for the efforts made by the regulator (especially in case multiple administrators are involved). Thus, the regular evaluation must involve various stakeholders of the reporting process, including inter alia:

- an analysis of the implemented data collection and assessment procedures within the involved authorities,
- a check of applicable reporting templates in the light of practicability and completeness
- a proof whether occurring technological progress could provide increased accuracy on a reasonable basis,
- the detection of potential loopholes for reporting entities
- where applicable, the sufficiency and practicability of categories for distinguishing installations and source streams
- the procedures for accreditation of verifiers

As an example, within the EU-ETS the evaluation process is highly institutionalized in order to facilitate a structured integration of lessons learnt into policy design and to enable continuous improvements by correcting inefficiencies. In this regard, working groups on several issues, such as the "EU-ETS Compliance Forum", have been established in order to exchange implementation issues and best practice among CAs with the aim to harmonise implementation and enforcement. Those working groups have a clear structure, an assigned chair and unambiguous terms of reference. Essential for the success is that all relevant stakeholders provide feedback on good as well as bad experiences and participate in open and honest discussions.

In linked systems it is of importance that mechanisms are established which provide the framework for corrective actions (harmonization) in case certain requirements have changed in systems or were not addressed correctly by either operators or stakeholders to guarantee the integrity of the system. In an early stage the evaluation could be based on the regular submission of questionnaires to involved institutions and randomly chosen operators and could be complemented by interviews and feedback meetings. In the long term, regular feedback cycles between all involved stakeholders within specific working groups are seen as highly recommendable and should be established in order to guarantee the best possible information exchange and engagement of all relevant bodies

With regard to the overall organization of the regular information exchange, it might be helpful, if external experts supported the entire process by running a secretariat, consolidating information, publishing respective technical paper and scheduling meeting.

8 Essentials for linking

As described in the previous sections and according to the projects findings, numerous design elements of MRV schemes have been identified as essential in the context of linking, if transparency, completeness and comparability within a common market are to be guaranteed. The following section summarizes which minimum requirements regarding MRV should be addressed in the respective regulations of the ETS to be linked in order to establish a successful linkage.

8.1 Identifying linking risks of crucial MRV design elements and facing them with minimum requirements

As shown above, a credible and transparent organisational and operational structure, the derivation of reliable data, an efficient control and proper enforcement in place are inter alia key elements of a sound and effective MRV scheme. However, there are also elements of an MRV scheme that – under certain conditions – could substantially differ in the schemes without hampering the envisaged linking. This is true e.g. for the absence of a monitoring plan in case the methodologies for determination of the data reported are displayed in a clear and unambiguous way in the underlying regulation.

Yet, in general, the requirements between systems to be linked shall be on a similar level for similar entities and similar emission sources/source streams. Moreover, all methodologies applicable to monitor and report emissions shall be described in a transparent way.

The following table takes the essentials from each section displayed above and collates them to inherent risks that are potentially aligned and minimum requirements in order to mitigate those.

The following issues have been identified as a risk in light of an envisaged link between two or more ETS and their underlying MRV schemes

- Weak implementation and enforcement of relevant regulations
- Differing uncertainty of reported emissions
- Inherent risks of double counting
- Existence of loopholes to transfer emissions out of the system

In parallel, minimum requirements are displayed, that, if implemented, reduce the above mentioned risks significantly and, thus lower potential barriers for linking.

Table 10: Potential risks and minimum requirements

Section	Design element	Potential Risk	Minimum requirements to minimize risks
3 4	Organisational and Operational Structure	Weak implementation and enforcement	- Provisions should contain clear definition of tasks and responsibilities of all institutions and stakeholders involved - An institutional setup that includes profound sector specific expertise to fully assess all relevant data and respective regulatory requirements is necessary; if the preparation of an MP is required, either the CA or a VB (different to the VB verifying the ER) should check compliance with the regulation.

Section	Design element	Potential Risk	Minimum requirements to minimize risks
			- A detailed check of Annual Emission Reports either by VB (verification of data) or/and CA is necessary, provided that a strong accreditation system is established and the CA is endowed with sufficient financial resources and appropriate staff. - Consistency and quality of verification services should be ensured by introducing/using quality standards for verification bodies and a certification/accreditation system; independency of the VB shall be assured by appropriate measures. - An efficient framework and support for a transparent and sufficient reporting to support operators and other involved stakeholders should be established. - Institutions involved must have appropriate legal power to ensure a proper implementation, enforcement and sanctioning, i.e. sanctions, either monetary or under criminal law, must be defined in a way that incentives for intentional non-compliance or misstatements are reduced to a minimum. - A suitable information exchange between all stakeholders should be regulated.

5.1	Scope	Double counting	- Clear and unambiguous definition of MRV provisions in the regulation including:
			  - explicit definition which GHG and emissions sources have to be reported,
			  - unambiguous criteria for the identification of covered entities (clear definition of “an entity”)
			  - clear description of inclusion thresholds (such as annual emissions threshold, sectors or activities covered etc.)
			- Mechanisms should exist to avoid double counting in case of the inclusion of indirect emission or combined upstream /downstream approaches.

5.2	Applicability criteria	Loopholes to transfer emissions out of the system	- The regulation shall contain unambiguous criteria for the identification of covered entities and emission sources.

Section	Design element	Potential Risk	Minimum requirements to minimize risks
	Categorization of entities and source streams	Differing uncertainty of determining emissions	- In interaction with the possibility to deviate from requirements, the categorization of installations, source streams and/or emissions sources should have a similar maximum effect on the total uncertainty of a system.
5.3	Applicable monitoring methods	Differing uncertainty of determining emissions	- The regulation shall contain transparent description of the required methods.
5.4.1	Determination of activity data	Differing uncertainty of determining emissions	- The regulation shall contain requirements on minimum standards for metering devices and their accuracy
5.4.2	Determination of calculation factors	Differing uncertainty of determining emissions	- Requirements should be established for sampling and analyses (use of standards, description of sampling procedure, use of analysis frequencies and use of reliable (accredited) laboratories). - It should be transparent, how default values are derived in the system in order to decide whether adjustments are needed.
5.5	Requirements for CEMS	Differing uncertainty of determining emissions	- The regulation shall contain requirements on comparable minimum standards for metering devices and if applicable thresholds for uncertainties - The requirements of systems to be linked shall be on a similar level
5.6	Transfer of GHGs	Loopholes to transfer emissions out of the system	- The regulation shall contain clear definitions under which conditions transferred GHG can be subtracted (e.g. transfer to other ETS installation in case of long term storage of GHGs). Transfers out of the system should rather be the exception.
5.7	Treatment of biomass	Loopholes to transfer emissions out of the system	- Necessary are a transparent definition of biomass (if applicable with additional quality criteria like sustainability) and provisions on determination methods and - Provisions to avoid double counting in cases where biomass is calculated based on invoices or other documentations.

Section	Design element	Potential Risk	Minimum requirements to minimize risks
5.8	Deviation from monitoring requirements	Differing uncertainty of determining emissions	- In interaction with the possibility to deviate from requirements (regular deviations), the categorization of installations, source streams and/or emission sources should have a similar maximum effect on the total uncertainty of a system. - In cases where the regulation does not define regular deviations there should be a procedure of official approval for potentially occurring deviations in place. - Conditions under which deviations will be approved should be on a similar level.
5.9	Data management	Differing uncertainty of determining emissions	- There should be formal requirements on data management and control systems and provisions on conservative closure of data gaps
6	Enforcement and sanctioning mechanisms	Loopholes to transfer emissions out of the system Weak implementation and enforcement	- The regulation shall contain adequate enforcement and sanctioning mechanisms for operators and verifiers to ensure that all relevant emissions within the scope of the scheme are reported.

8.2 Approach for comparing the specific “system risk” of two schemes

Based on the identification of risks and, in the same context, on the individual design of the key elements of an MRV scheme, a specific “system risk” could be assessed in order to create a basis for comparison of the schemes willing to link. However, the assessment is a highly complex issue and cannot be reduced to single numbers (such as minimum permissible errors). It is rather a combination of quantitative and qualitative factors that determine the overall uncertainty within an ETS. The tables below should be seen as an attempt to compare the specific risks within two schemes in light of the respective requirements on MRV. However, as mentioned before, a quantification of the impact of qualitative requirements on the respective risks could only be done (at the moment) on a rough basis. Similarly, the comparison of quantitative requirements should only be seen as an (important) indicator but does not create a complete picture. The following tables give an overview on the specific risks and their quantification within the EU-ETS and the Californian Cap-and-Trade Program. For each risk, if applicable and quantifiable, there is an explanation what factors determine its intensity.

Table 11: Risk regarding loopholes to transfer emissions out of the system in EU-ETS and CTP

Risk	Section of the study	Specific Risk EU-ETS	Specific Risk (California CTP)	Risk Quantification (EU-ETS)	Risk Quantification (California CTP)
Loopholes to transfer emissions out of the system	5.1 (Scope)	No risk identified (definition of scope is not a MRV relevant linking issue)	No risk identified (definition of scope is not a MRV relevant linking issue)	-	-
	5.2 (Applicability criteria)	Flexibility in defining installation boundaries (e.g. separate permit for boiler ‹20MW)	no risk identified	‹2 %	
	5.6 (Transfer of GHGs)	No risk identified (subtraction only in case of delivery to ETS or CCS)	No risk identified	-	-
	5.7 (Treatment of biomass)	No risk identified (clear criteria for biomass treatment and sustainability criteria required for liquid biomass)	No risk identified (clear criteria for calculation of biomass and definition of applicability criteria [including sustainability] for biomass)	-	-
	6 (Enforcement)	No risk identified (strong enforcement, backed by unambiguous MRV requirements and clear definition of respon-sibilities as well as third party verification and stringent accreditation scheme and appropriate sanction measures)	No risk identified (strong enforcement backed by third party verification, an underlying monitoring program that allows cross checks with historic data, clear provisions and high expertise within the involved authorities and appropriate sanction measures)	-	-

With regard to section 5.2 (applicability criteria) it was assessed to what extend operators might be able to transfer emissions out of the system in order to avoid coverage, thus, putting a risk on the overall stringency of the scheme. The shape of that risk is of course dependent on manifold factors that could not be expressed in absolute figures. Such factors are inter alia the unambiguous definition of the term “installation” and the respective enforcement. Moreover, underlying reporting schemes that go beyond the coverage of the ETS (as in California) can minimize the risks that operators try to bring parameters below certain thresholds in order to avoid coverage. In the EU-ETS the technical parameters (e.g. capacity) that are relevant for inclusion to ETS can at least be adjusted, if the value is close to the threshold. However, this restricts possible loopholes mainly to small emitters. Another possible loophole is the separation of one single permit into several permits which could theoretically divide one ETS installation into several installations that are below the relevant thresholds. However, eventhough there have been isolated instances, the permitting process itself follows strict regulations which prevent widespread application of such loopholes. Under the assumption that only emissions from small emitters (<25,000t/yr) could theoretically be shifted out of the system, a maximum risk level can be identified at the share of those installations on the total emission level. The percentage of those installations was 2.0% of the total EU-ETS emissions in 2013.[88]

In California the relevant threshold for the coverage on installation level is based on emission levels. Therefore, there are no similar loopholes as technical modifications would not lead to the exclusion of ETS as long as the emissions are above 25 kt CO_2 p.a. The separation of facilities exceeding the emission threshold into smaller facilities emitting less than 25 kt CO_2 p.a seems to be difficult as the definition of facility follows a broad approach.[89] A theoretical risk remains that a facility could be divided by the definition of different operators for parts of the facility. However, this effect could not be quantified and, therefore, the risk for loopholes is considered to be zero.

Table 12: Risk regarding differing uncertainty of determining emissions in EU-ETS and CTP

Risk	Section of the study	Specific Risk EU-ETS	Specific Risk (California CTP)	Maximum Uncertainty (EU-ETS)	Maximum Uncertainty (California CTP)
Differing uncertainty of determining emissions	5.4.1 (activity data) in interaction with 5.2 (applicability criteria and categorization of source streams)	Allowed uncertainty in tier approach	Allowed uncertainty for measurement devices	‹2.1 %	‹5% (but most probably much lower)

[88] European Commission (2014), Climate Action – European Union Transaction Log: Retrieved 28.06.2015 from http://ec.europa.eu/environment/ets/welcome.do and European Environment Agency (2014), EU Emissions Trading System (ETS) data viewer: Retrieved 28.06.2015 from http://www.eea.europa.eu/data-and-maps/data/data-viewers/emissions-trading-viewer

[89] California Environmental Protection Agency (2013e): Definition “facility”

Risk	Section of the study	Specific Risk EU-ETS	Specific Risk (California CTP)	Maximum Uncertainty (EU-ETS)	Maximum Uncertainty (California CTP)
	5.4.2 (calculation factors) in interaction with 5.2 (applicability criteria and categorization of source streams)	1. Application of standard values 2. Uncertainty of analyses	1. Use of standard factors 2. Uncertainty of analyses	1. <0.9 % 2. <0.5%	1. <6% (but most probably much lower) 2. not quantifiable
	5.5 (CEMS)	Allowed uncertainty in tier approach	Allowed uncertainty according to max. permissible error of measurement devices	<2.8% (probably much lower)	<0.7%
	5.8 (Deviation from monitoring requirements)	risk of increased uncertainty (limited risk due to required approval by authorities)	No provisions for a regular deviation except with regard to calibration frequencies	not quantifiable	-
	5.9 (Data management)	No risk identified (conservative closure of data gaps)	No risk identified (conservative closure of data gaps)	-	-

In the context of the determination of activity data, within the EU-ETS, the highest tier defines a 1.5% uncertainty for the determination of most of the relevant activity data. The share of installations that have to apply the highest tiers (category B and C) have emissions that correspond to 95.5% of the total EU-ETS emissions in 2013.[90] These large emitters (of category B and C installations) have minor and de-minimis source streams (accounting for about 5% of their emissions) for which they can use lower tiers (minimum tier 1 - usually 7.5%). The remaining installations of category A have to comply with at least tier 1 (7.5%, small emitters). Considering those requirements and the share of emissions, the weighted total uncertainty allowed in the system is at 2.1%.

[90] European Commission (2014) and European Environment Agency (2014)

Table 13: Calculation of maximum uncertainty for determination of activity data in EU-ETS[91]

			maximum uncertainty					
			major source streams			minor and de-minimis source streams		
Installation Category	verified Emissions 2013 [kt/a]	percentage of total emissions	uncertainty	share of major source streams	corresponding emissions [kt/a]	uncertainty	corresponding emissions [kt/a]	total maximum uncertainty
A (<50kt/a)	86.674	4,54%	7,50%	95,00%	6.176	7,50%	325	0,34%
B (< 500kt/a)	288.036	15,09%	1,50%	95,00%	4.105	7,50%	1.080	0,27%
C (>500 kt/a)	1.533.585	80,36%	1,50%	95,00%	21.854	7,50%	5.751	1,45%
							total all categories:	**2,06%**

In California, all measurement devices involved in the determination of activity data shall ensure a maximum of 5% uncertainty.[92] However, about 80% of the emissions covered by CTP were generated by combustion processes.[93] Of those emissions a share of >60% originates from the combustion of natural gas and could, thus, be monitored by using company records (tier 1) that, in the majority, are derived from fuel billing meters (financial transaction meters).[94] Those fuel billing meters guarantee permissible errors according to international standards, most probably much lower than 5%. The overall uncertainty is, thus, presumably rather around 3% in California.

With regard to the determination of calculation factors, the percentage of installations that are allowed to use standard values (category A) within the EU-ETS was 4.5% of the total EU-ETS emissions in 2013. Assuming that a standard value (like IPCC values) will be 10% below the real value (national values are expected to be more accurate), this would result in a maximum uncertainty of 0.5% for the whole system. Considering that also large emitters may use standard values for minor and de-minimis source streams (accounting for about 5% of their emissions) a maximum uncertainty of about 0.9% can be defined

Table 14: Calculation of maximum uncertainty for using standard factors for calculation of emission in EU-ETS[95]

Installation Category	verified Emissions 2013 [kt/a]	percentage of total emissions	uncertainty standard values	corresponding emissions	total maximum uncertainty
A (<50kt/a)	86.674	4,54%	10%	8.667	0,45%
B (< 500kt/a)	288.036	15,09%	10%	1.440	0,08%
C (>500 kt/a)	1.533.585	80,36%	10%	7.668	0,40%
				total all categories:	**0,93%**

[91] Ibid

[92] United States Environmental Protection Agency (2009a): §98.3(i)

[93] California Environmental Protection Agency (2015c), California Air Resources Board, Mandatory GHG Reporting: Retrieved 26.08.2015 from http://www.arb.ca.gov/cc/reporting/ghg-rep/reported-data/ghg-reports.htm

[94] United States Energy Information Administration (2015a). Independent Statistics & Analysis, California: Retrieved 27.08.2015 from http://www.eia.gov/state/?sid=CA (Data from 2013 subtracting fuels for mobile sources and nuclear power as well as renewables for electricity generation)

[95] European Commission (2014) and European Environmet Agency (2014)

In California, the use of standard factors is allowed, if standard fuels are combusted, for which the regulator has defined specific default values and no regular sampling and analysis of calculation parameters is happening anyway.[96] Recalling the share of emissions originating from combusted pipeline quality gas, the uncertainty due to uncertainty of standard factors appears relatively high. However, for the fuels listed by the regulator very stringent definitions of their composition exist.[97] The standard factors provided do incorporate those definitions. Thus, the uncertainty should be relatively low. However, also assuming a 10% underestimation caused by using standard factors and assuming a 60% share of natural gas on the total emissions, there would be a maximum uncertainty of 6% on the system.

With regard to the uncertainty of analysis the highest tier on calculation factors within the EU-ETS requires either compliance with the minimum frequencies of analyses or, if those cannot be met, the operator will have to show that the variation in the analytical values for the respective fuel or material does not exceed 1/3 of the uncertainty value allowed for the determination of activity data.[98] The allowed uncertainty for the determination of activity data is usually 1.5 % for the relevant categories, so the allowed value for parameters is 0.5%. This value is defined to be the maximum uncertainty in that case. In California, such requirements are not displayed in the regulation. There are no requirements with regard to laboratories used for analysis. However, during verification the parameters derived will be checked regarding their plausibility by respective sector experts. In this context, it is evident, that it is not possible to derive an absolute number for an uncertainty assessment, if qualitative factors are involved. In the context of linking, it is, therefore, of utmost importance that the methodologies for the determination of calculation factors are described in a transparent and clear way.

Similarly to the use of a calculation-based method, the use of CEMS could also add uncertainty to the system. Within the EU-ETS the maximum allowed uncertainty for category B and C installations is 2.5% for the CO_2-measurement and 5.0% for the N_2O-measurement.[99] The share of N_2O emissions was only about 0.1% of all ETS emissions in 2013. The lowest tier defines a maximum uncertainty of 10% for the measurement of both greenhouse gases. Under the assumption that all small emitters apply for tier 1 (10%) and the remaining category A installations apply for tier 2 (7.5%) and reflecting the share of N_2O emissions, a total maximum uncertainty of 2.78% results for the system.

Table 15: Calculation of maximum uncertainty resulting from application of CEMS in EU-ETS[100]

Installation Category	verified Emissions 2013 [ktCO2e/a]					max. uncertainty		
	Production of nitric acid	Production of adipic acid	other activities	share of N2O emissions	share of CO2 emissions	N2O	CO2	total
A Mini (< 25kt/a)	114	23	37.956	0,01%	1,99%	10,0%	10,0%	0,2%
A Small (<50kt/a)	269	0	48.312	0,01%	2,53%	7,5%	7,5%	0,2%
B (<500kt/a)	1.277	119	286.640	0,07%	15,02%	5,0%	2,5%	0,4%
C (>500kt/a)	514	0	1.533.071	0,03%	80,34%	5,0%	2,5%	2,0%
							total all categories:	**2,78%**

[96] California Environmental Protection Agency (2013e): §95115 and United States Environmental Protection Agency (2009a): §98.33

[97] California Environmental Protection Agency (2013e): §95102

[98] Official Journal of the European Union (2012a): Article 35

[99] Ibid: Annex VIII

[100] European Commission (2014) and European Environmet Agency (2014)

In California, only a small number of operators use CEMS to determine emissions to be reported. N_2O from adipic acid or nitric acid is just not relevant in the Californian CTP. Assuming that 10% (high estimation) of the total emissions in a scheme are monitored via CEMS and taking into account a 5% max. Uncertainty for each measurement device (7.07% combined for the CEMS consisting of a flow meter and a concentration meter) the system uncertainty would be an additional 0.7%.

Based on these results, the determined amount of emissions might diverge accordingly between the systems to be linked.

Table 16: Risk of doublecounting and weak implementation and enforcement in EU-ETS and CTP

Risk	Section of the study	Specific Risk EU-ETS	Specific Risk (California CTP)	Risk Quantification (EU-ETS)	Risk Quantification (California CTP)
Double Counting Non compliance of entities	5.1 (covered sectors and gases)	No risk identified (pure downstream approach)	Risk not quantifiable (ARB responsible to avoid double counting between suppliers and downstream operators)	-	-
Weak implementation and enforcement	4 (Operational structure)	No risk identified (clear operational structures)	No risk identified (clear operational structures and underlying reporting scheme going beyond coverage of ETS)	-	-
	6 (enforcement and sanctioning)	No risk identified (strong sanctioning mechanism)	No risk identified (strong sanctioning mechanism)	-	

Double counting is not relevant in the EU-ETS as the system follows a pure downstream approach. In California however there is a theoretical risk of double counting as suppliers of natural gas are included as well as operators that consume natural gas. However, double counting is prevented as the Californian Air Resource Board (CARB) subtracts emissions from fuel suppliers that are also reported by covered entities.

Both systems have implemented clear operational structures and a strong sanctioning mechanism.

8.3 Importance of meeting the general MRV principles

The general MRV principles have been described in chapter 2. The study has shown that an essential requirement for a successful linking of different systems is that at least those general principles are considered during linking negotiations and the design of the common scheme. Some of those criteria can be directly linked to the identified risks, i.e. Completeness with “Loopholes to transfer emissions out of the system”, Accuracy with “Uncertainty of determining emissions”. The other criteria, i.e. Consistency, Comparability and Transparency are partly prerequisite for the description and avoidance of the risks described. In other words, without adequate transparency it is not possible to determine the level of any of the risks. The comparability of systems requires that the level of the risk is comparable between systems and consistency is achieved when any change in methods of determination of emissions is within the required range of uncertainty. After the analysis of all relevant MRV design elements and their relevance for linking, in section 8.1 conclusions are made on which specific risks in the context of linking can occur, if the minimum requirements for the design of the above described and analysed design elements of MRV schemes are not met by both parties to be linked. A possible approach of analyzing and quantifying the risks of different systems that shall be linked is briefly shown exemplarily in chapter 7. The results of such an analysis could be the starting point for further qualitative and quantitative research on the identified risks and, finally, for policy makers to discuss possible adjustments in case there are crucial risks identified.

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