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Assessment of Emission Trading Systems

BACHELOR'S THESIS

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Author: Jan Knotek

Supervisor: doc. Ing. Tatiana Ivanova, Ph.D.

Declaration

I hereby declare that I have done this Thesis entitled "Assessment of Emission Trading Systems" independently, all texts in this Thesis are original, and all the sources have been quoted and acknowledged by means of complete references and according to Citation rules of the FTA.

In Prague 18 April 2019

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Jan Knotek

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Abstract

194 states of the world and the European Union committed by signing of the Paris Agreement to keep a global temperature rise in this century below 2°C above pre-industrial levels. To achieve this ambitious goal the production of greenhouse gases must be reduced worldwide. As the most cost-effective tool for abatement of greenhouse gas emissions experts frequently refer to a carbon pricing. There are two main instruments used for the carbon pricing: a carbon tax and an emission trading system also called cap-and-trade system.

This Bachelor's Thesis entitled "Assessment of Emission Trading Systems" was written in a form of literature review based mainly on scientific articles obtained from the well-known scientific web databases and documents of related international organisations. The Thesis summarizes information about carbon pricing instrument – an emission trading system. First part of the work assesses a theoretical background of this instrument, process of creating and specific approaches used in the designing of the system. Second part of this Thesis describes emission trading systems implemented around the world.

Key words: carbon pricing, cap-and-trade, carbon tax, emission allowances, greenhouse gases

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List of the abbreviations used in the Thesis

CDM…… Clean Development Mechanism

CO_2……. Carbon dioxide

CO_2e…… Carbon dioxide equivalent

EC…… European Commission

EEA……. European Environment Agency

ETS(s)…….. Emission Trading System(s)

EU…… European Union

EUA……. European Union Allowance

GDP……. Gross Domestic Product

GHG(s)…… Greenhouse gas(es)

HFCs…… Hydrofluorocarbons

ICAP…… International Carbon Action Partnership

IPCC…… Intergovernmental Panel on Climate Change

JI…….. Joint Implementation

KETS……Korean Emissions Trading Scheme

MSR…… Market Stability Reserve

NF_3…….. Nitrogen trifluoride

N_2O……. Nitrous oxide

NZ ETS……New Zealand Emissions Trading Scheme

PFCs……... Perfluorocarbons

PMR…… Partnership for Market Readiness

RGGI……... Regional Greenhouse Gas Initiative

SF_6……... Sulphur hexafluoride

TMG ETS…… Tokyo Metropolitan Government Emissions Trading Scheme

UNFCCC……. United Nations Framework Convention on Climate Change

1. Introduction

While in a public debate there are still rarely occurring voices disputing whether global warming is a reality or whether its causes are natural or human activities, predominant majority of scientific community and subsequently policymakers moved to a discussion how to respond to the global warming and climate change (Van Calster et al. 2016). According to Narassimhan et al. (2017) is the extent of climate change and urgency of dealing with it entirely clear.

Human activities are estimated to have caused 1.0°C of global warming above pre-industrial levels and likely to reach 1.5°C in 2030-2052 (IPCC 2018).

After the Paris Agreement was finalized in December 2015, nations realized that in order to meet the fundamental objective of the Agreement by keeping a global temperature rise in this century below 2°C above pre-industrial levels (UNFCCC 2019), they must quickly implement policies to mitigate greenhouse gases production (Narassimhan et al. 2017).

Experts concur that the most economically-efficient way to reduce greenhouse gases (GHGs) emissions are carbon pricing policy instruments (e.g. Swartz 2016; Ning et al. 2018) and policymakers all around the world are in increasing numbers starting to follow the experts' advice and are implementing these policies as a strategy to improve the economic efficiency and reduce emissions' production (Munnings et al. 2016).

According to World Bank and Ecofys (2018) is the objective of implementing carbon pricing initiatives not only the emissions' mitigation, but also further environmental goals. For example, the Beijing pilot Emission Trading System is intended as a key instrument for fighting an air pollution.

Carbon pricing is defined by World Bank (2017) as "initiatives that put an explicit price on greenhouse gas emissions, i.e., a price expressed as a value per ton of carbon dioxide equivalent". In practice there are two main instruments used for putting a price on carbon: a carbon tax and an emission trading system often referred to as cap-and-trade system (Tvinnereim & Mehling 2018).

This Thesis focuses primarily on an analysis of the emission trading instrument.

2. Aims of the Thesis

The goal of this Thesis was to analyse emission trading systems in order to describe their development, objectives and settings as well as to assess schemes established in the world including specifics of their design and achieved effects on the mitigation of greenhouse gases production.

3. Methods

This Thesis was written as a literature review consisting of six main chapters dividing the review into two parts: Part 1 (chapters 4.1 – 4.5.) and Part 2 (chapter 4.6.). The Thesis was elaborated according to the manual of the Faculty of Tropical AgriSciences for writing Bachelor's Thesis and all literature is cited in by Citation Rules of the Faculty of Tropical AgriSciences for writing Theses in English (2017 manual). Literature review was based on searching for scientific articles from web databases like Science Direct, Web of Science and others. Most of used articles were from well-known journals like Energy Policy or Climate Policy. In significant extent were also used both non-governmental sources such as World Bank publications or International Carbon Action Partnership reports and governmental sources such as European Commission Directives and other legislative documents or reports of European Environment Agency. The search for scientific information was done through the key words such as: cap and trade, emission trading systems, carbon pricing and others with utilisation of Boolean operators. Found articles related to the Thesis topic were processed and analysed.

4. Literature review

4.1. Emissions

In the context of this Thesis term "emissions" is used in the meaning of anthropogenic emission of greenhouse gases (GHGs).

Encyclopædia Britannica (2019) defines GHG as "any gas that has the property of absorbing infrared radiation (net heat energy) emitted from Earth's surface and reradiating it back to Earth's surface", but in the field of carbon pricing instruments are relevant only following GHGs (with a percentage share of total anthropogenic GHG emissions in 2010):

Carbon dioxide (CO_2) – 76%

Methane (CH_4) – 16%

Nitrous oxide (N_2O) – 6%

Fluorinated gases (HFCs, PFCs, NF_3, SF_6) – 2% (EPA 2014).

Greenhouse gas emissions are usually reported in CO_2 equivalent (CO_2e). This is measured by each specific GHG heat trapping capacity in the atmosphere compared to CO_2 over a specified period (Kyoto protocol uses 100 years) (Muthu 2014).

4.2. Carbon pricing mechanisms

Policymakers use for putting a price on carbon two basic instruments. Direct approach is setting a carbon tax and indirect is establishing a market for tradable emissions rights (called permits or allowances) under a cap-and-trade policy, commonly referred to as emission trading system (ETS) (PMR & ICAP 2016; Schmalensee & Stavins 2017). Some authors (e.g. Narassimhan et al. 2017) recognize beside these two a third basic option: a hybrid mechanism combining elements of both instruments.

Authors often mention in relation to carbon pricing mechanisms system of "offsets". A voluntary credit system, which offers credits for emissions reductions compared to some defined baseline (e.g. Green et al. 2014; Schmalensee & Stavins 2017;

Narassimhan et al. 2017). There are two widespread offset systems. One is the Clean Development Mechanism (CDM), an international offset system defined in Article 12 of the Kyoto Protocol. CDM allows parties of the Kyoto Protocol to implement an emission-reduction project in developing countries. Second is the Joint Implementation (JI) system defined in Article 6 of the Kyoto Protocol for projects in another country that signed Kyoto protocol. Projects under both CDM and JI can earn tradeable credits "emission reduction units", each for 1 tonne of CO_2e, which can be used to reach Kyoto targets and are also accepted in most of emission trading systems (UNFCCC 2019). Offset systems was criticized by Schmalensee and Stavins (2017). They stated that emission reductions are not directly observable and are often defined incorrectly compared to an emission production which can be measured directly.

According to the World Bank (2019) there are currently in the world 54 carbon pricing systems, that have been already implemented. 27 of these systems are emissions trading systems and the other 27 carbon tax systems. Together these carbon pricing initiatives cover 8 gigatons of CO_2e, representing 13.8% of global GHG emissions. After scheduled start of China national ETS in 2020 share of global GHG emissions covered is expected to rise to 19.6%.

Carbon prices in different jurisdictions vary substantially, from US$0.08 for 1 tonne of CO_2e in case of Poland's carbon tax to a maximum of US$130 for 1 tonne of CO_2e of Sweden's carbon tax (World Bank 2019).

Summarisation map of emission trading systems implemented and scheduled for implementation is shown in Figure 1.

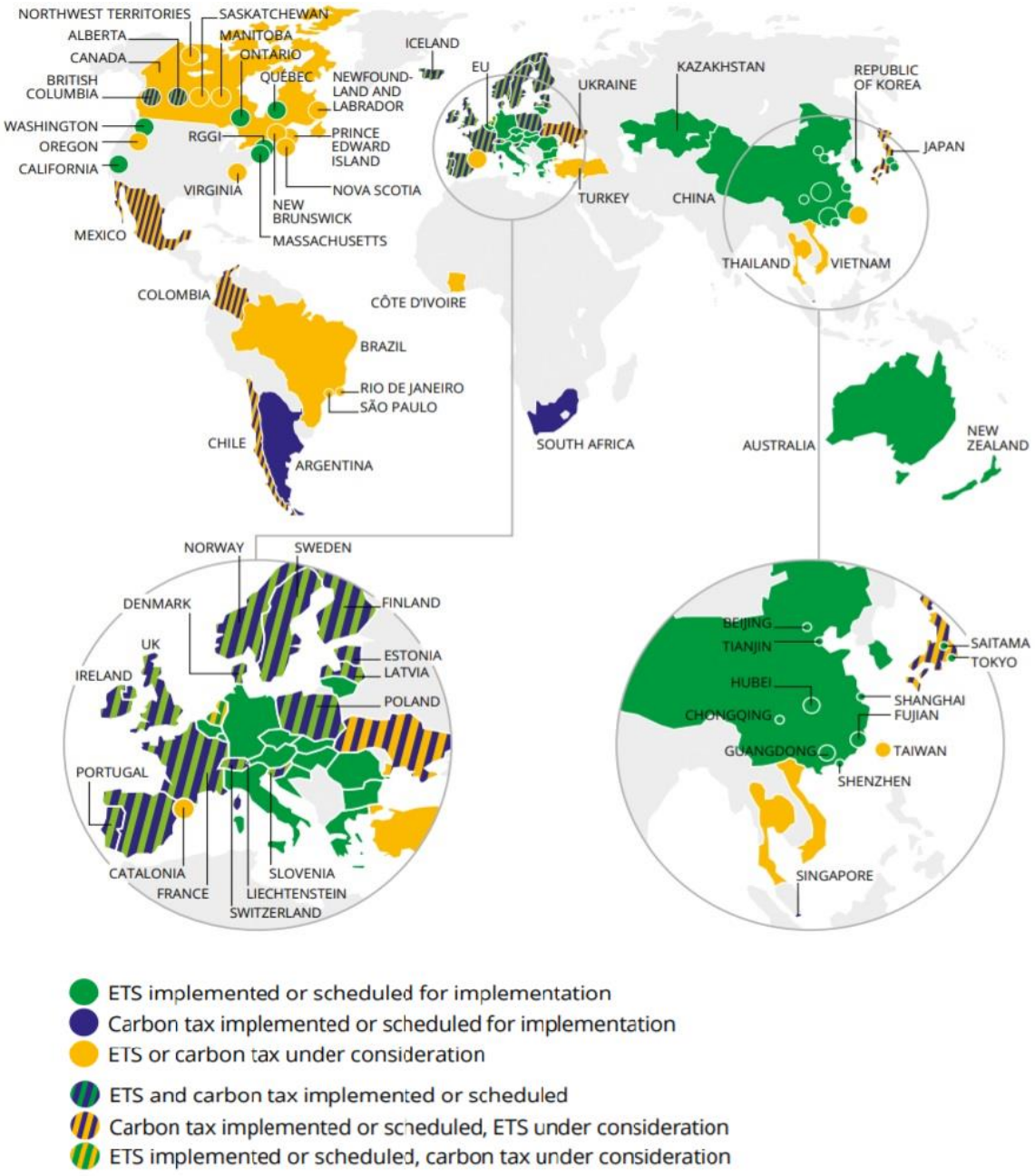

Figure 1: World map of ETSs or carbon tax initiatives. Circles mark subnational initiatives.

Source: Adjusted by author based on World Bank (2018)

4.3. Carbon tax

Carbon tax is type of Pigouvian tax - tax on economic activities that create negative externalities. Intended purpose of a carbon tax is to change behaviour of individuals and companies to achieve lower consumption of carbon, thus abate emissions (Xiang & Lawley 2019).

Tax directly determines a price of emissions or of the carbon content of a fuel. Mostly it is used for CO_2 emissions (76% of global GHG emissions), but it may include all main GHGs. Carbon taxes can be applied on whole economy or to selected sectors such as oil and gas industries or to products such as fuels (e.g. Finland's liquid fuels tax) (Narassimhan et al. 2017).

According to Tvinnereim and Mehling (2018) several researches confirmed that carbon tax lowered emission per unit of GDP, e.g. in Sweden and Norway where carbon tax was established in 1991.

4.4. Cap-and-trade

Cap-and-trade or ETS is a policy tool used to achieve environmental, economic and social outcomes (PMR & ICAP 2016).

First step in designing of the cap-and-trade system is setting the scope. Policymakers decide which sectors of economy and which GHGs will be regulated by the cap (PMR & ICAP 2016). Second step is setting the cap – to determine the highest possible quantity of emissions that can be produced in given period. The cap can be set either on total emissions or on emissions intensity, measured by emissions per unit of GDP (Narassimhan et al. 2017). Then is to the subjects of ETS allocated a corresponding amount of allowances. The subjects are obliged to surrender back to a government one allowance for every unit of emissions for which they are accountable. The regulators distribute allowances through a free allocation, auctioning or by combination of these two approaches (PMR & ICAP 2016). Free allocation is usually based on historical emissions of specific firms – allocation approach called grandfathering (Borghesi & Montini 2016). According to IPCC (2014) regulators prefer to allocate the allowances freely in the early phases of system's implementing in order to gain political support for ETS.

Firms can trade allowances in secondary market and thus, a price of allowance unit (and thus price of carbon) is determined by the supply and demand. Firms with lower abatement costs can sell their allowances in a market to firms with higher abatement costs. In this system firms have freedom to choose their own strategy to optimize their costs (Narassimhan et al. 2017). According to Curtis and Lee (2018) ETS favours innovative firms that can reduce their GHG emissions with lower costs than other market participant.

Perdan and Azapagic (2011) stated that although existing and emerging trading schemes vary greatly in their design such as coverage, scope, or allocation methods, they share one fundamental premise: mitigation of emissions should take place where the costs are the lowest, thus achieve lower costs of fighting climate change at general.

4.4.1. Point of regulation

Critical aspect of a design of an ETS is where are emissions regulated. Design must allow precise monitoring of emissions to make the system enforcement possible.

Two basic approaches are recognized:

1) Upstream: where is the source of the emissions (e.g. coal or oil) firstly commercialized by extractors or importers.
2) Downstream: where are the emissions physically released into the atmosphere (PMR and ICAP 2016).

4.4.2. Determination of the cap

Authors (e.g. Qi & Cheng 2018; Perdan & Azapagic 2011; ICAP 2018) concur that for functional design of ETS is vital correct setting of the cap. In practice are to determine the cap used three basic approaches: no-cap, top-down and bottom-up.

4.4.2.1. No-cap approach

In classical cap-and-trade system is cap necessary, but no cap approach can be used in the first implementing period of an ETS. For example, the New Zealand Emissions Trading Scheme (NZ ETS), which did not set an explicit cap in first implementing phase. Although missing nationwide emission target, firms were obliged

to buy allowances for emissions they produced, therefore system created incentive to lower emissions even without establishment of the cap (Perdan & Azapagic 2011).

4.4.2.2. Top-down approach

In classic top-down approach is the cap determination based on desired emission target for the economy as a whole counting both ETS covered and non-covered sectors, then are to the covered sectors distributed the amount of allowances to meet the nationwide emissions objective (Phylipsen et al. 2006). The determination of emissions targets is usually based on assumptions of economic conditions, emissions mitigation potential and costs, as well as political climate and other factors (Qi & Cheng 2018). According to Munnings et al. (2016) vital requirement for this approach is that government has accurate information on current emissions and a capacity to forecast future emissions.

Example of this approach is EU ETS Phase 3 or Japan's Tokyo and Saitama ETS (Qi & Cheng 2018).

This approach is also used in the Kyoto protocol, where single parties of the treaty (states) committed to mitigate their emission production by certain percentage – in other words set a cap.

4.4.2.3. Bottom-up approach

According to Qi and Cheng (2018) is this approach inversion of top down approach – coverage and allocation are determined before the cap. It takes two forms. First form is to create a model of expected development of economy (production volume, innovations etc.) of each sector of economy included in ETS. This model includes forecast of GHGs production and desired level of emissions reduction. Subsequently are these prognoses for all sectors or subjects summed up and the total cap is determined.

Other form of this approach is allocation of allowances to ETS installations based on certain rules (Phylipsen et al. 2006; Qi & Cheng 2018).

Comparison of top-down and bottom-up approach is shown also in Figure 2.

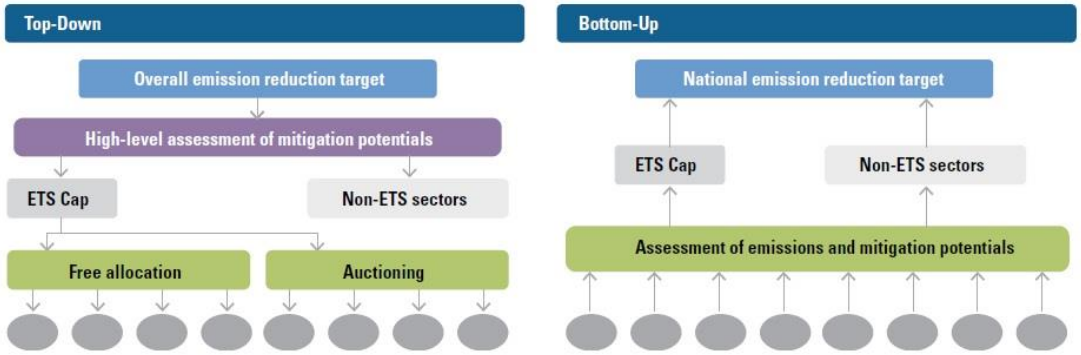

Figure 2: Top-Down and Bottom-Up approaches to setting the cap

Source: ICAP (2016)

Example of rules used for bottom-up approach to create ETS plan can be found in European Union Directive 2003/87/EC and European Commission guidance material for Annex III. of this Directive from the years 2003 and 2004. This Directive (and related material) sets criteria for allocation and determination of total number of allowances for member states as follows:

1. Kyoto commitments – state must consider their commitment in Kyoto protocol.
2. Assessments of emissions development – total quantity of allowances shall be consistent with assessments of actual and projected progress of both ETS covered and non-covered sectors.
3. Potential to reduce emissions – states should consider expected technological progress and in general technical options available to reduce emissions.
4. Consistency with other legislation.
5. Non-discrimination between companies or sectors.
6. New entrants – the plan must consider possible new entrants. Set a reserve of allowances; information for new subjects to be able to join ETS, etc.

7. Early action – subjects that have already reduced emissions even before legislation forced them to, should not be disadvantaged to other installations that have not undertaken such efforts.
8. Clean technology – the plan shall take into account if subject is already using clean technologies. Thus, it has lower potential to reduce its emissions further.
9. Involvement of the public – states must consider public comments in creation of ETS plan.
10. List of installations – the plan must contain a list of the installations covered by ETS with the amount of allowances allocated to them.
11. Competition from outside the Union – countries should consider how ETS will affect competitiveness of covered subjects in relation to subjects outside of Union.

Some authors (e.g. Green et al. 2014; Swartz 2016) use terms bottom-up and top-down approach in different connotation to describe trends of decentralisation of ETSs, where subnational regions or member states are designing their cap and other specific settings individually only following general guidelines of common (nationwide) ETS.

According to Green et al. (2014) various jurisdictions are moving from centralised ETS (top-down approach) due to unconvincing results of this approach which was established in Kyoto protocol.

Swartz (2016) states that the carbon markets substantially changed in a last decade. Markets moved from Kyoto centralised approach where international agreement on emission reduction targets resulted in the establishment of the first global carbon market in the form of the CDM and JI to fragmented national and subnational carbon markets. Although, there are some "linking" initiatives, this trend may be an obstruction for establishing a globally connected carbon market in the future.

The Paris Agreement also recognizes the trend of decentralisation, but not as a threat. Agreement supports development of a bottom-up international environmental movements. Various contributors, carbon pricing initiatives, energy efficiency initiatives should lead to diversified development of commitments. As a result, new carbon markets

may emerge with the potential of further linking on higher basis (World Bank and Ecofys 2018).

4.5. Carbon tax and cap-and-trade hybrid approach

In several cases, policymakers used in designing of carbon pricing system combination of both basic approaches or both approaches collaterally. Advantages of utilisation hybrid system of both carbon taxes and cap-and-trade schemes are considerable. Jurisdiction that participate in wider system like nationwide or supranational ETS can also apply carbon taxes domestically to follow their more ambitious environmental target without necessity to reach agreement with other participants in ETS. The main advantage of using both systems collaterally is in possibility to adjust policy to specific economic or political situation in the country by covering some sectors by carbon tax and some by ETS (Narassimhan et al. 2017).

Schmalensee and Stavins (2015) recognize two different hybrid approaches that was observed in the world:

1) a carbon tax system in some sectors and ETS in others, e.g. Norway and Ireland where a carbon tax is imposed on sectors, which are not fully covered by the EU ETS.

2) a price collar. An ETS approach with set collar – fixed minimum and/or maximum prices of allowances, the minimum price is in fact a carbon tax since it is set obligatory price for a unit of emissions. This system is used for example in United Kingdom.

4.6. Overview of established ETSs

In this second key part of the Thesis are analysed ETSs currently established in the world limited to systems based on emission allowances trading principle. For example, Australia's Emission Reduction Fund is recognized by the World Bank (2018) as an ETS (as you can also see in Figure 1), but according to other authors (e.g. Manaf et al. 2019) as well as to the Australian government (Clean Energy Regulator 2019) it is in

fact only a governmental fund for emission reduction projects, which are supported in form of non-tradeable "Australian carbon credit units". Therefore, Australia is not recognized in the available scientific literature and also in this Thesis as ETS.

4.6.1. European Union ETS

The European Union Emission Trading System is the basic pillar of the EU climate policy and is the oldest and still largest ETS for GHGs operating in the world (ICAP 2019). Therefore, it is widely considered as the prototype system for the other ETSs that are emerging around the world (Borghesi & Montini 2016)

The EU ETS was established by European Commission Directive 2003/87/EC in 2003 and launched in January 2005 as the largest cap-and-trade scheme in the world and one of the key policies to implement the EU commitment to the Kyoto protocol. It was the first environmental market established in the EU and first multinational emissions trading system in the world (Phylipsen 2006; Narassimhan et al. 2017).

The EU ETS is operating in 31 countries of European Economic Area – 28 EU Member states plus Iceland, Liechtenstein and Norway (Ning et al. 2018).

The system was initially applied only on CO_2 emissions and only on sectors with high energy consumption – such as oil refineries, processing of metals, mineral industry or paper industry (Borghesi & Montini 2016).

Currently, the system covers following GHGs:

1) CO_2 from power and heat generation and energy-intensive industry and aviation sectors (limited on flights within the European Economic Area)
2) N_2O from production of nitric, adipic and glyoxylic acids
3) PFCs from aluminium production (ICAP 2019; EC 2019).

The ETS covers around 11,000 installations that account for around 45% of the EU's GHG emissions (EC 2016).

The EU ETS is designed as a classic "cap-and-trade" system. The scheme operates by the allocation and trading of GHG allowances. One allowance gives the emitter right to produce one tonne of CO_2e (Perdan & Azapagic 2011). Companies receive or buy

emission allowances that they can trade with one another as needed. They can also use limited amounts of international credits from emission-saving projects within the CDM and JI systems. The cap is over time reduced to achieve determined emissions targets with costs for emission reduction distributed to a longer period (EC 2019).

At least 50% of revenues from auctioning of allowances are member states obliged to use for environmental related objectives. In practise states spend around 80% for both domestic and international environmental purposes (ICAP 2019).

The EU ETS has proceeded through three diverse trading periods.

4.6.1.1. Phase 1 (2005-2007)

EC (2019) refers to this period as "learning by doing pilot scheme".

Initially the scheme determined the cap with bottom up approach, one of the reasons was absence of relevant data to determine the cap with centralised approach. Member states allocated European Union Allowances (EUAs) through their National Allocation Plans following their national objectives with concerning their Kyoto commitment, but allocation was supervised and approved by the EC according to the criteria of the ETS (EC 2019).

According to Schmalensee and Stavins (2017) this setting of the ETS led to significant overallocation of allowances, because countries tended to protect their firms and economy competitiveness. The result was that summed EU cap exceeded even amount of emissions prior to the ETS establishment, which led to a fall of allowance prices to zero in 2007.

4.6.1.2. Phase 2 (2008-2012)

In second phase were the countries for the first time forced to follow strict emission targets due to their commitment in Kyoto protocol, where signed parties agreed to reduce their emissions by minimum of 5% in comparison to 1990 levels. EU-15 bloc committed in the Protocol to more ambitious 8% reduction. Each member state had individually set a target based on their specific situation, but as a whole European Union followed the 8%. Therefore, in 2008 old and new member states had varying caps (EC 2019).

In attempt to recover allowances trading after Phase 1, EC reduced number of allowances by 6.5% for the second period. Allowance prices increased to over €20/tCO_2e in 2008, but then due to world economic crisis the emission production declined significantly, followed by decreased demand for allowances. This again led to a surplus of unused allowances and price fall (Schmalensee and Stavins 2017).

Other basic changes in the second Phase were integration of Iceland, Norway and Liechtenstein in 2008 and extension of covered GHGs by N_2O and PFCs (Borghesi & Montini 2016).

In 2012 ETS expanded to cover an aviation sector (EC 2016). According to Nava et al. (2018) aviation sector cap-and-trade system is separated from the main system. Covering of aviation sector is important since emissions from aviation, in comparison to reduction in other sectors increased about 10% since 2005 and almost doubled in 1990-2017 and further increase is estimated (EEA 2018).

Emission targets of Phase 2 was achieved and even exceeded, but with significant role of economy crisis. During the second trading period emissions decreased significantly in 2008 and 2009 and in 2012 emissions were 18% lower compared to the base year of the Kyoto protocol 1990 (EEA 2013). Emissions in key economy sectors documenting the fall during Phase 1 and 2 are showed in Figure 3.

Figure 3: Emissions in key economy sectors in 2005-2012

Source: EEA (2013)

4.6.1.3. Phase 3 (2013-2020)

Fundamental change in Phase 3 was in the cap determination approach. The cap was set by the top-down approach, therefore for the first time the EU has single EU-wide cap instead of national caps (Laing et al. 2013). Also, a cap reduction rate of 1.74% annually was implemented (Narassimhan et al. 2017) to achieve the targeted 20% cut of GHGs emissions in 2020 (compared to 1990) (EC 2019).

Second fundamental change is in the allocation method. In Phase 1 and 2 around 90% or allowances were distributed freely and only around 3% auctioned. In Phase 3 57% of allowances should be auctioned (ICAP 2019).

Moreover, EC for the third Phase implemented the Effort Sharing Decision binding legislation, which established annual GHG targets for sectors not included in the EU ETS, such as transport, buildings, agriculture and waste (EC 2019).

Although, that according to a report of EEA (2018) in 2017 emissions of sectors covered in ETS increased (by 0.2%) for the first time since 2007, the surplus of allowances remained substantial.

At the start of the Phase 3 the surplus of allowances was around 2 billion and further increased to more than 2.1 billion in 2013. As a short-term solution EC established system of "back-loading" of allowances, EC regularly postponed auctioning of share of allowances to consecutive years – 400 million in 2014, 300 million in 2015 and 200 million in 2016 (EC 2016; EC 2019), but according to EEA (2017) although that for the second consecutive year the demand for allowances was higher than the supply of allowances, which led to reduction in the surplus of allowances, the surplus still remained significant, in 2017 was around 1.7 billion allowances – that would cover around one year of whole EU ETS emission production.

Extremely low price of allowances (in 2017 fluctuating around a level of €5 per EUA (EEA 2017)) was also criticized by Edenhofer et al. (2017), who stated that with low EUA prices firms lack incentive to invest into low-carbon technologies research and development, which would lead the future unavailability of low-carbon technologies, what is one of the basic objectives of whole ETS.

Bel and Joseph (2018) attempted to evaluate the relationship between the surplus of EUA's and its expected negative influence on low-carbon technologies development. For this evaluation they used a number of patents related to energy generation, transmission and distribution. Their results confirmed thesis that low prices and surplus of allowances have negative impact on research and development of new technologies.

According to Schmalensee and Stavins (2017) reason of low prices of EUA was a slow recovery after the financial crisis and other EU environmental policies, such as support for renewable energy sources and energy efficiency standards, both reducing emissions and therefore reducing demand for allowances.

As a long-term solution of low EUA prices EC implemented Market Stability Reserve (MSR), which started operating in January 2019. The reserve should deal with the surplus of allowances and improve the system's flexibility by adjusting the supply of allowances. The EUAs back-loaded in 2014-2016 will be transferred to the reserve and not auctioned in 2019 and 2020 as previously planned (EC 2019).

In 2018 Annual report EEA stated that in 2017 for the first year since 2007, emissions from stationary installations slightly increased. Emissions from the other industrial activities covered by the EU ETS are in the current phase rather stable. Reversion of so far decreasing trend of emission production in addition to EC measures led to significant grow of EUA price as shown in Figure 4.

Figure 4: Price of EU ETS allowance

Source: ICAP (2019)

4.6.1.4. Phase 4 (2020-2030)

In June 2018 the European Parliament, the Council of Europe and the European Commission reached agreement on emissions mitigation target for 2030 (EEA 2018). Therefore, following the Paris Agreement European Union submitted to the UNFCCC Nationally Determined Contribution plan where is the target established. The EU set absolute mitigation target to a 40% reduction in GHG emissions compared to 1990 levels (Li et al. 2019).

Swiss Federal Office for the Environment (2019) stated that in November 2017 was in Bern signed the Agreement to link EU ETS and Swiss ETS with expected start

after completed ratification process on 1st January 2020. According to Swiss Federal Office for the Environment (2019) both parties would profit from this linkage. Basic argument is that a larger and more established market is more liquid and keeps carbon prices stable.

According to World Bank (2018) the key reforms for Phase 4 include change of the annual cap reduction from 1.74% to 2.2% and a temporary doubling of the yearly withholding rate of surplus allowances into the MSR to 24% until 2023.

Last key reform is the new mechanism implemented to the MSR from 2023. If amount of allowances in the MSR exceeds the volume of allowances auctioned in the previous year the difference will be permanently deleted (Edenhofer et al. 2017).

4.6.2. China ETS

Due to its rapid economic grow over the last decade China become the world largest energy consumer and GHG emitter (Xiong et al. 2017). See also comparison to following largest emitters of the most important GHG CO_2, the United States and European Union in Figure 5.

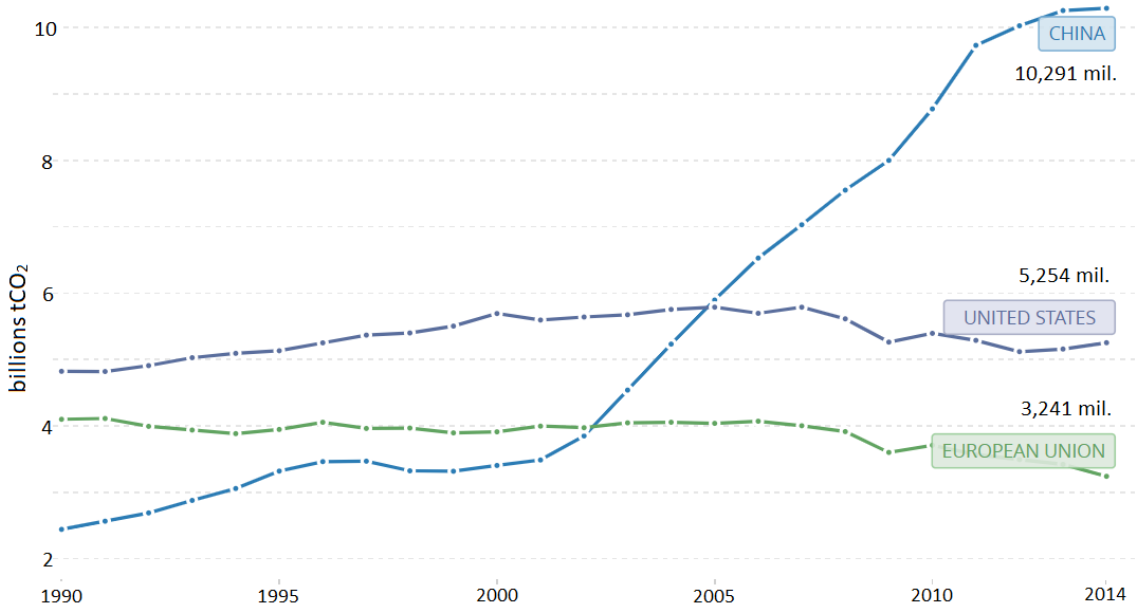

Figure 5: World three largest CO_2 emitters

Source: Adjusted by author based on World Bank (2019)

Munnings et al. (2016) stated that Chinese rapid economic growth and overlapping energy and environmental policies create the measurement and projection of emissions considerably challenging problem.

Following growing Chinese economy and country own environmental issues and also international commitments for emissions mitigation and after President Xi Jinping statement that "China should pursue a new mode of growth to promote more efficient, equal, and sustainable economic development" (Ning et al. 2017), China's National Development and Reform Commission (the government planning organization responsible for climate policy (Goulder et al. 2017)) launched seven local ETS pilot programs in Shenzhen, Beijing, Tianjin, Shanghai, Chongqing, Guangdong, and Hubei, which were established in 2013 and 2014 (Xiong et al. 2017). In 2017 was ETS established in Fujian, therefore ETSs are currently in operation in 8 of total 40 Chinese provinces (Chang et al. 2019).

Pilots vary considerably in their key design such as approach to determination of the cap, coverage of sectors, allowances allocation approach and price of allowance (Qi & Cheng 2018; Chang et al. 2019).

Starting phase of the pilot schemes was far from ideal. Most pilots experienced problems with implementing and covered subjects were lacking information or even unaware of the system and their obligations. This in addition to relatively low penalties for non-compliance led to delays in the first phase. However, in 2016 were the schemes and their carbon markets rather stable and in the last years pilots are even extending covered sectors and number of installations (ICAP 2019).

According to Qi and Cheng (2018) China's nation-wide emissions reduction target is based on emissions intensity, instead of absolute emissions. In its Nationally Determined Contribution to the Paris Agreement, China pledged to achieve the peak of CO_2 emissions around 2030 and committed to attempt to achieve the peak earlier and that the peak will be maximally 60%-65% higher than the 2005 level in terms of CO_2 emission per unit of GDP. Because the emissions trading mechanism needs an absolute cap to determine amount of allowances to allocate, China still must convert its emissions intensity target to an absolute emissions target before starting its national ETS.

According to Goulder et al. (2017) determining the total cap is one of the basic four emission mitigation objectives of China's current Five Year Plan (2016-2020).

Chang et al. (2019) stated that since pilot schemes fulfilled their "pioneer" role, experience gained will be essential for implementing much more ambitious China's objective to launch nation-wide ETS, what is estimated to be the world's largest CO_2 ETS.

According to ICAP (2019) the State Council, the highest executive organ of the government, approved creation of national ETS in December 2017. In the initial phase the ETS is expected to regulate around 1,700 companies from the power sector, which accounts for 30% of country CO_2 production. Currently is the ETS scheduled to start operating in 2020. In the initial phase the existing ETS pilots are expected to operate parallelly to the national market, covering the non-power sectors.

Swartz (2016) stated that start of China's ETS is fundamental change in carbon pricing movement not only because it will create the largest ETS market in the world, but also it will send strong signal to other major emerging countries that carbon pricing is no longer only developed countries initiative.

4.6.3. Korea ETS

In 2008 South Korean government announced plan as a Korean contribution to the world emission abatement movement, to reduce CO_2 emissions by 30% in 2020 compared to "business-as-usual" projections (Park & Hong 2014). That equates to 4% below the 2005 levels (Song et al. 2015). To achieve this objective and with strong political opposition to carbon tax (Park & Hong 2014) Korea implemented in 2015 emission trading scheme. It is focused mainly on industrial and power sectors and it forces companies to improve their energy efficiency and mitigate GHGs. After EU ETS is the Korean Emissions Trading Scheme (KETS) second largest carbon market in the world (Suk et al. 2017).

Intention to implement the ETS was followed by strong resistance of industry sector (Suk et al. 2017). In attempt to achieve consensus and support for ETS government decided to implement tax benefits and other financial incentives for companies covered

by the scheme (Song et al. 2015) and also by setting of allocation approach, where allowances were given 100% for free in the first phase (Suk et al. 2017).

Asian Development Bank (2018) also mentioned low number of participants in the system in the early stage and their unwillingness to sell unused allowances, therefore very low liquidity of the secondary market.

ICAP (2019) characterize the KETS as very robust and stable market despite mentioned issues of its implementing and early stage. KETS covers all main GHGs and has wide sectoral cover where both direct and indirect (emissions related to electricity consumption) emissions are included.

Currently is the KETS in its second phase (2018-2020) which is designed according to Korean Nationally Determined Contribution to the Paris Agreement to achieve 22% emissions reduction compared to 2012 levels in 2030. Second phase also for the first time implemented auctioning of allowances, with first auction taking place in January 2019. The ETS covers 591 of the country's largest emitters, which account for 68% of national GHGs emissions (ICAP 2019).

4.6.4. New Zealand ETS

The New Zealand Emissions Trading Scheme (NZ ETS) was launched in 2008 with specific design compared to other ETSs. Initially it covered whole economy including forestry and agriculture (agriculture subjects only had to report its emissions) (ICAP 2019). Second most significant difference was an absence of the total cap on emissions. The ETS design allowed unlimited purchase of international credits from Kyoto based CDM and JI mechanisms (other ETSs strictly limit maximum usage of credits) in combination of free allocation of NZ ETS allowance units (Narassimhan et al. 2017).

Diaz-Rainey and Tulloch (2018) explored effect of this specific design on carbon prices in NZ ETS market. Due to unlimited import of credits, the major price determinant of NZ allowances was price of credits on international market. From start of the system until 2011 was the price of NZ allowances lower than the price of credits and therefore, firms had limited incentive to buy international credits, but in June 2011 price of credits fell below the price of NZ allowances and therefore NZ allowance became a "price taker"

since firms started importing significant amount of credits. Price graph of both carbon units in this period is shown in Figure 6. In 2011 credits represented almost 70% of all used allowances in NZ (Mundaca & Richter 2013). This situation forced NZ government to establish in February 2013 partial ban on import of credits (Diaz-Rainey & Tulloch 2018) and from 1 June 2015 are international credits banned fully in NZ ETS what meant in fact end of the no-cap approach (ICAP 2019).

Figure 6: Price of NZ allowance (NZU) compared to Kyoto credits

Source: New Zealand Ministry for the Environment (2016)

On 12 December 2018, NZ government announced fundamental reforms of NZ ETS with two major changes: establishment of a nation-wide cap and auctioning of allowances since 2020. Further details of this reform are not yet known (ICAP 2019).

4.6.5. Switzerland ETS

Switzerland follows a hybrid approach with combination of a carbon tax (covering 51% of CO_2) and ETS (covering 33% of CO_2 emissions). ETS was implemented in 2008 on voluntary basis; incentive for firms to join the system was its mechanism allowing them to lower their costs from imposed carbon tax. Energy intensive installations could

participate and receive free allowances based on their emission mitigation potential (Narassimhan et al. 2017).

Switzerland committed in the Kyoto Protocol to lower its emissions by 8% in 2008-2012 (compared to 1990 levels).

According to Wölfl and Sicari (2012) it was relatively ambitious goal since Switzerland GHGs emissions production is relatively low and remained stable since 1990, therefore country has only very limited reduction potential. Main reason is Switzerland economy structure with high share of service sector and limited heavy industry, also it has high share of renewable and nuclear sources of energy. Wölfl and Sicari (2012) recommended increasing the CO_2 levy (carbon tax) in second phase, which started in 2013. This phase has even more ambitious reduction target - at least 20% reduction in 2020 (compared to 1990 levels) (ICAP 2019).

Swiss ETS is expected to be linked with EU ETS from 1st January 2020 as was stated in the chapter 4.6.1.4. of this Thesis.

4.6.6. Regional Greenhouse Gas Initiative of USA

In 2009, 10 states of United States of America (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont) launched The Regional Greenhouse Gas Initiative (RGGI) what was the first ETS in the United States. The program is limited to CO_2 emissions from power plants using fossil fuel in involved states. Allowances are allocated by auctioning (Hibbard et al. 2018).

According to ICAP (2019) in 2011 New Jersey withdrew from the program, but currently has intention to join again in 2020. In another US state, Virginia, is currently being established an ETS, with planned linking to the RGGI expected during 2020.

Hibbard et al. (2011) analysed the first control period (2009-2011). They stated that because the cap was only recommended in the first period there was observed only very limited effect on power sector. However, net income from allowances auctions was $912 million, which was distributed between participating states and used to fund government programs focused on reducing energy consumption. Therefore, Hibbard et

al. (2011) summarized that the system "has produced positive economic outcomes for each state and for the region as a whole".

Currently the RGGI covers 165 power plants, which account for 18% of GHG emissions in nine involved US states (ICAP 2019).

4.6.7. California and Quebec cap-and-trade

The Californian cap-and-trade system was introduced in the Global Warming Solution Act established in 2006. System came into operation in 2013, when it covered large industry and electricity installations (Borghesi & Montini 2019) and also all electricity sold in California. In 2015 was coverage expanded to fossil fuels. The cap is annually lowered to achieve objective of reaching 1990 emission levels in 2020 (Schmalensee & Stavins 2017), in practise that means about 3.3% annual reduction between 2018 and 2019 (ICAP 2019).

Narassimhan et al. (2017) refers to the program as "well-designed" with stable market and flexible design that allows regulators to remove or add allowances into the market in case of shocks. Narassimhan et al. (2017) also state that system indicate that covered subjects steadily reduce emissions.

In comparison, Tapia Granados and Splash (2019) affirmed that an emission production in the US is correlated with economic growth and available data does not support a claim that California cap-and-trade system leads to measurable differences in emission mitigation compared to other US states.

Quebec committed to emission reduction goal of 20% in 2020 (compared to 1990 levels). To achieve this objective Quebec started its ETS in 2013.

Subsequently in 2014, California and Quebec in the framework of the Western Climate Initiative (collaboration of US and Canadian subnational ETSs) linked its emission systems. States mutually accept allowances and auction allowances jointly (Schmalensee & Stavins 2017).

In January 2018, Ontario joined Quebec and California linked ETS. Despite that cooperation was considered successful (ICAP 2019), newly elected Ontario Premier Doug Ford in June 2018 announced withdrawal from the linked system and later cancelled

state’s ETS at all. Ford declared that "eliminating the carbon tax and cap-and-trade is the right thing to do and is a key component in our plan to bring your gas prices down by 10 cents per litre" (Office of the Premier-Designate 2018).

Despite the sudden shock from the Ontario withdrawal, joint ETS remained stable. Currently are both states covering in the ETS all main GHGs and around 80% of their total emissions (ICAP 2019).

In May 2018 Nova Scotia joined the Western Climate Initiative and since January 2019 it is implementing its ETS covering the industrial, power, heat (buildings), and transport sectors with the coverage of 80% of the state’s GHGs (ICAP 2019).

4.6.8. Kazakhstan ETS

Although, Kazakhstan established an ETS in 2013, related literature or any evaluations are lacking. Reasons may be that in 2016-2017 was system suspended and restarted not until 2018. Therefore, enough data for an evaluation are not available.

According to server Carbon Pulse (2016), suspension was caused by the industry protests, that ETS is too strict and has weak legal framework. In addition, Kazakh economy was at the time suffering because of the oil and metal prices fall.

Basic facts offer ICAP (2019) and World Bank Group (2019). ETS was restarted in 2018 with improved overall emissions regulation, the ETS operation, the monitoring, reporting and verification system. Cap in 2018-2020 is 485.9 million tCO_2 and ETS covers 225 installations belonging to 129 operators.

4.6.9. Tokyo and Saitama ETS

In 2007, the Tokyo Metropolitan Government announced establishment of cap-and-trade program and the Tokyo Metropolitan Government Emissions Trading Scheme (TMG ETS) started operating in 2010 (Tokyo Metropolitan Government 2010).

Tokyo Government’s objective was becoming a low carbon city. Due to the significant share and the increasing trend of CO_2 emissions from the commercial and business sector, TMG ETS covers emissions from the end-use of energy in large commercial buildings and factories. In total, the program covers around 1,300 facilities

(1,000 big commercial buildings and 300 factories). The cap is derived from the main objective of the ETS to reduce emissions by 17% in the second period (2015-19) (compared to baseline counted from three consecutive years freely selected by companies from 2002 to 2007) (Rudolph & Kawakatsu 2012).

According to Tvinnereim (2014) in 2011, covered entities achieved a 23% reduction compared to their baselines. Tvinnereim (2014) explains the achieved reduction by energy efficiency measures established after the Fukushima nuclear disaster and also by design of the ETS, which allowed companies select their baseline years itself, therefore they chose years with high energy consumption.

Latest report of Tokyo Metropolitan Government (2019) stated that facilities covered by the ETS program achieved in 2017 significant reduction of CO_2 emissions and also reduction rate of final energy consumption in TMG ETS covered business and commercial sector is lower compared to the rest of Japan, as is shown in Figure 7.

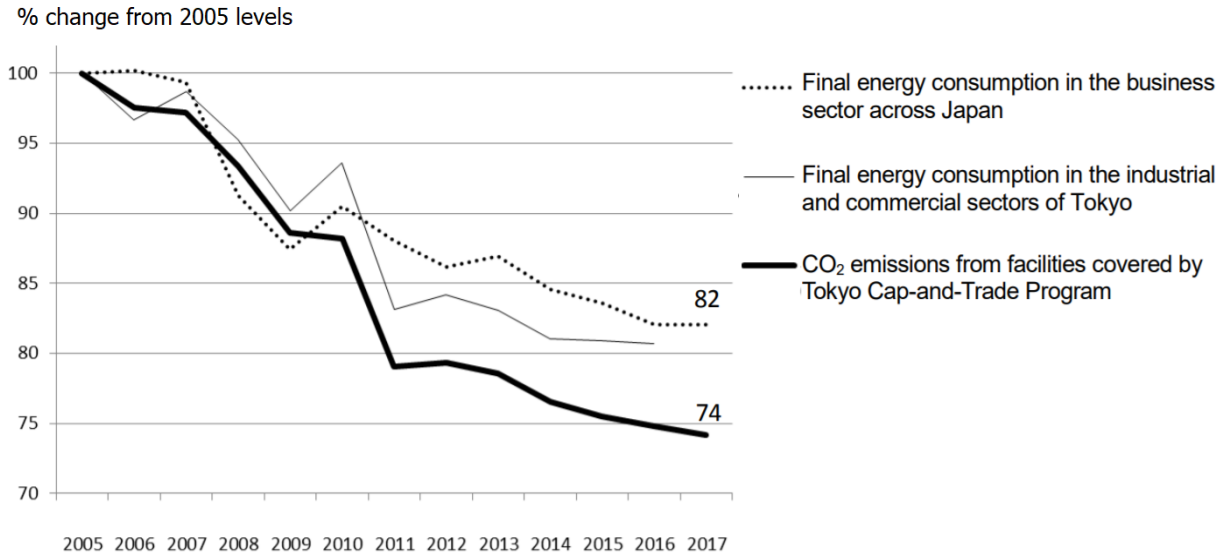

Figure 7: CO_2 emissions of facilities covered by TMG ETS and energy consumption of the Japan business sector compared to TMG ETS covered business and commercial sector.

Source: Tokyo Metropolitan Government (2019)

In April 2011 was ETS established in Saitama – neighbouring province of Tokyo. Design and setting are similar to TMG ETS and Saitama system was from its establishment linked with TMG ETS (ICAP 2019).

5. Conclusions

Emission trading systems together with the carbon tax are two fundamental instruments used in the world for an abatement of GHGs emissions. According to experts ETSs contribute to an economic efficiency by the creation of an incentive for GHGs emitters to reduce emissions where are the reductions cheapest to achieve. Emitters that would find it costly to diminish their emission can buy emission allowances from emitters that can mitigate emissions with lower costs. Carbon tax in opposite directly sets a price on produced emissions, compared to ETS it is a simpler mechanism, but also less flexible and in general, the imposition of new taxes is unpopular decision for policymakers.

The EU ETS is the most important and the biggest example of the ETSs currently operating in the world. Experts and policymakers from other countries are following experiences gained since launching of the system in 2005 in designing new ETSs that are emerging around the world. In 2020 the introduction of Mexico ETS is anticipated, and a principal impact on the world carbon pricing initiatives is expected from the start of China ETS. Experts predict that if China ETS will be successful, other emerging economies will follow with their own schemes to fulfil their commitment to the Paris Agreement.

Contribution of this work is mainly in summarisation of available scientific literature, other relevant sources and up to date information related to emission trading accessible in April 2019.

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