LIÈGE université

Energy Markets: Carbon Price

Author: Victor Dachet

Adrien Bolland, Thibaut Théate, Antoine Dubois, Raphaël Fonteneau and Damien Ernst

Course Overview

- Carbon Price: Economical Background
- Policy Mechanisms
- Historic Context
- World Overview
- EU-ETS
- Influence on Power Markets
- Assessment of the EU-ETS
- Conclusion

Carbon Price

Carbon Price

Main goal:

Decrease GHG emissions in Europe by setting a price.

This price must represent the externalities.

Source: https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2022)698890

Externalities : A Definition

Externalities refers to situations when the effect of **production or consumption** of goods and services **imposes costs or benefits on others** which are **not reflected in the prices** charged for the goods and services being provided.

Source: https://stats.oecd.org/glossary/detail.asp?ID=3215

Market Failure

Externalities either positive or negative that are not taken into account lead to respesctively underconsumption and overconsumption. This implies what we call a market failure.

E.g.: The overconsumption of fossil fuels.

Negative Externalities

The price of an externality is the difference between the marginal social cost (MSC) and the marginal private cost (MPC).

MPC + MEC = MSC

with MEC : marginal external costs

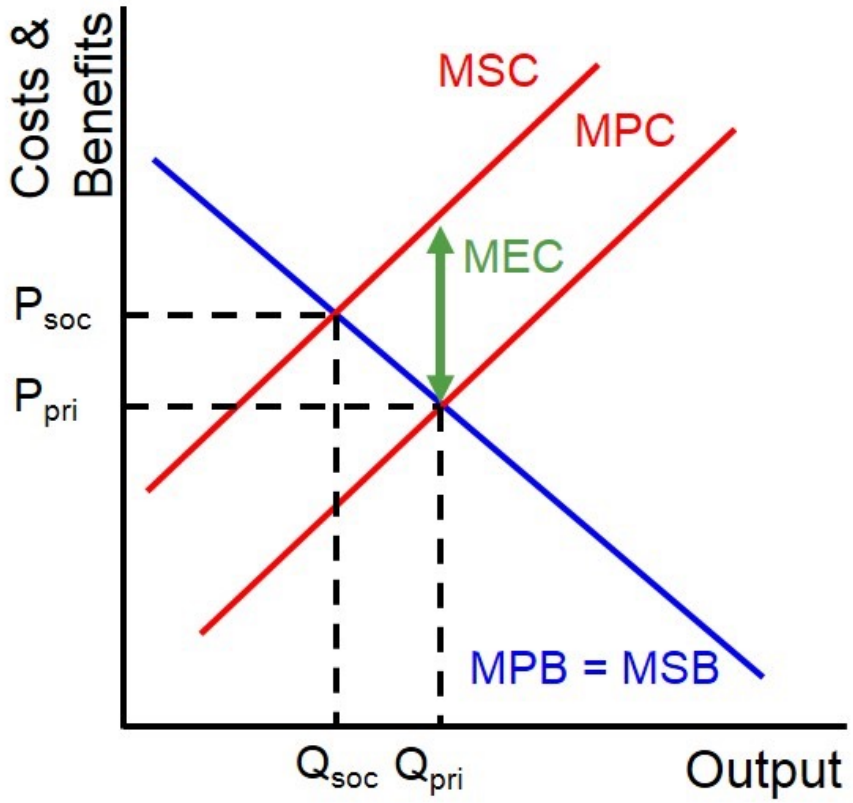


Figure source:
https://www.ezyeducation.co.uk/ezyeconomicsdetails/ezylexicon-economic-glossary/741-marginal-external-cost.html

Property Rights

Definition:

Property rights define the theoretical and legal ownership of resources and how they can be used. Property can be owned by individuals, businesses, and governments. These rights define the benefits associated with ownership of the property.

Source: https://www.investopedia.com/terms/p/property_rights.asp

Transactions

Definition:

A transaction is a completed agreement between a buyer and a seller to exchange goods, services, or financial assets in return for money.

Source: https://www.investopedia.com/terms/t/transaction.asp

Coase Theorem

Thrm - If **transactions costs are low** and **property rights are clearly defined**, private bargains will ensure that the market equilibrium is efficient even if there are externalities

- Often conditions are not met
- Suggests a solution – the creation of new markets:

  If governments can define property rights and reduce transaction costs markets can be used to control externality problems.

Source: Carbon Markets: An International Business Guide by Arnaud Brohé, Nick Eyre and Nicolas Howarth
https://www.youtube.com/watch?v=00HPak2RLlQ

Marginal Abatment Cost:

An abatement cost is a cost borne by firms when they are required to remove and/or reduce undesirable nuisances or negative by-products created during production.

It is the cost to reduce one more unit of an environmental negatives (e.g. the cost to reduce one ton of CO2).

Source: https://www.investopedia.com/terms/a/abatementcost.asp

Policy Mechanisms

How to set up a price on carbon?

Four ways to consider carbon externalities:

1. Baseline and Credit
2. Command-and-control regulation
3. Carbon Tax
4. Carbon Market: cap and trade mechanism

In this lecture, we will focus on the 2 last and more specifically on carbon markets.

Source: https://en.wikipedia.org/wiki/Emissions_trading

Baseline and Credit

You fix a baseline on emissions for a given sector. Then the actors which produce a good or a service with higher emissions must buy allowances from actors producing with less emissions than the baseline.

Command-and-Control Regulation

Command—and—control policy refers to environmental policy that relies on regulation (permission, prohibition, standard setting and enforcement) as opposed to financial incentives, that is, economic instruments of cost internalisation.

Source: https://stats.oecd.org/glossary/detail.asp?ID=383

Carbon Tax

This is a price mechanism. You fix a price on a given quantity of emission.

Then, the market will find an optimal quantity to emit.

Cap and Trade mechanism

This is a quantity instrument. You fix the maximum total amount of emissions and you sell by auction the allowances to emit.

Then, the market will find a price for this given volume of emissions.

Similarities between cap & trade and carbon tax

- Reduce emissions by encouraging lowest-cost emissions reductions (without prior knowledge on where these reductions will occur).
- Encourage investors and entrepreneurs to develop new low-carbon technologies.
- Generate government revenue

Source: https://www.wri.org/insights/carbon-tax-vs-cap-and-trade-whats-better-policy-cut-emissions

Advantages of a Carbon Tax

- Stable carbon prices, so energy producers and entrepreneurs can make investment decisions without fear of fluctuating regulatory costs.

Source: https://www.wri.org/insights/carbon-tax-vs-cap-and-trade-whats-better-policy-cut-emissions

Advantages of Cap and Trade

- By setting an emissions cap that declines over time, a cap-and-trade policy can increase certainty that emissions will fall below the predetermined emissions targets.
- Automatic response to inflation

Source: https://www.wri.org/insights/carbon-tax-vs-cap-and-trade-whats-better-policy-cut-emissions

Historic Context

Historic Context

Kyoto Protocol (signed in 1997) establishes 3 market-based mechanisms:

1. International Emissions Trading
2. Clean Development Mechanism (CDM)
3. Joint implementation (JI)

entered into force in 2005.

Source: https://unfccc.int/kyoto_protocol

Clean Development Mechanism (CDM) and Joint Implemenation (JI)

CDM and **JI** are the two project-based mechanisms which feed the carbon market.

The **CDM** involves investment in **emission reduction** or removal enhancement projects **in developing countries** that contribute to their sustainable development, while **JI** enables **developed countries** to carry out emission reduction or removal enhancement projects in other developed countries.

CDM: earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO2, which can be counted towards meeting Kyoto targets.

JI: to earn emission reduction units (ERUs) from an emission-reduction or emission removal project in another Annex B Party, each equivalent to one tonne of CO2, which can be counted towards meeting its Kyoto target.

Source: https://unfccc.int/process/the-kyoto-protocol/mechanisms

International Emissions Trading

The allowed emissions are divided into assigned amount units **(AAUs).**

Emissions trading, as set out in Article 17 of the Kyoto Protocol, allows countries that have emission units to spare - emissions permitted them but not "used" - to sell this excess capacity to countries that are over their targets.

Other traded units:

- A removal unit **(RMU)** on the basis of land use, land-use change and forestry (LULUCF) activities such as reforestation
- An emission reduction unit **(ERU)** generated by a joint implementation project
- A certified emission reduction **(CER)** generated from a clean development mechanism project activity

Source: https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading

International Emissions Trading

Transfers and acquisitions of these units are tracked and recorded through the registry systems under the Kyoto Protocol.

An international transaction log ensures secure transfer of emission reduction units between countries.

The commitment period reserve

In order to address the concern that Parties could "oversell" units, and subsequently be unable to meet their own emissions targets, each Party is required to maintain a reserve of ERUs, CERs, AAUs and/or RMUs in its national registry. This reserve, known as the "commitment period reserve", should not drop below 90 per cent of the Party's assigned amount or 100 per cent of five times its most recently reviewed inventory, whichever is lowest

Source: https://unfccc.int/process/the-kyoto-protocol/mechanisms/emissions-trading

Kyoto Protocol: Critics

- Caps reflect more a political negotiation than an optimization of environmental considerations. There was a lack of ambition.
- Lack of transparency and liquidity of the carbon market.
- Withdrawal of the Canada in 2011 due to oil sand development.
- No ratification by the US the biggest polluter country at that time (2nd one since 2006).
- Critics on the CDM:

  1 - High transaction costs for small scale projects (too long procedures often done by consultant in developed countries).

  2 - Geographical distribution of the projects (More than 85% of the issued credits from 5 countries (China, India, Brazil, South Korea and Mexico).

  3 - Overall climate impact, at best, neutral.
- At least, first steps of an international collaboration to fight climate change when the consensus was weaker than today.

Source: Carbon Markets: An International Business Guide by Arnaud Brohé, Nick Eyre and Nicolas Howarth and https://ourworldindata.org/co2-emissions

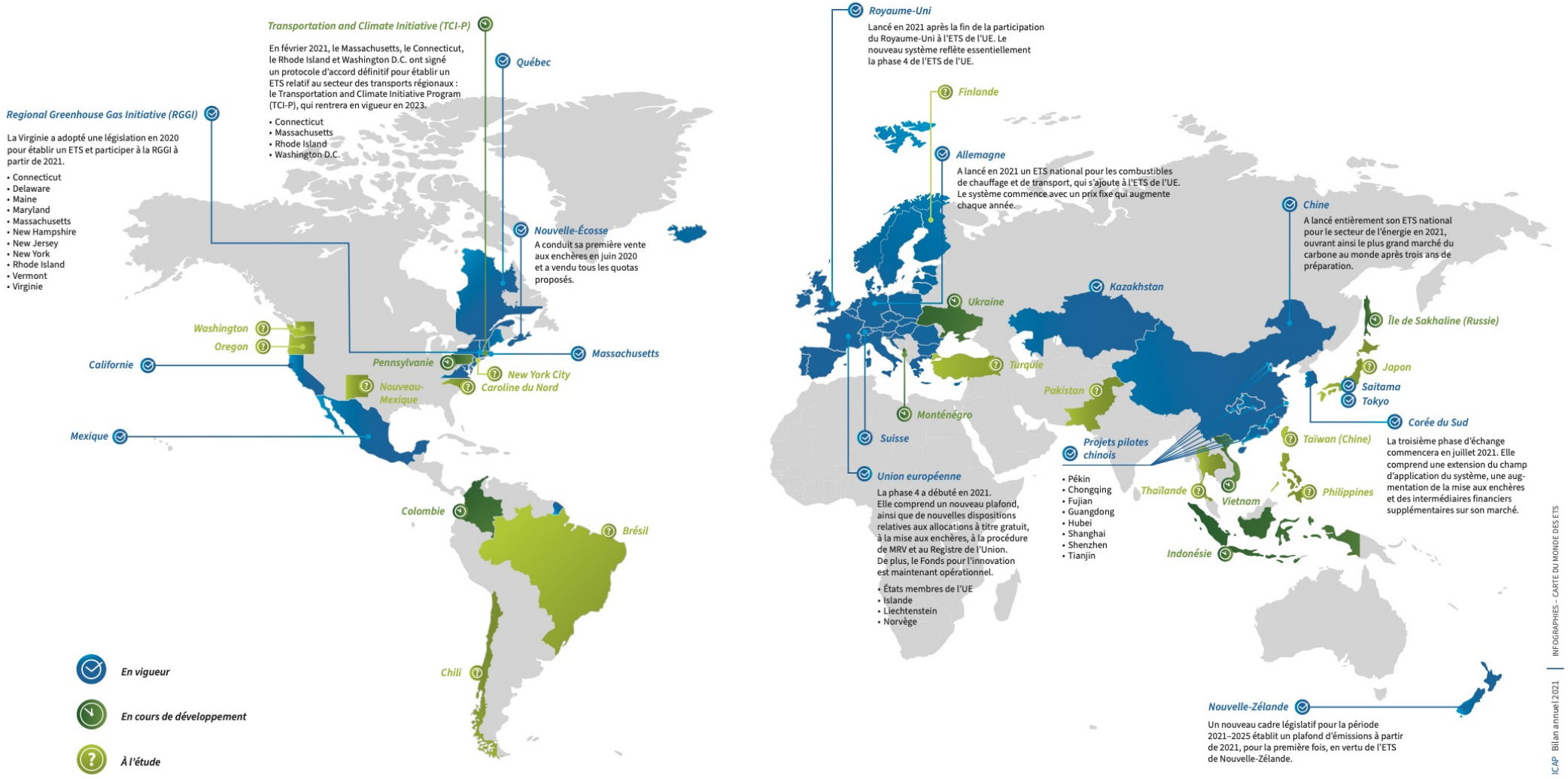
World Overview

Emissions Trading System (ETS) around the world

CARTE DU MONDE DES ETS

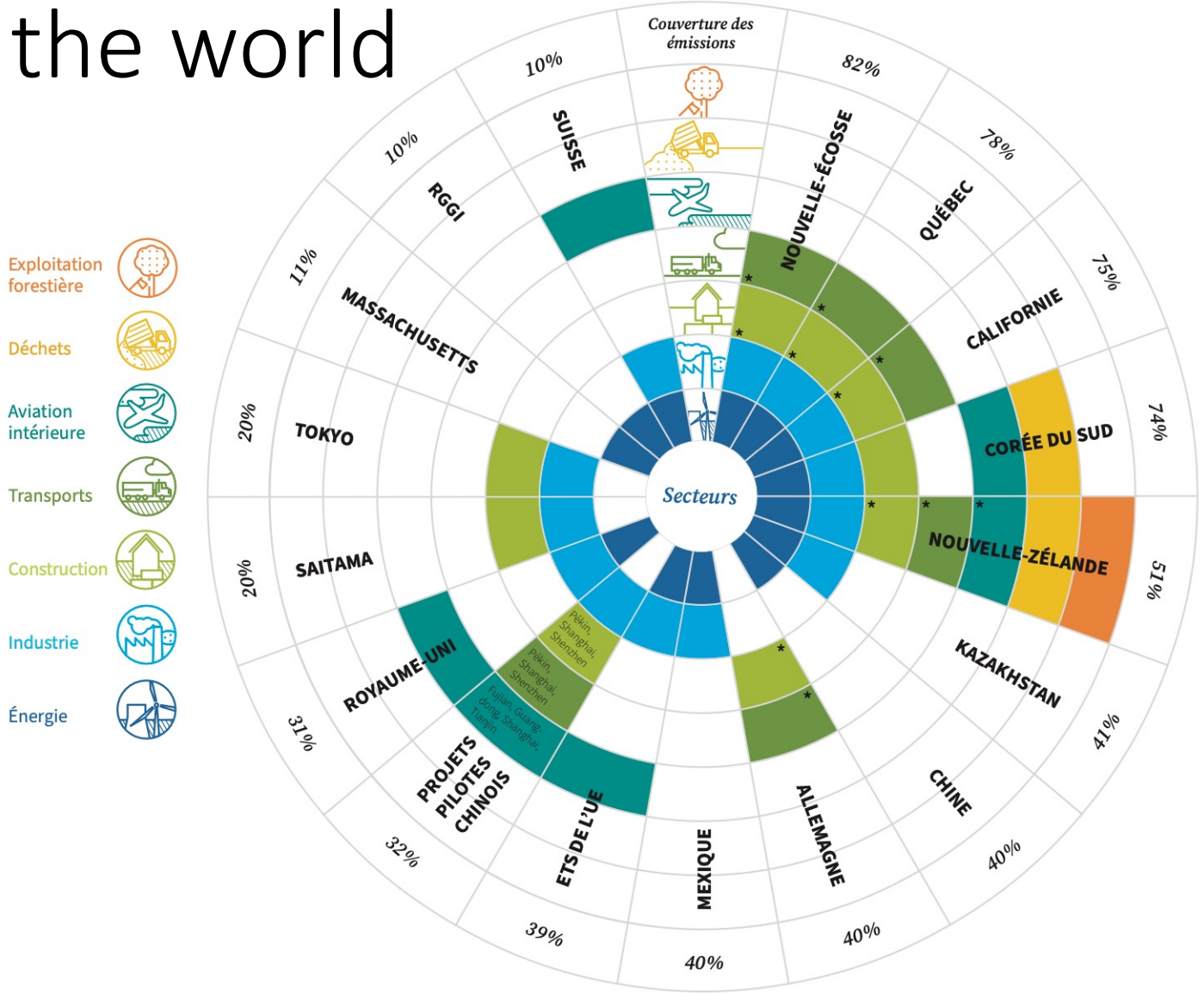
État des lieux des systèmes de plafonnement en 2021

La carte du monde des ETS de l'ICAP représente les systèmes d'échanges de quotas d'émission actuellement en vigueur, en développement ou à l'étude. Au 31 janvier 2021, il existe 24 ETS en vigueur. Huit autres sont en cours de développement et devraient entrer en vigueur dans les prochaines années. Ils comprennent les ETS de Colombie et du Transportation and Climate Initiative Program (TCI-P, programme d'initiative pour le transport et le climat) dans le nord-est des États-Unis. 14 pays, dont le Chili, la Turquie et le Pakistan, étudient également le rôle d'un ETS dans leur stratégie politique relative au changement climatique. Si un territoire dispose de plusieurs systèmes en vigueur, ou dispose d'un système en vigueur et est en train d'élaborer ou d'étudier un système supplémentaire, il est représenté en bleu.



Source: https://icapcarbonaction.com/en/publications/emissions-trading-worldwide-icap-status-report-2021

ETS around the world



Nowadays, 16% of the world GHG emissions are covered by an ETS

Source: https://icapcarbonaction.com/en/publications/emissions-trading-worldwide-icap-status-report-2021

European Emissions Trading System

EU Emissions Trading System

- operates in all EU countries plus Iceland, Liechtenstein and Norway (EEA-EFTA states),
- limits emissions from around 10,000 installations in the power sector and manufacturing industry, as well as airlines operating between these countries,
- covers around 40% of the EU's greenhouse gas emissions.

Source: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en

Figure source: https://en.wikipedia.org/wiki/European_Union_Emissions_Trading_System

EU-ETS: cap and trade

The EU-ETS works on the 'cap and trade' principle. A cap is set on the total amount of certain greenhouse gases that can be emitted by the installations covered by the system. The cap is reduced over time so that total emissions fall.

Within the cap, installations buy or receive emissions allowances, which they can trade with one another as needed. The limit on the total number of allowances available ensures that they have a value.

After each year, an installation must surrender **enough allowances to cover fully its emissions**, otherwise heavy fines are imposed. If an installation reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another installation that is short of allowances.

Source: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en

GHG Covered by the EU-ETS

- Carbon dioxide (CO2)
- Nitrous Oxyde (N2O)
- Perfluorocarbons (PFCs)

Source: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets_en

Link between Kyoto and European ETS

The European ETS was developed in order to achieve Kyoto protocol goals.

The European ETS recognises ERU and CER to allocate some ETS allowances.

Source: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32004L0101

Birth of the European Emission Trading System (ETS)

- Phase 1: 2005 - 3-year pilot phase
- Phase 2: (2008-2012) – First commitment period of the Kyoto Protocol. ETS covered aviation since 2012.
- Phase 3: (2013-2020) Broadened the scope to more sectors and gases, single EU-wide cap, auctioning default method for distributing allowances, harmonised the rules for free allocation.
- Phase 4: (2021-Now)

Source: https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2022)698890

Historical Data ETS Prices

Some statistics:

Lowest price: 0.01€

Highest Price: 99.22€

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Highest Price: 99.22€

Market Stability Reserve (MSR)

It started to operate in January 2019 as a response to the **over-supply of allowances** since 2009, a result of the **economic crisis** and **high imports of international credits**, which led to **lower carbon prices**.

The MSR allows for better matching of the supply of allowances to be auctioned with the demand. Under the revision of the EU ETS in 2018, the MSR intake rate (the percentage of the total number of allowances in circulation which is put in the reserve) until the end of 2023 was doubled from 12 % to 24 %, and the minimum amount of allowances placed in the MSR was doubled from 100 to 200 million. Moreover, from 2023 the allowances held in the MSR above the total number of allowances auctioned during the previous year should no longer be valid.

Source: https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2022)698890

Risk of Carbon Leakage

Carbon leakage refers to the situation that may occur if, for reasons of costs related to climate policies, businesses were to transfer production to other countries with laxer emission constraints. This could lead to an increase in their total emissions. The risk of carbon leakage may be higher in certain energy-intensive industries.

Source: https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/carbon-leakage_en

Carbon Border Adjustment Mechanism (CBAM)

The CBAM would initially apply to imports in five emissions-intensive sectors deemed at greater risk of carbon leakage: cement, iron and steel, aluminium, fertilisers, and electricity. The CBAM charge would cover imports of these goods from all third countries, except those participating in the ETS or a linked mechanism.

The price of the CBAM certificates would be directly linked to the weekly price of EU ETS allowance.

Source: https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/698889/EPRS_BRI(2022)698889_EN.pdf

In practice

The auction is hosted by EEX the market operator which ensures the reliability of the exchanges.

Who may participate in Emissions Auctions?

- Compliance buyers (operators of stationary installations, aircraft operator)
- Investment firms and credit institutions
- Business groupings of compliance buyers

They have to fulfil admission requirements according to EU and EEX rules:

- Establishment in the EU
- Hold a nominated holding account in the Union registry
- Hold a nominated bank account

Source: https://www.eex.com/en/markets/environmental-markets/eu-ets-auctions

Overview of the auction process

9:00-11:00 am CET	~11:01 am CET	~11:05 am CET	Auction Day + 1 ECC Business day	Upon Request
Bidding window: • Products: i. T3PA (Spot EU Allowances for Phase 4 of the EU ETS, lot size: 500 EUA) ii. EAA3 (Spot EU Aviation Allowances for Phase 4 of the EU ETS, lot size: 500 EUAA) • Bids could be submitted, modified and withdrawn during the bidding window • Bids could be submitted directly in the Auction System (see Video Tutorial) or indirectly via EEX Helpdesk or via Intermediary • Bids are submitted without seeing other participant's bids	Determination of the auction clearing price: • Bids are sorted in descending order of the price bid • Tied bids are sorted through random selection according to an algorithm • Bid volumes are added, starting with the highest bid • The price at which the summed up bid volumes match or exceed the volume of allowances auctioned sets the auction clearing price for all successful bidders Publication: • Main Auction Results in the Auction System and on the Website	Publication: • Detailed Auction Results on the Website (link to the dedicated auction website)	Payment: • From the Clearing Member of a Trading Member to ECC • From ECC to the Auctioneer Delivery (internal): • Transfer of allowances within the ECC Union Registry Account from the Auctioneer (Seller) to the Trading Member (potentially an Intermediary*) having been successful in the Emissions Auction (Buyer)	Delivery (external): • Transfer of allowances from the ECC Union Registry Account to the Union Registry Account of the Trading Member

Source: https://www.eex.com/en/markets/environmental-markets/eu-ets-auctions

Auction process: clearing price

Example: Auction for 1 million EUAs

Order book

after close of bidding window phase

Bidder	Price	Volume
A	82.00 €	500,000
B	86.00 €	600,000
C	84.00 €	300,000
D	85.00 €	800,000
E	85.00 €	500,000
F	95.00 €	10,000
Total		2,710,000

Order book

sorted by price

Bidder	Price	Volume
F	95.00 €	10,000
B	86.00 €	600,000
D	85.00 €	800,000
E	85.00 €	500,000
C	84.00 €	300,000
A	82.00 €	500,000
Total		2,710,000

Allocation
10,000
600,000
*390,000
0
0
0
1,000,000

Source: https://www.eex.com/en/markets/environmental-markets/eu-ets-auctions

Example of Volume planned to be auctioned in 2022

Volume 2022	States	Details
333,205,500	25 EU Member States and 3 EEA EFTA States, Innovation Fund and Modernisation Fund	Weekly auctions on Mondays, Tuesdays and Thursdays
84,230,000	Germany	Weekly auctions on Fridays
62,916,000	Poland	Bi-weekly auctions on Wednesdays
2,037,500	UK in respect of generation of electricity in Northern Ireland	23 February 2022: 1,108,500 EUA (volume of 2021) 21 September 2022: 929,000 EUA (volume of 2022)

Source: https://www.eex.com/en/markets/environmental-markets/eu-ets-auctions

Influence on power markets

What carbon price to make fossil fuel power plants out of business ?

Ref. fossil tech.	Coal with CCS			Nuclear		
	Case 1	**Case 2**	**Case 3**	**Case 1**	**Case 2**	**Case 3**
	8% capital cost	5% capital cost	12.5% capital cost	8% capital cost	5% capital cost	12.5% capital cost
Gas CCGT 8% capital cost	Carbon price 85€/tCO2	Carbon price **50 €/tCO2**	Carbon price 120€/tCO2	Carbon price 60 €/tCO2	Carbon price **20€/tCO2**	Carbon price 132€/tCO2
Coal plant 8% capital cost	Carbon price 35€/t	Carbon price **20€/t**	Carbon price 54€/t	Carbon price 30€/t	Carbon price **12.5 €/t**	Carbon price 60€/t

Source: Finon 2017 cfr https://www.carbonpricingleadership.org/open-for-comments/tag/Commission

Clean Spark Spread and Clean Dark Spread

Definition:

$$Clean\ Spark\ Spread = P_e - \frac{P_g}{\eta_{el}} - P_c\ I_{gas}$$

With P_e electricity price, P_g gas price, η_{el} efficiency, P_c the carbon price and I_{gas} the gas emissions intensity.

If Clean Spark Spread > Clean Dark Spread :

$\Rightarrow$ Gas-based production more interesting than coal-based

Sources: Carbon Markets: An International Business Guide by Arnaud Brohé, Nick Eyre and Nicolas Howarth and https://en.wikipedia.org/wiki/Spark_spread

Clean Spark Spread and Clean Dark Spread

Figure 8: Evolution du *clean spark spread* (efficacité PCS 50 %) et du *clean dark spread* (efficacité de 42 %) pour les contrats à terme année +1 (Cal +1)

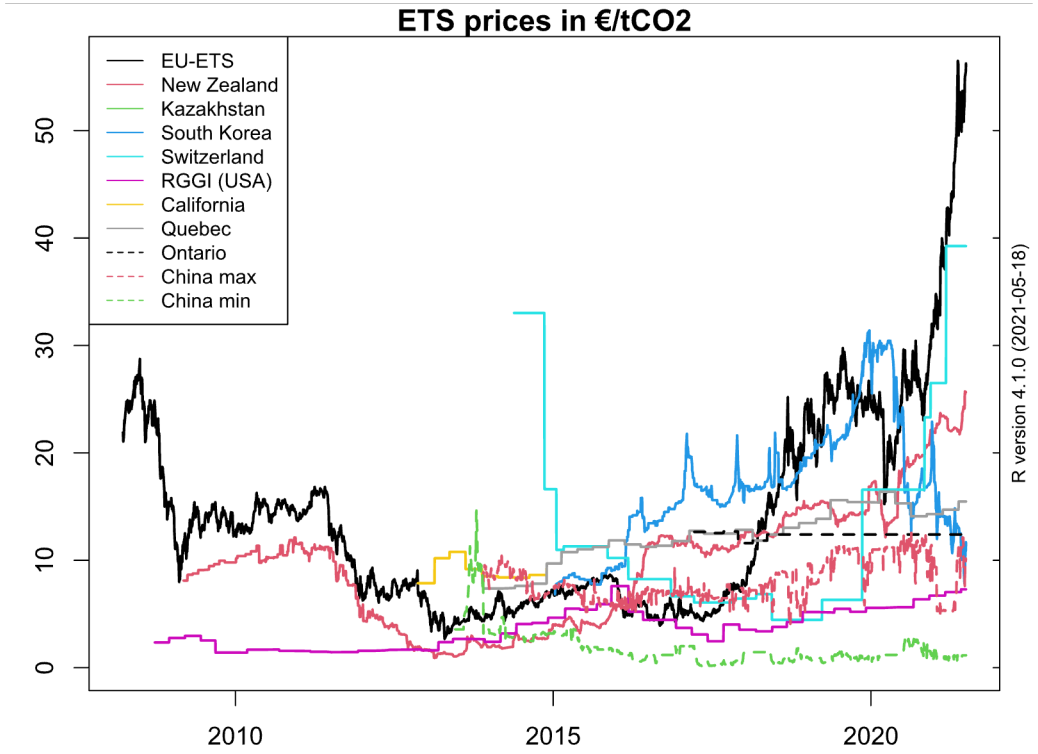
Source: https://www.creg.be/fr/publications/etude-f2289

Assessment of the ETS

Do Carbon Markets work in practice?

Prices are too low to achieve Paris agreement by 2030. Stern and Stiglitz estimated a range between 50 and 100 $ / t CO2 to decarbonate the economy.

The prices were too low to create enough incentives to decarbonate industries but are rising… Wait and see ?



Source: https://en.wikipedia.org/wiki/Carbon_price#/media/File:ETS-allowance-prices.svg

Source: The economist https://www.youtube.com/watch?v=m5ych9oDtk0

Conclusion

- The goal of putting a price is to internalize the price of externalities
- Market-based mechanism is a quantity policy instrument
- The Kyoto Protocol is the “father” of the EU-ETS
- 16% of the GHG emissions worldwide are covered by an ETS
- The EU-ETS is a market based on the cap-and-trade mechanism
- The prices are rising: it may become a real incentive soon
- Clean Spark Spread and Clean Dark Spread are profitability measures of respectively Gas and Coal power plant.

Vocabulary

- Auction = enchère
- Emission allowance = droit d’émission

References

- Carbon Markets: An International Business Guide by Arnaud Brohé, Nick Eyre and Nicolas Howarth
- Energie: Economie et politiques by Jean-Pierre Hansen and Jacques Percebois seconde édition.