

Mexico's Carbon Market Simulation Exercise

Results report for the third simulation¹

Context:

SEMARNAT, MÉXICO₂ (Mexican Carbon Platform) part of the Mexican Stock Exchange Group and Environmental Defense Fund (EDF) with funding from the World Bank through the Partnership for Market Readiness (PMR) program joined in 2016 to implement Mexico's Carbon Market Simulation Exercise with the voluntary participation of companies representing different sectors. The main objectives of the exercise are:

- 1) Ratify national environmental commitments and place Mexico a step ahead in the world's efforts to reduce emissions and address climate change,
- 2) Capacity building in the private sector through practical experience in the operation of a carbon market,
- 3) Strengthen national competitiveness in light of a new global economic context, by improving capacities on the use of cutting edge market tools,
- 4) Help the Mexican Government and companies inform themselves on the working of environmental commodities markets, and
- 5) Help the private sector be better prepared in order to participate in the discussion process related to the development of an Emission Trading Scheme (ETS) in Mexico.

The exercise uses a digital platform that reproduces most of the elements included in an Emission Trading Scheme (ETS) in a realistic fashion, using fictitious information (companies, emission base

¹ This document is a summary for the general public of the results of the Third Simulation Exercise. There are also reports on the first and second simulation's reports. The first report includes a section explaining the broader context of the exercise.

line, abatement project costs, etc.) as well as fictitious economic resources. In each simulation both human players and *bots*² operating on artificial intelligence participated.

The initiative was comprised of three stages:

- The first stage was comprised of a series of workshops on climate change, theoretical concepts regarding an ETS and the use of the simulation platform (CarbonSim).
- Three online simulations, lasting 3-6 weeks. During these simulations, participants had access to reference materials, as well as technical support either by phone, e-mail or during Q&A videoconferences. At the end of each virtual year, and at the end of each simulation, participants received a market bulletin.
- At the end of each simulation, a round table to discuss results, a closing ceremony and awards presentations were conducted.

Summary of the Simulation Exercise:

Workshop No.	Date	Venue	Participants
1	10-Oct-17	Mexican Stock Exchange, Mexico City	13
2	11-Oct-17	Mexican Stock Exchange, Mexico City	40
3	26-Oct-17	SEMARNAT Monterrey	19
4	27-Oct-17	ITESO Campus Guadalajara, Jalisco	26
5	1-Nov-18	Webinar	6
6	8-Nov-17	Mexican Stock Exchange, Mexico City	7
7	29-Nov-17	PEMEX	16
8	18-Jan-18	Mexican Stock Exchange, Mexico City	8
9	26-Jan-18	Mexican Stock Exchange, Mexico City	51
10	15-Mar-18	SEMARNAT, Mexico City	8
11	23-Mar-18	Webinar	7
12	27-Mar-18	Mexican Stock Exchange, Mexico City	5
Total participants			206

² Automated computer program that can interact with the system and users.

Participant Sub-sectors³

Automotive	Electronics	Oil and Gas
Aviation	Equipment and Machinery	Pulp and Paper
Cement	Finance	Renewables
Chemical/Petrochemical	Food and Beverages	Steel
Conglomerates (various)	Glass and Ceramics	Telecommunications
Consultancy	Government	Waste
Consumer Goods	Mining	Wood, pulp and paper
Electricity	NGO	

Results from the Third Simulation Exercise

Simulation Parameters:

The third online simulation took place from May 7 to June 15, in it 78 people representing 62 companies, institutions and organizations participated. They were divided in three groups (A, B and C) participating in simultaneous simulations.

The initial parameters for the simulation for all three groups were:

- Total duration was of six virtual years (6 weeks in real time).
- An initial system-wide emission cap of 355,850,000 tons of CO₂e.
- A 3% annual emission cap reduction (18% over six years)⁴
- All participant installations had an annual emission growth rate of 2-5%.
- All installations initially received free emission allowances (DEM, as per its acronym in Spanish) for 90% of their annual emissions. The percentage of free allocation was reduced yearly in function of emission reduction needs and emission growth for each company.
- Yearly surplus DEMs and offsets could be transferred to future years without any restriction.
- Offsets could be used to fill up to 10% of each year's compliance obligations.
- Each virtual year had 4 DEM auctions (opened for 3.5 hours each day).
- A \$100 and \$300 minimum and maximum auction price was established (fictitious currency).
- The options to place sell or buy offers at the regulated market (Exchange) or over the counter (OTC) sell offers to other human players.

³ In line with taxonomy used in the National Emissions Registry (RENE, as per its acronym in Spanish)

⁴ The cap reduction rate was increased twice as a result of market shocks.

- A price volatility mechanism was implemented at the regulated market, which did not allow posting of buy or sell offers which were 10% above or below the price of the last transaction.
- In cases of non-compliance by any company, a \$300 fine was established and a penalty of 1 DEM was imposed for every ton not surrendered at year's end.

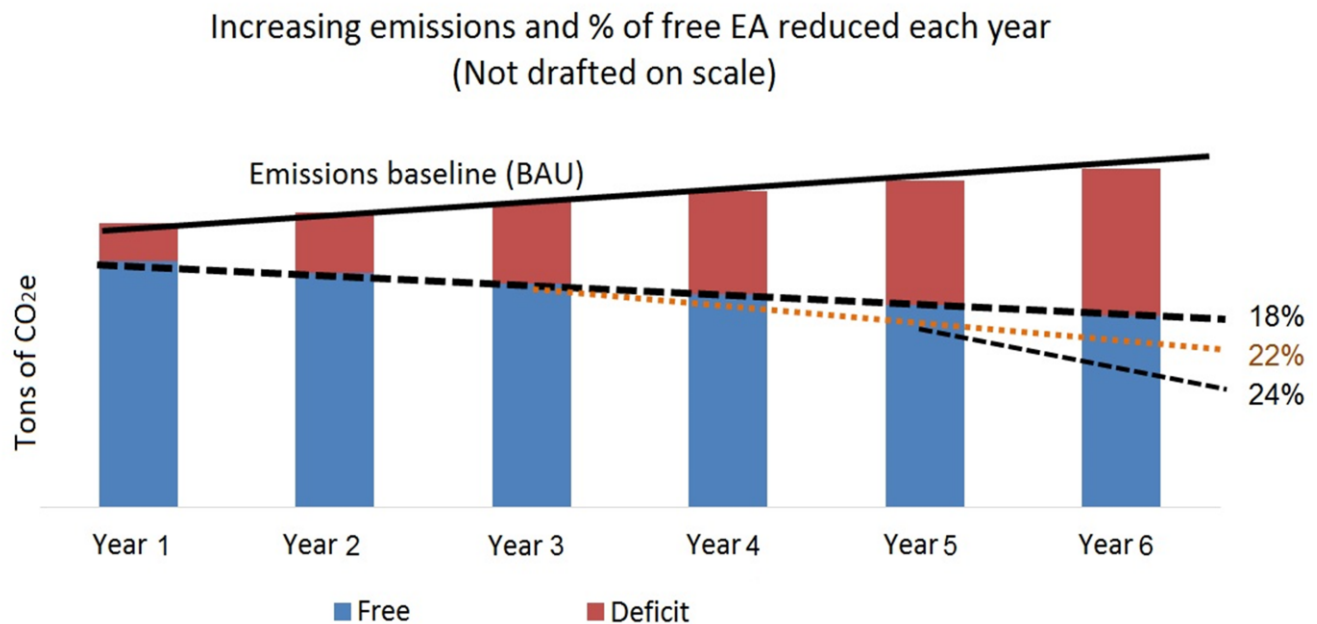
Market Shocks:

A shock is an unexpected or unpredictable event that affects the market. These shocks can be due to technological changes, changes in the local or global economy and, for the purposes of this exercise, shocks were reflected as changes in the market's parameters.

During the third simulation a large number of shocks were implemented, with the objective of increasing the difficulty on compliance obligations and the contest that was carried out. By doing this, we also hoped to incentivize conversations on the ETS' implementation flexibility.

Year	Effect	Shock
2	↑	The minimum auction price for a DEM was increased from \$100 to \$125
3	↑ ↑	The system-wide emission reduction target was increased from 18% to 22% The minimum auction price for a DEM was increased from \$125 to \$150
4	↓ ↑	The offset limit was reduced from 10% to 7% The minimum auction price for a DEM was increased from \$150 to \$175, and the maximum auction price was increased from \$300 to \$325
5	↑ ↓	The system-wide emission reduction target was increased from 22% to 24% The offset limit was reduced from 7% to 2%
6	↑	The offset limit was increased from 2% to 20%

Figure 1. Compliance challenge for each company



The emission cap is reduced every year (dotted lines). At the beginning of the simulation the emission reduction goal was of 18% over six years, during the third year it was increased to 22% and during year 5 it was increased to 24%.

Third Simulation Exercise – Simulation Objectives

The main objectives participants in the simulation must achieve are:

- **Comply with the regulation every year** (resolve the situation of having more emissions than allowances).
- Comply in the most cost effective manner possible.

In order to be a candidate for first place of the third simulation's contest, it was also necessary to finish the whole exercise without a surplus in compliance units (DEMs or offsets).

In order to comply with the regulation at the lowest possible cost, the participants had to consider all information provided by the platform concerning abatement costs, differing DEM and offset prices both at auctions and in secondary markets in their decisions. Prices varied among different markets (auctions, regulated market and OTC), among products (DEMs from different years and offsets) and with time.

Third Simulation Exercise – Final Results

All three groups presented similar results regarding compliance.

There were high compliance rates in all groups: 74%, 76% and 84% (respectively). However, the average compliance rate was 78%, far below the average rates present during the second simulation (84%) and the first simulation (82%). This can be due to the added difficulty due the simulation’s parameters and the use of market shocks.

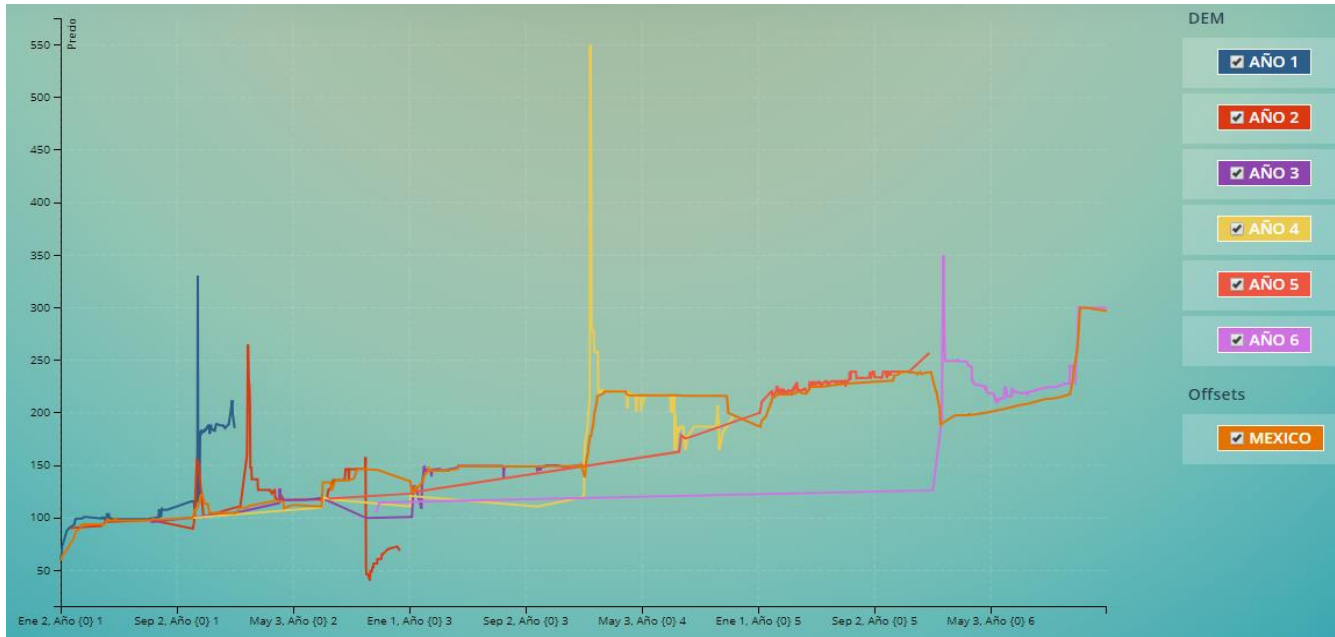
Comparison between groups A, B and C				
Metric	A	B	C	Average
Compliance average (6 years)	74%	76%	84%	78%
Compliance range (6 years)	54 – 88%	54- 88%	56 – 96%	55 – 91%
Average implemented abatements	2.2	2.1	1.6	1.9
Abatement implemented (million tons)	458	459	485	467
Surrendered offsets (million tons)	43	33	34	37
Reduced emissions (million tons)	501	493	518	504
Average DEM sell Price (\$)	160	219	179	186
Average offset sell Price (\$)	173	208	213	198
Accumulated compliance cost of all participants (\$/tCO ₂ e)	\$2.88 - \$102.57	\$3.22 – 122.13	\$2.92 - \$154.16	\$1.97 - \$126

In general terms, the obtained results in terms of environmental compliance (between 501 and 518 million tons of reduced CO₂ due to abatements and generated offsets) were very similar. In terms of participant’s compliance cost there was a large spread, from \$2.88 to \$154.16 per ton. The highest observed costs came from participants who failed to comply in one or more years and received fines of \$300 and a sanction of one DEM less during the following year for each missing compliance ton.

Relative to the two previous simulations, during the third simulation the abatement amount was reduced, which helped avoid an over-compliance in the system and reach similar results throughout all three groups.

Price behavior charts for DEMs and offsets in all three groups are presented below:

Figure 2. Behavior of regulated market during all 6 years for Group A



Prices gradually climbed throughout all 6 years. During most of the simulation prices were in the \$50-\$300 range, with some price spikes.

Figure 3. Behavior of regulated market during all 6 years for Group B



Group B presented the highest price volatility, in part due to some participants manipulating the market. Prices were generally in the \$100-\$350 range.

Figure 4. Behavior of regulated market during all 6 years for Group C



Prices were generally in the \$100-\$260 range. Some controlled volatility was observed during year 4, with the exception of a price spike.

Winning Strategies:

The participants who obtained the best results in terms of compliance and cost effectiveness, implemented certain strategies that included most of the following:

1. **Long term planning.** It is important to estimate future years' compliance and plan accordingly which abatements need to be implemented and what market actions need to be taken (such as buying future year DEMs in auctions and the regulated market when prices are attractive)-
2. **Early abatement and good choices.** It is relevant to consider the implementation of internal abatement options within companies, the sooner they can be implemented, the higher their yield during the simulation. It is important to consider the implementation time each abatement project requires to become operational and its corresponding reduction cost per ton.
3. **Abatements deliver long term benefits, but the capital expended becomes "stranded".** It was paramount to consider the available amount of capital to each company to comply with the regulation and not to "strand" to much capital on the

implementation of long term abatements, since it could leave the capital without the needed capital to purchase DEMs or offsets in the market, particularly during the first year.

4. **Constant monitoring of market and products.** By having constant information on the offer, demand and prices of the different products, one can be better informed in their decisions, for example knowing when to buy or sell DEMs of different vintages as well as offsets.
5. **Market posture management.** The decision to act and determining which prices are attractive to buy or sell depends as much on the current situation of the market as on the current situation of the company. For example, if a participant needs to purchase DEMs to end the year in compliance at a moment when demand is high (more interest on buying than on selling in the regulated market and auctions are fully subscribed with prices above the minimum), the participant will have a better chance of achieving compliance and avoid sanctions if she is willing to pay high prices (close to the cost of the fine).
6. **Seize arbitrage opportunities.** By closely monitoring the markets, one can find moments when it is possible to buy allowances at a relatively low price and sell at a later moment at a higher price, thus making a profit.
7. **Use of *limit order* and *stop loss orders*.** There are moments when using limit orders and stop losses can help obtain a more convenient price in a transaction.
8. **Use of *two way orders*.** This strategy involves having both limit orders and stop losses on the market at prices that are beneficial to the participant.
9. **Avoid ending the simulation on a long position.** If one ends the simulation with a surplus of allowances, this is indicative of a higher compliance cost than was needed.
10. **Limited use of “auto-trade” function.** The best results were observed when participants had control of system decision most of the time and used the option of handing control of the company to an artificial intelligence bot only for short periods of time and only when necessary.

Main Findings

1. A participant’s results in an ETS is a function of the program’s design and the participant’s skills.
2. Implementing abatement actions is paramount in the ETS’s operation and requires careful planning.
3. The simulation presents an environment where it is possible to learn from errors and try different strategies.
4. The adequate handling of a carbon portfolio requires the work and capacities of a multidisciplinary team.
5. Monitoring all markets is important to better inform decision.

6. It is important to take note of auction's subscription levels and prices. It is also important to constantly monitor the secondary market, whether supply or demand exists, whether transactions are being carried in the regulated market or OTC market, prices and trends.