DDP

The DDP is an initiative of the Institute for Sustainable Development and International Relations (IDDRI). It aims to demonstrate how countries can transform their economies by 2050 to achieve global net zero emissions and national development priorities, consistently with the Paris Agreement. Analyses are carried out at the national scale, by national research teams. National research teams openly share their methods, modelling tools, data and the results of their analyses to share knowledge between partners in a collaborative manner and to facilitate engagement with sectoral experts and decision-makers.

About this project

The ACT-DDP research project is an international pilot project, which aims at accelerating the implementation of national and sectoral deep decarbonisation through a better dialogue between private companies and governments and for a mutual enrichment of their low-carbon strategies. Through the synergy between two pioneer initiatives, the Assessing low Carbon Transition (ACT) initiative and the Deep Decarbonization Pathways initiative (DDP), the project partners built and tested methodologies and tools for developing national and sectoral deep decarbonisation pathways compatible with the Paris Agreement and assessing company strategies with them.

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DDP MEXICO

DEEP DECARBONIZATION OF CEMENT PRODUCTION IN MEXICO

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The *Deep Decarbonization Pathway* (DDP) presented here indicates that Mexico can meet the objectives of the Paris Agreement, through profound structural transformations of the main economic sectors (See the paper "Deep decarbonization in Mexico"). This note presents the main transformations in cement production required by a decarbonization pathway, as well as how they differ from current trends and Mexico's climate stated commitments.

Decoupling cement production from GHG emissions is very important given how extensively used this material is at present, and will remain so in the future. A suite of interventions, ranging from new technology R&D and plant retrofitting, to changing consumer behaviours, construction practices and regulation, will have to be coordinated throughout the whole production-consumption-reuse chain.

Due to their central role and large industrial capacity, cement manufacturers are in a privileged position to lead on many of the transformations required in association with other sectorial actors. Doing so, would potentially bring enormous benefits to the sector and society, beyond reducing GHG emissions.

KEY FINDINGS

1. Decarbonization of cement production is technically possible, and must occur rapidly to ensure that Mexico reduces its emissions in line with the Paris goals and while it develops climate-resistant built environment and infrastructure.

2. This will require changes to optimise our use of concrete and increase its recycling to reduce the demand for new material.

3. Reducing the amount of clinker in cement from its current 90% level to 60% will help reduce the energy intensity of its production.

4. Focused R&D of incipient carbon capture technologies can make them commercially accessible so they can be retrofitted at scale to capture 30% of all emissions by 2030 and 85% by 2050.

A DEEP DECARBONIZATION PATHWAY FOR CEMENT PRODUCTION

The DDP trajectory, shown below, achieves a reduction of 77% of CO_2 emissions by 2050 vs the *Current Policy Scenario* (CPS) as the combined effect of interventions at five main levels: future demand of cement, clinker content, energy efficiency, carbon footprint of energy used, and capture of process CO_2 emissions. The reduction in carbon intensity per ton of cement produced is achieved in spite of a marginally increasing energy footprint that reflects an improvement on currently observed trends for the sector.

While cement is a widely used commodity and will remain so for the foreseeable future, we are already seeing changes in construction practices that reduce the amount of concrete used in buildings. The DDP explores a 15% reduction in the demand for new cement in 2050 vs the CPS as the combined effect of demand-side interventions. In the first place, better design and construction practices in the future require less concrete in new buildings than presently. Secondly, more efficient use of structures and recycling of cement from old buildings allow for a longer lifetime of cement already produced.

The amount of clinker in cement could be reduced to 60% to reduce both, the energy intensity of the final cement produced, and the CO_2 emissions originating in the clinker formation process. In Mexico, cement producers already operate at very high energy efficiencies. Substitution of clinker for other materials with a smaller energy footprint can help increase energy efficiency of the sector.

During the remaining clinker production, capturing CO_2 process emissions (currently close to 60% of the emissions from the sector) is crucial to achieve decarbonization. These emissions are also a source of high-purity CO_2 that can be used in other applications, sectors and markets.

Decarbonizing the energy employed in heat applications is the last main decarbonization measure. Gas, biomass & solar thermal energy largely replace petroleum coke and residual fuel oil (RFO) used in the calcination process (the potential of waste and biogas is yet to be explored in this scenario). In addition, the electrification of processes other than calcination partially substitute gas currently employed in them.

Figure 1. Annual CO2 emissions from cement 2015 vs 2050

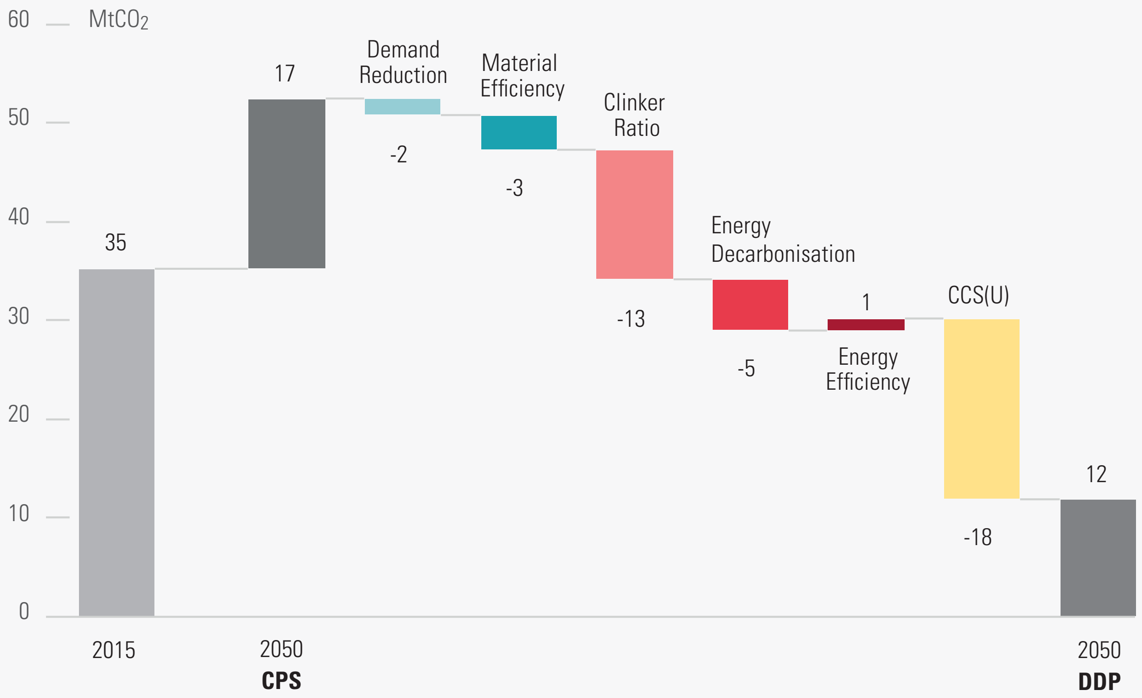
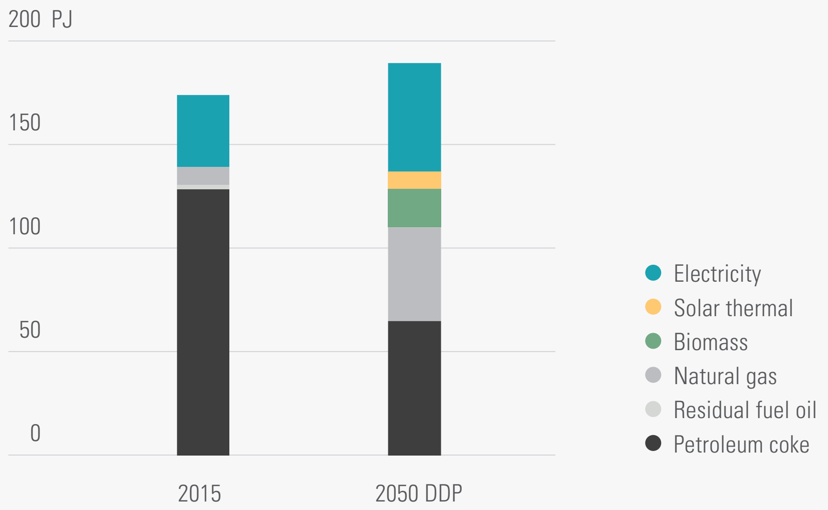


Figure 2. Final energy demand per fuel current vs DDP



CURRENT PATHWAY AND MAIN CHALLENGES

Cement production is one of the single sources with the highest emissions in Mexico, mainly due to the high energy intensity of the calcination process involved, the high carbon intensity fuels used to provide that energy, and the non-combustion CO_2 emissions that form as by-product in the same clinker manufacture process.

While representing only 0.15% of the country's GDP, cement production contributes with 4.5% of all GHG emissions, and demands 3% of all final energy. Historically, efforts have been made by manufacturers to increase their energy efficiency to gain a competitive advantage in a market with typically low-cost products. However, the preference for fossil fuels for high-heat applications has never ceased, and after a two-decade trend of migration from RFO (75.10 kg CO_2 per mmBtu) to petroleum coke, with an even higher carbon footprint (102.41 kg CO_2 per mmBtu), emissions have increased in the sector.

Additionally, 60% of the emissions are CO_2 that originates as a by-product in the calcination process to make clinker from limestone. Clinker is presently the main ingredient of cement with a clinker to cement ratio close to 90%. [F2]

In the CPS some currently observed trends are projected into the future. Construction GDP, the main driver behind projected cement demand, keeps its slow reduction in its share within the domestic economy. This does not mean the sector does not grow in the future, but only that it does so at a slower pace than the economy overall. In fact, under this reference scenario, production of cement is estimated to grow 60% in absolute terms in comparison to present levels. This estimation considers that the rate of recycling of concrete is kept at current levels (8% of annual demand).

The average sectorial energy intensity keeps its current increasing trend to reach 4.7 GJ/ton of clinker produced in 2050. Petroleum coke also keeps its predominant role as fuel in the future, with gas in a second place, and a marginal share of renewables. The resulting CO_2 emissions of the CPS increase by 49% in 2050 in comparison to 2015.

Figure 3. Cement production in Mexico

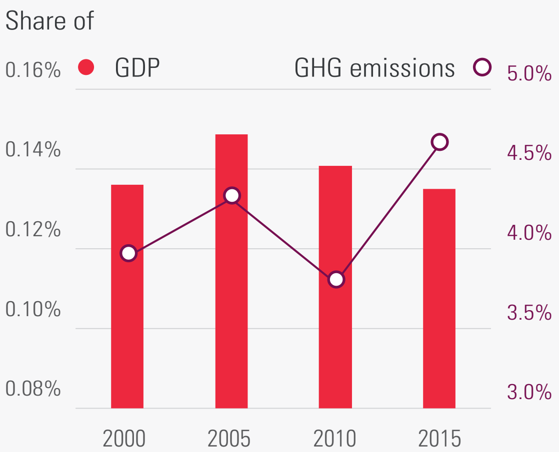
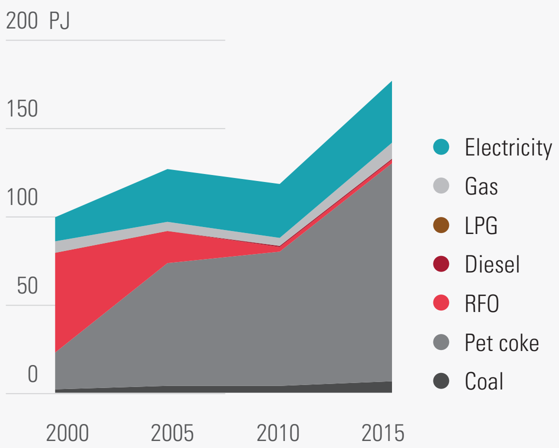


Figure 4. Energy demand per fuel



HOW TO KICKSTART DEEP DECARBONIZATION?

1. Decarbonization plans must ensure they align with, and contribute to, Mexico's economic and social development aspirations. For most sectors this will mean redirecting investment, reducing some activities while increasing others, and generally decoupling natural resource use from economic value-add. In this manner, Mexico's gradual population growth can sustain economic growth and improved productivity and quality of life across the board without a corresponding increase in per-capita energy consumption, while rapidly reducing emissions.

2. Decarbonizing the cement production process will not suffice to reach net-zero emissions in the sector, and increasing material efficiency as well as more and higher value recycling will also be needed to manage future demand of concrete. This is especially true in Mexico, where large-scale manufacturers have already captured opportunities for energy efficiency. Increasing material efficiency will need innovation in design for material substitution, longer lifetimes for structures, ease of deconstruction, reuse, and recycling when the useful life ends. All these changes, in turn, require strong engagement and communication throughout the production-consumption-reuse-recycle chain – designers, builders, manufacturers, users, and demolition companies – in order to create the adequate regulation.

3. R&D collaboration efforts between cement manufacturers and researchers could be very positive to advance technological key areas such as the development of new construction products (walls and ceilings, for example) with reduced amount of concrete; the substitution of clinker for other materials that provide similar performance but lower energy and carbon footprints; the CO_2 capture from the calcination process and retrofit at scale of legacy plants.

4. Government leadership will be important to crystallize and standardize new tools for design optimization of cement in buildings and infrastructure, to reform building codes, and to develop best practices that encourage material efficiency and longevity. It will also be key in providing valuable technical information, such as the mapping and planning of injection reservoirs and transmission infrastructure for captured CO_2.

5. Cement manufacturers can also provide valuable insight in the creation of lead markets for low carbon cement and concrete products, for example in guarantee contracts for public works or in large private projects. As we build the strategic climate-resilient infrastructure needed in the future, opportunities for niche markets for low carbon cement products should be opened.

6. Internalization of the environmental costs of cement production to address current price distortions that make incumbent high-carbon high-energy alternatives low-cost in comparison to low-carbon technologies will probably happen through a carbon tax (already in place but limited in Mexico). This could be combined with the removal of current energy subsidies to send the appropriate long-term signal to investors. Clear policy targets will help cement companies align their investment plans and commercial strategies to achieve those goals.

7. Last but not least, will be the need to create a whole new industry to inform the sector transition and to facilitate decision-making, for example, for workforce retraining or for assessment of life cycle wide impacts of materials, products and techniques.

OPPORTUNITIES OF THE TRANSITION

The transition of the cement production to sustainability will present attractive potential opportunities in the sector. Change is already happening in the construction industry, and cement manufacturers can capitalise on it by leading change forward to reach climate goals by 2050 while increasing value in the sector. Beyond the reduction in costs stemming from a resource-efficient economy, the structural depth of the transition presents a real opportunity to underpin future development and competitiveness by advancing a domestic high-value knowledge-based socio-economic model.

ECONOMIC GROWTH

- Increased resource and energy efficiency along with a more skilled labour force enhance manufacturers' international competitivity.
- Innovation to new business models (materials as a service and hybrid property-vs-use models) and new product-service niches of higher value.
- A national investment programme in green infrastructure, with its higher and dedicated investment and public spending, could be the niche that can make green cement go mainstream. Public procurement could involve specifications of low carbon cement or contracts for difference that provide higher prices.
- Access to potential new markets for energy-related services and carriers, such as zero-carbon liquid fuels synthetized from hydrogen and CO_2.

ENERGY SECURITY

- Enhanced energy security by diversification of sources, decoupling of oil prices (although gas remains relevant within the matrix).

SOCIAL DEVELOPMENT

- Higher investment and public spending present a basis for increasing public services and reducing poverty and inequality.
- Opportunities in new sectors and the evolution to a knowledge-based economy stimulate education, labor markets, and create opportunities (green jobs) for more people.

PUBLIC HEALTH

- Change to a cleaner fuel mix helps improve health of workers and communities near cement production plants.
- A low-carbon climate resilient built environment directly improves the quality of life of citizens and reduces their vulnerability to climate change impacts.

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