Pathways to Paris: Latin America

Technology and Policy Options to Reduce GHG Emissions

Massachusetts Institute of Technology

2018

https://globalchange.mit.edu/research/research-projects/pathways-paris

Main Takeaways – LAM Challenge

For the Paris Agreement process…

- **The Latin American (LAM) countries** pledge to reduce their emissions through 2030 and introduce numerous policies to fulfill their pledges.
- While the LAM countries have shown **impressive growth in renewables generation**, they face the challenge of enhancing regulatory and policy frameworks to **encourage private investment in clean energy projects**, with the goal of further reducing their GHG emissions.
- This **report** offers a discussion of **policy** and **technology options** in the energy sector that can assist LAM countries' in achieving their emission mitigation targets.
- *Focus on ten countries: Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Panama, Peru, Uruguay, Venezuela. Deep dive for two countries: Argentina and Colombia.*

Main Takeaways – Emissions Gap

The **"emissions gap"** is the needed reduction beyond planned policies to meet the Paris pledges.

The LAM region emissions gap

- About **70 $MtCO_2e$** under **UNCONDITIONAL pledges.** The LAM region will have to reduce emissions by **2%** in 2030 relative to its policy trajectory.
- About **350 $MtCO_2e$** under **CONDITIONAL pledges** (i.e., subject to more ambitious global efforts and technology and financial transfers). The LAM region will have to reduce emissions by **10%** in 2030 relative to its policy trajectory.

In aggregate, the LAM region is making strong progress towards its Paris goals with **government-led efforts** to increase the use of renewables and natural gas.

Individually, while some countries are projected to be close to or to even over-achieve their goals for 2030, others need **substantial additional efforts**.

Main Takeaways – Policy and Technology Options

There are many **policy** and **technology options** to reduce the emissions gap. We **recommend**:

Policy Options

- **Carbon pricing** through taxes or cap-and-trade systems tends to be the most cost-effective option but can be politically challenging to implement.

- **Other policy instruments** are therefore needed to promote clean technology, such as:
  - Renewable energy auctions
  - Support to natural gas infrastructure development for countries with large coal use

Technology Options

- **Wind** and **solar** generation provide attractive options for lowering emissions.

- **Natural gas** promotes lower-carbon power generation and enables higher penetration of intermittent renewables by serving as backup capacity.

Main Takeaways – Economy-Wide Analysis

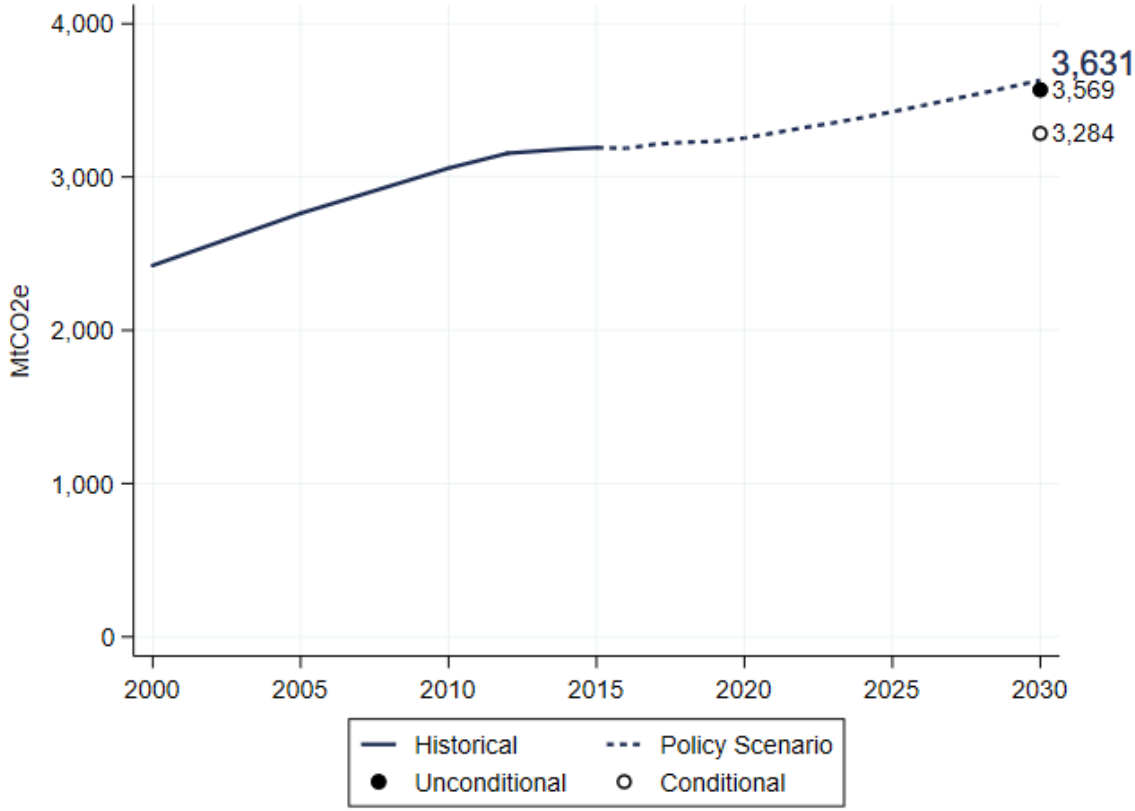
We perform a "deep-dive" (economy-wide) analysis for Argentina and Colombia to assess the economic impacts of meeting their NDC pledges.

In meeting conditional emissions and renewables targets…

- **The GDP cost in Argentina is 0.17%** relative to GDP in a business-as-usual scenario in 2030.
- **The GDP cost in Colombia is 0.50%** relative to GDP in a business-as-usual scenario in 2030.

The economy-wide analysis also illustrates that regulations (e.g., a RPS) **are more costly** than market-based measures.

LAM countries face the challenge of enhancing regulatory and policy frameworks to encourage private investment in clean energy projects, with the goal of further reducing their GHG emissions.



Gap from Policy scenario in 2030:
Unconditional – 2%
Conditional – 10%

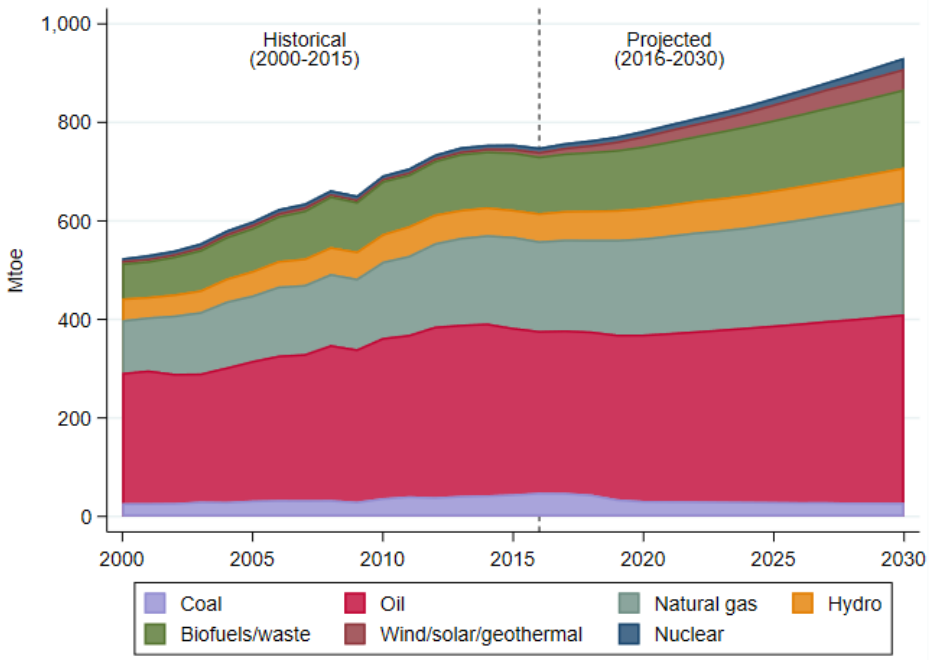
Numerous policy and technology options are available to close the gap.

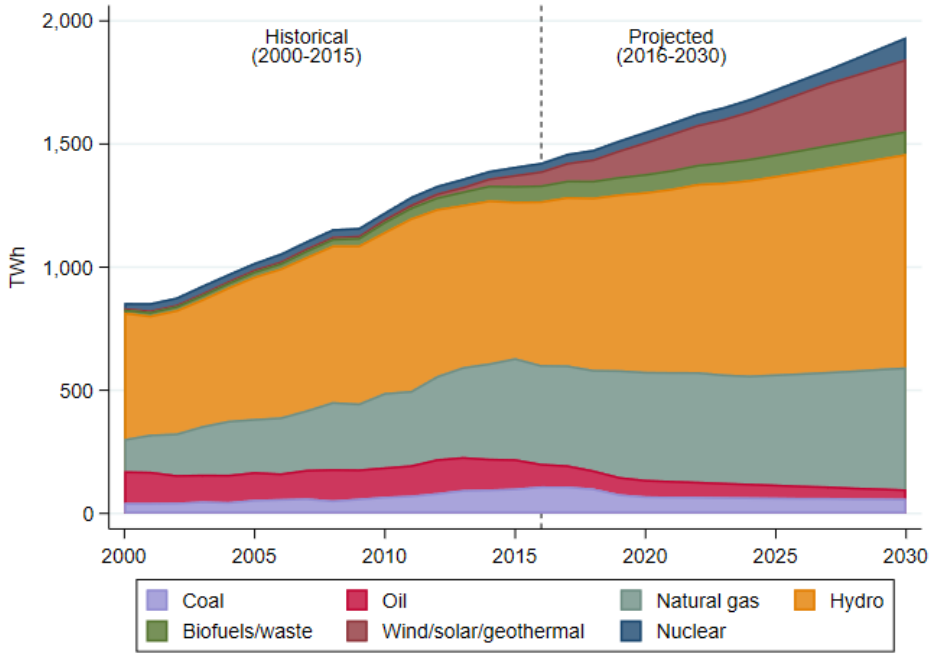
Source: MIT analysis

NDC Pledges and Resulting Emissions

Country	Policy Scenario Emissions (MtCO2e)	Modeled Target			Gap from Policy Scenario	
		Type	*Description*	*Emissions (MtCO2e)*	*Emissions (MtCO2e)*	*Percent of Policy Scenario*
Argentina	459	Unconditional	Total emissions cap of 483 MtCO2e in 2030	483	-24	-5%
		Conditional	Total emissions cap of 369 MtCO2e in 2030	369	90	20%
Brazil	1,468	Unconditional	43% reduction in emissions in 2030 (relative to 2005)	1,692	-224	-15%
		Conditional	None - same as unconditional	1,692	-224	-15%
Chile	128	Unconditional	30% reduction in emissions intensity of GDP in 2030 (relative to 2007)	136	-8	-6%
		Conditional	35% reduction in emissions intensity of GDP in 2030 (relative to 2007)	126	2	2%
Colombia	183	Unconditional	14% reduction in emissions in 2030 (relative to Baseline scenario)	169	14	8%
		Conditional	27% reduction in emissions in 2030 (relative to Baseline scenario)	144	40	22%
Ecuador	85	Unconditional	20.4% reduction in energy emissions in 2025 (relative to Baseline scenario)	69	16	19%
		Conditional	37.5% reduction in energy emissions in 2025 (relative to Baseline scenario)	54	31	36%
Mexico	789	Unconditional	18% reduction in emissions in 2030 (relative to Baseline scenario)	757	32	4%
		Conditional	32% reduction in emissions in 2030 (relative to Baseline scenario)	628	161	20%
Panama	19	Unconditional	None - same as Baseline scenario	23.4	--	--
		Conditional	Increase share of renewables in generation by 15 percentile points in 2030 (relative to 2014)	22.8	-4	-20%
Peru	137	Unconditional	20% reduction in emissions in 2030 (relative to Baseline scenario)	139	-2	-1%
		Conditional	30% reduction in emissions in 2030 (relative to Baseline scenario)	133	4	3%
Uruguay	53	Unconditional	27%/62%/51% reduction in CO2/CH4/N2O emissions intensity of GDP in 203 (relative to 1990)	54	0	-1%
		Conditional	31%/63%/57% reduction in CO2/CH4/N2O emissions intensity of GDP in 2030 (relative to 1990)	51	3	5%
Venezuela	309	Unconditional	None - same as Baseline scenario	366	--	--
		Conditional	20% reduction in emissions in 2030 (relative to Baseline scenario)	293	16	5%
LAM	**3,631**	**Unconditional**	--	**3,569**	**62**	**2%**
		Conditional	--	**3,284**	**347**	**10%**

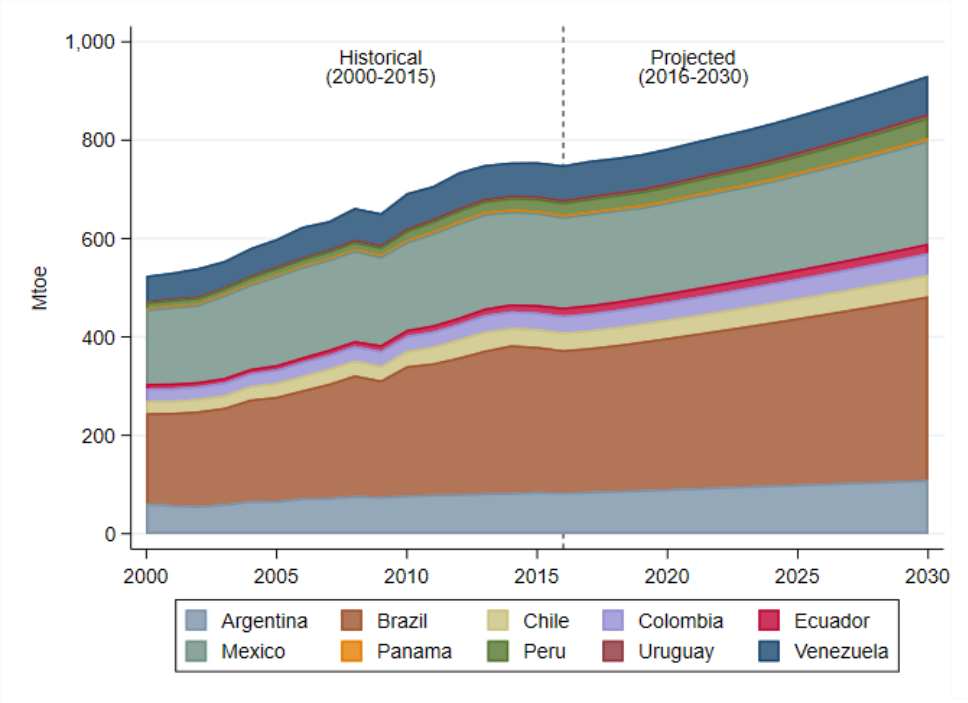
LAM Primary Energy and Electricity by Type

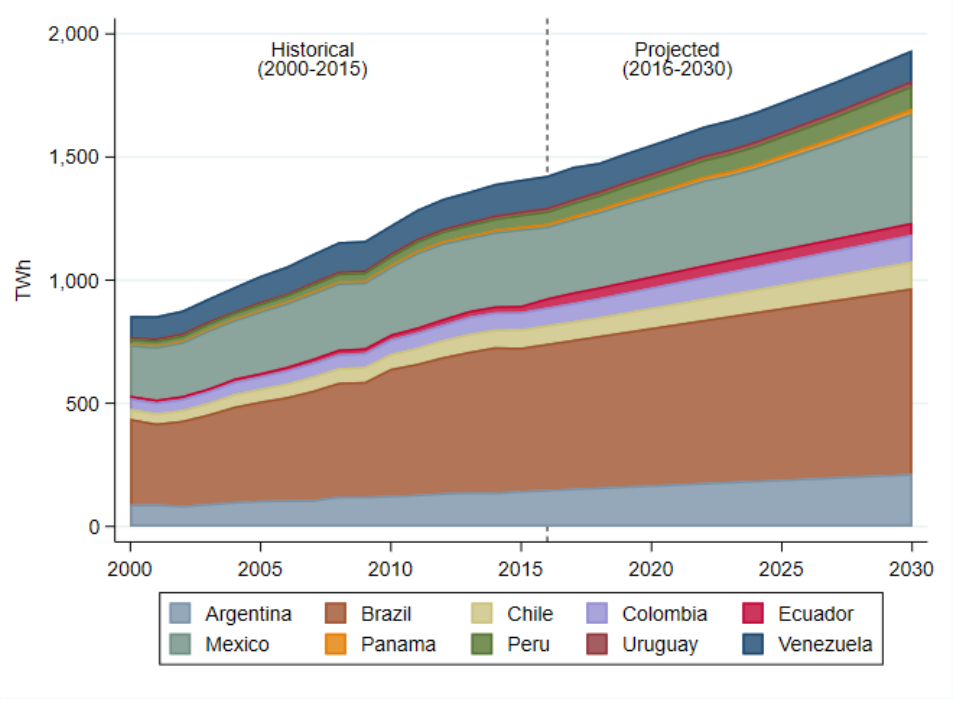




Solar and wind generation is expected to **grow about 550%** between 2015 and 2030 while generation from fossil fuels will **decrease by 3%.**

LAM Primary Energy and Electricity by Country

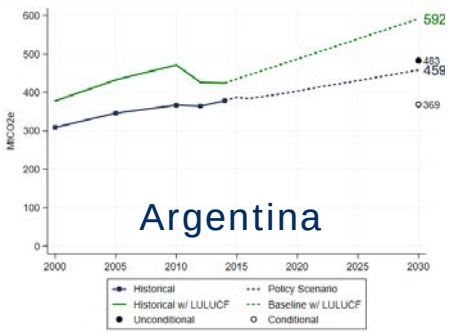


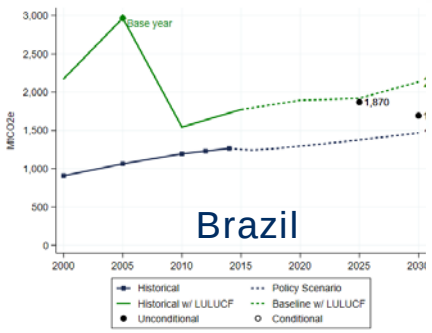


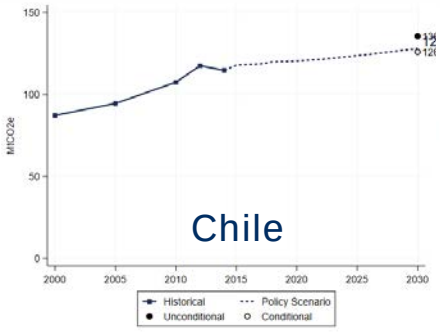
Increase in primary energy and electricity in all LAM countries

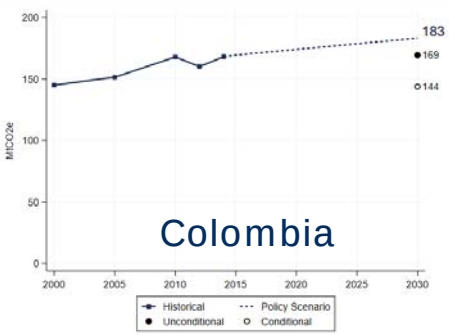
Country-specific analysis (Illustrative – see Report for details)

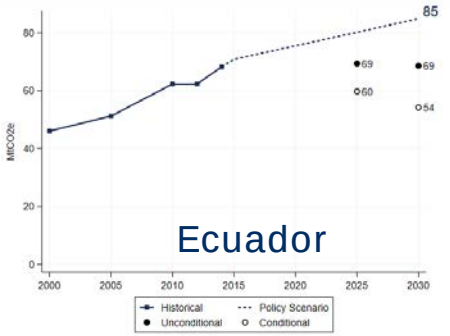
Projections of Energy, Electricity, Emissions - The resulting unconditional and conditional gap

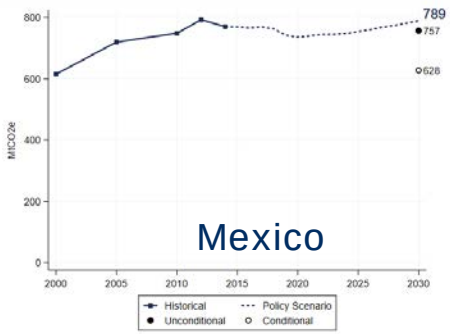


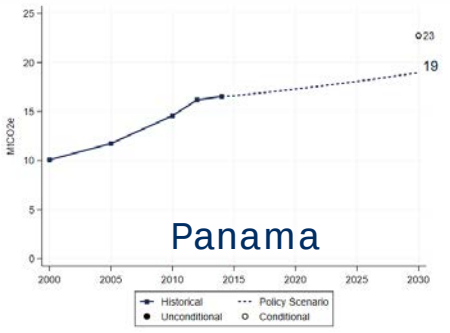


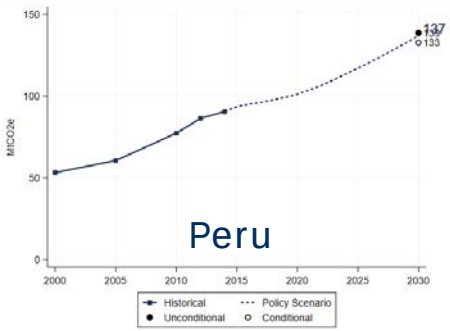


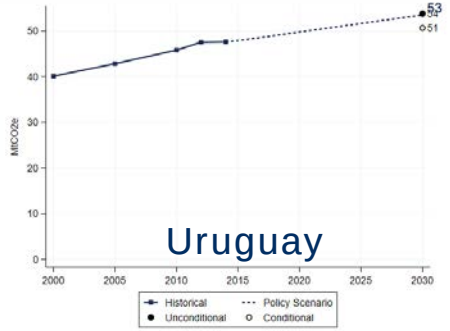


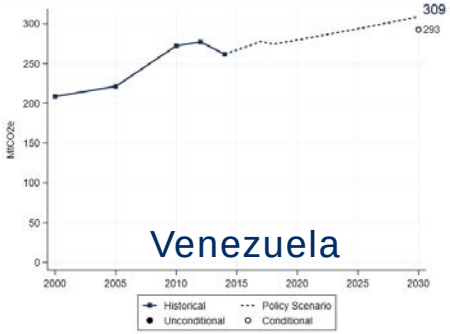












Technology Options

CATEGORY		EXAMPLES
TIER I: Building and Retrofitting Power Plants	**Less Capital-Intensive**	Natural gas
		Wind and solar
		Renewables more limited by geography (e.g. small-scale hydro, pumped hydro, waste, geothermal, and tidal/wave)
	More Capital-Intensive	Nuclear and large hydro
TIER II: Improving Efficiency and Optimization		Higher efficiency power plants (e.g. ultra-super critical coal plants)
		Higher utilization of the currently installed lower-carbon generation technologies
		Digitalization applied to both the production and consumption sides
TIER III: Enhancing Market and Network Organization		Options to enable distributed generation
		Time-of-day pricing
		Improved integration of renewables (e.g. new transmission lines, virtual power plants, microgrids, tools for better citing and forecasting of wind and solar farms)
		Battery energy storage
TIER IV: Options with Potential Sustainability Issues		*Large scale biomass-based options*
TIER V: Options for Future Consideration		*Carbon capture and storage (CCS), advanced nuclear, advanced energy storage (e.g. generating hydrogen with renewable power)*

Policy Options and Instruments

CATEGORY		EXAMPLES
Price Controls		Carbon tax
		Non-fiscal price support measures (e.g. feed-in tariffs, feed-in premiums, generation-based direct payments)
Quantity Controls	**With Trading**	Emissions trading (cap-and-trade and baseline-and-credit schemes)
		Green/white certificate schemes (e.g. renewable portfolio standards with trading, energy efficiency certificate trading)
	Without Trading	Renewable energy auctions
		Performance standards
Technology Controls		Technology standards
		Permitting and licensing requirements
(Fiscal) Subsidies		Grants
		Credits and rebates (e.g. production and investment tax credits, reduction in energy and other taxes)
		Depreciation rules
		Loan guarantees
Suasive Instruments		Labeling and information
		Mandatory audits
		Energy management/Corporate Social Responsibility (CSR) systems
Planning Instruments		National action plans, programs, and strategies
		Resources and infrastructure planning (e.g. resource mapping, siting and zoning, and grid integration planning)

Structure of the Report

Executive Summary

Section I	Introduction
Section II	Pledges of the LAM countries for the Paris Agreement process
Section III	Projected LAM Energy and Electricity Profiles out to 2030
Section IV	Policy and Technology Options for LAM to Reduce Emissions
Section V	Country-level studies (Energy, Electricity Generation, Emissions, Policies and Measures)
Section VI	Economy-wide analyses for Argentina and Colombia
Section VII	Experience in other regions with policy measures to reduce emissions

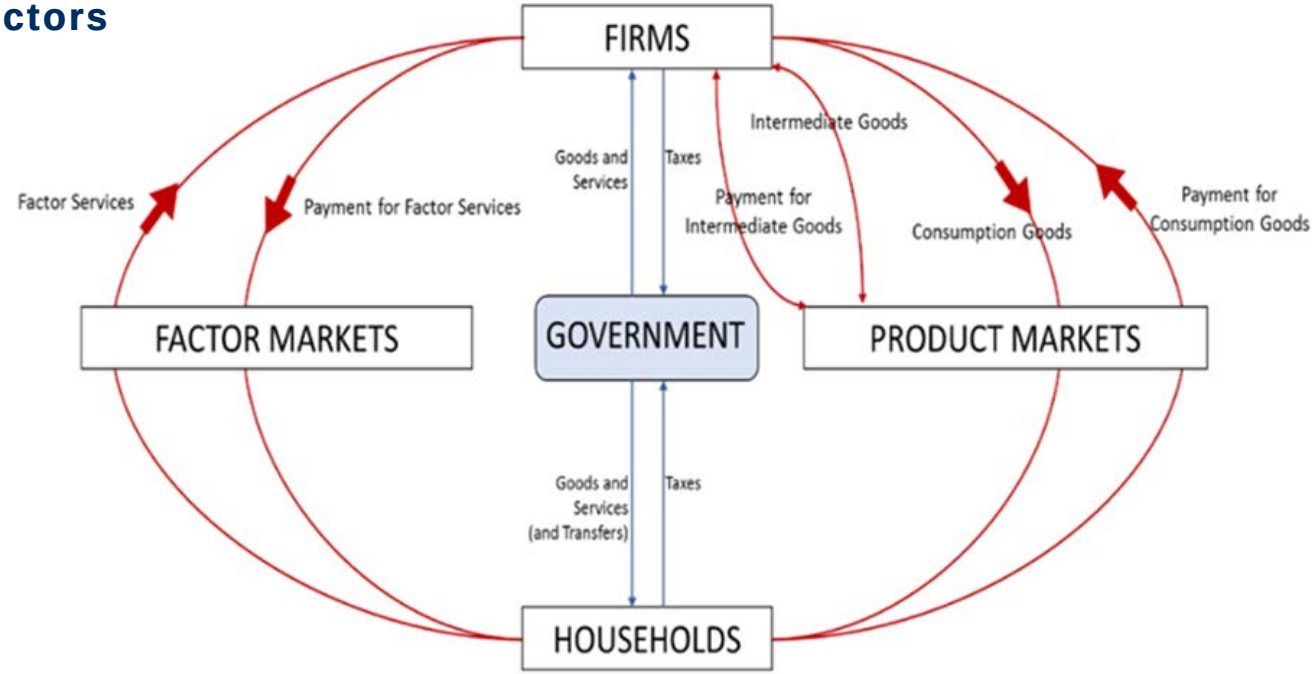
References

Appendices

Economy-Wide (AGE) Modeling

Deep-dive analysis: one "business-as-usual" (BAU) and five policy scenarios

- No climate policy (BAU)
- Renewable portfolio standards (RPS)
- Meeting conditional targets **with RPS** and ETS coverage of **all sectors**
- Meeting conditional targets **with RPS** and ETS coverage of **selected sectors**
- Meeting conditional targets **without an RPS** and with ETS coverage of **all sectors**
- Meeting conditional targets with **increased adoption of digitalization** and ETS coverage in **all sectors**



Main Quotes - Overview

Main takeaways on…

…the role of the energy sector.

"While eventually emission reductions will need to come from all sectors of the economy, the energy sector offers a significant opportunity to obtain reductions using available technology and policy solutions at a relatively low cost."

…low-carbon generation.

"…wind and solar generation provide the most attractive options for lowering emissions."
"…further development of natural gas infrastructure would enable higher penetration of intermittent renewables by serving as backup capacity."

…the importance of well-designed policies.

"Policy frameworks are the key to determine a nation's ability to incentivize the deployment of new technologies, attract private capital, internalize externalities (such as the health effects of air pollution), modernize electricity transmission and distribution, and expand access to energy."

Main Quotes – Energy Profile

A view of the 2030 LAM energy profile through…

…total primary energy supply (TPES).

"We project that the main components of the LAM primary energy supply in 2030 will be of oil (41% of total primary energy), natural gas (24%) and biofuels (17%)."

…electricity generation.

"…the main sources of generation in 2030 are projected to be hydro (45% of total generation), natural gas (26%), and… renewables such as wind and solar (15%)."

…the role of renewables.

"Solar and wind generation in the LAM region is expected to grow about 550% between 2015 and 2030 while generation from fossil fuels will decrease by 3%. As a result, the share of electricity generated from fossil fuels will decrease from 45% in 2015 to 31% in 2030."

Main Quotes – Policy Options

Key policy takeaways on…

… energy sector subsidies.

"The reduction and eventual elimination of energy subsidies leads to the correction or removal of distortions in costs and prices that inform the decisions of producers, investors, and consumers."

…the advanced policy options.

"For the LAM countries with more advanced administrative and technical capacities, we recommend carbon pricing through taxes or quantity controls with tradeable emission permits because they offer the greatest economic efficiency benefits."

… supporting wind and solar.

"For countries where a carbon tax or emission trading is not currently feasible, we recommend an initial focus on technology-specific policies such as renewable energy auctions and renewable portfolio standards."

Main Quotes – Technology Options

Key technology takeaways concerning…

…energy transition.

"Energy transition can be achieved by investments in less-carbon-emitting technologies (like natural gas, wind, solar, hydro, nuclear), technologies that improve energy efficiency (like digitalization), and technologies that enable better network organization and integration of renewables…"

…emission reduction from all sources rather than favoring any particular technology.

"Despite substantial progress in bringing down costs of certain types of low-carbon power generation, the considerable uncertainty about the future costs of different technologies and the challenges for their integration to the system necessitates a flexible approach."

…digitalization and energy management.

"We also recommend a wider use of technologies that enable energy efficiency improvements, both in the construction of more efficient power plants and through the use of digital technology to improve existing supply- and demand-side processes and incorporate new methods of energy transformation, delivery and usage processes such as Microgrid, Virtual Power Plant, storage and distributed energy management."

Main Quotes – Economy-Wide Analysis

Insights from the deep-dive analysis on…

…emission reduction targets in Argentina and Colombia.

"Targets for renewable electricity (including planned increases in electricity from nuclear and hydro) combined with business as usual efficiency improvements are sufficient to meet unconditional pledges in Argentina and Colombia. In both countries, more-stringent conditional emission targets can be achieved with moderate additional policies."

…sectoral coverage of climate policies.

"…if the emission trading only includes electricity and energy-intensive sectors, the required carbon price is much larger and the GDP costs are much greater… This is because emissions from electricity and energy-intensive sectors only account for… (a small portion) of total emissions, so a large proportional reduction in emissions from these sectors is required to meet the economy-wide emissions target."

Main Quotes – Economy-Wide Analysis for Argentina

…policy and technology options in Argentina.

"Although a renewable portfolio standard (RPS) to meet non-fossil electricity generation targets lowers the carbon price, it increases the GDP cost of reducing emissions. For example, when meeting Argentina's conditional emission reduction pledge using an all-sectors emission trading system (ETS), removing the RPS increases the carbon price from \$2.7/tCO_2e to \$16.7/tCO_2e and deceases the reduction in GDP from 0.17% to 0.06%."

"Increased adoption of digitalization in electricity generation lowers the cost of meeting emission reduction targets. For example, when a RPS and an economy-wide ETS is used to meet Argentina's conditional target, digitalization lowers the reduction in GDP from 0.17% to 0.08%."

"Future emissions growth in Argentina will largely center in the energy sector. Rapid growth in electricity demand and related power sector emissions, coupled with a relatively ambitious NDC, offer a significant opportunity for renewable energy deployment."

"Abundant shale gas reserves offer an opportunity to simultaneously address energy security concerns and provide a dispatchable, lower-carbon bridge fuel to balance the growing share of renewables in electricity generation until battery storage is economically more viable."

Main Quotes – Economy-Wide Analysis for Colombia

…policy and technology options in Colombia.

"Colombia's conditional emissions pledge can be achieved with moderate additional policies. For example, when non-fossil electricity targets are met using an RPS, the addition of an all-sectors ETS that caps emissions at the level consistent with Colombia's conditional pledge results in a carbon price of $2.9/tCO$_2$e and increases the reduction in GDP from 0.495% to 0.500%."

"Increased adoption of digitalization in electricity generation lowers the cost of meeting emission reduction targets. For example, when a RPS and an economy-wide ETS is used to meet Colombia's conditional target, digitalization reduces the reduction in GDP cost from 0.500% to 0.477%."

"As renewable energy technologies decline further in price, Colombia should consider reducing and eventually phasing out fiscal subsidies for all energy sources while extending carbon pricing..."

"Aside from renewable energy sources, this can also improve the prospects for development of the country's significant, but largely untapped, natural gas reserves..."

Report Approach

"Our assessment is unique in providing a gap analysis that ***covers both large and small Latin American economies***

and ***clearly documents*** *the data and assumptions associated with our calculations.*

We hope the open source format of our input data and tools for analysis will enhance the capacity ***to analyze the Latin America countries' pathways*** *in meeting their emission mitigation goals."*

Questions or comments about the report?

Please contact Sergey Paltsev at paltsev@mit.edu