SUMMARY OF KEY FINDINGS

ZERO CARBON

LATIN AMERICA AND THE CARIBBEAN

2019

The coupled decarbonization of the power and transport sectors in Latin America & the Caribbean

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"…on going pathway…will lead to significant disruptions of ecosystems, society and economies…" Letter from 11,000 scientists from 84 nations Dec 2019

"..no avenues left other than full decarbonization to avert major irreversible impacts on our biosphere..." IPCC 2019 Special Report on Global Warming 1.5 °C

"…1.5°C almost Impossible" without deeper and faster Cuts…" UNEP Emissions Gap Report 2019

"…leaving an inhabitable planet to future generations is first and foremost up to us…" Pope Francis, *Laudato Si*

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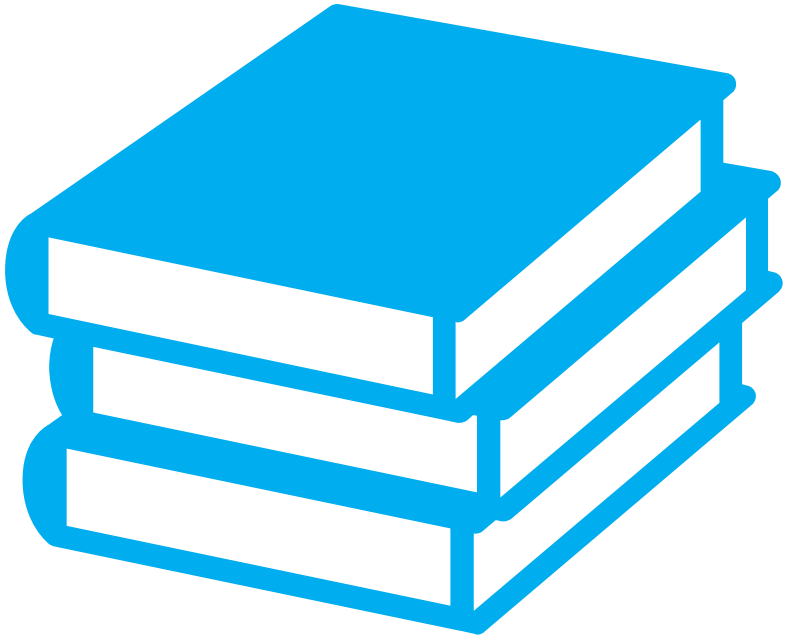
Coupled decarbonization of power generation and transport:
Opportunity, cost and benefits

Methodology

Based on available information in the technical literature and industry data.

Baseline based on Global Change Assessment Model (GCAM v5.1.3) created and maintained by the Global Change Research Institute of the University of Maryland & Pacific Northwest Laboratory

Projected costs using the Greenhouse Gas Abatement Model (GACMO) created and managed by UNEP/DTU partnership



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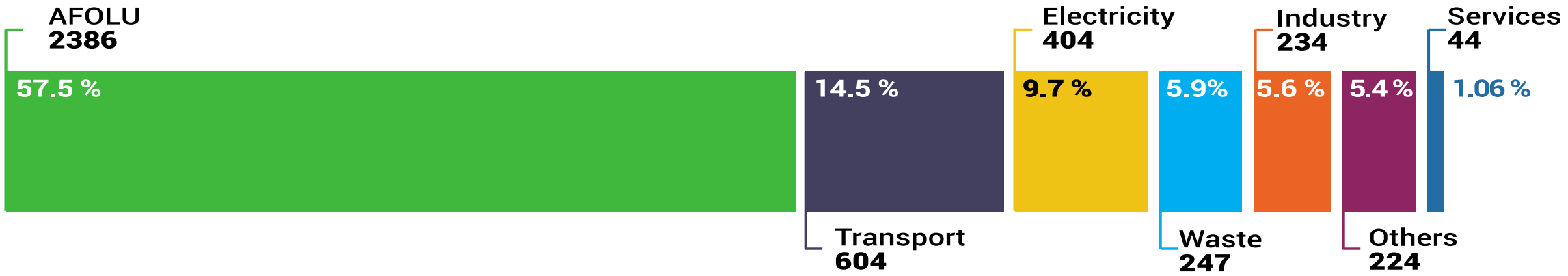
Emissions of the power and transport sector

Region's carbon footprint in 2018



Power and transport (2018):

67% fossil GHG

25% all GHG

Source: GACMO, consulted, October, 2019; CAIT, Climate Data Explorer, for fugitive emissions and bunker fuels, included as others, http://cait.wri.org and GFW for deforestation rate of 3.2 M ha of primary forest in 2018

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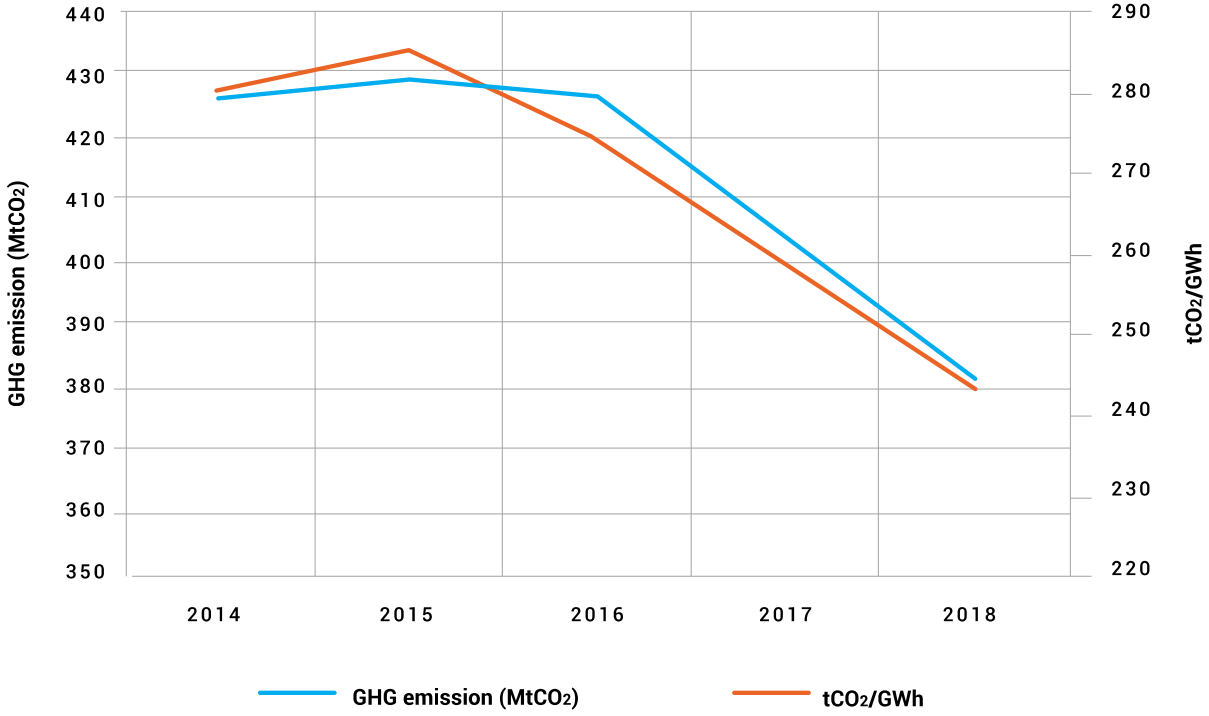
Power sector is already low carbon and moving toward even lower GHG emissions

57 GW added (2012 – 2018)

53% hydro

47% unconventional renewables

Non-conventional renewables X2 has reduced tCO2/GWh in 15%



Source: Based on data from ENERDATA, accessed August, 2019

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BAU SCENARIO

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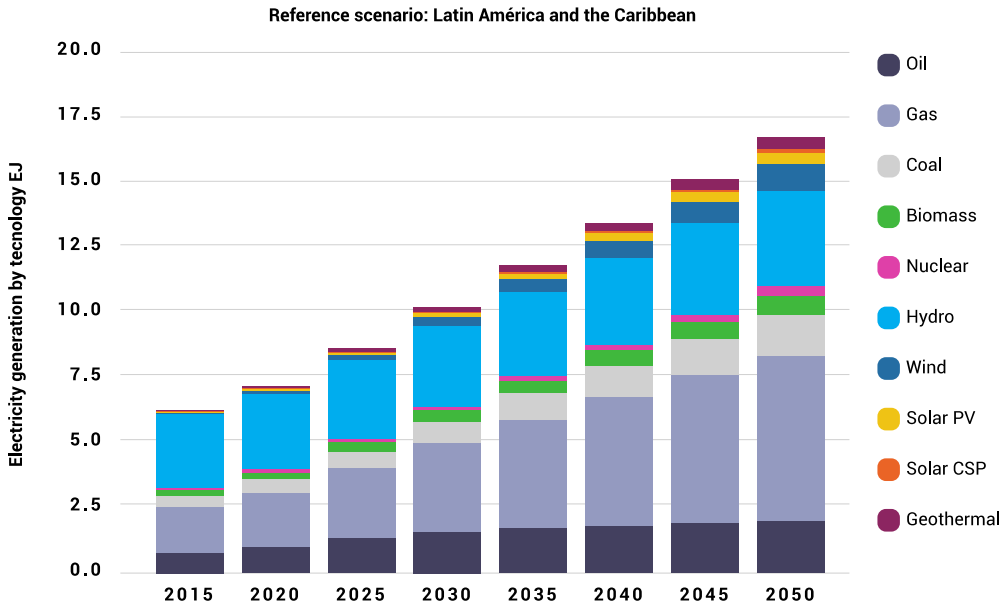
Projected demand for transport and sector under BAU scenario

Power sector

Projected demand 16.7 EJ

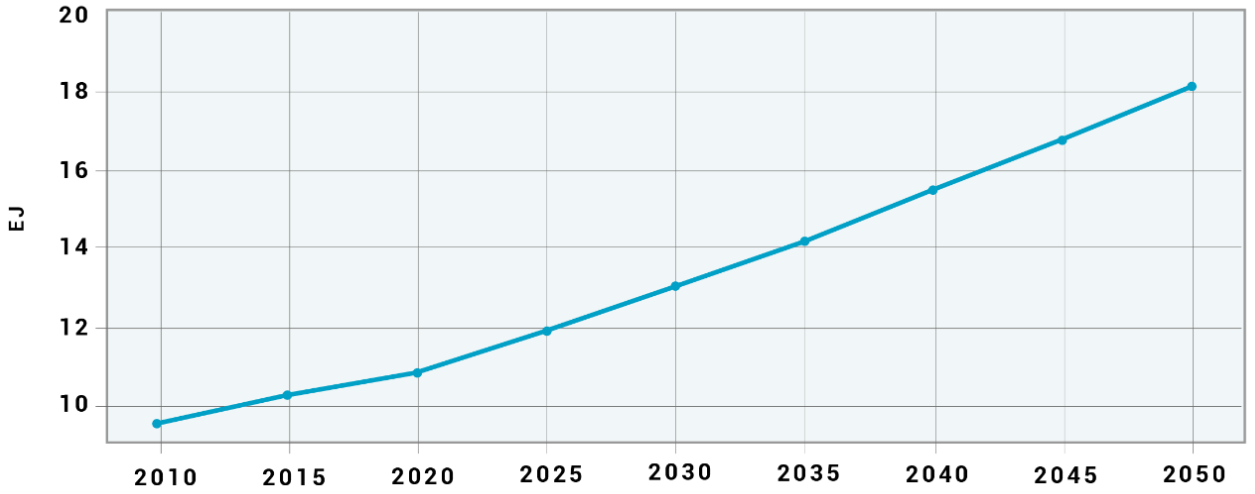
Investment: US$ 1083 billon



Transport sector

Projected demand 18 EJ

83% gas & diesel



Source: As projected under GCAM BAU outputs, August 2019

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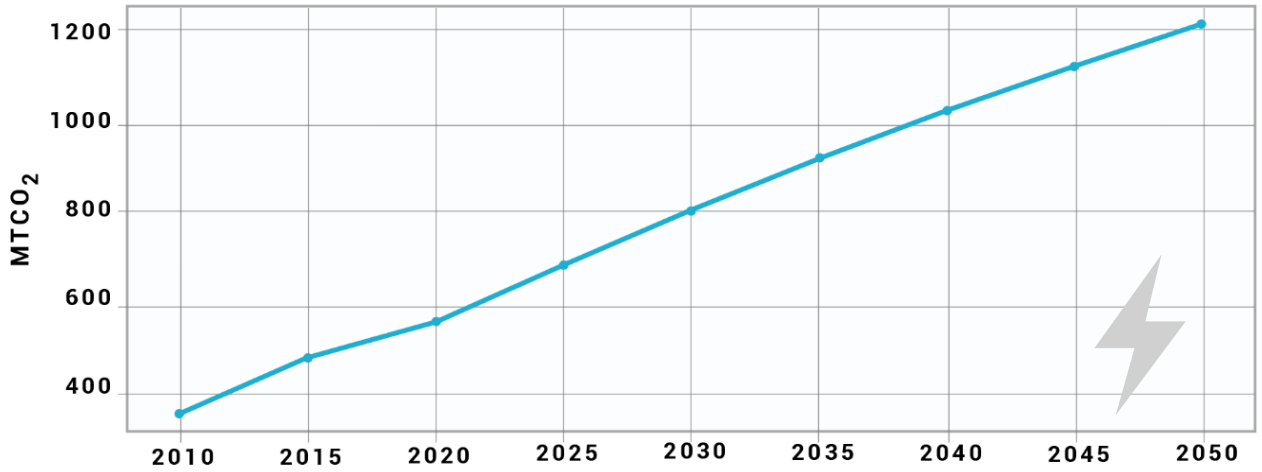
Current trends are not enough to get to zero emissions by 2050

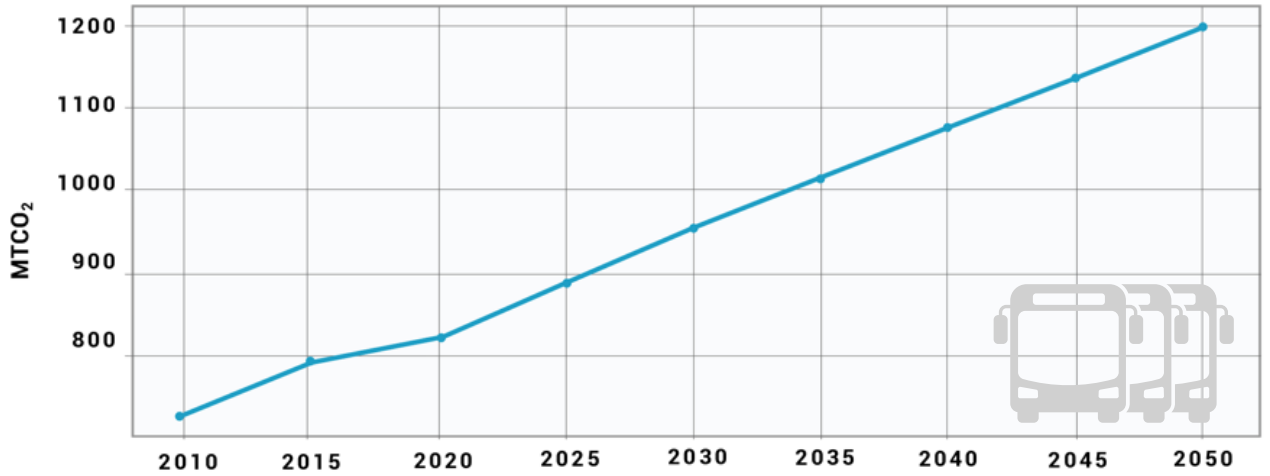
x2 emissions by 2050 BAU

Source: As projected under GCAM BAU outputs, August 2019

Power sector



Transport sector



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FAVORING CONDITIONS
FOR A COUPLED TRANSITION

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The region has a world-class endowment of renewable energy resources

SOLAR ENERGY
· *Atacama Desert*
Potential generation: 2700 GW
(with 10% of area under use)

· *Sonora Desert*
Potential generation: 4,940 GW
(with 10% of area under use)

HYDROPOWER ENERGY
· *All countries particularly the Andes and the Amazon basin*
Potential generation: 675 GW

MARINE ENERGY
· *Southern Pacific Coast*
Potential generation: 200- 240 GW

GEOTHERMAL ENERGY
· *Andes Cordillera and Central American Cordillera*
Potential generation: 44 GW

OFF-SHORE WIND ENERGY
· *The entire region has 50,000 Km of coastline*
Potential generation : 1,300 GW (Brazil)

WIND ENERGY
· *High southern latitudes*
Intensity: 600-1300 W/m^2

· *Southern Atlantic Coast*
Intensity: 100-450 W/m^2

· *Brazil coastal and northeastern areas*
Potential generation: 500 GW

· *Guajira Peninsula*
Intensity 10 GW

· *Isthm of Tehuantepec*
Potential generation: 30 GW

· *Southern Atlantic Coast*
Intensity 100-450 W/m^2

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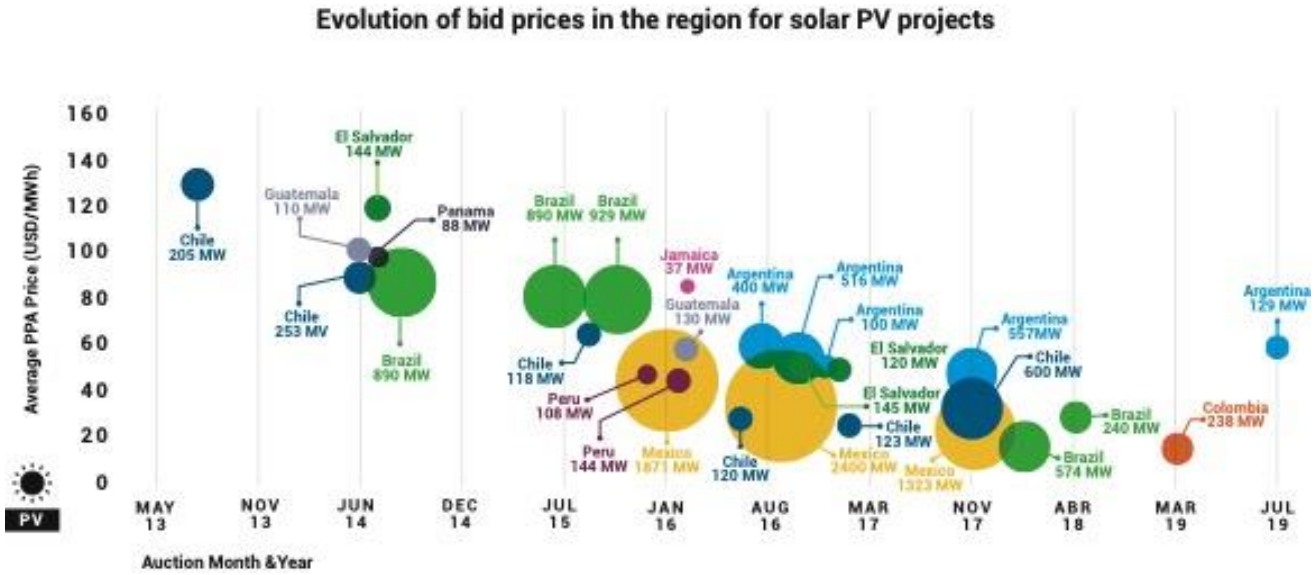
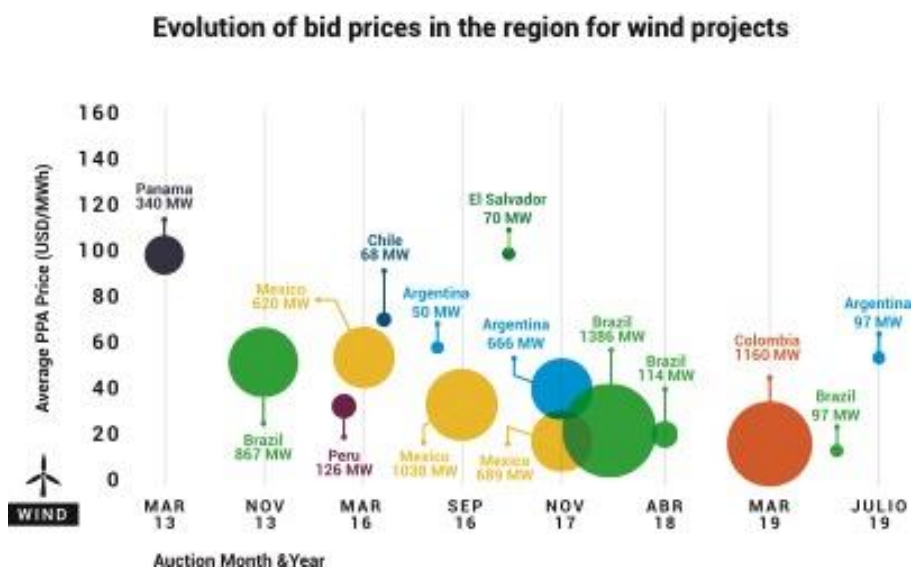
Auctioned prices for wind and solar have fallen by more than 80% (2013-2019)



Source:Based on data from Nagendran S., 2017 and industry data.



Source:Based on data from Nagendran S., 2017 and industry data.

The generation cost of electricity from unconventional renewables in the region is already very competitive and costs are falling fast

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Cheapest source of new bulk power generation on a LCOE basis for the LAC region, 2H 2019

Considering purely economic grounds it is difficult to justify investments for power generation using fossil fuels in some LAC economies.

Source: Adapted from BNEF. This map shows the technology with the lowest benchmark LCOE in each market, excluding subsidies/tax credits.

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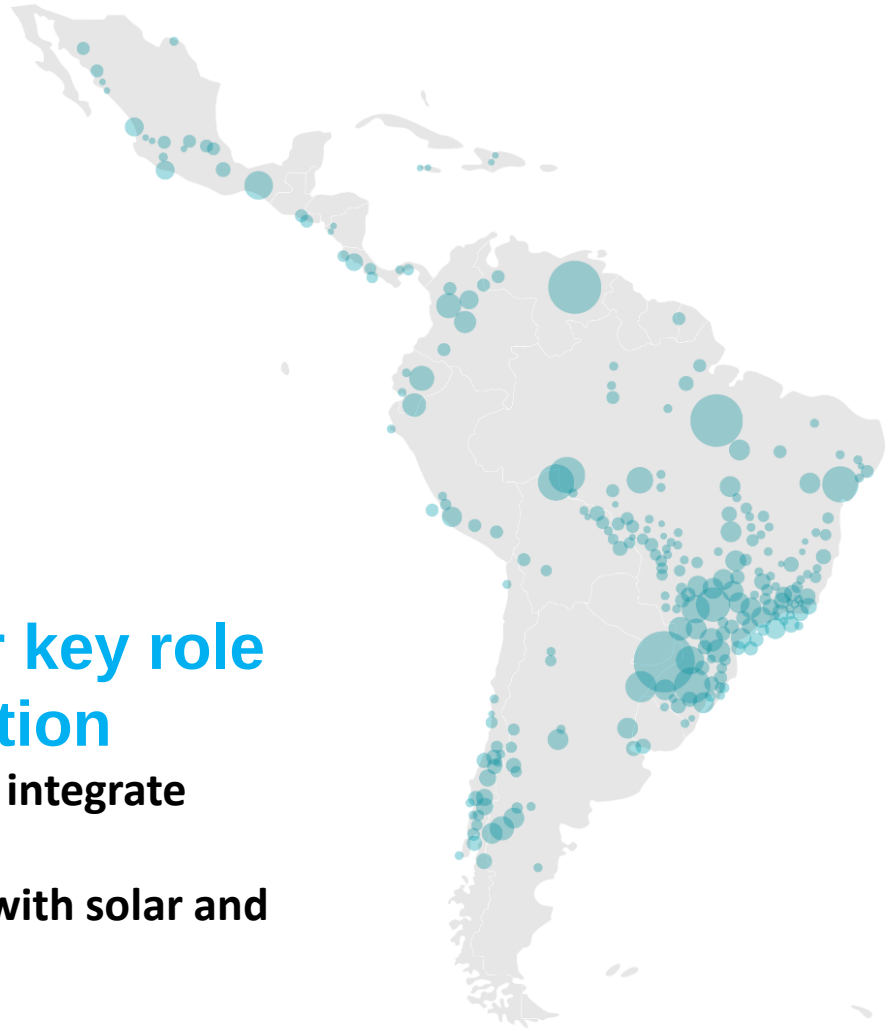

Hydropower key role in the transition

Major baseload to integrate renewables due to complementarity with solar and wind regimes

Country	Hydro as share of peak demand	Share of hydro in total generation
Argentina	46	23
Brazil	131	63
Chile	64	30
Colombia	118	67
Costa Rica	177	73
Mexico	33	12
Panama	112	70
Peru	75	58
Uruguay	94	52

Source: Global Energy Observatory, Google, KTH Royal Institute of Technology in Stockholm, Enipedia, World Resources Institute. 2019.

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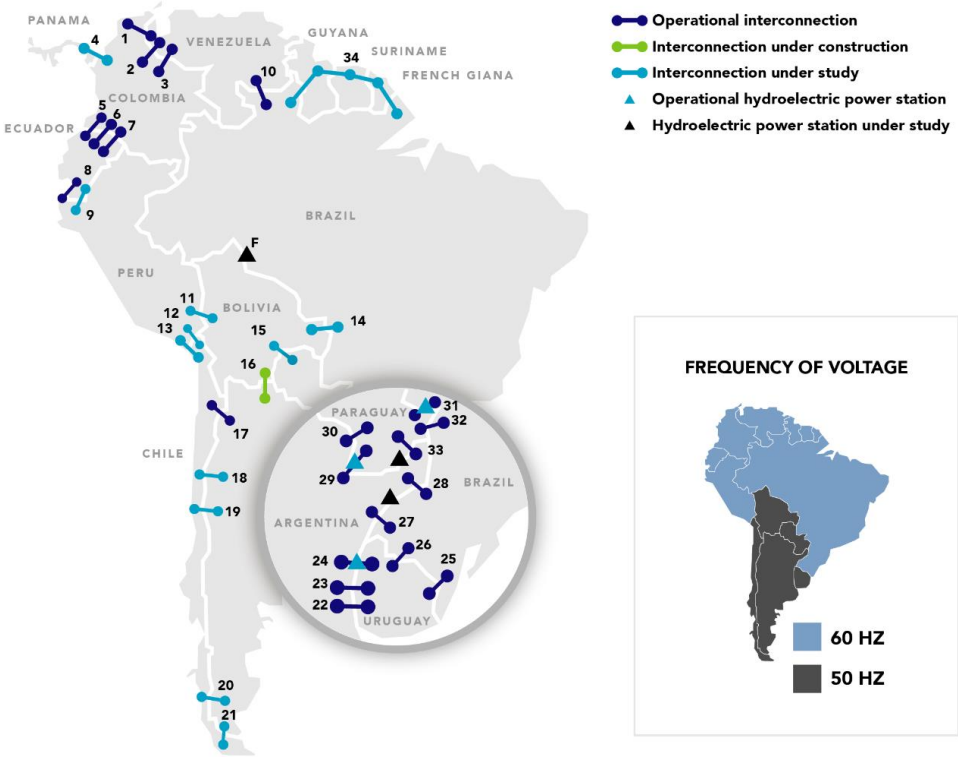
Existing integration of the power sector is a plus

Additional investments are required

Source: CIER, 2019



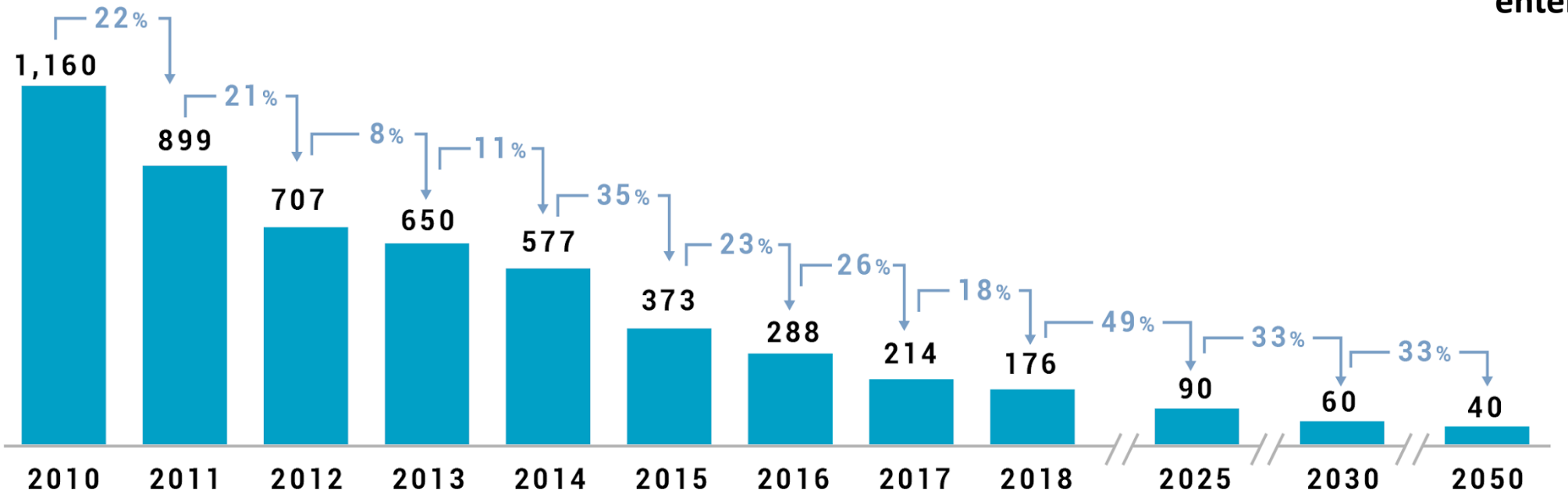
Source: CIER, 2019

National investment in T&D lines is crucial for the well-connected and flexible grid of the future

Battery prices fall nearly 50% in 3 years, spurring more electrification

The cost of electric vehicles is rapidly decreasing, and new technologies are entering the market.

Volume weighted average lithium-ion pack price
Real 2018 USD



Source BNEF, 2019; and author's estimates.

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Public transport in LAC

- Highly urbanized cities
- High bus utilization rate per capita
- 99 BRT systems in operation in the region
- Age of bus fleets in Latin America is very diverse: in some cases reaching up to more than 20 years of operation.
- Some cities are achieving electric buses TCO parity with ICE buses
- Electricity use in transport has increased x15 between 2010 and 2018

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INTERVENTION SCENARIO

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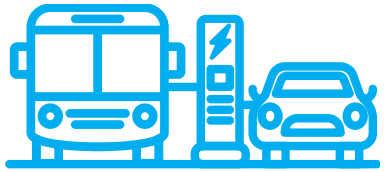
Zero carbon pathway by 2050: key assumptions

100% of power demand met by renewables.

LCOEs below natural gas and coal.

All currently operated fossil-fuel plants will be decommissioned.

Coal & oil by 20.30, gas by 2040



Gradual electrification of the transport sector.

All modes for cargo and passenger transport, except air travel are gradually electrified as LCOTs outcompete IC options.

No new refineries commissioned.

By 2030, existing facilities decommissioned by 2050.

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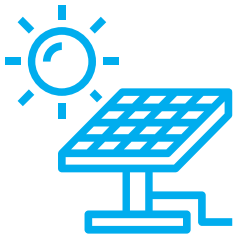
New demand is met through a combination on renewables reflecting projected relative competitiveness

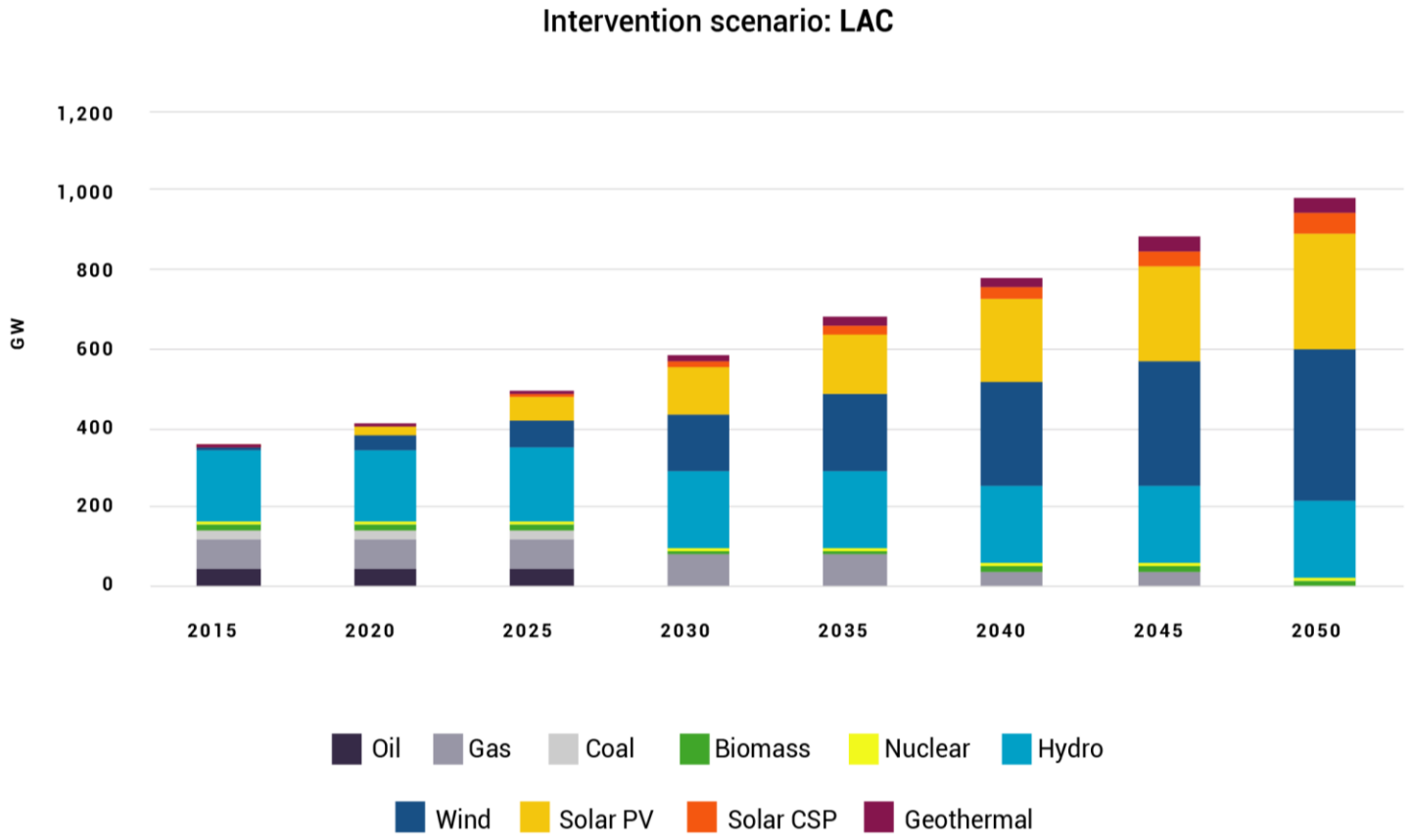
Projected demand by 2050

16.7 EJ

Investment: US$ 800 billon



Solar PV comprised of
- Distributed Solar PV
- Utility-scale solar



Source: Author's estimates

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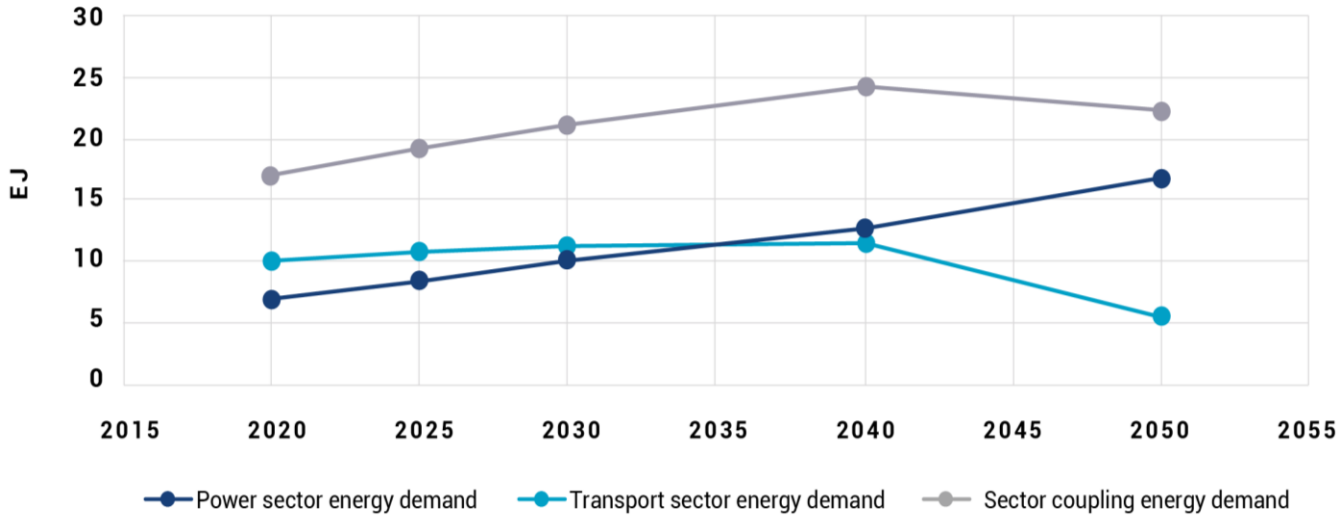
Electrification of transport will reduce energy consumption with savings of 12 EJ/year by 2050



Electrification of transport will

increase power demand by 33%

Requiring

327 GW

US$ 214 billlons

Source: author's estimates

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ECONOMIC RESULTS
OF A COUPLED TRANSITION

Energy security · Load balancing · Avoided cost of illness · Impact on refining operations · Value of capital assets in refining & power generation · Cost of services

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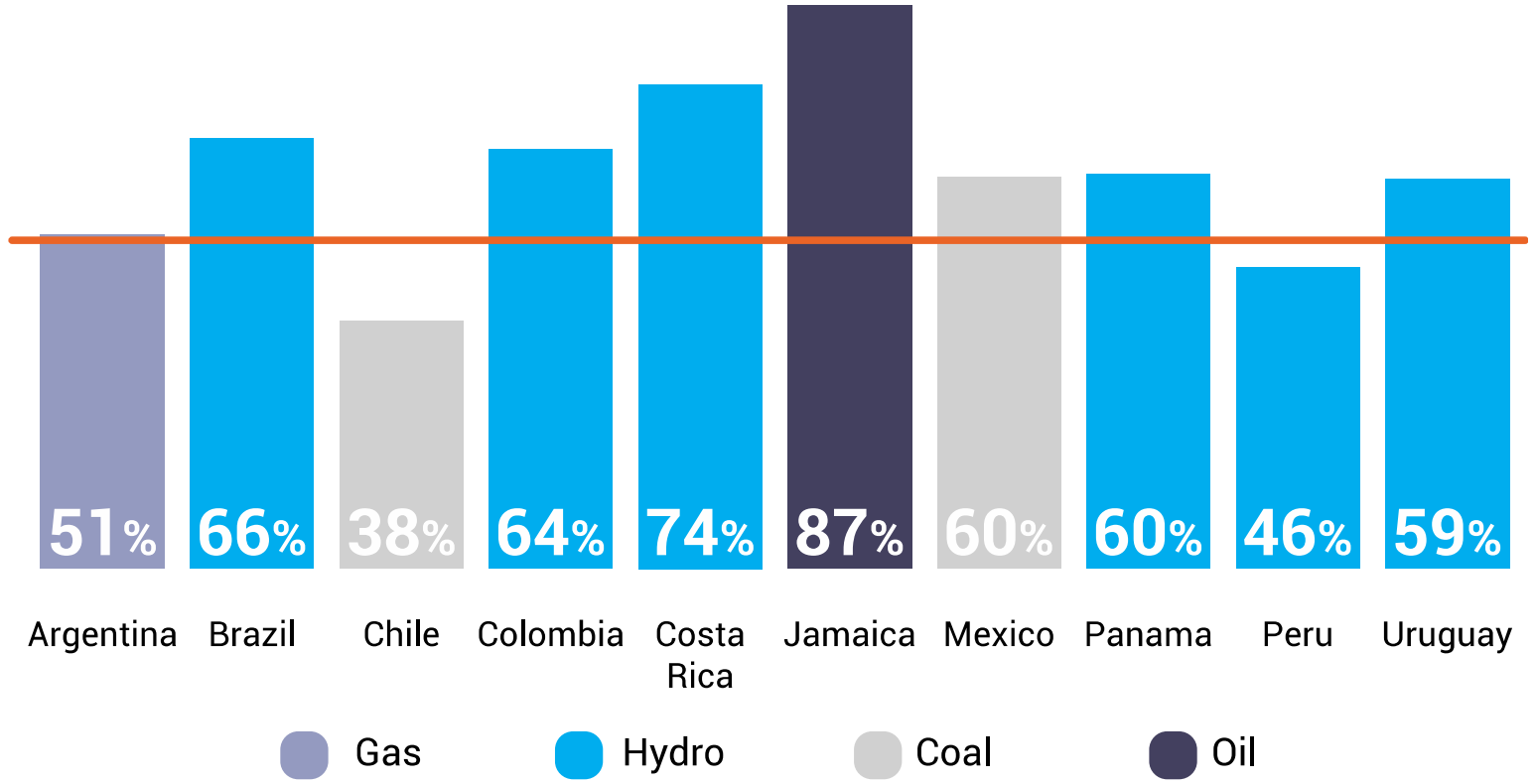
Energy Security

Diversified renewable matrix will eliminate fossil fuel dependency, eliminate imports of oil/coal/gas and improve resilience to climate events.

Share of largest generation of power supply (%)



Source: based on data from ENERDATA consulted September 2019

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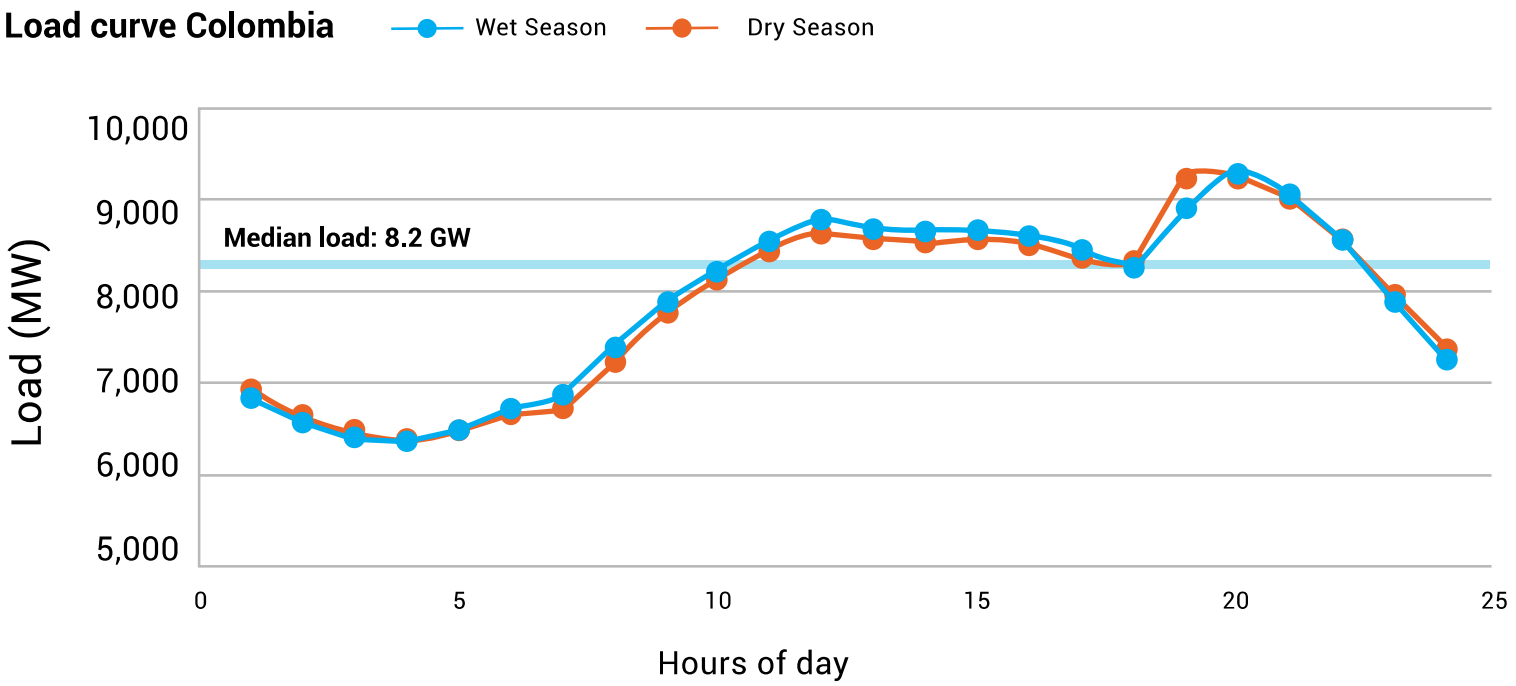
Load balancing

Electrification of transport will add substantial demand for power; demand management could reduce net impacts through “valley filling” (estimated 10 GW regionally by 2050)



Source: author’s estimates

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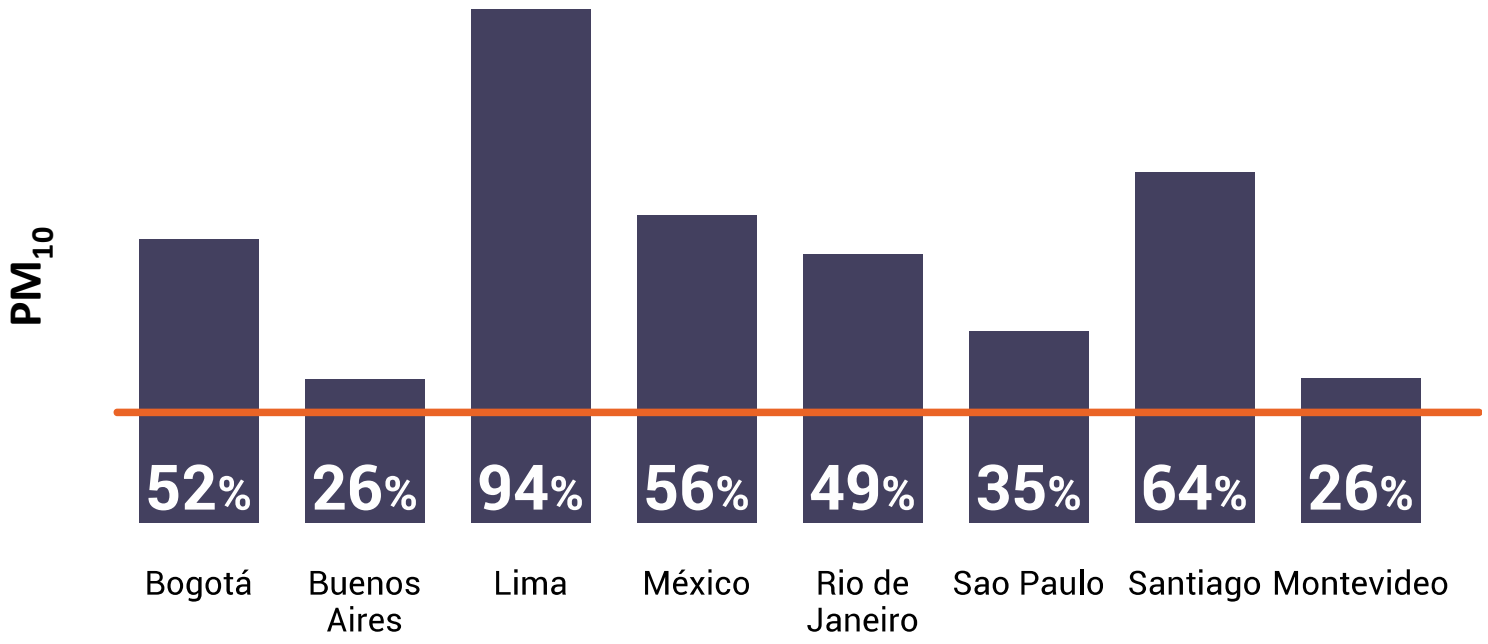
Avoided costs of illness

Electrification of transport in a fully renewable energy matrix will eliminate its contribution to airborne pollutants including PM, NOx, VOCs



Avoided health costs by mid-century

US$ 30 billion (2018).

Avoid the early deaths of

24,000 people (in 5 cities)

Source: WHO Standard for PM10: not to exceed 20 µg/m3 annual mean

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Impact on fossil fuel assets

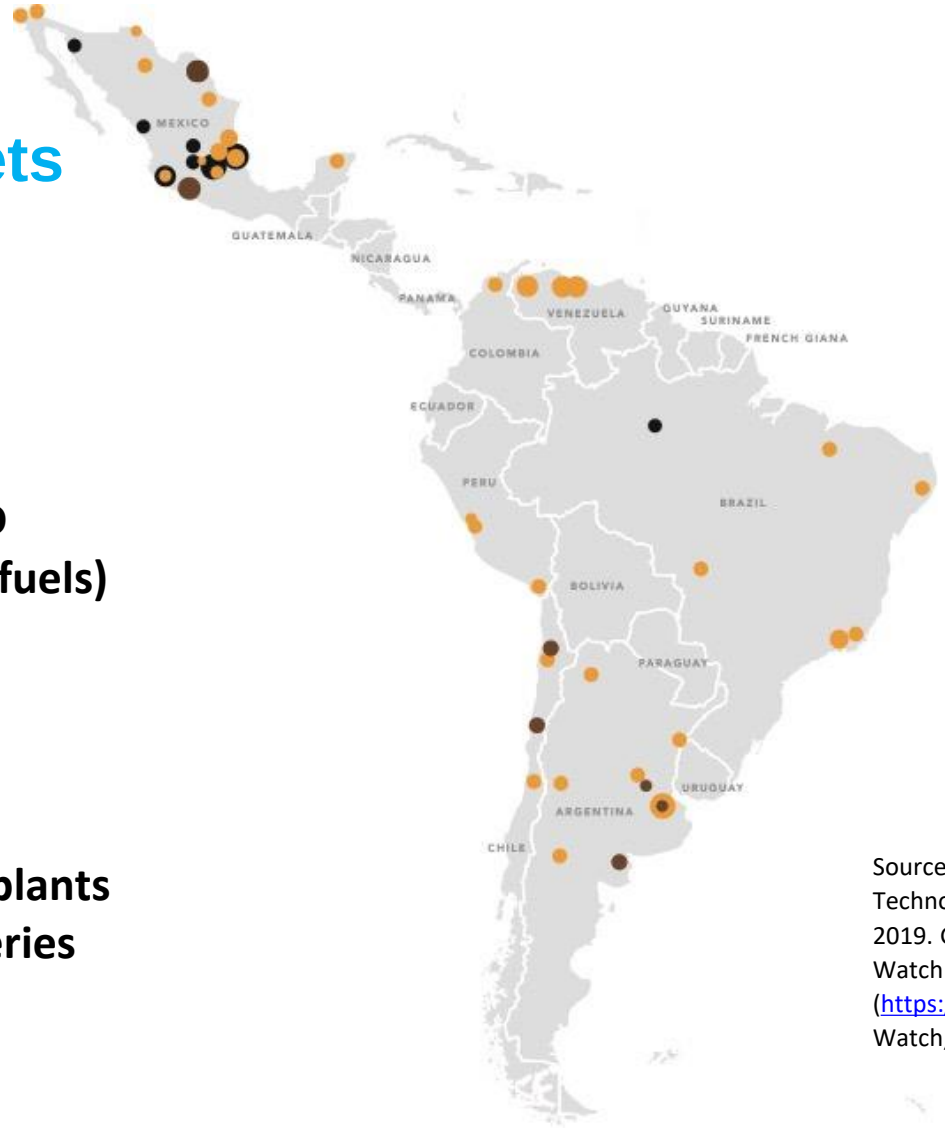
In 2018:

· Installed capacity of 172 GW of thermal power plants.

· Installed refinery capacity of 7.7 BBPD (optimized for production of transport fuels)

Cost of stranded assets:

· US$ 80 billion (2018) power plants
· US$ 10.5 billion (2018) refineries



Location of major thermal power plants

Oil
Coal
Gas

Source: Global Energy Observatory, Google, KTH Royal Institute of Technology in Stockholm, Enipedia, World Resources Institute. 2019. Global Power Plant Database v1.2.0. Published on Resource Watch (http://resourcewatch.org/) and Google Earth Engine (https://earthengine.google.com/). Accessed through Resource Watch, (October, 2019). www.resourcewatch.org.

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Projected LCOES for the power sector

LCOEs for wind already outcompete gas (and coal). Projections through GACMO indicate further competitive advantage for wind and solar

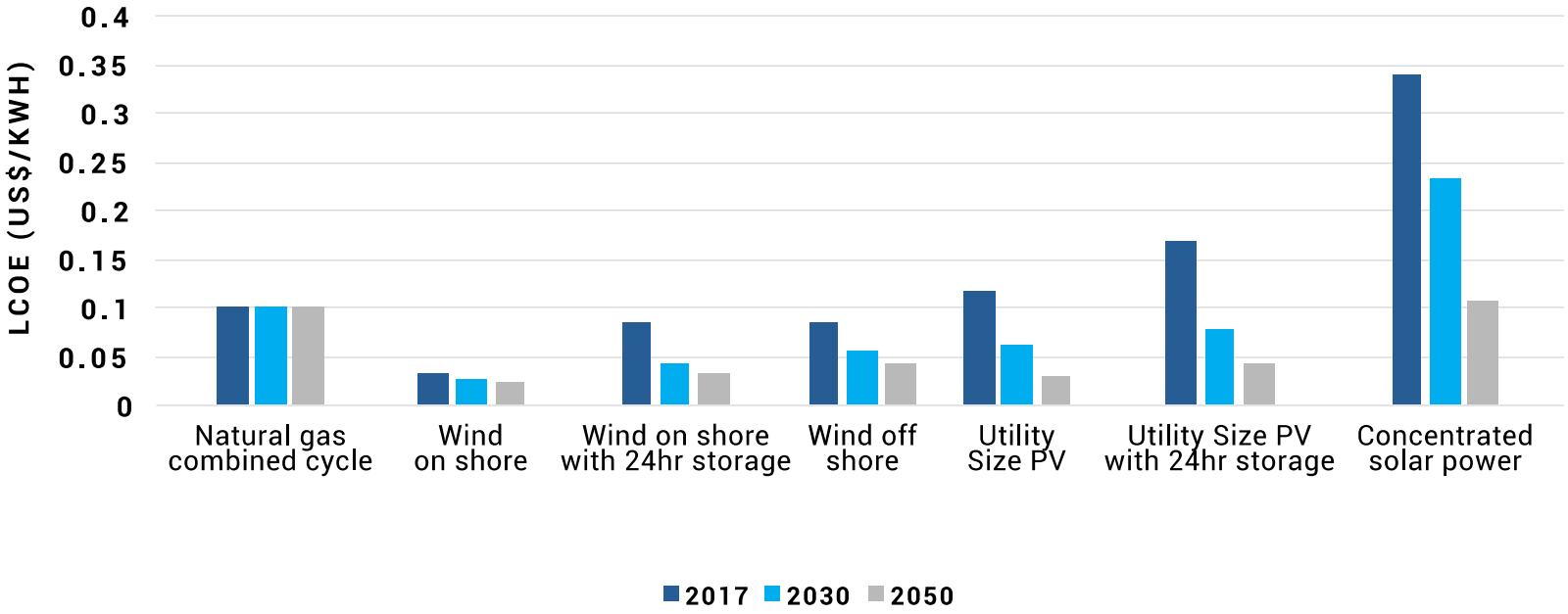
Compound LCOE for the región

50% less

than in a BAU scenario

US$ 283 billions (2018)

less with respect to bau scenario



Source: As projected under GCAM BAU outputs, August 2019

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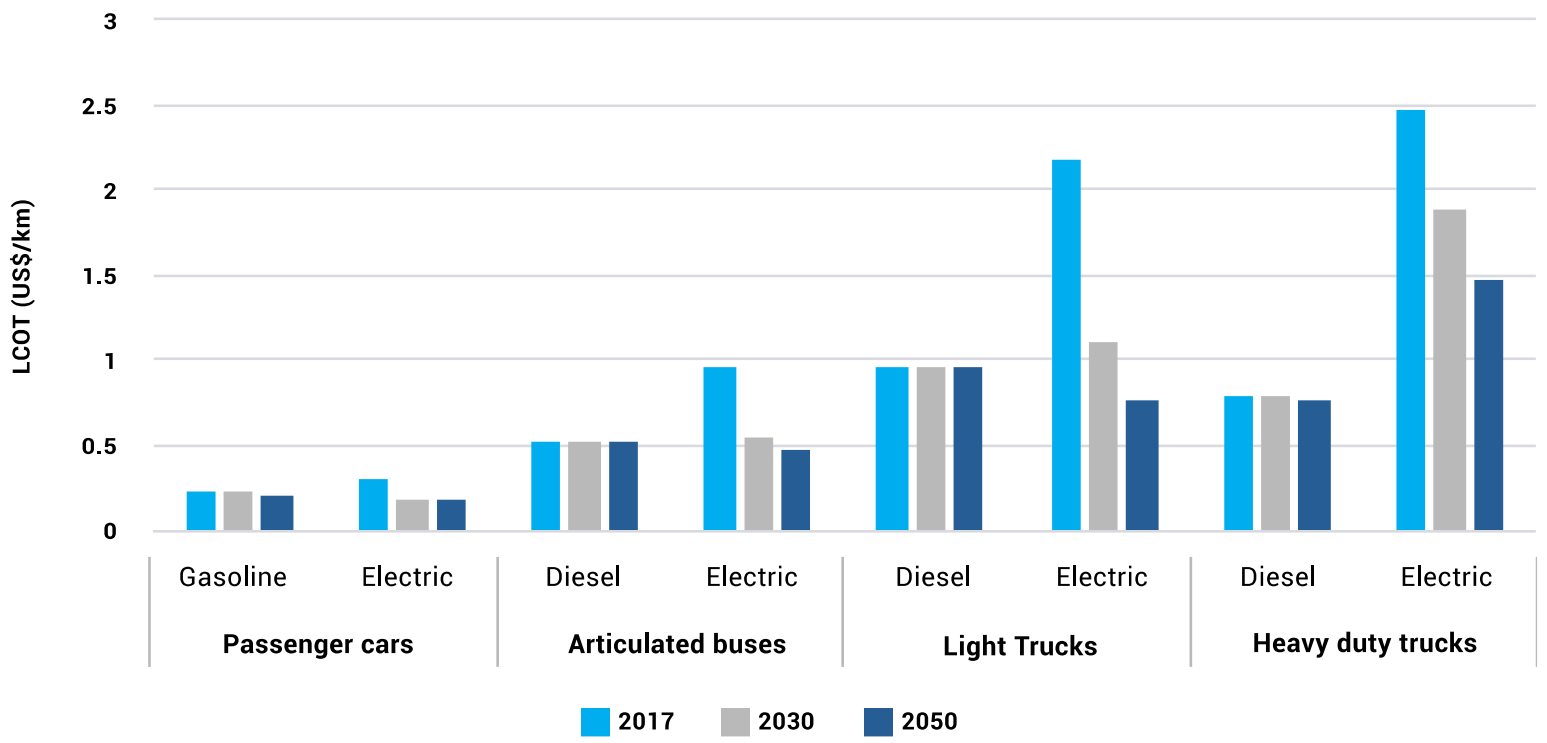
Projected LCOTs for the transport sector

LCOTs projection through GACMO indicates significant gains for all electric modes outcompeting internal combustion options



Source: As projected under GCAM BAU outputs, August 2019

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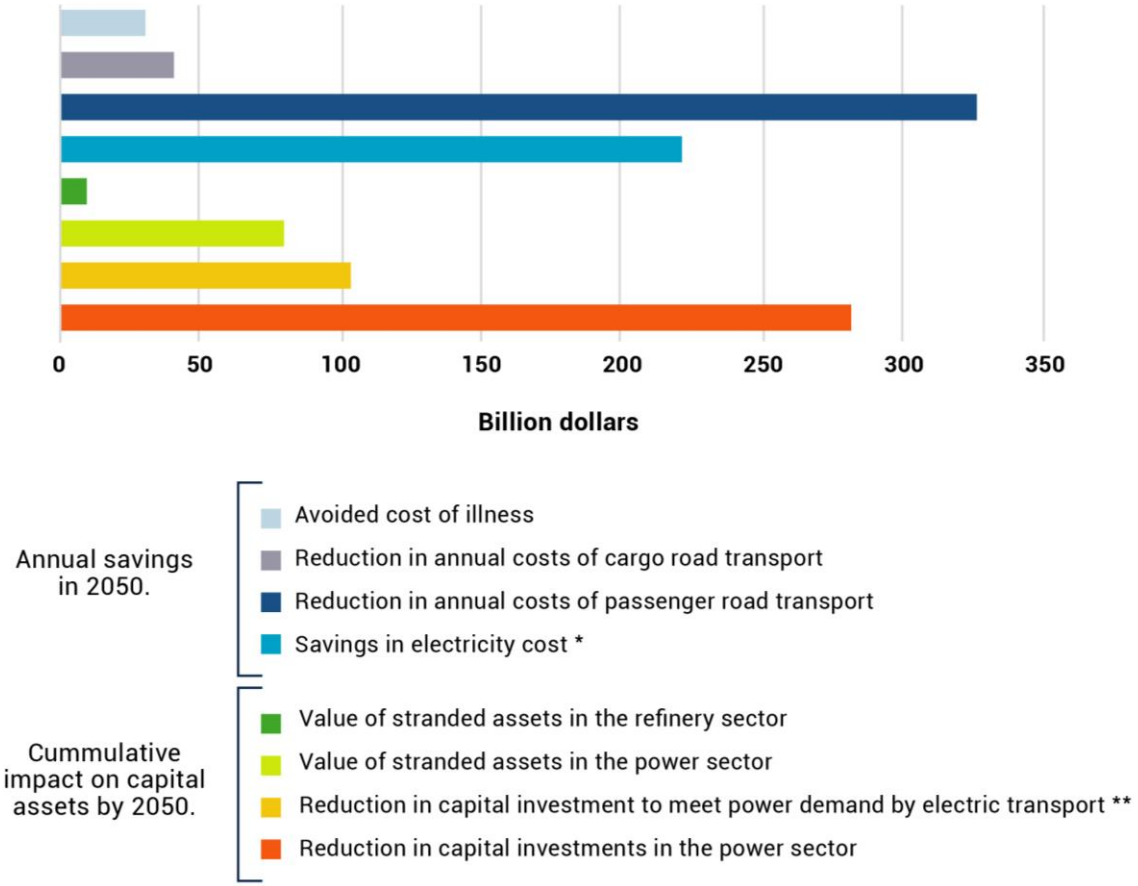
Coupled decarbonization results in substantial economic benefits.



Annual savings linked to the coupled transition by 2050:

621 US$ billion

Accumulated capital savings for provision of power and transport services by 2050:

386 US$ billion

Value of stranded fossil fuel capital assets by 2050:

90 US$ billion

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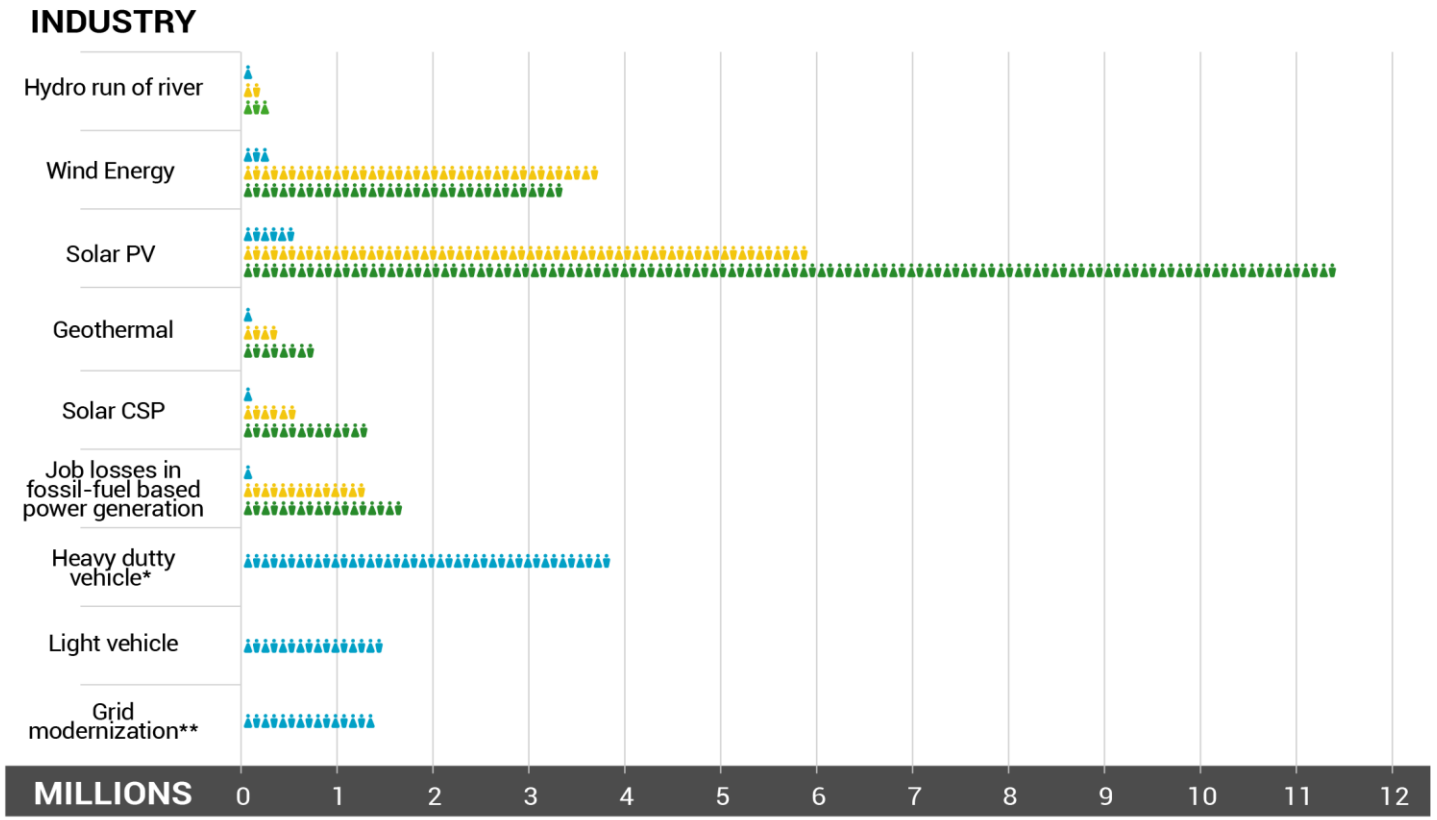
Coupled decarbonization generates jobs

Jobs (millions) generated by 2050



TOTAL	17.13 Construction (Job years***)	10.83 Manufacturing (Job years)	1.06 Operation and maintenance (jobs)

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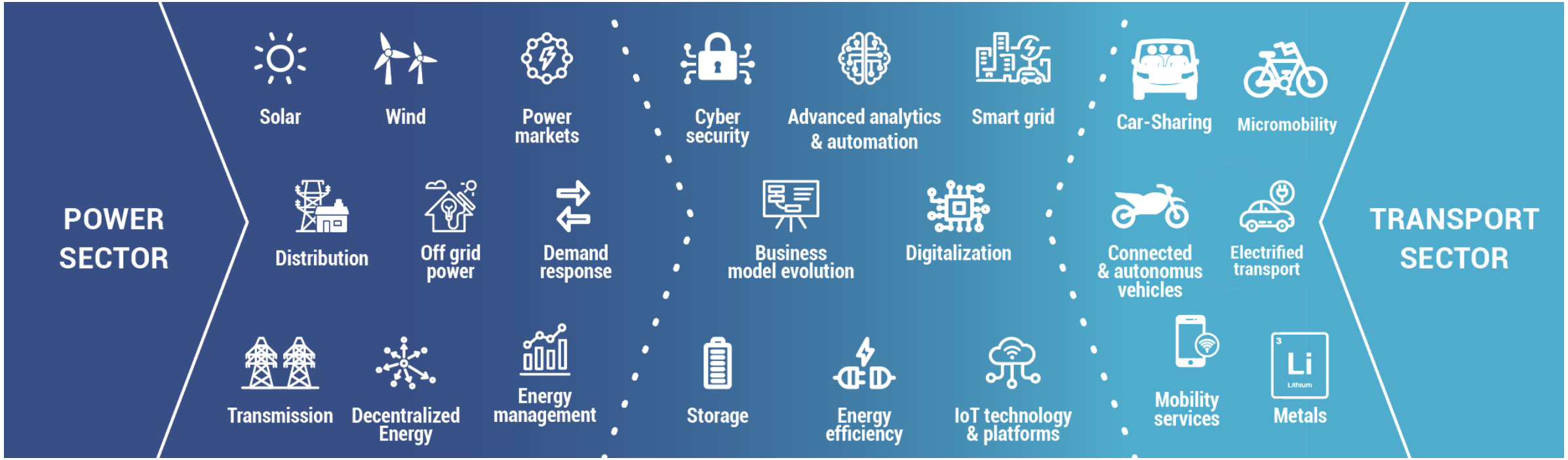
Elements of a coupled transition - new business & enterprise opportunities



The power sector is undergoing a profound transformation towards **decarbonization, decentralization and digitalization.**

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Examples of business models

Examples of business models accelerating the transition

ENSA

Energy distribution company in Panama

This company offers solar PV panels installation and monitoring while providing financing through the electric bill

Charging infrastructure

Utilities, Automakers, oil & private companies

Different players involved in the deployment of charging infrastructure in different countries. Examples: BMW in Mexico and Brazil, La Casa de las Baterías in Panama, YPF in Argentina and Terpel in Colombia, Enel & Engie in Chile

Megapower

Private sector initiative in Barbados

The company pioneered introduction of EVs through the roll out of a network of public charging stations powered by renewable energy

Distributed Solar Generation Finance

Mexico

Catalysing financing for Commercial & Industrial (C&I) end-users by structuring a solar-customised financial scheme (USD$60 million) via commercial banks

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A just transition

The transition must:

· Minimize disruption for workers and communities reliant on unsustainable industries and energy sources

· Address social and economic inequalities

· Focus on bringing everyone on the table

Equal participation, equitable distribution, recognition and equal capabilities, as well as social justice

Summary of elements of a macro policy agenda

A well-constructed enabling environment, with clear, consistent and robust policy frameworks, will be critical to attract investment flows towards a coupled transition

Goal	Policy	Instrument
Reduce losses in stranded assets	Discourage investment in fossil capital assets	Decarbonization policy Sunset provisions to encourage early retirement
Modernize grid	Encourage investments in modern transmission and distribution infrastructure	Clear regulations on demand management and storage Regional power exchange market
Internalize health and climate costs of transport emissions	Enable allocation of costs	Fiscal measures to pass costs to emitters
Encourage level playing field for new technologies	Open competition with fossil fuels Removal of policy barriers	Eliminate subsidies and rents Adopt standards for charging stations
Encourage innovation	Promote R&D in zero carbon technologies	Fiscal and regulatory measures to encourage investments in R&D
EV deployment	Promote electric transport adoption	Standards, electric tariff incentives, non-fiscal incentives, EV targets

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Examples of policies to support the transition

The decarbonization pathway towards 2050

Carbon pricing

Mexico · Chile · Colombia

Carbon pricing based on “a polluter pays principle” can generate funds to support the transition

Electric Buses

Business & Government alliance in Chile

Procurement plan that included technical and business model innovations to keep the total cost of electric buses close to that of an internal combustion bus to enable purchase without using subsidies

Renewable Energy auctions

Colombia

Will be incorporating 2250 MW to the electrical system - equivalent to an investment of US$ 2,000 million

Regulation updates for DG deployment

Brazil · Chile · Mexico

Allow net metering for larger installation capacities to stimulate the deployment of rooftop PVs

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Thank you

SUMMARY OF KEY FINDINGS

ZERO CARBON

LATIN AMERICA AND THE CARIBBEAN

2019

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