

# ZERO CARBON

L A T I N   A M E R I C A   A N D   T H E   C A R I B B E A N

2 0 1 9



**"THE OPPORTUNITY, COST AND BENEFITS OF THE COUPLED  
DECARBONIZATION OF THE POWER AND TRANSPORT SECTORS  
IN LATIN AMERICA AND THE CARIBBEAN"**



THE OPPORTUNITY, COST AND BENEFITS OF THE COUPLED  
DECARBONIZATION OF THE POWER AND TRANSPORT SECTORS  
IN LATIN AMERICA AND THE CARIBBEAN.



Funded by  
the European Union





# EXECUTIVE SUMMARY

The UNEP has developed the “Zero Carbon Latin America and the Caribbean: the opportunity, cost and benefits of the coupled decarbonization of the power and transport sectors” report as a follow up to an earlier analysis released at COP 21 (December 2015) on a pathway for full decarbonization of the regional economy in Latin America (UNEP Zero Carbon Latin America, 2015) referred to as Zero Carbon 1.0 hereafter. The report will be followed by an analysis on land use options and oceans as a central anchor for decarbonization strategies in Latin America and the Caribbean, scheduled to be completed by COP 26 (December 2020).

The objective of this report is to illustrate the opportunity, costs and benefits of the coupled decarbonization of the power and transport sectors in the Latin America and the Caribbean (LAC) region by mid-century.



Cerro Pelado, Cañas., Guanacaste, Costa Rica  
Photo by Juliana Barquero on Unsplash

The report also presents on the ground examples, from successful policies to business models, which signal a potential coupled decarbonization transition, if escalated, would put the region in a virtuous scenario, raising the ambition of next generation of Nationally Determined Contributions to the Paris Agreement (NDCs).

This analysis has been conducted in the context of calls for immediate and drastic action to arrest the continuing increase of CO<sub>2</sub> concentration in the atmosphere, which at the start of 2019 reached 409 parts per million (ppm) (NOAA, 2019). Global temperatures have already increased 1.1°C above pre-industrial levels. If current trends continues, temperatures can be expected to rise to 3.2°C this century (IPCC, 2018; W. Steffen et al, 2018, UNEP

Emissions Gap Report, 2019). The situation has prompted warnings from the scientific and global governance community that the biosphere may be reaching a point of no return (Aegenheyster M. et. al, 2018, UNEP, 2018).<sup>1</sup>

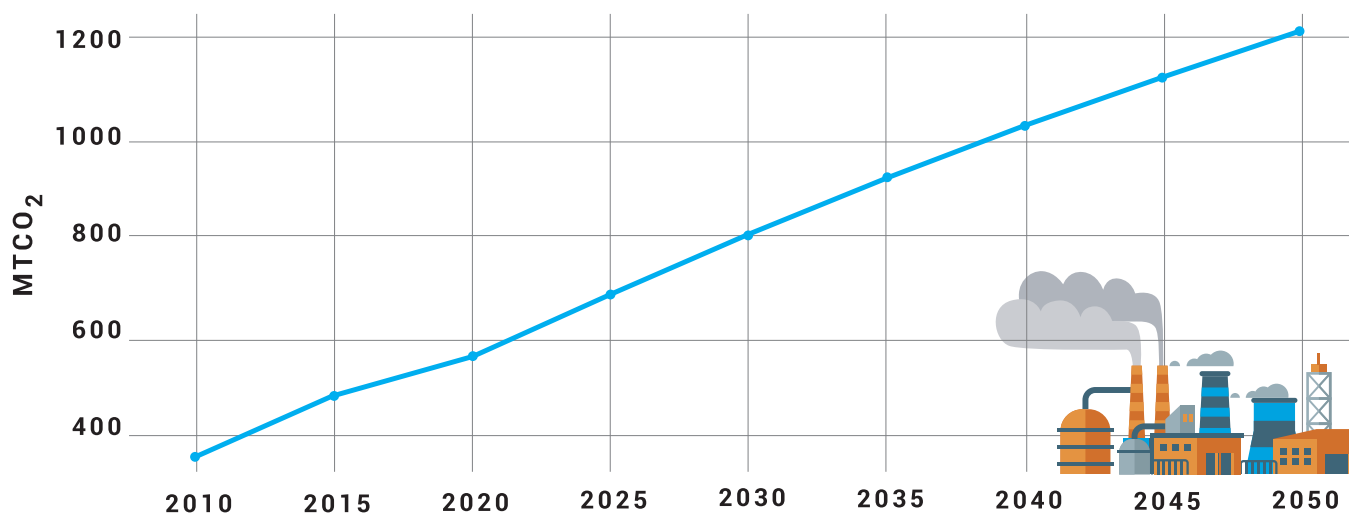
We are on the brink of missing the opportunity to limit global warming to 1.5°C. It is imperative to act now while we still have the chance. While there will still be climate impacts at 1.5°C, this is the level scientists say is associated with less devastating impacts than higher levels of global warming (IPCC, 2018). Countries need to take a quantum leap in emissions reductions – globally a 7.6% reduction every year from 2020 to 2030 (UNEP Emissions Gap Report, 2019). Scientists have spoken, now is the time for governments and industries to take the lead and assure a transition path consistent with the 1.5 °C track. Economies must shift to a decarbonization pathway now.

Under the 1.1°C track, climate change has become a national security threat to the LAC region. Climate impacts have affected not only the ecology of the systems impacted

but also the livelihoods and sustenance of millions in the region, even forcing migrations from affected areas. Climate is already starting to threaten the foundations of the region's economy, with droughts, hurricanes and/or floods. If the global temperature continues to rise, climate impacts will be increasingly severe and expensive.

The entire LAC region does have a relatively small contribution in the global carbon footprint (9.5%)<sup>2</sup> with approximately the same amount of global population.<sup>3</sup> However, the regional average GHG emissions per capita (7tons of CO<sub>2</sub>-eq)<sup>4</sup> is greater than the global figure (5 tons of CO<sub>2</sub>-eq)<sup>5</sup>. The region has a significant and growing carbon footprint in its transport sector, as well as a comparable emissions footprint from the power generation sector that together are responsible for 25% of GHG emissions in 2019. According to this report, under the business as usual (BAU) scenario, emissions from both sectors are expected to double by 2050 (Figure 1 and 2). This will place the region further away from the 1.5°C pathway.

**Figure 1. Projected associated CO<sub>2</sub> emissions from the power sector under GCAM BAU, 2010-2050**



Source: As projected under GCAM BAU outputs, August 2019.

1. Global peaking of emissions by 2020 is crucial for achieving the temperature targets of the Paris Agreement, but the scale and pace of current mitigation action remains insufficient. (Emissions Gap Report 2019, UNEP).

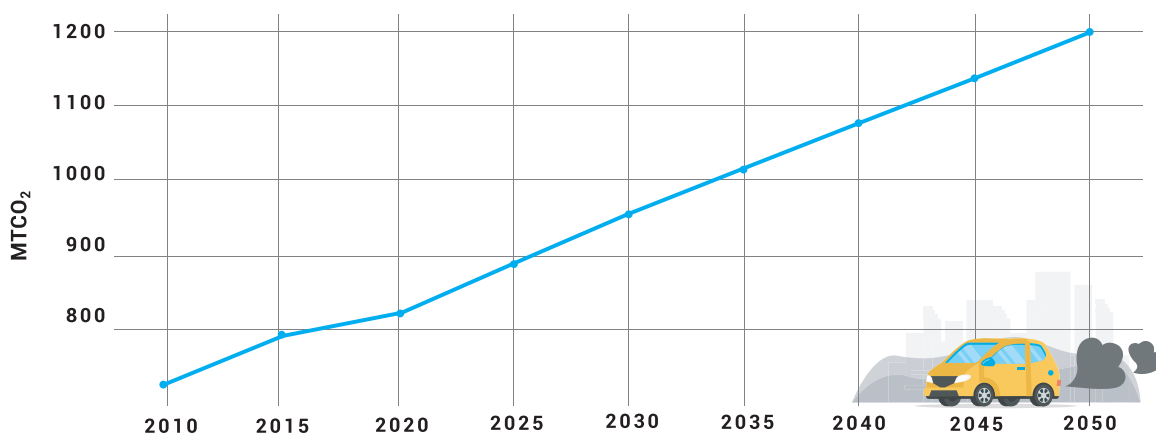
2. The Brookings Institution 2014 A New Global Agreement Can Catalyze Climate Action in Latin America [https://www.brookings.edu/wp-content/uploads/2016/06/Correct-Climat-LAC-GlobalViews52015\\_FINAL.pdf](https://www.brookings.edu/wp-content/uploads/2016/06/Correct-Climat-LAC-GlobalViews52015_FINAL.pdf)

3. World Bank 2018 <https://data.worldbank.org/indicator/SP.POP.TOTL?locations=ZJ-1W>

4. World Resources Institute 2014 Climate Analysis Indicators Tool (CAIT). <http://cait.wri.org>

5. World Bank 2014 <https://data.worldbank.org/indicator/EN.ATM.CO2E.PC>

**Figure 2. Projected associated CO<sub>2</sub> emissions from the transport sector under GCAM BAU, 2010-2050.**



Source: As projected under GCAM BAU outputs, August 2019.

Transformational change needed to meet the Paris Agreement and reach net zero emissions by mid-century can be critically supported by coupling the power and transport sectors. Furthermore, LAC is the most urbanized region on the planet - 80% of its population lives in cities.<sup>6</sup> Consequently, most of the energy consumption and road activity are concentrated in urban areas. This current situation of the region's urban world opens opportunities for rapid and far-reaching environmentally sound and financially attractive actions in both sectors; making cities a key part of the solution.

Embarking on the road to electrify the transport sector coupled with the transition towards a fully renewable power sector could contribute to cost-efficient decarbonization.

Realizing synergies and interlinkages between sectors of the economy derive in potentially higher economic benefits and greater mitigation impact.

The measures proposed in this report fit into the mold of bold climate action, as called for by the UN Secretary General Climate Summit and the Global Commission on the Environment and Climate (New Climate Economy)<sup>7</sup> that can result in new jobs, economic savings, market opportunities, and improved well-being. Actions to decarbonize can likewise be framed in the context of a green economy, defined by the UNEP as "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP, 2012).

The coupled pathway, the intervention scenario, consists of actions to decarbonize both sectors by mid-century:<sup>8</sup>

**Power sector:** it is assumed that all future power demand (16.7 EJ) will be met fully by a combination of renewables technologies by 2050.<sup>9</sup> Starting in 2020 no new fossil fuel-based power units would be commissioned. The existing capacity for coal is decommissioned by 2030 and that of gas by 2050. It also considers regional grid integration and local decentralized energy resource (DER) deployment during the period. Considering current trends regarding solar PV distributed, it is estimated that the distributed solar PV will reach a great percentage of the total solar PV installed capacity by 2050.

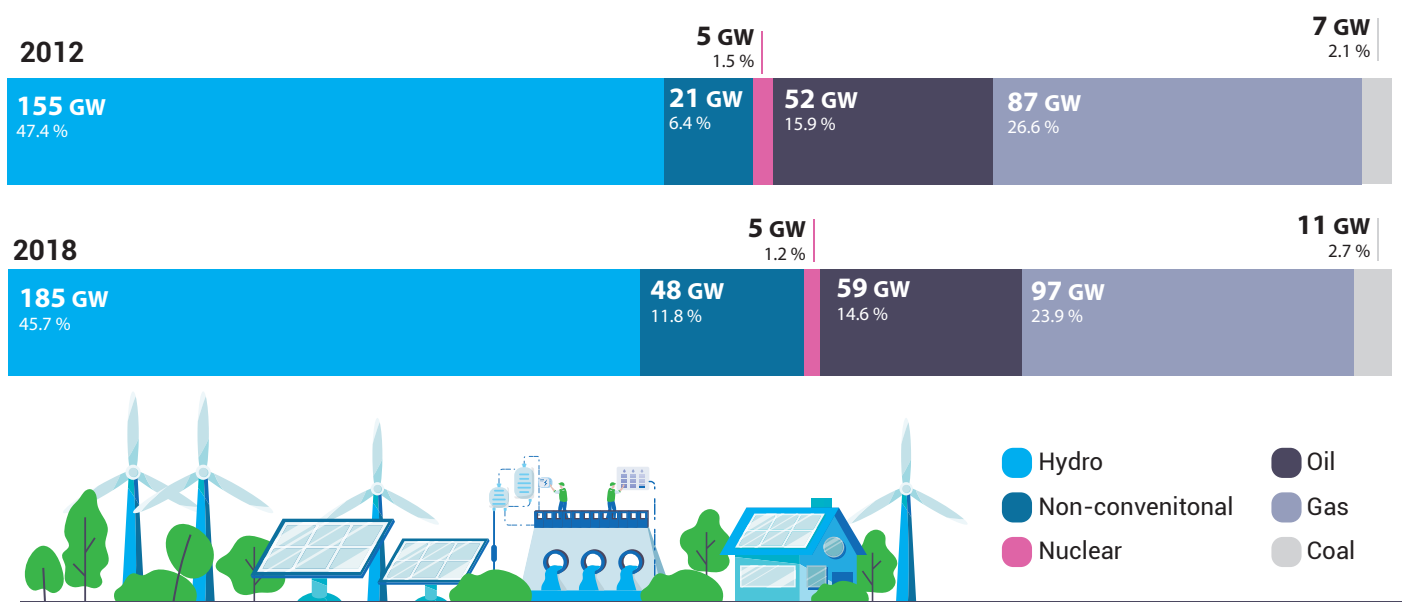
**Transport sector:** it is assumed that all modes for cargo and passenger transport, except air travel,<sup>10</sup> switch to electric drives by 2050; and no internal combustion engine (ICE) fleet is in operation by then.<sup>11</sup> Specifically, it is considered a shift to electric mode for all existing and new Bus Rapid Transit (BRT) systems by 2025.<sup>12</sup> Car fleet becomes 10% electric by 2025, 60% electric by 2040 and is fully electrified by 2050. The same conversion rate is expected from light trucks and all buses, while all railroad cargo and passenger transport are electrified by 2040. Also, all marine and heavy road cargo transport is fully electrified by 2050.

### Power sector

The first steps of transitioning toward a fully renewable energy power matrix are already in place in the region. LAC has one of the cleanest power sectors worldwide. Renewables already account for 58% of the total installed capacity, including hydropower (46%). Non-conventional renewables have doubled their installed capacity since 2012, accounting for 12% of the total in 2018 (Figure 3).

The increase in participation of renewables has clipped the carbon intensity of the sector by 15% in last 3 years (Figure 4); from an already low value of 285 tCO<sub>2</sub>/GWh in 2015 to 243 tCO<sub>2</sub>/GWh in 2018,<sup>13</sup> one of the lowest worldwide.

**Figure 3. Evolution of power installed capacity by source of energy (GW), 2012 to 2018**



Source: from data in ENERDATA, accessed August 2019

6. World Bank 2018 [https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=ZJ&name\\_desc=false](https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=ZJ&name_desc=false)

7. <https://newclimateeconomy.report/>

8. This scenario was first described by UNEP Zero Carbon Latin America version 1.0.

9. The ratio of new installed capacity considered in the zero emissions scenario is 50% wind, 38% solar PV, 5% solar CSP, 5% geothermal and 2% hydro. (limited availability of new sites and escalating environmental and social concerns will temper past rapid deployment of hydropower capacity. The Solar PV fraction includes utility size and distributed scale. See Chapter 7 and Annex 7 for additional details on the intervention scenario.

10. Air travel was not considered in the intervention scenario (see Chapter 2).

11. The intervention scenario assumes that there is a faster transition to electric drives for cars and buses, a slower transition for trucks and rails and an even slower transition for vessels. Details of the schedule of transition are included in Annex 7.

12. While this shift will not produce substantial reductions in fossil fuels, it could be an emblematic change with visible co-benefits in urban areas, as well as stimulate development of the market in electric drives for public transport vehicles.

13. GACMO database accessed July, 2019



However, not all subregions or countries represent the overall regional situation. The Caribbean's main source for electricity continues to be fossil fuels at 82 % (McIntyre A., et. al., 2016), with extremely high electricity prices and all countries being energy importers except for Trinidad and Tobago.

Although some countries in the region, have reached, or are in the process of attaining 100% renewable power and more are aligning actions and policies toward this goal, it is still a long way from achieving carbon neutrality.

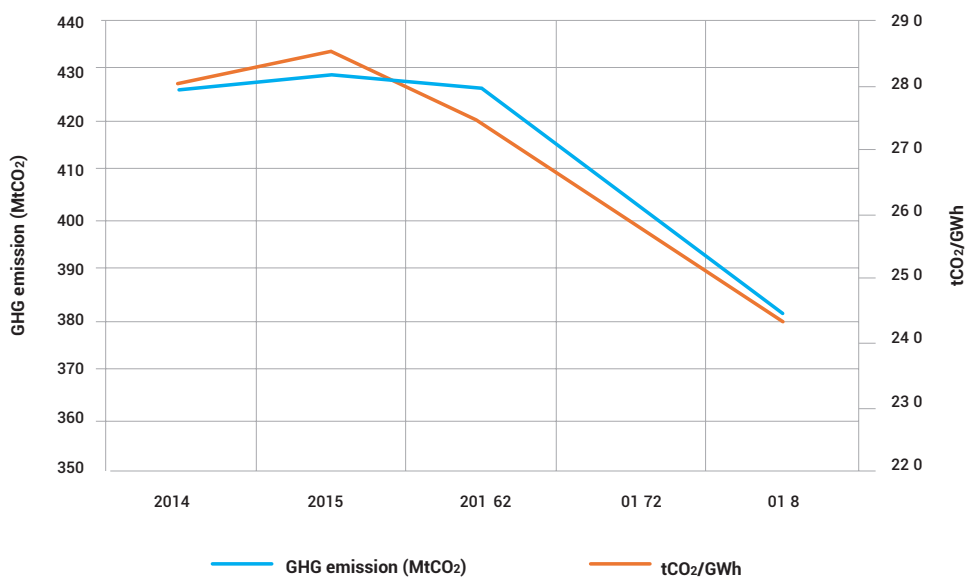
### Transport sector

Although electric transport has evidenced a slow-paced adoption in the region, the electricity demand in the transport sector has multiplied by 10-fold in the last 6 years. The decarbonization of the transport sector has moved more towards improving energy efficiency and carbon emissions standards. However, it remains the sector of the economy with the highest fossil-energy use and, therefore, leading in terms of fossil-fuel related emissions (15% of all regional GHG emissions in 2018).<sup>14</sup>

Diesel fuel and gasoline continue to be the fuels most used in transport, accounting for 83% of the total in terms of energy use (Figure 5).

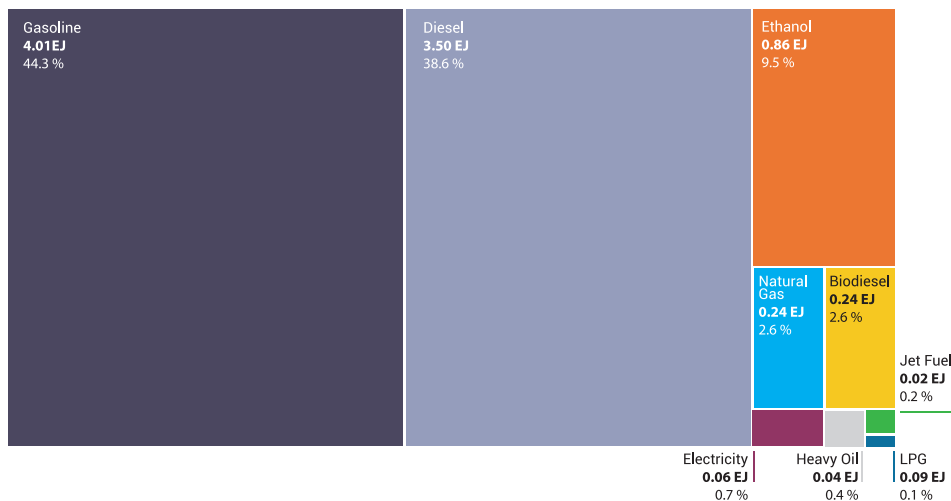
The regional transport sector includes a large fleet of road transport vehicles, where cargo and passenger, participate in approximately equal parts in energy use and GHG emissions. It also includes a significant railroad fleet, concentrated in a few countries (Brazil, Chile, Colombia and Mexico), as well as marine (ocean and fluvial) and air transport components.<sup>15</sup>

**Figure 4. Evolution of GHG emissions from the power generation sector**



Source: from data in ENERDATA, accessed August 2019

**Figure 5. Fuels used in the transport sector in the region  
(Total: 9 EJ in 2018)**



Source: Compiled from Enerdata through GACMO). Emissions from manufacture of the fuels are not included. Emissions from electricity estimated assuming a 50% renewable power matrix and three times efficiency in delivery of work. Some coal is used in rail operations but the tonnage is marginal.



Puerto de San Antonio Chile

Photo by Ministry of Transportation and Telecommunications - Government of Chile

While buses carry a large number of passenger kilometers and trucks most of the cargo, light vehicles have a similar carbon footprint. Rail and shipping are relevant only in a few countries. As a result, the automobile fleet continues to produce most of the carbon footprint in urban areas, while delivering a minority of the passenger kilometers.

In terms of passenger-kilometers, public transport has the highest share of all modes. The region has one of the largest bus fleets and the highest per-capita bus use in the world. The region is the world's leader in Bus Rapid Transit (BRT) systems.<sup>16</sup> There are now BRTs in 54 cities in Latin America.<sup>17</sup> These include 99 BRT routes operating with an extension surpassing 1300 kilometers in 10 countries. At least three BRTs are now including or about to commission electric buses (Santiago de Chile, Bogota and Curitiba) in their core or feeder routes. Santiago de Chile has launched the first 100% electric-fleet BRT<sup>18</sup> with 389 electric buses in total and Colombia has just acquired 379 electric buses for the TransMilenio. These cities have the largest electric bus fleets in the world outside of China. There are also 21 additional BRT systems in construction and 10 in expansion in the region.<sup>19</sup> The region has also been a pioneer in the development of the institutions, operational protocols and infrastructure for BRT systems, which could be further expanded or replicated in other cities to increase the overall impact on mobility and emissions.

About 70% of cargo transport in the region is carried by trucks. There is a continuous growth in the fleet of trucks of all sizes, and the kilometers travelled by road, in direct response to increases in economic activity and the demand for exports of food, fiber, metals and minerals from the international and domestic markets.

Eliminating emissions from this heterogeneous fleet would require of an enormous effort. Passenger and cargo transport use very different technologies and are driven by a different set of economic factors. Likewise, light and heavy vehicles present widely different market realities. Rail and vessels operate under very different management and operations. But, foremost, there is a large share of the economy that is vested in the current system of transportation and must be included in the process to facilitate the changes required.

---

14. Compilation in GACMO, accessed August 2019, using data from ENERDATA

15. The overall road transport fleet, cargo and passenger fleet in the region for some countries is presented in annex 5 of the report.

16. BRTs or Bus Rapid Transit Systems is a bus-based transport system with dedicated transit lanes designed to improve the occupancy of public space and deliver improvements in mobility of passenger transport in cities.

17. (<https://brtdata.org/>; consulted August 2019)

18. <https://www.electrive.com/2019/10/16/chile-launches-latin-americas-first-electric-bus-corridor/>

19. (<https://brtdata.org/>; consulted August 2019)



## Technology and economic transition of power generation.

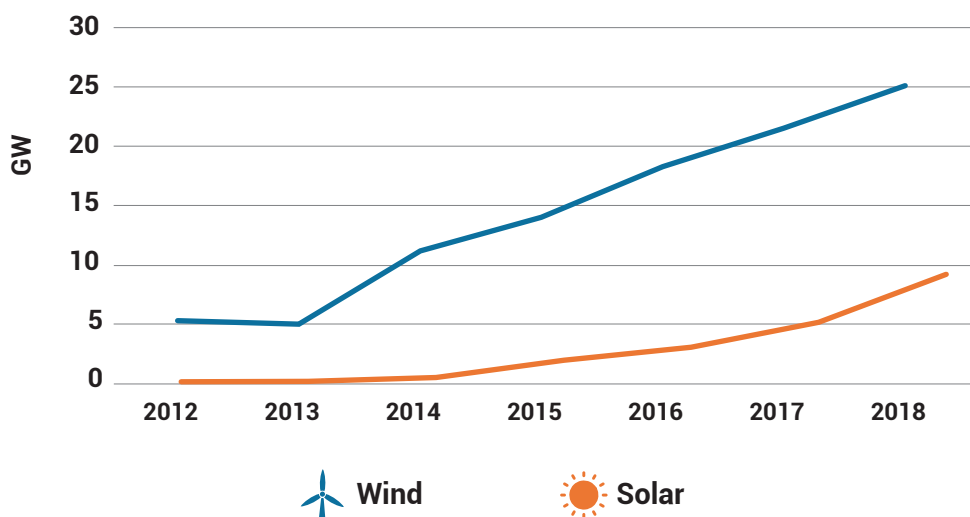
### Renewable energy resources, technologies and economics.

The LAC region has a substantial renewable energy resources for power generation. Its resource base has the potential to provide 22 times the electricity needs of the global economy. The region has global-class hotspots of solar (Atacama, Sonora-Chihuahua), wind (Patagonia, Atlantic Coast of South America, Isthmus of Tehuantepec, Guajira Peninsula), marine (southern pacific coast of South America), geothermal (Andes, central American Cordillera), and hydropower all over the region.

In the last 5 years, the non-conventional renewable energy sector in Latin America and the Caribbean received more than USD\$35 billion in investment (44% of global direct foreign investment flows). Besides renewable resources endowment, non-conventional renewable energy investment tends to blossom in countries with well-constructed enabling environments, which means clear and consistent renewable energy policies, including well-structured auctions. As is the case in Mexico, Brazil, Chile and Argentina, which received 70% of the region total investment flows.<sup>20</sup> Other countries are beginning to attract foreign direct investment 2018 are Colombia, El Salvador and Dominican Republic, since they have built legal and regulatory frameworks that give certainty to private investment.

In terms of non-conventional renewable technologies, 90% of the region total investment flows was destined to solar PV and wind projects. Since 2012, installed capacity for wind energy increased by nearly 400%,

Figure 6. Evolution of wind and solar PV installed capacity in the region (GW), 2012-2018



Source: Enerdata

and for solar PV increased 29,000% (Figure 6). Currently, wind and solar PV installations together exceed 50GW, which is almost a third of the total generation capacity installed to power Brazil. This growing trend is expected

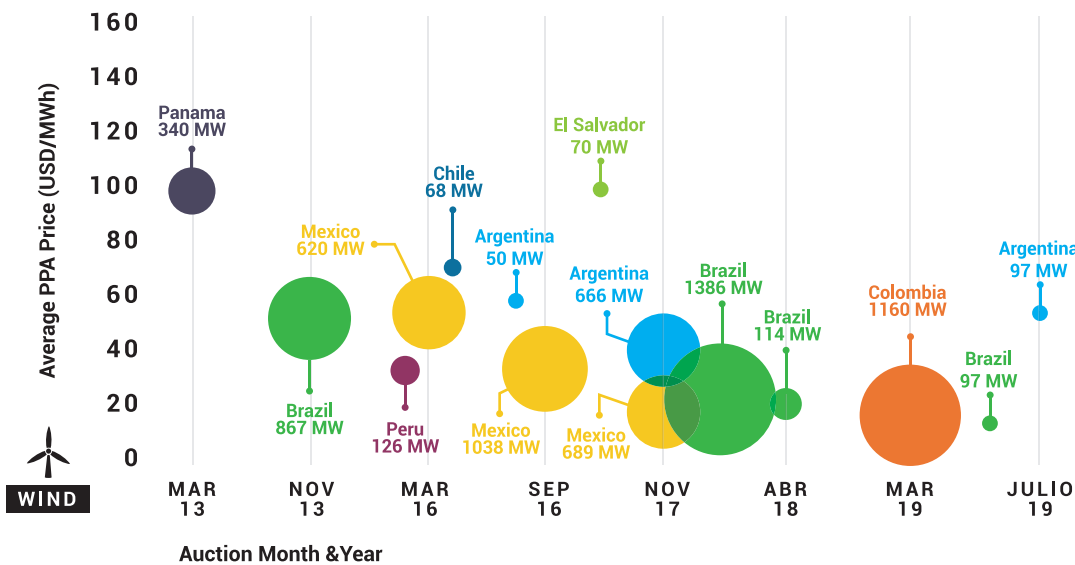
to continue due to the significant pipeline of solar PV and wind projects under construction or contracted, which, in many countries, is higher than the capacity already in operation.



Antofagasta Region, Chile

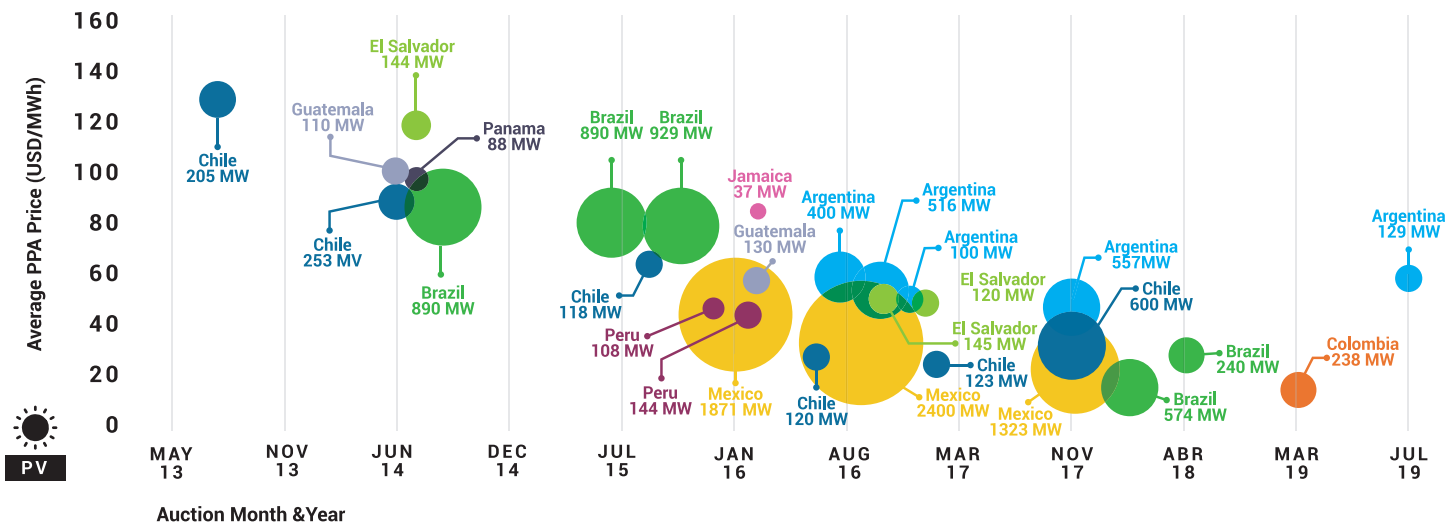
The fast deployment of wind and solar PV energy installations was driven by the significant decrease in costs of main components (wind turbines and PV modules) and technology improvements, which, consecutively, has led to tremendous decline in cost of power generation (LCOE) through these two technologies. Recent auctions for wind and solar PV energy installations in the region confirm the long-term trend of improved economic competitiveness. Auctioned prices have fallen, between 2013 and 2019, by more than 80% for both technologies (Figure 7 and 8).

Figure 7. Evolution of auction prices for wind projects in LAC



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

Figure 8. Evolution of auction prices for solar PV projects in LAC



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

The LCOE for solar PV and wind power reached cost parity with hydrocarbons-based generation in some LAC countries. New wind and solar PV plants are cheaper than new coal and gas plants in some countries in LAC, making the renewable energy pathway a no regret option. These technologies are winning the race to be the cheapest sources of new generation. In many countries, such as Peru, Mexico, Uruguay, Argentina and Brazil, wind energy is below LCOEs for fossil fuels. In the case of solar PV, Chile has one of the lowest LCOEs in the world meanwhile in Peru, Chile, Colombia and Mexico solar is already cost competitive with fossil fuels. The Figure 9 shows that on purely economic grounds it will be increasingly difficult to justify investments for power generation using fossil fuels in some countries.

While acknowledging the challenges and differences between national circumstances, a full decarbonization of the power sector is found to be technically and economically feasible as well as financially attractive, given the substantial resource endowment, well-structured policy framework, technological improvements, abrupt cost reductions, and strong institutional capacities. Moreover, the fact that 7 countries in the region have been named as attractive markets for clean energy investments is indicative of the opportunities in LAC to achieve the decarbonization of the power sector by 2050. Specifically, Chile, Brazil, Argentina and Peru are in the Top 10 and Colombia, Panama and Uruguay made it to the Top 20 most attractive countries for clean energy investments out of 104 nations.

However, despite these improvements, the region is currently at a crossroads to make strategic decisions that will

**Figure 9. Cheapest source of new bulk power generation on a LCOE basis for the LAC region, 2H 2019**



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

define the future of its power system in conditions of efficiency, quality, reliability, safety and sustainability. According to the report, dams – the largest source of electricity production today (46% of total installed capacity) – will produce a quarter less due to water variability by 2040. At current pace, gas will overcome hydro as the main source of electricity production in about 10 years, by 2030. Apart for

the increase in GHG emissions this will create a technology lock-in for many years ahead and likely put us out of the Paris Agreement goals.

LAC nations should include the highest share of non-conventional renewables in their power matrix, discouraging technologies that contribute to climate change and that pose future economic uncertainties.





San Pedro, Belize

Photo by Aristedes Carrera on Unsplash

## Transmission and distribution

Transmission and distribution (T&D) infrastructure is a critical element of the coupled transition process. The report finds that the management, structural and resource elements to support a smart regional grid are already present in LAC. The hydropower capacity installed in the region and the non-conventional renewable potential makes this a unique avenue to launch a decarbonization pathway taking advantage of the complementarity of the baseload and intermittent renewable resources. Other factor that could underpin the decarbonization of the power sector is the existing interconnected power systems in the region and country-to-country links that form the basis for a larger integration effort. The strengthening of the interconnection of power grids would provide benefits in terms of better supply demand conditions and thus potentially lower overall generation costs.

However, there are still gaps elements, and policy instruments missing that could be used to accelerate the transition toward a smart, regional grid. The report concludes that a regional grid designed to cater to a 100% renewable power system, and a higher level of integration with demand, would further need to:

- a) Be able to accept large shares of intermittent or variable renewable energy sources to dampen fluctuations and take advantage of existing complementarities between energy endowments.
- b) Provide a link between major reservoirs in different climatic zones (areas with complementary pluviometry) allowing effective shares of baseload at a regional scale.
- c) Allow the integrated operation of storage systems and demand management systems.

- d) Enable the operation of distributive power in nodes connected to the grid for stability and reliance.
- e) Provide efficient, low loss, competitive, transmission systems over long distances and with sufficient capacity.
- f) Permit the integration and demand/supply management of an extensive fleet of electric vehicles.
- g) Enable a high-level of market transparency with clear rules of access and open competition.

The T&D system will be aided by a more decentralized grid, closer to load centers requiring less infrastructure of this kind. Particularly, renewable distributed generation (DG), mainly distributed solar PV, is starting to gain a larger share of LAC's renewable market. By the first half of 2019, almost 2GW of distributed solar PV has been installed in the region. Brazil (870MW), Mexico (817GW), Dominican Republic (119MW) and Chile (27MW) with the largest share. Emerging markets for DG in Latin America are starting to flourish, including Honduras, Colombia and Argentina. A growing number of LAC countries are issuing net-metering/net-billing laws and incentive packages to promote DG deployment. At the end of 2010, only two countries in the region had pledged net-metering/net-billing laws to promote decentralized generation from renewable energy sources. In contrast, in 2019, at least 15 have done so in Latin America (Figure 10).

21. <https://www.aneel.gov.br/>

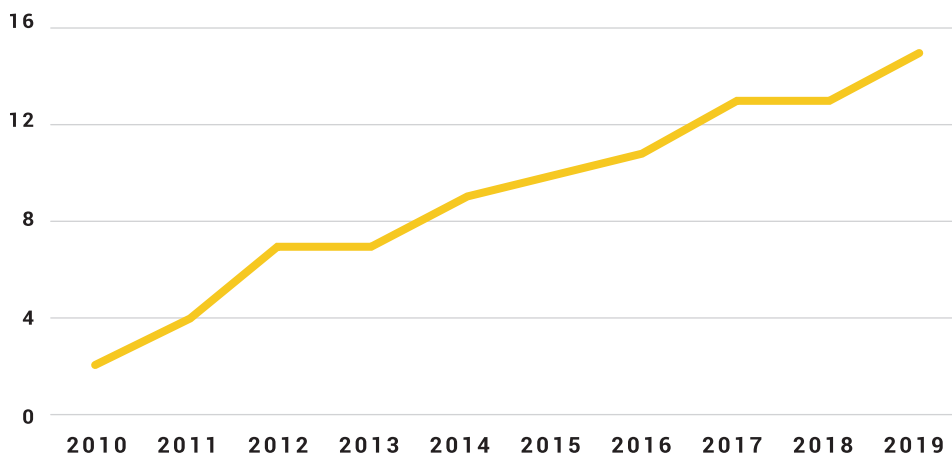
22. [https://www.gob.mx/cms/uploads/attachment/file/483322/Estadisticas\\_GD\\_2019-1.pdf](https://www.gob.mx/cms/uploads/attachment/file/483322/Estadisticas_GD_2019-1.pdf)

23. <https://www.cne.gob.do/medicion-neta/>

24. <https://acera.cl/wp-content/uploads/2019/11/2019-10-Bolet%C3%ADn-estad%C3%ADsticas-ACERA.pdf>



**Figure 10. Number of countries in Latin America with net metering/net billing laws issued.**



Source: Author's estimate with policy information from countries.

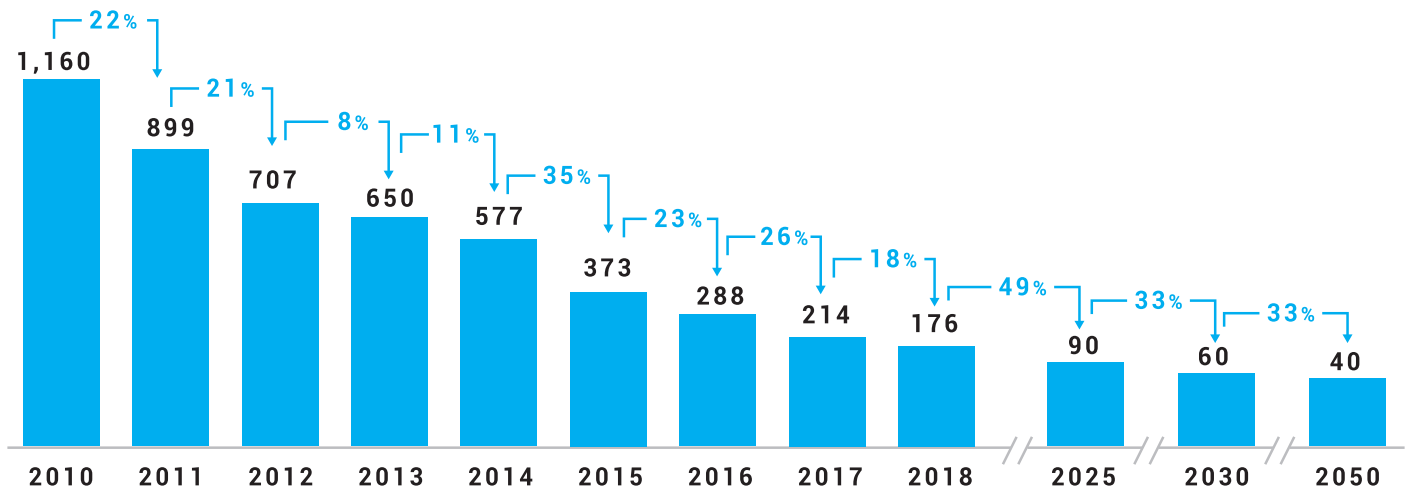
As more and more players enter the energy system, this will shift towards decentralization, becoming a system of systems, where the traditional vertically integrated energy scheme will need to adapt to integrate a great number of DER. Prosumers, electric vehicles, demand-response and many more technologies and agents making use of the grid and providing ancillary services, like storage, generation, flexibility and perhaps even balancing are slowly but steadily becoming a reality. This new meshed system will only be possible with the digitalization of the power system to create a smart grid. It will also open opportunities for traditional utilities to provide services for which they already have the know-how and the technical capabilities.

### **Electric transportation**

The characteristics of the transport sector of having most road passenger activity concentrated in cities, high bus utilization rate per capita, and well-known patterns of cargo transport are crucial elements to vouch its electrification and develop ancillary industry tailored to regional needs. Battery prices fall nearly 50% in 3 years (Figure 11), the cost of electric vehicles is rapidly decreasing, and new technologies are entering the market, supported also by increased concern on air quality and congestion, make possible to consider faster market entry of electric transport options. Also, increases in energy density of electric batteries have allowed improvements in vehicle autonomy and feasibility of entry of heavy-duty vehicles. Ongoing technology developments include: a) deployment of dual battery systems that could reduce overall battery costs for heavy duty applications; b) high-performance charging infrastructure with voltages suitable for heavy vehicles; c) market entry of new high-



**Figure 11. Recent and projected costs for battery packs for electric vehicles (US\$/kWh)**



Source: Author's estimate with policy information from countries.

performance battery systems, eventually enabling denser, lighter batteries; d) development of electric highways for modified electric vehicles to charge while driving; and, e) on the software side, demand management of transport fleets.

The large number of buses in the region, concentrated in urban areas and its high utilization rate per capita offer an important market for the development of an electric-bus and ancillary industry tailored to the regional needs. Momentum for electric buses is beginning to be built regionally, since policy makers continue to push toward zero emissions public transport.

As analyzed, common actions are identified among countries for the promotion of electric mobility. One of them is the electrification of public transport systems. Policy makers continue to push toward zero emissions public transport. Improving economics, while complying KPIs, and growing concern about health and environmental impacts of emissions from ICE buses in cities are the two main drivers. In this respect, momentum for electric buses is beginning to be built regionally. The total cost of ownership (TCO) of electric buses is reaching cost parity with ICE buses in some cities of the LAC region. This is mainly due to the development of new business models through tendering process for public bus system that are boosting electric buses adoption, such as in Santiago de Chile and Bogota. The investment decision making under this business models was based on the TCO rather than the purchase price. In this sense, the TCO of electric buses was lower than that

of ICE buses, mainly due to a 70% reduction in operating expenses. The bus characteristics and requirements in the region are different of those under development elsewhere (capacity, climate control, route lengths). Age of bus fleets in Latin America is very diverse; in some cases, reaching up to more than 20 years of operation. For this reason, large number of buses will be tendered throughout the region in the short and medium term. This opens a window of opportunity to increase e-buses deployment. In addition, cities with higher emissions standards (EURO VI) are more easily able to transit to zero emissions public transportation, since purchase price gap between electric buses and ICE buses is reduced.

Policy and regulation will play a critical role to decarbonize public transport systems fully. Clear targets and roadmap are a must for the development of this brand-new market structure. This entails policies supporting deployment of public electric transport systems and the entrance of new players in the electric market. The promotion of electric mobility implies a cross-cutting coordination between sectors. Although it is seen as a transport issue, it involves the energy sector and all its actors in the electricity subsector, from generators to electricity retailers. Decisions taken today in the transport sector will define the climate future. Many cities are renewing large fleets of buses with dirty technologies (ICE vehicles), which will be in the market for at least 15 years creating stranded assets. The renewal of fleets is an excellent opportunity to transition to electric vehicles.



In 2019, the electrification of other transport segments, such as official fleets, delivery and cargo fleets, as well as public sanitation, has become more evident. Mostly, consisting of pilot projects to evaluate the performance of the technology for later scale up. The road cargo transportation offers opportunities for electrification at the point of use, which is particularly attractive for cities (about 70% of cargo transport in the region is carried by trucks). Electric small size trucks will provide an opportunity for cargo applications, as "last mile" delivery and small logistics, particularly in urban areas. In this segment, the TCOs are starting to reach attractive values compared to those of small ICE trucks and thus same business models are beginning to evolve in the region.

In terms of charging infrastructure for electric vehicles, there has been an increase in the deployment of this type of infrastructure. This charging infrastructure has been developed mostly by strategic investors, such as oil and gas and utility companies and automakers. Mexico stands out in absolute terms, as the country with the highest number of public cargo centers in the region. While Barbados, stands out as the country with the largest coverage of recharge infrastructure by population density or number of registered electric vehicles. On the other hand, in 2019, Mexico launched the longest electric vehicle corridor (also known as the "electro corridor") in Latin America and the Caribbean with a distance of 620km. Uruguay was the first country in the region to install its electro corridor, followed by Brazil. For its part, Chile, as well as other countries and cities, are deploying charging infrastructure with the purpose of extending the autonomy radios of electric vehicles (Figure 12).

**Figure 12. Electric corridors for electric vehicles in LAC**



**1 Mexico**

- Corridor 620km S.L.Potosí, CDMX, Puebla.
- ChargeNow network with +660 charging centers.
- Tesla network with ~80 super chargers.

**2 Costa Rica**

- 47 DC charging centers (4 intalled)

**3 Panamá**

- (release pending) 12 charging centers + solar panels.

**4 Barbados**

- 50 charging centers with membership.

**5 Colombia**

- (soon to be constructed) Corridor with 15 charging centers in Bogotá and Medellín.

**6 Brasil**

- Corridor with 434 km with 6 DC charging centers Rio de Janeiro and Sao Paulo.

**7 Uruguay**

- 30 semi-fast charging centers of the electricity company
- First corridor installed in LAC.

**8 Chile**

- Corridor from Marbella to Temuco 730km, works with fee.
- Temuco Corridor to Chiloé 500km + Coyhaique and Aysén 70km

**9 Argentina**

- 212km corridor in the province of San Luis Integrated charging center Argentina-Chile in Neuquén.

Source: MOVE, 2019

As electric vehicle fleets and associated charging infrastructure increases, it becomes highly important to foster interoperability, infrastructure standardization and management and recharge commercialization systems. A vital aspect that still has the possibility of being explored more deeply is the integration of the national and local electricity network (distribution) with the necessary recharging infrastructure to allow the development of large-scale electric mobility.

On the other hand, consumer interest in electric vehicles is growing as car manufacturers launch more electric car models. This context signals a promising transition in the transport sector.

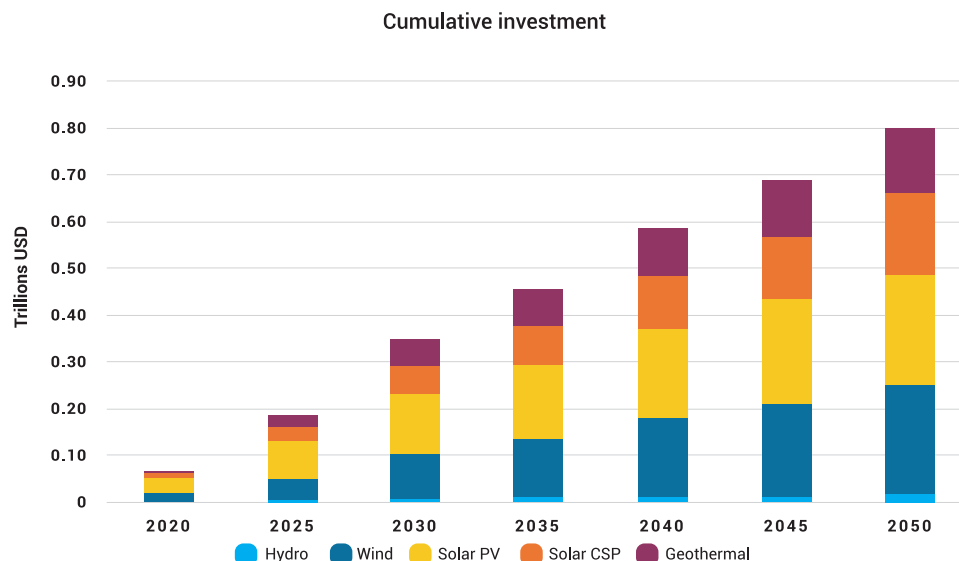
### Benefits and economic costs of a coupled decarbonization.

A coupled transition not only aims to reach zero emissions by 2050, but it also has the potential to grow the region's economy while improving public health.

#### Reduced capital investment requirements.

By 2050, electricity demand is anticipated to almost triple (16.7 EJ), which does not include the future power demand caused by an electrified transportation sector-requiring substantial additional installed capacity. Meeting the 2050 electricity demand under a fossil fuel-based generation matrix (BAU scenario) would increase 2.4 times CO2 emissions up to 1,200 million tons. This would place the region further away from the 2°C pathway. Additionally, the investment volume required in installed capacity is

**Figure 13. Cumulative annual capital investments required in the power sector, 2020-2050, under the intervention scenario.**



Source: Author's estimates

estimated at US\$ 1083 billion (2018). A fully renewable energy power matrix will deliver zero CO2 emissions and require substantially less capital investment than a fossil fuel-based generation (US\$ 800 billion), resulting in US\$ 283 billion in capital investment reductions by 2050 (Figure 13). On the other hand, capital investments linked to the scenario with compliance of the Paris Agreement (RCP 2.6), which includes instead heavy reliance on carbon capture and storage while maintaining a hefty participation of fossil fuels, would be considerably higher (US\$ 2,200 billion (2018)).

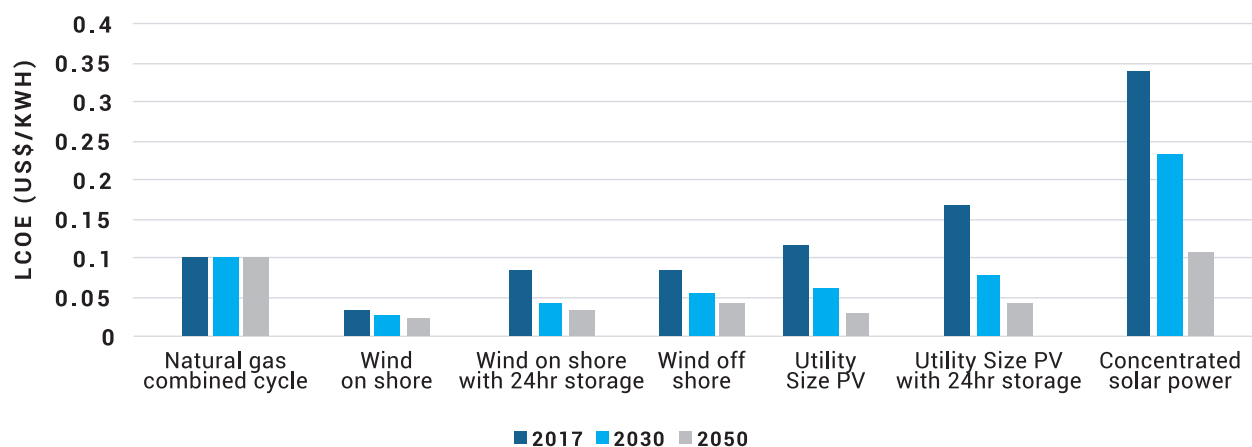
Clearly a pathway that takes advantage of the competitiveness of renewables in the region is less capital intensive.

It is worth noting that more and more countries are developing legal and regulatory frameworks that create the enabling conditions for distributed solar PV deployment. In some nations, distributed PV is already an important

market (Mexico, Brazil, Chile and Dominican Republic), in others are rapidly growing (Colombia, Argentina and Honduras). In this sense, if current trends continue, under the intervention scenario, it is estimated that the distributed solar PV will reach a great percentage of the total solar PV installed capacity by 2050 – penetration of decentralization is growing. To unlock solar PV distributed potential is critical to implement robust legal and regulatory frameworks adapted to small-scale installations that tackle main market barriers, such as generation permitting procedures, technical standards, grid connection rules, among others. The renewable DG sector is a strategic market to foster innovation and promote new business and job creation.

This could be achieved through the development of installer training programs, certification of technology standards and eligibility criteria for installation companies.

**Figure 14. Projected LCOEs of non-hydro renewables vs natural gas (USD\$/kWh)**



Source: Author's estimates.

Developing the local distributed PV industry will help create new sources of employment and increase the countries' competitiveness in an evolving global industry.

### Lower electricity and rolling stock costs

It is considered that the LCOE for solar PV, wind and hydro technologies continue to drop, reaching and surpassing cost parity with hydrocarbons-based generation by 2050 (Figure 14). It is worth noting that LCOEs presented in Figure 14 are an average for the region. LCOE from on-shore wind and solar PV already outperform natural gas and coal while off-shore wind and solar PV with storage are expected to do so before 2030. LCOEs from hydropower and geothermal are already competitive with fossil fuels. Marine energy continues to be relatively expensive but warrants investments in R&D given the sizable resources available in the region.

The comparison of projected LCOEs (Figure 14) indicate that on purely economic grounds it will be increasingly difficult to justify investments for power generation using fossil fuels. Coal is no longer competitive in many countries and there are no sound reasons for new coal plants to be installed in the region. Also, the arguments in favor of new investments in natural gas are questionable. Natural gas is being outperformed by wind and challenged by solar PV and even if the differences today are small, investments in

natural gas capacity already appear not to be competitive (Figure 14). The deployment of solar PV and wind with storage provides firm capacity to these technologies and is anticipated to also become competitive with natural gas power plants. New advances have the potential to accelerate the economic competitiveness gaps.

Cheap renewables will pave the road to electricity decarbonization. The lower capital and operational costs associated with wind, solar, geothermal and hydropower are anticipated to result in lower electricity generation costs (LCOEs). The projected LCOE under the intervention scenario by 2050 is estimated to be US\$ 0.048/kWh (50% lower than in the BAU scenario).<sup>25</sup> The estimated cost of generation under the BAU scenario is US\$ 0.097/kWh. Shifting to a renewable energy matrix would result in significant savings in electricity costs to the regional economy in the order of US\$ 222.7 billion by mid-century.<sup>26</sup> The reductions in generation costs would be directly accrued by electricity consumers making manufacture more competitive and delivering savings to households.

On the other hand, future costs of electric transportation LCOTs<sup>27</sup> also continue to drop. The results confirm an expectation of increased competitiveness for all segments of the fleet, with electric cars and buses becoming the cheapest alternative before 2025. It is worth noting that LCOTs presented in Figure 15 are an average for the region. In many cities, such as Santiago de Chile, Chile, and Bogota,

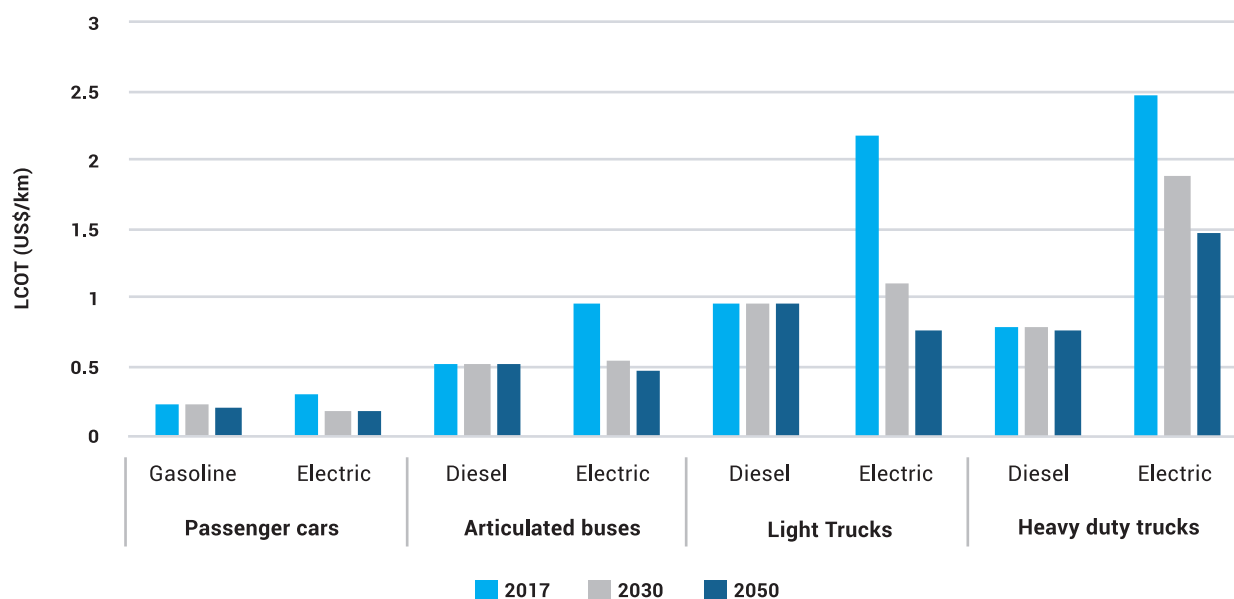
25. The LCOE was estimated on the basis of the LCOEs for each technology and the corresponding share of generation under the intervention and BAU scenarios.

26. Based on a demand of 16.7 EJ

27. LCOTs measure the levelized capital, operation and maintenance charges during the lifetime of the vehicle. The calculation for the LCOT includes depreciation costs, fuel costs, insurance, financing, repairs and maintenance cost. The only difference with total cost of ownership (TCO) is that it does not include fees and taxes. This explains why the LCOT curves for ICE vehicles remains flat in time instead of increasing.



**Figure 15. Projected LCOEs of non-hydro renewables vs natural gas (USD\$/kWh)**



Source: Author's estimates.

Colombia, electric buses have reached cost parity with ICE buses. Under the intervention scenario, most of the service is projected to be delivered through road transport. For passenger road transport, big reductions in LCOTs are anticipated for electric light vehicles while electric buses will at most have the same costs of the diesel options. The intervention scenario assumes that the car fleet will not increase more than 30% its current size by 2050, while the bus fleet will more than double its size to compensate the reduction in light vehicles transport measured in passenger kilometers. Under these assumptions, it is estimated that the overall savings in passenger transport costs to the economy would be of the order of US\$ 328 billion in passenger transport. No estimates were made for passenger transport in other modes (rail, vessels).

For cargo transport, the calculated LCOTs for electric light trucks (90% of the road cargo fleet) are also lower while heavy duty vehicles continue to be more expensive by mid-century. The composition of the fleet (90% light trucks; 10% heavy trucks) is kept constant. Under these conditions, it is estimated that the overall savings in capital costs to the economy would be of the order of US\$ 41 billion in cargo road transport. No estimates were made for cargo transport in other modes (rail, vessels).

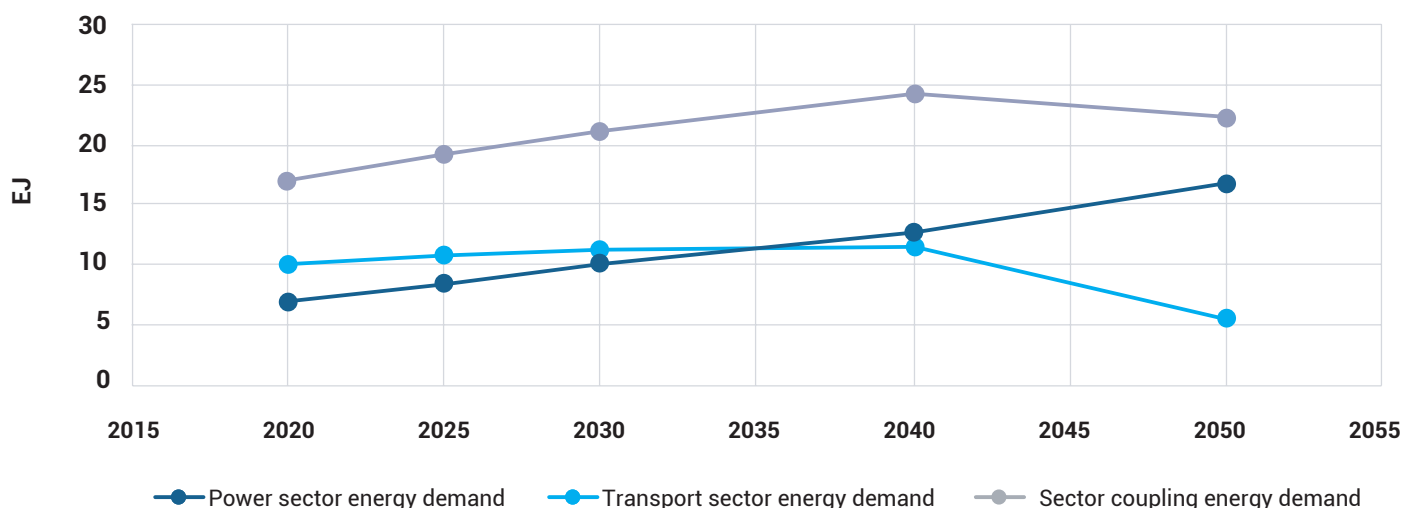
The reduced cost of rolling stock and electricity will provide savings in road transport at US\$ 369 billion by 2050.

#### **Combined lower energy demand**

As the energy efficiency of electric drives is 3 times higher than for ICE, the energy demand of the transport sector under the intervention scenario is much lower compared to the BAU scenario. The transition to electric transport has the net effect of reducing total energy demand in the region while increasing future power requirements. A 100% electrification scenario - except air travel - by mid-century would have the net effect of reducing the total energy demand by almost 2,000 million barrels of oil (12 EJ), equivalent to the Canada's annual consumption, while increasing electricity demand by 33% more than the BAU scenario (21.5 EJ). The combined power requirements are shown in Figure 16.

The installed capacity needed to meet the additional power demand is 327 GW mostly required by 2040 and afterwards. If the electrification of transport is coupled to a fully renewable power matrix, the investment associated with the additional power demand is estimated at US\$ 214 billion by 2050. Otherwise, if the electrification of transport occurs under a BAU power sector scenario, the investment associated with the remainder of the additional power demand is estimated at US\$ 317 billion. The cost of the additional capacity to meet this power demand is lower under the coupled transition because the CAPEX associated with power generation under a fully renewable power matrix is lower. The difference in costs is estimated to be US\$103 billion. This is an additional benefit of coupling the transition process.

**Figure 16. Projected demand under a coupled decarbonization of power and transport sectors (EJ).**



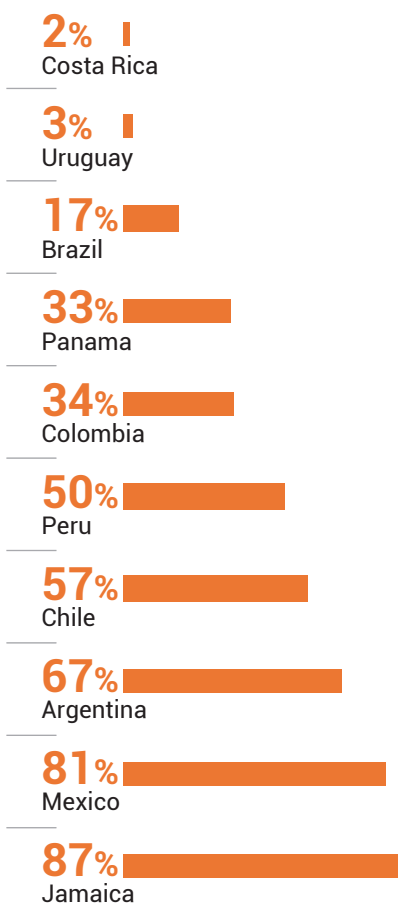
Source: Author's estimates.

Additionally, as it transitions, the transport sector becomes capable of storing and managing larger amounts of energy. It is difficult to project the role that the storage of power in transport can play under the supply/demand characteristics of the region. For example, it is estimated that the combined electric truck fleet would represent a power storage capacity of the order of 8 GWh by mid-century.<sup>28</sup> If properly managed, electric transport demand would also improve the operation of baseload generation capacity through its flattening of demand.

### Energy security

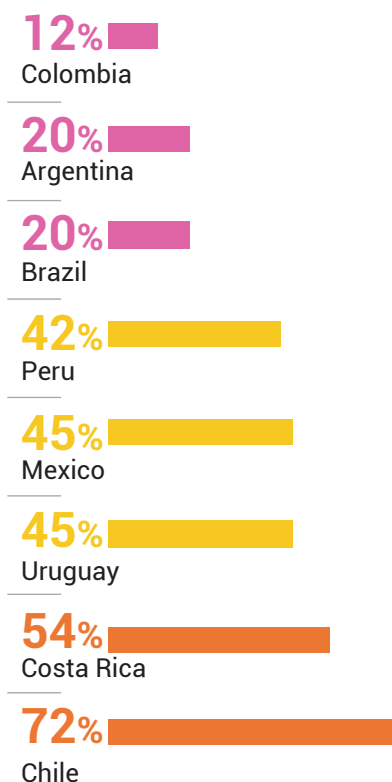
Failure to ensure power supply can result in serious disruptions to national economies. The more the nations consume power from local and clean resources, the less exposed they are to external shocks, such as price volatility or political risks from the energy seller country, which may result in an energy crisis for the buyer.

**Figure 17. Share of fossil fuel in electricity generation**



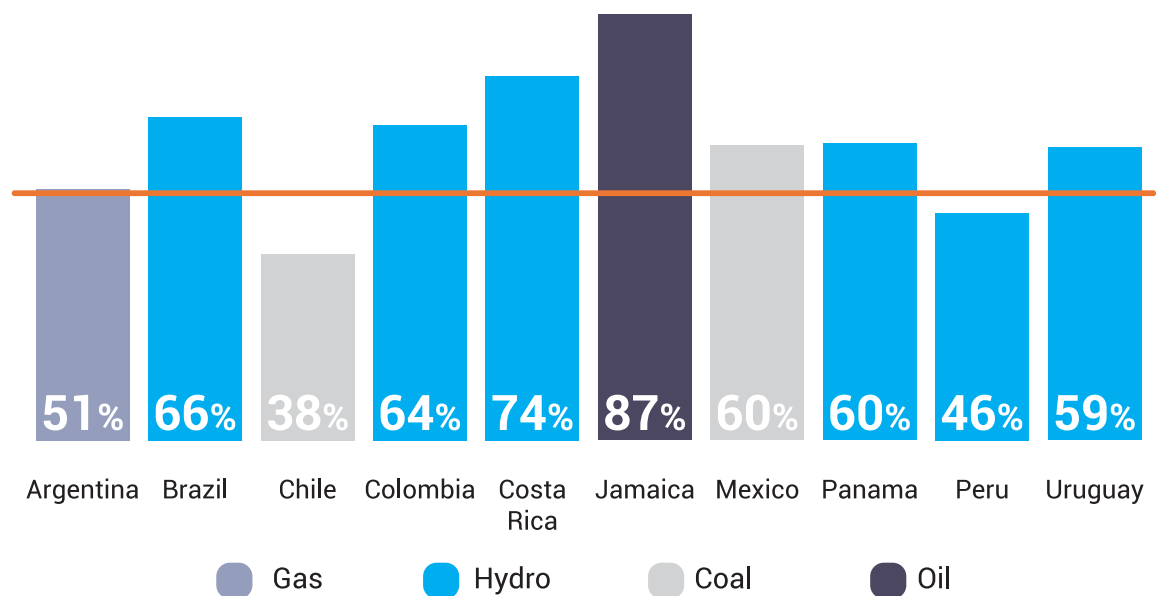
Source: Based on data from ENERDATA consulted September 2019

**Figure 18. Imports of energy feedstock as percentage of total primary energy supply (TPES)**



Source: Based on data from ENERDATA consulted September 2019

**Figure 19. Share of largest generation of power supply**



Source: Based on data from ENERDATA consulted September 2019

The intervention scenario relies on a fully diverse renewable power matrix and the electrification of the transport sector by 2050. This simultaneous and coupled transition of the power and transport sectors will reduce risks of disruption. Particularly, fossil fuel energy import dependency will be reduced, since it eliminates fossil fuel use for power generation and transport by 2050. It also minimizes hydropower generation, considering climate change impacts on water availability.

Under the intervention scenario, the largest change in the security indexes, would be experienced by countries with a large dependence on imported fossil resources for power generation - Jamaica, Mexico and Argentina – (Figure 17) and for transport use - Chile, Costa Rica and Uruguay – (Figure 18), followed by countries with reliance on mostly one source of energy, such as Jamaica as the least diverse (87% of generation from oil derivatives) and Costa Rica, Brazil and Colombia (74%, 64% and 63% of generation from hydropower, respectively) (Figure 19).

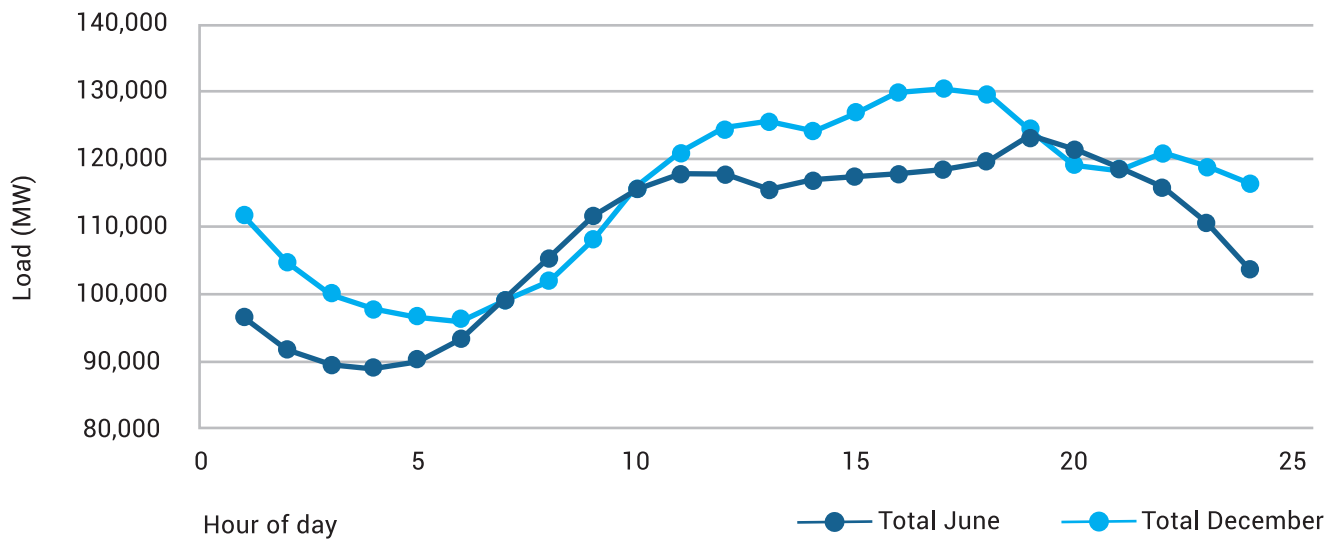
### Impact on power sector loads and size

The entry of a large electric fleet in the region would add additional power demand (estimated by 33% increase in electricity demand by 2050). The power requirements of electric transportation have the potential to destabilize the grid. Through proper demand management, charging in urban areas could be steered toward periods of lower load, in a process that is known as “valley filling”. In theory this process would enable the installed capacity to operate at a more efficient level by flattening the demand curve using new transportation loads at the most adequate time through robust demand management. The use of the valleys in the load curve (demand flexibility) has been estimated to equal about 10 GW of equivalent capacity (Figure 20). Additional loads of the size required by the electrification of transportation will require new capacity but also result in reduced overall energy demand through the higher efficiency expected from electric engines.

28. Based on a fleet of 20,000 trucks each equipped with a battery storage of 400 kWh, for an autonomy of 200 miles. Energy efficiency as calculated by CARB, 2018 for electric trucks (<https://ww3.arb.ca.gov/msprog/actruck/docs/180124hdbvefficiency.pdf>)



**Figure 20. Aggregated load curve for Latin America <sup>29</sup>**



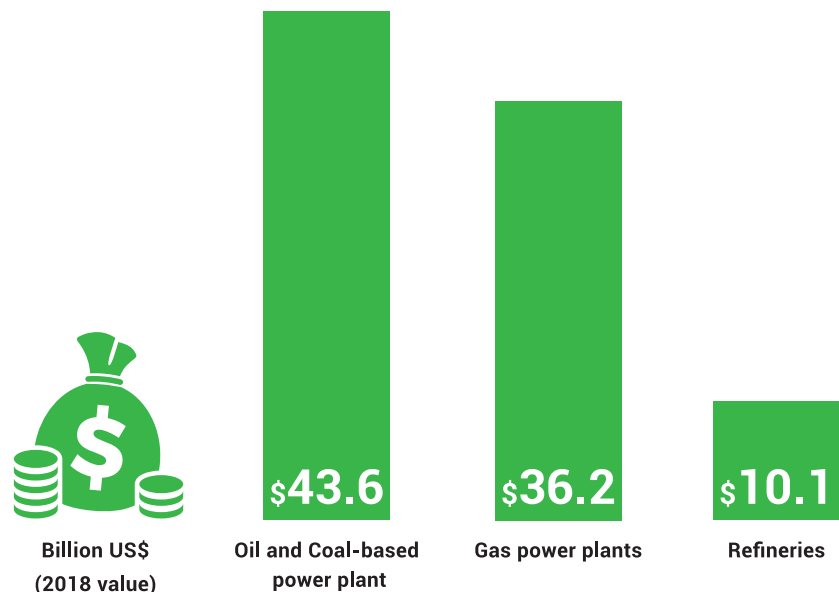
Source: Compounded graph from country-based load curves provided through the Latin America Energy Organization (OLADE) in personal communication. Straight line indicates the mean load for each curve, 109 GW in June and 115 GW in December.

### Impact on refining operations and stranding of capital assets

The projected decrease in the demand for gasoline and diesel will reduce the need for most refinery operations. Initially, sizable entry of electric fleets, of the magnitude anticipated under the intervention scenario would eliminate the need for additional refining capacity and reduce the need for imports of middle distillates (gasoline and diesel; estimated to be at 0.5 billion barrels per day, bbpd and 1.0 bbpd respectively by 2030 under BAU conditions). The total electrification of fleets would eventually eliminate the need for refining of middle distillates. The complete transition of the electricity sector would displace all fossil fuels used in the generation of power. Consequently, there would be an impact on the use and value of associated production, refining, transportation and distribution infrastructure.

A fully renewable power scenario considers that installed fossil fuel power plants will be decommissioned

**Figure 21. Estimated residual value of assets in power generation and refining at time of retirement (in billion US\$ 2018)**



Source: Author's estimates

before the depreciation schedule is completed. The not-depreciated value was estimated at US\$ 80 billion (2018) by 2050. The cost to the economy of these stranded assets are highly compensated by the CAPEX reduction between scenarios. The projected loss of competitiveness represents a clear cautionary signal for fossil fuel

investors. Electrification of transport will also eliminate the need for imports of middle distillates and eventually cause the early retirement of refinery capacity resulting in a loss of non-depreciated value to the order of US\$ 10.2 billion by 2050. Like in the case of power plants, impending market changes in transport should back a

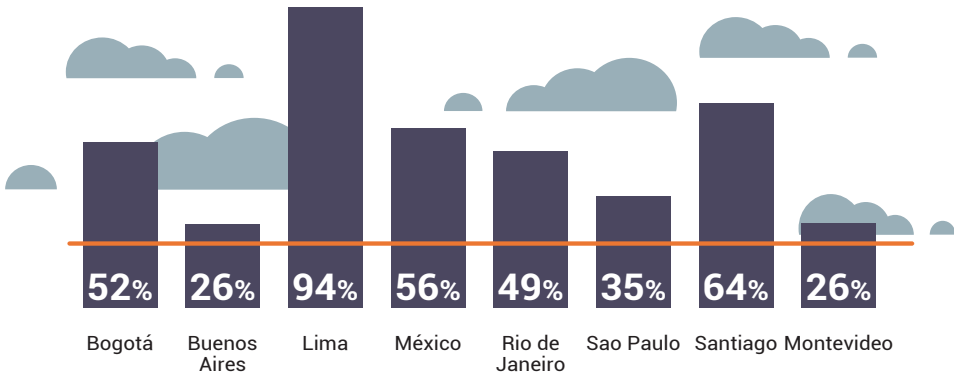
cautionary warning against longer-term additional CAPEX in refinery processes for middle distillates.

The economic consequences of the transition caused by displacement of some of these capital assets in the region can be seen in Figure 21.

Health benefits

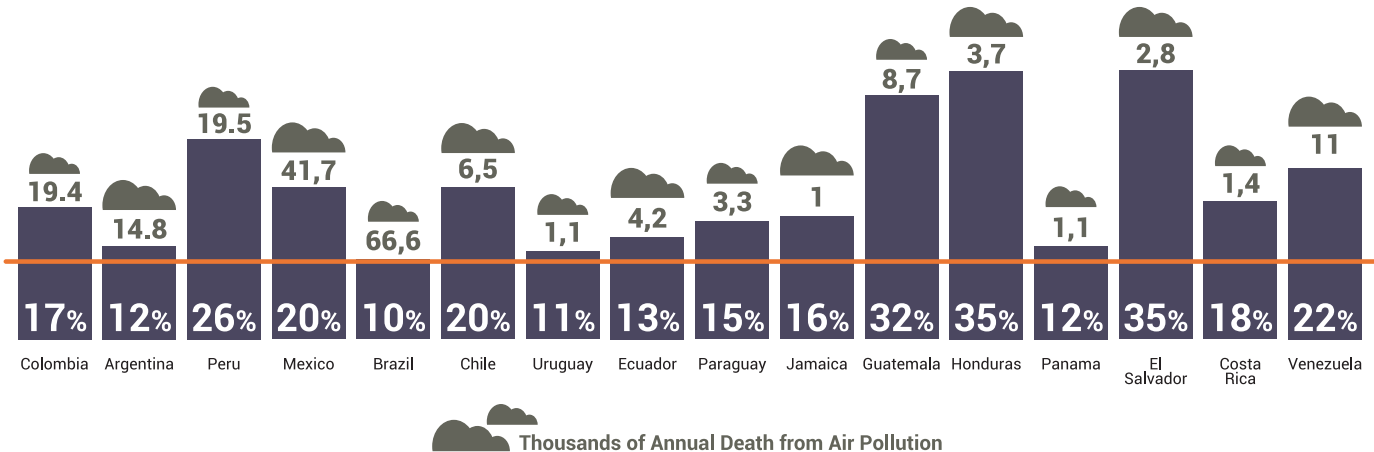
Urban air pollution in LAC has long been identified as a major health concern.<sup>30</sup> The World Health Organization (WHO) has recommended human exposure indicators, including for particulate matter (PM<sub>10</sub> = 20 µg/m<sup>3</sup> and PM<sub>2.5</sub>=10 µg/m<sup>3</sup>), that should not be exceeded.<sup>31</sup> Exposure to harmful levels of some pollutants (particulate matter and ground level ozone) has been linked to increases in morbidity and mortality levels and losses in productivity. Even lower levels of exposure have some effects on health and productivity.<sup>32</sup>

Figure 22. Annual average of PM<sub>10</sub> in some cities in Latin America exceeding recommended levels of exposure



Source: WHO<sup>33</sup> ; Rioja-Rodriguez et al, 2016. WHO Standard for PM<sub>10</sub>: not to exceed 20 µg/m<sup>3</sup> annual mean.

Figure 23. National annual average of PM<sub>2.5</sub> for some countries in Latin America



Source: BreathLife campaign. WHO Standard for PM<sub>2.5</sub>: not to exceed 10 µg/m<sup>3</sup> annual mean

29. Aggregated load curve for the electricity system in Latin America, prepared assuming full integration at a regional level. Similar conditions prevail at a national level.

30. <https://publications.iadb.org/en/publication/urban-air-quality-and-human-health-latin-america-and-caribbean>

31. [https://apps.who.int/iris/bitstream/handle/10665/69477/WHO\\_SDE\\_PHE\\_OEH\\_06.02\\_eng.pdf;jsessionid=AFB0FCE10BF597AD230326327D2D5E61?sequence=1](https://apps.who.int/iris/bitstream/handle/10665/69477/WHO_SDE_PHE_OEH_06.02_eng.pdf;jsessionid=AFB0FCE10BF597AD230326327D2D5E61?sequence=1)

32. A recent study (UNEP, 2018 <https://www.unenvironment.org/news-and-stories/press-release/efforts-reduce-air-and-climate-pollutants-latin-america-could-reap>) estimated that 64,000 people died prematurely in the region from exposure to fine particulate matter (PM<sub>2.5</sub>) and ground level (tropospheric) ozone. Ozone was also responsible for an estimated 7.4 million tonnes in yield losses of soybean, maize, wheat, and rice. If no action is taken to improve air quality, by 2050 annual premature mortality from PM<sub>2.5</sub> and ozone exposure is expected to almost double while annual crop losses could rise to about 9 million tonnes.

33. [https://www.who.int/phe/health\\_topics/outdoorair/databases/en/](https://www.who.int/phe/health_topics/outdoorair/databases/en/); [https://apps.who.int/iris/bitstream/handle/10665/69477/WHO\\_SDE\\_PHE\\_OEH\\_06.02\\_eng.pdf;jsessionid=AFB0FCE10BF597AD230326327D2D5E61?sequence=](https://apps.who.int/iris/bitstream/handle/10665/69477/WHO_SDE_PHE_OEH_06.02_eng.pdf;jsessionid=AFB0FCE10BF597AD230326327D2D5E61?sequence=)

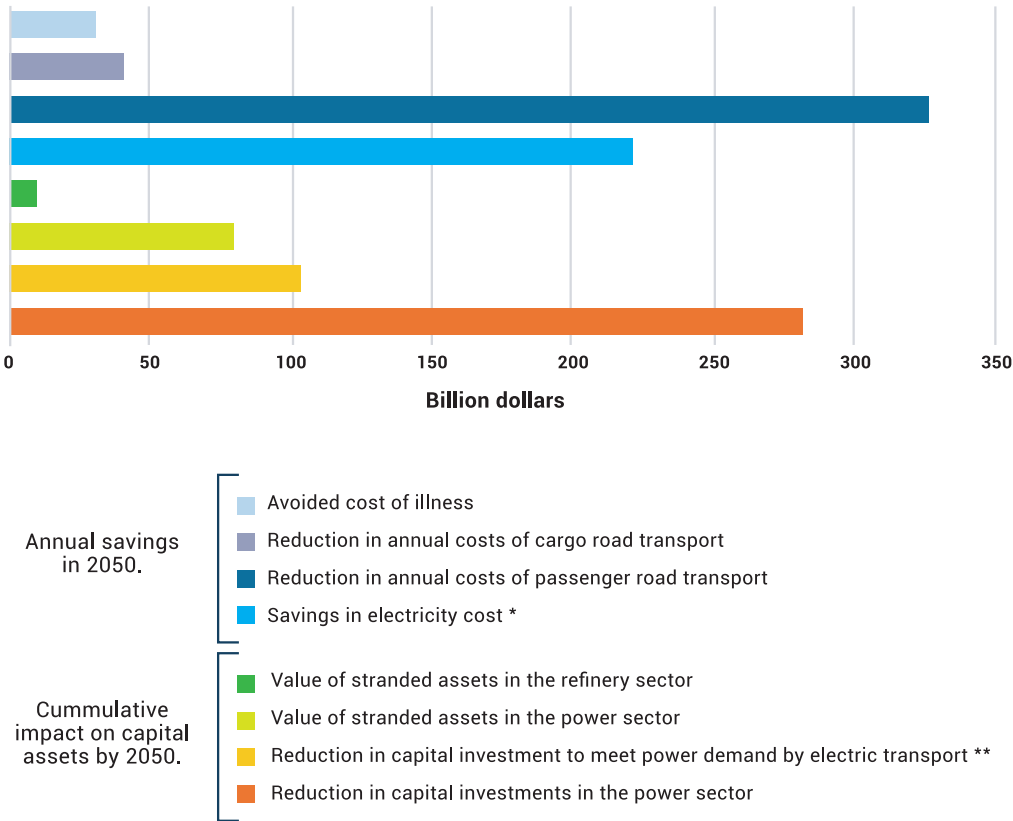
Many cities in Latin America exceed the safe thresholds set by WHO and despite efforts to address the problem, unhealthy levels of particulate matter (Figure 22 and 23) and other airborne pollutants continue to prevail. The region is highly urbanized and therefore a high percentage of the total population in Latin American nations is exposed to these effects. PM<sub>10</sub> and PM<sub>2.5</sub> are respirable particulate matter that can penetrate deeply into the lungs producing harmful effects on human health.

Electrification of transportation in urban areas in a fully renewable energy matrix would eliminate the emissions of particulate matter (PM), a proven human-health risk factor, from mobile sources, mainly by eliminating diesel fuel in transportation. It would also lower ozone formation by eliminating emissions of volatile organic compounds and NOx. These reductions in emissions and exposure translate into avoided cost of illnesses and overall reductions in morbidity and mortality. Under the intervention scenario, the elimination of diesel from the transportation sector in urban areas, where exposure to PM is concentrated, is conservatively estimated to trigger annual avoided health costs of US\$ 30 billion (2018) by mid-century.

In addition, only by changing the entire vehicle fleet to electric vehicles in five Latin American cities – Buenos Aires, Santiago, San Jose, Mexico City and Cali– would avoid the early deaths of 24,000 people due to reduced air pollutants by 2050. The combined costs, benefits and avoided costs of the coupled transition are summarized in Figure 24.

Annual savings linked to the coupled transition by 2050 are valued at: US\$ 621 billion. Net cumulative savings by mid-century on capital assets for the regional economy are estimated at US\$ 296 billion.

**Figure 24. Combined costs, benefits and avoided costs by mid-century under a coupled power and transport zero emissions pathway (in billion dollars, 2018).<sup>34</sup>**



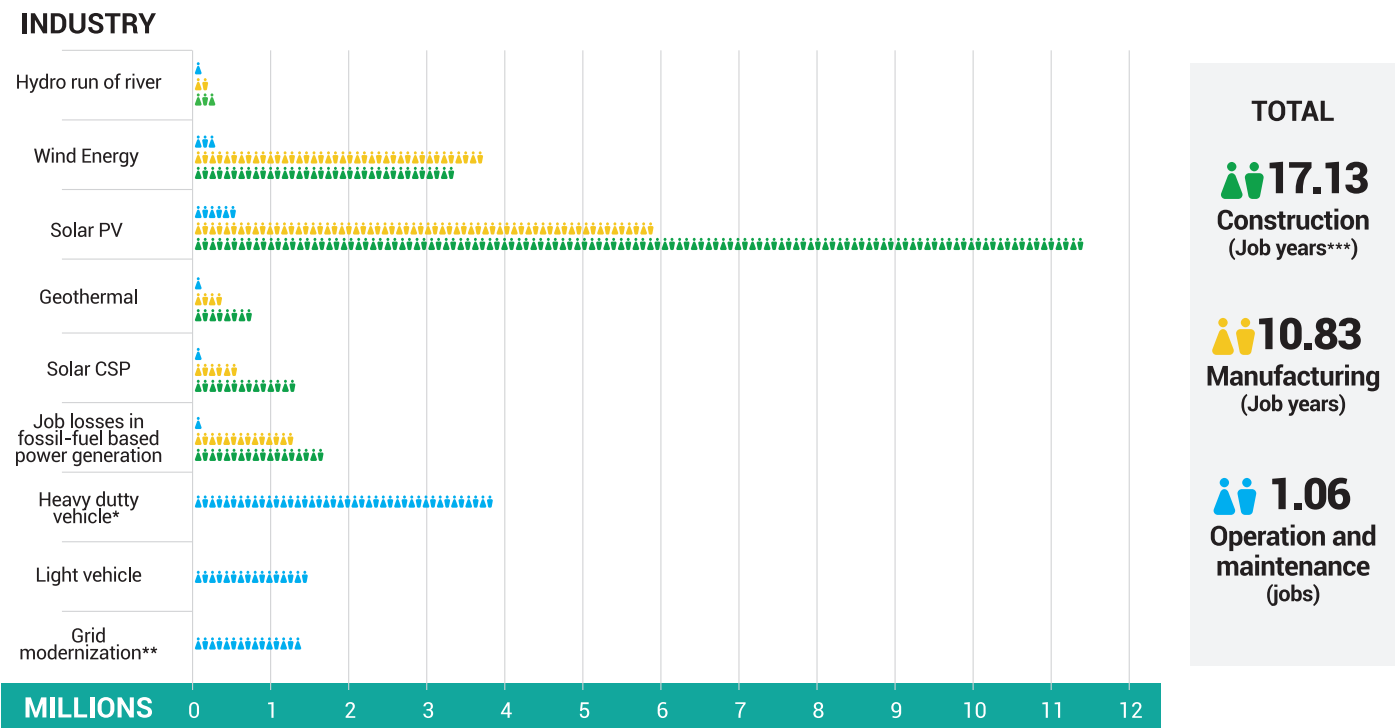
Source: Author's estimates. \*Does not include reduction in electricity costs for the transport sector which are captured in the reduction in costs for road transport. \*\*Is calculated as the difference in capital costs to provide the required energy under the GCAM-BAU power system and the Intervention Scenario.

Jobs and enterprise creation and capacity building

The report estimates that the activities associated with the transition will generate new jobs, educational opportunities and business models for the design, implementation and management of installations, the manufacturing, supply and assemblage of components, and the provision of auxiliary services such as information technologies that will play a major role in the nexus between energy and transport. This transition may be an opportunity for a rekindling of manufacturing, engineering, and financial activity in the region. But it is also a call for new efforts in education and training which are critical to generate local employment for new technologies in the region. On the other hand, the transition will result in job losses in the fossil fuel industry, including in power generation, refinery operations and distribution and retail fuel sales.

The report estimates that a coupled transition to renewable energy and electric mobility in the region will create over 35 million new jobs by 2050 (Figure 25).

Figure 25. Estimate of additional jobs (millions) generated regionally under the intervention scenario per energy technology by mid century <sup>35</sup>



Source: Author's estimate based on of factors an multipliers reported by Dominish E., et. al. 2018. \* Job estimates based on a constant fleet of 150 million cars; 4 million buses and 34 million trucks by 2050. See assumptions and details in Annexes 5 & 12. \*\* Job estimates based on an investment of 26 billion USD between now and 2030 and using the factors for job creation of a smart energy study<sup>36</sup> \*\*\*Job years is a metric used to assess the size of temporary jobs created by activities with a limited time frame.

34. The table reflects the impact of the coupled transition on costs of delivery of prices and capital flows. It does not include subsidies, levies, tariffs or taxes.

35. Job estimates on the basis of factors reported by Dominish E., et. al. 2018 [https://link.springer.com/chapter/10.1007/978-3-030-05843-2\\_10](https://link.springer.com/chapter/10.1007/978-3-030-05843-2_10) and proposed multipliers to reflect conditions in Latin America. The estimated new jobs in transport electrification are underestimated given that ancillary jobs for this sector such as those associated to charging infrastructure are not considered.

36. <https://www.smart-energy.com/regional-news/north-america/new-study-confirms-job-creation-potential-of-smart-grids-in-u-s/>





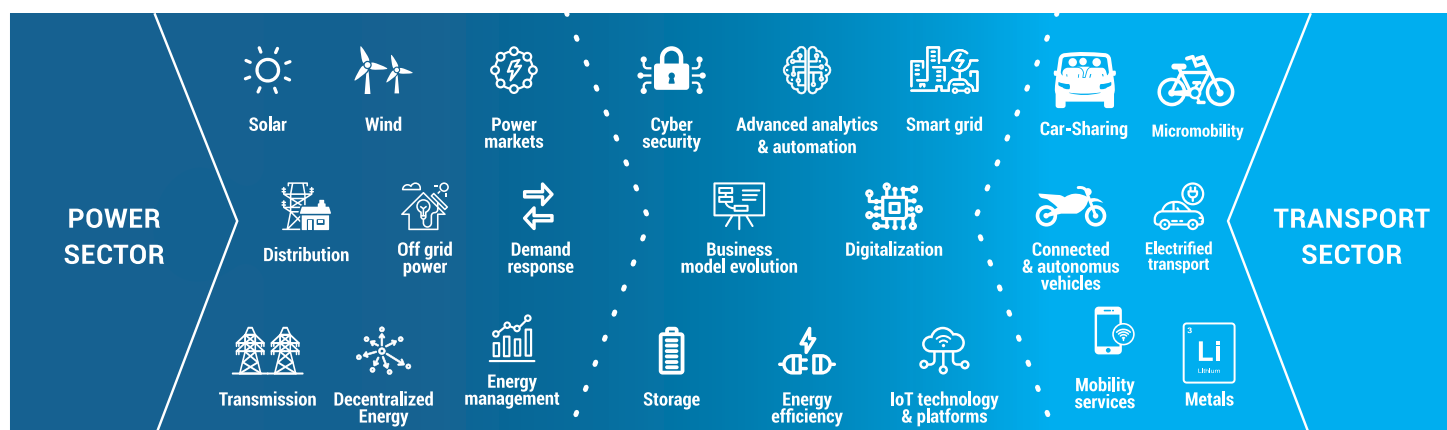
The power sector is undergoing a profound transformation towards decarbonization, decentralization and digitalization. This implies an increase of renewable energy in the power matrix, the installation of DER closer to load centers and the management of this new and connected system through powerful computing tools, respectively. Digitalization is the enabler for a coupled transition of the power and transportation sectors towards decarbonization. Figure 26 summarizes the elements of this transition.

Countless business models will be developed in the coupled decarbonization of the transportation and power sectors. Utilities expanding their services, new players entering both markets, development of DER and digital services are some of the major trends the region is experiencing (described in Chapter 8), showing that the coupled decarbonization has already started in LAC and is picking up fast following global patterns.

### Policy options for an accelerated transition

The policy environment has evolved throughout the region in support of a cleaner power matrix, low carbon resilient development, and a cleaner transport system. The trends in technology and economics have contributed to the growth in the use of renewables, utility scale and DG, and are beginning to make a difference in the emergence of electric vehicles. Nonetheless, the degree and speed of change required to a coupled transition by mid-century makes leadership critical through a clear, consistent and robust policy agenda. Therefore, it is critical that decision-makers overcome silos and consider public policies that address these two sectors in a coupled manner. A well-constructed enabling environment will be critical to attract investment flows towards a coupled transition. The elements of such agenda are summarized in Table 1. Specific examples of each of the public policy instruments mentioned in the Table 2 are deeply described in Chapter 9.

**Figure 26. Business opportunities in the coupled decarbonization of power and transport sector**



**Table 1. Key goals and instruments of a bold policy agenda in support of the coupled decarbonization of the power and transport sectors.**

| Goal                                                                                                                                                                                             | Policy                                                                                                                                                                                                                                         | Instrument                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Reduce the cost of stranded assets in the power generation and refinery sector.                                                                                                                  | Discourage capital investments in the fossil industry.                                                                                                                                                                                         | <ul style="list-style-type: none"> <li>• Clear energy and transport policy adopting zero emission goals by mid-century.</li> <li>• Allow early depreciation of assets.</li> <li>• Eliminate fossil fuel subsidies.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Promote DG, storage capacity and auxiliary services to provide grid flexibility and integration of distributed options to ensure that variable resources can operate in a cost-effective manner. | <p>Promote investments in modern, smart generation, transmission and distribution infrastructure and auxiliary services to integrate VRE.</p> <p>Clear regulations on demand management, storage, self-generation and distributed options.</p> | <ul style="list-style-type: none"> <li>• National targets on DER.</li> <li>• Development of technical standards for DG.</li> <li>• Development of public financial mechanisms.</li> <li>• Clean energy certificates.</li> <li>• Permitting procedures for DG installations.</li> <li>• Net metering/net billing/self-consumption schemes.</li> <li>• Renewable energy mandate for new construction.</li> <li>• RE and/or storage auctions.</li> <li>• Update regulation to include RE in government procurement.</li> <li>• Soft loan programs.</li> <li>• Industrial policies for renewable energy.</li> <li>• Distributed solar PV installers certification programs.</li> <li>• Fiscal incentives.</li> </ul> |
| Optimize allocation of generation and transmission infrastructure to meet demand.                                                                                                                | Promote regional grid integration.                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li>• Market-based power exchange with neighboring countries.</li> <li>• Regional integration of transmission system.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Internalize health and climate costs in transport emissions.                                                                                                                                     | Develop fiscal or carbon pricing measures that enable allocation of the costs of health and climate impacts.                                                                                                                                   | <ul style="list-style-type: none"> <li>• Fiscal measures to pass costs to emitters of airborne pollutants and GHGs.</li> <li>• Carbon emissions trading systems.</li> <li>• Use revenues to promote public investments in enabling infrastructure.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Facilitate market entry of electric transport.                                                                                                                                                   | Removal of regulatory and policy barriers.                                                                                                                                                                                                     | <ul style="list-style-type: none"> <li>• National targets on EV by segments.</li> <li>• Prohibitive measures over ICE vehicles.</li> <li>• Electric tariff incentives for EV owners.</li> <li>• Adopt standards for charging.</li> <li>• Review/modify road standards.</li> <li>• Regulations for standardization and interoperability of charging stations.</li> <li>• Regulate composite fleet emissions.</li> <li>• Enact transit and parking preferences.</li> <li>• Standards for BEV.</li> <li>• Industrial policies for EV manufacture.</li> <li>• Emission standards.</li> <li>• Energy efficiency standards.</li> <li>• Fiscal incentives.</li> </ul>                                                   |
| Interconnected, reliable system for a couple transition.                                                                                                                                         | Assure resiliency of the system, quality of service and protection of stakeholder information.                                                                                                                                                 | <ul style="list-style-type: none"> <li>• Implementation of cybersecurity standards.</li> <li>• Smart grid standard policy.</li> <li>• Stimulate investment in ICT services.</li> <li>• Cooperation between nations in the region and internationally to share information, lessons learnt and good practices.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                         |
| Promote technology and business development in support of the transition.                                                                                                                        | Promote investments in R&D and technology development in zero carbon technologies.                                                                                                                                                             | <ul style="list-style-type: none"> <li>• Science, technology and innovation policy in favor of zero emission goals by mid-century.</li> <li>• Fiscal measures to support investments in R&amp;D.</li> <li>• Grants to escalate startups with a proven minimum viable product with substantial impact on decarbonization.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                              |
| Transition addresses social and economic inequalities.                                                                                                                                           | Assure a just transition.                                                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>• Policies for social protection.</li> <li>• Ensure green jobs are decent.</li> <li>• Retraining of workers.</li> <li>• Promote inclusive participation in dialogues.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

In order to assure the long-term electricity supply - in conditions of efficiency, quality, reliability and safety - and reduce the country's vulnerability to the effects of climate change, some countries in the region have developed a legal, regulatory and policy framework that promotes diversification and decentralization of the power matrix by renewable sources. The main existing public policy instruments to achieve the decarbonization of power sectors is summarized in Table 2 as part of two big areas within the sector (decarbonization and decentralization measures).

Regarding public policy and legal framework, countries and cities in the region have sought to guide and stimulate the development of electric mobility in various ways (Table 3). Countries like Colombia and Costa Rica have comprehensive electric mobility laws in force and there are several others with initiatives underway to formulate similar legal instruments. There is also a broader group of countries with partial legal or regulatory instruments, some provide fiscal and non-fiscal incentives, others regulate the efficiency of the car fleet and others encourage the development of industries and enterprises associated with electric mobility. There is also a broad group of countries with an incipient development of these instruments.

Source: Climatoscope (http://global-climatescope.org/policies), Regulatory indicators for sustainable energy (RISE, World Bank - https://rise.esmap.org/), IRENA 2015<sup>37</sup>

**Table 2. Key goals and instruments of a bold policy agenda in support of the coupled decarbonization of the power and transport sectors.**

|                                  | RE National Targets | Net Metering | Accelerated Depreciation | VAT exemption | Import tax exemption | Carbon Tax | Clean energy certificates | Priority dispatch | Auctions |
|----------------------------------|---------------------|--------------|--------------------------|---------------|----------------------|------------|---------------------------|-------------------|----------|
| Antigua and Barbuda              |                     |              |                          |               |                      |            |                           |                   |          |
| Argentina                        |                     |              |                          |               |                      |            |                           |                   |          |
| Bahamas                          |                     |              |                          |               |                      |            |                           |                   |          |
| Barbados                         |                     |              |                          |               |                      |            |                           |                   |          |
| Belize                           |                     |              |                          |               |                      |            |                           |                   |          |
| Bolivia                          |                     |              |                          |               |                      |            |                           |                   |          |
| Brazil                           |                     |              |                          |               |                      |            |                           |                   |          |
| Chile                            |                     |              |                          |               |                      |            |                           |                   |          |
| Colombia                         |                     |              |                          |               |                      |            |                           |                   |          |
| Costa Rica                       |                     |              |                          |               |                      |            |                           |                   |          |
| Cuba                             |                     |              |                          |               |                      |            |                           |                   |          |
| Dominica                         |                     |              |                          |               |                      |            |                           |                   |          |
| Ecuador                          |                     |              |                          |               |                      |            |                           |                   |          |
| El Salvador                      |                     |              |                          |               |                      |            |                           |                   |          |
| Grenada                          |                     |              |                          |               |                      |            |                           |                   |          |
| Guatemala                        |                     |              |                          |               |                      |            |                           |                   |          |
| Guyana                           |                     |              |                          |               |                      |            |                           |                   |          |
| Haiti                            |                     |              |                          |               |                      |            |                           |                   |          |
| Honduras                         |                     |              |                          |               |                      |            |                           |                   |          |
| Jamaica                          |                     |              |                          |               |                      |            |                           |                   |          |
| Mexico                           |                     |              |                          |               |                      |            |                           |                   |          |
| Nicaragua                        |                     |              |                          |               |                      |            |                           |                   |          |
| Panama                           |                     |              |                          |               |                      |            |                           |                   |          |
| Paraguay                         |                     |              |                          |               |                      |            |                           |                   |          |
| Peru                             |                     |              |                          |               |                      |            |                           |                   |          |
| Dominican Republic               |                     |              |                          |               |                      |            |                           |                   |          |
| Saint Kitts and Nevis            |                     |              |                          |               |                      |            |                           |                   |          |
| Saint Vincent and the Grenadines |                     |              |                          |               |                      |            |                           |                   |          |
| Saint Lucia                      |                     |              |                          |               |                      |            |                           |                   |          |
| Suriname                         |                     |              |                          |               |                      |            |                           |                   |          |
| Trinidad and Tobago              |                     |              |                          |               |                      |            |                           |                   |          |
| Uruguay                          |                     |              |                          |               |                      |            |                           |                   |          |
| Venezuela                        |                     |              |                          |               |                      |            |                           |                   |          |

37. [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA\\_RE\\_Latin\\_America\\_Policies/IRENA\\_RE\\_Latin\\_America\\_Policies\\_2015.pdf](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA_RE_Latin_America_Policies/IRENA_RE_Latin_America_Policies_2015.pdf)

On the other hand, countries such as Colombia, Chile, Costa Rica and Panama already have national electric mobility strategies or plans - Argentina, Mexico and Paraguay are in the process of formulating their own strategies. In this regard, it is worth mentioning the emergence of goals (Table 4) associated with the deployment of electric mobility by countries and cities, derived from the legal instruments or strategies mentioned above.

The transition to electric transport is incipient and will require a much more forceful support agenda. The region is at an early stage to assess the impact of these public policy instruments and legal framework. It is concluded that there is no single solution or approach in this regard and that there is great interest in the region to continue

creating an enabling environment for the development and regulation of technologies such as electric mobility. Undoubtedly, it is worthwhile to monitor the impact of these types of instruments through periodic reviews to align the enabling environment with technological developments and the context and priorities of each country and city in the region.

A policy environment to develop a coupled transition should be dynamic and country customized. The economics of the transition are not set in stone as technology prices are coming down fast, new elements come into play and the impacts of climate change keep evolving. Therefore, policies should be reviewed periodically in order to help countries achieve their improved NDCs, and meet

**Table 3. Existing transport policies in some countries in the region.**

| Country              | Value-added tax | Import tax | Other purchase incentives | Property & circulation tax | Exemption of tolls and parking fees | Other incentives for use and circulation | Exemption of vehicular restriction | Differentiated electric rates | Regulation for charging stations | National electric mobility strategy |
|----------------------|-----------------|------------|---------------------------|----------------------------|-------------------------------------|------------------------------------------|------------------------------------|-------------------------------|----------------------------------|-------------------------------------|
| Antigua and Barbuda  |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |
| Argentina            |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |
| Brazil               |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |
| Chile                |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |
| Colombia             |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |
| Costa Rica           |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |
| Ecuador              |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |
| Mexico               |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |
| Panama               |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |
| Paraguay             |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |
| Peru                 |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |
| Republica Dominicana |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |
| Uruguay              |                 |            |                           |                            |                                     |                                          |                                    |                               |                                  |                                     |

■ Completed incentive for electric vehicles / Approved and running instrument.  
 ■ Partial incentive for electric vehicles / Instrument in design phase.



**Table 4. Electric transport targets of some countries in LAC.**

| Country    | Targets                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Barbados   | <ul style="list-style-type: none"> <li>• <b>National Energy Policy for Barbados 2019 – 2030</b></li> <li>- 100% renewable energy and carbon neutrality</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Chile      | <ul style="list-style-type: none"> <li>• <b>National Electromobility Strategy</b></li> <li>- 100% of electrified public transport by 2050</li> <li>- 40% of electrified private transport by 2050</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Colombia   | <ul style="list-style-type: none"> <li>• <b>National Development Plan</b></li> <li>- 600 thousand electric vehicles by 2030</li> <li>• <b>Ley 1964 of 2019</b></li> <li>- In cities with mass transit systems, 100% of vehicles purchased to replace others must be electric as of 2035</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Costa Rica | <ul style="list-style-type: none"> <li>• <b>Decarbonization Plan</b></li> <li>- 70% of buses and taxis zero emissions by 2035</li> <li>- 25% of the light vehicle fleet (private and institutional) will be zero emissions in 2035</li> <li>- 100% of buses and taxis zero emissions by 2050</li> <li>- Increase of at least 10% of commutes in non-motorized modes within the main urban areas by 2050.</li> <li>- By 2050, 60% of the fleet of light vehicles - private and institutional - will be zero emissions, with higher percentages for those that have commercial and government use.</li> <li>- By 2050 at least 50% of freight transport will be highly efficient and will have reduced emissions by 20% compared to 2018 emissions.</li> </ul> |
| Ecuador    | <ul style="list-style-type: none"> <li>• <b>Draft Energy Efficiency Law</b></li> <li>- Beginning in 2025, any vehicle incorporated into the urban and interparroquial public transport service must be electric and enjoy preferential differentiated energy rates.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Mexico     | <ul style="list-style-type: none"> <li>• <b>Mexico City electromobility strategy 2018 - 2030</b></li> <li>- In 2030, 15% of new car sales in Mexico City will be hybrid and / or electric.</li> <li>- In 2030, 80% of the taxi fleet and ERT (Transport Network Companies) of Mexico City will be hybrid and / or electric.</li> <li>- In 2030, 30% of the new fleet of utility vehicles in Mexico City is hybrid and / or electric.</li> <li>- In 2030, 30% of shared bicycle systems (public and private) will be electric in Mexico City.</li> <li>• <b>Integral Mobility Program 2013-2018</b></li> <li>- By 2030, provide 150 electric buses for new Zero Emissions corridors of the STE (Electric Transportation Service) (federal level).</li> </ul>  |
| Panama     | <ul style="list-style-type: none"> <li>• <b>National Electric Mobility Strategy of Panama</b></li> <li>- In 2030, between 10 and 20% of the total private vehicle fleet will be electric</li> <li>- In 2030, between 25 and 40% of private vehicle sales will be electric</li> <li>- In 2030, between 15 and 35% of buses in authorized concession fleets will be electric</li> <li>- In 2030 between 25 and 50% of public fleets will be composed of electric vehicles</li> </ul>                                                                                                                                                                                                                                                                           |
| Paraguay   | <ul style="list-style-type: none"> <li>• <b>By 2020, 20% of state vehicles will be electric</b></li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Peru       | <ul style="list-style-type: none"> <li>• <b>National Competitiveness and Productivity Plan 2019-2030</b></li> <li>- 20,000 vehicles renewed by 2025 and 50,000 vehicles renewed by 2030 - technology not specified</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

Source: MOVE, 2019



decarbonization objectives by 2050, as well as the SDGs in a changing environment.

All countries in the region have presented NDC setting priorities for mitigation and adaptation to climate change. Measures in the energy sector are present in all NDCs, which highlights the importance of the sector in the region and in the achievement of the Paris Agreement. Since the presentation of the NDCs several countries have strengthened their commitments in the renewable energy and electric transportation sectors in their National Energy Plans, Decarbonization Plans and/or in other energy and environmental policy instruments (Table 2, 3, 4). The goal of the study in this respect is to support countries efforts, for the next round of NDCs, to consider the coupled benefits of addressing these two sectors conjunctively to further advance their climate goals.

📍 Mexico City, Mexico

