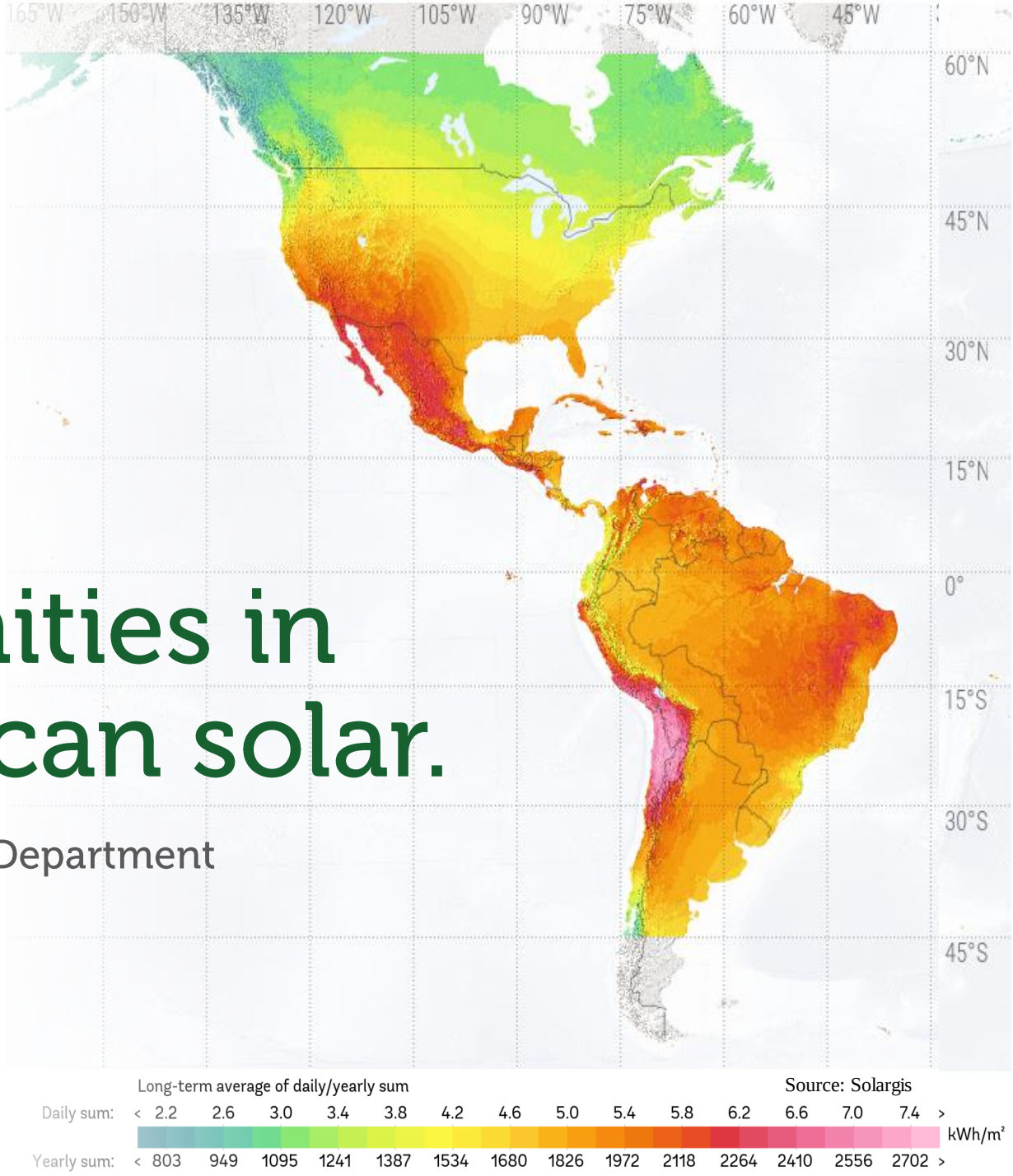
350PPM

Capitalist Solutions to Climate Change

Opportunities in Latin American solar.

350 PPM Research Department



Solar in 2020

Solar's inflection point

Solar power is now the cheapest form of electricity generation in many countries worldwide. Despite this, the industry presents very clear cost-reduction roadmaps, which should see solar costs halving again by 2030. Innovations such as bifacial modules already allow panels to capture solar energy directly as well as reflected up off the ground while new production methods continually reduce the need for expensive inputs like silver and silicon[1].

In certain countries and regions, blessed with high levels of solar irradiation, we have already breached a hugely important inflection point in which the cost of producing electricity, and the consequential profit to be made from selling it without subsidies, now satisfies a large majority of renewable energy investor's project hurdle rate, or minimum accepted investment return. See visualisation in **Figure 1**.

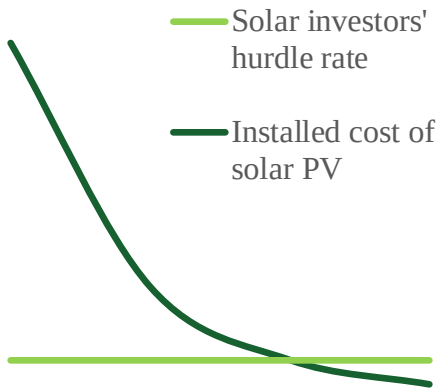


Figure 1 – Visualisation of solar investment inflection point.

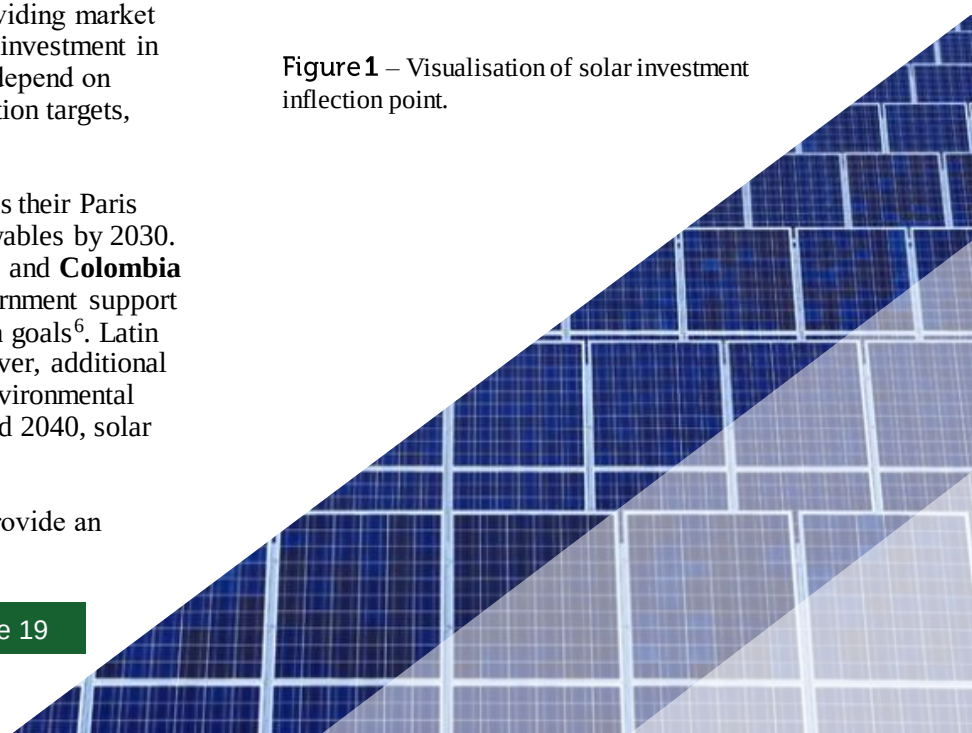
Promoting renewables and solar

Inevitably, this is leading to huge penetration of solar in electricity grids. However, even though the technology's standalone economic viability is ever increasing, governments are still providing market based support mechanisms. A variety of techniques can be implemented which increase investment in renewable energy in order to provide generation that is: relatively inexpensive; doesn't depend on imported fuels so improves energy security; and contributes to national emissions reduction targets, committed to under the Paris Agreement and others.

In addition, at COP 25, nine Latin American countries committed to significantly surpass their Paris Agreement obligations, and even EU country clean energy targets, and reach 70% renewables by 2030. **Chile**, Peru, Ecuador, Costa Rica, Honduras, Guatemala, Haiti, the Dominican Republic and **Colombia** are part of the pact. Panama and **Brazil** are still weighing participation. Significant government support is expected to incentivise the magnitude of investment required for such ambitious green goals[6]. Latin America already generates over 50% of its power from large hydroelectric plants. However, additional potential hydro capacity is dwindling mainly due to local opposition to the social and environmental costs of building large dams. With electricity demand set to swell 91% between 2016 and 2040, solar will have to play a significant role in filling the gap[7].

This report will outline some of Latin America's key tools to promote investment and provide an insight into some of the region's most attractive markets for solar investment.

Note: Sources are cited throughout with a superscript number[X] with a reference on page 19



Key Market Mechanisms

Clean energy auctions

Renewable energy auctions incentivise market investment without the use of subsidies. Bidders offer proposals to provide a certain installed capacity or quantity of long-term generation in return for guaranteed purchase of the electricity generated by the government or distributer, in the form of a power purchase agreement (PPA) . Such PPAs are valuable because the security and stability of the cash flows solidifies and reduces a portion of the project risk which opens up a wider selection of investors while greatly increasing the likelihood of projects securing debt financing.

Latin America has been at the forefront of using auctions to develop renewable energy capacity. Some of the world's first successful renewable energy tenders were held in the region and they have contributed to Latin America's position as a leading destination for renewable energy investment—in 2015, three of the top ten solar markets were Brazil, Mexico, and Chile[5].

Feed In Tariffs (FITs)

FITs guarantee prices for power producers, which often amount to large subsidies. Widely used in Europe in the incipient stages of renewable technology development which brought down technology costs for the whole world. Though expensive for governments, they provide significant incentive.

Corporate PPAs

Though not a government scheme, private PPAs allow companies that use large amounts of electricity to secure a stable green energy source for a locked in price while offering the generator the aforementioned financing benefits. Corporate PPAs are exploding globally with Latin America seeing a threefold increase from 2018-19.

Others

Other mechanisms used to promote renewable energy generation include: net-metering, tax exemptions, direct funding, clean energy mandates, cap and trade systems and carbon taxes.

Brazil background

Brazil has the ninth largest economy in the world and is expected to multiply 2.7x by 2030[18]. Brazil's government, led by Jair Bolsonaro has so far maintained an abysmal record on environmental protections, all but promoting deforestation of the Amazon since his inauguration at the beginning of the 2019. However, their pro business focus has been positive for renewable investment prospects. As recently as this year, the president has eliminated a form of solar tax (grid fee) proposed by the electricity regulator on small scale, net metered generators while proclaiming "There will be no taxation for solar energy,".

In addition to net metering for micro plants, other benefits for utility scale plants include: exemptions on import tax for foreign equipment and VAT for domestic purchases; suspension of federal tax applicable to energy project equipment/services and even financing of renewable projects, both directly and through loans. The government has committed to expand non-fossil power by 23% by 2030.

Furthermore, though Brazil places third for renewable energy generation globally, it faces high levels of hydrological risks as ~75% of this power comes from hydroelectric dams, many of which have been below average levels for five straight years leading it to hold at least nine reserve auctions (for backup power capacity)[8]. Thus, Brazil is promoting mechanisms that will allow it to expand its non-hydro renewables to 33%. Brazil's main obstacle to achieving this goal is the location of cities relative to generating regions resulting in high transmission costs.

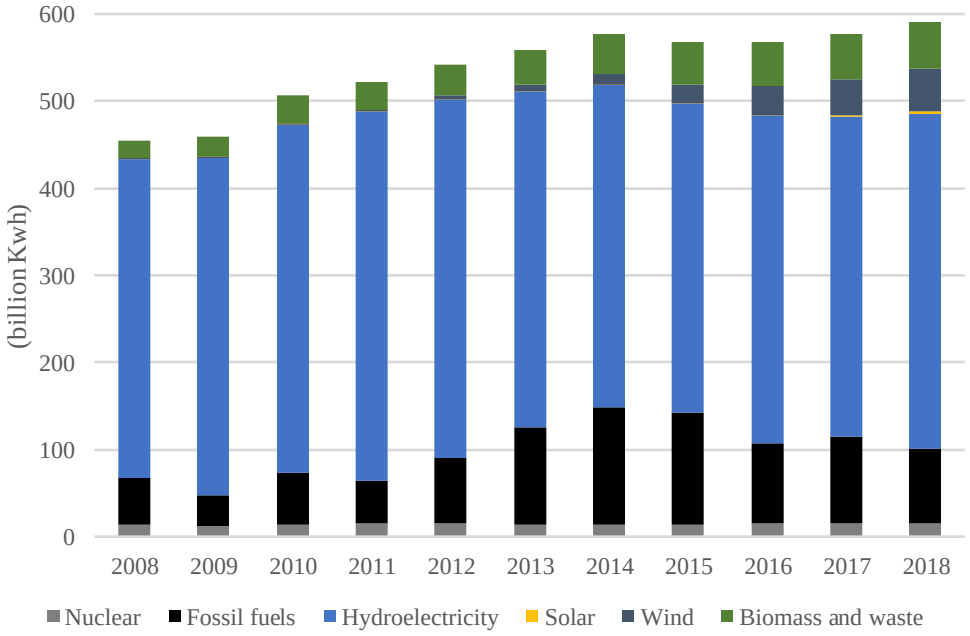


Figure 2 – Brazil electricity generation by fuel.
Source: U.S. Energy Information Administration

Brazil opportunities

Utility Scale

Brazil's solar market has been made globally famous by the success of its auctions. Having conducted its first renewable energy auction in 2005, it has since completed over 60. Its auction are sited as the most competitive in the world with bids as low as 17.3 USD/MWh, the lowest cost for energy of any technology ever[2]. Despite the record breaking prices, Brazil's auctions remain attractive to investors as a result of the low proportion of project output being allocated to them, in favour of the currently lucrative merchant(/spot) market. An allocation of ~30% of the total project output to a government backed PPA has been enough to secure cheap bank debt financing[9]. This allows investors to expose ~70% of the project to the lucrative merchant market where prices currently exceed 100 USD/MWh [10].

Outside of government auctions, Brazil's corporate PPA market is expanding rapidly, utilised by its local manufacturing, significant mining sector and large, conscious service companies[19]. Much of Brazil's private PPA growth has come from 'wholesale customers', often consortiums of smaller consumers that pool demand to meet minimum thresholds. Though it should be noted that such PPAs tend to result in lower bankability and debt support from banks[20].

Distributed generation

The introduction of net metering, which allows solar projects <5 MW to earn billing credits on surplus energy has contributed to 1.6 GW of distributed solar being constructed by the end of 2019. However, the non-monetary nature of the subsidy makes it irrelevant to pure export generators/investors.

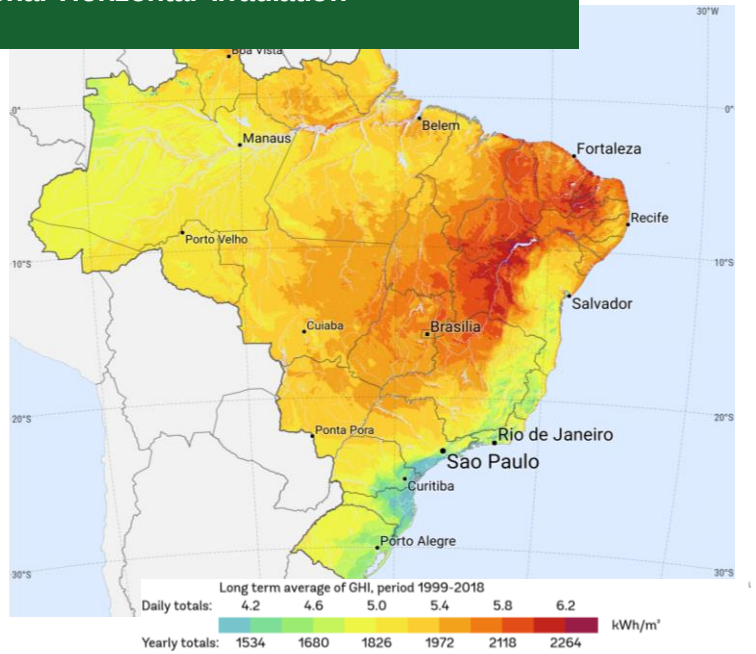
Furthermore, the smaller PPAs that can be sought for distributed projects are inherently riskier so banks will only tend to finance up to 20% of the project value. This means projects need more capital so proceed, negatively impacting IRRs.

Brazil Summary

Conclusion

350 PPM is optimistic about the long-term prospects for utility scale solar investment in Brazil. As the government continues to capitalise on the cheap supply from auctions, investors will continue to benefit from the country's existing supply shortfall. A shortfall which may deteriorate further as a result of climate change exacerbated by their own environmental policy. Hence, lower damn reserves will prevent significant downside of merchant price, maintaining yields.

Regional Horizontal Irradiation[0]



Metric	Value	Unit	Source (see page 19)
2018 GDP	1.869	Tr USD	16
Annual average horizon irradiation	1534 – 2264	kWh/m^2	12
June-19 business electricity prices	138	USD/MWh	10
Lowest auction price	17.3	USD/MWh	2
Electricity consumption growth through 2030	2.8	%	11
EY Global Solar PV Ranking	12th	World rank	13
2019 actual solar	3.1	GW	14
2030 forecast solar	13.6	GW	14
Implied CAGR to 2030	14 %	%	14
Tax incentives	Yes		17
Clean Energy Auctions	23/4/2020, 24/9/2020, 29/4/2021, 30/9/2020	Dates	15
Onerousness of auction prerequisites	High	H/M/L	page 17
Other mechanisms	Net metering (<5 MW)		17
Corporate PPA market	Active		
Regulator	ANEEL		

Mexico background

Mexico has the 15th largest economy in the world and is expected to double by 2030[24]. Over 30% of its economy is industrial, including significant high tension users in mining and construction. Many western companies utilise the relatively inexpensive labour market, making Mexico an export heavy manufacturing hub for the region. However, Mexico has historically been infamous for its high electricity prices and consumption is expected to balloon.

Until 2013, the power sector was monopolised by the Comisión Federal de Electricidad (CFE), the inefficient, debt laden state utility. During 2013, the government liberalised power generation, creating investment opportunities for private companies while increasing competition. The aim being to reduce electricity prices, increase energy security in a industry heavily dependent on gas imports and help achieve its aggressive renewable energy goals of 35% by 2024 and 50% by 2050, with a specific carve-out for solar at 23% of the total. Mexico is blessed with almost unparalleled renewables resources. Its irradiation levels, across large amounts of the country are some of the highest on earth reducing the number of panels required for a given generation level which can greatly reduce project cost.

A key reform meant to encourage investment was the introduction of three long-term clean energy auctions, covering PPAs of 15 years. The auctions proved to be a great success and resulted in a total of 8.6 billion USD of investment covering 7.5 GW of solar and wind construction.

As part of the same agenda, Mexico opened up the private PPA market by allowing companies to purchase power directly from generators as well as introducing a market for clean energy certificates (CELs). CELs are awarded to renewable energy projects installed after 2014 for each MWh of electricity generated. Utilities and certain 'obligated users' are required to purchase a number of CELs each year, hence a market value (currently around 20 USD/MWh) is created along with supplementary revenue stream for new projects.

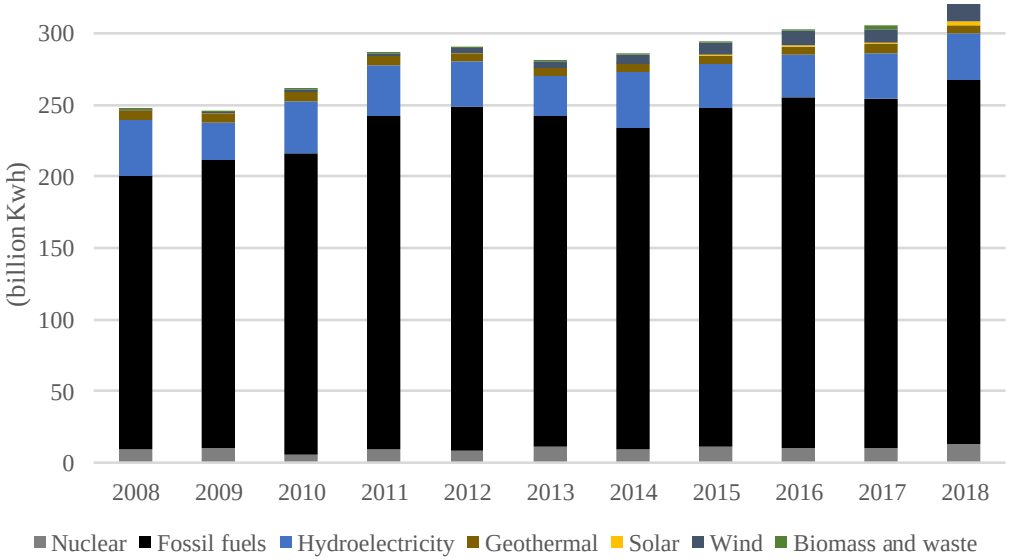


Figure 3 – Mexico electricity generation by fuel.
Source: U.S. Energy Information Administration

Mexico opportunities

Utility Scale

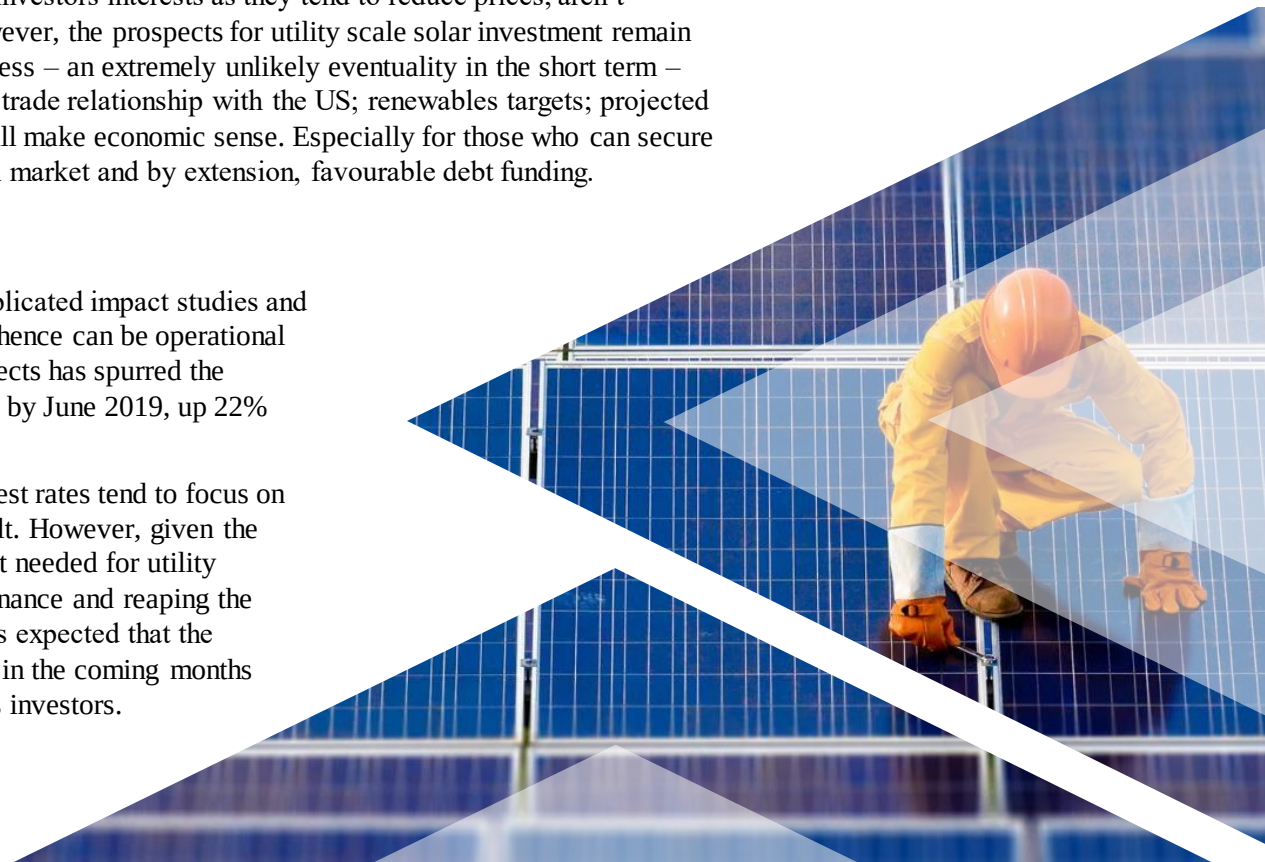
Since the appointment of Andrés Manuel López Obrador and his left wing, nationalist government in Dec 2018, a number of the incentives driving renewables investment in Mexico have been rescinded in an effort to promote the interests of CFE, the state utility. 2019 saw the indefinite cancellation of the renewable energy auctions and an attempt to incorporate legacy (pre 2013), mainly state owned, renewable projects, such as large hydro, into the Clean Energy Certificate (CEL) programme. The latter has so far been blocked in the courts after a consortium of affected parties have contested its legality. The change would saturate the CEL supply, reduce the price, eroding the subsidy and investor confidence in equal measure.

Mexico's clean energy auctions, which aren't always in investors interests as they tend to reduce prices, aren't expected to restart under the current administration. However, the prospects for utility scale solar investment remain positive. Even if clean energy certificates become worthless – an extremely unlikely eventuality in the short term – the fundamentals of Mexico's economy; geographic and trade relationship with the US; renewables targets; projected demand and merchant electricity prices mean projects still make economic sense. Especially for those who can secure offtake in the Mexico's hugely successful corporate PPA market and by extension, favourable debt funding.

Distributed

Projects under 500 kW in Mexico don't require the complicated impact studies and approvals from the grid that utility scale projects do and hence can be operational in weeks rather than years. Net metering on self use projects has spurred the installation of 94,893 units of roof/distributed generation by June 2019, up 22% from only 6 months earlier[22].

International banks that can offer more competitive interest rates tend to focus on larger projects so obtaining debt financing can be difficult. However, given the total capital required to be operational is a fraction of that needed for utility projects, some investors are constructing without bank finance and reaping the increased capture rates possible by smaller off-takers. It's expected that the regulator will increase the maximum threshold to 1 MW in the coming months then potentially 1.5 MW which would increase synergies investors.

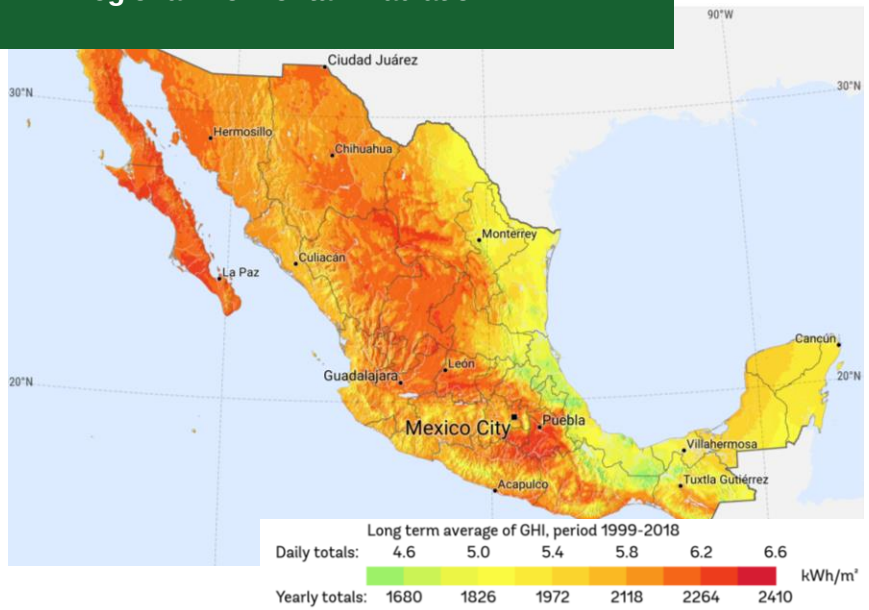


Mexico Summary

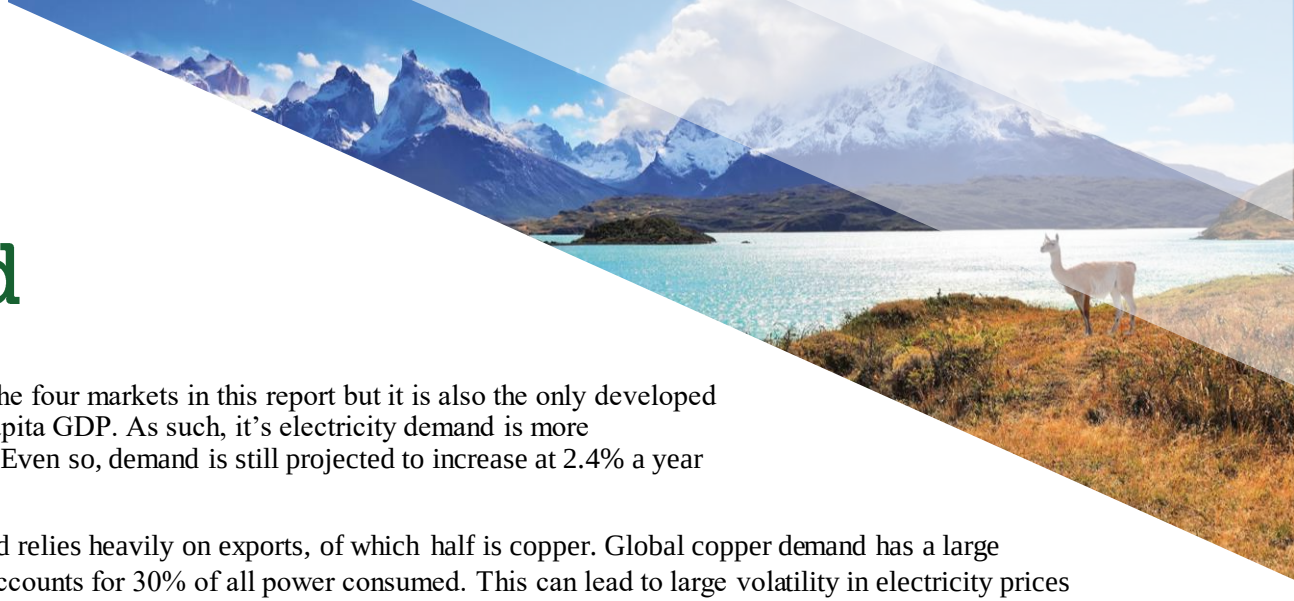
Conclusion

Despite the mixed signals from Mexico's president about renewables, 350 PPM is optimistic about the continued legal validity and security of the key liberalisation policies implemented by the prior administration, principally those enabling private PPAs. We have a positive outlook on both utility scale and distributed generation investment prospects given the state, regardless of aspirations, doesn't have the resources to install enough new capacity to satisfy current/future demand.

Regional Horizontal Irradiation[0]



Metric	Value	Unit	Source (see page 19)
2018 GDP	1.221	Tr USD	16
Annual average horizon irradiation	1680 – 2410	kWh/m^2	12
June-19 business electricity prices	170	USD/MWh	10
Lowest auction price	20.57	USD/MWh	25
Electricity consumption growth through 2030	4 - 5	%	21
EY Global Solar PV Ranking	10th	World rank	13
2019 actual solar	5.0	GW	22
2030 forecast solar	30.0	GW	23
Implied CAGR to 2030	17.7	%	
Tax incentives	Yes – Expense CAPEX		17
Clean Energy Auctions	Gov - cancelled Private – in progress		
Onerousness of auction prerequisites	Low – Previous experience	H/M/L	page 17
Other mechanisms	Net metering (<0.5 MW) Clean energy certificates		17
Corporate PPA market	Active		
Regulator	Comisión Reguladora de Energía (CRE)		



Chile background

Chile's nominal dollar economy makes it the smallest of the four markets in this report but it is also the only developed market of the selection and hence by far the highest per capita GDP. As such, it's electricity demand is more comparable to a European market than the rest of LatAm. Even so, demand is still projected to increase at 2.4% a year through 2038[21].

Though developed, its economy is over 30% industrial and relies heavily on exports, of which half is copper. Global copper demand has a large impact on Chile's electricity use. The industry currently accounts for 30% of all power consumed. This can lead to large volatility in electricity prices

Chile has had a remarkable half decade for renewables. Heavily dependent on fossil fuel imports, Chile's liberalisation and policy support have aggressively redrawn the generation landscape. Attracted to Chile's balance of political stability/support and ample energy resources, investors have capitalised on the energy auctions that have taken place annually since 2006.

From virtually nothing in 2013 to 13% today, wind and solar is expected to be responsible for 40% of the country's electricity by 2030. Chile has around 2.76 GW of solar PV generation with another 2.34 GW currently under construction. Much of the renewables growth to date can be apportioned to a requirement for utilities to meet 20% of their supply with renewable sources by 2025. Other policies that will drive them towards their COP 25 ambition include:

- Auctions, the next being in June 2020[27].
- Coal moratorium, decommissioning existing plants by 2024[26].
- Net metering.
- Carbon tax of $5/ton of CO_2 emission on fossil generators.
- Bi-annual price guarantees for medium (<9MW) generators[30].

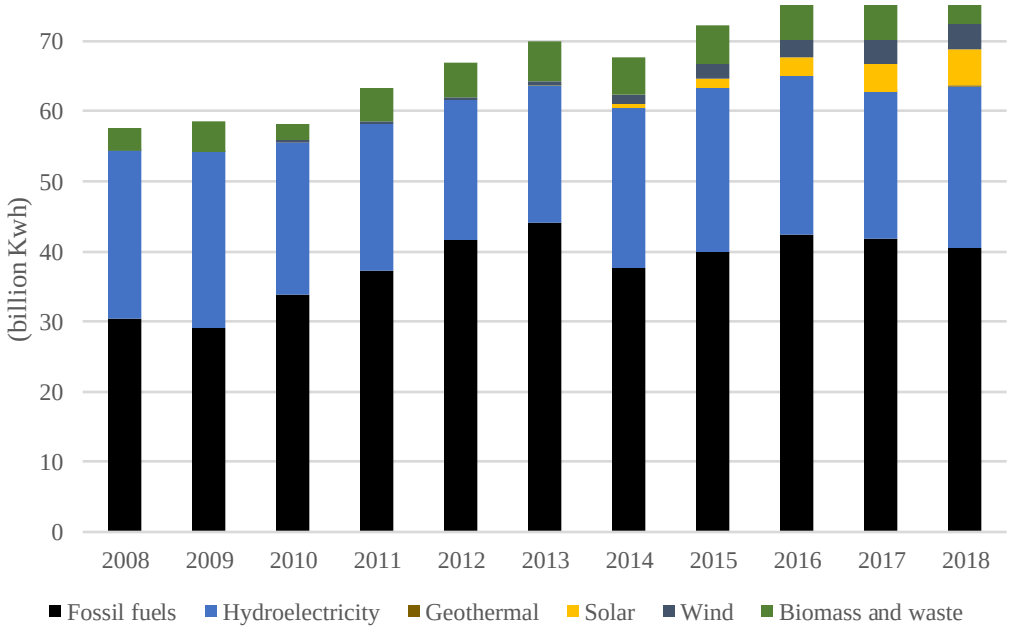


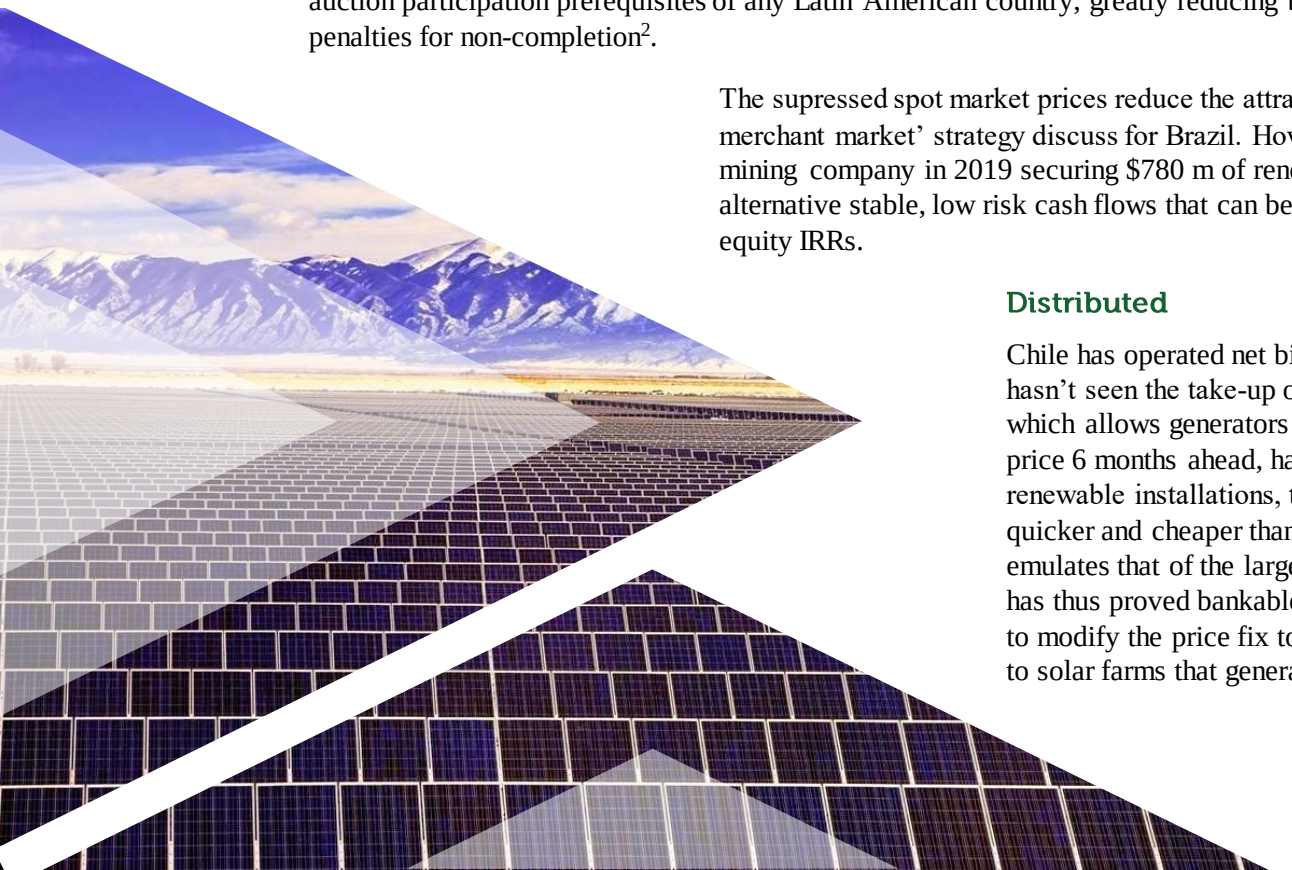
Figure 4 – Chile electricity generation by fuel.
Source: U.S. Energy Information Administration

Chile opportunities

The extent of Chile recent renewables expansion has created unexpected consequences including suppression of power prices and even instances of curtailment in some region, though these have partly been a response to changes in copper demand and low fossil fuel prices. Annual average electricity market prices dropped from over 150 USD/MWh pre liberalisation to less than 70 USD/MWh in 2019[28]. Furthermore, lower than expected demand meant 8% of solar and wind generation went unconsumed in 2018, though this was down from 14% the year before despite increased generation.

Utility Scale

The extent of Chile's renewables success has reduced its attractiveness to investors in terms of these reduced capture prices which also affect bankability. However, it remains a developed, stable and simple place to do business. For example, Chile enforces the least stringent auction participation prerequisites of any Latin American country, greatly reducing barriers to entry. Though, they do impose hefty penalties for non-completion[2].



The supressed spot market prices reduce the attractiveness of the 'X% government auction PPA, (1-X)% merchant market' strategy discuss for Brazil. However, key corporate PPA deals in 2019, including one mining company in 2019 securing $780 m of renewable generation over the next 15 years, highlights alternative stable, low risk cash flows that can be used to further reduce debt financing and increasing equity IRRs.

Distributed

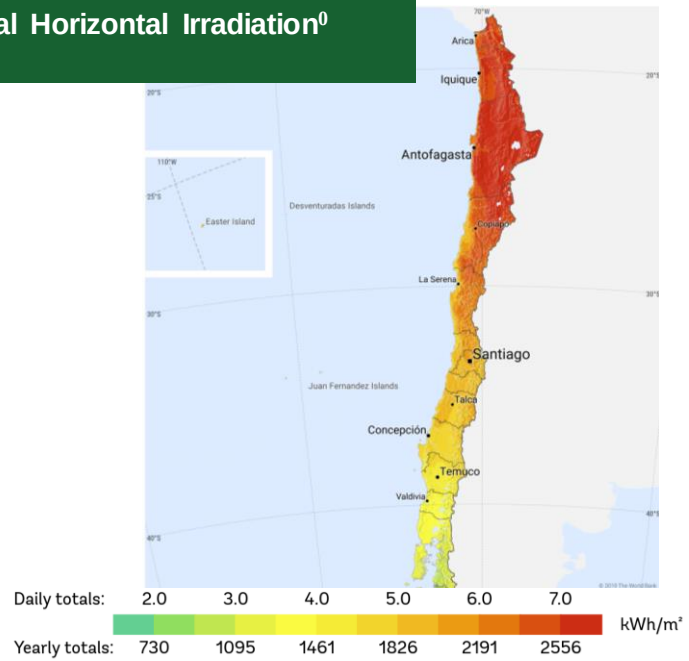
Chile has operated net billing for micro projects under 300kW since 2014 but hasn't seen the take-up of others in the region[29]. However, their PMGD scheme, which allows generators <9MW to sell into the spot market at a 100% fixed price 6 months ahead, has been hugely successful. Responsible for 13% of all renewable installations, the scheme's connection approval process is also quicker and cheaper than that of utility scale project. The cash flow stability emulates that of the large auctions, shielding volatility from spot market, and has thus proved bankable. Unfortunately, the government has expressed intent to modify the price fix to reflect hourly deviations which would be detrimental to solar farms that generate when prices are lowest in the day.

Chile Summary

Conclusion

Investors looking for region topping yields may be disappoint entering Chile in 2020. However, the country's stable renewables procurement agenda and developed market status will continue to interest more risk averse capital. 350 PPM notes the attractive current opportunities possible from the PMGD scheme but the risk of the sector's continued success eventually supressing such incentives is significant. Despite consumption growth, recent electricity prices have been hit hard by excess supply though rising copper prices, half what they were a decade ago, could have a prominent impact on future yields.

Regional Horizontal Irradiation[0]



Metric	Value	Unit	Source (see page 19)
2018 GDP	0.29	Tr USD	16
Annual average horizon irradiation	730 – 2556	kWh/m^2	12
June-19 business electricity prices	55	USD/MWh	28
Lowest average auction price	32.5	USD/MWh	25
Electricity consumption growth through 2030	2.4	%	21
EY Global Solar PV Ranking	18th	World rank	13
2019 actual solar	2.76	GW	31
2030 forecast solar	15	GW	32
Implied CAGR to 2030	16.6	%	
Tax incentives	Yes		17
Clean Energy Auctions	Usually annually. Next: 11/6/2019		
Onerousness of auction prerequisites	Low	H/M/L	page 17
Other mechanisms	Net metering (<0.3 MW) PMGD		17
Corporate PPA market	Industry leading		
Regulator	CNE (National Energy Commission)		

Colombia background

Colombia is the fastest growing of Latin America's biggest economies. In 2019 it achieved 3.4 % growth and foreign investment is booming[36]. Having signed a peace agreement with Marxist guerrillas in 2016, it has done well to remove legacy associations with violence that once hindered foreign interaction. Tourists now flock to the country and investors are betting on this economic and political stability to continue. The IMF forecasts the next five years to beat 2019 expansion with GDP growing at 3.6-3.7%.

Electricity consumption is expected to grow massively over the coming decade. Partly to service Colombia's heavily industrial economy but also to supply the needs of richer households that can afford power hungry appliances including air conditioners.

Until last year, Colombia's history with renewables has only included hydro which cannot alone provide the magnitude of growth required by that of the wider economy. Though Colombia currently has some of the lowest solar and wind penetration of any country in the region, it's these renewables that are expected fill the gap.

As shown in Colombia's Regional Irradiation map, much of its solar resources are concentrated in the north of the country which are home to relatively small demand. Fortunately, a strong transmission grid, already set to be reinforced by the government by 2030, will allow for a huge growth in renewables, especially solar. A recent study showed that the large forecast growth wouldn't require additional transmission upgrades at interconnection nodes, a potentially huge saving for investors that would normally front at least a portion of such reinforcements[34].

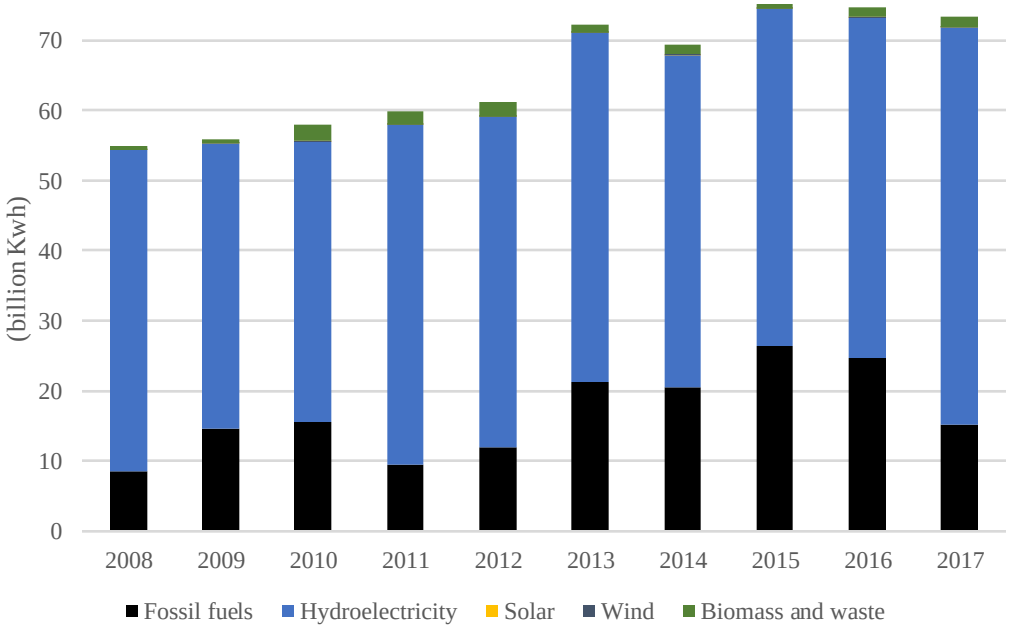


Figure 5 – Chile electricity generation by fuel.
Source: U.S. Energy Information Administration

Colombia opportunities

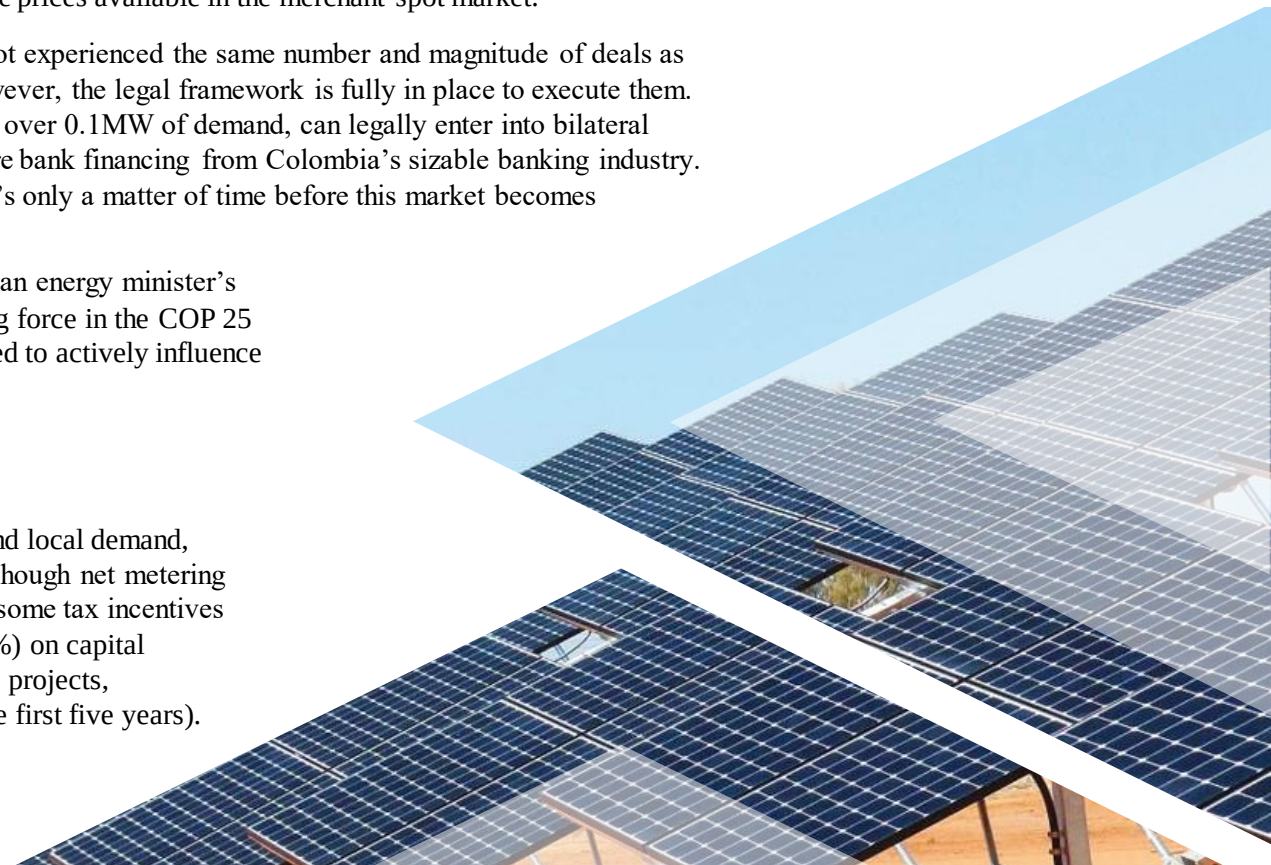
Utility Scale

In addition to strong fundamentals, Colombia completed its first successful energy auction in October 2019. They matched 1.37 GW of generation, 230 MW of which was solar, with 15 year 'take or pay' PPAs with 22 power distributers/retailers. This mammoth opening auction will bring 2.2 bn USD of investment into the country's renewable sector[37]. The government has intermated that the next auction will be held in 2020.

Separate from the public auctions output, Colombia's private renewables segment is experiencing its own huge growth story. By the beginning 2020, the energy regulator, UPME, had approved interconnection of 107 solar projects with a total capacity of up to 5.2 GW to be developed over the next few year, dwarfing that of the auctions[38]. Such projects are leveraging the huge liquidity of Colombia's disproportionally large banking industry and the attractive prices available in the merchant spot market.

To date, Colombia's private corporate PPA market has not experienced the same number and magnitude of deals as the region's more developed markets, such as Chile. However, the legal framework is fully in place to execute them. Under Colombian law, "non-regulated users", those with over 0.1MW of demand, can legally enter into bilateral PPAs. Hence, investor can freely secure take-off to secure bank financing from Colombia's sizable banking industry. Given the trend shown in other countries in the region, it's only a matter of time before this market becomes significant[19].

Investor sentiment is made more positive by the Colombian energy minister's openly bullish view on renewables. She was a key driving force in the COP 25 decision to achieve 70% renewables by 2030 and expected to actively influence policy to achieve this goal.



Distributed

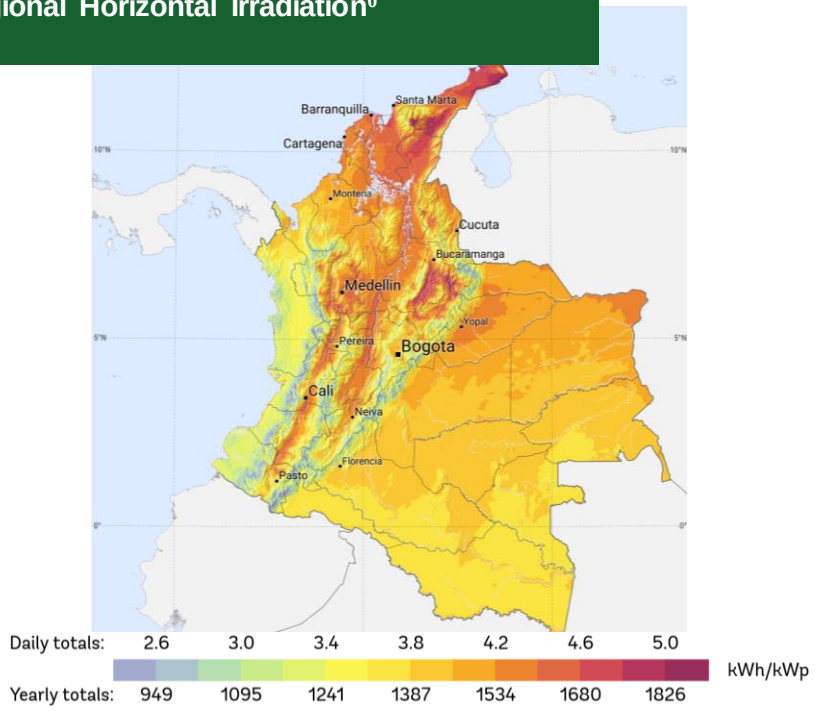
Given the negative correlation between solar resources and local demand, investors' main focus has been on utility scale projects. Though net metering hasn't been introduced, the government have introduced some tax incentives for distributed power generation: no value added tax (16%) on capital equipment, import duty exemptions for renewable energy projects, accelerated depreciation on capital equipment (50% in the first five years).

Colombia Summary

Conclusion

350 PPM views Colombia as the 'market to watch' in Latin America. Though the full outcomes of their first auction are yet to be realised, the country looks perfectly placed to facilitate secure, stable, high yielding solar investment opportunities into the coming decade. Investors should move quickly to benefit from the new auction schedule, bearing in mind the development pre-requirements, and take comfort in the strong renewables agenda laid out by the current administration.

Regional Horizontal Irradiation[0]



Metric	Value	Unit	Source (see page 19)
2018 GDP	0.331	Tr USD	16
Annual average horizon irradiation	949 – 1,826	kWh/m^2	12
June-19 business electricity prices	141	USD/MWh	10
Lowest average auction price	27	USD/MWh	25
Electricity consumption growth through 2030	2.88	%	34
EY Global Solar PV Ranking	N/A	Not rated	
2019 actual solar	0.17	GW	35
2030 forecast solar	7.8	GW	34
Implied CAGR to 2030	41.6	%	
Tax incentives	Yes		17
Clean Energy Auctions	First: Oct 2019 Next expected: 2020		
Onerousness of auction prerequisites	Medium	H/M/L	page 17
Other mechanisms	N/A		
Corporate PPA market	Embryonic		
Regulator	The Ministry of Mines and Energy (UPME)		

Comparison of Auction Requirements

Market	Brazil	Chile	Mexico (cancelled)	Colombia
Preliminary Grid Access	✔			✔
Environmental Permitting	✔			✔
Environmental Impact Assessment	✔			✔
Land Use Rights	✔			
Financial Qualifications	✔	✔	✔	✔
Previous Solar Experience			✔	
Previous Experience of this scale			✔	
Resource Assessment	✔			✔
Grid Interconnection Study	✔			✔
Source (see page 19)	2	2	2	39

Conclusion and comparison

Latin America is on course for another impressive decade in renewables growth. This proliferation presents myriad investment opportunities in many markets in the region. Each country reviewed in this report will be an ideal investment location depending on the strategy and risk profile.

That said, 350 PPM views Colombia as an extremely exciting market for solar development and installation in Latin America in 2020. We expect economic and business fundamentals, that are attractive today, to continue in the medium term and the government's bullish renewables commitments to positively influence policy in investors' favour.

Sources for the below data are detailed in the relevant country summary pages above.

Metric	Unit	Brazil	Mexico	Chile	Colombia
2018 GDP	Tr USD	1.869	1.221	0.29	0.331
Annual horizon irradiation	kWh/m^2	1534 – 2264	1680 – 2410	730 – 2556	949 – 1,826
Jun-19 business electricity prices	USD/MWh	138	170	55	141
Lowest average auction price	USD/MWh	17.3	20.57	32.5	27
Electricity consumption growth	%	2.8	4 - 5	2.4	2.88
EY Global Solar PV Attractiveness	Ranking	12th	10th	18th	N/A
2019 solar penetration	GW	3.1	5.0	2.76	0.17
2030 solar forecast	GW	13.6	30.0	15	7.8
CAGR solar generation	%	14.0	17.7	16.6	41.6
Tax incentives	Yes/No	Yes	Yes – Expense CAPEX	Yes	Yes
Clean Energy Auctions		23/4/2020, 24/9/2020, 29/4/2021, 30/9/2020	Gov - cancelled Private – in progress	Usually annually. Next: 11/6/2019	First: Oct 2019 Next expected: 2020
Other mechanisms		Net metering (<5 MW)	Net metering (<0.5 MW) Clean energy certificates	Net metering (<0.3 MW) PMGD	N/A
Corporate PPA market		Active	Active	Industry leading	Embryonic

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