Low Carbon Economies in Latin America

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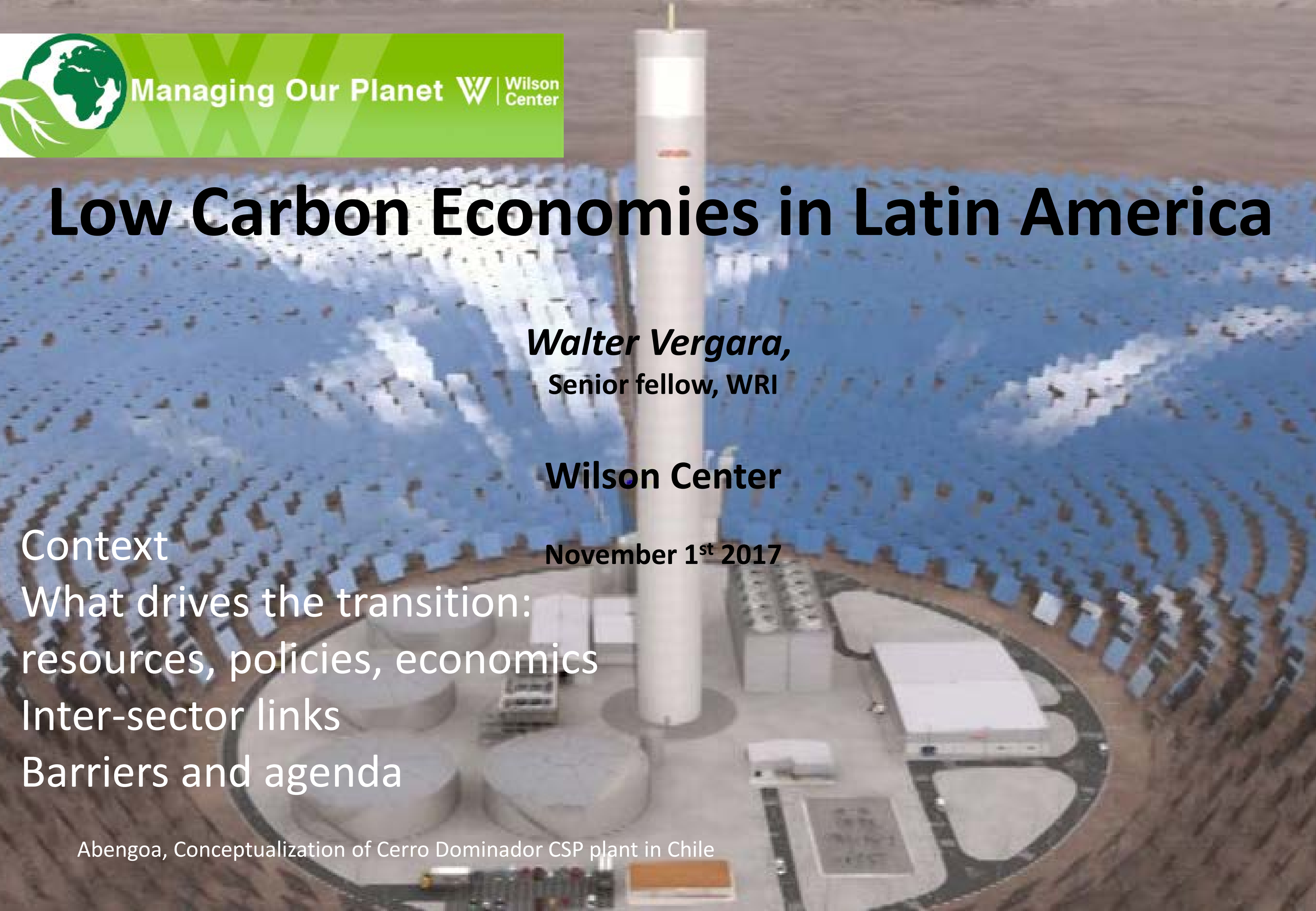
November 1st 2017

Context
What drives the transition:
resources, policies, economics
Inter-sector links
Barriers and agenda

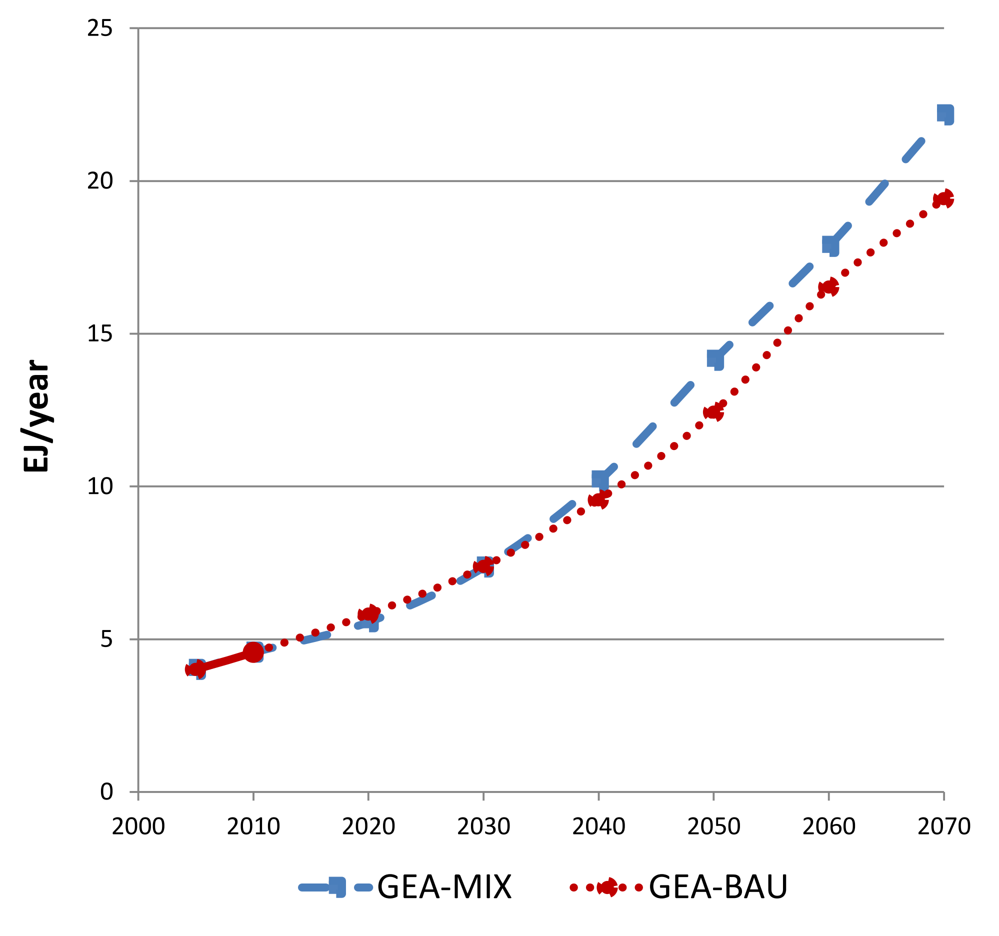


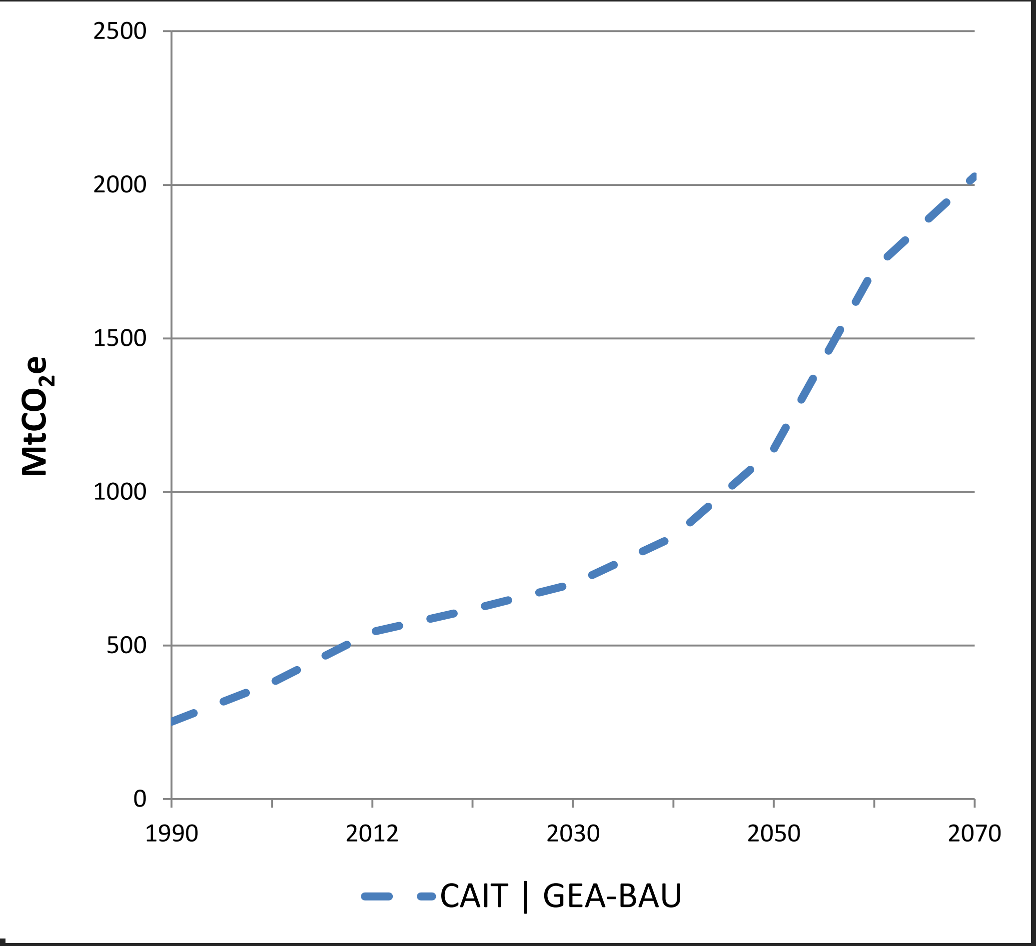
Abengoa, Conceptualization of Cerro Dominador CSP plant in Chile

LAC's carbon footprint

- 10% of global emissions (4.6 $GtCO_2e$); 7.7 tCO2e per capita;
- 22% decrease in carbon intensity per GDP-PPP since 2000;
- 48% renewable power = 0.21 tCO_2e /MWh;
- Urban public-transport share of passenger trips even higher than in Northern Europe;
- Nearly 50% of emissions come from land use and land use change.

Projected demand and emissions of the power sector





(CAIT, 2015; IIASA, 2015)

Atacama Desert Energy field

Area: 102,000 sq km

Irradiance 265 W/m2 (highest worldwide)

Power received 27.4 TW or 80 PWh per year

Proven oil reserves of Saudia Arabia

268 billion barrels of oil

If all converted to power: 26 PWh

If the average efficiency of PV systems is 15% , in 16 years, 4% of the area of Atacama generates same power as all the proven oil reserves of Saudi Arabia.

Isthm of Teuhantepec, Mexico

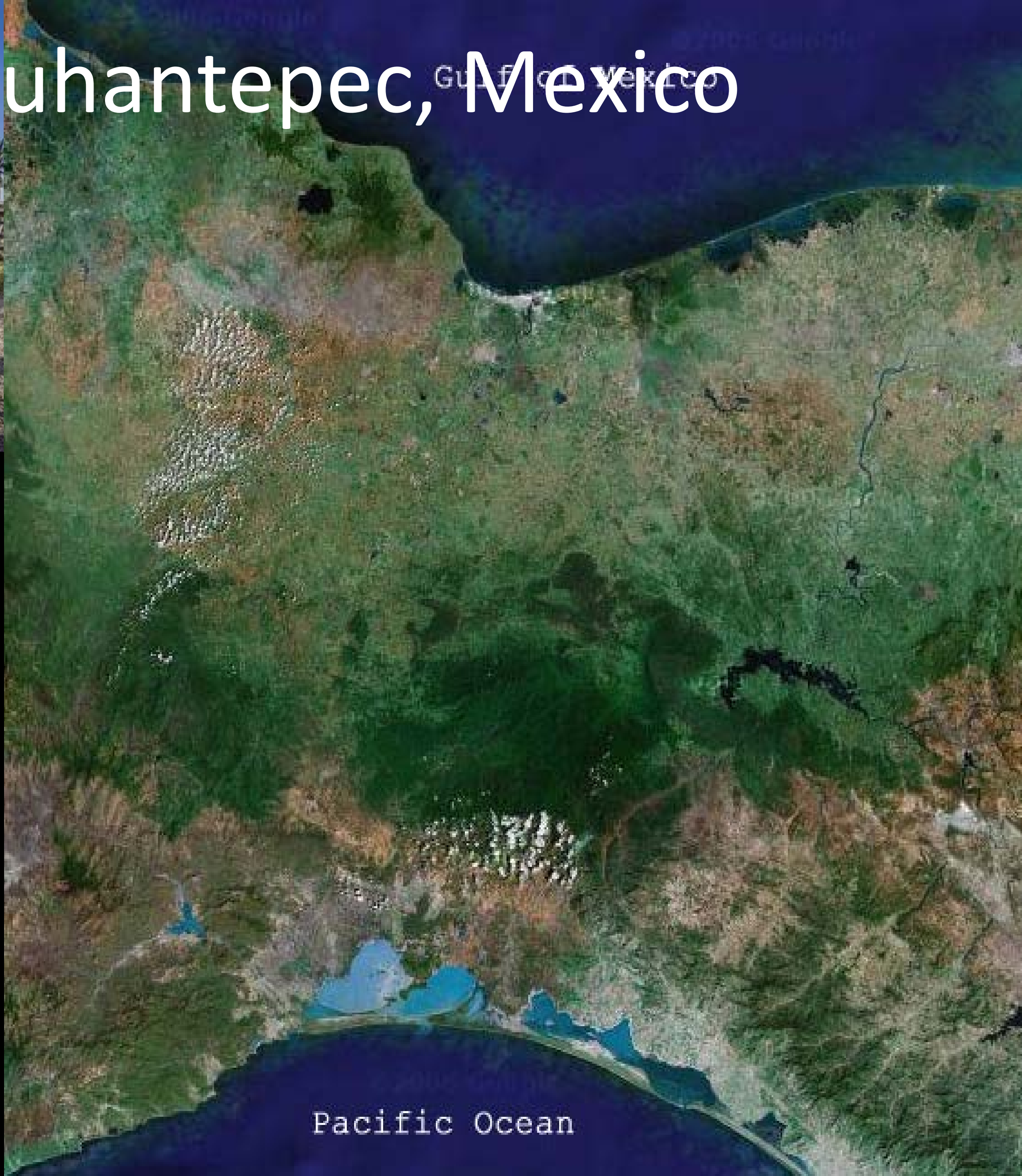
Wind field covers 91,500 km2 (classes 5 to 7)

Potential: 33 GW (ITM, 2013)

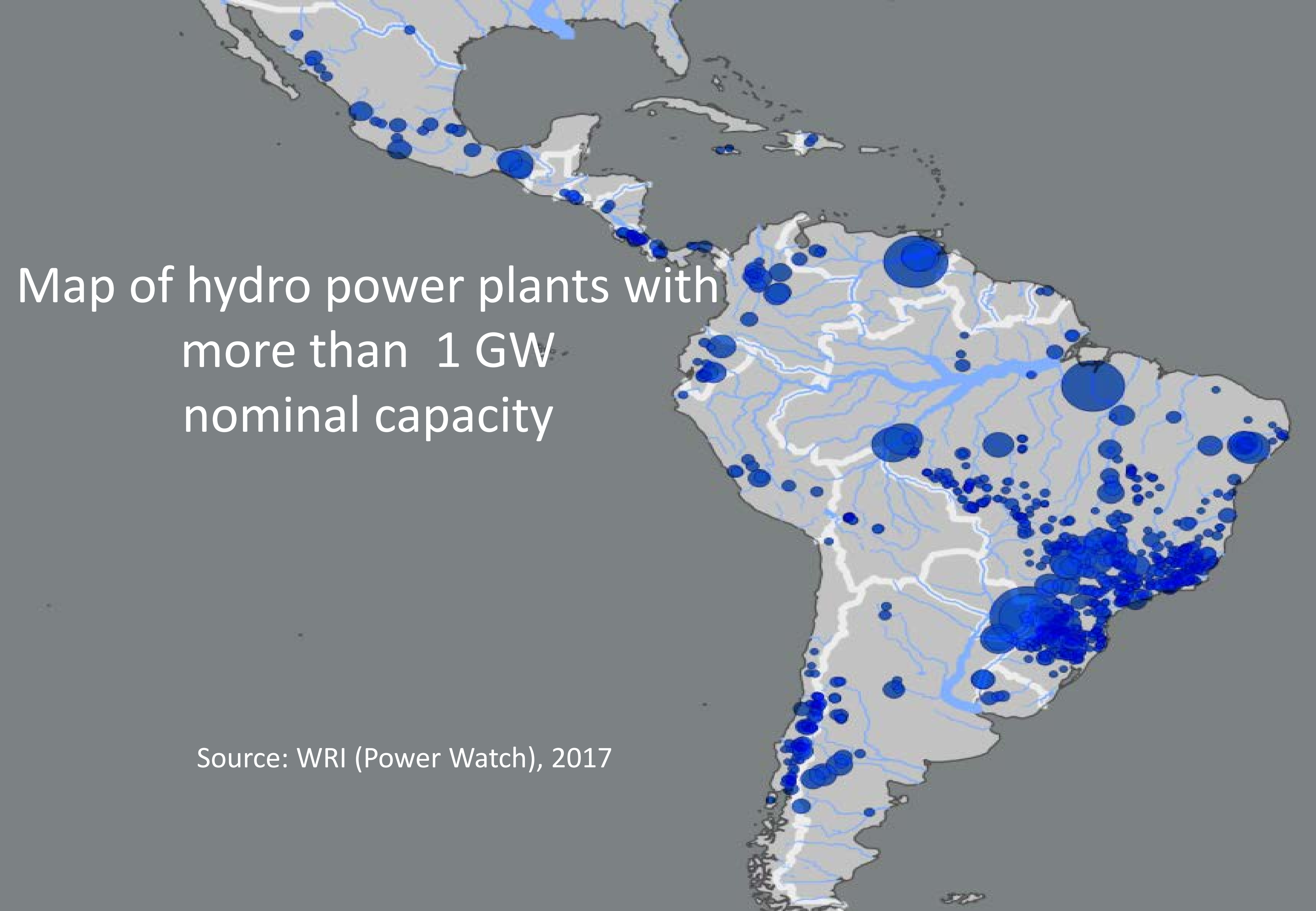
Current installed power capacity in Mexico: 63.7 GW (IEA, 2016)

(wind: 2.5 GW)

Demand: 248 TWh

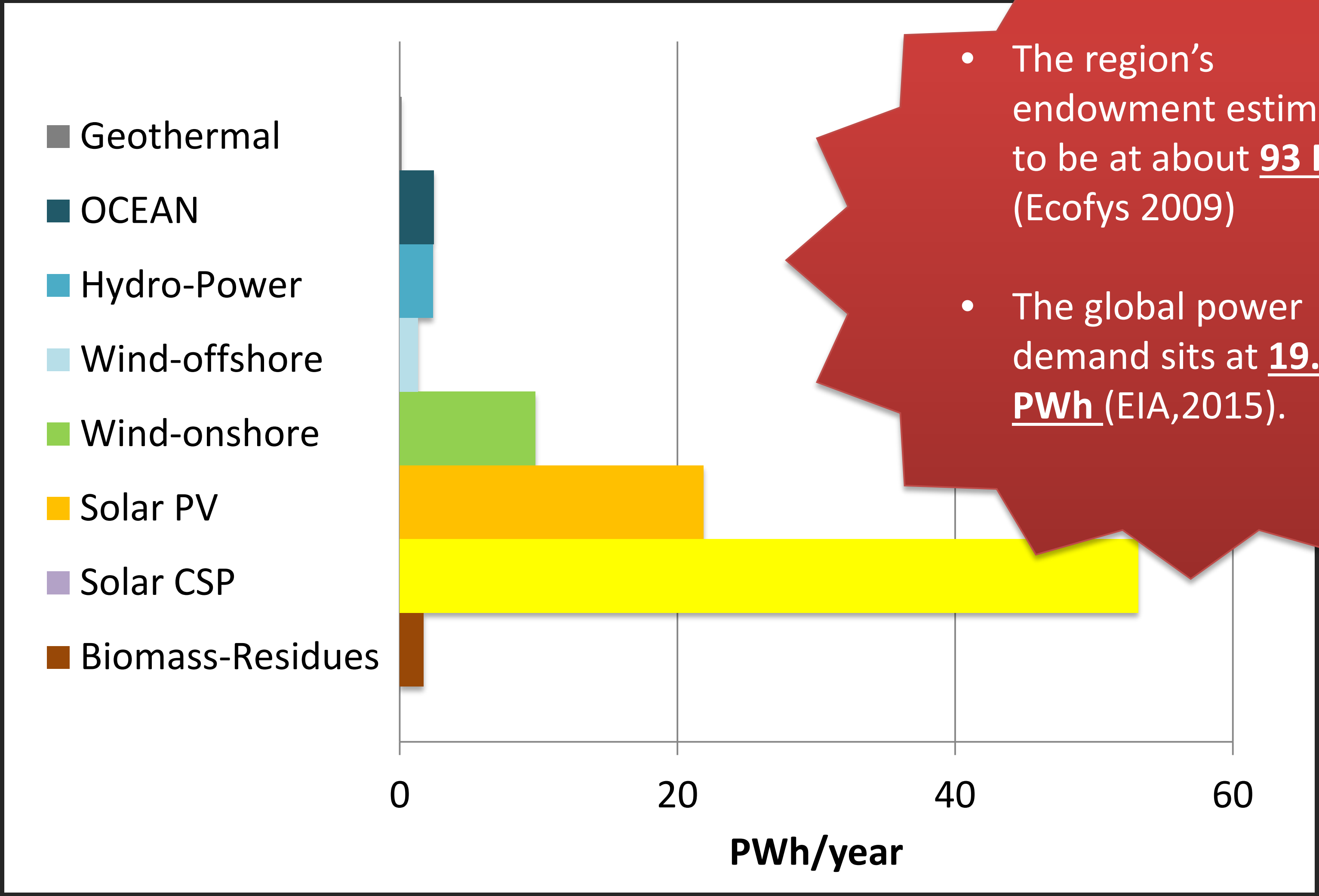


Map of hydro power plants with more than 1 GW nominal capacity



Source: WRI (Power Watch), 2017

Resource endowment Renewable energy sources in Latin America



- The region's endowment estimated to be at about **93 PWh** (Ecofys 2009)
- The global power demand sits at **19.7 PWh** (EIA,2015).

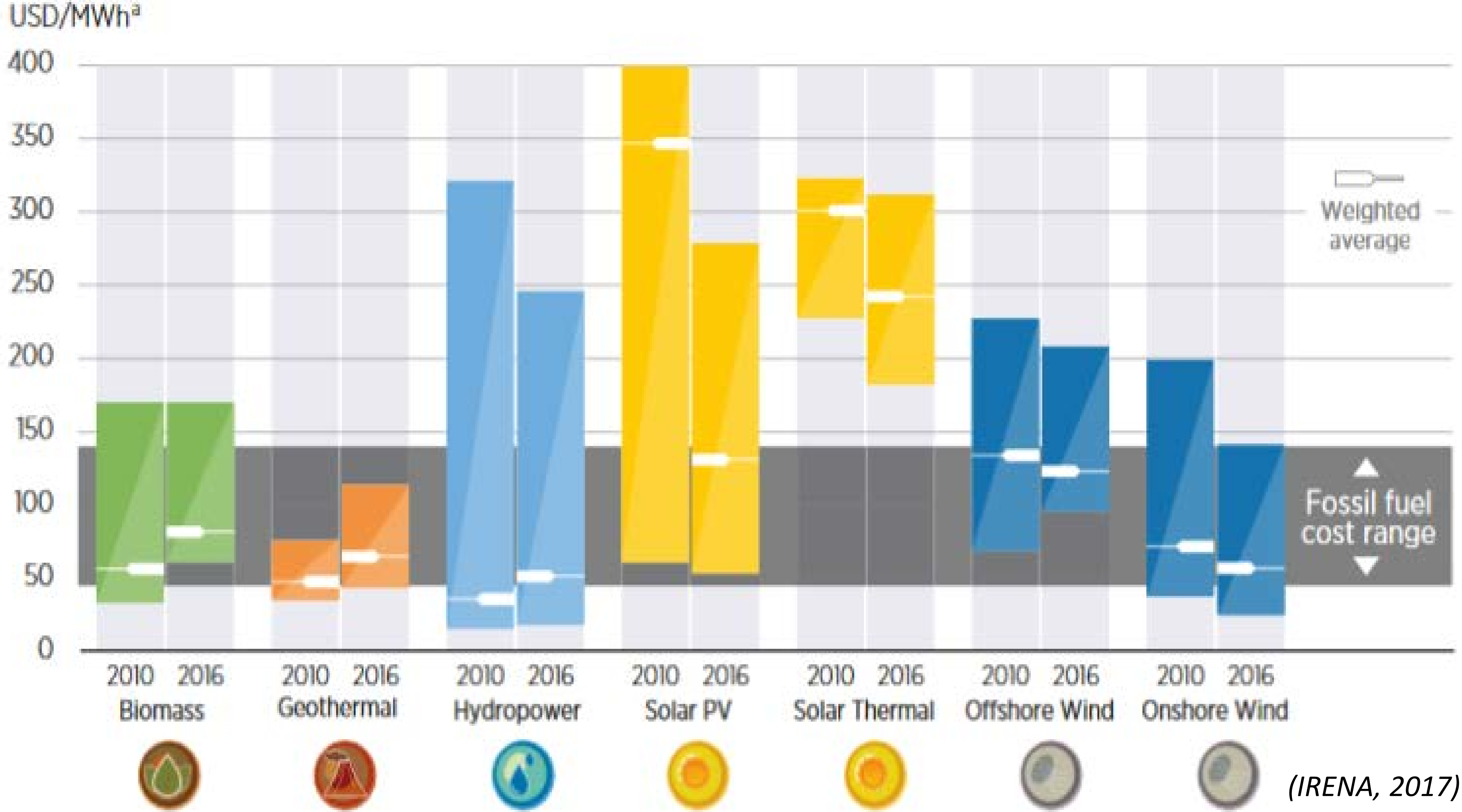
(Ecofys, 2009)

Policy Framework has evolved

Country	Share in 2013	Target
Argentina		8% by 2016
Bolivia		160 MW new by 2025
Brazil	79% (2014)	20% capacity in other than hydro by 2030
Chile	8.6% (2014)	20% by 2025 ; 70% other than hydro by 2050
Colombia	72%	6.5% other than hydro by 2020
Costa Rica	90%	100% by 2021
Ecuador	48%	85% by 2017
Guatemala		80% by 2027
Mexico		25% by 2026
Nicaragua	51% (2014)	90% by 2027
Paraguay	100%	
Peru		60% by 2025
Uruguay	84%	92% by 2015
Venezuela	64% (2012)	500 MW additional wind by 2019

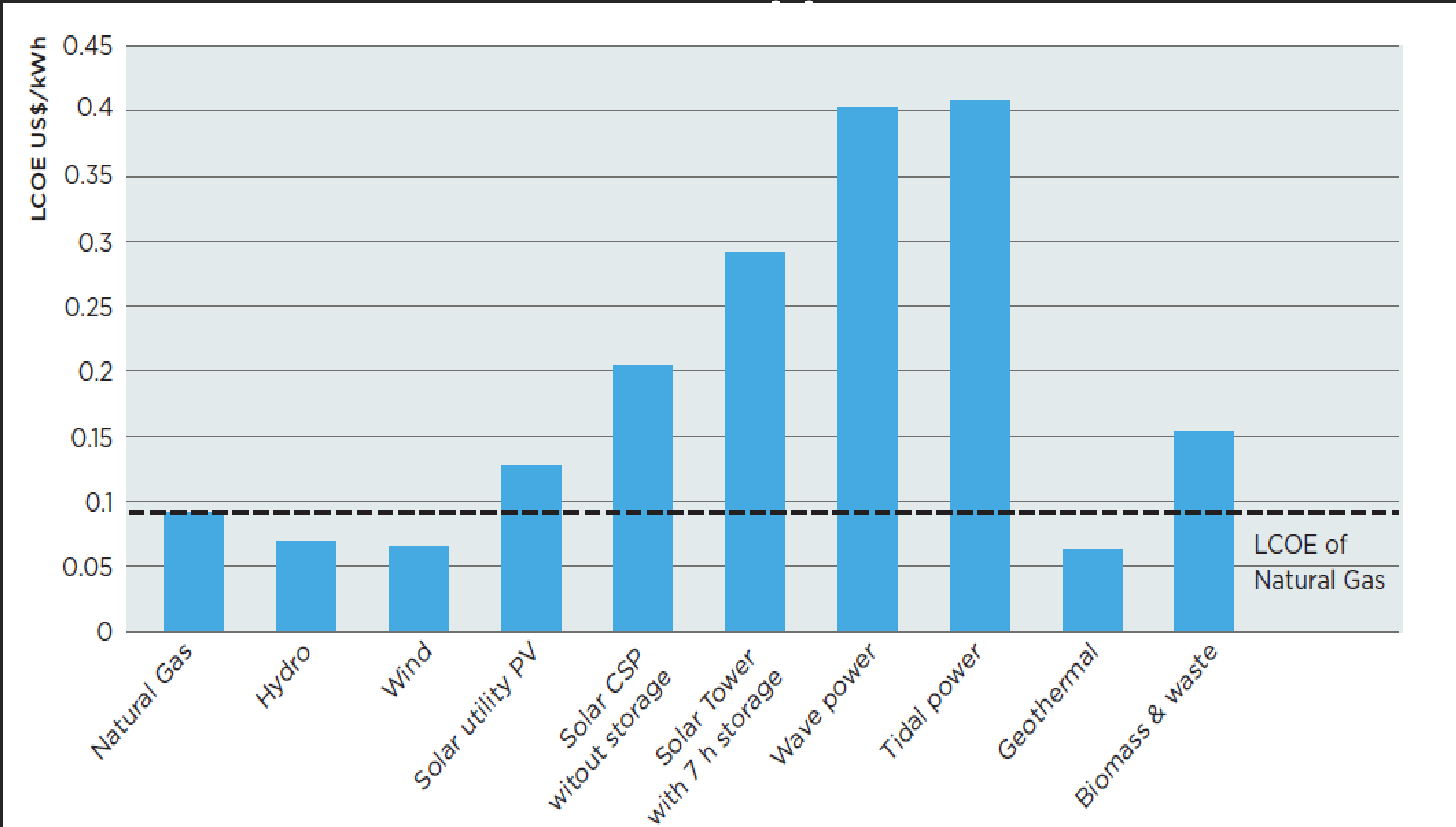
- Most countries:
  - RE targets
  - RE programs & policies
- Many countries:
  - Fiscal incentives/provisions
- Some countries
  - Carbon tax
  - Preferential dispatch
  - Regs on distributive power

Generation costs continue to fall (LCOEs in USD/MWh)

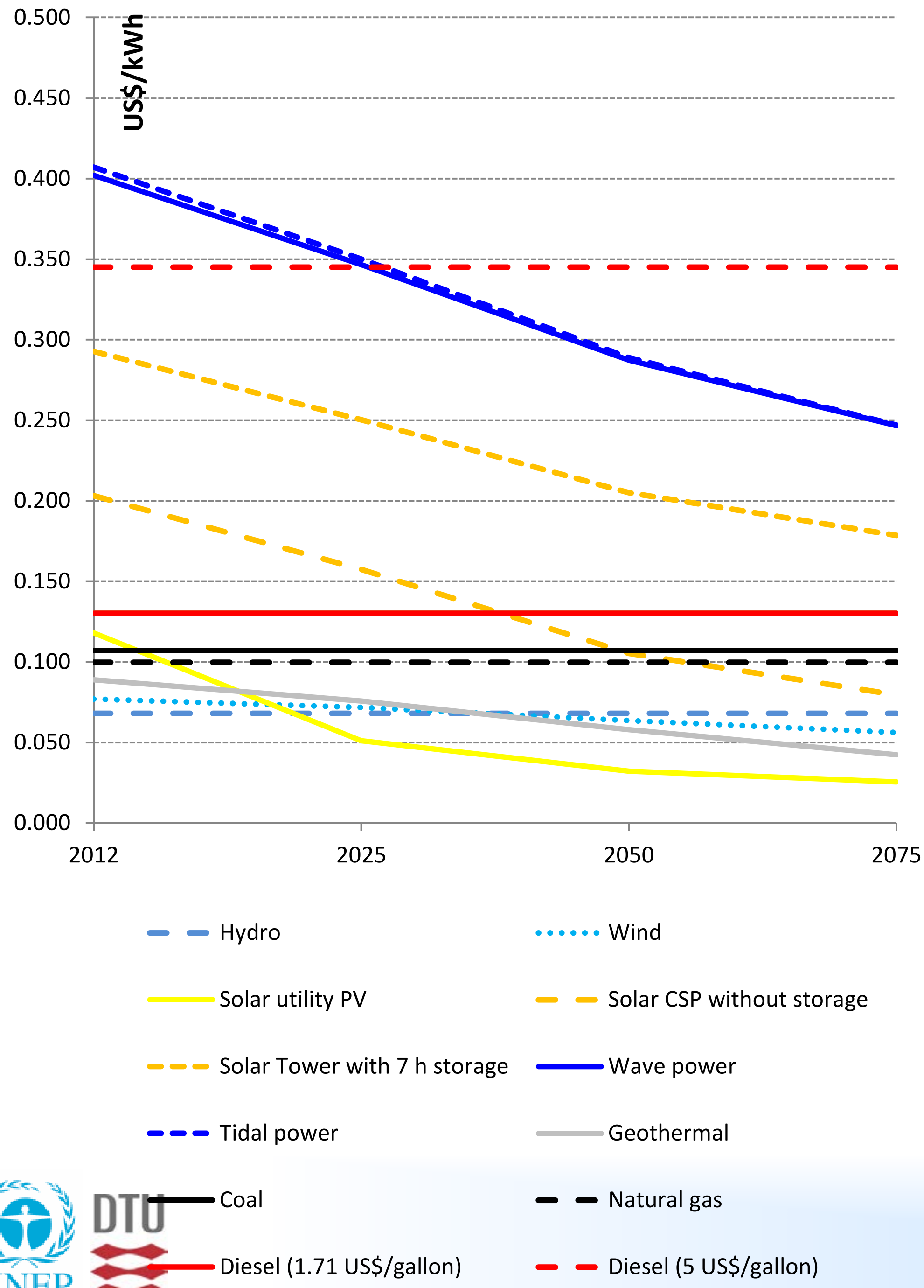


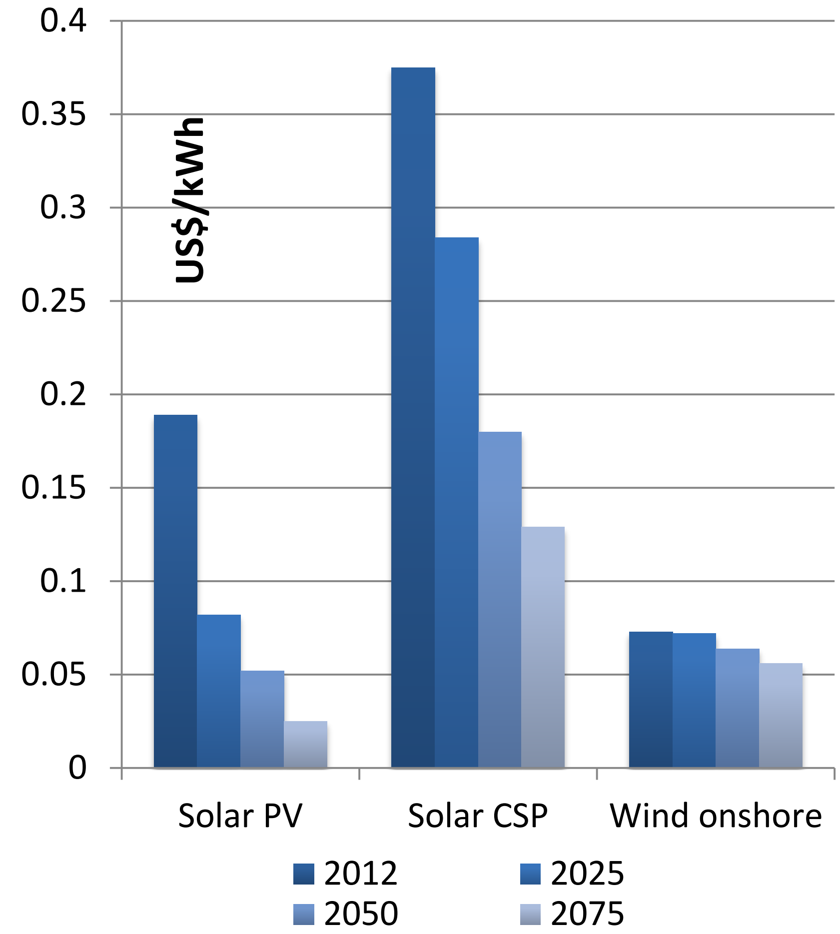
(IRENA, 2017)

Power generation through renewables: cheaper than fossil alternatives. (LCOEs in USD/kWh)



Source: Vergara et al, 2016)





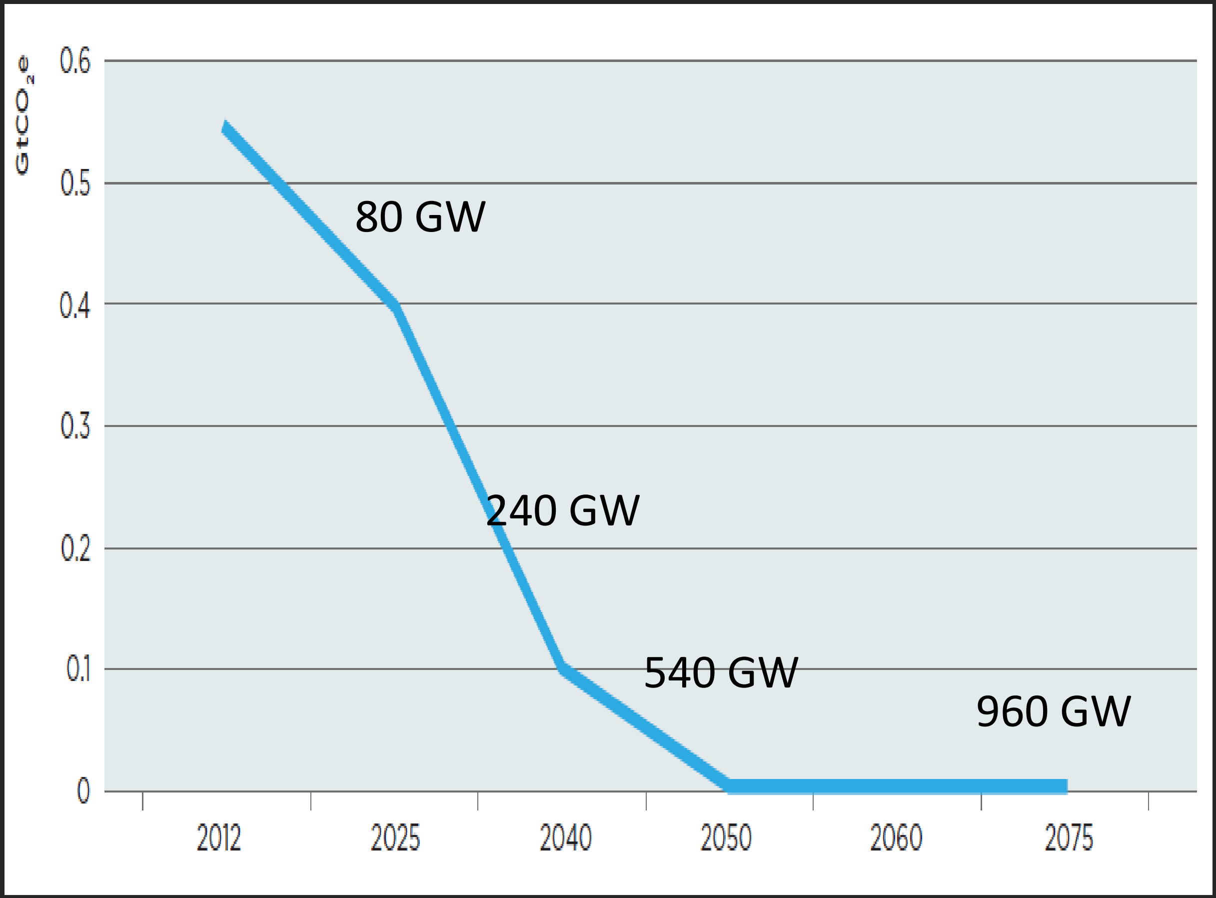
Learning curves for renewables (in LCOEs, US$/kWh)

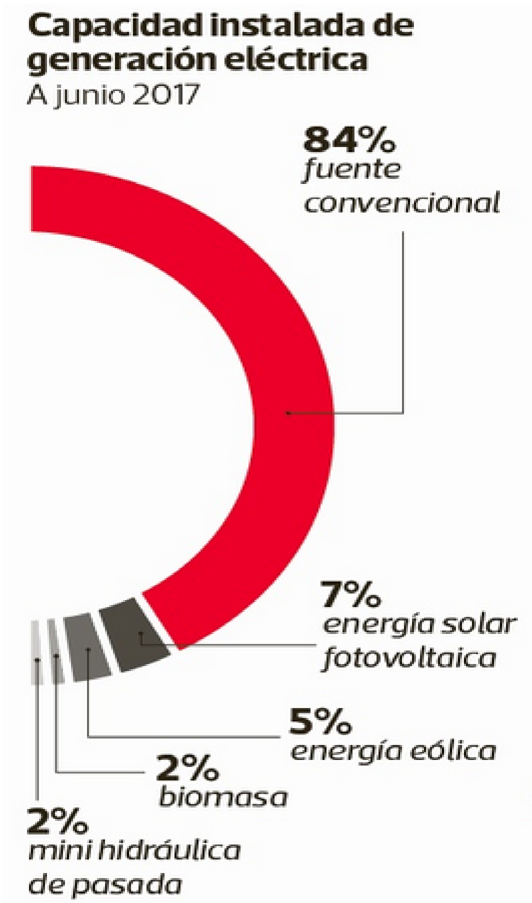
Source: Vergara et al, 2016

Pathway to zero carbon power in LAC, if…

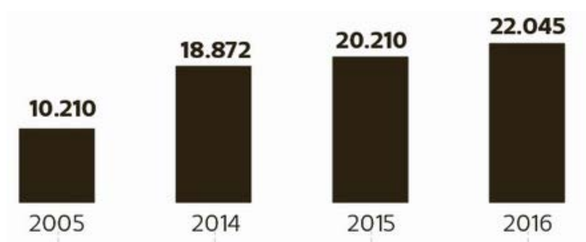
- All new demand is met by renewables by 2020
- Fossil plants other than gas are mothballed by 2030
- All gas plants are mothballed by 2050
- Grid integrated by 2030 (regional storage in hydro)
- Widespread distributed power by 2030

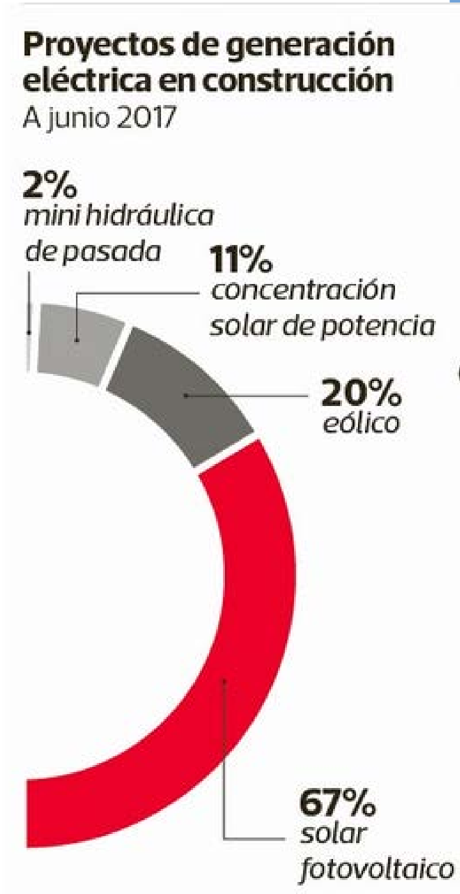
- Can be done but will not be easy!





MW installed





Chile: Recent evolution of the Power Matrix

Source: Chile's Ministry of Energy, Monthly report. July 2017

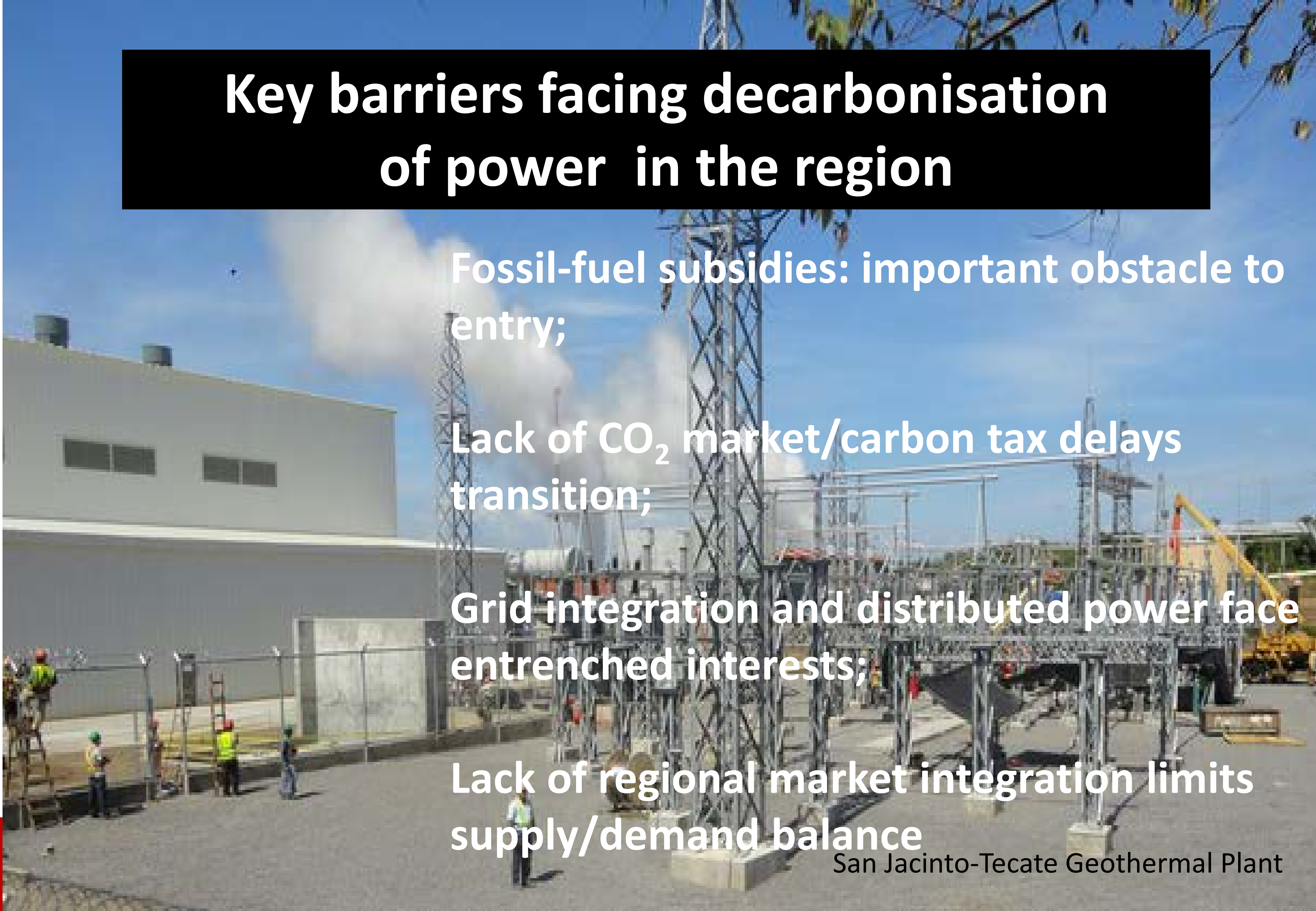
Key barriers facing decarbonisation of power in the region

Fossil-fuel subsidies: important obstacle to entry;

Lack of CO_2 market/carbon tax delays transition;

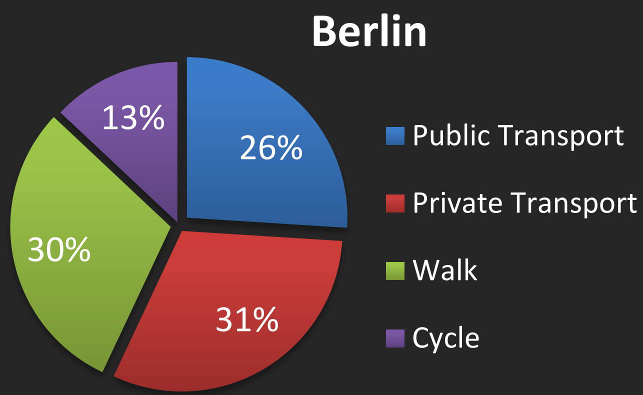
Grid integration and distributed power face entrenched interests;

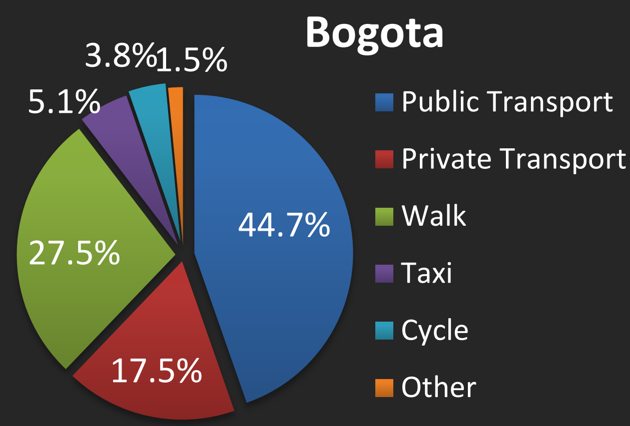
Lack of regional market integration limits supply/demand balance

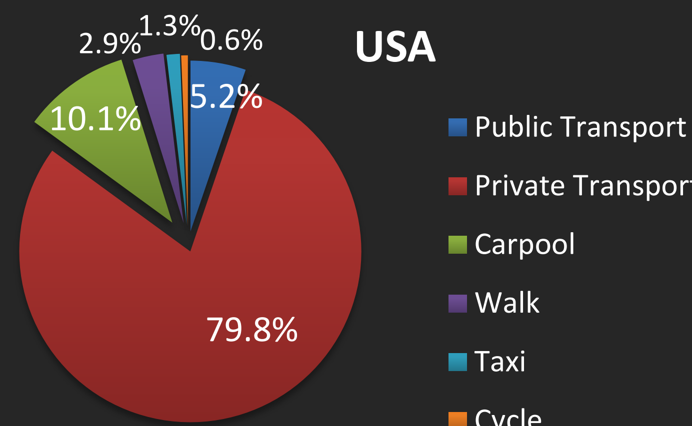


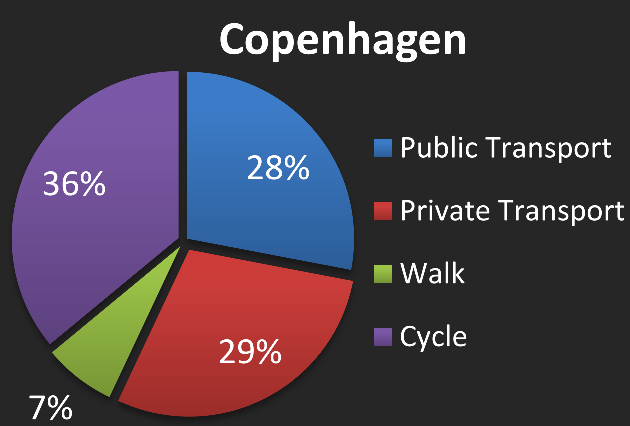
San Jacinto-Tecate Geothermal Plant

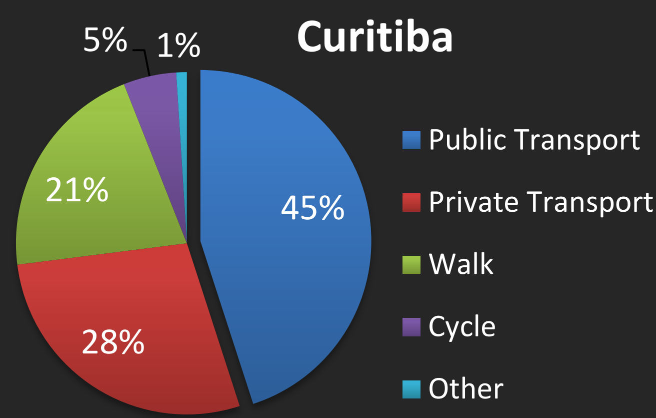
Modal share in urban transport











Sources: (Berlin, 2013), (Bogotá, 2013), (Curitiba, 2011), (Copenhagen, 2013), (USA, 2012) recalculated

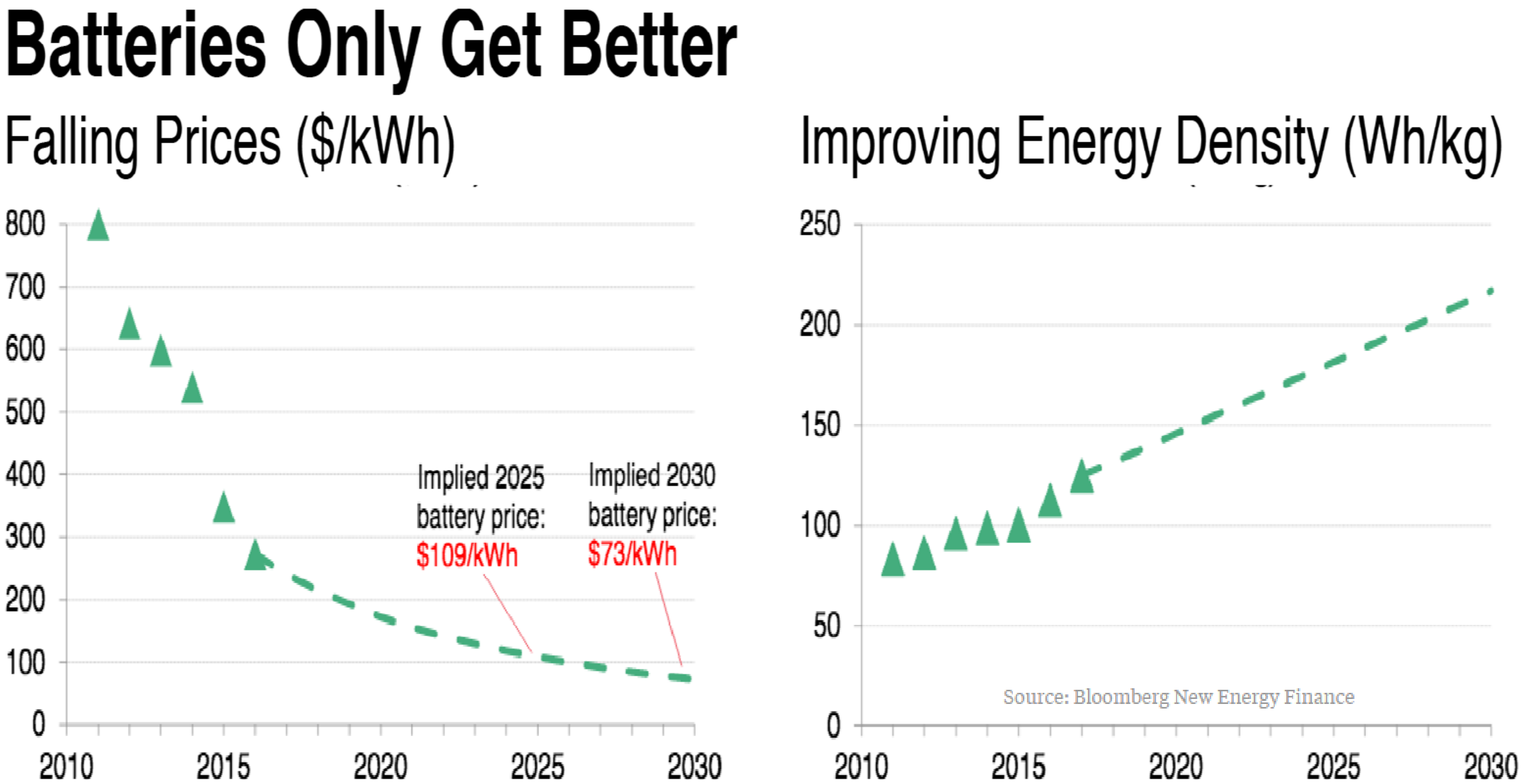
Motorization rates

- Rapid motorization in LAC, 4.5% per year.
- Counter trend in US: vehicle miles travelled peaked in 2006.
- Bus Rapid Transit Systems (BRTs) have grown exponentially

Air pollution

- US$1.7 trillion health impact of air pollution in OECD countries in 2010;
- US$39 billion the total costs of air pollution in México in 2010;
- Airborne pollutants of concern associated to diesel (91% of $PM_{2.5}$, 95% of NO_2 attributable to diesel vehicles in London).

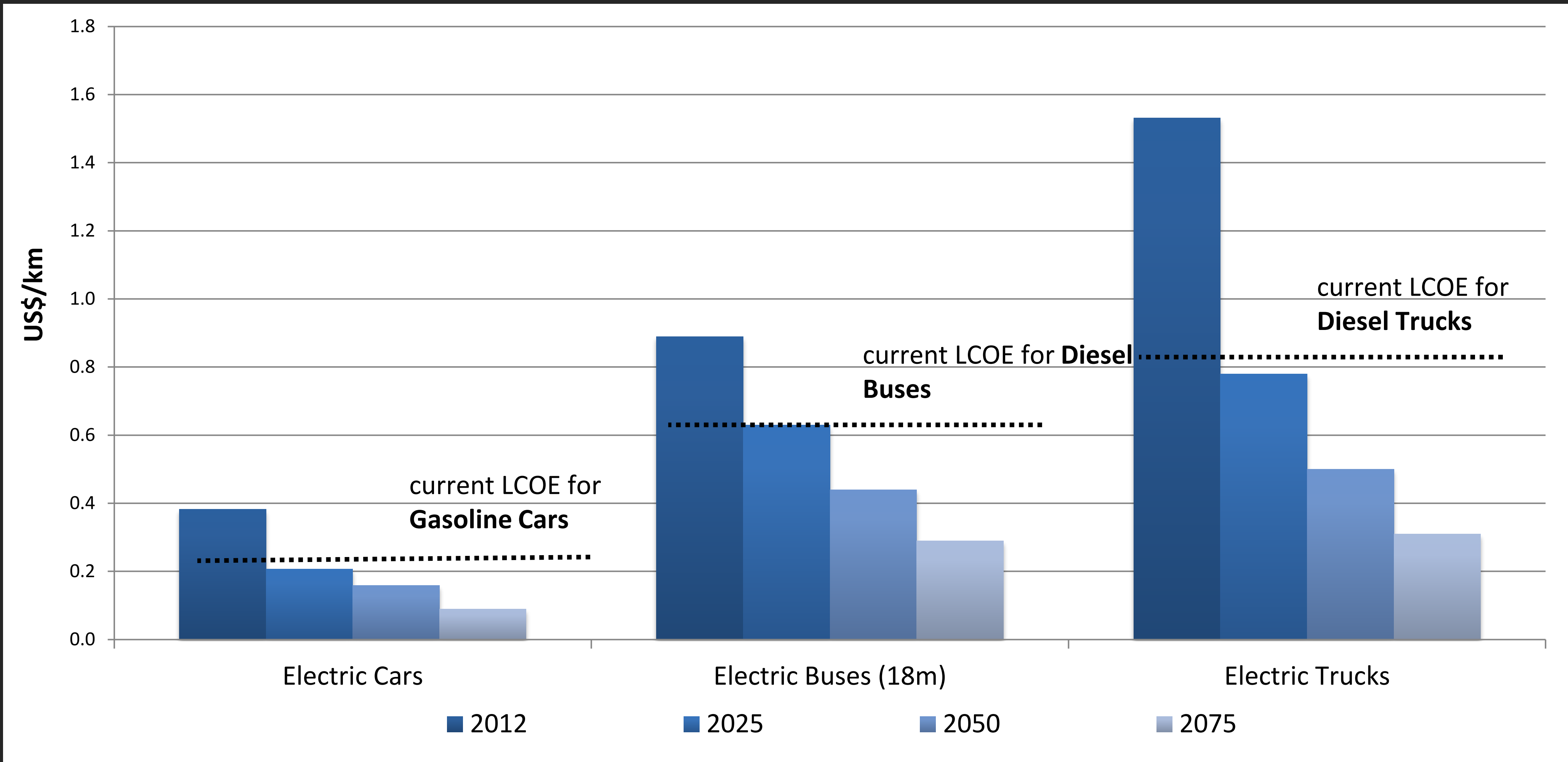
A market disruption over the horizon



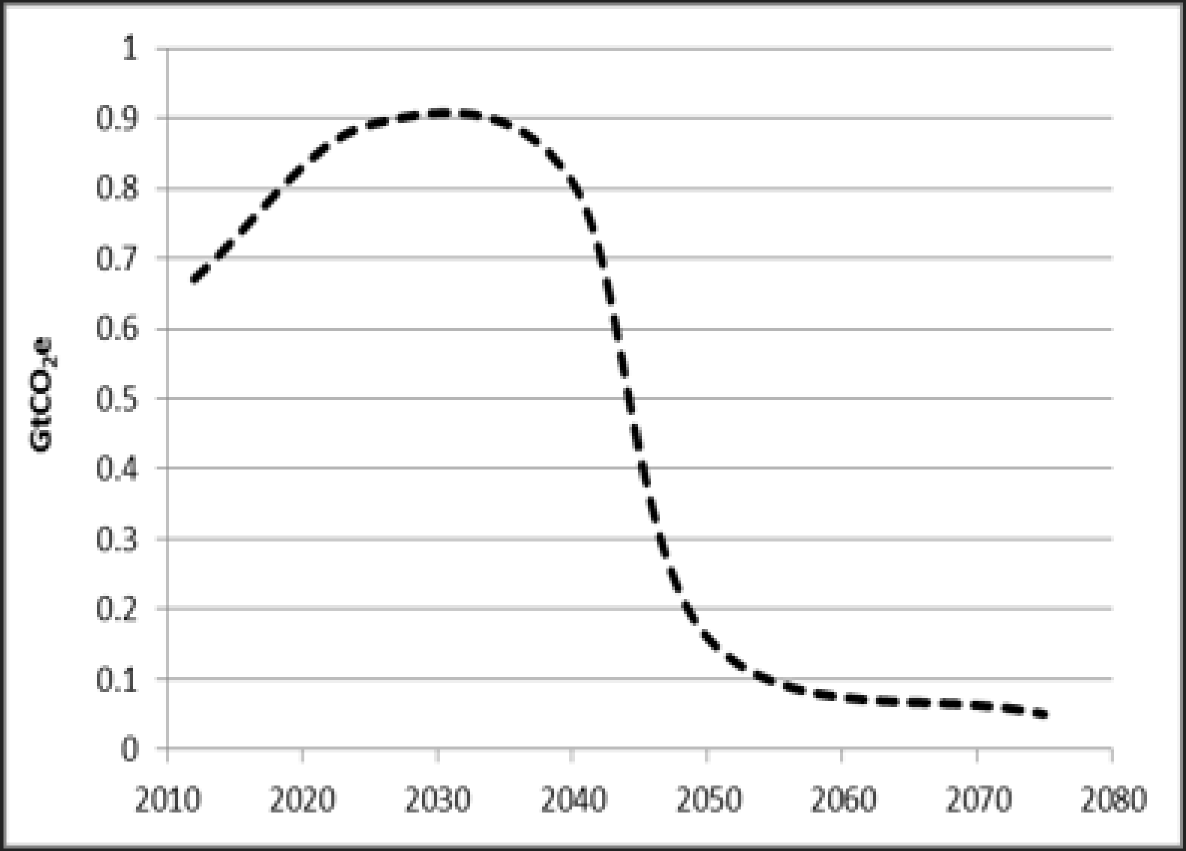
Synergies between low-carbon power and transport.

Technology	Pace of Change	Impact
Renewable energy	PV costs down 22% per year since 1976; Market size for PVs up 40% per year 2000-2015	Reduced operational costs of electric vehicles
Energy storage	Costs down at 14% per year since 2000	Matches supply & demand. Increases autonomy of vehicles.
Electric vehicles	Costs to be at par with ICE by 2020	Can complement power demand curves
Charging stations	Wireless stations emerging	Increased driving range
		Source: Vergara et al 2016

Projected learning curves for EV options with credit for avoided cost of air pollution (LCOE, US$/km)



Pathway to zero carbon transport if....



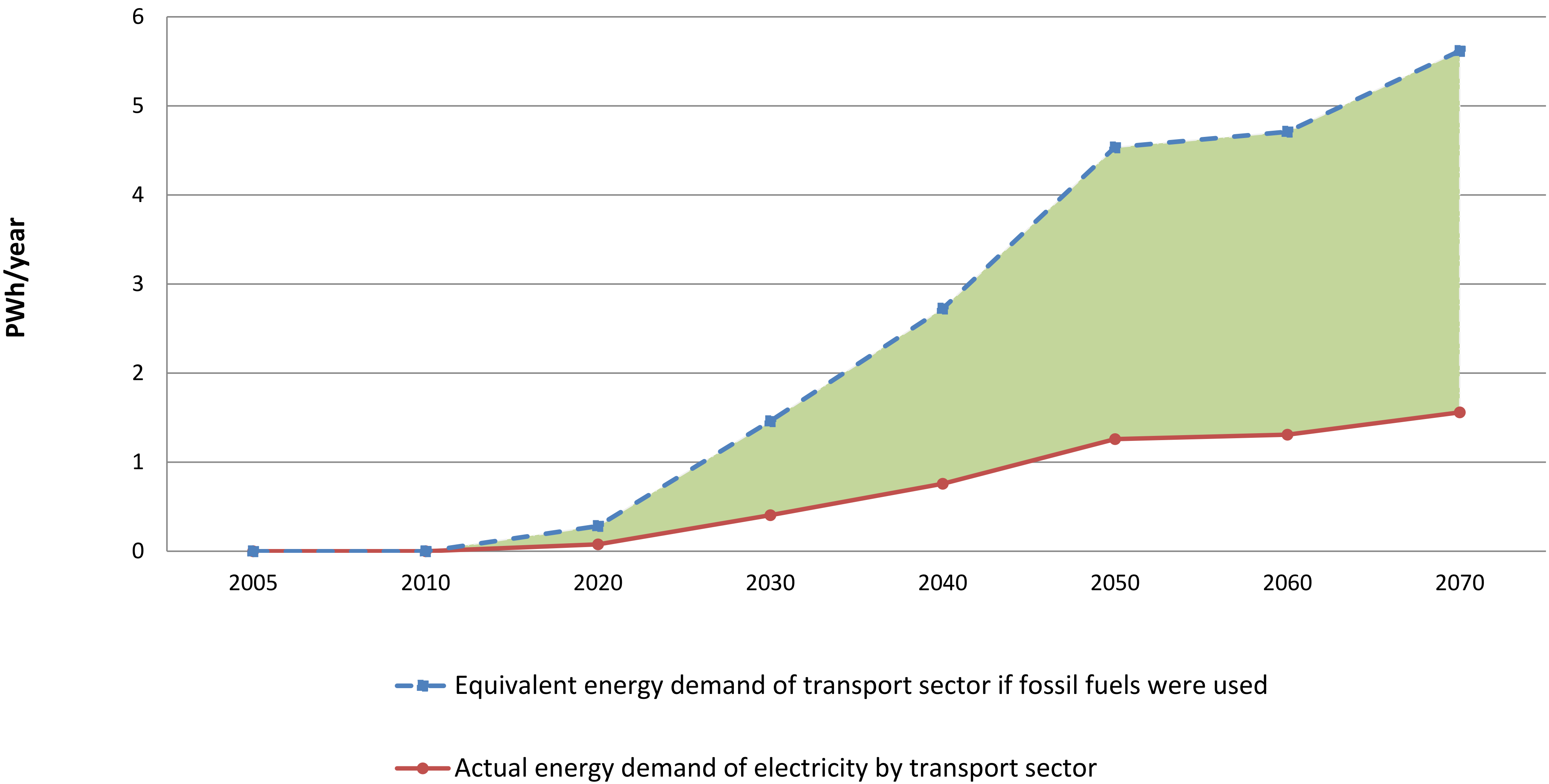
- 2025 shift to electric for all existing BRTs; all new BRTs in designing stage are electric;
- Car fleet becomes 15% electric by 2025, 60% by 2040 and is fully electrified by 2050;
- Railroad cargo and passenger transport is electrified by 2040.
- Heavy road cargo transport becomes 5% electric by 2025, 60% electric by 2040 and is fully electrified by 2050;
- Aviation remains fossil fuel-based until mid-century.

Doable, feasible, difficult

Key barriers for electrification of transport systems

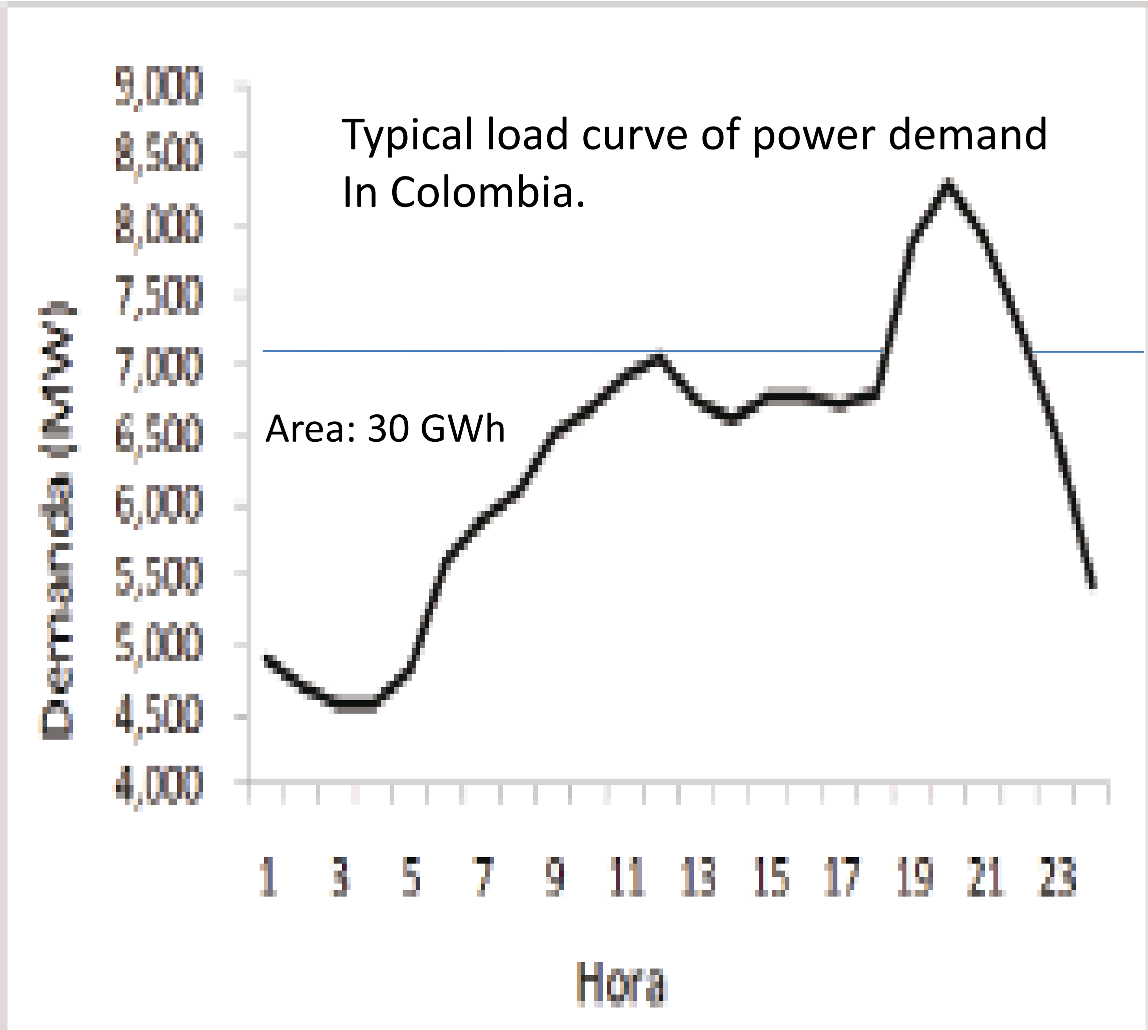
- Limited policies for use of public space for public transport
- Fossil fuel subsidies
- Poor internalization of health costs
- Limited carbon markets/taxes

Energy savings from full transport electrification: 3.5 PWh/year by 2050



Vergara et al 2016

Complementarity of electricity and transport demand



Nominal capacity for hydro is 10GW.

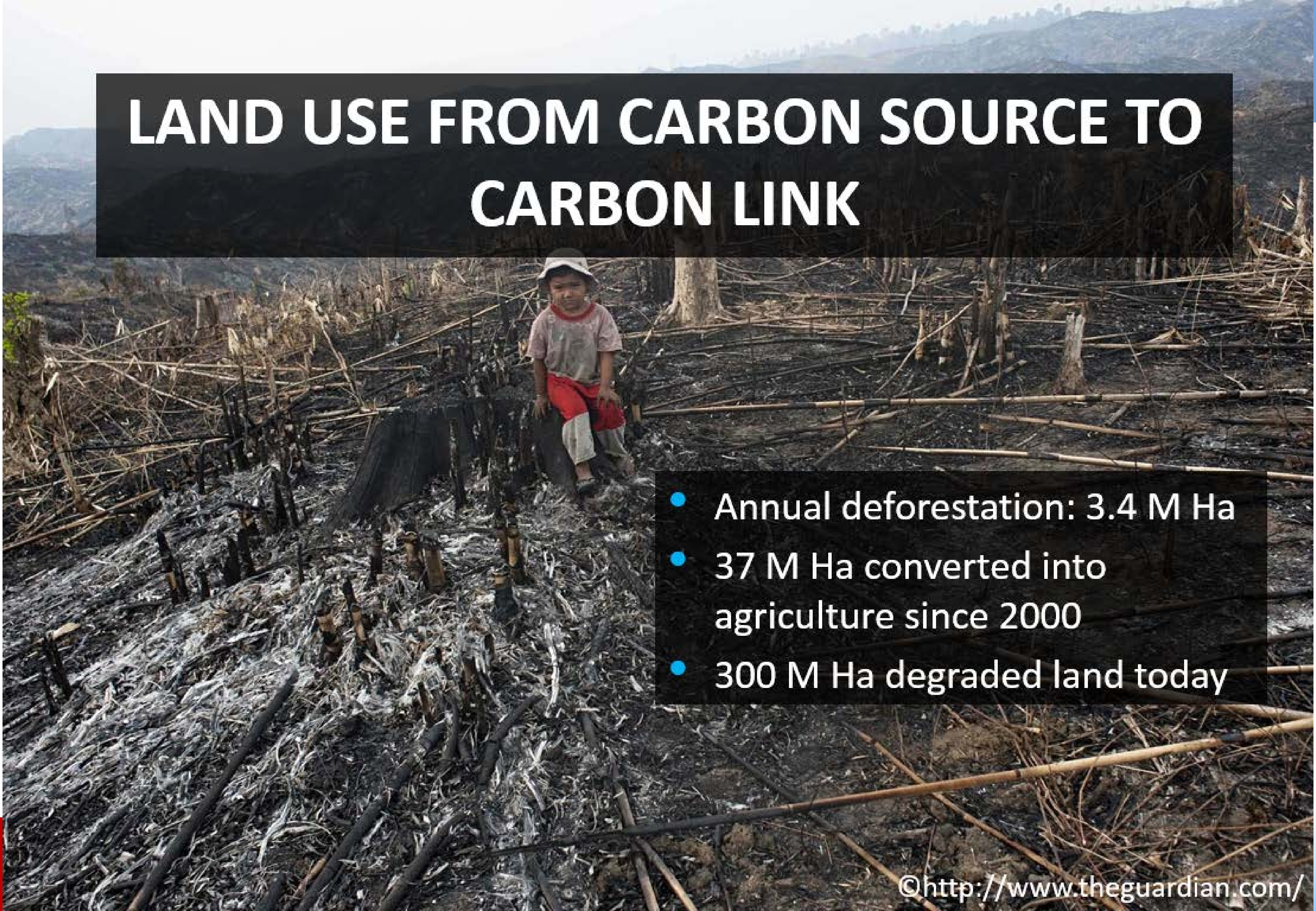
System requires expansion to handle peak demand.

Daily eq. energy demand of diesel is 60 GWh electric.

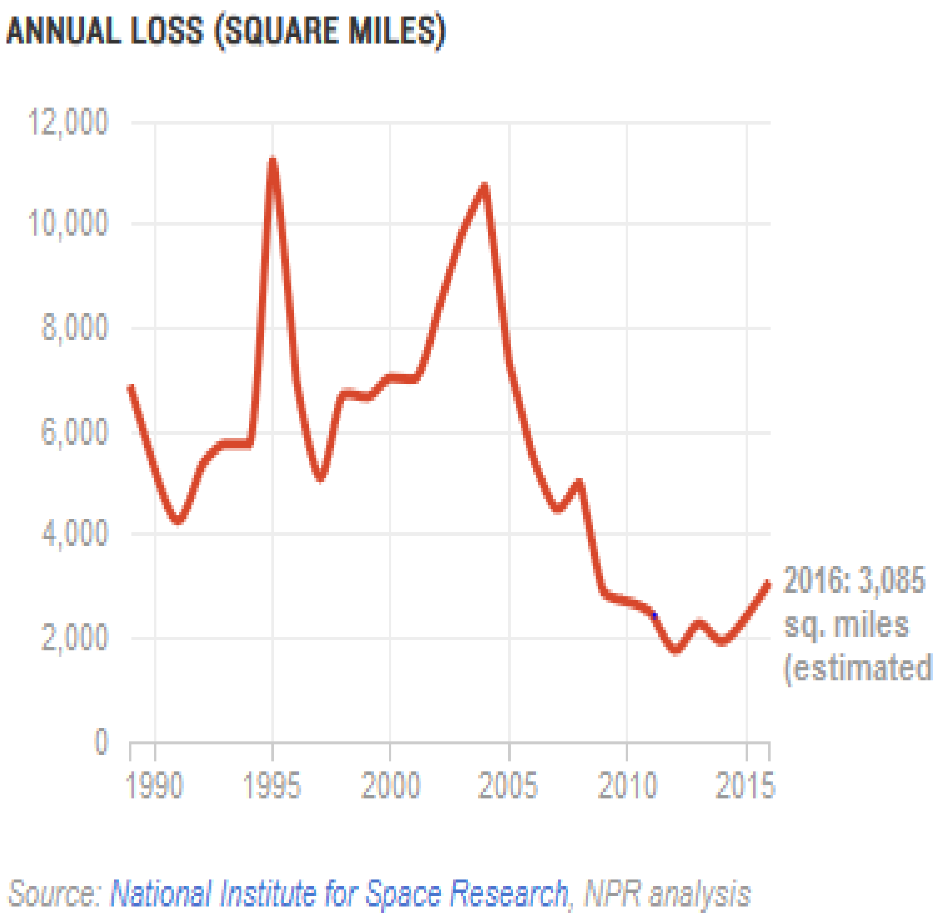
Without expansion, system could accommodate half of additional demand

LAND USE FROM CARBON SOURCE TO CARBON LINK

- Annual deforestation: 3.4 M Ha
- 37 M Ha converted into agriculture since 2000
- 300 M Ha degraded land today



Deforestation in the Brazilian Amazon



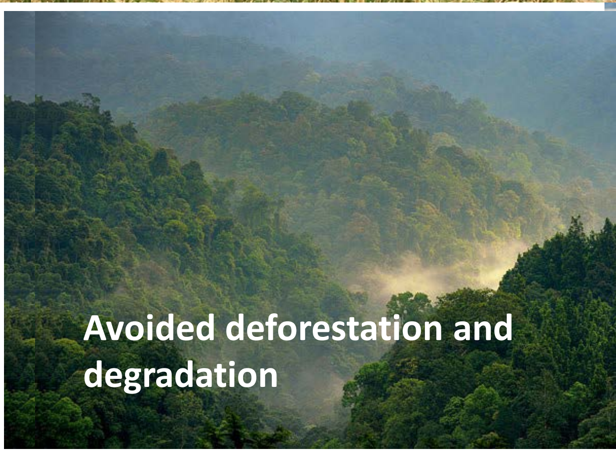
Potential for land restoration

Forest Condition [Mha]			Restoration Opportunity in degraded and deforested land [Mha]		% of Total
Intact	449		Wide-scale Restoration	91	14
Fragmented	559		Mosaic Restoration	456	70
Degraded	299		Natural Restoration	2	-
Deforested	349		Agricultural Lands	99	15
Total	**1,656**			**648**	

- Major inefficiency in the use of natural resources, land

Restoration approaches

Methods that can sustainably bring back land functionality to the landscape (carbon, topsoil, water, vegetation, and biodiversity)



Source: Initiative 20x20, 2017

Land use can become a major carbon sink, again if…

CARBON SINKS	Size of effort (million ha by 2050)	Potential carbon storage rates (tC/ha-year)	Accumulated Carbon sinks ($GtCO_2$ e/year)
Reforestation	50	3.5	0.6
Restoration through agroforestry and silvopastures	200	2	1.3
Avoided deforestation	0.8	260	0.7
Management of fertilizers in cropland for abatement of N_2O	n.a.	0.15 - 0.4	0.2
Management of nutrients for livestock for abatement of CH_4	n.a.	n.a.	0.2
Total	250		3.0

INITIATIVE 20X20

A country-led effort to initiate restoration
of 20 Mha of degraded land in Latin America and the Caribbean by 2020

Notes:
*Goals to be accomplished by 2030
**Commitment to define a national restoration strategy

Sample investments under 20x20

- 100,000 ha of silvopastures. Althelia Climate Fund. Brasil
- 100,000 ha of grasslands restoration. SLM Partners. Chile
- 28,000 ha of agroforestry. CARANA. Perú
- 5,000 ha of agroforestry. Moringa Partnership. Nicaragua
- 24,300 ha of agroforestry and conservation. Ecotierra. Peru
- 1.4 M ha of protected rainforest. Amazon/Andes Fund. Peru
- 28,400 ha of sustainable use and protection of grasslands. ABC. Mexico
- Total: More than 40 projects with 10 million Ha under active restoration/conservation

Key barriers facing accumulation of carbon sinks in land use

- Weak governance, education and lack of fiscal/financial incentives to eliminate deforestation.
- Lack of fiscal and financial incentives for reforestation.
- Fiscal incentives are needed to promote restoration as an alternative to expanding the agricultural frontier.
- Absence of a robust carbon market prevents faster adoption of abatement measures. Fiscal incentives are needed for widespread application.

Sector	2012 $GtCO_2e$	2050 GEA-BAU $GtCO_2e$	2050 Zero GHG pathway ($GtCO_2e$)	Transformation drives
Total	4.6	5.3	-0.1	
Power generation	0.5	1.1	0	Renewables increase their margins overtime; grid integration and distributed power aid the transition.
Industry, manufacturing & construction	0.5	0.5	0.4	Industry/manufacturing implements energy savings and technology improvement measures.
Transportation	0.7	1.4	0.2	Evolving EV technologies and air-quality policies assist in transformation, overtaking internal combustion options.
Land use & forestry, agriculture and waste	2.6	1.9	-1.1	Zero deforestation and large-scale restoration and reforestation efforts are implemented.
Other Sectors	0.3	0.4	0.4	Fugitive emissions and other fuel consumption kept constant as per GEA-BAU

Interconnected regional grid

- Allow large reservoirs of renewable energy to access regional market;
- Dampen the intermittencies of local renewable resources;
- Allow regional multi-annual reservoirs to operate as a large energy storage facility;
- Reduce power costs.

- Continue support for grid integration

Fuel Subsidies

Estimated $200 billion/year (Di Bella, 2014)

- Drives deficits
- Drags down long-term competitiveness
- Distorts market

Assess impacts and transfer resources to assist in transition

Carbon taxes, carbon markets

Framework for reforestation/restoration

- Carbon markets/taxes: cheapest mitigation measure
- Eliminate fossil fuel subsidies
- Fiscal/regulatory mechanisms

Added value of a Zero GHG development path

- Energy security (inexhaustible renewable resources);
- Improvements in terms of trade (energy, food, fiber);
- Improved air quality in urban areas (electrification of transport);
- Regional cooperation (integrated grid and means of transport); and,

- Places the region on a path more consistent with the sustainable development goals just adopted by the UN (climate, cities, energy, forests)

- It would support the deployment of new means of production and better use of natural resources with improvements in quality of life. And not just signal a leadership role for the region in the climate arena.

Data sources

- CAIT (emissions today, www.cait.wri.org),
- IIASA (emissions under BAU projections, (www.iiasa.ac.at/web-apps/ene/geadb/dsd)
- ENERDATA (energy use in transport and energy, www.enerdata.net)
- GACMO (LCOE and LCOT, www.cdmpipeline.org)
- Contact: Wvergara@wri.org
- The report can be downloaded with the following links:
- - English: http://orbit.dtu.dk/files/123115955/Zero_Carbon_Latin_America_rev.pdf
- - Spanish: http://orbit.dtu.dk/files/123116630/Carbono_Cero.pdf