

Challenges of Distribution Ratemaking in Latin America

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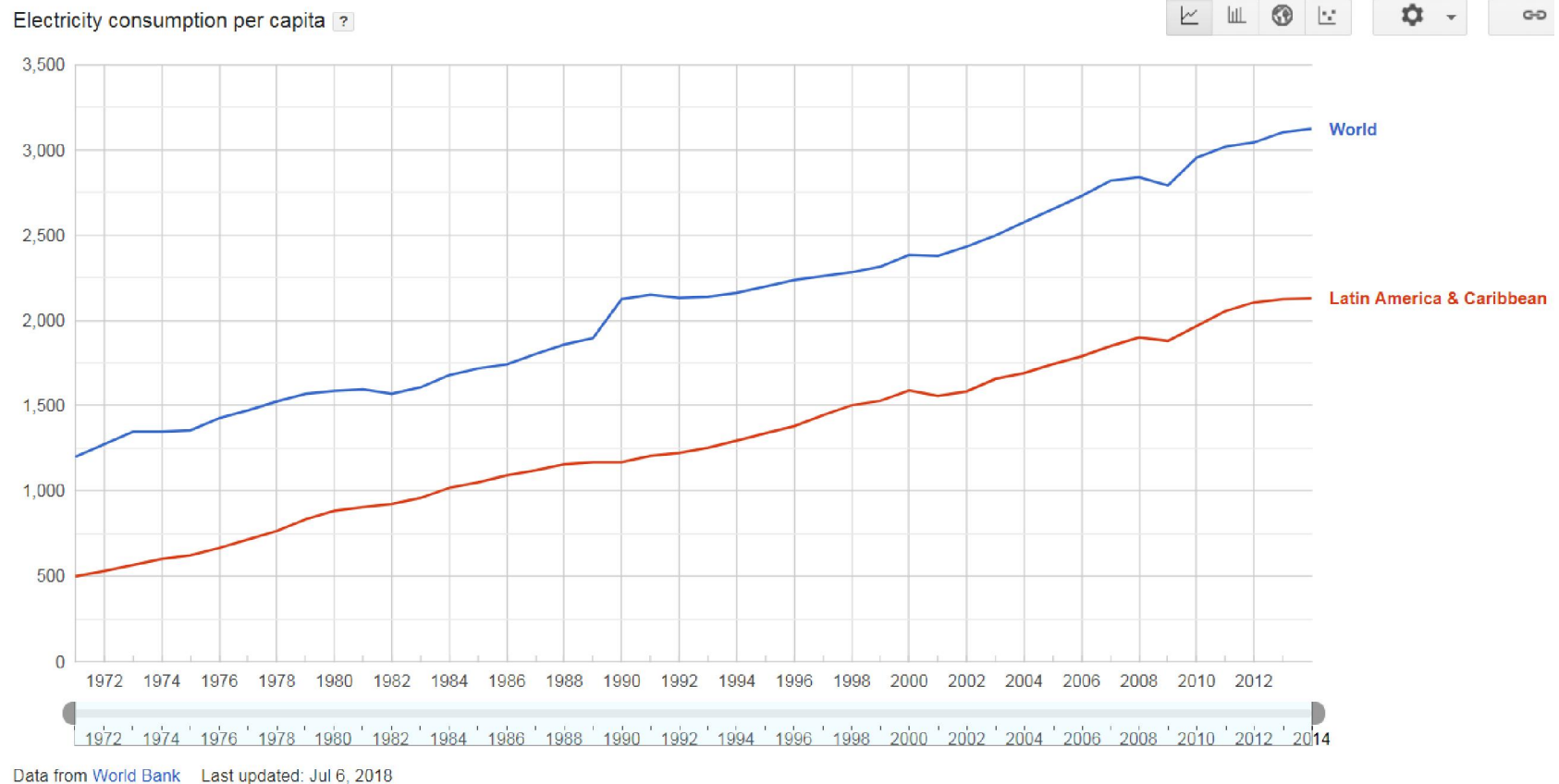
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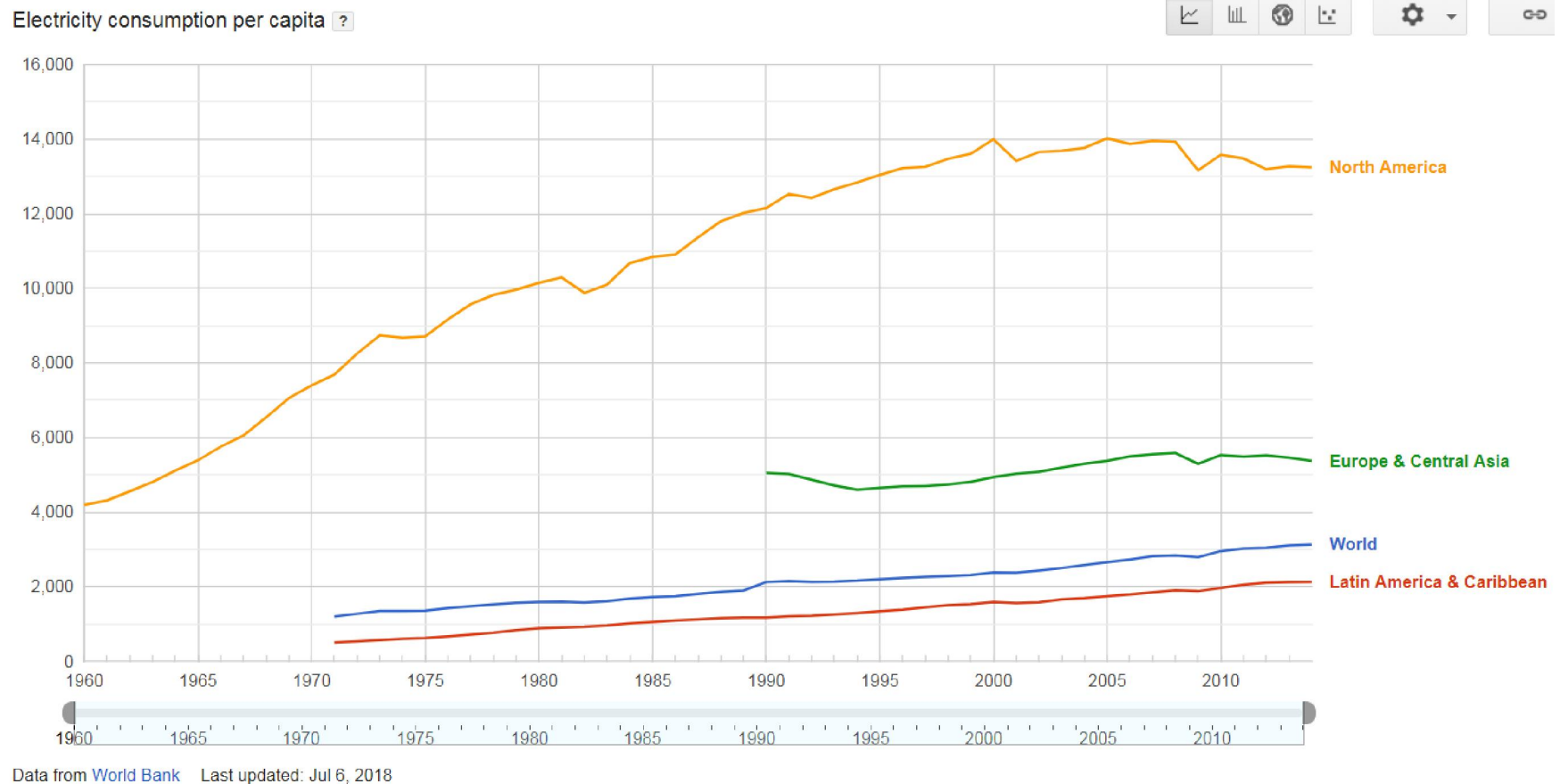
Motivation

- Energy consumption is still growing up in our region !!!



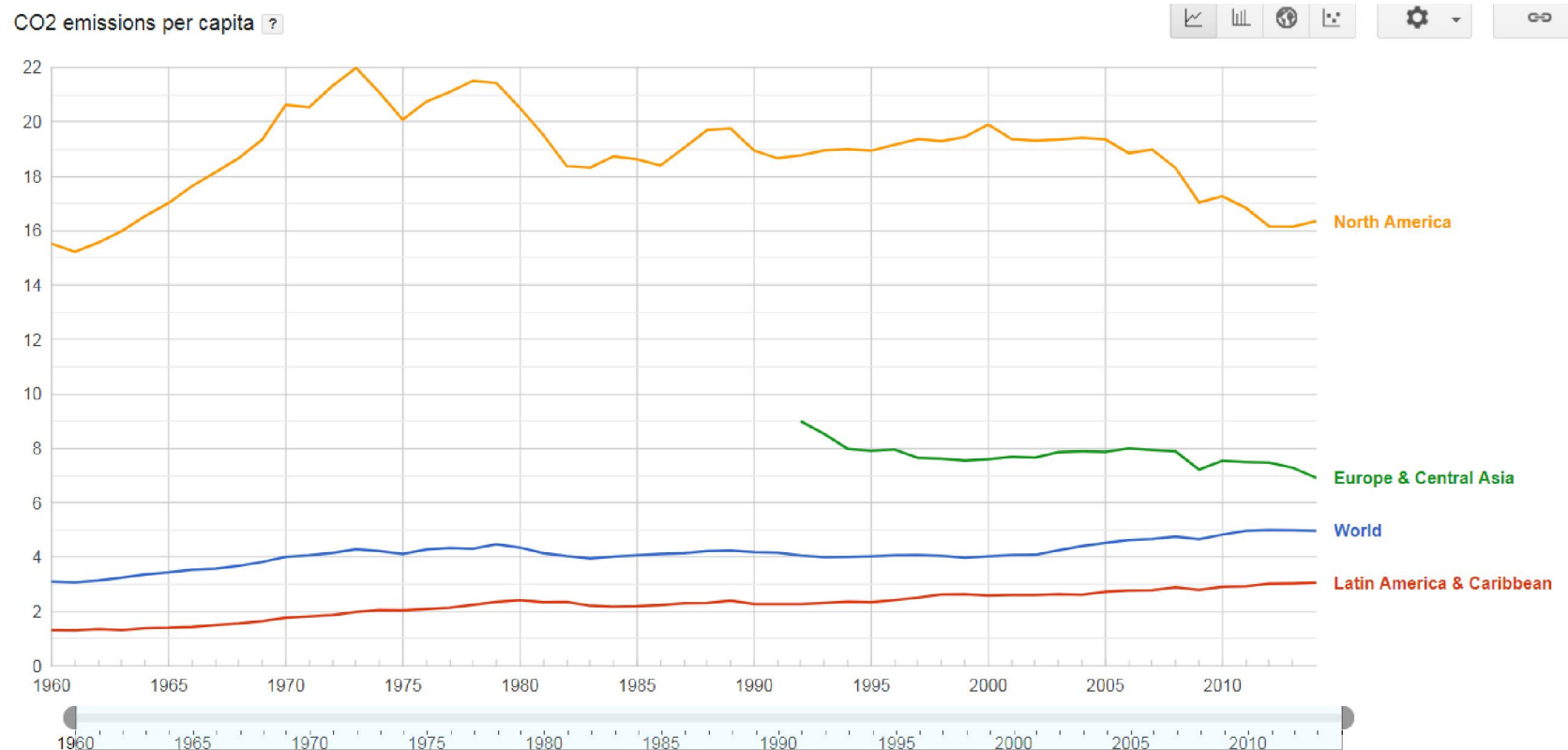
Motivation

- But don't worry, we are still far away from the developed world



Motivation

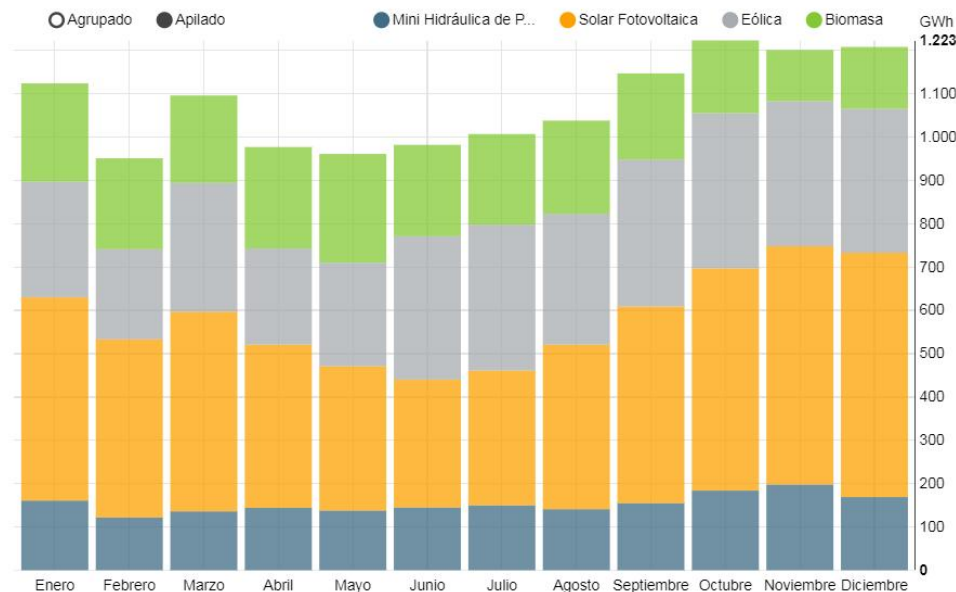
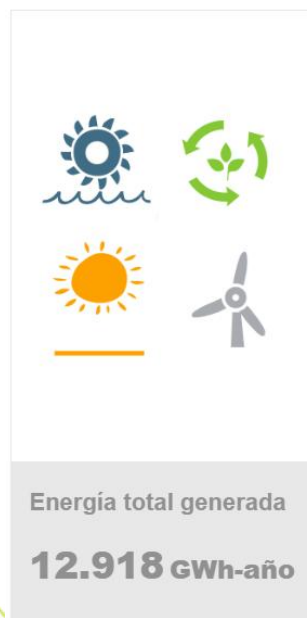
- And although we are not the countries with the largest contributions to global emissions, we must do our part !!!



Data from [World Bank](#) Last updated: Jul 6, 2018

Motivation

- To do our part, several countries in Latin America have launched programs and policies to incentivize the integration of renewable energy to our systems.
- For instance, Chile, Peru, Colombia, Brazil and Mexico have specific targets regarding renewable energies.

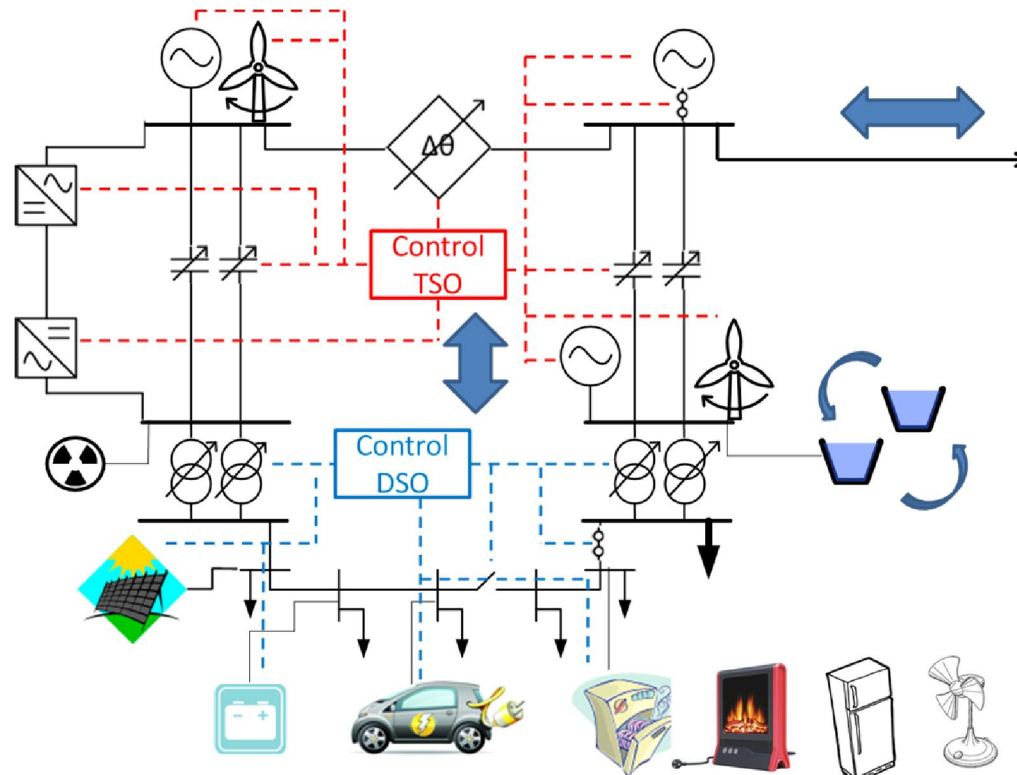


**For instance,
17% of the
yearly
generation was
using variable
renewable
energies in Chile
during 2018**

Motivation

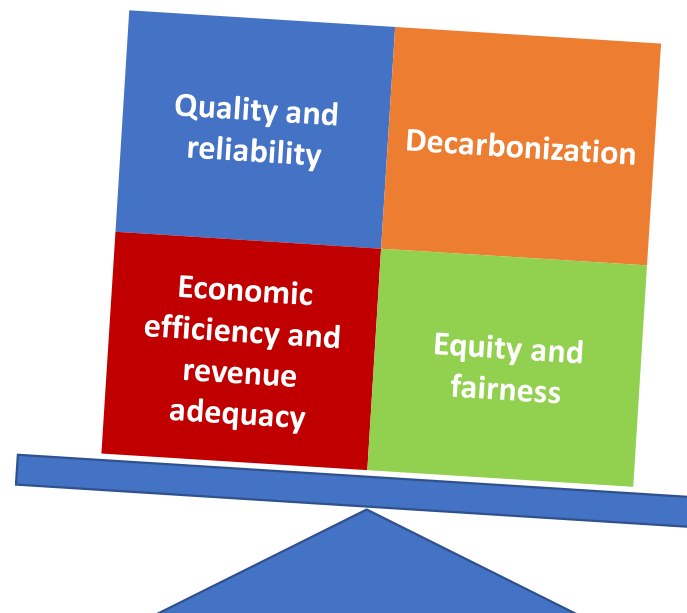
- To host the new technologies, our system needs to be prepared.
- Particularly, the distribution network must be modernized, from a “fit and forget” approach to a smart grid framework.

To make this happens we need a regulatory update!!



Elements to consider in this transition

- Policy makers need to take into account energy security, economic efficiency and energy security, but in developing regions with low/medium level of incomes, it is also crucial to consider equity and fairness.



The tetralemma for distribution network regulation in Latin America

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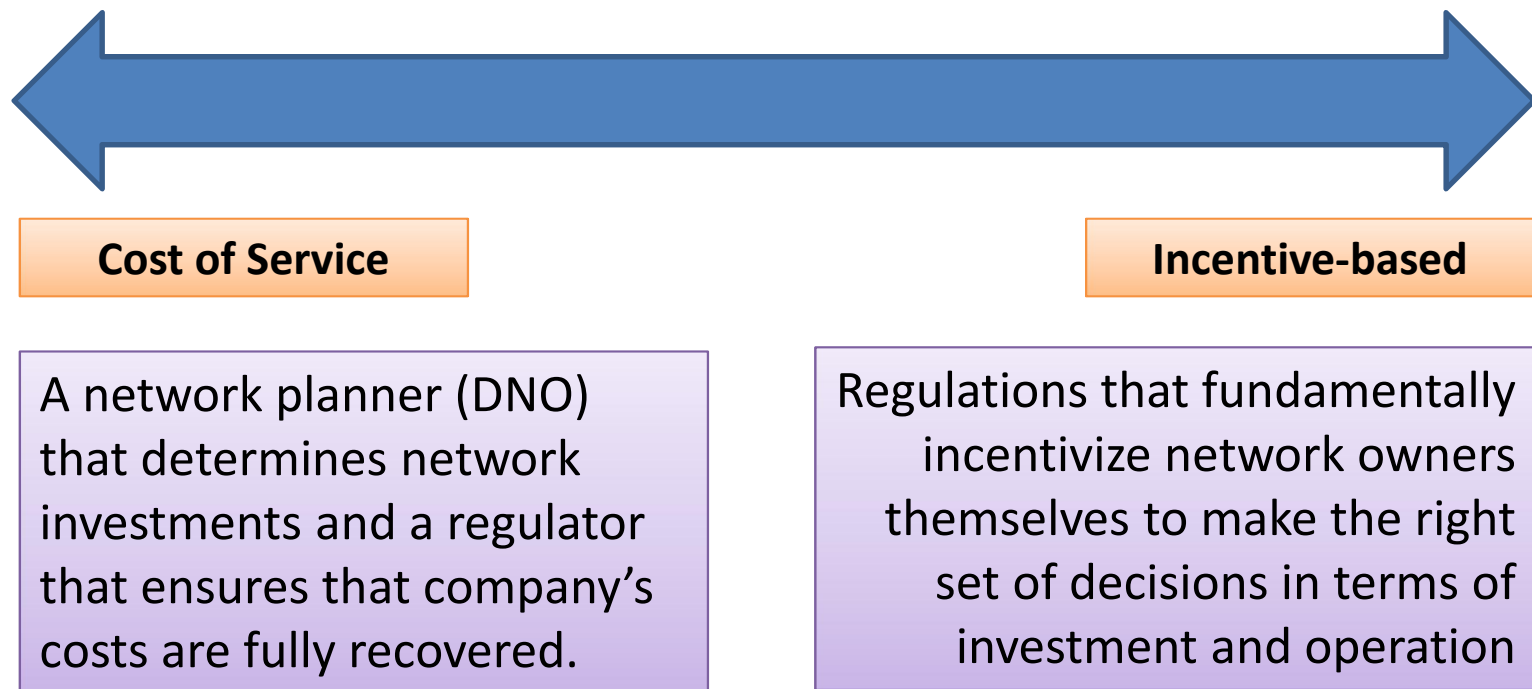
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- Remuneration challenges
- Tariffs setting challenges
- Final remarks

What is ratemaking?

- It is the combined process to determine:
 - the allowed, regulated revenue for a distribution network company.
 - the tariffs to collect this allowed revenue from its network users.
- The appropriate ratemaking design of such a process should consider that:
 - remuneration will affect network owners' decisions (investment, operation, maintenance, administration, etc.)
 - tariffs will impact network users (locations, consumption and production profiles, etc.).

Framework for allowed revenue determination

- All the way from full cost of service regulation to incentive-based regulation.



Framework for allowed revenue determination

We found both types in the region

	Argentina	Bolivia	Brazil	Chile	Colombia	Costa Rica	Dominican Republic
Property	Mixed	Mixed	Mixed	Private	Mixed	Public	Mixed
Price control	Incentive-based	Incentive-based	Incentive-based	Incentive-based	Incentive-based	Cost-based	Incentive-based
Referential rate of return	8.1% (Edesur)	According to public utility companies included in the Dow Jones	8.09% (benchmark company)	10% (model firm)	Between 11.8 and 12.4%	4.24%	9.02%
Control period	4 yrs	4 yrs	4 yrs	4 yrs	4 yrs	1 yr	4 yrs
	Ecuador	El Salvador	Guatemala	Honduras	Panama	Peru	
Property	Mixed	Private	Mixed	Mixed	Mixed	Mixed	
Price control	Cost-based	Incentive-based	Incentive-based	Incentive-based	Incentive-based	Incentive-based	
Referential rate of return	No public info.	10%	7%	Between 7 and 10%	8.94%	12%	
Control period	1 yr	5 yrs	5 yrs	5 yrs	4 yrs	4 yrs	

Tariffs Overview

- The region presents different tariff structures (i.e. residential, commercial, industrial, public lighting, etc.).
- Some of these tariffs present fixed (per user) and variable components (in \$/kWh and \$/kW), various spatiotemporal granularity levels (in time: peak and off peak hours, winter and summer, day and night, etc., and in space: per company, per municipality, per voltage level, etc.)
- The tariffs can be based on either average or marginal (or incremental) network cost principles.
- No LMPs are used for distribution networks

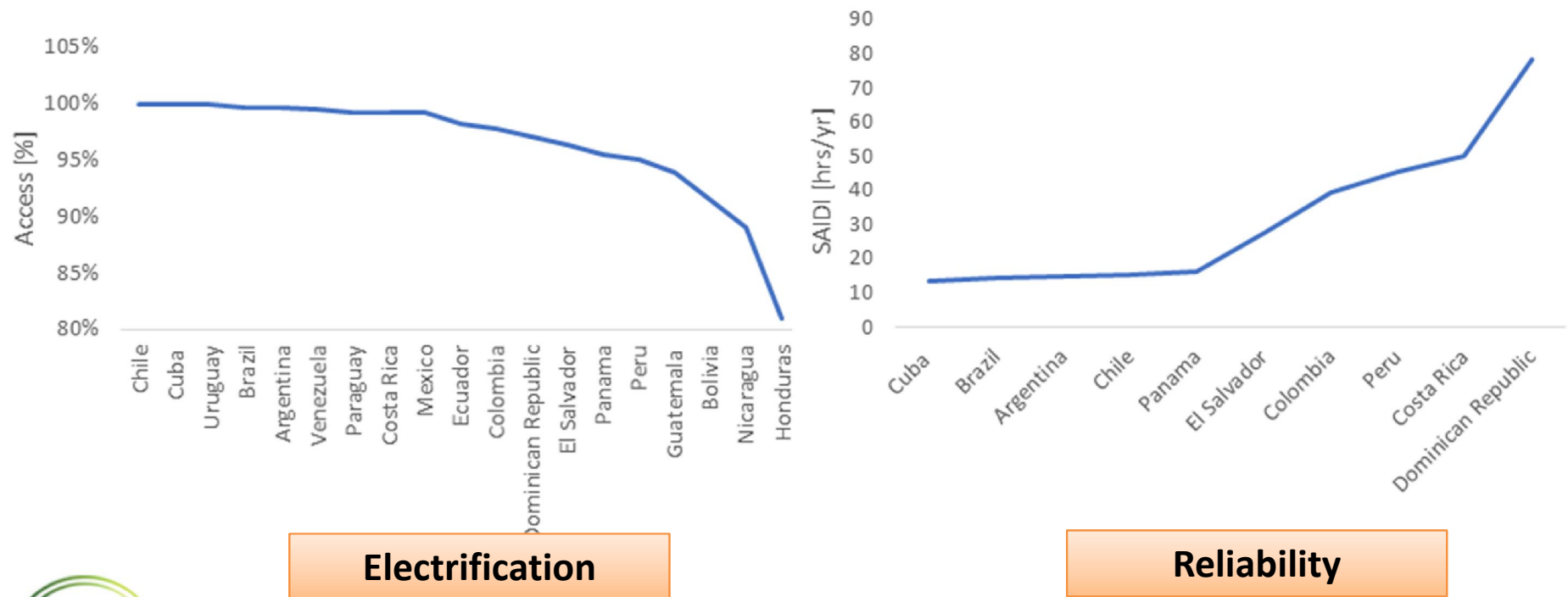
Tariffs Overview

Sector	Unit	Santiago - Low voltage		Quito* - Low voltage		Rio de Janeiro - Low voltage	
		Residential	Industrial	Residential	Industrial	Residential	Industrial
Generation	\$/month	-	-	-	-	-	-
	\$/kWh	0.10	0.08	0.03	0.03	0.06	0.06
	\$/kW/month	-	6.99	-	-	-	-
Transmission	\$/month	-	-	-	-	-	-
	\$/kWh	0.02	0.02	0.01	0.01	0.03	0.03
	\$/kW/month	-	-	-	-	-	-
Distribution (inc. metering and billing)	\$/month	0.85	0.99	1.41	-	-	-
	\$/kWh	0.02	-	0.05	0.03	0.03	0.03
	\$/kW/month	-	9.20	-	4.18	-	-
Others	\$/month	-	-	-	-	-	-
	\$/kWh	0.001	0.001	0.01	0.01	0.03	0.03
	\$/kW/month	-	-	-	-	-	-
Total	\$/month	0.85	0.99	1.41	1.41	-	-
	\$/kWh	0.14	0.10	0.10	0.08	0.16	0.16
	\$/kW/month	-	16.20	-	4.18	-	-
Time resolution (max)		\$/kWh rate with up to 3 levels in a day	\$/kWh and \$/kW rates with no time variations	No time variations	\$/kWh rate with up to 3 levels in a day	No time variations	No time variations

*In Ecuador, there is a government subsidy of about 0.05 \$/kWh that reduces the overall bill to the values shown above

Current Status

- The current regulatory frameworks (some of them 40 years old) have been successful to increase the level of electrification in Latin America but they have not been yet able to significantly increase reliability.



What is going on?

- Policy makers in Latin America are instigating regulators to include other objectives in remuneration and tariff regimes:
 - Equity and fairness, in both tariffs and quality
 - Quality of service, beyond reliability and voltage quality, including resiliency to hazards and customer satisfaction
 - Innovation and network modernization, evolving towards the concept of the so-called smart grid
 - De-carbonization and renewables
- Remuneration should evolve to allow distribution networks to innovate and become more active, operating their networks by using new smart grid technologies and adopting DER.

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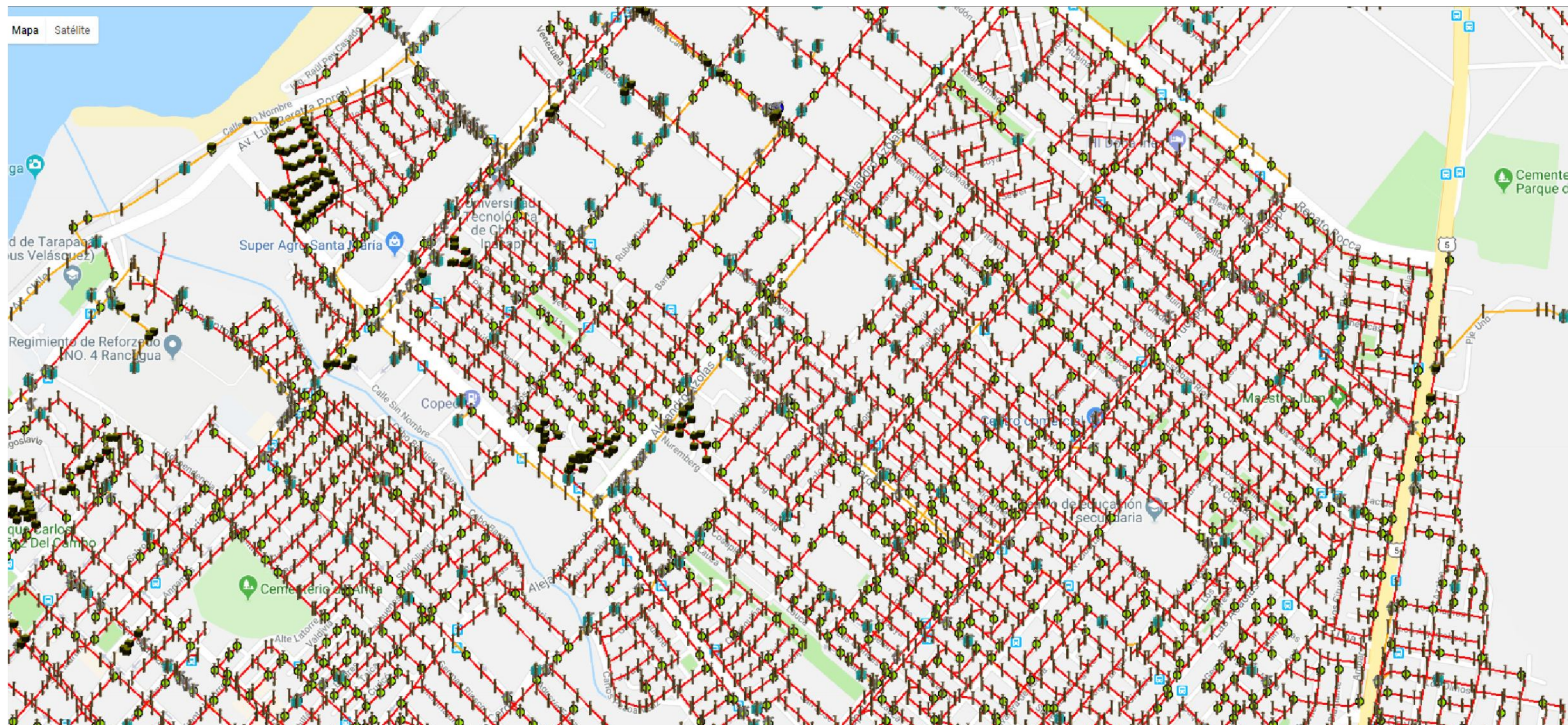
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Incentive based regulation: Model Firm

- We will use Chile as case study to understand challenges, current practices and opportunities related to the determination of the allowed company remuneration.
- Since the 80', Chile uses an **incentive based regulation called model firm**, which is a theoretical, “virtual” company, optimally designed in a greenfield fashion at the beginning of each control period (i.e. every 4 years) and is planned to provide distribution network services in the same area as the corresponding real company does.
- Once model firms have been determined and valued, final network tariffs to be applied on real network companies, are calculated in order for the model firms to feature a 10% cost of capital.

Model Firm

- The main idea behind is to incentivize real companies to be economically efficient as their revenues and costs are decoupled (in fact, under this philosophy, the costs functions of real companies do not affect tariffs).



Model Firm: Advantages

- Pros:
 - the efficiency incentives perceived by firms.
 - its simplicity and low-cost implementation by regulators,
 - its ability to deal in a pragmatic fashion with significant information asymmetries between the regulator and firms.
- This remuneration approach was successfully exported to other countries in Latin America like Argentina, Peru, Bolivia and other countries in Central America, demonstrating its attractiveness and practicality at the time when economic efficiency and investments on recently privatized companies were key.

Model Firm: Concerns

- **On security of supply:** Target: 1 hour in 2050, 4 hours in 2035, but we have an average of 15,5 hours of interruption per customer.

Region	Population	2012	2013	2014	2015	2016	2017	2018	7-year average
Aysen	103,158	23.1	27.9	26.1	29.9	19.7	31.2	14.0	24.6
Magallanes y Antartica Chilena	166,533	6.2	8.8	8.2	9.2	5.1	6.0	6.9	7.2
Arica y Parinacota	226,068	21.0	14.3	33.9	12.3	10.7	15.3	23.2	18.6
Atacama	286,168	25.9	19.5	22.8	53.6	11.1	22.6	16.4	24.6
Tarapaca	330,558	29.8	24.4	59.9	23.8	20.2	18.1	14.6	27.3
Los Rios	384,837	27.9	25.6	25.1	26.6	22.3	24.7	19.5	24.5
Antofagasta	607,534	18.6	14.9	25.2	22.9	15.9	16.3	11.7	17.9
Coquimbo	757,586	10.0	11.5	9.8	44.0	11.5	10.5	10.1	15.3
Los Lagos	828,708	30.1	24.2	25.9	23.9	18.4	22.3	17.2	23.2
O'Higgins	914,555	16.6	18.2	18.0	20.4	17.9	23.2	16.8	18.7
La Araucania	957,224	34.1	34.6	30.7	32.3	31.5	51.0	28.3	34.6
Maule	1,044,950	20.1	14.1	16.9	26.0	20.8	33.1	14.7	20.8
Valparaiso	1,815,902	12.4	9.3	10.1	17.2	9.4	10.0	7.1	10.8
Biobio y Nuble	2,037,414	28.6	19.3	20.6	19.3	16.9	20.5	13.2	19.8
Metropolitana de Santiago	7,112,808	8.9	7.7	8.4	8.8	8.2	13.6	8.5	9.2
Country level	17,574,003	16.7	13.9	15.7	18.1	13.4	18.6	12.1	15.5

SAIDI in hours !!!!

Model Firm: Concerns

- **On security of supply:** so question is, how to improve the present remuneration method to deliver efficient investments that aim to ensure a more secure, reliable and resilient future?

Debate in Chile to answer that question

- The model firm approach would need additional incentives (penalties and/or rewards) to discourage reliability degradation, because delivering adequate reliability levels usually requires cost increases that are clearly discouraged by a remuneration approach that incentivizes cost savings.
- Penalties will not encourage further investments if there is not enough funding for them (and not enough certainty in the future revenue streams related to these funds).

Model Firm: Concerns

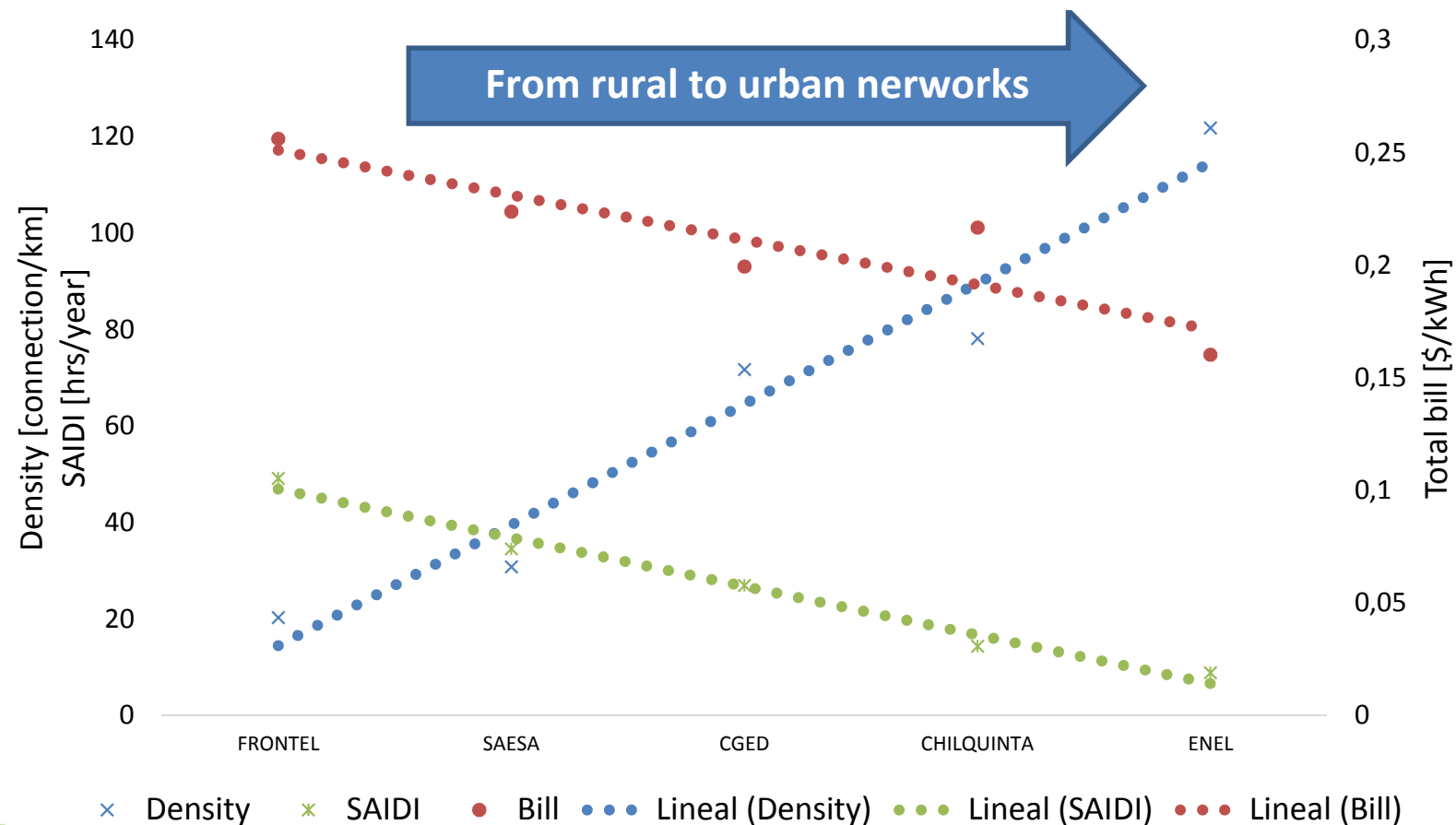
On reliability fairness and affordability in rural networks:

- Delivering reliability to consumers in rural areas is costlier than in urban areas due to population density differences.
- A cost-benefit analysis to determine network investments that properly balance investment costs against their reliability benefits, will justify worse reliability levels in rural areas.
- Incurring higher costs to improve reliability in rural areas is not trivial since rural consumers, who already pay a higher electricity are also prone to feature lower incomes.

All of this is already happening under the current regulatory scheme !!!

Model Firm: Concerns

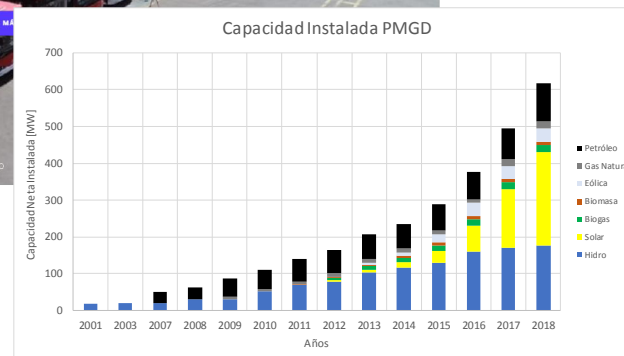
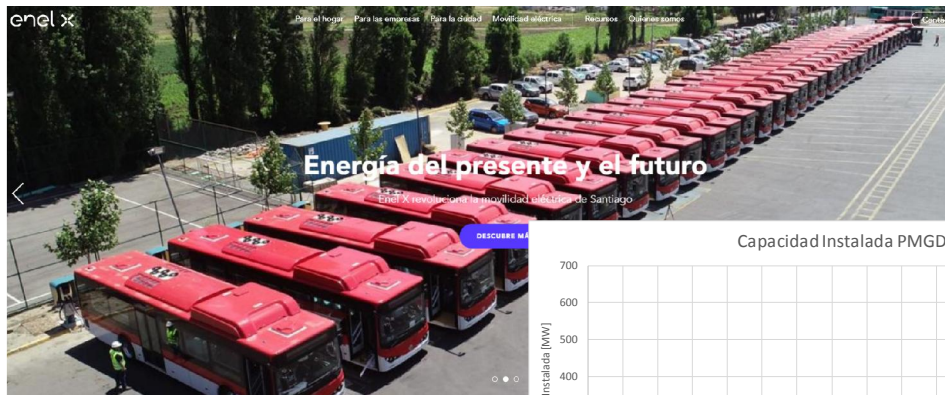
- On reliability fairness and affordability in rural networks:



Model Firm: Concerns

On de-carbonization through grid modernization:

- This increasing adoption of new low carbon technologies will necessarily require innovation in distribution, relying more and more on operational measures and non-wires solutions. (and we need to move fast)



Chile posee el primer bus interurbano 100% eléctrico de América

Su autonomía de 250 kilómetros le permite realizar el trayecto entre las ciudades de Santiago y Rancagua, ida y vuelta, con sólo una carga.



Publicado el 18 de enero del 2019

Model Firm: Concerns

On de-carbonization through grid modernization:

- Modernizing the present distribution networks will require strategic investments that have to be remunerated.
- Under the current model firm paradigm, where remuneration is fixed for the next 4 years and revenue streams beyond that point remain uncertain.
- Without the certainty that strategic investments will be adequately remunerated during their entire lifespans, companies are likely to prefer conventional solutions that may be cheaper in the short term, but that compromise the economic performance of the distribution system in the longer term

Model Firm: Concerns

- **On de-carbonization through grid modernization:**
- More uncertainties in the network planning process due to the potential incorporation of new technologies. This brings two challenges:

1. **How to deal with uncertainty?** Under uncertainty, innovative solutions become more attractive so as to cost-effectively deal with (and hedge against) a number of scenarios that might happen in the near future.

2. **Regulatory checks under uncertainty**, it is important to recognize that an optimal investment solution that was made under uncertainty, cannot be successfully evaluated and justified ex-post, under perfect information of what happened.

The way forward

- **Two main positions today in Chile:**
 - Smaller changes in network remuneration are needed, supporting it mostly on its simplicity and low-cost implementation by regulators.
 - More important changes are needed, to move towards a remuneration method similar to RIIIO in the UK (despite its known difficulties, particularly in overloading the regulator and in tuning the increases or rewards in investors' rates of return as a function of their effort to provide a better and more cost-effective service).

Obviously, the answer is at some point in between of both approaches

up to which point do real costs have to be recognized in the remuneration process? and what would the new role, set of tasks and burden be for regulators?

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Tariff Setting challenges

- We will use Brazil as case study to understand challenges, current practices and opportunities related to the tariffs settings.

Context:

- Brazil's total installed generation capacity is about **158 GW** (as of 2017), with an energy consumption of 467,161 GWh per year, serving 82.5 million consumers.
- Tariff structures of consumers connected to distribution networks:
 - Binomial tariffs: with two components, one representing charges for energy, losses and other sector charges in \$/MWh, and another one representing transmission and distribution charges in \$/kW.
 - **Monomial tariffs: in which all components are summarized in a single volumetric tariff in \$/kWh.**

Tariff Setting challenges

- Binomial tariffs are compulsory for high voltage consumers, and monomial tariffs are compulsory for low voltage consumers.
- The tariff menu offered currently to consumers is summarized in four tariff modalities:

Tariff	User	Structure	Time-dependent pricing	Network remuneration
Conventional	Low voltage level	kWh only	No	Volumetric
Blue	High voltage level	kWh and kW	Peak/Off-peak	Peak demand
Green	High voltage level	kWh and kW	Peak/Off-peak	Peak demand
White	Optional for low voltage level	kWh only	Peak/Intermediate /Off-peak	Volumetric

Low voltage customers have only volumetric tariffs
(i.e., the remuneration of the network depends directly on the energy consumption)

Tariff Setting challenges

Tariff	User	Structure	Time-dependent pricing	Network remuneration
Conventional	Low voltage level	kWh only	No	Volumetric
Blue	High voltage level	kWh and kW	Peak/Off-peak	Peak demand
Green	High voltage level	kWh and kW	Peak/Off-peak	Peak demand
White	Optional for low voltage level	kWh only	Peak/Intermediate /Off-peak	Volumetric

- Times of use tariffs are not real time pricing so they do not reflect the actual system constraints, and indeed the rational customers adapt to them.
- Peak period was defined on working days from 5:30 PM and 8:30 PM, with the increase of consumers using AC, in many regions the peak load has shifted to 2-3pm. However, the regulator has not yet updated the definition of the peak time, so they increase their consumptions during the real peak time.

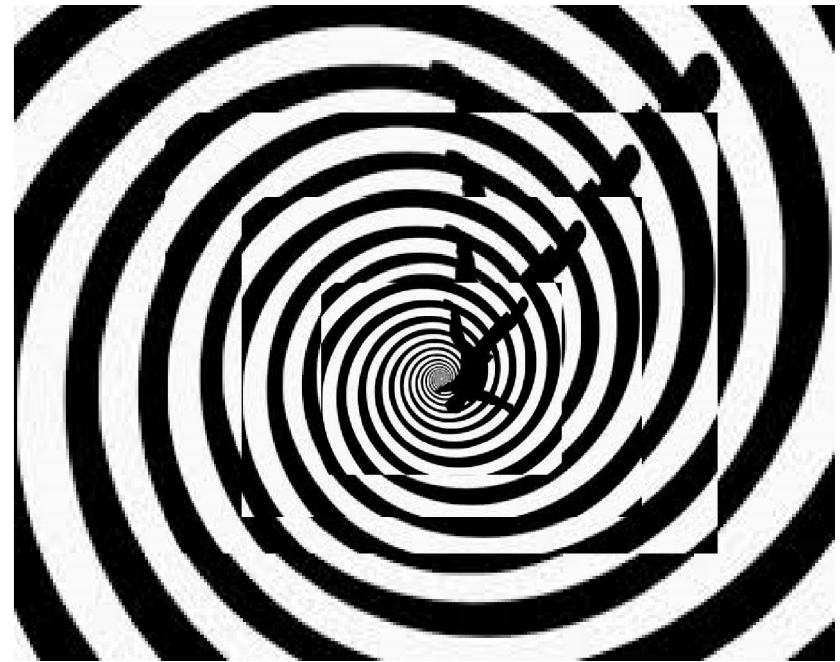
Concerns with tariffs at LV level

- Since the tariff is entirely volumetric, the contribution of low voltage customers to the allowed company revenue depends totally on their electricity consumption.
- Given the growth in DG, the volumetric tariff will not guarantee adequate remuneration due to the death spiral problem.
- Therefore, and following the **death spiral principle**, there will be an increase in tariffs, originating a spiral of incentives for consumers to become prosumers.



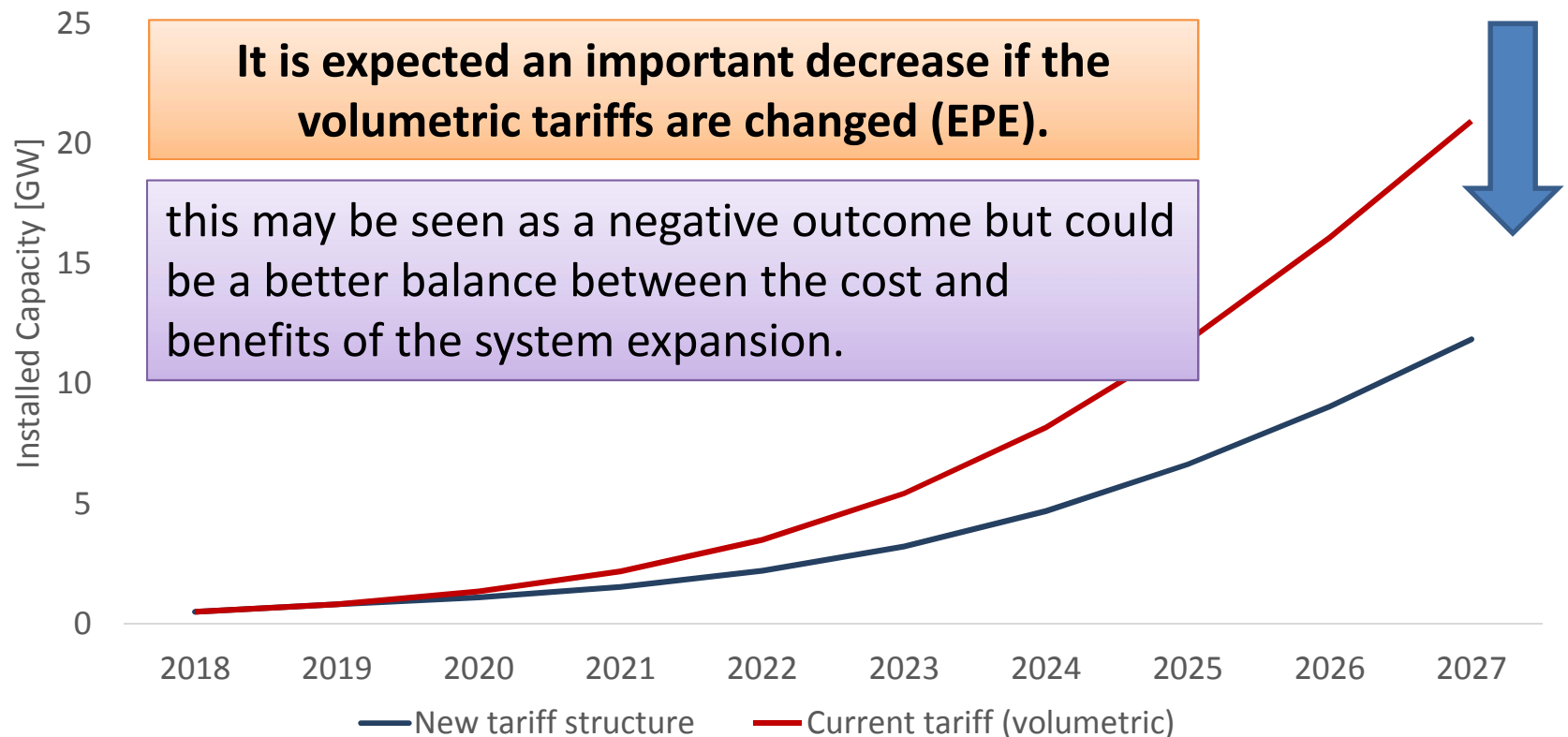
Concerns with tariffs at LV level

- This **death spiral effect** is well known **in the literature**, but our regulators and policy makers maybe...
- In Brazil there are volumetric tariffs but also net metering for low voltage customers (If the net consumption is zero or below a small availability network fee is paid – 100 kWh).
- So, all the incentives are put in increasing the adoption of solar rooftop, but **is this efficient from a whole system approach?**



Concerns with tariffs at LV level

- To solve this potential problem, one regulator idea is extending the application of binomial tariffs to low voltage level consumers (i.e., having a volumetric and non volumetric part in the tariff).



Tariff structure – Current discussion

- During the 2018-2019 period, the Brazilian regulator ANEEL has launched two public hearings to discuss new tariff structures for the low voltage consumers and changes in the net metering mechanism

Alternative	Name	Description
0	Current	Current condition, used as a comparison parameter
1	New minimal payment	Increase the minimum consumption levels
2	Commercial cost	Definition of fixed tariff, without differentiation among consumers, charged in \$ per consumer, to recover distribution commercial costs (e.g. billing, help desk)
3	Fixed cost	Definition of fixed tariff, with differentiation among consumers, charged in \$ per consumer, to recover commercial costs and distribution network costs
4	Differentiated Fixed cost	Definition of fixed tariff for different consumer sizes, charged in \$ per consumer
5	Load	Define a tariff in \$ per kW for distribution system availability costs

Alternatives for LV customers

Tariff structure – Current discussion

- During the 2018-2019 period, the Brazilian regulator ANEEL has launched two public hearings to discuss new tariff structures for the low voltage consumers and changes in the net metering mechanism:

Alternative	Distribution network tariff	Transmission network tariff	Sector charges applied to peak load	Distribution network losses	Sector charges applied to consumption	Energy tariff
0 (status quo)	X	X	X	X	X	X
1		X	X	X	X	X
2			X	X	X	X
3				X	X	X
4					X	X
5						X

Alternatives for DG injection

The alternative chosen will remain functioning only temporarily, until a given prescribed threshold of DG penetration is reached

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Final Remarks

- Learn from the mistakes of other countries in the region ☺.
- Proper regulatory frameworks are needed to **incentivize more active approach in network operation**, taking advantage of new innovative and smart grid technologies, creating opportunities for OPEX-based solutions (that are more cost-effective) to displace CAPEX-based solutions.
- This **will require deployment of smart meters and new IT technologies**, price signals and other control signals that must be managed in real time.
- Incentive-based regulations and tariff structures **will need to evolve in order to align private and public policy objectives**, fostering both network companies and users (producers, consumers and prosumers) to act accordingly

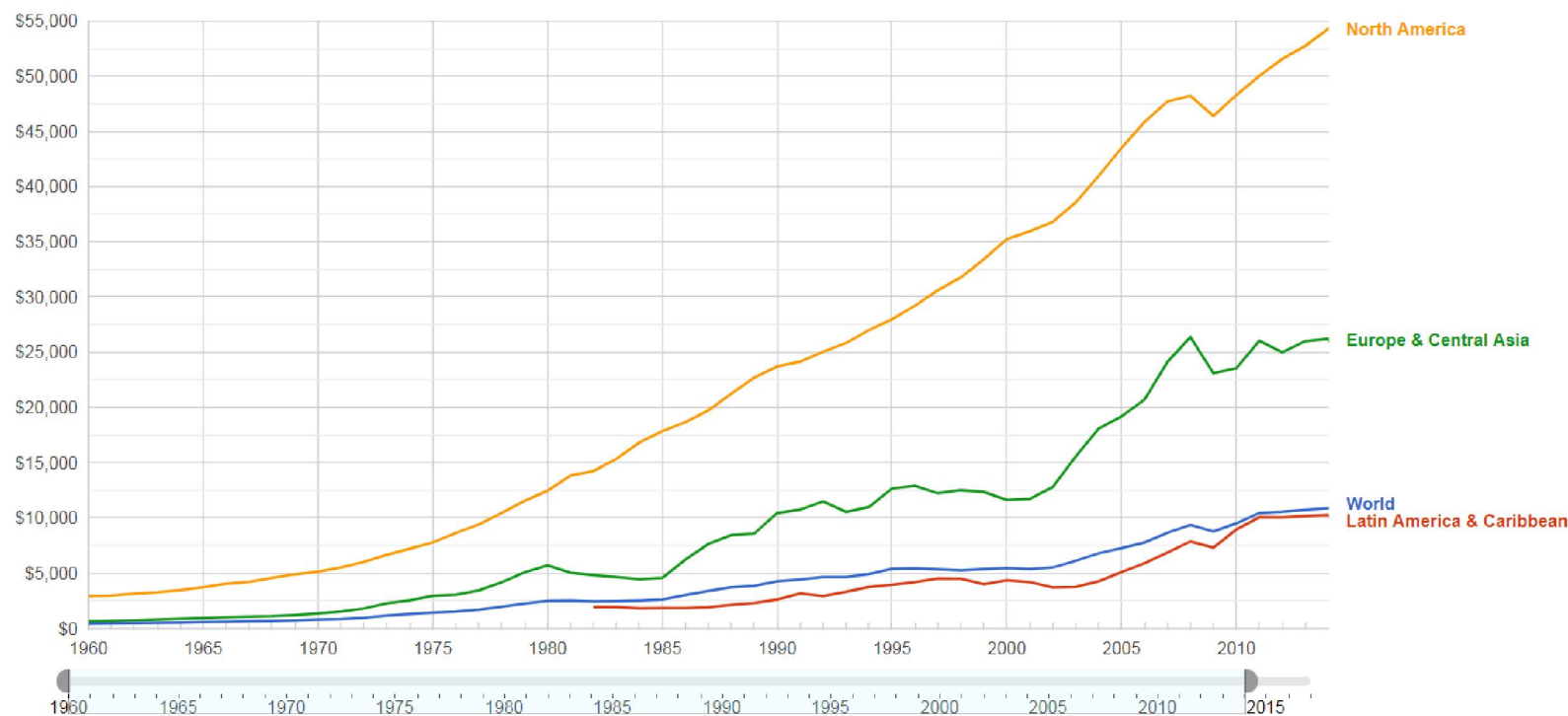
Final Remarks

- Don't be reactive, be proactive !!!!
- Under a new, evolved approach, **it is expected that regulators will take a more active role in scrutinizing real companies'** data regarding costs, assets and plans.
- Regulations would need to provide more appropriate guarantees, rewards and penalties for companies and users, **incentivizing them to deploy the correct solutions as well as ensure that the resulting tariffs are affordable by all**, including vulnerable consumers in rural areas.

To keep in mind

- We are not that rich (far from it), so our policies must always work towards the improvement of our society.

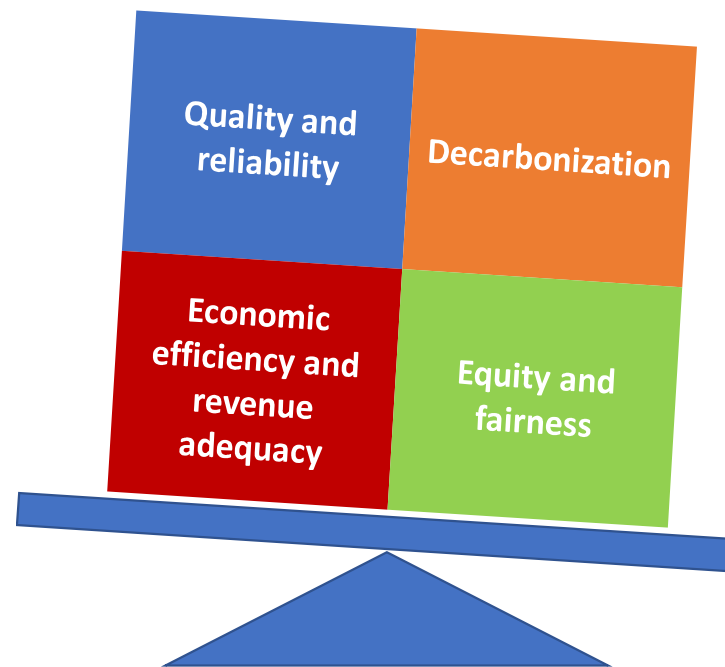
GDP per capita (current US\$) ?



Data from World Bank Last updated: Jul 6, 2018

To keep in mind

- Developing countries do not have a dilemma to solve, not even a trilemma, we have to solve a tetralemma ☹️ (o maybe more), so let's be proactive together.



Acknowledgments

- List of contributors:
 - Rodrigo Moreno, Bernardo Bezerra, Hugh Rudnick, Carlos Suazo, Martha Carvallo, Alejandro Navarro and Carlos Silva.
- More details will be found soon in the PES Magazine.

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