Reforming the Mexican Electricity Market: Design and Regulatory Issues

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Outline

1. New industry and institutional structure
2. Critical issues
   - Market design
   - Nodal prices, FTRs and subsidies
   - Transmission and renewable integration
3. Implications for policy making in Mexico

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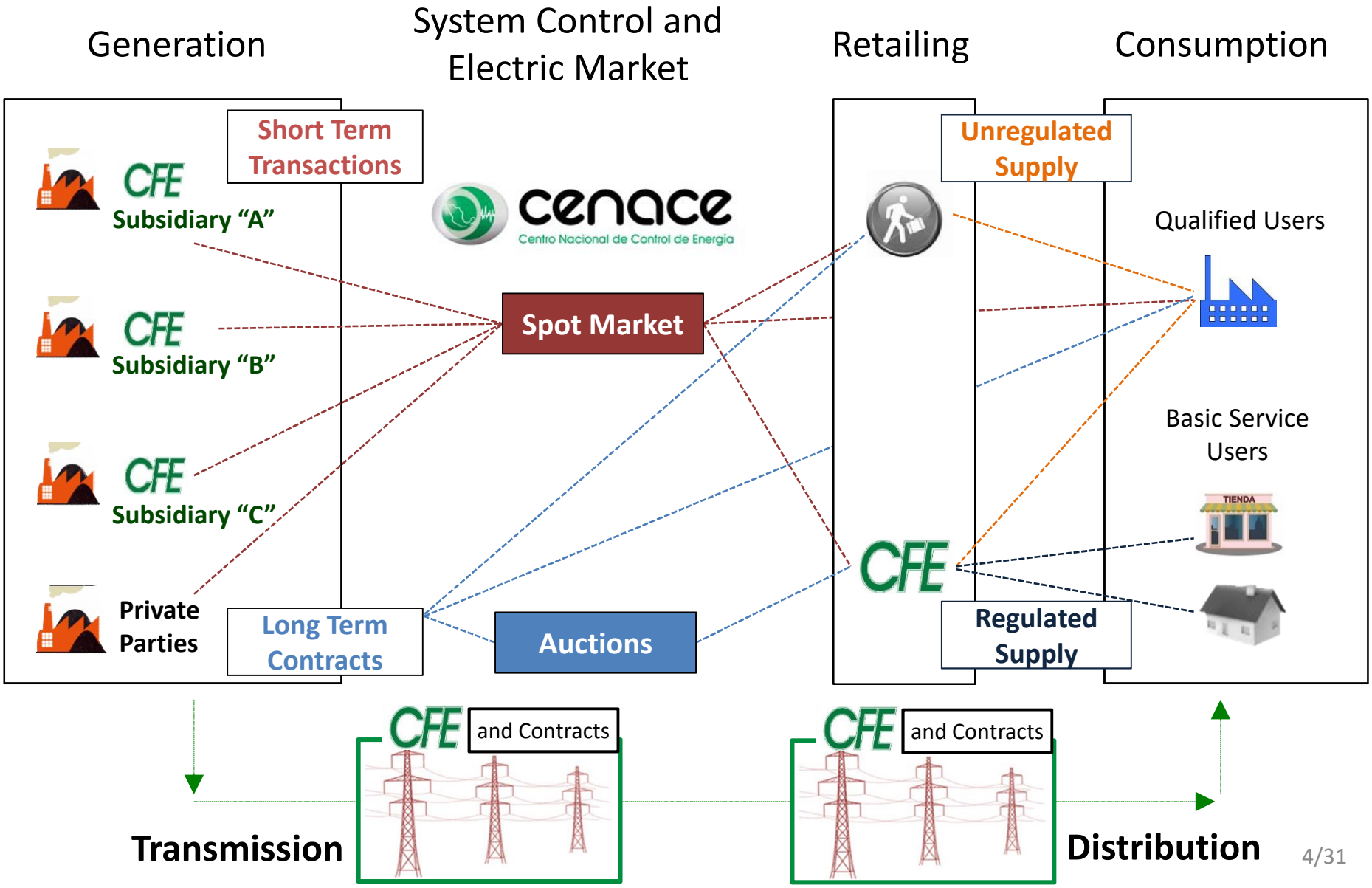
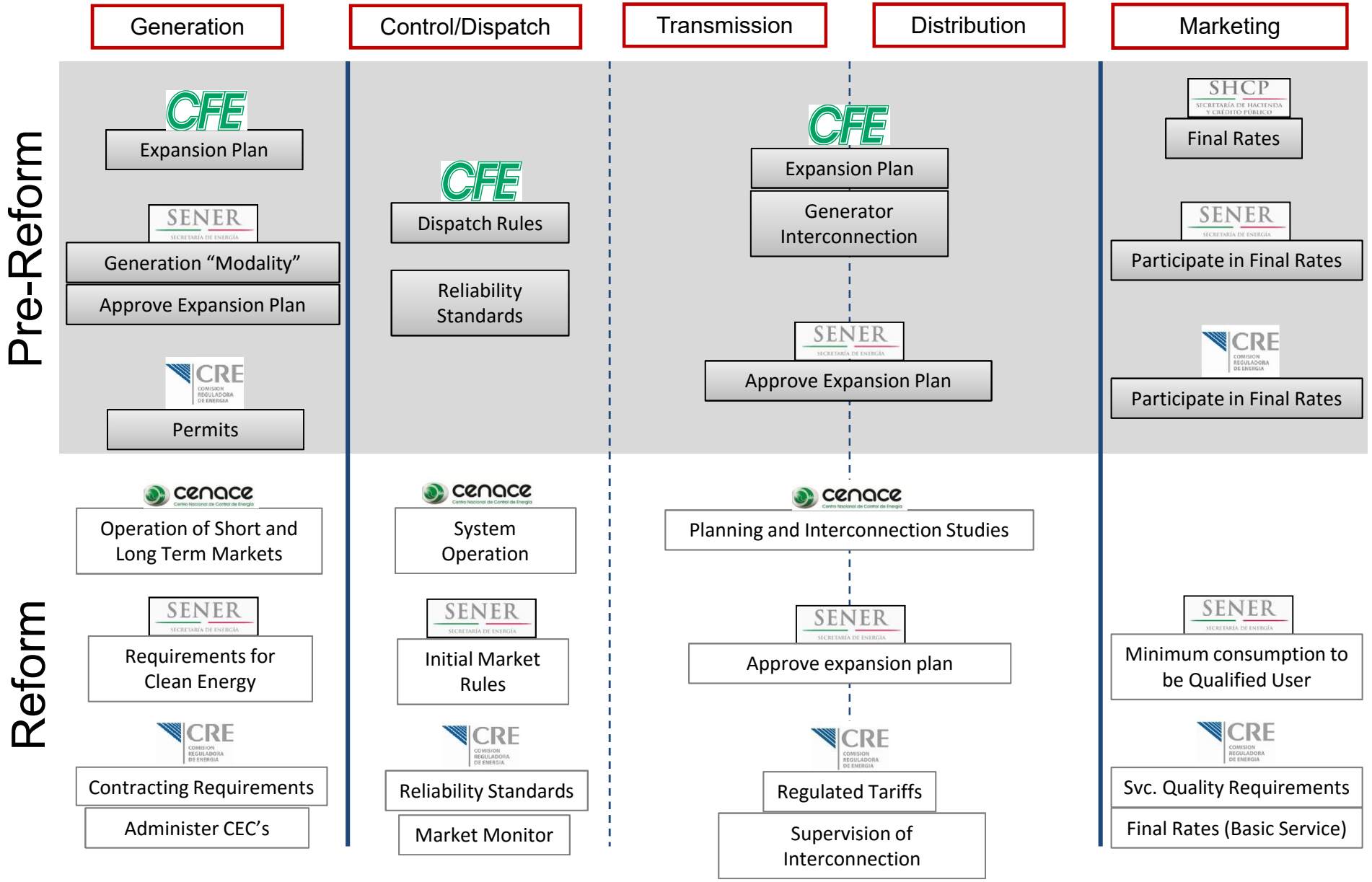
New Industry Structure

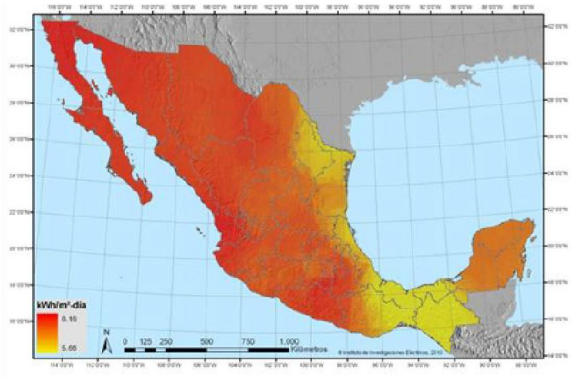


New Institutional Framework

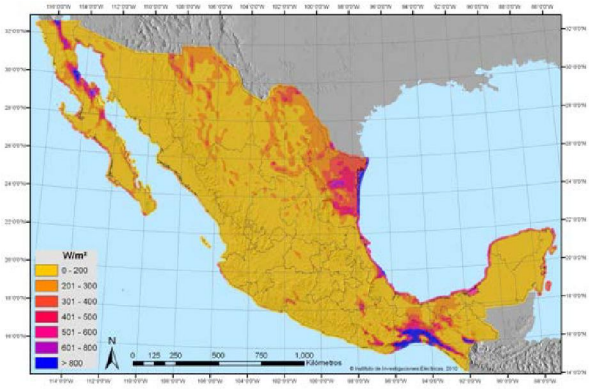


Clean Energy Potential in Mexico

Solar Resources



Wind Resources



Geothermal Resources

- Mexico has sufficient resources to exceed its goals of 35% non-fossil generation in 2024, 40% in 2035 and 50% in 2050.
- Portfolio standard will assure that they can be developed.

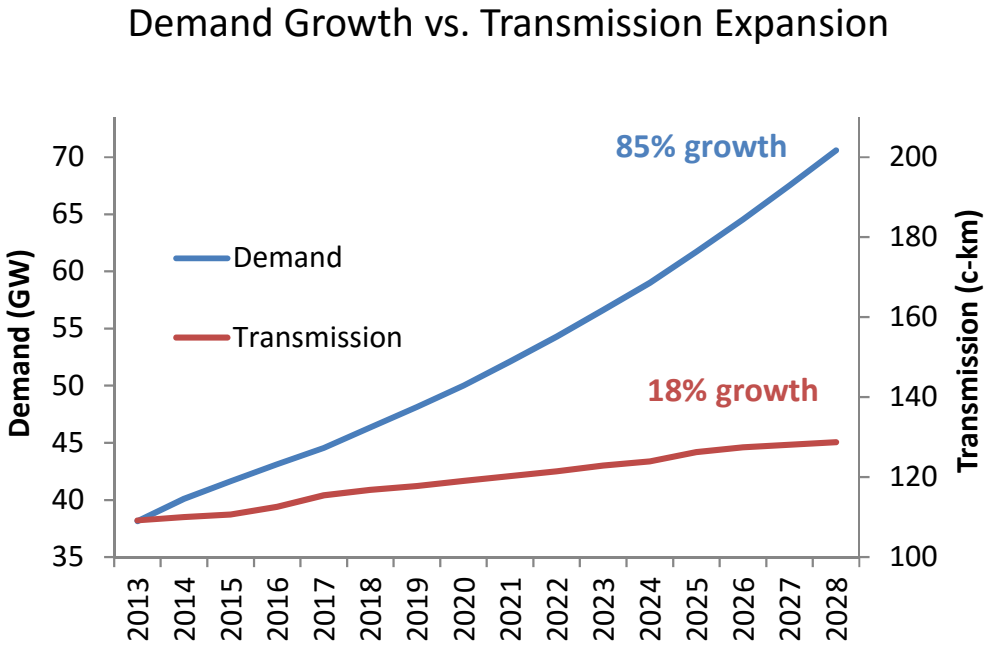
	Installed Capacity 2° semester 2014 (MW)	Renewable Energy Potential			
		Actual Generation Year 2013 (% of total GWh)	Actual Generation + Proven Resources	Actual Generation + Proven Resources +Probable Resources	Actual Generation + Proven Resources +Probable Resources +Possible Resources
Wind	1900	1.38%	5.30%	5.30%	34.80%
Geothermal	823	2.04%	2.22%	22.52%	40.03%
Solar	64	0.01%	0.65%	0.65%	2,189.40%
Mini Hydro	419	0.54%	1.72%	9.48%	24.35%
Total	**3206**	**3.97%**	**9.89%**	**37.95%**	**2,288.59%**

Opportunities for Transmission Investment

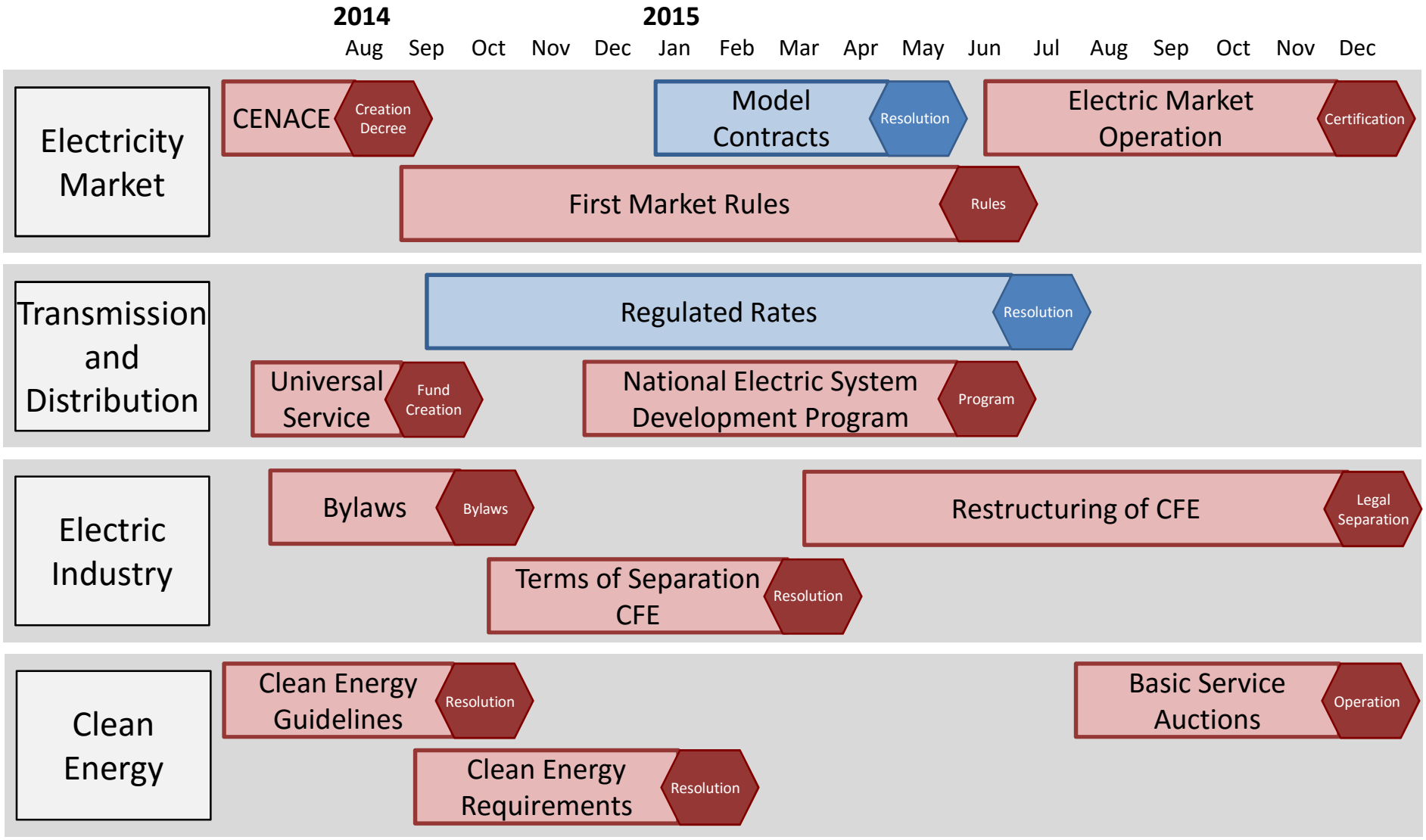
Existing Program: In the 15 year plan, CFE has included 19.3 billion USD of transmission projects including 19,555 circuit-km of lines.

Planning: Expansion plan will be proposed by an independent entity with a mandate to promote open access (CENACE).

- Transmission in US and Canada expands faster than demand growth.
- Expansion in Mexico should become more aggressive.



Implementation plan



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Market Design

Liberalization of Generation Markets

- Horizontal integration in generation markets under a dominant incumbent (CFE)
- How to accomplish a level-playing-field to allow fair competition?
- Potential collusion of CFE's plants
- Arms' length separation
- Merit order pricing under CFE plants' regulation

Market Design

Liberalization of Generation Markets

- Spot, one-day ahead, long-term capacity and bilateral generation markets
- IPP's, self-supply, cogeneration old schemes and the new electricity market
- Existence of IPPs with long-term contracts of energy sales to CFE
- Basic Service's auctions and CECs

Organización industrial nueva: Separación horizontal

Generación	CFE Generación 1
Generadores CFE	CFE Generación 2
	CFE Generación 3
	CFE Generación n

Distribución
CFE distribución 1
CFE distribución 2
CFE distribución 3
CFE distribución n
Contrato privado 1
Contrato privado n

CRE

Market Design

Vertical Integration

- Open access enforcement
- Access pricing
- Auctions of transmission and distribution projects
- Prelude of future privatization?

Market Design

ISO's and regulatory capture

- ISO's corporate governance and regulation (CENACE)
- Structure of incentives for the ISO
- Is CENACE a profit-maximizing or welfare-maximizing dispatch entity?
- Really independent?
- CFE capturing the regulator (CRE)?

Market Design

Distribution

- CFE's basic-service to (captive) consumers
- Cross subsidies
- Role of private marketers (*suministradores*)

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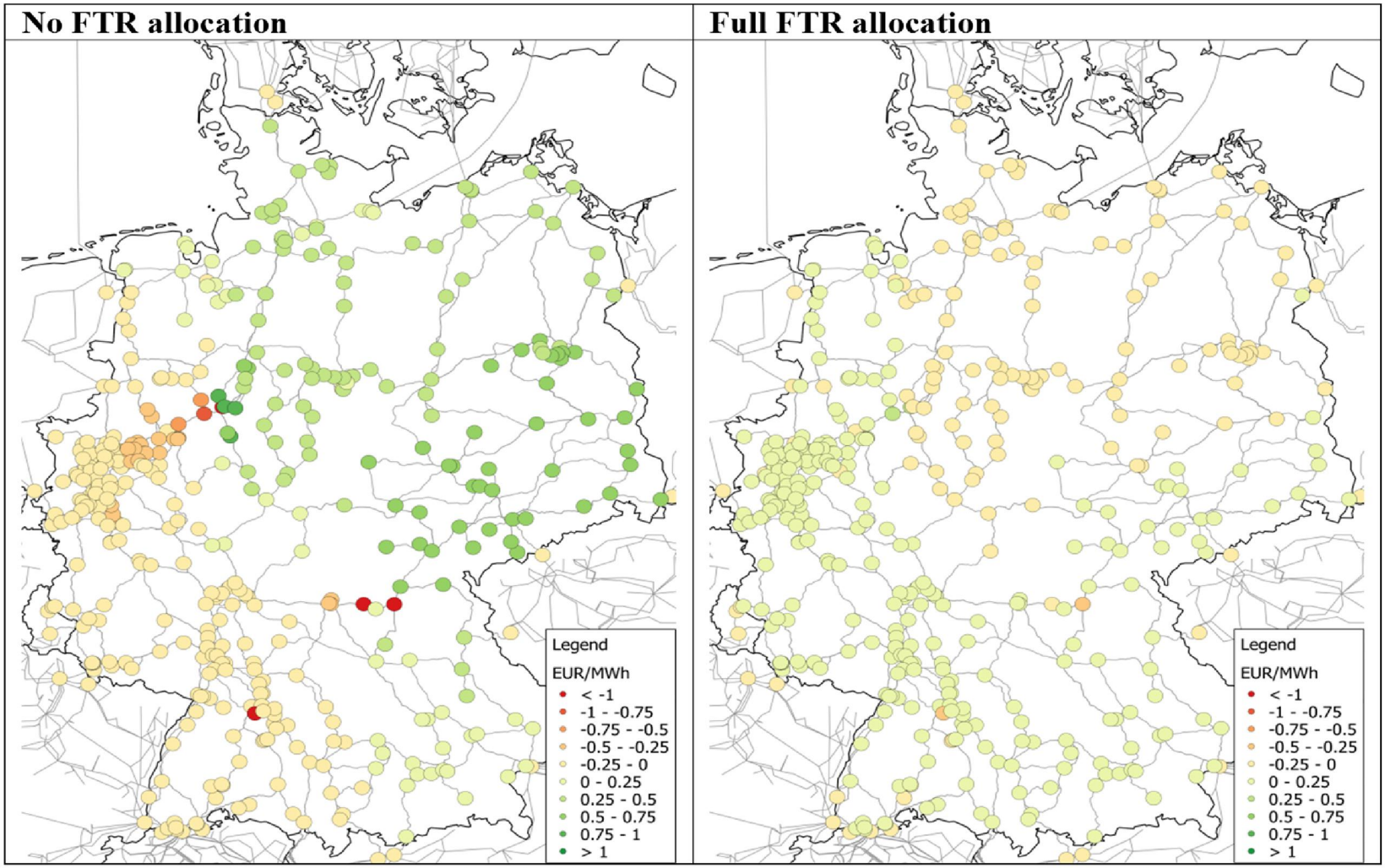
Nodal prices, FTR Auctions and Subsidies

- Transition to nodal prices starting from a confusing regressive subsidy scheme
- Free allocations of FTRs to smooth out revenue or cost shocks (distributive efficiency)
- Grandfathered FTRs (*legados*)
- FTR auctions?
- Lump-sum subsidies in a now progressive scheme
- Subsidies carried out by the finance ministry (Hacienda) and not by the Energy authorities

Kunz, F., K. Neuhoff and J. Rosellón (2014). "FTR Allocations to Ease Transition to Nodal Pricing: An Application to the German Power System," Discussion Papers of DIW Berlin 1418, German Institute for Economic Research.



Average change in surplus of demand in the high wind winter week under production-based allocation approach

Precios nodales: esquema CTCP mejorado y ampliado

1	Sonora Norte
2	Sonora Sur
3	Los Mochis
4	Sinaloa
5	Mazatlán 1
6	Juárez
7	Moctezuma
8	Chihuahua
9	Camargo
10	Laguna
11	Durango
12	Coahuila
13	Monterrey
14	Bravo
15	Lajas Güemes
16	Champayán
17	Anáhuac
18	La mesa
19	Huasteca
20	Tamos
21	Tuxpan
22	Oriente
23	Central
24	Laguna Verde
25	Veracruz
26	Sureste
27	Puebla
28	Acapulco
29	Petacalco
30	Balsas
31	Colima
32	Tepic
33	Occidente
34	Querétaro
35	Santa Lucía
36	Campeche
37	Yucatán
38	Valladolid
39	Cozumel
40	Chetumal
41	Mexicali
42	La Paz

CRE

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Transmission Expansion

- *Optimal* regulation of the transmission network
- The *Prodesen's* planning process: stages
- Does *Prodesen* converge to welfare optimality?
- Auctions of transmission projects
- Transmission CRE's tariff regulation
- Application of an incentive mechanism to promote the efficient regulation of the operation and expansion of the Mexican networks?
- Is there room for incentive transmission-tariff regulation?

A combined merchant-regulatory mechanism

*Rosellón, J. and H. Weigt (2011), "A dynamic incentive mechanism for transmission expansion in electricity networks – Theory, modeling and application", **The Energy Journal**, 32(1), 119-148.*

Upper level problem: Profit maximizing Transco:

$$\max_{k,F} \quad \pi = \sum_t^T \left[\sum_i (p_i^t d_i^t - p_i^t g_i^t) + F^t N^t - \sum_{i,j} c\left(k_{ij}^t\right) \right]$$

s.t.

$$\frac{\sum_i (p_i^t d_i^w - p_i^t g_i^w) + F^t N^t}{\sum_i (p_i^{t-1} d_i^w - p_i^{t-1} g_i^w) + F^{t-1} N^t} \leq 1 + RPI + X$$

Regulatory constraint

Lower level problem:

ISO welfare maximization:

$$\max_{d,g} \quad W = \sum_{i,t} \left(\int_0^{d_i^t} p(d_i^t) \mathrm{d}d_i^t \right) - \sum_{i,t} mc_i g_i^t$$

s.t.

Line capacity restriction $\quad \left| pf_{ij}^t \right| \leq k_{ij}^t \quad \forall ij$

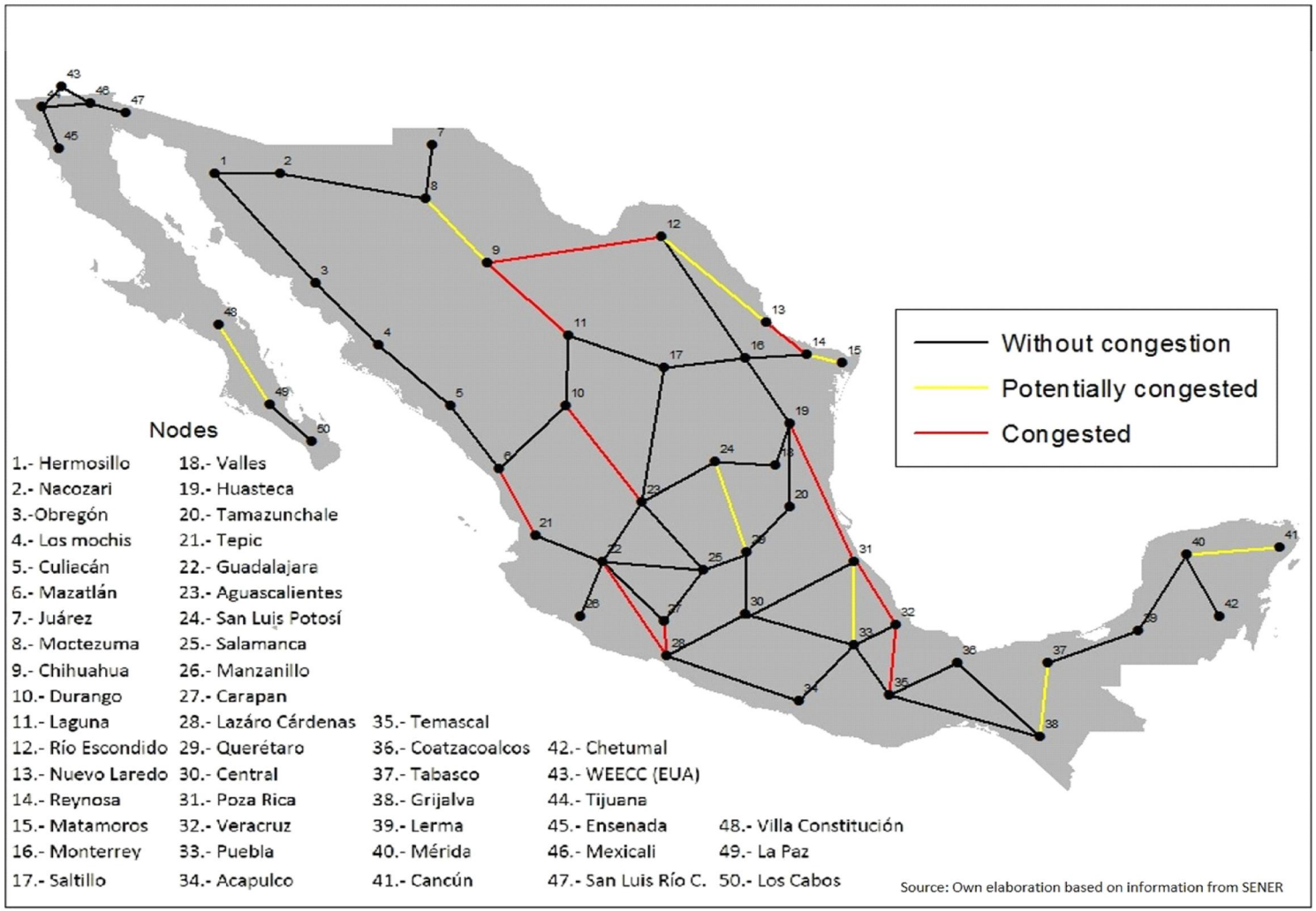
Energy balance $\quad g_i^t + q_i^t = d_i^t \quad \forall i,t$

Plant capacity restriction $\quad g_i^t \leq g_i^{t,\max} \quad \forall i,t$

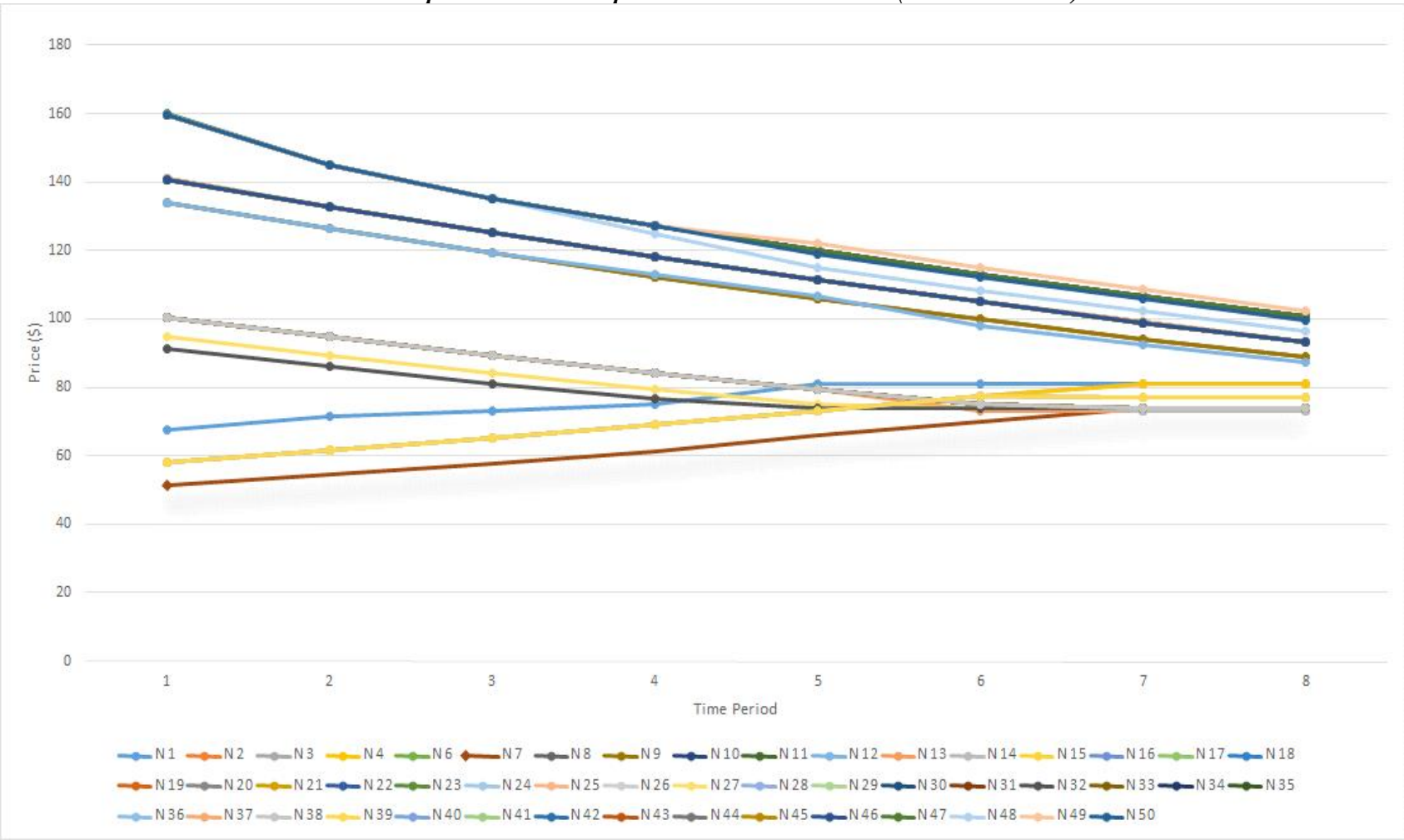
Zenón, E. and J. Rosellón (2016), "Optimal Transmission Planning under the Mexican New Electricity Market,"

CIDE Working Paper

Congested zones in Mexico 2012



Nodal-price developments in Mexico (2012-2020)



Source: Own elaboration.

Comparative welfare results for Mexico, PJM and Ontario.

	Network without expansions			*Hybrid regulatory mechanism (HRV)*			*Centralized ISO*		
	México	*PJM*	*Ontario*	*México*	*PJM*	*Ontario*	*México* *(e.g. Prodesen)*	*PJM*	*Ontario*
Consumer surplus (MioUSD/h)	2.71	6.53	0.83	3.14	6.63	0.89	3.211	6.67	0.96
Producer surplus (MioUSD/h)	0.118	0.36	0.051	0.253	0.59	0.087	00.271	0.64	0.105
Congestion rent (MioUSD/h)	0.0073	0.067	0.013	0.019	0.01	0.00104	0.0168	0.006	0.0009
Total social welfare (MioUSD/h)	2.835	6.957	0.894	3.42	7.23	0.978	3.50	7.316	1.0659
Total network capacity (GW)	9.14	35.8	2.52	13.47	50.83	4.536	14.26	52.83	4.74

Source: Own elaboration based on Rosellón et al (2011) and Rosellón et al (2012).

Transmission Expansion and Renewable Integration

- Time resolution, and supply and demand fluctuations of a renewable integration process
- Hourly time resolution to substantially increase the applicability of regulatory mechanisms
- Price-cap incentive HRV regulation is still superior to cost-plus regulation

Comparison of Welfare and Extension Results

Schill, W.-P., J. Egerer, and J. Rosellón (2015), "Testing Regulatory Regimes for Power Transmission Expansion with Fluctuating Demand and Wind Generation." ***Journal of Regulatory Economics***

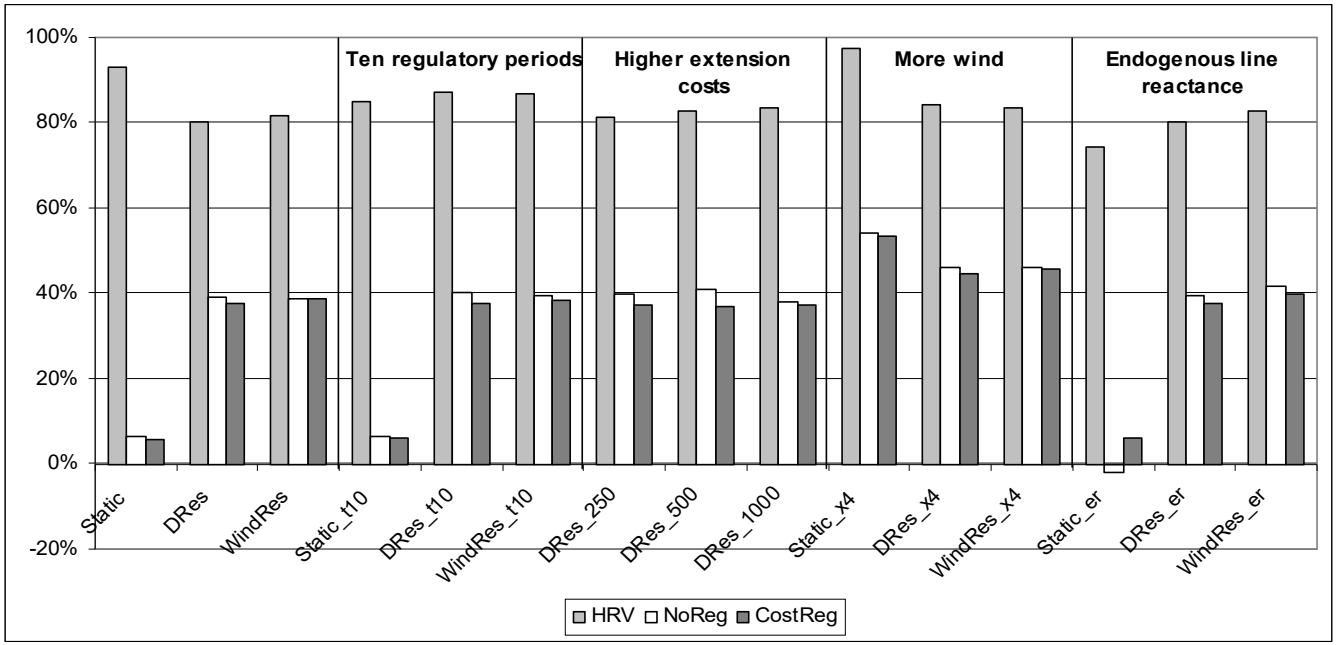


Figure 17: Social welfare gain of extension compared to *WFMax* for different model runs

→ Fluctuating demand and wind power both increase the gap between wf-max and the regulatory cases.

→ HRV much closer to wf-optimum in all cases → robust!

Transmission Expansion and Renewable Integration

- Rationality of transmission investment under a dynamic process of renewable generation integration.
- Transmission investment under gradual substitution of conventional energy (e.g., coal or fuel oil) with renewables (wind, solar or geothermal energy)
- Diverse developments of the technological mix in the generation park that implies different network congestion scenarios

*Egerer, J., J. Rosellón and W-P. Schill (2015), "Power System Transformation toward Renewables: An Evaluation of Regulatory Approaches for Network Expansion," **The Energy Journal**, Vol. 36 (4)*

Figure 1: Line extension results (relative to initial line capacity, Laspeyres weights)

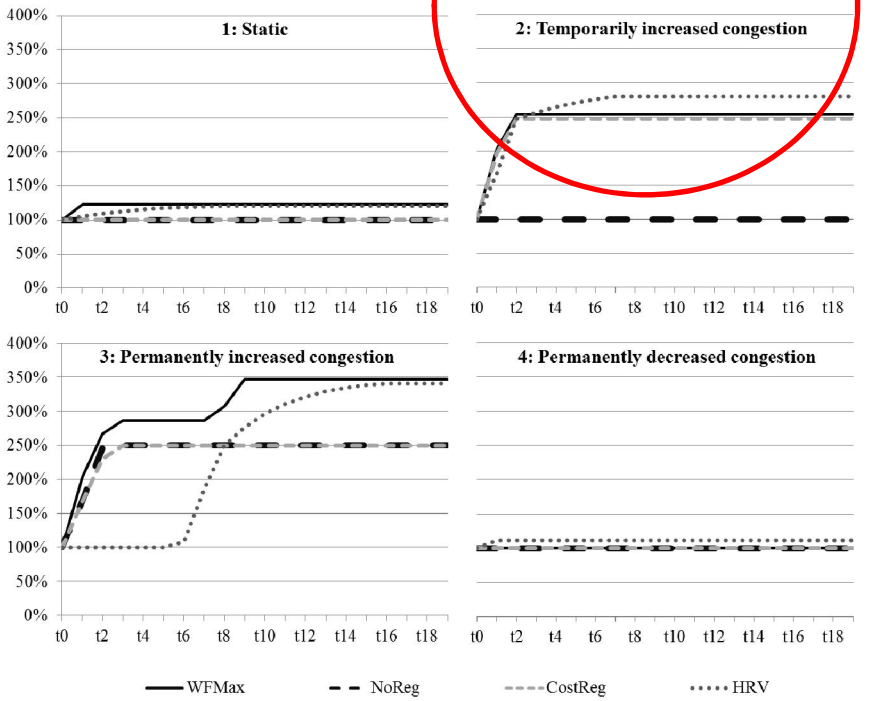


Table 1: Welfare changes relative to the case without extension

	Weights	Static	Temporarily increased congestion	Permanently increased congestion	Permanently decreased congestion
		1	2	3	4
WFMax		0.29%	1.28%	11.62%	0.00%
NoReg		0.00%	0.00%	9.25%	0.00%
CostReg		0.00%	1.27%	9.22%	0.00%
HRV	Laspeyres	0.25%	1.01%	9.02%	-0.17%
	Paasche	-0.11%	0.38%	9.39%	-0.32%
	Average Lasp.-Paasche	0.29%	0.89%	9.21%	-0.32%
	Ideal	0.29%	1.28%	11.62%	0,00%

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Implications for Policy Making in Mexico

- Analysis of allocative, productive and distributive efficiencies in the electricity sector.
- Increase in economic welfare.
- Efficient integration of renewable energies into transmission networks (with consequent reduction of greenhouse emissions).
- Efficient expansion of transmission networks.
- Nodal-price systems and financial hedging mechanisms that grant adeaquate property rights which incent efficient investments
- Research results with potential to be applied in actual public-policy making: **CEPG**