The roles of energy efficiency and renewable energy in energy planning in Brazil

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Overview

- Energy background
- Current situation
- Integrated resources planning: Demand, supply and interface resources
- Solar resources and the interconnected system

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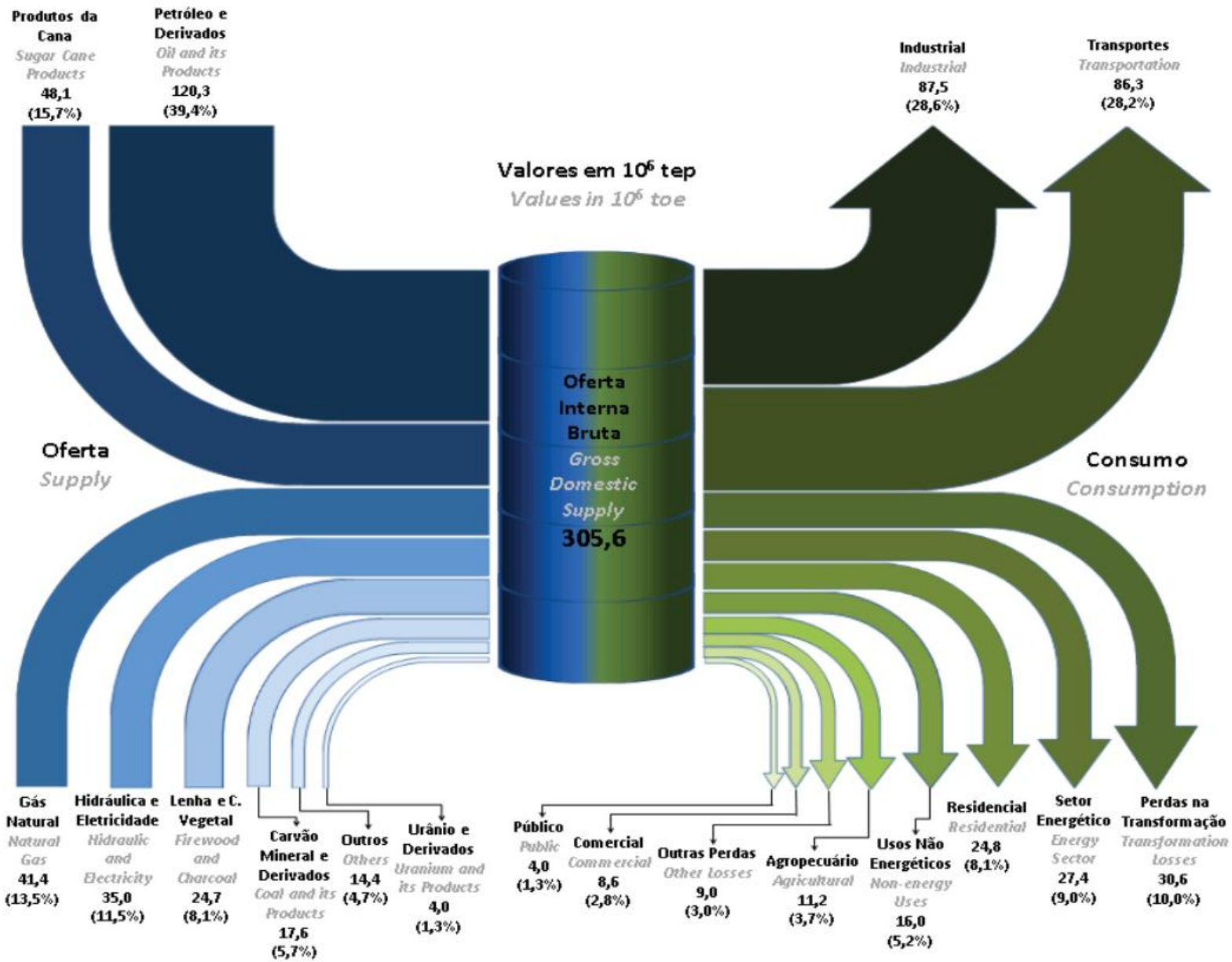
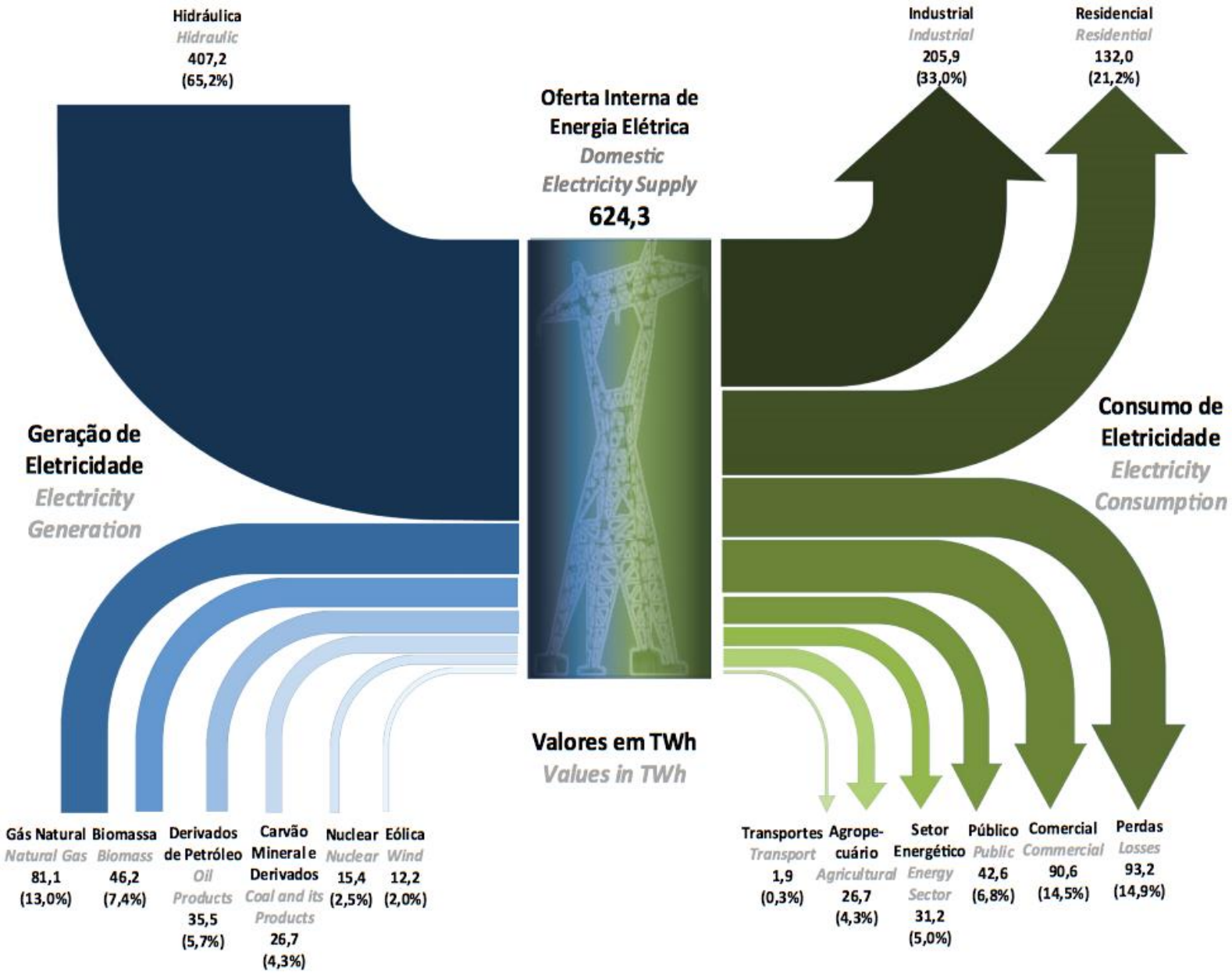
Energy background

Structure of energy supply and demand


Produtos da Cana
Sugar Cane Products
48,1
(15,7%)
Petróleo e Derivados
Oil and its Products
120,3
(39,4%)
Valores em 10⁶ tep
Values in 10⁶ toe
Industrial
Industrial
87,5
(28,6%)
Transportes
Transportation
86,3
(28,2%)
Oferta
Supply
Oferta Interna Bruta
Gross Domestic Supply
305,6
Consumo
Consumption
Gás Natural
Natural Gas
41,4
(13,5%)
Hidráulica e Eletricidade
Hidraulic and Electricity
35,0
(11,5%)
Lenha e C. Vegetal
Firewood and Charcoal
24,7
(8,1%)
Carvão Mineral e Derivados
Coal and its Products
17,6
(5,7%)
Outros
Others
14,4
(4,7%)
Urânio e Derivados
Uranium and its Products
4,0
(1,3%)
Público
Public
4,0
(1,3%)
Comercial
Commercial
8,6
(2,8%)
Outras Perdas
Other Losses
9,0
(3,0%)
Agropecuário
Agricultural
11,2
(3,7%)
Usos Não Energéticos
Non-energy Uses
16,0
(5,2%)
Residencial
Residential
24,8
(8,1%)
Setor Energético
Energy Sector
27,4
(9,0%)
Perdas na Transformação
Transformation Losses
30,6
(10,0%)


Hidráulica
Hidraulic
407,2
(65,2%)
Oferta Interna de Energia Elétrica
Domestic Electricity Supply
624,3
Industrial
Industrial
205,9
(33,0%)
Residencial
Residential
132,0
(21,2%)
Geração de Eletricidade
Electricity Generation
Consumo de Eletricidade
Electricity Consumption
Valores em TWh
Values in TWh
Gás Natural
Natural Gas
81,1
(13,0%)
Biomassa
Biomass
46,2
(7,4%)
Derivados de Petróleo
Oil Products
35,5
(5,7%)
Carvão Mineral e Derivados
Coal and its Products
26,7
(4,3%)
Nuclear
Nuclear
15,4
(2,5%)
Eólica
Wind
12,2
(2,0%)
Transportes
Transport
1,9
(0,3%)
Agropecuário
Agricultural
26,7
(4,3%)
Setor Energético
Energy Sector
31,2
(5,0%)
Público
Public
42,6
(6,8%)
Comercial
Commercial
90,6
(14,5%)
Perdas
Losses
93,2
(14,9%)

The current energy context

- Short run challenges
  1. High dependency on electricity and transportation fuels
  2. Energy management and planning: coordination of energy auctions, planning schedules generation/transmission
  3. Re-establish the financial standing of utilities
  4. Economic recession
- Longer term challenges
  1. Decrease the carbon content of transportation and electricity sector
  2. Electricity sector:
     1. Optimize the operation of the interconnected system including energy storage, and changing climate patterns and competing uses of water
     2. Integrate large potential of renewables together with de-centralized options (including demand-resources)

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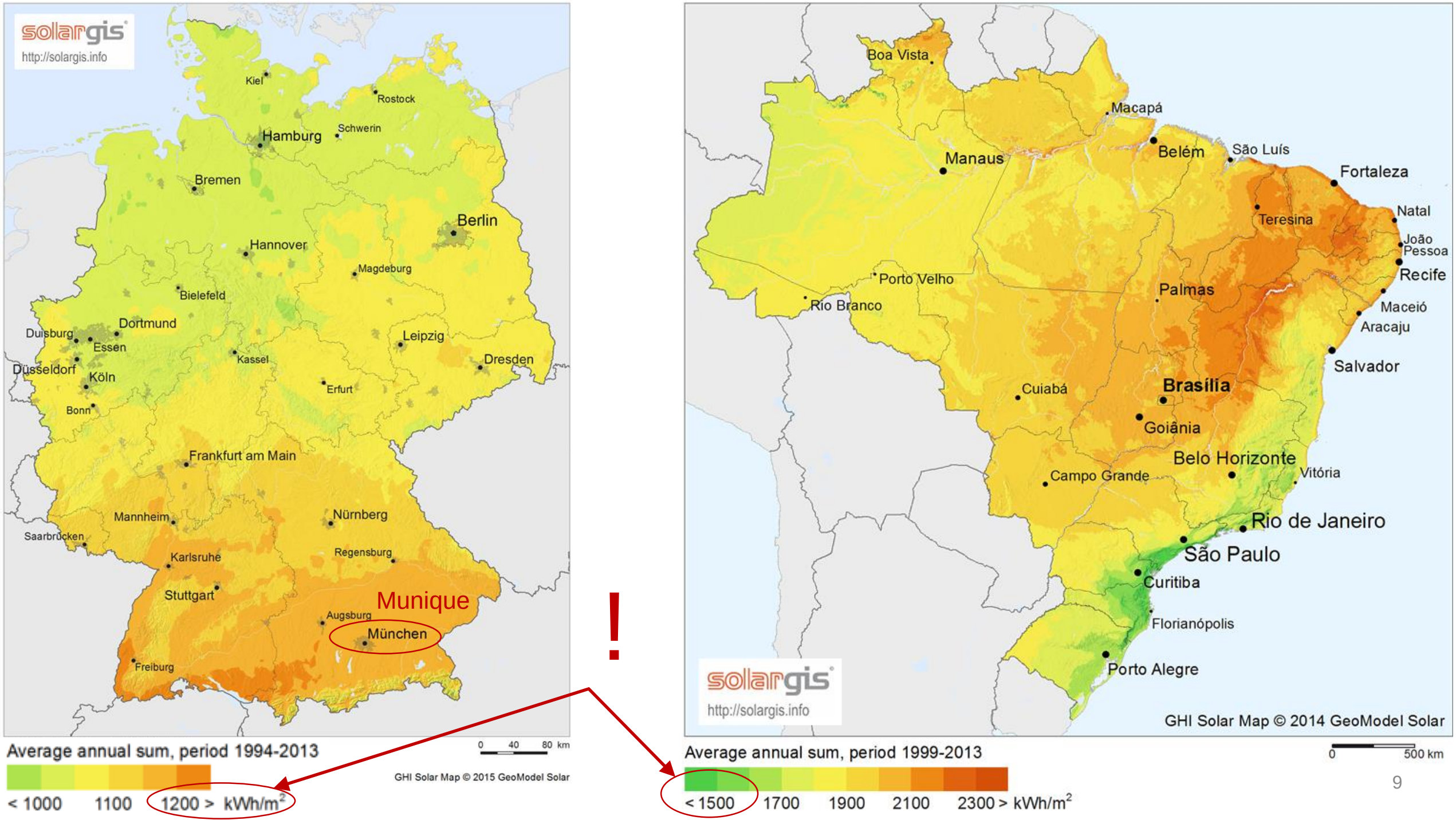
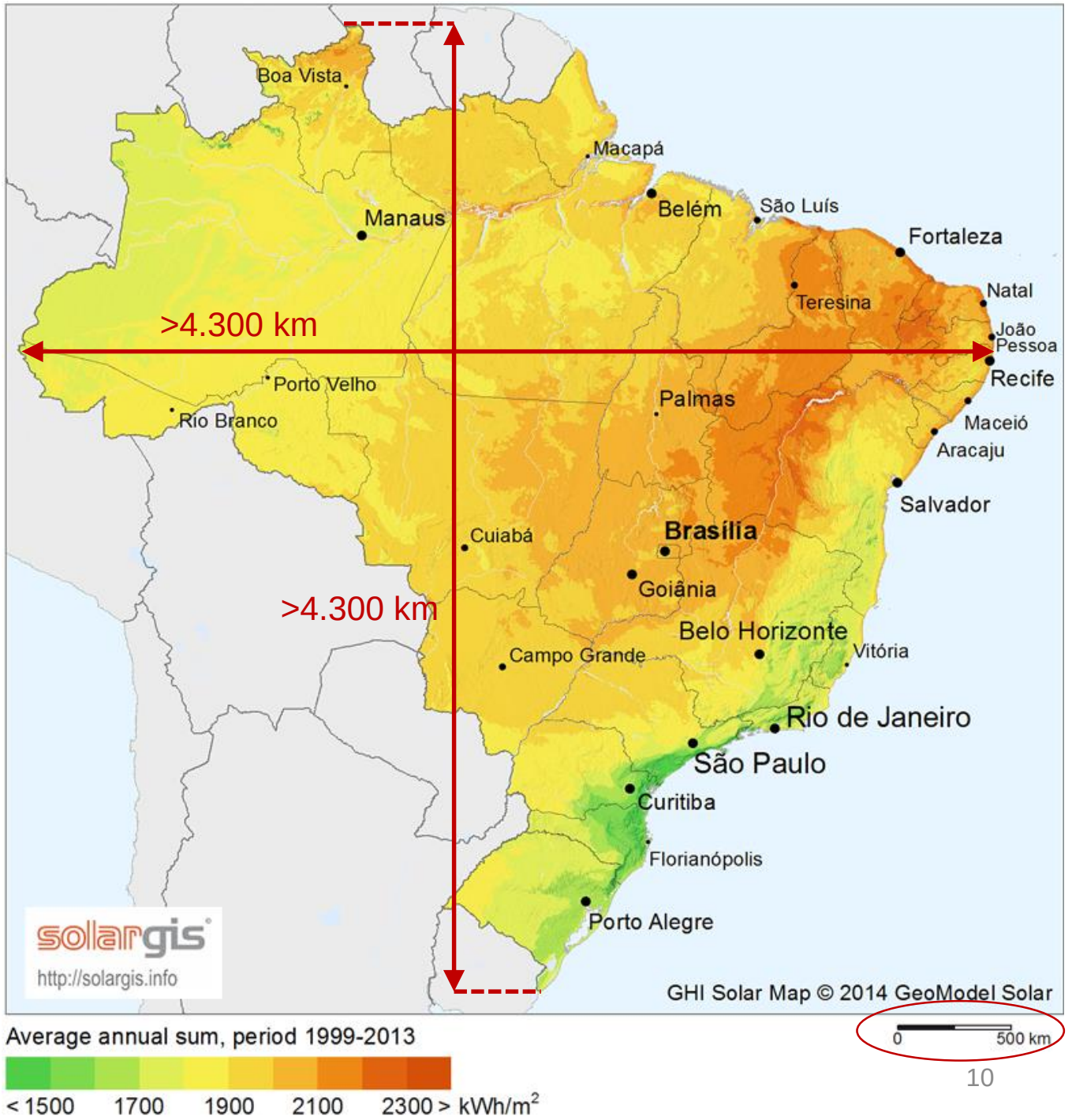
Solar PV, +wind + biomass as strategy to optimize existing centralized energy storage (electricity) and flexibility of demand

Significant RE potential (not only hydroelectricity)

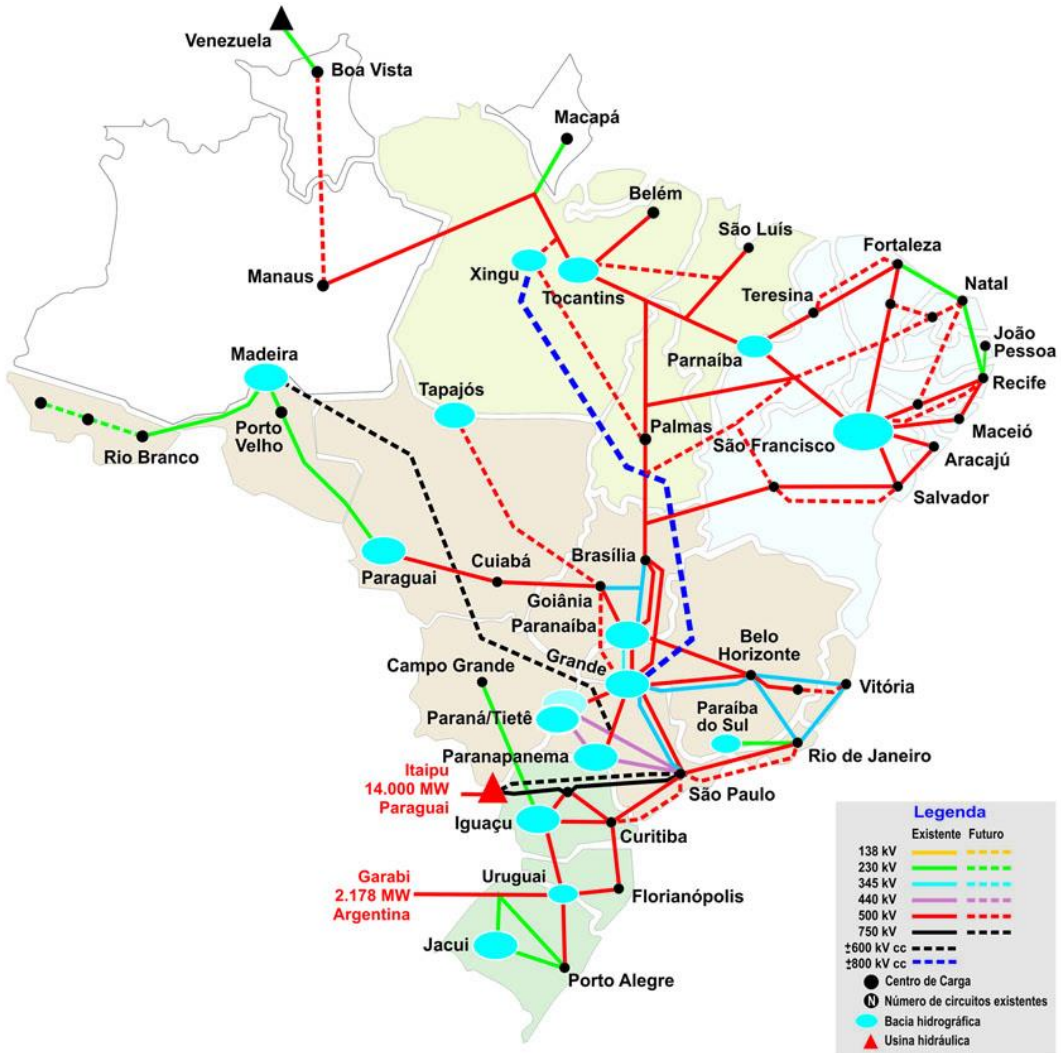

solargis
http://solargis.info
Kiel
Rostock
Hamburg
Schwerin
Bremen
Berlin
Hannover
Magdeburg
Bielefeld
Dortmund
Duisburg
Essen
Düsseldorf
Köln
Bonn
Kassel
Leipzig
Dresden
Erfurt
Frankfurt am Main
Mannheim
Nürnberg
Saarbrücken
Karlsruhe
Regensburg
Stuttgart
Augsburg
München
Munique
Freiburg
Average annual sum, period 1994-2013
0 40 80 km
GHI Solar Map © 2015 GeoModel Solar
< 1000 1100 1200 > kWh/m²
!
Boa Vista
Macapá
Manaus
Belém
São Luís
Fortaleza
Teresina
Natal
João Pessoa
Recife
Porto Velho
Rio Branco
Palmas
Maceió
Aracaju
Salvador
Cuiabá
Brasília
Goiânia
Belo Horizonte
Campo Grande
Vitória
Rio de Janeiro
São Paulo
Curitiba
Florianópolis
Porto Alegre
solargis
http://solargis.info
GHI Solar Map © 2014 GeoModel Solar
Average annual sum, period 1999-2013
0 500 km
< 1500 1700 1900 2100 2300 > kWh/m²

Germany and Brazil

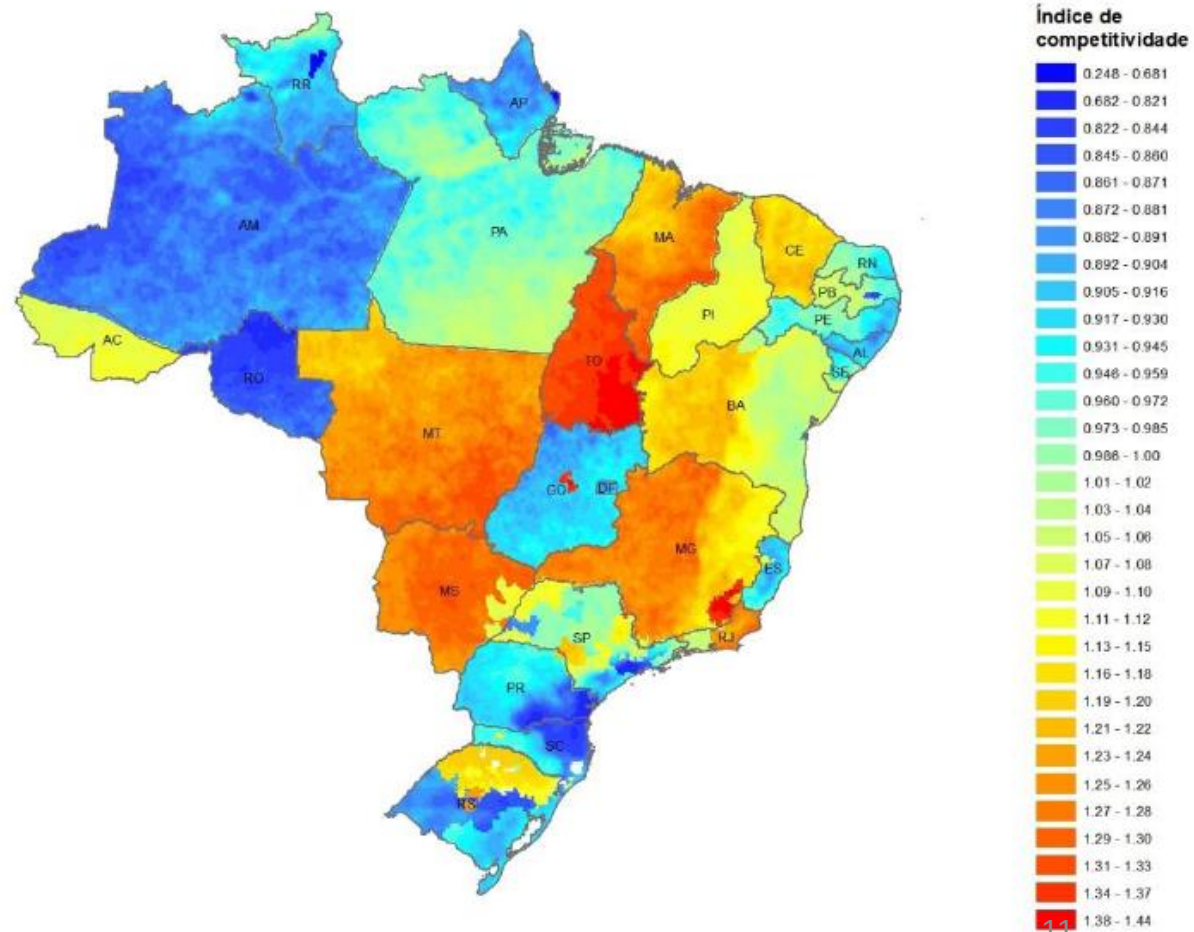
- Comparison



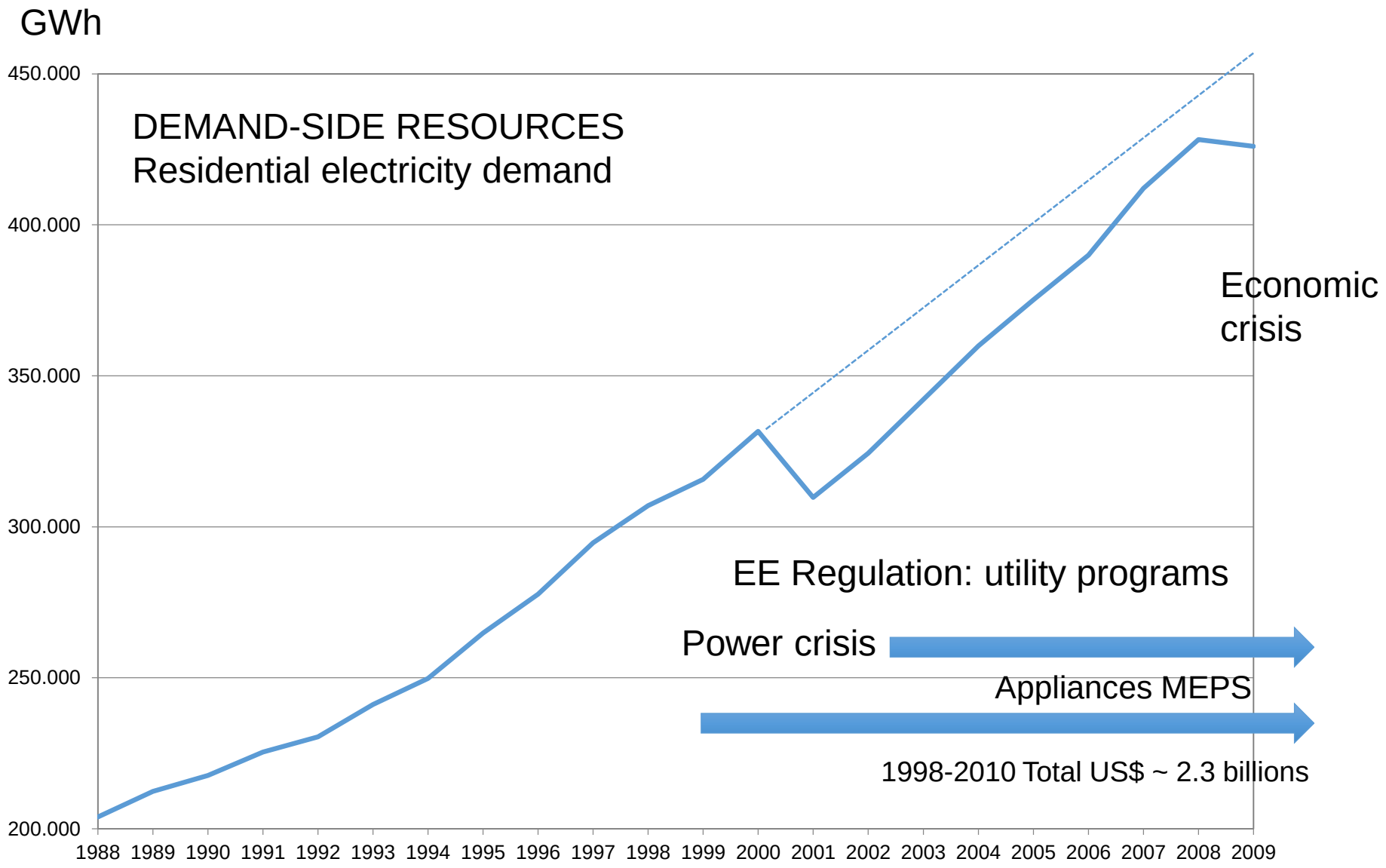
Sources: http://solargis.info/doc/free-solar-radiation-maps-GHI; www.cia.gov/library/publications/the-world-factbook/


Venezuela
Boa Vista
Macapá
Belém
São Luís
Fortaleza
Manaus
Xingu
Tocantins
Teresina
Natal
João Pessoa
Madeira
Parnaíba
Recife
Tapajós
Palmas
São Francisco
Maceió
Porto Velho
Rio Branco
Aracajú
Salvador
Cuiabá
Brasília
Paraguai
Goiânia
Paranaíba
Belo Horizonte
Campo Grande
Grande
Vitória
Paraíba do Sul
Paraná/Tietê
Rio de Janeiro
Paranapanema
Itaipu 14.000 MW Paraguai
São Paulo
Iguaçu
Curitiba
Garabi 2.178 MW Argentina
Uruguai
Florianópolis
Jacui
Porto Alegre
Legenda
Existente Futuro
138 kV
230 kV
345 kV
440 kV
500 kV
750 kV
±600 kV cc
±800 kV cc
Centro de Carga
Número de circuitos existentes
Bacia hidrográfica
Usina hidráulica

(ABINEE 2012)


Índice de competitividade
0.248 - 0.681
0.682 - 0.821
0.822 - 0.844
0.845 - 0.860
0.861 - 0.871
0.872 - 0.881
0.882 - 0.891
0.892 - 0.904
0.905 - 0.916
0.917 - 0.930
0.931 - 0.945
0.946 - 0.959
0.960 - 0.972
0.973 - 0.985
0.986 - 1.00
1.01 - 1.02
1.03 - 1.04
1.05 - 1.06
1.07 - 1.08
1.09 - 1.10
1.11 - 1.12
1.13 - 1.15
1.16 - 1.18
1.19 - 1.20
1.21 - 1.22
1.23 - 1.24
1.25 - 1.26
1.27 - 1.28
1.29 - 1.30
1.31 - 1.33
1.34 - 1.37
1.38 - 1.44
RR
AP
AM
PA
MA
CE
RN
PB
PE
AL
SE
PI
AC
RO
TO
BA
MT
GO
DF
MG
ES
MS
SP
RJ
PR
SC
RS

Energy Efficiency/ Demand-side resources


GWh
450.000
400.000
350.000
300.000
250.000
200.000
1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
DEMAND-SIDE RESOURCES
Residential electricity demand
Economic crisis
EE Regulation: utility programs
Power crisis
Appliances MEPS
1998-2010 Total US$ ~ 2.3 billions

Results for the Greenpeace study (Greenpeace, 2016)

Reduction (%) in Electricity consumption vis a vis BAU

	Setores	INDUSTRIAL (*)	PÚBLICO	RESIDENCIAL	COMERCIAL	AGROPECUÁRIO	ENERGÉTICO
2015 - 2030	**Desempenho Global**	**23,8**	**23,1**	**26,7**	**23,6**	**31,2**	**29,5**
	Iluminação	14,1	15	35	31,5	28,5	18
	Refrigeração/Resfriamento	10,1	35	30	14	15	
	Calor de Processo	7,0		25		25	15
	Força Motriz	30,0	32,4	32	31,5	33,5	30,5
	Eletroquímica	4,7					
	Aquecimento Direto	11,0	15	15	15	15	

	Setores	INDUSTRIAL (*)	PÚBLICO	RESIDENCIAL	COMERCIAL	AGROPECUÁRIO	ENERGÉTICO
2030 - 2050	**Desempenho Global**	**36,7**	**36,4**	**36,1**	**33,1**	**45,9**	**43,0**
	Iluminação	47,1	35	50	34,5	33,5	32
	Refrigeração/Resfriame	19,6	31	35	31	35	
	Calor de Processo	10,5		37,5		37,5	22,5
	Força Motriz	43,3	46,6	46	45	48	44
	Eletroquímica	7,1					
	Aquecimento Direto	21,5	22,5	22,5	22,5	25,4	

(*) the study considered 8 industrial sectors.

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Results for the Greenpeace study

(Greenpeace, 2016)

Reduction (%) in fuels consumption vis a vis BAU

2015-2030																		
Setores	**INDUSTRIAL (*)**			**RESIDENCIAL**			**PÚBLICO**			**COMERCIAL**			**AGROPECUÁRIO**			**ENERGÉTICO**		
	Fóssil	Renov.	**total**	Fóssil	Renov.	**total**	Fóssil	Renov.	**total**	Fóssil	Renov.	**total**	Fóssil	Renov.	**total**	Fóssil	Renov.	**total**
Desempenho Global	22	6	28	10	15	**25**	5	2	**7**	15	20	**35**	15	20	**35**	20	5	**25**

2030-2050																		
Setores	**INDUSTRIAL (*)**			**RESIDENCIAL**			**PÚBLICO**			**COMERCIAL**			**AGROPECUÁRIO**			**ENERGÉTICO**		
	Fóssil	Renov.	**total**	Fóssil	Renov.	**total**	Fóssil	Renov.	**total**	Fóssil	Renov.	**total**	Fóssil	Renov.	total	Fóssil	Renov.	**total**
Desempenho Global	29	14	43	12	18	**30**	8	10	**18**	20	25	**45**	20	27	**47**	30	10	**40**

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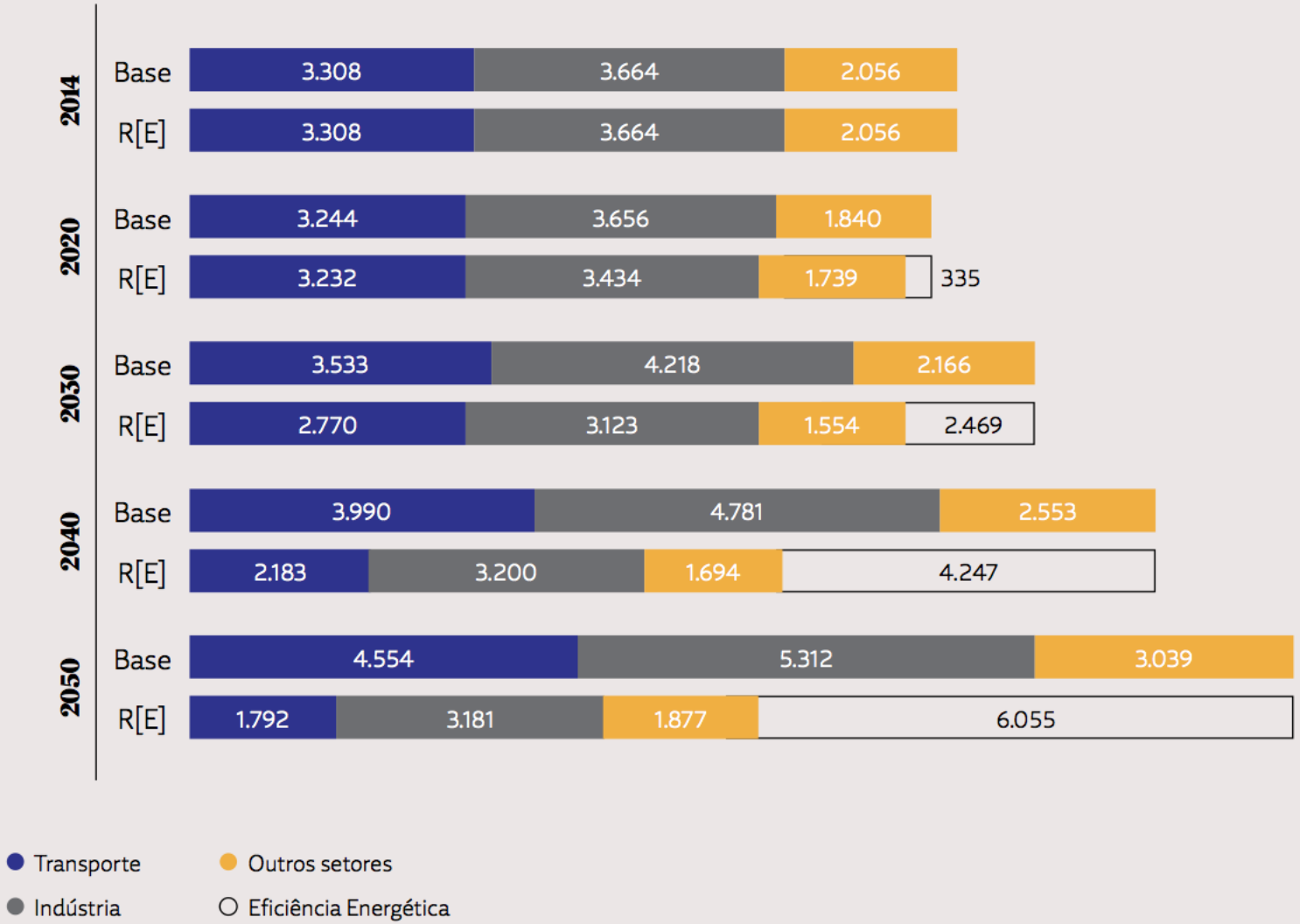
→ Demanda de Energia por Setor (PJ/ano)

Como nossa matriz energética vai mudar até o ano de 2050 se seguirmos a tendência atual ou se seguirmos a proposta do Greenpeace Brasil.



Greenpeace 2016

Challenges (Research topics)

1. Transportation
   - Liquid biofuels VS electricity for transportation
   - Transition to a future with more efficient modes of transportation and mobility
2. Power sector: we have a large RE electricity system
   - Transition to a new system with larger share of solar and wind
   - How climate affects: RE electricity production, competition for water resources, changes in energy demand patterns
   - Restricted expansion of conventional hydro generation and energy storage (water resevoirs)
     1. Strategies to maximize the usage of the existing "battery" (water reservoirs)
     2. Strategies to develop demand-side resources (energy effciency and distributed generation)
   - Regulation and business models: incentives to greater dissemination of EE and RE
3. Assess the socio-economic impacts of these changes

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