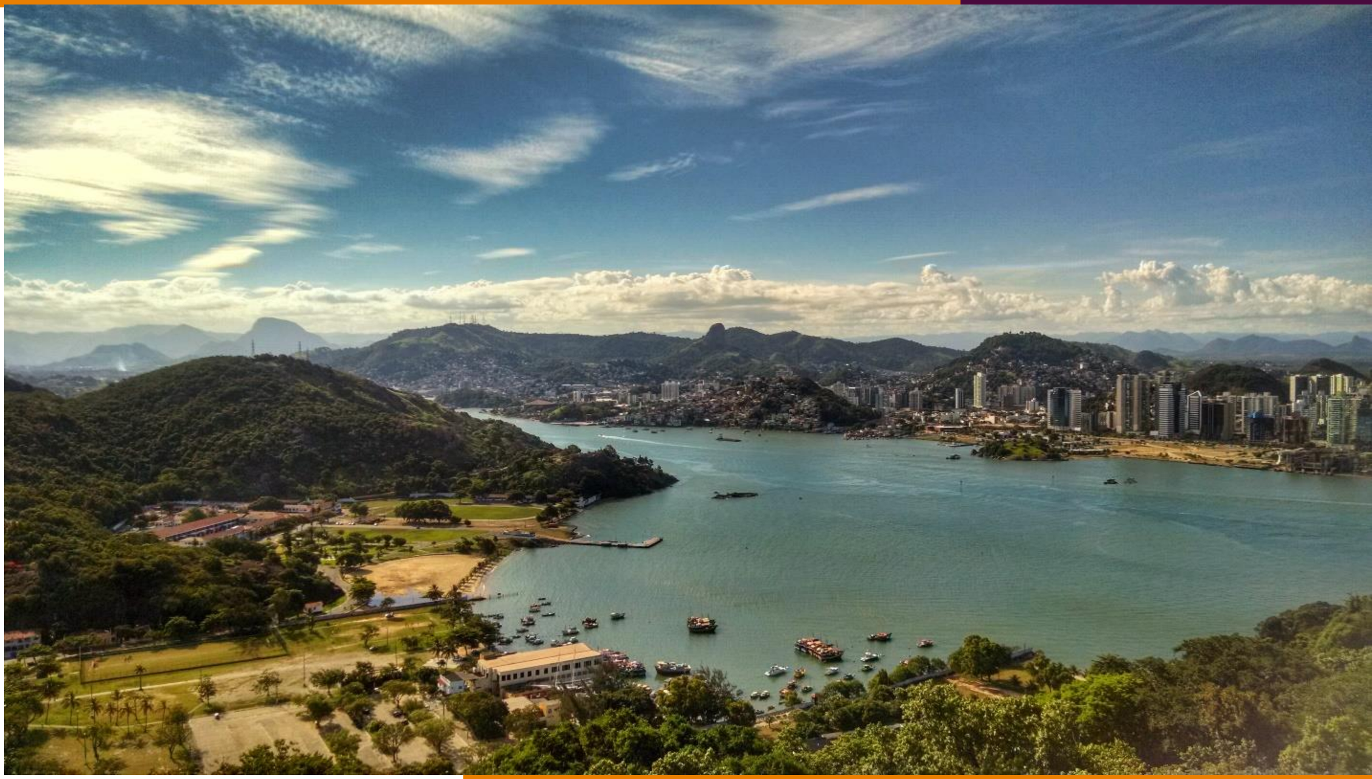
POST-2015 CONSENSUS

Post-2015 Development Agenda

Brazil Perspectives



Energy

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Brazilian Foundation for Sustainable Development

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Brazil is blessed with a wide range of energy resources. The country has a large hydroelectricity capacity – although longer-term reliance on this has been put into question to some extent by the current extended period of drought – as well as being a large producer of ethanol, has good wind resources and large reserves of oil, gas and coal.

Brazil is the world's eighth largest energy consumer and tenth largest producer, and is nearly self-sufficient in energy. By 2035, energy production is forecast to rise by 115%, with consumption growing by only 72%.

A primary post-2015 development goal it to ensure universal access to both electricity and modern cooking fuels. Brazil already has a very good record on these issues. The *Luz para todos* program increased access to electricity from 71% in 2000 to 98% in 2010, and has since been refocused on mini-grids and isolated systems to target the most remote consumers. Consumption of firewood for cooking has declined by 2.9% per annum since 1970 and over 95% of the population now has access to modern cooking fuels.

Another target is to double the rate of energy efficiency improvement. This is more difficult for Brazil than some countries because it already has very low energy intensity and its rate of efficiency improvement has stagnated; it has actually been rising by about 0.2% annually since 2000. The country is ranked 21st in terms of global energy efficiency, but there is still some way to go to reach the level of the most efficient countries such as Colombia, the UK, Spain and Italy.

To reach the top ten and achieve the current efficiency level of the EU will need an efficiency improvement of 1.1% each year. But there are some real challenges. There has been a trend away from hydro towards thermal power generation, and the old, strained electricity network suffers from considerable losses, for technical reasons as well as energy theft. Also, grid capacity will need to be expanded to meet future demand.

The *Plano Nacional de Energia 2030* (PNE) and *Plano Decenal de Expansão de Energia* (PDE) both include energy efficiency targets. Increasing the efficiency of energy use would save money for consumers and businesses and reduce the risk of energy shortages, and some of the measures to be used are directly cost-saving. Overall, investing a Real in improved energy efficiency would pay back around 2.3 Reals in benefits, mainly avoiding further investment, improving business productivity and lowering consumer bills, and reducing CO_2 emissions.

A further global target is to double the share of renewable energy. But Brazil already has a 40% share and doubling this to 80% would not be cost-effective. A more realistic target is to reduce the share of fossil fuels to 40% by 2035 (from the expected 52-57% for business as usual). This allows for a greater contribution of nuclear energy as well as renewables.

Investing more in nuclear and renewable electricity generation would reduce both climate impacts and pollution and increase energy security and improve the balance of payments. With population growth in Brazil being quite low, most increased demand for transport energy comes from greater prosperity. Investing in public transport, electric vehicle infrastructure and ethanol expansion could avoid greater use of fossil fuels. Investing a Real in this way would be expected to produce over two Reals of benefits.

A final goal is doubling investment in R&D in energy technologies. Brazil has a well-educated population and experience in high tech industries which should make the country well placed to achieve this. R&D spending

per capita is a fifth of that of South Korea, so there is plenty of scope for improvement. Estimating costs and benefits is really difficult, but it seems clear that this effort could be very beneficial to the Brazilian economy.

White Paper Report by Isabel Galiana

Current State of Affairs

Brazil is well known for its clean energy mix, including hydro, wind and ethanol, but with recent discovery and accelerated extraction of its large oil reserves, the picture is changing. Furthermore, rapidly growing internal energy demands, ageing infrastructure, and the impacts of climate change need to be addressed within the nation's energy policy.

Brazil is the largest country in South America and the fifth largest country in the world in terms of surface area. It has vast resources including; a diverse geography (long coast line, rain forest, etc.), a population of over 200 million (the fifth largest in the world), a diversified economy and an abundance of energy resources. Brazil is the seventh largest economy in the world: in 2014 GDP reached 2.2 trillion US$. As a BRICS country, it is considered an emerging economy with a GDP/capita of 5823USD and relatively rapid GDP growth. Annual growth rates in Brazil averaged 2.98 percent from 1991 until 2014, but the last three quarters have seen economic contraction. Brazil has reduced the share of the population living in poverty from 20.1% in 2005 to 8.9% in 2013. Population and economic growth contribute to driving the steady increase in Brazil's demand for energy. By 2025, the country will have to nearly double its power supply capacity to meet demand.

Brazil is well placed as a global energy powerhouse and could act as a global leader on energy policy as well. Brazil is the 8th largest total energy consumer and 10th largest producer in the world.[1] Brazil is has a highly diversified energy mix and is nearly energetically self-sufficient. BP forecasts that by 2035 Brazilian energy production will rise by 115% while consumption grows by only 72%. The world's largest oil discoveries in recent years have come from Brazil's offshore, pre-salt basins. The country has the second-largest reserves of natural gas in South America. It is expected to produce 4.0 million bbl/d of crude oil by 2020-22 and export 1.5-2.0 million bbl/d by 2022, sustained by the pre-salt oil fields.[2] In addition, Brazil has the largest coal reserves in Central and South America and the 6th largest uranium reserves. It has the third-largest electricity sector in the Americas, behind the United States and Canada and is planning new hydroelectric power projects to meet growing demand for electricity. For the second consecutive year, parts of Brazil experienced drought conditions, resulting in declining hydro generation in 2013. The share of hydroelectricity in total power generation fell to 69%, from 75% in 2012 and 81% in 2011. As we will see, Brazil no longer has traditional energy access issues. However, power outages are becoming a concern due to transmission and distribution constraints as well as low water levels for hydro generation.

Post 2015 targets – The Brazilian context

With regards to the Post 2015-recommendation on Energy, many lessons can be extracted from Brazil's progressive approach to energy policy. Here the targets assessed within Galiana & Sopinka (2014) are discussed in the Brazilian context. This section examines the relevance of the proposed targets to Brazil and offers modifications where appropriate.

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[1] http://www.eia.gov/countries/country-data.cfm?fips=BR

[2] Platts, "Brazil to Export Up to 2 million b/d by 2018-2020: ANP," (September 15, 2014), http://www.platts.com/latest-news/oil/riodejaneiro/brazil-to-export-up-to-2-million-bd-by-2018-2020-21231640.

A primary target in POST 2015 millennium development goals is ensuring universal energy access, both in terms of electricity and modern cooking fuels. Here, Brazil can provide lessons as an example for countries struggling with energy access issues. The program '*Luz para todos'* increased electricity access from ~71% to 98% from 2000-2010 and current World Bank data suggests access is now at 99%. *Luz para Tudos*, loosely translated as *Electricity for All*, was implemented in 2003. This program was set up to provide free energy to low-income consumers, and to residential consumers with consumption less than 80kW/month (Coelho and Goldenberg 2013). The cost was initially estimated at 7billion USD with a target of 100% electrification by 2008. The program was re-launched in 2011 focusing on mini-grids and isolated systems to target the most remote consumers. Ultimately the program is thought to have benefited ~15 million people at a cost of ~7billion$, just over 450$ per person currently using the system. The benefits are extremely likely to be significantly higher given the long-term benefits to future generations. The program, initially developed for poverty alleviation, will need to be re-evaluated as these new consumers' energy demand increases and thus improvements in energy efficiency, increasing the share of renewables and new energy technologies will be needed. Brazil is a particular case in which 100% electrification seems to have been cost effective and worthwhile. The Brazilian Ministry of Mines and Energy estimates that the benefits in terms of quality of life, access to health care and education were significant. [3] In the case of modern cooking fuels, the consumption of wood fuel declined by an average of 2.9% per annum since 1970. In large part due to economic development and migration to cities but also thanks to a governmental program to subsidize LPG, a cooking fuel to replace the use of wood. Currently over 95% of the population has access to modern cooking fuels.

Double the rate of energy efficiency improvement - Brazil

The most economical and greenest energy source, energy efficiency, has a central role in Brazil's energy future. The target as stated above makes sense globally where energy efficiency has been improving at about 1% per annum but not so for Brazil. While Brazil has a very low energy-intensity, its rate of improvement had stagnated, increasing by 0.2% since the year 2000. Notwithstanding Brazil's low absolute energy-intensity, well below the global average and closer to OECD countries than BRICS, there is still need and room for improvement (figure 1). Brazil is currently (2013) ranked 21st globally in terms of energy efficiency with the most efficient countries (Colombia, the UK, Spain, Italy) having close to double the level of efficiency. In order to achieve the current level of efficiency of the European Union (putting it within the top 10 in the world), Brazil will need to improve efficiency by 1.1% per annum. Since the year 2000, Brazil has had the 8th lowest rate of efficiency improvement globally and one of only eight to see a decrease in energy efficiency (Enerdata 2014).

[3] https://www.mme.gov.br/luzparatodos/Asp/o_programa.asp

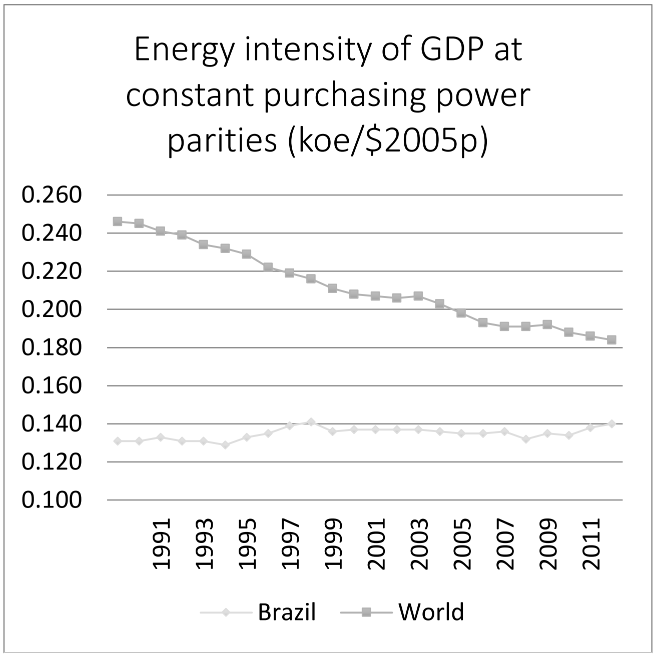

Figure 1: Energy Intensity (source: IEa 2015)

Recent trends away from hydropower and towards thermal power as well as an increasing demand for air conditioning have contributed to the recent rise in energy intensity. Brazil faces three main challenges associated with its electricity network. First, it is old and strained electricity network, resulting significant losses. For the past two decades, in addition to technical losses and energy theft, electricity transmission and distribution losses have been quite high, at ~17 per cent (IEA 2013c). Second, Brazil will need to expand the grid and capacity to meet future demand (WEC 2012.) In 2011, losses totalled 88 TWh. (World Bank 2013). These challenges can also be seen as opportunities to develop smart grid capabilities and reduce inefficiencies, losses and theft.

Brazil has a number of polices and institutions that target energy efficiency. The *Plano Nacional de Energia 2030* (PNE) and the *Plano Decenal de Expansão de Energia* 2023 (PDE) both developed by the ministry of Mines and Energy have targets for energy efficiency built in. The PNE provides over 200 pages of detailed analyses of the potential costs and benefits of efficiency improvements of various technologies. A policy goal included in the PDE is to maintain the carbon intensity of the economy (measured in emissions/GNP) below 2005 levels, which given rising use of fossil fuels and will require large improvements in energy efficiency. In 2011, the Ministry of Mines and Energy published the National Energy Efficiency Plan, *Plano Nacional de Eficiência Energética: Premissas e Diretrizes Básicas, PNEf*, which stipulates a 10% reduction in electricity consumption in 2030 compared to business as usual consumption. According to Abesco, the Brazilian energy service companies' association, efficiency measures by consumers alone could result in a 10 per cent reduction in consumption and R$11.5bn (US$5.2bn) in savings (Ordoñez 2014).

Increasing the efficiency of energy use would save consumers and businesses money and reduce the risk of new energy shortages (Geller et al 2004). Some of the measures needed to improve energy efficiency are directly cost-saving with huge benefit-cost ratios. Examples of these include, labelling, building efficiency, vehicle fleet efficiency, building codes for new buildings, performance standards for major appliances, use of best available technologies and efficiency improvements in industry, and vehicle fuel economy standards and labelling.. In the case of Brazil, some of the most significant improvements will come from reducing losses on the grid including electricity theft and oil saved in the transport, buildings, and industrial sectors.

The IEA's World Energy Outlook 2006 estimates that an investment of US$3.2 trillion will be required worldwide to double the rate of energy efficiency improvement. These efficiency investments avoid new supply investments of US$3 trillion worldwide, and result in a net incremental investment of US$200 billion worldwide. These relatively small net efficiency investments generate significant additional benefits in improved business productivity and reduced consumer energy bills worth approximately

US$500 billion annually by 2030. According to the IEA, investments of ~US$360 billion in energy efficient technology will be needed and lifetime savings in energy costs are estimated to be more than US$900 billion (IEA 2006). This is expected generate capital expenditure savings of save more than US$270 billion worldwide along with fuel savings of almost US$0.001 per kWh that would offset the capital cost in only four years (MIT, 2007). The imposition of efficiency standards for coal-and oil and gas fired plants would reduce projected CO2 emissions in 2030 by 5 billion tonnes per year (Moss, Chandler et al. 2007).

Brazil makes up 3.1% of world output and thus we use this share to estimate costs and benefits based on the global data outlined above.

Benefits: Globally

1. US$3 trillion in avoided new supply investments – Brazil's share US$93 billion

2. Improved business productivity and reduced consumer energy bills worth approximately US$500 billion annually by 2030 Brazil's share US$15.5 billion

3. CO2 reductions – increasing linearly to 25 US$ billion (5$/ton CO2) – US$250 billion (50$/ton CO2) annually in 2030 – Brazil 775 million USD– 7.75billion USD

Cost: Globally: US$3.2 trillion Brazil's share: 99.2 billion

BCA = 1.1 - 3.6

Double the share of renewable energy - Brazil

With 88GW of hydro, 4GW of wind, and 9GW of biomass, renewables currently make up 85% of Brazil's electricity generation (2013). Accordingly, non-hydro renewables make up 13% of electricity generation. In terms of renewable energy, which includes transportation, heating/cooling as well as electricity, Brazil stands at about 40% in 2013 (Enerdata).[4] In absolute terms, wind and solar energy capacities are still not well developed and contribute less than 4 per cent to the country's total electricity production. What is worrisome is that the share of renewables is declining due to the combined impact of severe drought reducing hydro capacity and new oil and gas discoveries. Demand for all fuels expands to 2035: gas (+79%), oil (+52%), and coal (+18%). Renewables in power generation expand by 270%, biofuels by 109%, nuclear by 97% and hydro by 66% (IEA 2014). Fossil fuels are forecast to account for 52% of Brazil's energy consumption in 2035 down from 59% in 2013 (EPE 2014), the IEA estimate is for 57% fossil fuels in 2035. The share of intermittent renewable power rises to 10%; hydro maintains 30%, biofuels account for 7% and nuclear accounts for just 1%. A doubling of renewable energy in Brazil requires yields a 80% share of renewables by 2035. In terms of Brazil's capacity to increase renewables, the hydropower potential is estimated at 261 GW, wind energy potential at 350 GW, not to mention potential to expand biomass. Even with Brazil large renewable potential, given Brazil's current share of 40% renewables, a doubling to 80% is not cost-effective and double the global target of ~40%. A more realistic target in set terms of

[4] http://www.developmentprogress.org/sites/developmentprogress.org/files/case-study-report/brazil_full_report_-_final_small.pdf

fossil fuels use and allows for greater nuclear is to **'reduce the share of fossil fuels by 2035 to 40%'** from the forecast 52-57%. This is a quite ambitious target but given Brazil's renewable energy potential, combined with a push to electric or ethanol vehicles and energy efficiency improvements is cost effective.

An important consideration is the current impact of climate variability on hydropower. The current long lasting drought has impacted the hydro capacity (previously 80% of electricity). This may hint at a need to diversify their energy sources if droughts are expected more frequently. Hydropower is by far the most economical and environmentally friendly option, at around a third of the cost of sugarcane bagasse and natural gas, and 35–40 per cent of the cost of nuclear and coal (Carvalho and Sauer 2009), with some studies estimating an even greater price difference, with large-scale hydropower at R$85/MWh (US$38) at one extreme and oil-powered thermal power at R$600/MWh (US$270) at the other (Oliveira 2014). Brazil's hydropower generating facilities are located far from the main demand centers (cities), resulting in high transmission and distribution losses. However recent droughts have reduced the hydro potential and have increased use of natural gas. This has had three important effects, fluctuations in the cost of electricity production, increased the share of fossil fuels in the energy mix and decreased energy efficiency (thermal plants are less efficient than hydro). Huge market price fluctuations adversely affect the economy and thus Brazil should consider increasing its share of nuclear and wind to offset these scenarios. The PNE 203 (BRASIL, 2007), forecasts expansion of the electric grid to include 1) renewable energy – 191,35 GW (92 GW in 2010); 2) Conventional thermal plants – 21,5 GW (16 GW in 2010); e, 3) Nuclear – 8GW (2 GW in 2010). In December 2014 the ministry of mines and energy approved the PDE (Plano Decenal de Expansão de Energia 2023) (PDE 2023), that sets investments of 1,3 trillionR$ in the in order to guarantee energy access[5]. Installed capacity is set to increase from 124.8GW to 195.9 GW.

[5] http://www.epe.gov.br/Estudos/Paginas/Plano%20Decenal%20de%20Energia%20–%20PDE/MMEaprovaPDE2023.aspx

The estimates for the share of fossil fuels in 2035 are 55% of the 480 Mtoe (5580TWh) total primary energy consumption forecast up from the 267Mtoe in 2013 (Enerdata). **Reducing this share to 40% implies an increase of 72 Mtoe (837 TWh) in non-fossil energy consumption from business as usual (BAU) projections**. Currently, 11Mtoe (128TWh) are fossil fuel energy in electricity consumption, expected to rise to 32Mtoe (372 TWh). Fossil fuels in the transport sector are at 61Mtoes (709TWh), forecast to increase to 96 Mtoes (1 116TWh), and industrial consumption of fossil fuels is forecast to double to 59Mtoes.

The cost-benefit analysis is undertaken on the modified target: **'reduce the share of fossil fuels by 2035 to 40%.** We will consider reducing the share of fossil fuels in the electricity sector by 244TWh (21 Mtoe), the entire planned expansion, and the transport sectors, by 51 Mtoe. The production increases assigned in Table 1 in non-fossil shares are well below the estimated potential production for each energy source.

Population growth in Brazil is quite low and so the majority of the increased demand for transport energy comes from increased wealth. Preemptive investment in well-functioning public transport, railways, electric vehicle infrastructure and ethanol expansion are ways in which fossil energy could be excluded from transportation. This requires a significant reduction in oil consumption from forecast levels. Despite the relatively popularity of flex-fuel vehicles in Brazil, ethanol use is currently disadvantaged due to the government-imposed cap on domestic oil prices. In fact, as a result of artificially low oil prices, ethanol

Table 1:	IEA 2011	IEA 2035	40% non-fossil target	Δ from BAU
Total primary energy demand (TPED, Mtoe)	267	480	480	0
– TPED of oil/natural gas/coal (Mtoe)	109/23/15	165/77/24	100/77/15	-65/0/9
– TPED of bioenergy (Mtoe)	78	138	160	+22
– TPED of hydropower (Mtoe)	37	58	75	+17
– TPED of other clean energy (incl. nuclear, wind, Mtoe)	5	19	53	+34
Total final consumption of fossil energy (Mtoe) by sector				
– Consumption of fossil fuels in transport (Mtoe)	61	96	45	-51
– Consumption of fossil fuels in industry (excl. electricity, Mtoe)	30	59	50	-9
– Use of fossil fuels in electricity generation (Mtoe)	11	32	11	-21
Share of non-fossil of energy supply	55%	55%	40%	-15%

use has decreased, and Petrobras has been forced to import gasoline to cover the growing demand (Laporta 2013; IEA 2013). Brazil's currently produces ethanol on 1% of its territory and studies show 7.6% is suitable. The elimination of these fuel subsidies (price ceilings) would encourage a natural expansion of ethanol and easily allow for the additional 16Mtoe saved. Moreover, by expanding biofuel production, large quantities of oil would be available for export generating significant revenues. Natural gas is recommended to increase as projected as local consumption is though to be more economical a option than export. There do not appear to be any significant costs associated with this policy.

With respect to the electricity sector, the benefits of increasing the share of non-fossil energy are estimated as the avoided climate impacts and air pollution as well as increased energy security, balance of payments and net job creation and the levelized cost of the fossil fuel not utilized. Air pollution costs and climate change costs are based the RFF report "The true cost of Electric Power"[6]. It is expected however that these external costs would rise with increased future fossil consumption and thus the benefit cost ratios provide are lower bounds. Balance of payments and net job creation also come from the IADB report on renewables in Latin America. There has recently been some concern about the ability to integrate large quantities of renewables and maintaining the stability and reliability of the electric grid due to the intermittency of wind and solar. Brazil is uniquely positioned in this respect. First, given its privileged geography, wind blows quite constantly near coastal densely populated areas. Second, the share of intermittent renewables would remain quite low (likely <15%) of electricity production with the rest of the increased non-fossil share coming from base load hydro, nuclear and biomass.

The costs are the addition cost of electricity production based on current levelized costs of production. Levelized costs in Brazil for various energy sources: Nuclear 90 USD/MWh; coal 123 USD/MWh; gas fired plant 65 USD/MWh; large hydro 60 USD/MWh ; biomass 110 USD/MWh; wind 70 USD/MWh.

Results indicate that the aggregated value of societal benefits of non-fossil fuels over fossil fuels are from US$19/MWh to US$92/MWh. Thus in the case of the electricity sector, if the 244 TWh of capacity expansion expected to be undertaken with fossil fuels were to be undertaken instead with non-fossil sources we could expect a benefit/cost ratio of:

Benefits = 127 to 219 USD per MWh (incudes cost of fossil electricity not incurred, and the social costs not incurred)

Costs = 82.5 USD per MWh using an average mix for non-fossil fuels: wind, hydro, biomass and nuclear equally weighted. 80 USD/MWh, if using only wind and nuclear (this is feasible given domestic potential). Though hydro is less costly, it has political limitation particularly given the current drought situation.

BCR = 1.54 – 2.74

Double investment in R&D in energy technologies

Brazil has a large and diverse economy, a large population with a tertiary education and experience in high tech industries. High-tech exports already make up 10% of manufacturing exports in Brazil. All of these qualities make managing and undertaking a sustained R&D effort in energy technologies possible an interesting from a developmental perspective. For example, Brazil's development of ethanol has resulted in the development of 'flex-fuel' car engines that can use both petrol and bio-fuel though sustained leadership, responsive regulation, public and private investment in research and technology.[7] Public investment in research is well known to have been instrumental to improving yields in the early

[6] http://www.ren21.net/Portals/0/documents/Resources/RFF-Rpt-BurtrawKrupnick.TrueCosts_Summary_web.pdf
[7]http://www.developmentprogress.org/sites/developmentprogress.org/files/case-study-report/brazil_full_report_-_final_small.pdf

stages of the ethanol's development. R&D in ethanol in now dominated by private firms thanks to early government-supported investment. Brazilian R&D expenditure per capita are more than ten times smaller than the US per capita expenditure and five times less than South Korea (Jannuzzi 2005). It has been shown that an important positive influencing factor in energy efficiency is energy technology R&D (Cui 2014).

Moreover, given the wide range of energy sources available in Brazil, it is an ideal ground for testing and demonstration of new technologies. For example, CCS in the pre-salt oil fields, integration of large amounts of renewables, and more basic research in storage and biofuels. Estimating the potential costs and benefits of a broad R&D programme is an incredibly difficult task but it is clear that increasing efforts in existing programmes and pushing new areas could be extremely beneficial to the Brazilian economy.

Conclusion

Brazil is an energy powerhouse in terms of its hydro resources, fuel reserves (oil, gas, coal) and also its potential for renewable energy integration. Rapid economic growth has driven energy demand in recent years although the current economic situation is reducing investment incentives. Nonetheless, Brazil is uniquely placed to lead on energy policy. In the wake of Brazil's success in providing energy access, it should turn its attention to energy efficiency improvements, integrating large shares of renewables and developing a strong research, development and demonstration program. It is important to note that there are strong synergies between these objectives. Integrating renewables at a large scale will require developing, testing and demonstrating a much smarter electric grid. A modernized grid is an important component of reducing losses and thus improving energy efficiency. And lastly the transportation sector will be critical to achieving both the efficiency and renewable energy targets.

Target	**Benefit-Cost**	**Revised target**	**Comments**
Double the rate of energy efficiency improvement	**1.1 – 3.6**	Improve global energy efficiency ranking from current 21st to top ten in the world.	As an emerging economy, Brazil has significant inefficiencies, particularly in the electricity sector.
Double the share of renewable energy	**1.54 – 2.74**	Reduce the share of fossil fuels to 20%	Brazil already has very high levels of renewables (mainly hydro)
Double investment in R&D in energy technologies	Uncertain	No revision necessary	Brazil has all the characteristics necessary to implement a successful RD&D program

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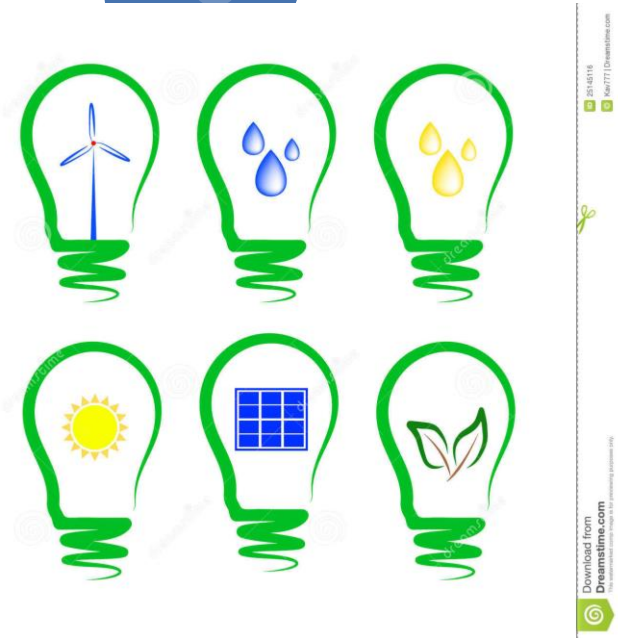
Post-2015 Development Goals

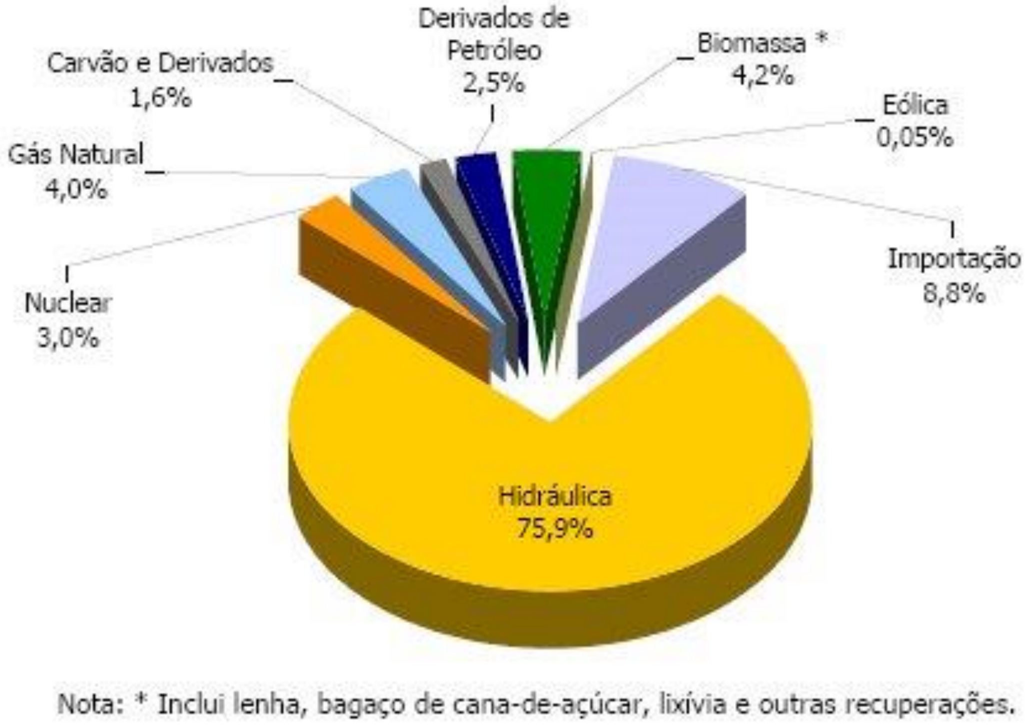
Energia no Brasil
Isabel Galiana



Estado Atual das Coisas

- O Brasil é reconhecido internacionalmente por sua mistura de energia limpa, incluindo a hídrica, eólica e etanol,
- Com a descoberta recente e extração acelerada de suas grandes reservas de petróleo, o quadro está mudando.
- A extração vai continuar mas a escolha e:
  - será para consumo domestico?
  - ou para exportação?

Eletricidade no Brasil



http://www.ecodebate.com.br/2014/04/08/desenvolvimento-sustentavel-e-a-matriz-energetica-brasileira-artigo-de-alarico-jacomo/

Eficiência energética

- O Brasil tem um nível de eficiência muito bom com respeito ao resto do mundo mas tem muitas perdidas associadas e muito potencial para melhorar.
- A eficiência energética do Brasil empioro nos últimos anos.
- Perdidas na rede elétrica são de ~17% - o equivalente de 88TWh
- Uma melhoria de 1%/ano levaria o Brasil entre os melhores 10 países do mundo em términos de eficiência energética além de custar só R$ 1 para cada R$ 2 de beneficio.

Energia renovável et não-fósseis

- O Brasil tem uma potencialidade energética muito grande portanto, a utilização desses recursos requer investimento consideráveis no tratamento e redes de distribuição.
- O Brasil possui a matriz energética mais renovável do mundo industrializado. 42% da energia produzida é proveniente de fontes como recursos hídricos, biomassa e etanol, além da energia eólica.
- As usinas hidrelétricas são responsáveis pela geração de mais de 75% da eletricidade do pais.
- O uso da expressão não-fosseis em vês de renovável, permite a inclusão de nuclear na mistura energética limpa.

Benefícios de energia não-fósseis

- ambientais – polução atmosférica, emissões de CO_2
- saúde -- polução atmosférica causa enfermidades respiratórias et ate mortes
- emprego – um sector industrial renovável tem o potencial de gerar muitos empregos em investigação, fabricação, instalação e manutenção.
- aumentar a exportação de recursos fósseis

Reduzir a energia fósseis a 40% da mistura energética

- Reduzir o consumo de carvão et petróleo.
  - permite maior exportação
- Manter o consumo de gás natural
  - limpo et difícil de exportar
- Aumentar a produção hídrica, nuclear, eólica e de biomassa e etanol
- Trás benefícios de ~$R 2.2 por $R 1

- https://revelacaoglobal.files.wordpress.com/2012/08/tiago_carro_cana1.jpg

Bioenergia / Etanol

- Brasil é o segundo maior produtor de etanol do mundo
- A eliminação de subsídios para o petróleo crera um ambiente mas favorável pra o etanol
- Área total plantada do cultivo para produzir etanol e só 1%, isto pode facilmente aumentar ate 3-7%

Energia hidrelétrica

- O Brasil produz 70-80% da eletricidade com recursos hídricos
- Só 1/3 do potencial é desarrolhado
- A proposição é de aumentar de 17mtoe do previsto em 2035

Nuclear

- O Brasil tem 1/6 das reservas globais de uranio
- Hoje só produz 3% da eletricidade brasileira
- Existem 2 centrais e uma em construção
- A proposição é de aumentar o nuclear de 3.3 mtoe hoje a 20 mtoes (232TWh)
- O Plano Nacional de Energia 2030 – PNE 2030 pede 5,345 megawatts (MW) a mais 2030
- Isto e aproximadamente 5 centrais com capacidade total de 33 000 MW

Os objetivos do Brasil

Target	Benefit-Cost	Revised target	Comments
Double the rate of energy efficiency improvement 	**1.1 – 3.6**	Improve global energy efficiency ranking from current 21st to top ten in the world.	As an emerging economy, Brazil has significant inefficiencies, particularly in the electricity sector.
Double the share of renewable energy	**1.54 – 2.74**	Reduce the share of fossil fuels to 40%	Brazil already has very high levels of renewables (mainly hydro)
Double investment in R&D in energy technologies	Uncertain	No revision necessary	Brazil has all the characteristics necessary to implement a successful RD&D program

05 de maio de 2015

Post-2015 Consensus: Energy

FUNDAÇÃO BRASILEIRA PARA O DESENVOLVIMENTO SUSTENTÁVEL

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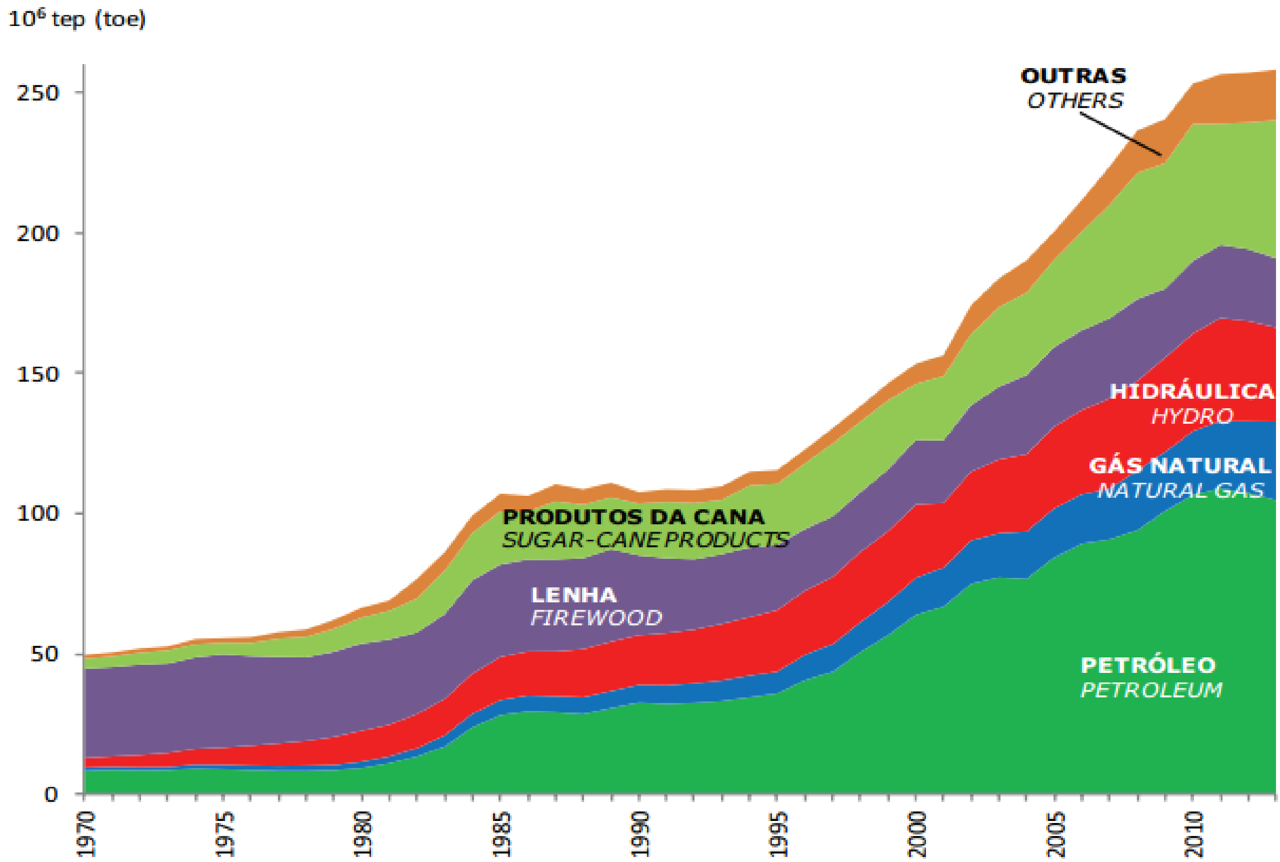
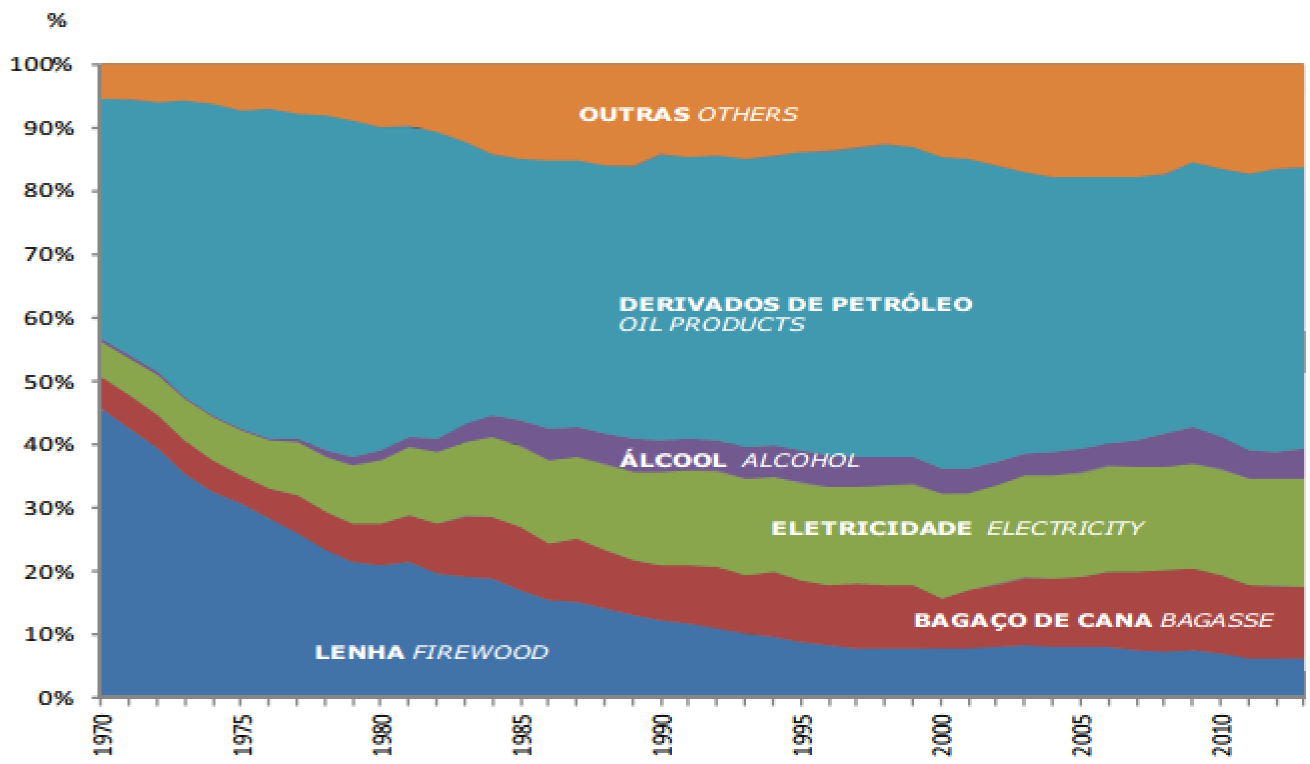


Balanço Energético Nacional (EPE,2014)



Balanço Energético Nacional (EPE,2014)

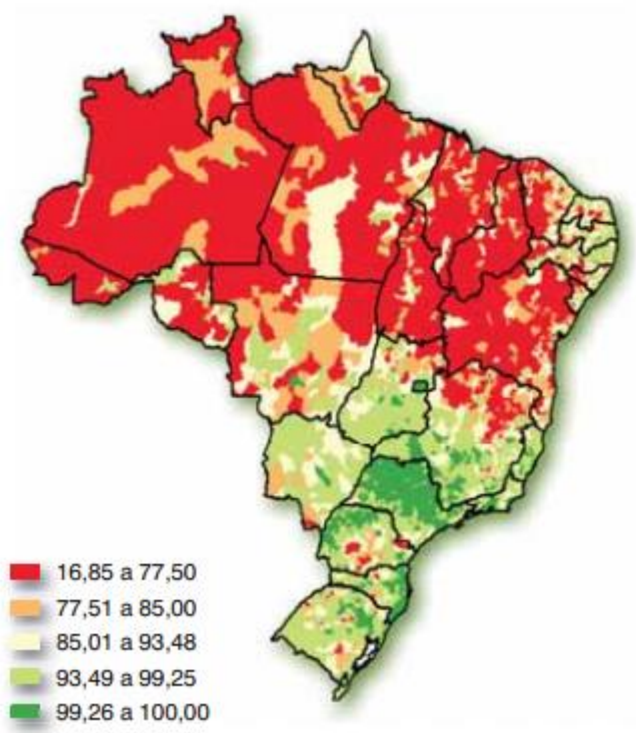
Discriminação	2014		2018		2023		2014-2018	2018-2023	2014-2023
	mil tep	Participação relativa (%)	mil tep	Participação relativa (%)	mil tep	Participação relativa (%)	Variação (% a.a.)		
Gás natural	18.101	7,1	26.413	8,8	33.002	9,4	8,3	4,6	6,4
Carvão mineral e coque	13.693	5,4	15.910	5,3	15.850	4,5	4,3	-0,1	2,1
Lenha	16.616	6,5	14.825	4,9	14.057	4,0	-1,7	-1,1	-1,4
Carvão vegetal	5.306	2,1	6.435	2,1	6.570	1,9	9,1	0,4	4,7
Bagaço de cana	29.156	11,5	34.583	11,5	40.471	11,5	3,2	3,2	3,2
Eletricidade	46.028	18,1	55.193	18,3	67.116	19,1	4,4	4,0	4,2
Etanol	12.467	4,9	17.170	5,7	22.189	6,3	7,6	5,3	6,4
Biodiesel	2.588	1,0	3.891	1,3	4.602	1,3	14,8	3,4	9,0
Outros	6.140	2,4	7.748	2,6	9.296	2,6	4,1	3,7	3,9
Derivados de petróleo	104.402	41,0	119.668	39,6	138.197	39,3	3,9	2,9	3,4
Óleo diesel	48.836	19,2	57.188	18,9	67.618	19,2	4,1	3,4	3,7
Óleo combustível	4.444	1,7	5.120	1,7	5.630	1,6	4,8	1,9	3,4
Gasolina	26.502	10,4	29.478	9,8	32.426	9,2	3,8	1,9	2,9
GLP	8.306	3,3	8.953	3,0	9.768	2,8	1,5	1,8	1,6
Querosene	4.080	1,6	4.708	1,6	5.730	1,6	5,4	4,0	4,7
Outros derivados de petróleo	12.234	4,8	14.220	4,7	17.024	4,8	4,3	3,7	4,0
Consumo final energético	**254.497**	**100,0**	**301.835**	**100,0**	**351.350**	**100,0**	**4,4**	**3,1**	**3,7**

Fonte: EPE

PDE 2023 (EPE,2014)

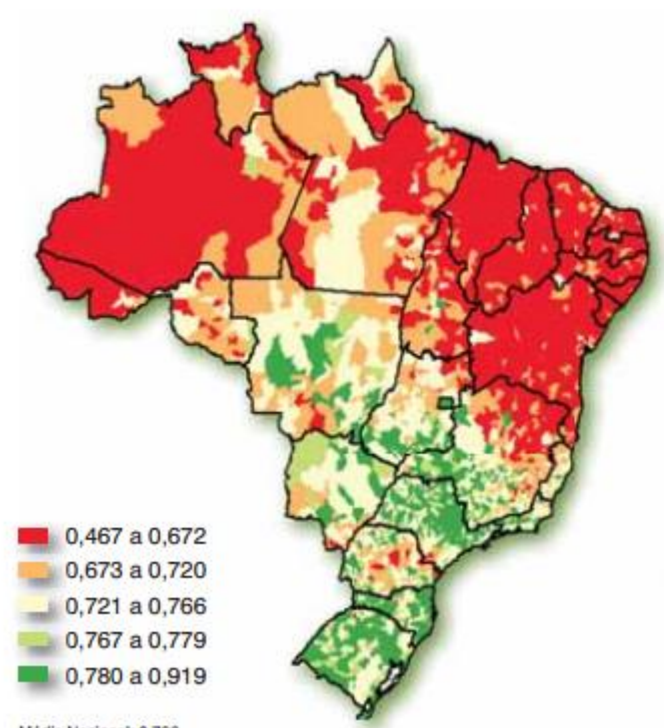
Universalização – Eletricidade
Luz para Todos

EXCLUSÃO ELÉTRICA
ÍNDICE DE ATENDIMENTO



Em %
Média Nacional: 93,48%
Fonte: Atlas Desenvolvimento Humano, 2000

ÍNDICE DE DESENVOLVIMENTO HUMANO
IDH

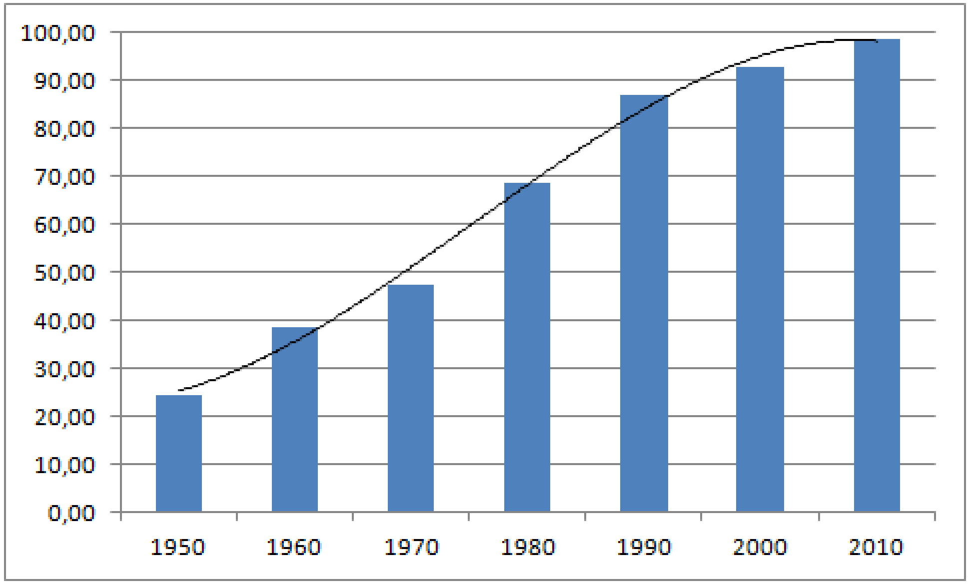


Média Nacional: 0,766
Fonte: Atlas Desenvolvimento Humano, 2000

Universalização – Eletricidade
Luz para Todos

- Até 2014:
  - 3,1 milhões de ligações (equivalente a 15 milhões de pessoas atendidas)
  - Investimentos de R$ 23 milhões desde 2003

- Em 2010, 98,73% dos domicílios cobertos (CENSO 2010)



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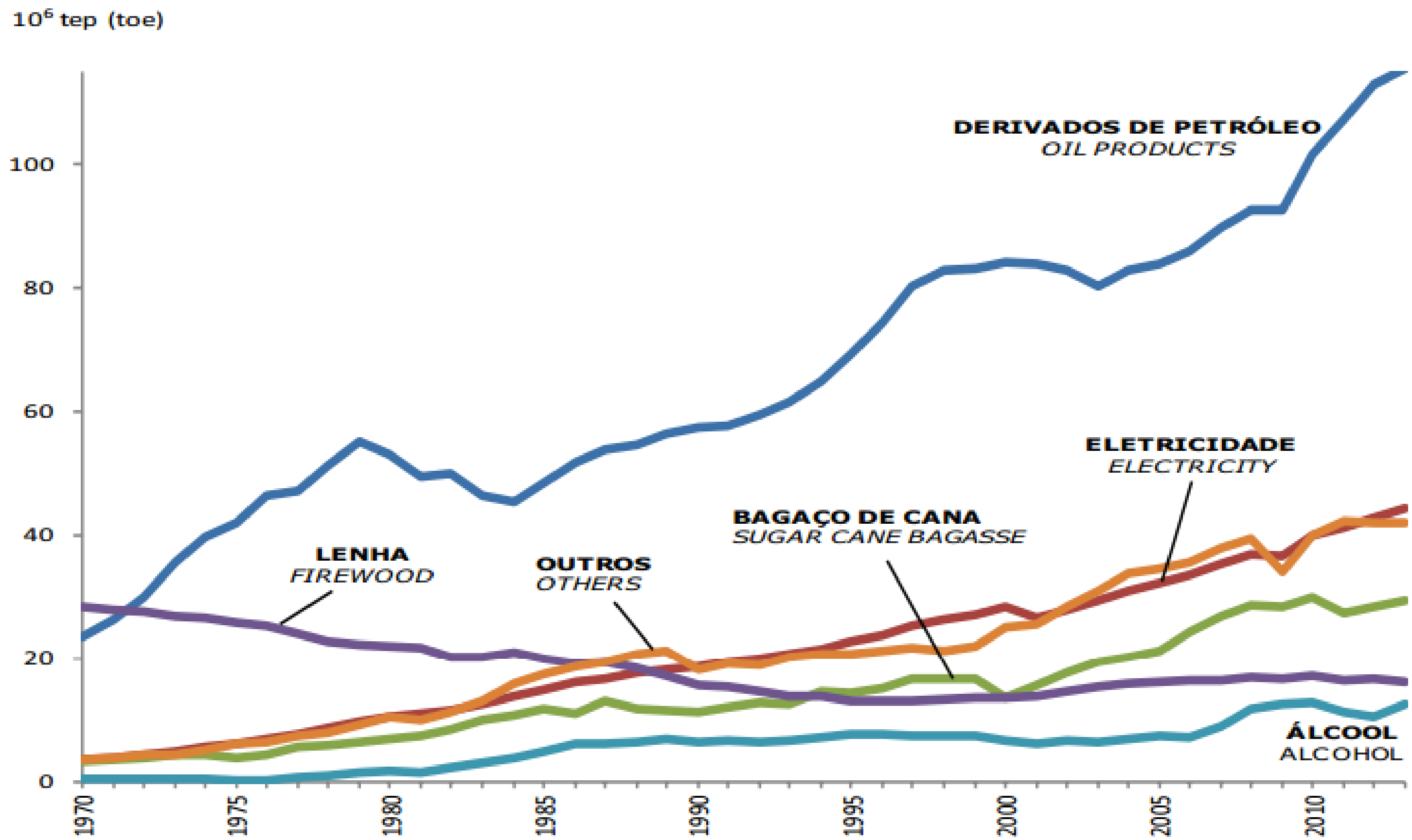
DESAFIO

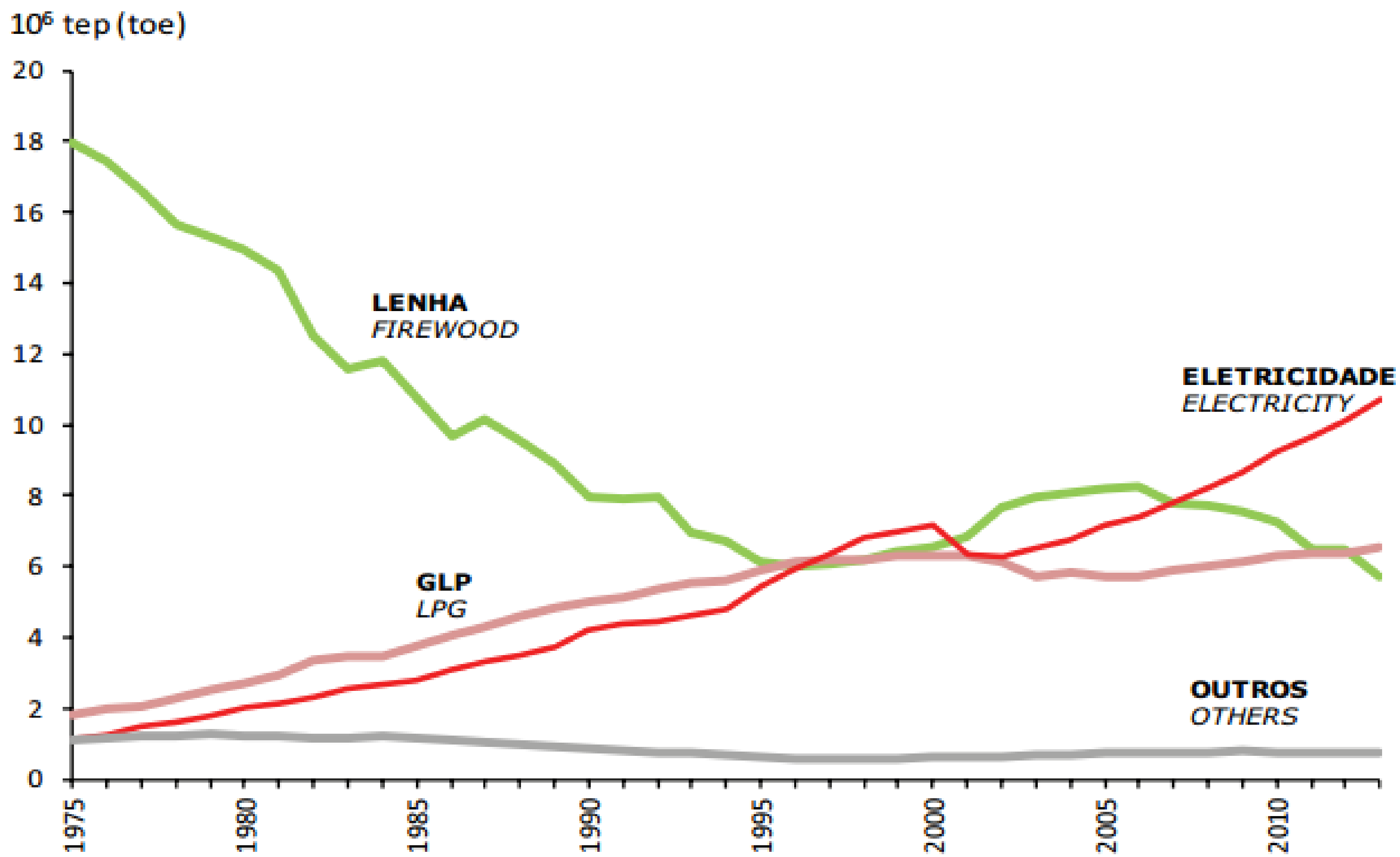
- Financiado pela CDE (Conta de Desenvolvimento Energético)
- A partir de 2015, o governo retirou quase todo o financiamento público da CDE
- Custos de R$ 23 bilhões de reais foram transferidos para os consumidores
- Novas expansões impactam valor da conta de luz
- Haverá apoio?

Universalização – Cocção
Lenha



Balanço Energético Nacional (EPE,2014)

Universalização – Cocção
Consumo Residencial



Balanço Energético Nacional (EPE,2014)

Universalização – Cocção
Consumo Residencial

Ano		2002		2008	
Energético		Lenha	CV	Lenha	CV
Classes de renda	SM ≤ 2	2.212	125	1.532	109
	2<SM≤3	1.462	77	1.067	58
	3<SM≤5	1.871	75	2.392	83
	5<SM≤6	500	23	886	25
	6<SM≤8	637	25	1.113	65
	8<SM≤10	255	27	346	42
	10<SM≤15	377	30	282	72
	15<SM≤20	199	15	17	30
	20<SM≤30	98	19	66	32
	SM > 30	63	18	5	15
Consumo total		7.675	435	7.706	531

Thiago Fonseca Morello (FIPE,2011)

País/Região	População (10^6 hab)	PIB[1] (10^9 US$)	Consumo de energia		Indicadores	
			OIE[2] (10^6 tep)	Eletricidade (TWh)	(tep/10^3 US$)	(kWh/hab)
OECD	1.178	31.158	5.537	9.872	0,18	8.381
Ásia	2.120	7.661	1.330	1.414	0,17	667
América Latina	455	3.425	531	808	0,15	1.777
África	937	2.207	614	522	0,28	557
África do Sul	47	489	129	227	0,26	4.810
Argentina	39	534	69	102	0,13	2.620
Chile	16	180	29	52	0,17	3.207
China	1.319	8.916	1.897	2.716	0,21	2.060
Estados Unidos	299	11.265	2.320	4.052	0,21	13.515
Índia	1.109	3.671	565	557	0,15	503
México	104	1.030	177	208	0,17	1.993
Rússia	142	1.473	676	872	0,46	6.122
Brasil	**189**	**1.476**	**224**	**389**	**0,15**	**2.060**
Mundo	**6.536**	**57.564**	**11.740**	**17.377**	**0,20**	**2.659**

Notas: (1) PIB expresso segundo conceito de "paridade de poder de compra".
(2) OIE: Oferta Interna de Energia

NOTA TÉCNICA DEA 14/10 Avaliação da Eficiência energética na indústria e nas residências (EPE,2010)

Uso final	Setor					TOTAL
	Residencial	Transporte	Industrial	Energético	Outros[1]	
Força motriz	22,6	4.817,0	591,6	641,3	289,2	**6.361,7**
Calor de processo	49,2	0,0	1.962,6	1.347,7	87,4	**3.446,9**
Aquec. direto	1.819,2	0,0	3.085,7	50,6	177,6	**5.133,2**
Refrigeração	357,3	0,0	111,5	0,0	194,5	**663,3**
Iluminação	894,3	0,0	76,6	36,8	567,7	**1.575,4**
Eletroquímica	0,0	0,0	150,5	0,0	0,0	**150,5**
TOTAL	**3.142,6**	**4.817,0**	**5.978,6**	**2.076,4**	**1.316,4**	**17.330,9**

[1] *Inclui os setores comercial, público e agropecuário*

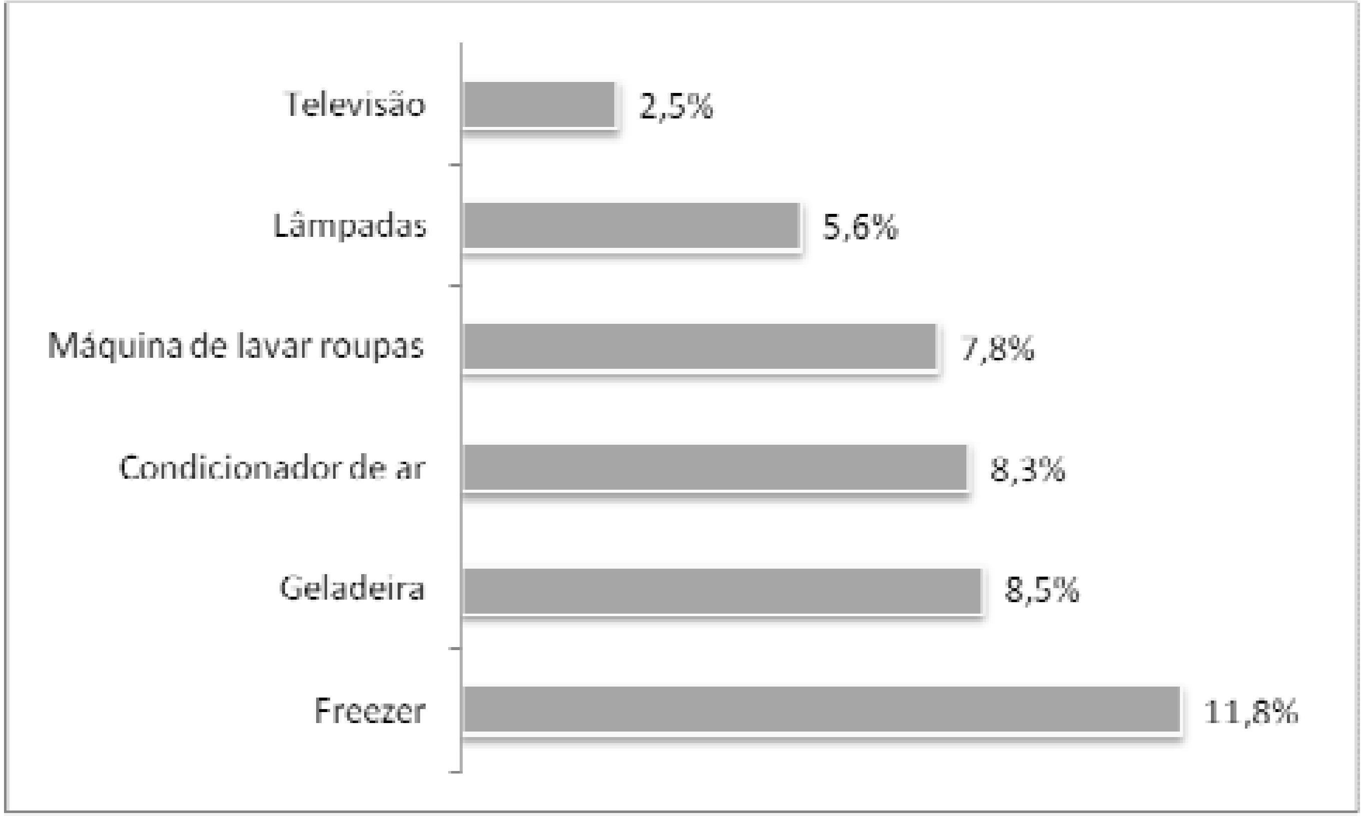
NOTA TÉCNICA DEA 14/10 Avaliação da Eficiência energética na indústria e nas residências (EPE,2010)

Uso da energia	Potencial (por ano)		Subsetores com maior potencial de conservação
	10^3 tep	GWh	
Força motriz	2.032,4	23.640	Siderurgia Extrativa mineral Alimentos e bebidas
Refrigeração	46,6	540	Alimentos e bebidas Químico Têxtil
Fornos elétricos	370,9	4.310	Siderurgia Minerais não ferrosos Ferroligas
Eletrólise	191,4	2.230	Metais não ferrosos Química Papel e celulose
Iluminação	60,2	700	Alimentos e bebidas Têxtil Extrativa mineral Papel e celulose
Outros usos	2,4	30	Extrativa mineral
TOTAL	**2.703,9**	**31.450**	

Fonte: CNI (2009)

NOTA TÉCNICA DEA 14/10 Avaliação da Eficiência energética na indústria e nas residências (EPE,2010)

"O potencial de conservação de energia elétrica na indústria avaliado pela CNI equivale a uma usina hidrelétrica com 6.500 MW de potência instalada. Isto é equivalente a todo o consumo de energia elétrica dos grandes consumidores industriais da rede interligada do subsistema Sudeste/Centro-Oeste previsto para o ano de 2009"



NOTA TÉCNICA DEA 14/10 Avaliação da Eficiência energética na indústria e nas residências (EPE,2010)

Eficiência Energética
Residências

05 de maio de 2015

Equipamento	Aumento do consumo em GWh devido Aumento posse equipto. (A)	Aumento potência equipto. (B)	Conservação (C)	Aumento do consumo A + B - C
Ar condicionado	2.971		735	2.236
Geladeira	6.100		2.370	3.730
Freezer	0		725	- 725
Lâmpadas	4.661		1.303	3.358
Máquina de lavar roupas	1.105		317	787
Televisão	7.581		535	7.046
Subtotal	**22.418**		**5.985**	**16.432**
Chuveiro elétrico	6.724	1.916		8.640
Outros usos	33.177			33.177
TOTAL	**62.319**	**1.916**	**5.985**	**58.249**

"A energia elétrica conservada equivale à geração de uma usina hidrelétrica com 1.200 MW de capacidade instalada, comparável à potência da usina de Machadinho, em operação no rio Pelotas, Santa Catarina, ou da usina Emborcação, no rio Paranaíba, Minas Gerais".

NOTA TÉCNICA DEA 14/10 Avaliação da Eficiência energética na indústria e nas residências (EPE,2010)

- A porcentagem de renováveis na demanda final fica estável no período 2014-2023 (cerca de 40% do total) – BUSINESS –AS -USUAL

- Na geração elétrica, há uma queda da participação das hidroelétricas, mas que será compensada pela entrada de outras fontes renováveis

	Participação Relativa (%)										
RENOVÁVEIS	**82,9%**	**83,2%**	**83,9%**	**84,6%**	**85,4%**	**85,5%**	**85,5%**	**85,1%**	**84,8%**	**84,5%**	**83,8%**
HIDRO	68,9%	66,9%	65,8%	66,1%	65,3%	63,7%	62,8%	61,7%	61,1%	60,5%	59,7%
OUTRAS	13,9%	16,4%	18,0%	18,5%	20,1%	21,7%	22,7%	23,4%	23,7%	24,0%	24,1%
NÃO RENOVÁVEIS	**17,1%**	**16,8%**	**16,1%**	**15,4%**	**14,6%**	**14,5%**	**14,5%**	**14,9%**	**15,2%**	**15,5%**	**16,2%**
URÂNIO	1,6%	1,5%	1,4%	1,3%	1,3%	2,0%	2,0%	1,9%	1,9%	1,8%	1,7%
OUTRAS	15,6%	15,3%	14,7%	14,1%	13,4%	12,5%	12,5%	13,0%	13,4%	13,7%	14,5%
TOTAL	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**

Notas: (a) Os valores da tabela indicam a potência instalada em dezembro de cada ano, considerando a motorização das UHE.
(b) Estimativa de importação da UHE Itaipu não consumida pelo sistema elétrico paraguaio.
(c) Não considera a autoprodução, que, para os estudos energéticos, é representada como abatimento de carga. A evolução da participação da autoprodução de energia é descrita no Capítulo II.
(d) Valores de capacidade instalada em dezembro de 2013, incluindo as usinas já em operação comercial nos sistemas isolados, com previsão de interligação dentro do horizonte do estudo.
Fonte: EPE.

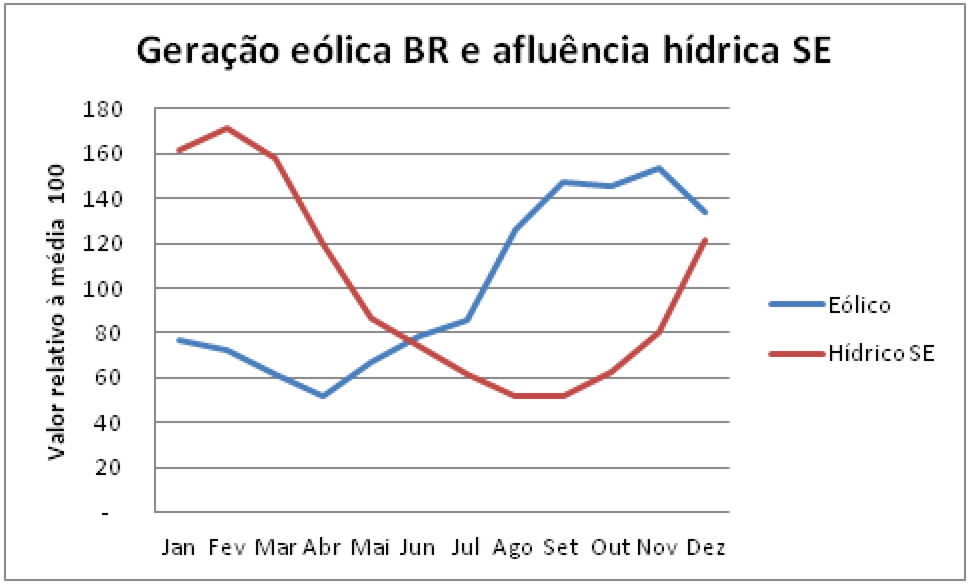
PDE 2023 (EPE,2014)

PRINCIPAIS POTENCIAIS

- Geração distribuída fotovoltaica
  - Preço da eletricidade no consumo torna a fonte mais competitiva
- Eólica
  - Crescimento de 30% na produção e 16,5% na capacidade instalada em um ano (2012-2013)
- Biomassa
  - Usina de cana-de-açúcar têm grande potencial de aumento de eficiência na geração com uso de caldeiras de alta pressão

SOBRE INTERMITÊNCIA

- Reservatórios de hidroelétrica podem fazer o papel de baterias gigantes
- Sazonalidade das fontes são intercaladas
- CSP tem avançado no armazenamento térmico e hibridização com GN



Contatos

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