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This study has been produced on behalf of the **Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH** through its regional **project RE-ACTIVATE ("Employment Promotion through Renewable Energy and Energy Efficiency in the Middle East and North Africa**") in the scope of the SE4JOBS project ("Sustainable Energy for Jobs").

RE-ACTIVATE is working on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ) to help develop markets for employment-intensive renewable energy (RE) and energy efficiency (EE) applications in the countries of the MENA region.

SE4JOBS was launched as a collaborative effort and working platform of several GIZ projects dealing with different aspects of sustainable energy and socio-economic development promotion. RE-ACTIVATE serves as a coordinator and "secretariat" of the project.

Several GIZ sector project have been actively involved in SE4JOBS, specifically those working on "Sustainable Economic Development", "Innovative Approaches of Private Sector Development", and "Employment Promotion in Development Cooperation".

The project has been supported by a consortium of adelphi, a Berlin-based think tank and public policy consultancy for climate, environment and development issues, and the Centre for Environmental Policy Research (FFU) of the Free University of Berlin (FU).

SE4JOBS aims to identify and assess available worldwide experience and good practices in developing and emerging countries on how to strengthen the link between socio-economic development and sustainable energy. The focus is on employment and value creation.

The goal is to support international know-how exchange and policy dialogue by offering a set of specific, application-oriented instruments and recommendations that help policy makers and planners to develop better approaches and institutional settings for an optimal valorisation of the socio-economic benefits of sustainable energy applications while adapting them to the specific needs and conditions of their countries and organisations.

The following key deliverables have been produced in the framework of SE4JOBS:

- A set of good-practice case studies assessing in greater analytical depth and according to a single methodology the specific approaches and trajectories of six selected global front-running countries in Asia, Africa, and Latin America.
- The creation of an application-oriented toolbox based on the results of these studies as well as on available global experiences in this regard, including from MENA.
- A set of capacity building and training modules allowing for the targeted dissemination of the findings and the conclusive strengthening of local stakeholders.

A series of national and international outreach activities and expert workshops was organised by RE-ACTIVATE throughout 2015. Participants mainly included government representatives, technical experts, and practitioners from international organisations who provided insights and inputs that proved in fact instrumental for the success of the project.

These meetings allowed for the first-hand presentation of intermediary results, the collection and integration of comments and suggestions and the consequential refining of the SE4JOBS products. They also permitted an interactive exchange with local stakeholders, which moreover came at an auspicious moment as many of the involved countries are currently in the process of scaling up their RE/EE deployment, often in conjunction with ambitious industrial development and job creation schemes. The outcomes of these exchanges could therefore be used to support and enrich discussions and decisions on the ground.

The authors of the study are Klaus Jacobs and Holger Baer from the FFU. The text was reviewed by Steffen Erdle from RE-ACTIVATE as well as by GIZ experts working in Brazil, notably Christoph Buedke, Juliane Dammann, Johannes Kissel and Torsten Schwab. Further input came from the involved sector projects. Proofreading was done by Malte Forstat.

All contributions received in this context are gracefully acknowledged.

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Abbreviations

ANEEL	National Agency for Electric Energy
BAU	Business as usual
BNDES	Brazilian National Development Bank
BRL	Brazilian Real
CONPET	National Programme for the Rational Use of Natural Gas and Oil Products
CCEE	Chamber for the Commercialisation of Electrical Energy
CGIEE	Steering Committee of Energy Efficiency Indicators
CNPE	National Council on Energy Policy
CMSE	Monitoring Committee of the Electricity Sector
EE	Energy Efficiency
EPE	Energy Research Company
INMETRO	National Institute of Metrology, Standardisation and Industrial Quality
MME	Ministry of Mines and Energy
MVA	Mega Volt Ampere
PBE	Brazilian Labelling Programme
PEE	Energy Efficiency Programme
PROINFA	Programme of Incentives for Alternative Electricity Sources
PPP	Power Purchasing Parity
PROCEL	National Programme for Electricity Conservation
PNEf	National Energy Efficiency Plan
PV	Photovoltaic
RE	Renewable Energy
SWH	Solar thermal water heaters
Toe	Tons of oil equivalent
TYP	Ten-Year Energy Expansion Plan

1 The Brazilian market for renewable energies and energy efficiency

1.1 Focus of the case study

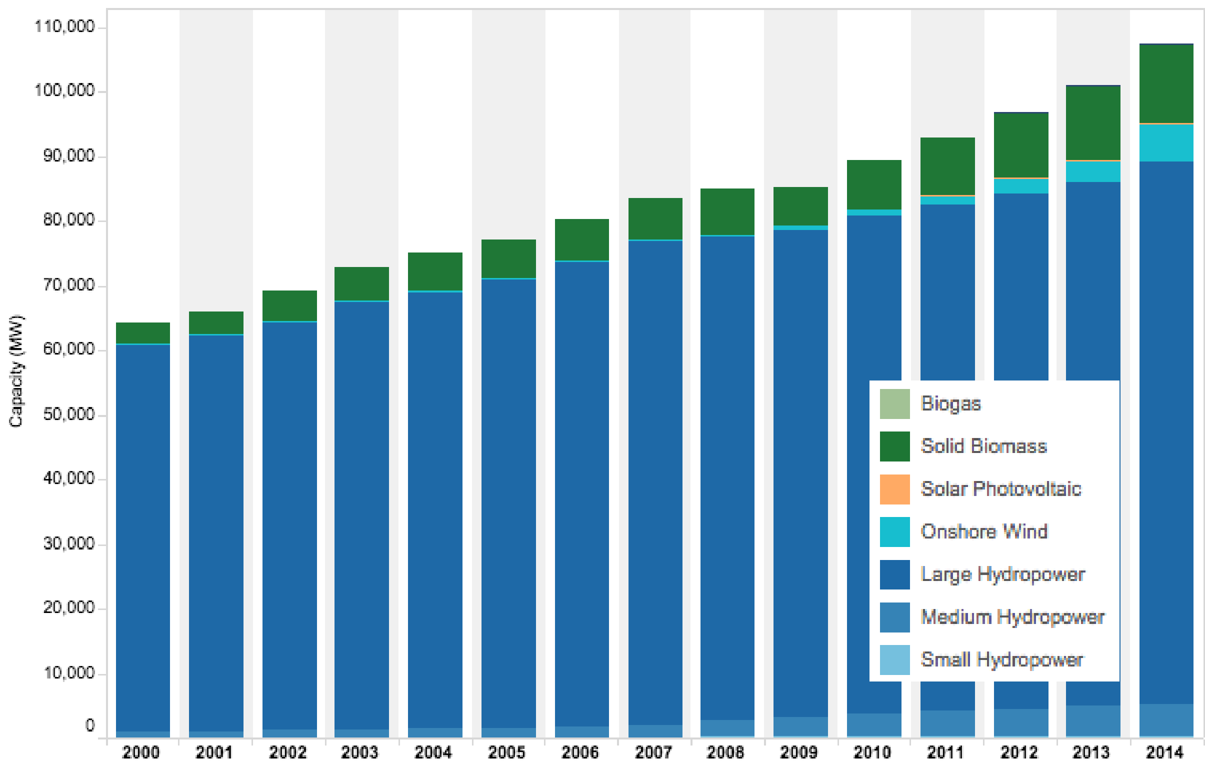
Due to its huge hydroelectric power capacities, Brazil is already as of now one of the largest producers of renewable electricity worldwide. Similarly, given its favourable natural conditions, the country is a major producer of biomass and biofuels. These types of RE will not be in the focus of the study, as they depend on natural conditions that are (abundantly) present in the case of Brazil, but not in the large majority of partner countries in which GIZ works and which form the reference group of the SE4JOBS project. In the framework of this study, the focus will therefore lie on RE markets and employment from wind power and solar energy as well as energy efficiency.

1.2 Renewable energies in Brazil

1.2.1 Structure and key properties of renewable energies

Power generation from renewable energies in Brazil is dominated by large-scale hydropower and solid biomass. While the share of hydropower is declining, in 2014 it still accounted for over 83% (89 GW) of installed renewable power capacity, followed by biomass accounting for 11.5% (12 GW) and wind power with 5% (6 GW) (IRENA, 2015a). The figure below illustrates both the dominance of hydropower, but also the accelerating growth of non-hydro RE sources such as wind power capacity in Brazil.

Figure 1: Installed renewable power capacity in Brazil, 2000-2014, in MW



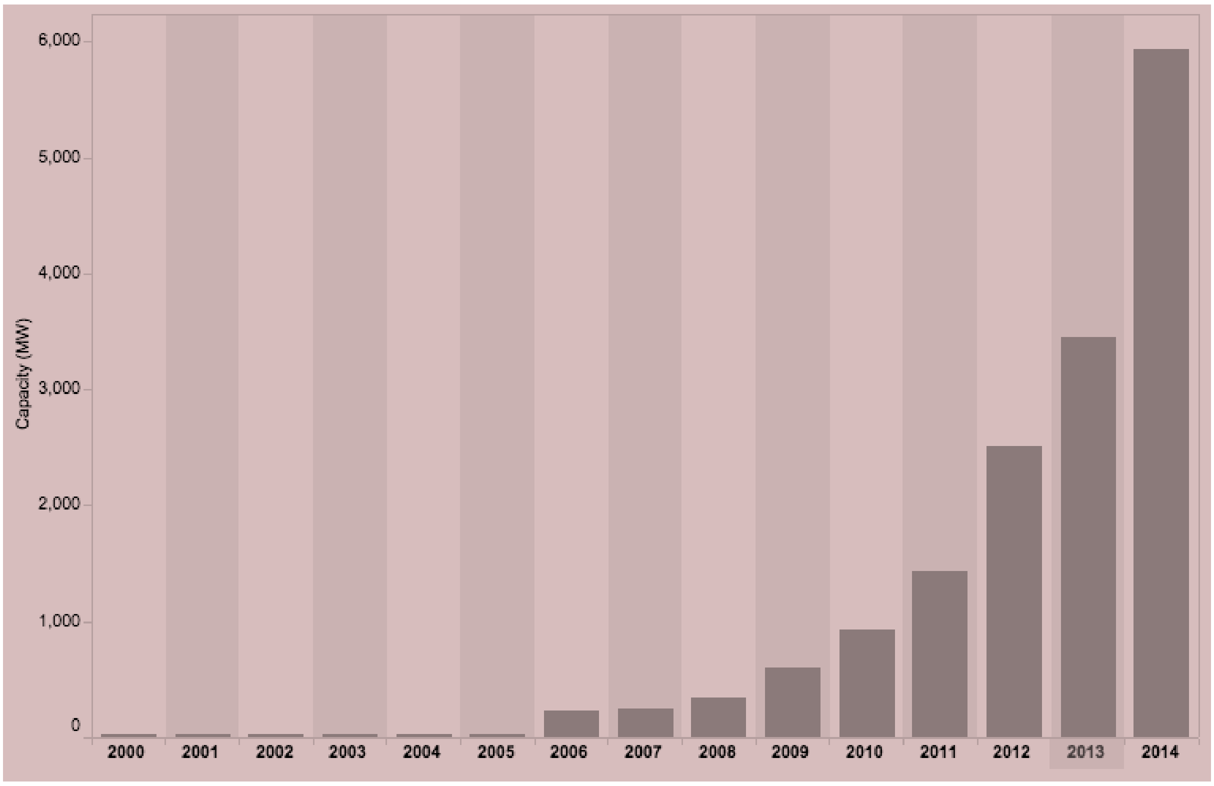
Source: (IRENA, 2015a)

1.2.1.1. Wind power

In 2013, wind power capacity grew by more than 1 GW to reach a total of about 3.5 GW. In 2014, wind power further accelerated its growth by adding 2.5 GW of capacity to reach close to 6 GW at the end of year. By global comparison, Brazil ranked 4th in wind power capacity added in that year (REN21, 2015, p. 71,). The success of wind power in capacity allocation auctions has created a long project pipeline. The projects that were already awarded and are awaiting completion are expected to reach over 15 GW by 2018, and thereby to more than quadruple the capacity installed in 2013 (Spatuzza, 2014a). Most of the wind farms under development are located along Brazil's coastlines and particularly in the two northern states of Ceara and in the state of Rio Grande do Norte. Observers point out that there have been problems connecting all of the newly available wind power capacity to the transmission grid because of the fast rate of growth (REN21, 2015, p. 72,).

While there had been installations thanks to the feed-in tariff scheme in the first phase of the Brazilian Programme of Incentives for Alternative Electricity Sources (PROINFA), the market for wind power installations really kicked off after 2009 with the first wind-power specific capacity auction and the subsequent price reductions, which boosted wind power's competitiveness compared to other means of electricity generation (IRENA & Global Wind Energy Council, 2012; Zubaryeva, Thiel, Barbone, & Mercier, 2012).

Figure 2: Installed wind power capacity in Brazil, 2000-2014, in MW



Source: (IRENA, 2015a)

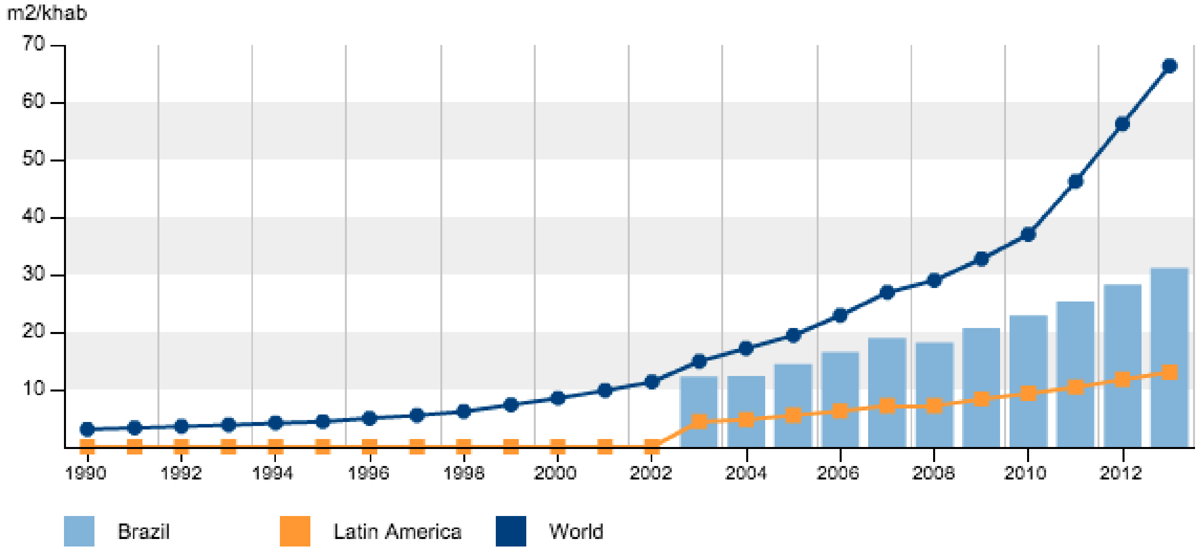
1.2.1.2. Solar PV

The development of a domestic solar PV market should benefit from favourable natural conditions, high electricity prices and recently adopted net metering policies, but it has “not yet delivered” (Roselund, 2013). A net metering policy which serves as an incentive for small-scale installations was introduced in 2012 (see section 4.4.1.3). Most of the solar PV installations are small-scale (below 5 KW in capacity) and covered by the net metering policy (Holdermann & Kissel, 2015, p. 46). Larger PV installations are subject to RE power auctions. Until 2014, solar PV projects were outcompeted by other RE sources, as the power generation costs for solar PV were still significantly higher than those for wind power. In 2014, the first solar-specific auctions were held (for solar PV installations of more than 5 MW capacity), with more on the way in 2015. The capacity offered by project developers was larger than the capacity aimed for by the government and at prices significantly below the price ceilings set for such auctions. This recent evidence shows that the prices for solar power are falling quickly, which is likely to result in sharp increases in PV generation capacity in the coming years (Willis, 2015). In the 2014 auction, 890 MW of PV capacity were contracted at an average bid price of US$87/MWh that will be connected to the grid over the next few years as these wind farms and the necessary grid connections are being built (Ernst and Young, 2015; Zubaryeva et al., 2012). Two-thirds of the projects and capacity installed were in the states of Bahia and Sao Paulo (Griebenow & Kissel, 2015).

1.2.1.3. Solar thermal water heaters

Brazil is the leading market for SWH in South America. By the end of 2012, the country had the fifth largest installed capacity (5.800 MW in total) and the fourth highest capacity increase globally. Still, the South American market accounts for only 2.7% of global total installed SWH capacity (largely due to the dominance of China in the SWH market). The Brazilian market is dominated by unglazed flat plate collectors, for which the country ranks by global comparison third in terms of installed capacity and tenth in terms of per capita use (Mauthner & Weiss, 2014).

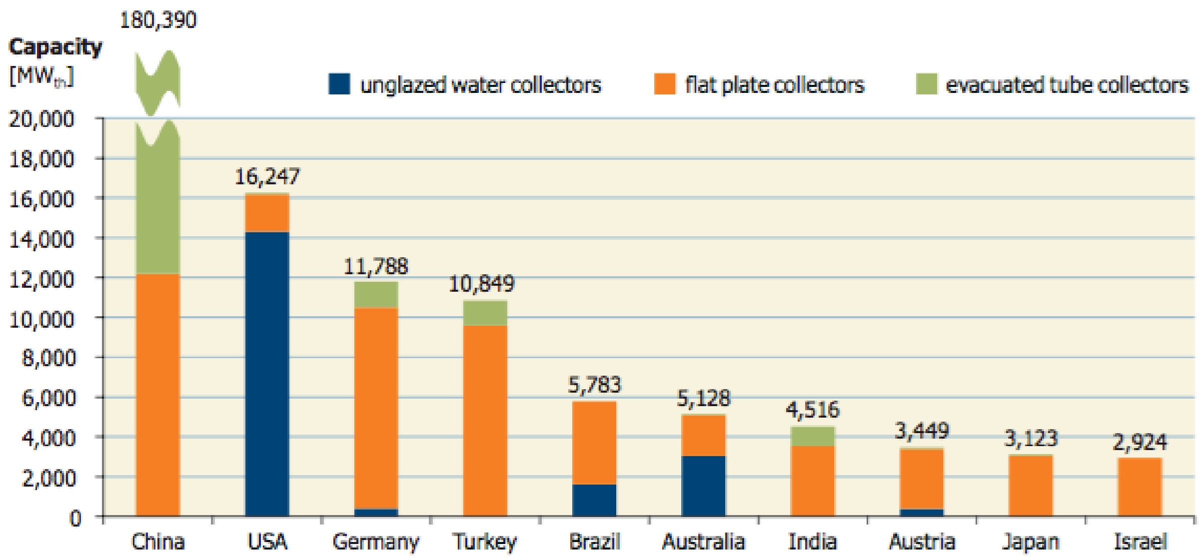
Figure 3: Solar water heaters per thousand inhabitants, in Brazil, Latin America and the World, 1990-2013



Source: (World Energy Council, 2015)

The demand for installations is high, as they are cost competitive and amortise their investment costs within two to three years (REN21, 2014, p. 19). The Brazilian market is the world's third largest for unglazed water collectors.

Figure 4: Top 10 global markets in terms of cumulated installed capacity of glazed and unglazed water collectors (2012)



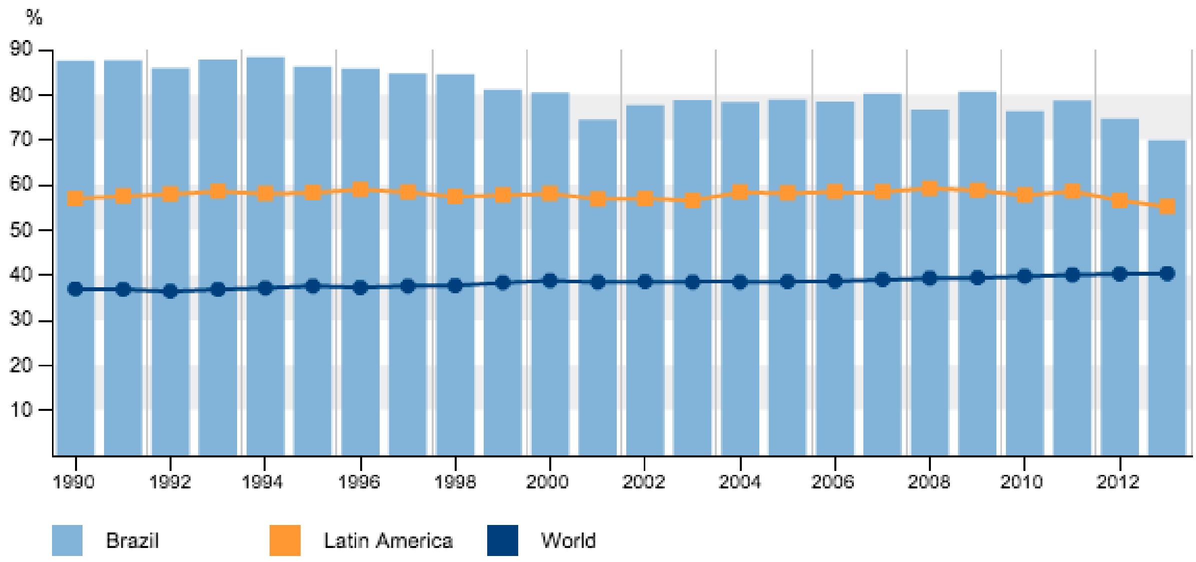
Source: (Mauthner & Weiss, 2014, p. 11)

1.3 Energy efficiency in Brazil

1.3.1 Efficiency of power generation

Energy efficiency in power generation in Brazil is very high by international comparison, as a result of the large share of hydroelectric power. Its decline can be attributed to the aging of power plants. Data on the efficiency of coal-fired power generation are not available and the efficiency of gas-fired plants is similar to Latin American and global averages.

Figure 5: Efficiency of power generation in Brazil, Latin America and the World

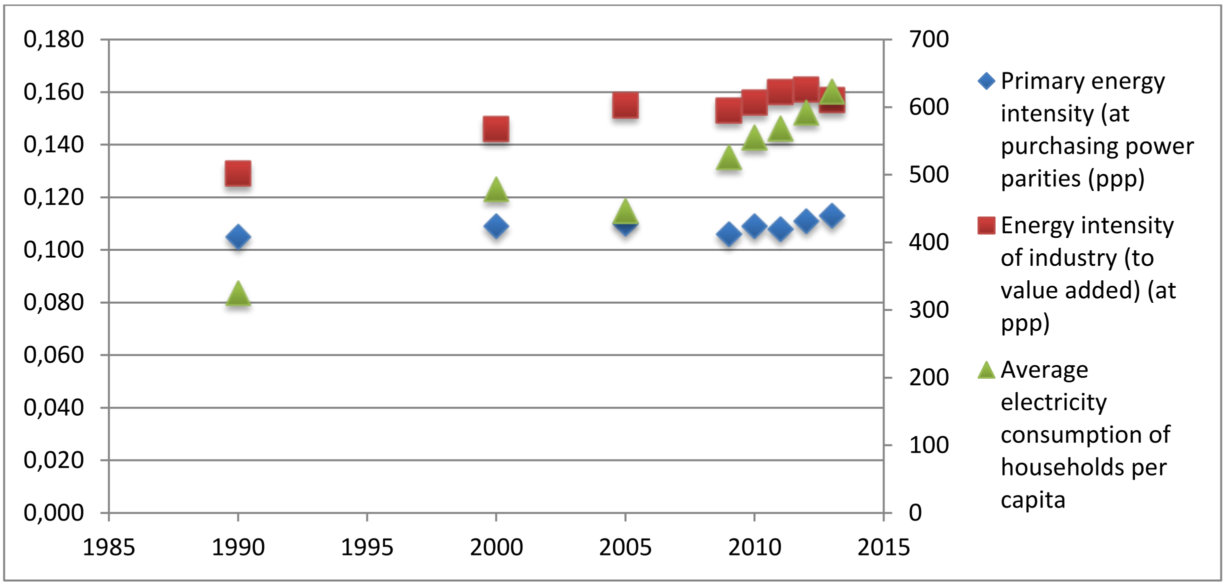


Source: (World Energy Council, 2015)

1.3.2 Efficiency in energy usage

Data on energy efficiency in Brazil shows a slightly different picture compared to other BRICS countries. The ratio of primary energy intensity and industrial energy intensity to value added has not fallen over the last decades, but remained fairly stable – with some increases for industrial energy intensity. The sector with the largest growth in recent years, and which is furthermore projected to continue growing above average in the future, is the electricity consumption by private households.

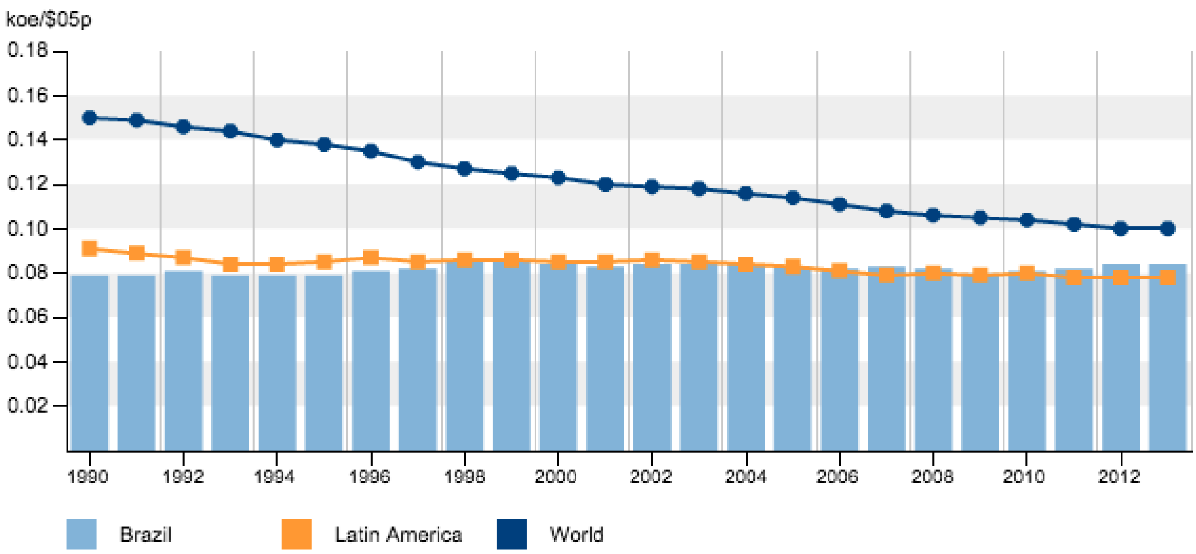
Figure 6: Primary energy intensity, industrial energy intensity (primary axis) and average electricity consumption per capita (secondary axis) in Brazil, 1990-2013



Source: (World Energy Council, 2015)

However, the growth in energy intensity of industry and in household power consumption must be interpreted from a wider international perspective. The low level of energy intensity of Brazil – at nearly half the world average in 1990 – suggests that the recent developments should be interpreted as a result of Brazil and the world average converging – rather than as a significant increase in energy intensity of the Brazilian economy or growth in the electricity consumption (see figure below).

Figure 7: Final energy intensity in Brazil, Latin America and the World, 1990-2013



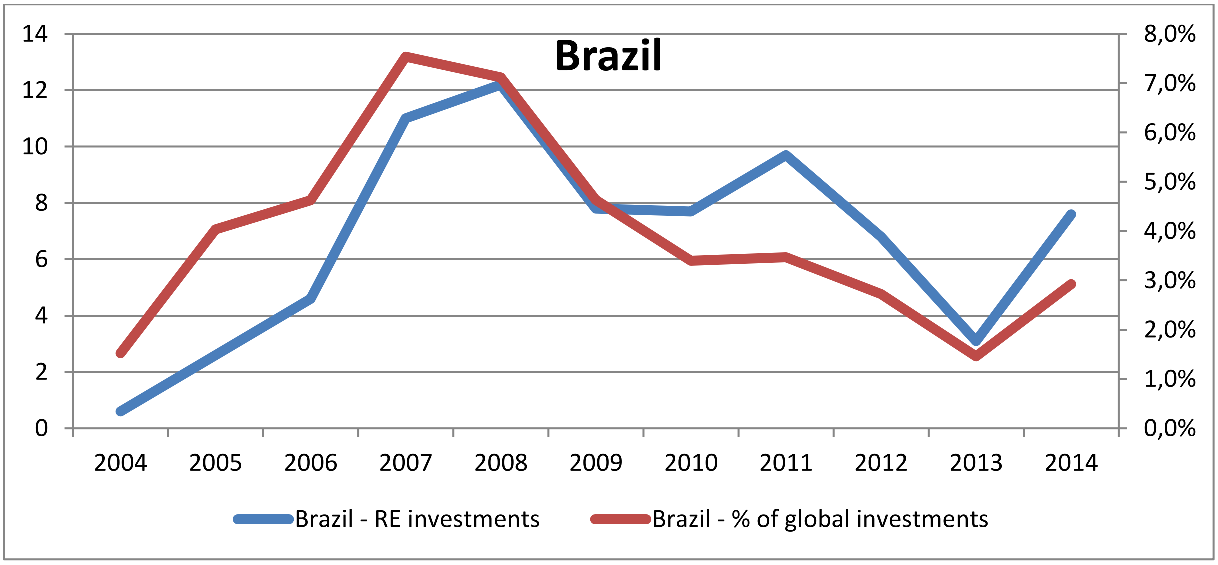
Source: (World Energy Council, 2015)

1.4 Domestic value added and employment

1.4.1 Investments in renewable energies

Investments in RE generation capacity show Brazil following the globally declining trend in recent years. RE investments have more than doubled between 2013 and 2014 after a short slump from US$3.1 billion to US$7.6 billion in 2014, accounting for nearly 3% of all global RE investments in that year. The downward trend in recent years has been due to reduced investments in biofuels – a trend that continued in 2014, a year in which biofuels accounted for 'only' US$700 million. The recent increase in investments is almost entirely (93%) related to new RE capacity commissioned under the country's auction scheme (FS-UNEP Collaborating Centre, 2015, p. 20). Of the US$7.6 billion invested in RE in 2014, US$6.2 billion (84%) went into the development of wind farms that were procured in RE auctions, a trend that is likely to continue this year, as an additional 2.7 GW of wind power were commissioned in 2014 alone (FS-UNEP Collaborating Centre, 2015, p. 26).

Figure 8: Investments in RE in Brazil, 2004-2014, in US$ billion and in % of global investments



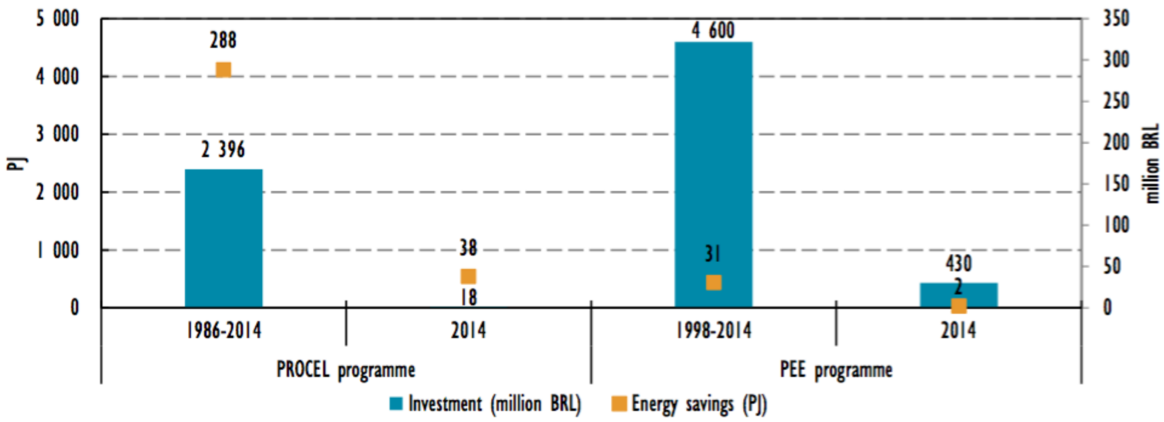
Source: Own figure based on (FS-UNEP Collaborating Centre, 2015)

The strong deployment of renewables in Brazil is directly correlated to the fact that the country is considered an attractive market for RE investments by global comparison – ranking eighth in general RE attractiveness, fifth for onshore wind power, eighth for solar PV and CSP, second for hydropower and third for bioenergy (Ernst and Young, 2015, p. 20).

1.4.2 Investments in energy efficiency

Investments in energy efficiency are much harder to measure. There are estimates that between 2012 and 2014, energy distributors and the country's publically owned utility Eletrobras invested nearly two billion Real (BRL1.9 billion / US$530 million) in energy efficiency measures (IEA, 2015, p. 141). The government's national energy conservation programme PROCEL and its Energy Efficiency Programme (PEE) as well as financial instruments provided by BNDES[1] play a key role in facilitating private investments in energy efficiency.

Figure 9: Investments (in BRL million) and energy savings (in PJ) achieved by the PROCEL and PEE programmes over their durations and in 2014



Source: (IEA, 2015, p. 146)

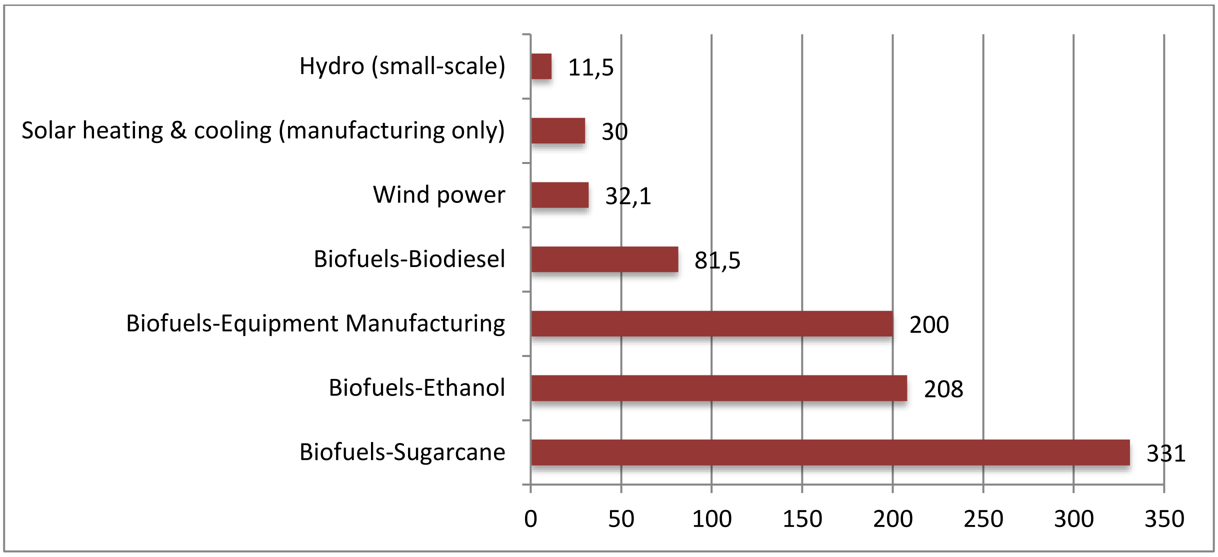
It should be noted that as a result of the economic crisis in Brazil, government funding for PROCEL and PEE has been slashed – by more than half for PEE (from BRL712 million in 2011 to BRL342 million in 2014) and by over 80% for PROCEL (from BRL114 million in 2011 to BRL18 million in 2014) (IEA, 2015, p. 144).

1.4.3 Employment in renewable energies

Data collected by IRENA on RE employment in Brazil shows that most employment is – by far – in different types of bioenergy production. However, the data also shows a very significant 32,100 jobs in wind power and a similar number for employment in SWH.

[1] For more information on BNDES' EE programmes, see (IEA, 2015, p. 147).

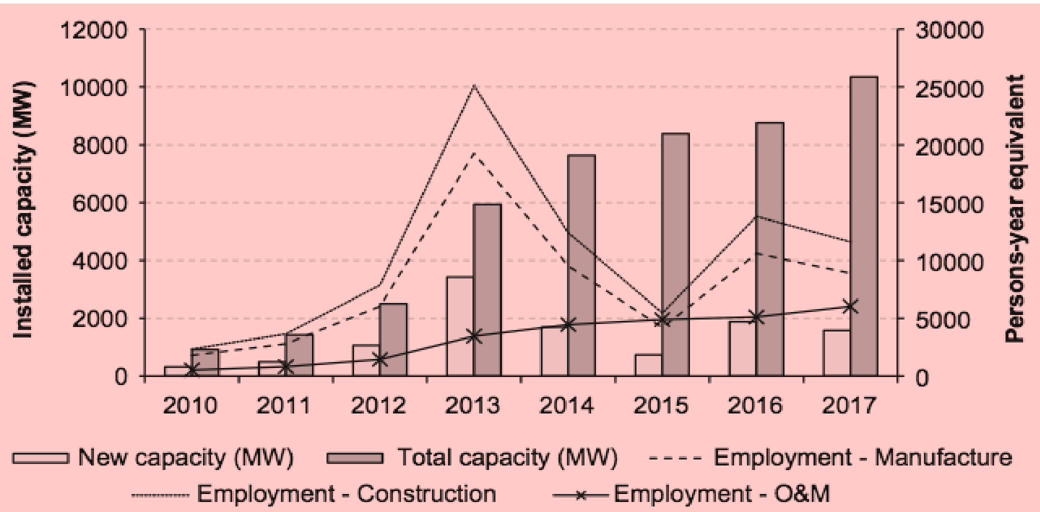
Figure 10: Employment in renewable energy sectors in Brazil, in thousand jobs (2014)



Source: (IRENA, 2015a)

A study conducted on employment in Brazilian wind power is in line with the data and illustrates the distribution of employment effects between manufacturing, construction and the operation & maintenance of wind power. For the period between 2010 and 2017, the study calculates employment of 170,000 person-years: 82,000 in construction, 63,000 in manufacturing and 26,000 in operation and maintenance (Simas & Pacca, 2014). The data also shows that while employment in construction and manufacturing fluctuates with investments, employment in operation and maintenance is growing in line with the installed capacity.

Figure 11: Wind power capacity and estimated employment in Brazil



Source: (Simas & Pacca, 2014, p. 88)

There is no data available on employment induced by energy efficiency investments.

1.4.4 Manufacturing capacities in renewable energies

The Brazilian government has used conditional financing and trade policies to foster the development of domestic RE value creation and employment. As a result of the attractiveness of the market and of such policies, a large number of international RE companies, particularly in the wind industry, have moved/opened manufacturing capacities to/in Brazil in order to be considered 'domestic'. Among them are the Danish Vestas, German Enercon and Siemens, American GE, Indian Suzlon or Argentine Impsa (IRENA, 2012, p. 62).

Solar PV manufacturing in Brazil is still in its infancy, but manufacturing capacities are being built as a reaction to the demand created by the solar PV auctions (Kenning, 2015b). In the solar water heating sector, 34 companies are currently manufacturing systems in Brazil and are approved for sale by the country's top certification organisation INMETRO (National Institute of Metrology, Standardisation and Industrial Quality) (State Government of Rio de Janeiro, 2013).

2 Brazil's framework conditions

2.1 Natural conditions

Brazil has an enormous potential for the use of renewable energies. Wind power is estimated to have a potential of 350 GW and solar energy of 114 GW (IRENA, 2012, p. 62) (see also section 8.1)[2]. The potential of small hydropower is assumed to be a further 17.5 GW (Ministry of Mines and Energy, 2013a). In comparison, the total electricity generation capacity installed in Brazil in 2012 was about 122 GW – 89 GW of which are accounted for by large hydropower (US Energy Information Administration, 2015). Therefore, the potentials indicated for electricity generation, particularly from wind and solar PV sources, vastly surpass the current capacity required to meet Brazil's electricity demand, and suggest that only a fraction of these potentials has been used so far.

Beyond the potential capacity for power generation itself, wind power development in Brazil is also benefiting from the fact that it is relatively compatible with the country's large supply of hydroelectricity: dry seasons that reduce hydropower generation are, on average, windier than humid seasons (Global Wind Energy Council, 2014, p. 27).

2.2 Demographic information

Similar to other BRICS countries, Brazil's growing population and rising incomes are drivers of the strong growth in electricity demand. While the population growth rate has already slowed significantly from 1.4% (2000) to 0.9% (2013), Brazil's population very recently crossed the 200 million threshold and is likely to reach 240 million by 2030 (Ministry of Mines and Energy, 2007; World Bank, 2015). Along with that trend, per capita incomes are likely to increase. They have already increased by a third between 2000 (US$3,750) and 2013 (US$4,984), swelling the ranks of the consumption-prone middle classes. Similarly, the proportion of people living with less than US$2 (purchasing power parity, PPP) per day has starkly decreased from 20% (2001) to 7% (2013) (World Bank, 2015). All of these factors are bound to further stimulate the country's energy consumption in the future.

2.3 Energy system

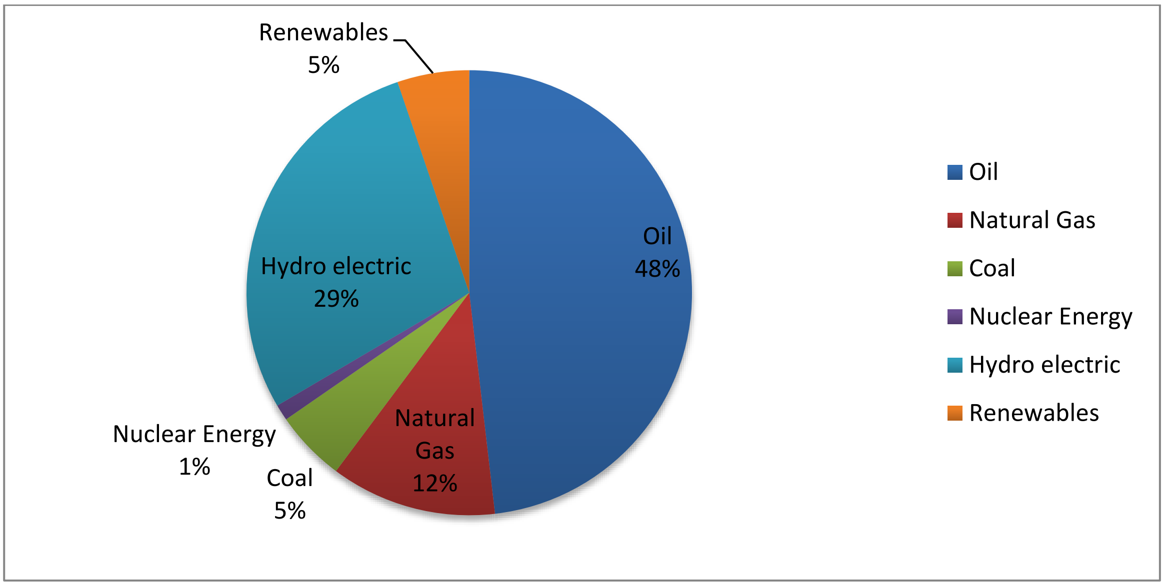
2.3.1 Structure and key properties of the energy and electricity system

The Brazilian energy consumption today (296 million toe in 2014) is met by a rather diverse set of energy sources. Oil accounts for nearly half of the energy consumed (142 million toe in 2014). The country also holds significant oil reserves – the second largest in Latin America. The second largest source of energy – and largest source of electricity – is the country's hydropower (84 million toe in 2014), followed by natural gas (36 million toe in 2014) and coal and renewables at a similar level (15 million toe in 2014).

[2] The IRENA study doesn't qualify the term 'potential' with regard to the question if this capacity is technical or already an economic potential.

The large share of hydropower and the relatively strong position of biofuels in Brazil are the result of energy and industrial policy measures to reduce the dependence on oil started as a reaction to the escalating oil prices in the late 1970s (IRENA, 2015b, p. 28,).

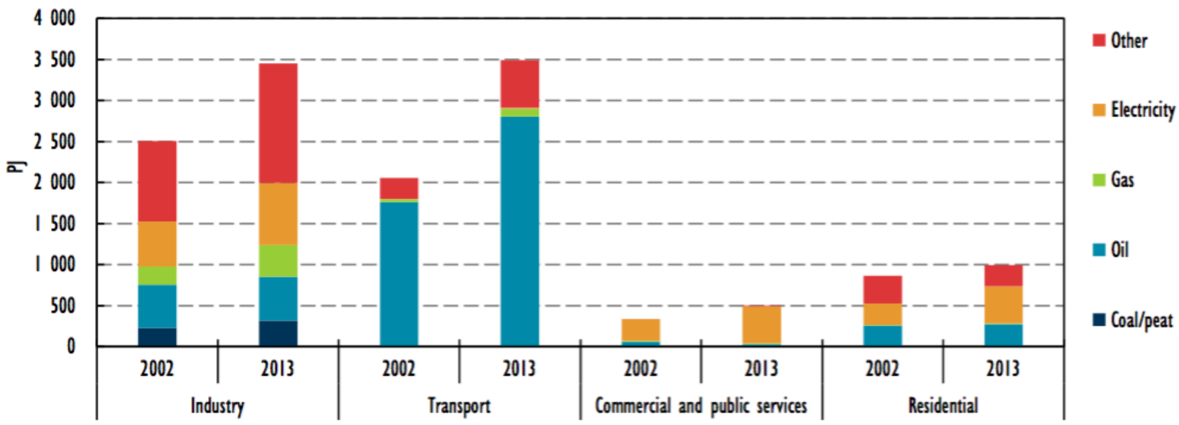
Figure 12: Final energy consumption by fuel, 2014, in million toe



Source: (BP, 2015)

In 2013, the two largest sectors in terms of energy consumption were transport (37%) and industry (36%), followed by the residential sector (10%), services (5%), agriculture (5%) and other non-specified sources of consumption (7%) (IEA, 2015, p. 142). When comparing the development over time, it is noteworthy that growth in energy consumption between 2002 and 2013 has been more pronounced in industry and transport than in the other sectors.

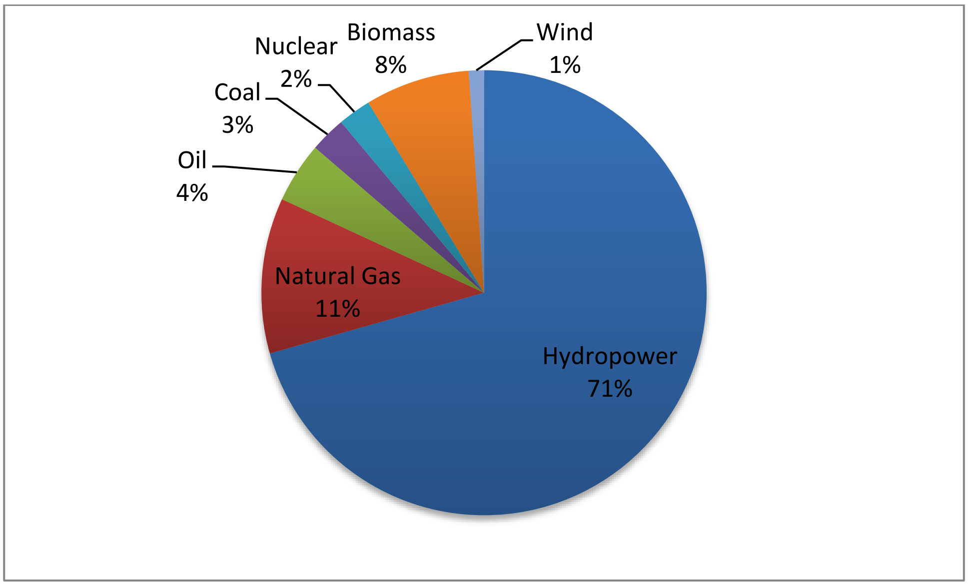
Figure 13: Total final energy consumption in Brazil, by sector and source, in 2002 and 2013



Source: (IEA, 2015, p. 143)

Power generation in Brazil is dominated by large-scale hydropower – accounting for over 70% of electricity production in 2013, or 430 TWh out of 610 TWh. Fossil energy sources play a minor role in power generation in Brazil, accounting for less than 20%.

Figure 14: Power generation in Brazil in 2013, by source

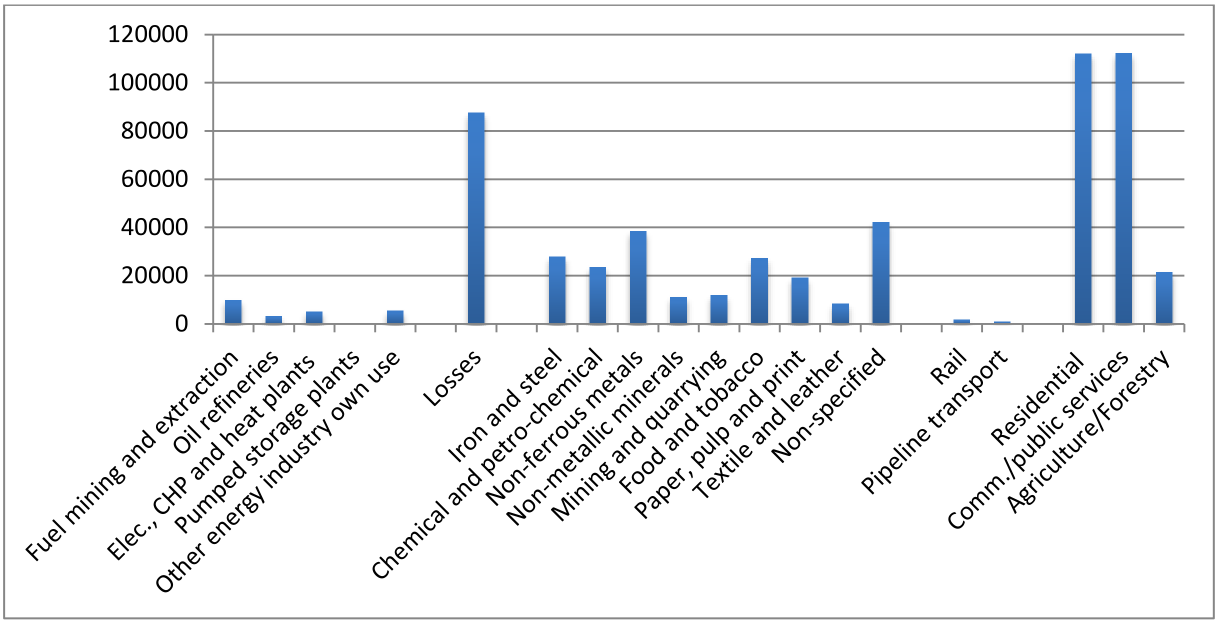


Source: (Ministry of Mines and Energy, 2014)

The publically owned Eletrobras is the largest generator and transmitter of electricity in Brazil. However, since the beginning of the liberalisation of the energy and electricity markets in the 1990s, prices have been deregulated, and allowing for private and foreign ownership of power companies has led to a diversification in power generation. Particularly in the wind sector, foreign companies and joint ventures with foreign companies make up a major share.

The largest source of electricity consumption in Brazil are the various sectors of industry – accounting for a total of 37% in 2013, followed by commercial/public services and residential consumption, both accounting for around 20%. The fourth largest source of 'consumption' are losses in the generation, transmission and distribution of electricity, accounting for more than 15% of electricity generation, particularly due to the long distances over which electricity is transmitted in Brazil. The value is similar to the average of Latin American countries, but above the world average. The fifth largest source is the own consumption of the energy sector at a low (compared to other countries) 4% – due to the high share of hydropower plants in the Brazilian power generation structure.

Figure 15: Electricity consumption in Brazil in 2011, in GWh, by subsector



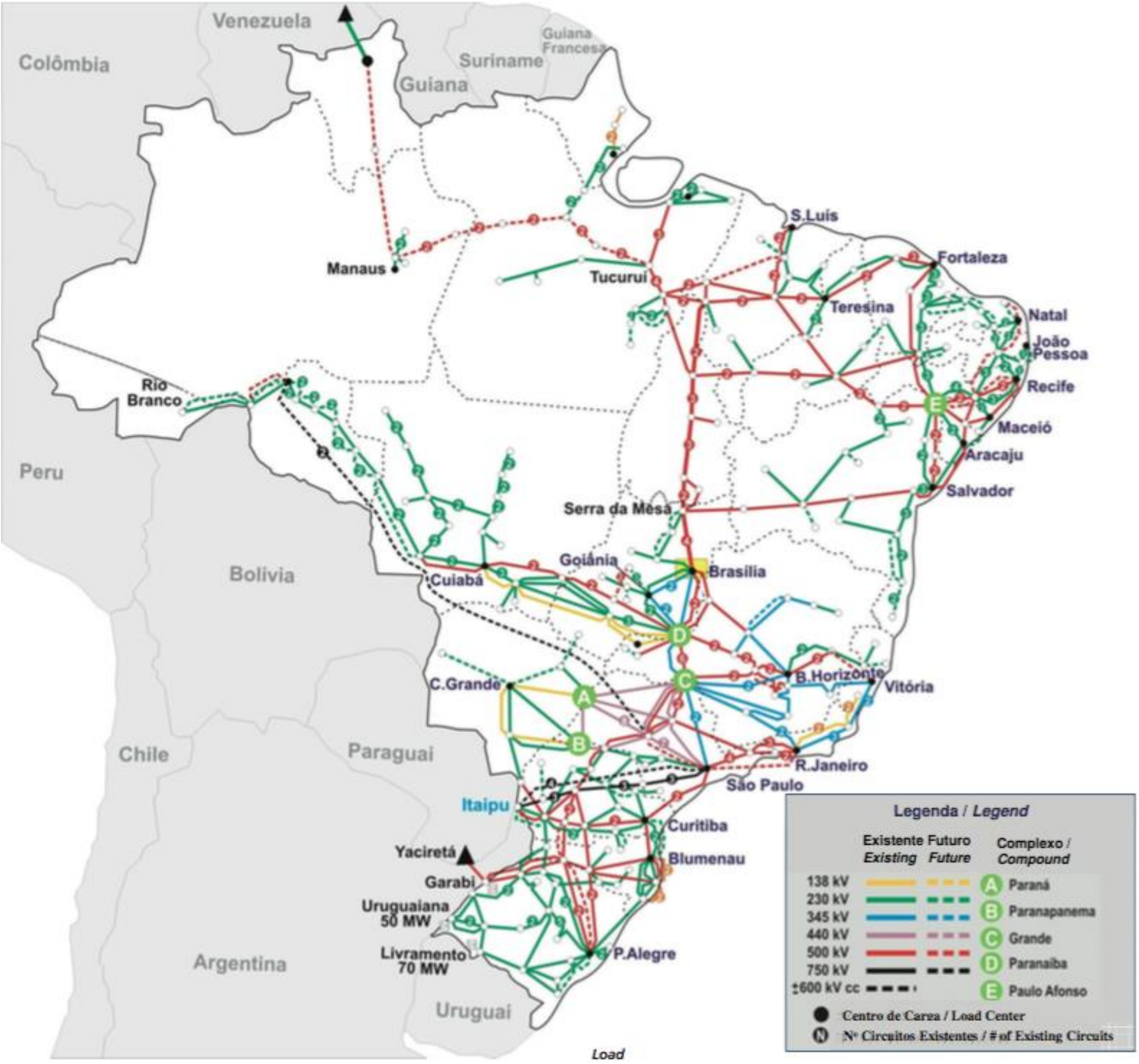
Source: (IEA, 2014)

2.3.2 Electricity infrastructure

There is a national power grid (*interconnected national system*) – in addition to non-connected local power grids serving indigenous communities in the Amazon basin – that provides power to more than 99.5% of the population (in 2012). The grid capacity needs to expand fast in order to keep up with the expansion of power generation capacity and achieve the goal of electrifying rural areas not yet connected to the grid. The National Agency for Electric Energy (ANEEL) and the energy planning agency of the Ministry for Mines and Energy (EPE) are monitoring grid stability and planning its expansion. The map below charts the expansions planned until 2022 that are expected to cost US$30 billion and are aimed at increasing grid capacity by 50% in terms of kilometres of transmission lines (from 104,000 in 2012 to 156,000 in 2022) and at increasing transmission capacity (in low, medium and high voltage lines) by more than a third (from 250,000 MVA to 353,000 MVA) (Ministry of Mines and Energy, 2013b, p. 37).

In order to attract needed investments in the electricity grid, the government is also holding auctions to award contracts to build electricity infrastructure – particularly in the south of the country – to connect large wind farms to the grid (Blackwell, 2014). The transmission line auctions are coordinated by EPE and conducted by state governments. They have been attracting both Brazilian and foreign companies. In July 2015, the Chinese State Grid Corporation won the bid for Brazil's longest transmission line of over 2,500 km, which is expected to cost more than US$2.2 billion (Reuters, 2015).

Figure 16: Existing and planned lines for power transmission and distribution



Source: (Ministry of Mines and Energy, 2013b, p. 34)

2.3.3 Electricity prices

Brazil features a dual system that combines a free and a regulated market for electricity. It is a free market for consumers of large amounts of electricity. The regulated market covers all regular consumers whose electricity prices are regulated by ANEEL (Gallo & Lopes Lobianco, 2015). The average national electricity price for households in Brazil was US$0.17 per KWh in 2011 (Clean Technica, 2013).

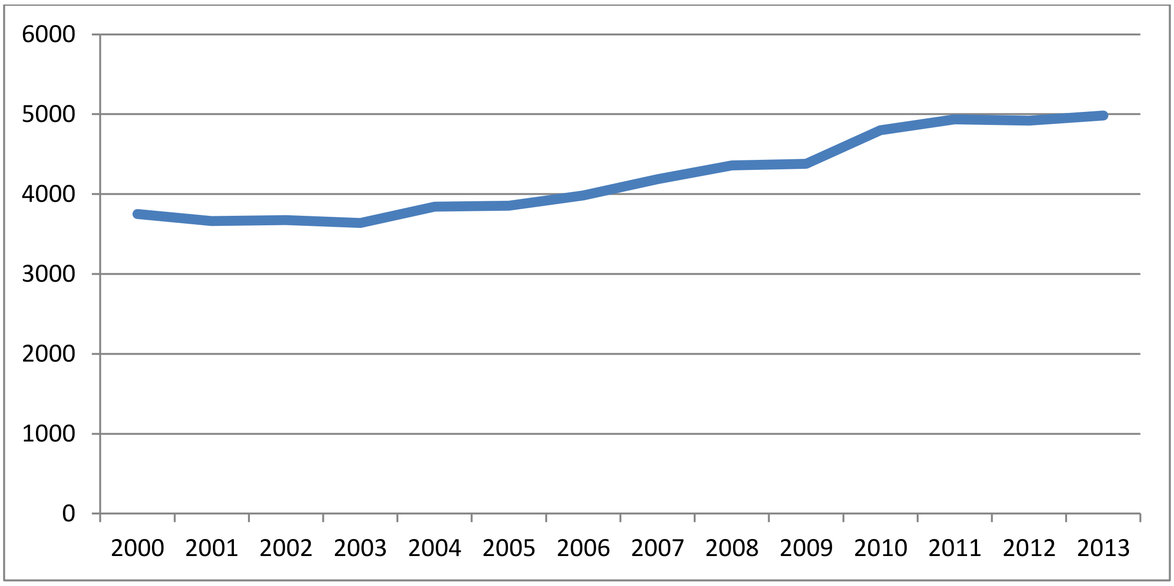
Electricity generation prices are increasing due to high demand and due to the declining share of (cheap) hydropower. The share of hydropower in electricity output has dropped in recent years due to dry summers. As a consequence, fossil fuel power plants (gas and diesel) that traditionally only covered peak demand have increasingly provided base load power as well – thus increasing the cost of power generation. This additional cost has not been passed on to consumer, but had been financed through credit and financing for energy utilities. As of 2015, a change in policy aims to have electricity tariffs cover the actual costs of power generation, which is expected to result in an increase in electricity tariffs between 25% and 40% (cp. Holdermann & Kissel, 2015, p. 46). Given this development, RE power is likely to become competitive faster and the RE capacity auctions in recent years underscore that the generation costs for RE power are falling quickly and that some – such as wind power – already are competitive with conventional power sources and others – such as solar PV – are likely to become competitive very soon.

These developments can be illustrated with data from capacity auctions: A 2012 auction for nearly 600 MW of capacity saw equal shares going to large hydro and wind power – with wind power bids at a slightly lower bid price of around US$42/MWh (IRENA, 2013, p. 20). In 2014, wind power was auctioned at an average bid price of US$53.41/MWh at an auction that was completely open to both RE and conventional energies (Spatuzza, 2014b). The recent increase is largely due to higher costs for components sourced in the world market. The first solar PV auction in 2014 awarded projects totalling nearly 1 GW in capacity at an average bid price of US$86.78/MWh (Willis, 2015).

2.4 Economic development

Since 2000, the average per capita income in Brazil has risen by nearly a third as a result of economic growth and the government's efforts to lift people out of poverty (see below). These rising incomes and the currently almost universal access to electricity in Brazil have increased the demand for energy and electricity there.

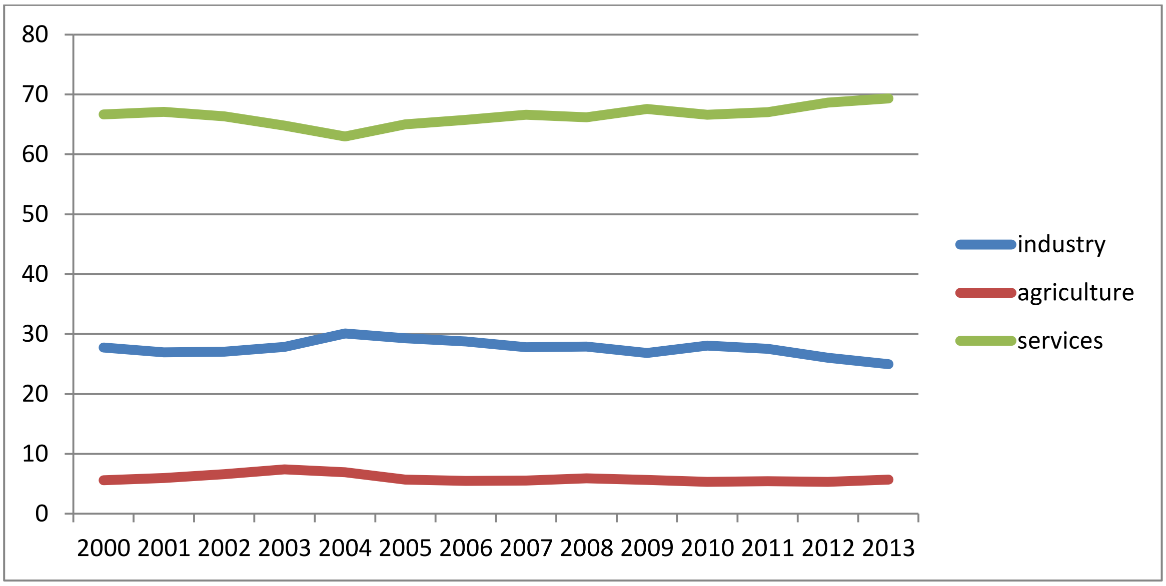
Figure 17: Adjusted net national income per capita in Brazil, in constant 2005 US$



Source: (World Bank, 2015)

The share of the services sector in Brazilian GDP is large, accounting for 69% in 2013. Industry, by comparison, had a relatively small share of only 25%, about half of which (13%) was accounted for by manufacturing, and the primary sector made up the remainder (6%).

Figure 18: Structure of the Brazilian economy, by sector, in % of GDP, 2000-2013



Source: (World Bank, 2015)

2.5 Financial system

The public sector plays a key role in the financing of RE and EE investments in Brazil and provides capital through its national and state development banks. The central institution is the Brazil National Development Bank (BNDES). It provides, in collaboration with regional banks, funding to project developers – mainly through low-interest loans. In order to raise capital, BNDES also works with international financing institutions – for example the German development bank KfW, which is financing small hydropower investments and pilot schemes in biogas and solar PV (IRENA, 2012, p. 65). The launch of the "New Development Bank" by the BRICS countries is expected to also increase the availability of capital for infrastructure investments in Brazil. For more detailed information on how BNDES and the other involved banks provide access to capital for RE/EE investments, see section 4.2.

Finally, international carbon finance through the Clean Development Mechanism has been another important source of financing for RE and EE projects. Brazil accounted for 44% of all certified emission reductions in South America until 2012 (IRENA, 2012, p. 66).

3 Political strategies, actors and processes

Brazil is a federal republic made up of 26 states and the federal district of Brasilia. The government structures at the state level mirror those at the national level. The Brazilian constitution considers Brazil's natural energy resources to be "property of the union" (Article 20) and therefore grants the federal level the exclusive authority on energy policy. For that reason, the study will focus on policies and measures at that level.[3]

The fundamental characteristics of Brazil's political system provide the framework for policies and strategies that develop markets for RE and EE technologies and create employment. The identity and configuration of the main actors are described in the following section. The relevant strategies and policies are then described in the subsequent sections.

3.1 Key actors and the involvement of stakeholders in strategy processes

3.1.1 National government actors

- *Ministry of Mines and Energy (MME)*. The MME is the key ministry on all energy policy matters – including renewable energy and energy efficiency. It oversees a number of relevant policy implementation bodies. The MME is also – in collaboration with ANEEL – directly involved in the capacity auctions (further details below).
- *Ministry of the Environment*. Through its chairmanship in the Executive Group on Climate Change, the ministry takes a lead role in the development, implementation and evaluation of the country's National Plan on Climate Change.
- *National Electric Energy Agency (ANEEL)*. ANEEL is a federal regulatory agency for the electricity market. Under the direction of the MME, it regulates energy prices, grants operation licenses and supervises concession agreements with power companies. Another field that ANEEL regulates is grid access and the transmission and distribution of electricity. ANEEL supervises the Operator of the National Electricity System (ONS) in charge of monitoring and planning the expansion of the electricity grid. ANEEL's counterpart for the non-electricity energy sector is the National Agency for Petroleum, Natural Gas and Biofuels (ANP).
- *Energy Research Company (EPE).* The EPE is part of the MME and focuses primarily on energy research that informs the long-term planning of the energy sector in Brazil. It authors – in collaboration with the MME – the ten-year plans for energy expansion and the annual updates to the Brazilian Energy Matrices (Ministry of Mines and Energy, 2013b).

[3] The constitution specifically mentions hydropower and minerals, but not the sun or the wind. There are no legal sources available that clarify whether the term "natural resources" also covers renewable sources of energy.

3.1.2 Other key actors

Petrobras & Eletrobras. The two companies are the largest energy and power producers in Brazil and are both majority-owned by the government. They both also implement the government's programmes on energy efficiency in their respective areas of operation: Petrobras with regard to the National Programme for the Rational Use of Natural Gas and Oil Products CONPET and Eletrobras with regard to the National Programme for Electricity Conservation PROCEL – each in coordination with the MME.

Brazilian National Development Bank (BNDES). The largest national development bank plays a key role in providing access to finance for RE and EE projects in Brazil. Through its lending policies, it is also advancing other policy goals, such as the creation of domestic value added and employment by means of theoretically non-binding, but de facto mandatory local content requirements being attached to public financial support.

3.2 The process of strategy development and implementation

3.2.1 Processes and capacities for strategy development in government

The EPE's Brazilian Energy Matrices serve as an annually updated analysis of the energy and electricity market. The direction of energy strategy and policy is generally determined by the MME and the Presidency, which uses the CNPE (see below) as a source of guidance.

3.2.2 (Vertical/horizontal) integration of interests in strategy development

Advisory councils on the energy and electricity sector. There is a total of three advisory councils that foster coordination and integration between national government ministries and agencies – one focused on energy policy, CNPE, one focused on electricity, CMSE, and one focused on energy efficiency, CGIEE. All of these are chaired by the MME. Their memberships include non-governmental entities, but not energy utilities or private businesses.

- *National Council on Energy Policy (CNPE)*. The CNPE is a presidential advisory body on energy policy and approves the capacity development in the area of energy generation (e.g. oil and gas exploration) being secured from fossil energy sources.

Table 1: Membership in the National Council for Energy Policy

Ministry of Mines and Energy (Chair)	Ministry for Science and Technology	Ministry of Planning, Budgeting and Management
Ministry of Finance	Ministry of Environment	Ministry of Development, Industry and Trade
Presidency	Ministry of National Integration	Ministry of Agriculture, Livestock and Supply
A representative of the Federal States and the Federal District	A representative of civil society/expert in the field of energy	A Brazilian university representative/an expert on energy
President of Energy Research Company		

Source: (Ministry of Mines and Energy, 2015)

- *Monitoring Committee of the Electricity Sector (CMSE)*. The CMSE follows the development of the electricity generation from both renewable and fossil sources. In its twice-monthly meetings, the CMSE reviews the ongoing development of power generation capacity as well as of the energy transport infrastructure (transmission and distribution of electricity as well as pipelines for oil and gas). The CMSE reviews upcoming auctions in the field of electricity generation as well as for transmission capacity.

Table 2: Membership in the Monitoring Committee of the Electricity Sector

Ministry of Mines and Energy (Chair) (4 representatives)	National Electric Energy Agency (ANEEL)	National Petroleum Agency
Electrical Energy Trading Chamber	Energy Research Company (EPE)	National Electric System Operator

Source: Website of the MME **http://www.mme.gov.br/**

- *Steering Committee on Energy Efficiency Indicators (CGIEE)*. The committee was established to coordinate the implementation of energy efficiency measures within government. For that purpose, it develops regulations and sets up expert bodies working on technical aspects of EE regulations, and monitors and assesses the development of energy efficiency in different sectors. Its membership goes beyond government ministries and regulatory agencies and includes two non-governmental representatives who are appointed by the Minister of Mines and Energy.

Table 3: Membership in the Steering Committee of Energy Efficiency Indicators

Ministry of Mines and Energy (Chair)	Ministry of Science and Technology	Ministry of Development, Industry and Foreign Trade	Brazilian university representative*
National Electric Energy Agency (ANEEL)	National Petroleum Agency	National Electric System Operator	Civil society representative*

Source: Website of the MME **http://www.mme.gov.br/**

Inter-Ministerial Commission on Climate Change. The commission was already established in 1999 and is composed of government ministries (see table below) to coordinate Brazil's position in international climate policy negotiations as well as domestic climate policy, including Brazil's participation in the Clean Development Mechanism.

Table 4: Membership in the Inter-Ministerial Commission on Climate Change
and the Executive Group on Climate Change (marked in bold)

Ministry of Science & Technology (Chair)	**Ministry for External Relations**	**Ministry of Agriculture, Livestock and Supply**
Ministry of Transport	**Ministry of Mines and Energy**	Ministry of Planning, Budgeting and Management
Ministry of Environment	**Ministry of Development, Industry and Trade**	**Presidency**
Ministry of the Cities	Ministry of Finance	

Source: Own depiction.

Executive Group on Climate Change. The executive group is headed by the Ministry of the Environment and tasked with the implementation, monitoring and evaluation of the National Plan on Climate Change. It is a subset of the Inter-Ministerial Commission.

3.2.3 Participation of non-governmental stakeholders

CNPE and CGIEE. The CNPE and CGIEE also include non-governmental members who are nominated by the government, such as civil society energy experts and scientists who participate in the work of the two advisory councils on energy and energy efficiency policies.

Public Participation in the National Plan on Climate Change. The plan prescribes that civil society should be involved in the review of the plan via public consultation forums, such as the National Conference on the Environment or the Brazilian Climate Change Forum.

Public Participation in Energy Planning. Both the National Energy Plan and the Ten-Year Expansion Plans use public consultations with civil society and businesses in the energy sector to adapt the substance of planning and improve the accuracy of its predictions (Ministry of Mines and Energy, 2013b, p. 8).

Public participation in energy efficiency standards. While outside the strategic framework, the 2001 Energy Efficiency Law established public participation of civil society in consultations and public hearings regarding the establishment and revision of minimum energy efficiency standards or maximum consumption limits for equipment and machinery.

3.2.4 Institutions and capacities for implementation

A large number of specialised agencies of government provide guidance for policy development or the implementation of policies. Key among them are ANEEL and the National Agency for Petroleum, Natural Gas and Biofuels (ANP). The Operator of the National Electricity System (ONS) is tasked with ensuring the stability of the power grid and the expansion of its capacity. The Chamber of Electricity Energy Commercialisation (CCEE) is another agency under ANEEL tasked with regulating electricity trade.

3.2.5 Monitoring and Evaluation

Review of the National Plan on Climate Change. The preparation, monitoring and evaluation of the National Plan on Climate Change are assigned to the Executive Group on Climate Change (eight government ministries) that is guided by the Ministry of Environment. In addition to these consultations within government, the plan arranges for public consultations with civil society in the framework of existing forums, such as the National Conference on the Environment and the Brazilian Climate Change Forum.

3.3 Goals and action programmes

3.3.1 National Plan on Climate Change (2007/2008)

The National Climate Change Strategy is a non-binding document that combines a vast number of climate-related efforts from various government ministries and should be considered a first stocktaking towards greater climate policy integration within the Brazilian government (Interministerial Committee on Climate Change, 2007). The plan focuses on encouraging a number of ways of saving greenhouse gas emissions domestically. It includes a broad range of policy goals and measures, e.g.

- to reduce power consumption by 106 TWh/year by 2030, equivalent to 30 million tons of CO_2.
- to increase SWH capacity to 2,200 GWh by 2015,
- to increase urban recycling by 20%,
- to replace one million old refrigerators
- to foster sustainable farming and sustainable charcoal
- and – key to GHG reduction goals – to reduce the annual rate of deforestation by 40% between 2006 and 2009 and by another 30% in the following four-year periods (relative to the previous period) until 2017.

In 2009, the subsequent National Policy on Climate Change was adopted, which established an overall goal of reducing GHG emissions by "36.1% to 38.9%" below BAU by 2020, which had not been included in the original plan.

3.3.2 National Energy Planning

3.3.2.1. The National Energy Plan 2030 and Brazilian Energy Matrix 2030 (2008)

Both documents represent different methodological approaches to understanding (and planning) the Brazilian energy market until 2030. While the plan serves as a stable planning document, the matrix is updated annually to account for trends in energy markets and to guide current policymaking.

The National Energy Plan 2030 aims to provide a long-term framework for the development of both the energy and electricity supply of the country. The plan was developed under the leadership of EPE and the MME – with input from the public and extensive media coverage. It lays out a plan for the expansion of energy and electricity production, the contribution of energy efficiency to meet the expected energy and electricity demand in 2030. The plan is not a policy strategy as such, but provides an integrated planning framework. It shows that per capita energy demand is expected to double between 2005 and 2030 to 2.3 tons of oil equivalent, and that per capita electricity demand will nearly triple from 452 kWh in 2005 to 1,200 kWh in 2030. It formulates the overall goal that by 2030, 45% of all energy consumed shall be from renewable sources and that electricity generation will grow by 4% annually and nearly triple between 2005 (441 TWh) and 2030 (1,197 TWh) (Ministry of Mines and Energy, 2007). The main indicators for the development of energy and electricity supply and consumption are summarised in a table in section 8.3.

The government is currently working on the development of a National Energy Plan 2050, which has not been published yet. It will replace PNE 2030 as the reference framework.

3.3.2.2. National Energy Efficiency Plan (2011)

The National Energy Efficiency Plan (PNEf) was adopted in 2011 and is based on the National Energy Plan. Its contributions are part of the Ten-Year Plan (TYP). The plan integrates existing programmes on various aspects of energy consumption, such as industry, transport, construction, public buildings, lighting, sanitation or solar heating. Additionally, it addresses necessary education, research and development issues, funding schemes as well as the regulatory environment and policy instruments.

The plan serves as a general framework for various kinds of programmes related to energy efficiency in order to achieve a 10% reduction in final energy consumption by 2030 (Moss, 2012). It is assumed that half of this reduction will be reached without policy support and half will require additional policy measures – which will be coordinated by the PNEf. However, no specific measures have been implemented to reach this goal so far, and investments in energy efficiency – including government funding for them – have also been falling (compare section 1.4.2).

3.3.2.3. Ten-Year Energy Expansion Plan

The Ten-Year Plan (TYP) is an annually updated planning document that complements the National Energy Plan 2030. It similarly tracks the development of all main aspects of the energy and electricity markets and projects them into the future. Given that it is updated annually, it allows taking recent developments such as delays in infrastructure development into account, which will reduce existing bottlenecks in the various electricity grids.

Table 5: Planned development of installed capacity by electricity source until 2023, in MW

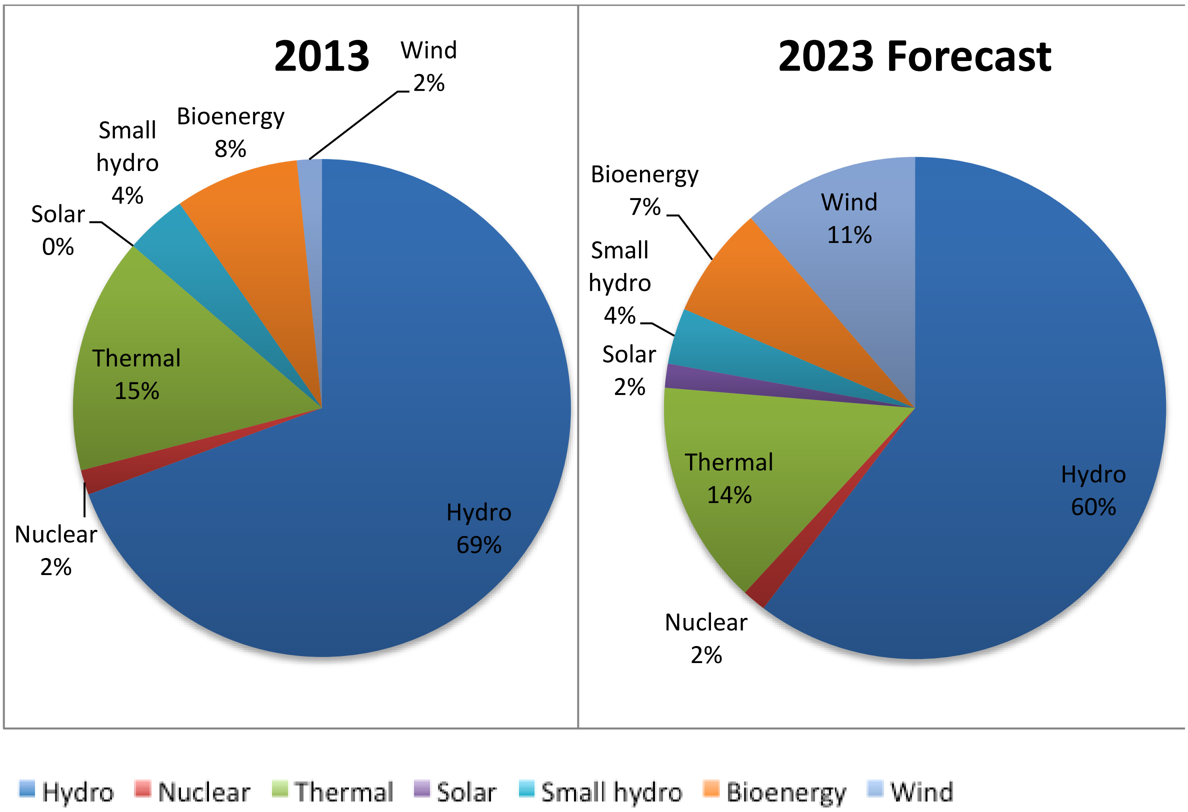
Fonte / *Source*	**2013**	**2018**	**2023**
RENOVÁVEIS / *RENEWABLES*	**103.399**	**142.849**	**164.135**
HIDRO / *HYDRO*	79.913	100.935	112.178
IMPORTAÇÃO / *IMPORTS* [(a)]	6.120	5.583	4.716
OUTRAS / *OTHERS*	17.366	36.331	47.241
PCH / *SMALL HYDRO*	5.308	6.289	7.319
EÓLICA / *WIND*	2.191	17.439	22.439
BIOMASSA / *BIOMASS*	9.867	11.603	13.983
SOLAR	0	1.000	3.500
NÃO RENOVÁVEIS / *NON-RENEWABLES*	**21.397**	**24.248**	**31.748**
URÂNIO / *URANIUM*	1.990	3.395	3.395
GÁS NATURAL / *NATURAL GAS*	10.666	12.516	20.016
CARVÃO / *COAL*	3.210	3.210	3.210
ÓLEO COMBUSTÍVEL / *FUEL OIL*	3.442	3.493	3.493
ÓLEO DIESEL / *DIESEL FUEL*	1.402	947	947
GÁS DE PROCESSO / *COKE GAS*	687	687	687
TOTAL	**124.796**	**167.097**	**195.883**

Source: (Ministry of Mines and Energy Energy Research Company, 2014, p. 24)

The TYP expects power generation from non-large-hydro renewables to grow significantly faster than that from other power sources.[4] Wind power is the fastest-growing market among them – expected to increase its nominal capacity more than ten-fold between 2013 and 2023. Consequently, the most significant expected change in Brazil's electricity mix will be the increase of wind power at the (relative) expense of large-scale hydro and fossil sources.

[4] The comparison between different TYPs illustrates the enormous dynamics, particularly in wind power. While the 2013 TYP projected that the growth in wind power would average 8.5% per year, the 2014 TYP revised that figure to 11% per year (projected until 2023).

Figure 19: Development of installed capacity by electricity source, 2012 to 2023



Source: (Ministry of Mines and Energy Energy Research Company, 2014)

4 Specific measures to address framework conditions

4.1 Personal qualification and technological know-how

- *Public funding for university research*. The government has provided funding for university research in RE/EE over the last decade. This has been moderately successful as – unlike in Europe or the United States – universities lack established domestic manufacturers as partners in applied research. A promising approach in Brazil has been to support niche markets – such as micro wind power – through R&D subsidies, net metering policies and connection fee reductions in order to develop such decentralised forms of power generation (da Silva, 2013, p. 696).
- *SENAI technical training programmes for wind and solar power as well as EE*. The National Service for Industrial Training (SENAI) is preparing two specific training centres for technicians in the wind power sector, which will provide skills training on the operation and maintenance as well as the construction of wind parks. The courses will consist of 20% theory and of 80% practical training. For training in wind as well as solar power, occupational standards and curricula have been published by SENAI at the national level. Several regional training centres are preparing to offer the new training courses for solar technicians. Training courses for energy efficiency specialists will be set up in 2016. The initiatives in the three sectors are cooperation projects with GIZ (Energypedia, 2015b).
- *PROCEL Network of Laboratories and education and training in EE*. PROCEL includes various programmes to foster the dissemination of information about energy efficiency. This involves public awareness-raising and education as well as targeted training for professionals which enables them to identify efficiency potentials in their organisations. PROCEL operates a network of 24 laboratories all over Brazil that test products and provide training in various fields from construction, lighting, industrial energy efficiency to sanitation and municipal energy management. Training is offered through courses, in the context of pilot projects and through technical publications (PROCEL, 2012). From 2012 onwards, a pilot project has started to also include education on energy efficiency in public school curricula. A similar programme on energy efficiency in schools exists under CONPET (CONPET, 2012).
- *PROCEL databank on training courses and education*. PROCEL provides a platform for all kinds of short and long-term training courses related to energy efficiency (as well as SWH) ranging from professional training to academic programmes.
- *PROCEL public education and awareness measures*. PROCEL also provides a range of information materials for children, students and adults to raise awareness about energy efficiency. Between 2008 and 2013, over 1.7 million students in 11 Brazilian states learned about energy efficiency through this programme (ANEEL, 2014).
- *Centres of excellence at Brazilian universities*. PROCEL's network of laboratories and research centres also cooperates with "centres of excellence on energy efficiency" at various Brazilian universities. These centres aim to develop teaching materials for professionals as well as methodologies for measuring energy efficiency.[5]

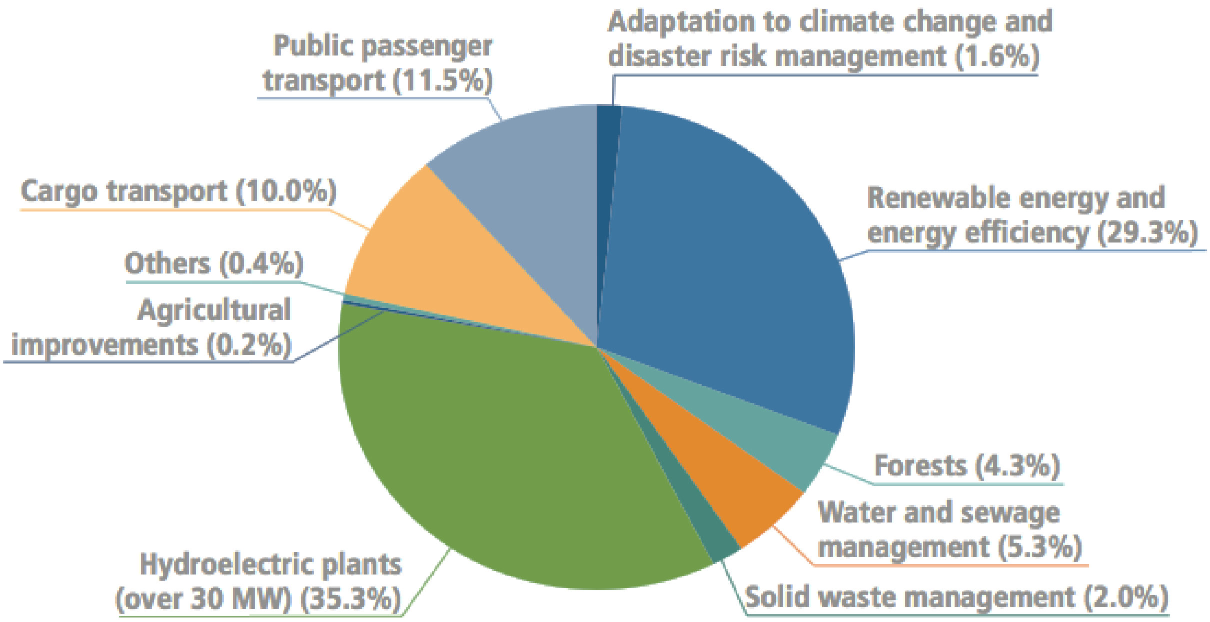
[5] The three centres of excellence in place so far are at the Federal University of Itajubá, at the Federal University of Pará and at São Paulo State University - Unesp.

- *Capacity building in solar mapping*. In cooperation with GIZ, EPE developed a methodology and training manuals for solar mapping software in order to identify the best locations for rooftop solar installations (Energypedia, 2015a).
- *Energy efficiency measurement and verification courses.* ANEEL – in collaboration with GIZ – has developed a manual, accompanying training courses as well as online training for professionals in energy distribution companies (GIZ, 2015).
- *Online training courses by UNIDO on RE and EE.* Another approach to providing training programmes in renewable energies is organised by the United Nations Industrial Development Organisation (UNIDO). UNIDO Brazil provides technology-specific training courses in different fields of renewable energies and energy efficiency online and free of charge (UNIDO, 2015).
- *Innovation funding through the Programa Inova.* The programme is a cooperation between FINEP (Financiadora de Estudos e Projetos, a publically owned company under the Ministry of Science and Technology), BNDES and ANEEL to foster technological innovation and a better coordination of policy measures in the fields of solar energy and wind power, hybrid vehicles and vehicle energy efficiency as well as smart grids. The programme will provide subsidies and grants for the development of technological capacities to the tune of BRL3 billion (around US$700 million) in order to strengthen cooperation between Brazilian research institutes and the private sector and to promote entrepreneurship and technological innovation (Nath & Sant'Anna, 2013). Its first call for bids from businesses was launched in 2013.

4.2 Access to capital

- *BNDES low-interest loans for RE & EE*. The Brazilian National Development Bank (BNDES) plays a key role as the largest source of funding for RE power projects in Brazil. BNDES is considered one of the world's largest lenders to the RE industry and has so far been involved in financing all but one of 81 wind farms in Brazil. In 2014, BNDES provided about US$2.7 billion in loans – largely to finance the construction of the large capacities of RE power that was contracted in RE auctions in 2013 and 2014 (FS-UNEP Collaborating Centre, 2015, p. 48). Similarly, BNDES also provides low-interest loans for energy efficiency investments through the Efficiency in Energy Use Programme (CONSERVE), its PROESCO programme (for energy efficiency of lighting, motors, processes optimisation, compressed air, pumping, air conditioning and ventilation, refrigeration and heating) and the MPME Inovadora programme on energy-efficient buildings for small and medium-sized businesses (IEA, 2015, p. 147). In 2013, BNDES disbursed over BRL24.4 billion (US$8.1 billion) into the "green economy" – nearly 30% of which went into renewable energies and energy efficiency (and over 35% to hydro-power). An additional BRL4.7 billion (US$1.7 billion) were provided in 2013 for the expansion of the transmission grid (BNDES, 2014).

Figure 20: Breakdown of BNDES disbursement into the “green economy” in 2013



Source: (BNDES, 2014)

- *National Programme for Energy Development of States and Municipalities (PRODEEM).* The programme aims to foster the deployment of renewable energy sources in rural communities and therefore provides financing to local communities for the procurement of RE equipment. The programme is financed through the national government and from international sources.
- *Banco do Brasil loans for energy efficiency.* Similarly to BNDES, Banco do Brasil offers financing schemes for businesses investing in energy efficiency (PROCEL, 2015).
- *National Fund for Climate Change (Fundo Clima).* The fund is supervised by the Ministry of the Environment, implemented by BNDES and overseen by a steering committee consisting of the Brazilian federal government, BNDES, state governments, municipalities, non-governmental sectors and the scientific community. About 90% of its resources are managed by the Ministry of the Environment, the rest is used by BNDES to finance low-interest loans for RE, EE or the protection of native forests. In 2014, the fund had a financial volume of BRL390 million (US$96 million) and has disbursed BRL1.4 billion (US$350 million) since 2011 (BMUBGIZ, 2014).
- *Public benefit charge on electricity utilities to finance EE projects and R&D.* The largest source of public finance for the Energy Efficiency Programme is a 1% charge on electricity utilities’ annual net operating income in the regulated market. The programme was introduced in 2000 and is overseen by ANEEL. The funds raised from the charge are used for funding EE projects as well as R&D. The shares allocated to these goals have varied significantly over time – from 90% being devoted to EE in the beginning, to today’s configuration in which half of the annually raised funds are invested in EE projects, 40% in R&D and 10% finance the operations of the EPE (World Energy Council, 2010). Some of the funding is used for EE projects initiated by the electricity utilities themselves and approved by ANEEL.

By 2011, a total of nearly BRL2 billion (about US$500 million) had been invested in EE projects financed through the public benefit charge. That year, an annual investment of nearly BRL400 million (about US$100 million) had been disbursed. Estimates by ANEEL specify the programme's economic benefits to be nearly BRL5 billion (US$1.25 billion) and its electricity savings to about 5.5 GWh per year (ANEEL, 2012).

4.3 Level playing field and setting of fair prices

- *National Fund for Climate Change*. The fund is levelling the playing field slightly as it uses fossil fuel revenues to finance RE and EE projects. It is funded by allocating government revenues from Petrobras and uses its funds to support capacity building, research and development related to climate change mitigation and adaptation (IRENA, 2012). For the usage of the funds raised, see section 4.2.

4.4 Support measures

4.4.1 Renewable Energies

4.4.1.1. Wind and solar PV

- *Feed-in tariffs under PROINFA* [ended]. The Programme of Incentives for Alternative Electricity Sources was started in 2002 and sought to incentivise a RE capacity of 3,300 MW by 2009 – a third of the total amount coming from wind, small hydro and biomass. The initial feed-in tariff scheme provided for a fixed tariff, which was later changed: Feed-in tariff rates were set at US$150/MWh for wind, US$96/MWh of small hydro and US$70/MWh for biomass. RE projects were also guaranteed market access through a power purchasing agreement with Eletrobras valid for 20 years (IRENA & Global Wind Energy Council, 2012, p. 37). The PROINFA programme narrowly missed its capacity targets. By 2009, it had installed RE capacity to the tune of 1,157 MW from 60 small hydro projects, 1,182 MW from 51 wind power projects and 550 MW from 21 biomass projects (IRENA, 2013, p. 16). The feed-in tariff policy also contained a local content requirement. It mandated that a 60% share of the RE plant be manufactured domestically. The measurement was based on weight, which created unintended distortions in that demand for domestically produced steel rose so quickly that it could only be supplied by the domestic steel company, which benefited from this inflated demand (IRENA & Global Wind Energy Council, 2012).
- *Two-stage capacity auctions*. Since 2007, RE power generation capacity is allocated through an auctioning system in two stages. The auctions are administered by a committee consisting of the MME, ANEEL, the Chamber for the Commercialisation of Electrical Energy (CCEE) and the Energy Research Company (EPE). This group determines the auction's size, sets price ceilings for the auction and defines the terms of the contracts that will be concluded with successful bidders. Auctions always follow the same principles, even though they can be differentiated between technology-specific and multi-technology calls, and between those that add regular capacity and those that add reserve capacity. Additions in conventional power capacity (large-scale hydro or coal) are also allocated through (separate) auctions. Wind and biomass contracts include a 20-year power purchasing agreement with distributors, hydro-power typically has a longer 30-year running time (IRENA, 2013, p. 18). The auctions also stipulate a three- to five-year timeframe in

which installations have to be grid-connected (so-called A-3, A-4, A-5 auctions), with severe penalties if deadlines are not met. An overview of the characteristics of the bidding process can be found in section 8.2.

- *Multi-technology vs. technology-specific auctions*. Brazil has so far held auctions that were restricted to a single RE technology or open to various competing technologies. The latter have generally been dominated by wind power bids because wind power is still often the most cost-competitive RE generation technology (REN21, 2014, p. 27). Various auctions, in 2012 or 2014, have seen bids for wind power capacity installations being competitive with large-scale hydro, gas or coal power plants (IRENA, 2013, p. 20; Spatuzza, 2014b) (also see section 8.2). As particularly solar PV projects were then unable to compete in multi-technology auctions, the first solar PV auction in Brazil was held in 2014, with two more (one for solar PV only, one for solar PV and wind) to be held in 2015. Both of these have been heavily oversubscribed with bids (see Kenning, 2015a).

4.4.1.2. Industrial policies on RE – local content and trade policies

- *Local content requirements for BNDES financing*. While there is no formal local content requirement to take part in the capacity auctions, there are such requirements attached to BNDES financing. Given the omnipresence of BNDES in financing RE, the conditions serve as a "de facto local content requirement" (US Department of Commerce, 2014, p. 14). The minimum 'nationalisation' rate is set at 60%, measured in the total construction costs. In addition to that, the states can require a share for 'their' companies of up to 20% (for wind and biomass), or 15% (for small hydro) (IRENA, 2012, p. 65). These requirements are credited with inducing major international RE companies to open manufacturing sites in Brazil. Since 2013, BNDES has developed a computerised system which accredits domestic manufacturers that are eligible for BNDES funding as an approach to progressively increasing the share of domestically produced RE technologies and thus to increase employment in RE in Brazil (see BNDES, 2015, p. 35).
- *Import tariffs on foreign wind turbines and solar PV and SWH equipment*. Another push factor motivating global power companies to open manufacturing sites in Brazil are import tariffs levied on imports of RE technology. These are set at 14% for wind turbines and at 12% for solar PV and SWH equipment (US Department of Commerce, 2014, p. 14). For some components, they are set at even higher rates – such as 28% on PV modules or 81% on inverters (Holdermann, Beigel, & Kissel, 2013).
- *Tax exemptions for the sale or import of RE equipment and construction of RE capacity*. Other equipment that is considered necessary for the development of RE benefits from tax exemptions. The sale and import of certain equipment and materials associated with RE installations and approved by the MME is eligible for a tax break and the suspension of social contributions related to the construction process (for up to five years) (Gallo & Lopes Lobianco, 2015).

4.4.1.3. Small-scale solar PV

- *Micro and small RE support: net metering and tax credits*. In late 2012, ANEEL introduced a net metering policy and provided a regulatory framework for integrating power from small-scale installations into the grid. As additional incentives, solar PV installations of up to 30 MW capacity enjoy an 80% discount on transmission and distribution fees; wind power installations of up to 30 MW capacity receive a 50% discount on these fees (Gallo & Lopes Lobianco, 2015). In 2015, ANEEL planned a revision of the net metering policy in order to further facilitate the application process for small-scale PV installations (Holdermann & Kissel, 2015, p. 48 f.).

4.4.1.4. Solar water heating

- *Minha casa, minha vida (*MCMV). The programme financially supports low-income families to build their own houses. Depending on their income level, they can either receive direct subsidies or low-interest loans (through the 'Caixa' development bank). Since the first phase of the MCMV programme in 2009, the housing scheme subsidises the installation of SWH systems for families with monthly incomes below BRL1,600. At the beginning of the second phase in 2011, the installation of SWH was mandated for low-income families and was subsidised for families in the MCMV programme with incomes over BRL1,600. As of August 2015, more than 224.000 SWH installations have been installed in houses under the MCMV programme, 41.000 in the first phase (2009-2011) and 183.000 in the second phase (2011-2015) (Epp, 2015; REN21, 2015, p. 66). With the mandate in place, this number is expected to rise very significantly in the coming years.

4.4.2 Energy Efficiency

There are three main energy efficiency programmes in Brazil that address both electricity and other forms of energy use.

Figure 21: Key energy efficiency programmes in Brazil

Source: (PROCEL, 2012)

- *Brazilian Labelling Programme (PBE).* The PBE programme (Programa Brasileiro de Etiquetagem) is coordinated by the National Institute of Metrology, Standardisation and Industrial Quality (INMETRO). PBE certification is voluntary for some product categories (e.g. SWH systems or vehicles) and mandatory for others (e.g. household devices or industrial equipment). Given the type of product, the scale ranges from the most energy-efficient 'A' products down to 'C' or even 'G' for the least efficient. Certification is reviewed annually, which allows for increasing the requirements for the products. Additionally, there are EE labels under the CONPET and PROCEL programmes. Depending on the type of energy used, these products fall under the PROCEL programme (for electricity) or the CONPET programme (for oil or gas-powered devices). These labels do not differentiate between different ratings.
- *PROCEL label.* The Brazilian National Electricity Conservation Programme (Programa Nacional de Conservação de Energia Elétrica) has been in place since 1985. Its PROCEL label identifies energy efficient products to consumers and serves as an incentive for manufacturers to produce them. The label covers close to 3,800 products in 32 categories ranging from household items (lighting, fans, refrigerators, washing machines) to engines and other equipment (PROCEL, 2012).
- *CONPET programme label.* The National Programme for the Rational Use of Natural Gas and Oil Products promotes efficient use of non-electric energy, e.g. by awarding its energy efficiency label to gas ovens, stoves, gas water heaters or vehicles.
- *EE labelling for buildings.* Buildings are a subcategory of CONPET (CONPET Edifica). Since 2014, public buildings larger than 500m^2 floor space are required to get certified and are evaluated as part of the certification process in three specific areas: lighting, air conditioning and walls and windows. The label is voluntary for all privately owned buildings.

Figure 22: Energy efficiency label for buildings

Source: (Brazil Business, 2015)

- *Energy-efficient public lighting.* PROCEL's programme on public lighting provides funding for replacing streetlights in municipalities. Since 2000, more than 2.5 million light bulbs have been replaced under the programme (PROCEL, 2015).
- *Sustainable public procurement*. In 2010, the Planning Ministry issued an "instruction" that energy efficiency criteria have to be considered in public procurement. There are no specific targets yet, but the instruction uses the PROCEL and PBE labels (A-level) as mandatory criteria for procurement decisions (Moss, 2012).
- *'Light for All' Rural Electrification Programme*. The programme is part of the rural electrification strategy. It provides for 130,000 solar PV systems in 17,500 local communities in remote Amazonian regions (IRENA, 2012, p. 66).
- *Energy Efficiency Programme:* Under the programme managed by ANEEL, the concession agreements with power distribution companies require them to spend half of the public benefit charge (see also section 4.2) on EE projects. The implementation and the criteria for such investments are set and monitored by ANEEL. A 2013 review of the programme has led to a change in criteria in order to address the significant potential for energy savings in industry (GIZ, 2014).

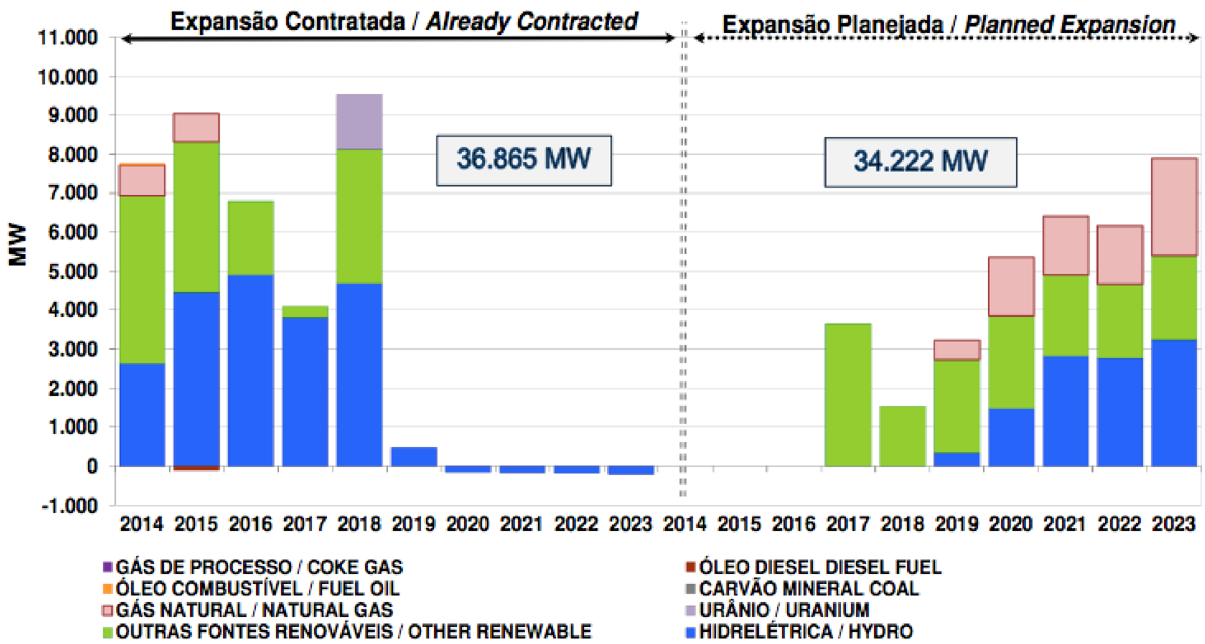
5 Outlook on Brazil's market development and employment potentials in renewable energies and energy efficiency

5.1 Anticipated development for electricity and RE

Brazil has continuously improved its standing as an attractive RE market and is again attracting higher investments (Ernst and Young, 2015; FS-UNEP Collaborating Centre, 2015). While the country is entering, or already is in, an economic recession since the summer of 2015, the government has pledged to continue to increase investments in RE and the electricity transmission and distribution grid, and to spend US$53 billion on the electricity sector until 2018: US$33 billion on new power generation capacities (half of this on renewables excluding large hydro) and the remaining US$20 billion on expanding the electricity infrastructure (Ernst and Young, 2015, p. 29).

Along with investments, demand for electricity is expected to keep growing at a stable rate of around 5% per year over the next decade (Ministry of Mines and Energy, 2013b). The drought in the last years will continue to push investments into the fast expansion of RE power generation capacities and away from large hydropower and fossil fuels. As a consequence, the RE capacity is expected to grow on average by 11% annually until 2023, mainly driven by the strong growth in wind power (Ministry of Mines and Energy Energy Research Company, 2014, p. 23). The figure below shows the TYP's energy investments, and the prioritisation of RE capacities illustrates this by identifying the additional capacities that have already been contracted and those that are planned in order to match electricity supply and demand that is expected for 2023 under the TYP. This development will be further sustained by the rising electricity tariffs that will make RE installations – and particularly small-scale solar PV using net metering – a more and more attractive investment in many parts of the country (see Holdermann & Kissel, 2015, p. 49). A potential threat to RE competitiveness is the devaluation of the Brazilian Real, which will increase the costs for RE components that have to be paid for in US Dollars or Euros (compare Griebenow & Kissel, 2015).

Figure 23: Increase in power capacity by energy source: contracted and planned



Source: (Ministry of Mines and Energy Energy Research Company, 2014, p. 20)

Both the official TYPs for the energy sector and independent studies show the tremendous growth that can be expected in power generation in general and from renewable sources in particular. Perreira et al estimate that total energy demand will increase from 491 TWh in 2010 to 771 TWh in 2020 and 1,123 TWh by 2030 – thus more than doubling in 20 years (Pereira, da Costa, do Vale Costa, de Moraes Marreco, & La Rovere, 2013).

5.2 Anticipated employment in RE

The national energy plan or the TYP do not directly discuss employment effects from RE.[6] However, there is data on current employment in various renewable energy technologies. The study by Simas et al. estimates future employment effects of the already contracted wind power investments until 2017 and finds that about half is in construction, more than a third in manufacturing, and the remaining sixth in operation and maintenance (Simas & Pacca, 2014). While the majority of these jobs are temporary, the vast increase in investments to expand RE generation capacity, particularly in the wind power sector (see previous section), suggests that if the necessary capacity is made available, employment in renewable energies will grow over the coming years.

[6] In some documents, the EPE discusses assumptions that it uses for such estimations. For example, a technical note on distributed solar PV in Brazil explains how it adjusts European employment factors (15 direct and 30 indirect jobs per installed MW of distributed solar PV capacity) - reflecting the fact that some parts of that value chain will not create employment in Brazil - to 9.5 direct jobs and 15 indirect jobs per MW of installed distributed solar PV capacity (EPE & Ministry of Mines and Energy, 2014, p. 47).

5.3 Anticipated development in EE

The TYP assumes that final consumption of energy will grow from 251,000 (in 10^3 toe) in 2013 to 369,000 (in 10^3 toe) by 2023. It forecasts energy savings of 5.2% (compared to a BAU scenario) from energy efficiency measures (Ministry of Mines and Energy Energy Research Company, 2014, p. 10). This means that in order to reach the 2030 goal of reducing energy demand by 10% (compared to BAU), additional measures are likely to be necessary. Specific data on the value added or employment effects from energy efficiency policies and measures is not available and it is unclear how different effects will impact investments in EE overall: The recent reductions in government spending on EE measures are partly compensated for by additional international funding and higher electricity prices (compare section 2.3.3) provide stronger incentives to private businesses to invest in energy efficiency (also see IEA, 2015, p. 141 ff.).

6 Conclusion: Key features of the Brazilian approach, explanatory limitations of the study and open questions for future research

This concluding section aims to distil some key features that distinctively characterise the strategies and policies employed by the Brazilian government and its partners; to highlight the remaining explanatory limitations of the study (which are essentially due to gaps in the data that could not have been overcome within the scope of the project) and to point out areas for future research and technical cooperation needed to fully understand the intricacies and contingencies of the Brazilian experience and to further operationalise it in the framework of international cooperation and know-how exchange.

6.1 Key features of the Brazilian strategies and policies on RE and EE

A number of central findings on both the strategic approach undertaken and the policy instruments employed by the Brazilian government shall be highlighted in this section.

6.1.1 Strategic approach

- *Energy/electricity planning, but not a policy strategy.* The development plans are capacity expansion plans and serve to inform energy policy-making. However, the plans themselves do not contain specific links to policy measures that are designed to achieve the changes in the structure of energy and electricity generation and consumption. The annually updated TYPs merely serve as an indicator what capacities for electricity generation from which types of energy will be developed in the medium-term. To give an example, between TYP 2023 and TYP 2024 the expected solar PV capacity to be installed increased from 3,5 GW to 7 GW, which indicates that the government will continue the realisation of solar PV auctions.
- *Lack of policy integration*. The plans for the generation of energy and electricity focus on forecasting developments and 'possibilities', but they do not provide a framework that effectively fosters the integration of environmental, industrial or employment policy goals. The country has not yet adopted a strategic approach to linking energy development plans to industrial or employment policy that would create initiatives across government agencies or coordinate existing measures. The energy strategy and the coordination processes are dominated by the Ministry of Mines and Energy, whose primary focus lies of the expansion of generation capacity and supply security, which trumps all other policy goals.

6.1.2 Policy instruments

- *Sole focus on expanding generation capacity*. The introduction of the auctioning system in Brazil was a clear success with regard to the reduction of RE prices and capacity expansion. However, it has also led to a dominance of wind power over other RE sources and caused financing problems and delays due to the extremely low profit margins (IRENA, 2013, p. 22). This also concentrates wind farms in the most profitable areas of the country (those with the highest wind capacity) – regardless of how high the demand for electricity is in these regions.

- *Hurdles to further expansion.* A number of policy-related problems slow down the expansion of RE. Complicated bureaucratic licensing requirements and environmental impact assessment procedures are delaying projects, the expansion of the electricity grid is so slow that some capacity – particularly in the central-western regions – remains unconnected, and social conflicts often arise with local communities over land use rights for installations and grid infrastructure (da Silva, 2013).
- *Lack of coordination between policies*. The government has itself identified the existence of various energy efficiency labelling schemes as confusing to consumers (ANEEL, 2014). Other examples for trade-offs are the import tariffs on RE components or distortions of the steel market caused by the roll-out of wind power.

6.2 Limitations of data and evidence on job creation from RE/EE in Brazil

6.2.1 Explanatory limitations of the study

Some limitations and gaps in the study result from the focus of the analytical framework and from the availability of data (or lack thereof). Firstly, the study's analytical framework was focused on studying the development of renewable energies and energy efficiency in Brazil, analysing the local employment and value effects achieved in this context, understanding which frameworks were key in this regard and assessing the role which government strategy and policy played in this endeavour. Secondly, many of the international sources and policy documents that are available to analysts and have been used in this study focus on the development of policies or contain data on markets. This is typically the case, for example, for data on installed capacity and generated electricity from large RE installations or for public spending and support in this regard. However, other relevant developments are often not reflected by the data that is available as of now.

Therefore, a number of shortcomings and limitations of the study are:

- *Data on industry and private sector structure*. There still is very limited data available on the makeup of the Brazilian RE/EE industry – e.g. on the exact relationships and working arrangements between Brazilian and foreign companies or on the effectiveness of R&D and local content policies in strengthening domestic businesses' competitiveness and innovation.
- *Data limitations as developments are ongoing*. The developments being discussed in the study are currently happening and some of the RE capacities under discussion will need a few years before they actually are constructed and grid-connected. Much of the information that would give greater insight into who the involved developers and investors and what their respective roles, shares and strategies are, what legal structures and policy measures have been relevant in this regard and, most importantly of all, what their exact effects will be in terms of local value and employment creation – for all of these, data is not yet available or uncertain.
- *Lack of data on small-scale and distributed energy.* The data available through IRENA and the other publications used for this study is largely based on capacity from utility-scale RE installations that were contracted through power auctions. It is much less clear how much capacity has so far been installed from small and distributed sources of RE power, such as distributed solar PV or micro wind turbines.

- *Breakdown of investment data*. The data available on RE worldwide investments (e.g. by FS-UNEP Collaborating Centre, 2014) presents aggregated data and overall numbers. It does not break down investments to sub-national levels or analyse the actors providing financing (e.g. with regard to the relative importance or interaction patterns of public vs. private banks).

6.2.2 Open questions for policy design and future research

Against the background of these gaps in the data, some questions regarding local value and employment creation from RE and EE technologies in the case of Brazil (and lessons that can be derived from this experience for the benefit of international policy dialogue and know-how transfer) must remain unanswered. Some of these are:

- What is the scope of and potential for decentralised power generation from RE sources in Brazil – particularly considering the size of the country? How do costs and employment opportunities from decentralised RE power generation compare with centralised RE power generation? Besides costs, what other impacts and trade-offs could be expected from decentralisation, e.g. grid stability, quality assurance, local ownership and benefit sharing, on-site investments and capital formation, regional development effects?
- Given the tradition of pro-active industrial policies in Brazil, what is the relationship between the different affected policy goals and approaches (including climate and environmental policy, employment and labour market policy, education and research policy, housing and transport policy) and the development of RE and EE, and how could these be better coordinated and integrated?
- What interactions exist between the types of RE not analysed in this study (e.g. biofuels, biogas and other forms of modern biomass) and the development of wind and solar power?
- What are the challenges for the integration of ever-increasing portions of RE in the Brazilian electricity grid? What are appropriate market regulation measures to ensure a stable grid?
- What has been the impact of non-state stakeholder participation in the various advisory bodies to the government? Did their participation contribute to the mobilisation of efforts among the various non-governmental stakeholders or did it block a further development of RE/EE-friendly policies?
- What are the advantages (and disadvantages) of the methodological approach represented by the annually updated ten-year energy expansion plans? How well have they served policymakers in guiding their energy policy decisions? And what are the exact formats used for monitoring the progress and success of policies and – if necessary – for revising those that have been judged unsuccessful?

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8 Annex

8.1 Natural conditions for solar and wind energy

Figure 24: Solar irradiation map of Brazil

Source: (Solargis, 2014)

8.2 The Brazilian Auctioning System

Table 6: Major characteristics of the auctions in Brazil

Legal basis	Laws 10,847 and 10,848 adopted in 2004
Authorities in charge	Government: Ministry of Energy and Mines (MME), Executive body: Electricity Regulatory Agency (ANEEL)
Eligible technologies	Auctions can be technology-specific (e.g. biomass-only auction in 2008 and wind-only auctions in 2009 and 2010), multi-technology (wind, small hydro and biomass in 2007 and in 2010) and technology-neutral (carried out regularly since 2005, where all RETs have been participating since 2011). ANEEL determines which RET are eligible in auctions and they can compete with conventional power (as in the case of the 2011 auction)
Selection process	Pre-requisite to bid for projects: prior environmental license; grid access approval; technology-specific documents (such as fuel contracts for biomass and certified production for wind). Selection in 2 stages: stage 1 descending price clock auction; stage 2: final pay-as-bid auction
Agenda of auctions	New energy auctions annually based on forecast energy capacity needs. These auctions are technology-neutral but the government can determine the eligible technologies, thus allowing exclusive participation of RE. Reserve auctions are held at the discretion of the MME. Typically, one reserve energy auction is held for RE-based power generation every year, but this is not the rule.
Duration of tariff	Typically 20 years for wind; 20 years for biomass; 30 years hydro
Compliance	Long list of technical documents to participate. Bidders have to deposit several guarantees, including a bid bond of 1% of project's estimated investment cost and a project completion bond of 5% of project's estimated investment cost. Penalties for delays and under-production. Contract termination for delays of more than one year.

Source: (IRENA, 2013, p. 19)

Table 7: Summary of volumes and prices in Brazilian RE auctions (2007-2012)

NAME OF AUCTION	AUCTION TYPE	TECHNOLOGY	TOTAL CAPACITY (MW)	AVERAGE PRICE (USD PER MWh)
1st Alternative Energy Auction 18-Jun-07	Alternative Energy	Small Hydro	97	71.04
		Biomass	541	73.07
1st Capacity Auction (Biomass) 14-Aug-08	Technology Specific	Biomass	1284	36.50
2nd Capacity Auction (Wind) 14-Dec-09	Technology Specific	Wind	1806	84.79
3rd Capacity Auction 26-Aug-10	Technology Specific	Small Hydro	30	74.70
		Biomass	648	76.84
		Wind	528	70.10
2nd Alternative Energy Auction 27-Aug-10	Alternative Energy	Small Hydro	101	83.69
		Wind	1520	78.81
		Biomass	65	76.83
12th Energy Auction 17-Aug-11	Technology Specific	Wind	1068	62.84
		Biomass	198	64.65
4th Capacity Auction 18-Aug-11	Alternative Energy	Wind	921	62.27
		Biomass	297	62.32
13th Energy Auction 20-Dec-11	Technology Neutral	Wind	977	56.9
		Biomass	100	53.76
		Large Hydro	135	49.47
14th Energy Auction	Cancelled			
15th Energy Auction 14-Dec-12	Technology Neutral	Wind	289	42.09
		Large Hydro	294	42.42

Source: (IRENA, 2013, p. 20)

8.3 National Energy Plan 2030

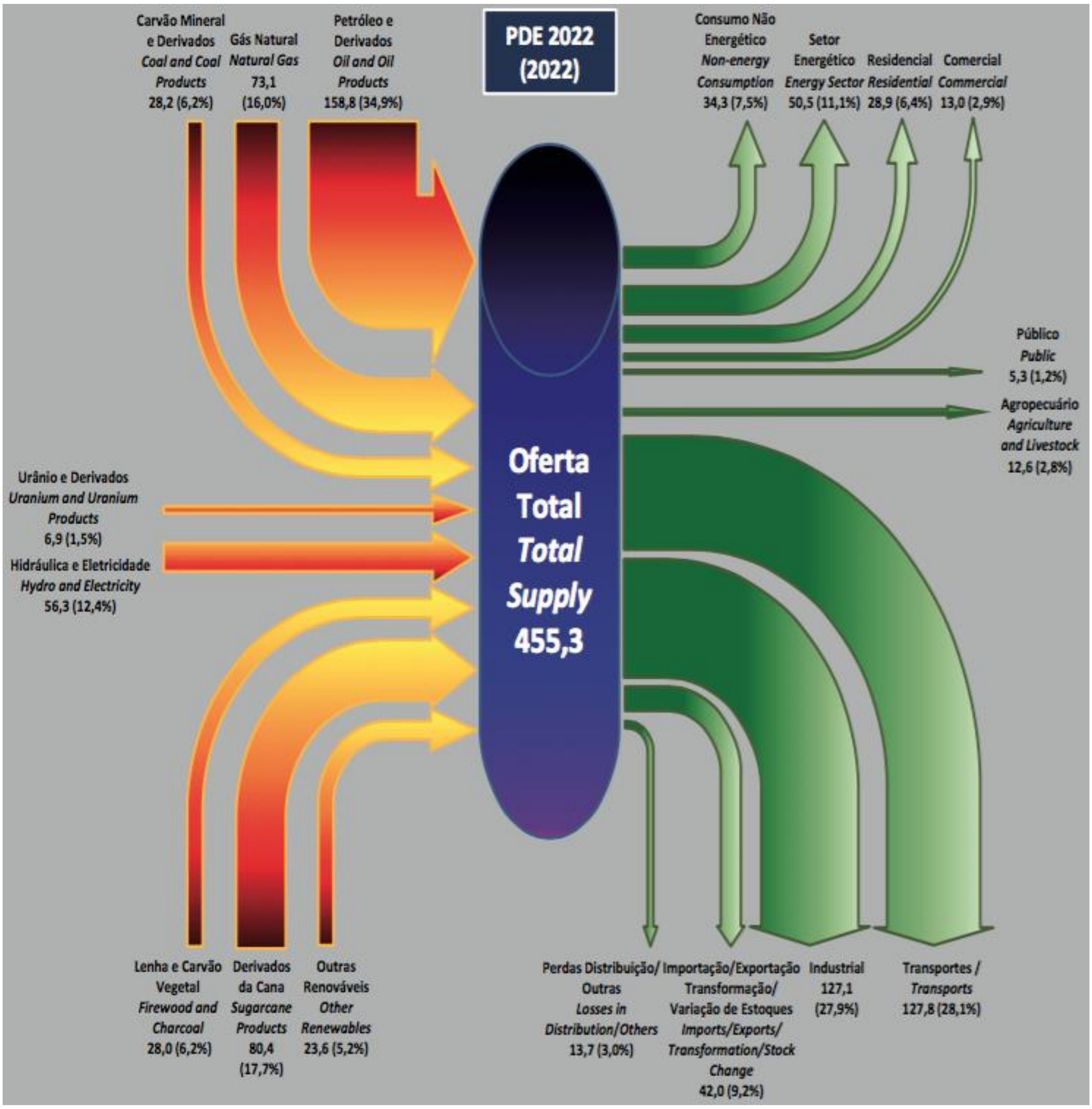
Table 8: Main indicators of the National Energy Plan 2030

	Unidade	2005	2030
PIB	US$ bilhões [2005]	796,3	2.133,2
População	milhões de habitantes	185	239
Renda per capita	US$ [2005]/hab	4.330	8.925
Reservas de petróleo	bilhões de barris	11.775	19.450
Produção de petróleo	mil barris por dia	1.632	2.960
Consumo de petróleo	mil barris por dia	1.700	2.924
Capacidade nominal de refino	mil barris por dia	1.916	3.640
Produção total de óleo diesel	milhões de litros	38.396	107.491
Diesel de petróleo	*milhões de litros*	*38.396*	*90.642*
H-Bio	*milhões de litros*	*0*	*5.104*
Biodiesel	*milhões de litros*	*0*	*11.745*
Consumo de óleo diesel	milhões de litros	40.421	97.876
Consumo de gasolina	milhões de litros	17.712	42.190
Reservas de gás natural	bilhões de m^3	306	1.654
Produção de gás natural	milhões de m^3/dia	48	252
Consumo final de gás natural	milhões de m^3/dia	57	267
Importação de gás natural	milhões de m^3/dia	25	72
Produção de etanol	milhões de litros	16.040	66.570
Consumo de etanol	milhões de litros	13.990	54.700
Produção de eletricidade[1]	TWh	441,9	1.197,6
Geração hidrelétrica[2]	*TWh*	*335,7*	*817,6*
Geração a gás natural	*TWh*	*13,9*	*92,1*
Centrais nucleares	*TWh*	*9,9*	*51,6*
Centrais eólicas	*TWh*	*0,1*	*10,3*
Cogeração biomassa da cana	*TWh*	*0,0*	*33,5*
Consumo de eletricidade	TWh	375,2	1.032,7
Consumo residencial	*TWh*	*83,2*	*283,3*
Consumo industrial	*TWh*	*175,4*	*455,5*
Oferta interna de energia	milhões de tep	218,7	555,8
Energia renovável	*milhões de tep*	*97,3*	*248,5*
Energia não-renovável	*milhões de tep*	*121,4*	*307,3*
Demanda de energia per capita	tep/hab	1,187	2,326
Intensidade energética	tep/mil US$ [2005]	0,275	0,261
Consumo de eletricidade per capita residencial	kWh/hab	452	1.188

Source: (EPE, 2007)

8.4 Ten-Year Energy Expansion Plan 2022

Figure 25: Brazilian energy balance: Energy flows in 2022 (in thousand toe)



Source: (Ministry of Mines and Energy, 2013b)