mKETs-PL working document

Country report Brazil

Date:	August 23, 2013
Authors:	CEA, TNO
Number of pages:	19
Number of Annexes:	

The project partners of the mKETs-PL consortium are:

- Netherlands organisation for Applied Scientific Research TNO
- Fraunhofer-Gesellschaft
- Commissariat à l'énergie atomique et aux énergies alternatives (CEA)
- Cambridge University-Cambrigde enterprise
- VTT
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Content

1. Policy perspective

This chapter describes the policy initiatives implemented by the Brazilian government addressing Key Enabling Technologies. The main actors of the Brazilian Innovation System involved in KETs are describes as well as the policy and corresponding instruments supporting them.

1.1. Country specific innovation system with emphasis on KET

Brazil is the largest country on the Latin America continent with an area of 8.5 million km²; and a population of 190,732,694 (2010) accounting for about 33% of Latin America's population. Brazil is a federation composed of 26 federal States plus the Federal District (Distrito Federal, which contains the capital city, Brasília) and a total of 5,565 municipalities. Each of these entities has specific roles and responsibilities in the innovation system. But within the framework of this report we focus on the federal government as it has the most relevant role with respect to supporting (enabling) technologies.[1]

Brazil's GDP in 2011 reached €1,607.1b (R$4,143b), the world's 6th largest (7th in 2010) and the second largest among the BRICs, after China. Its GDP per capita in 2011 was €8,425.7 (2010 population). The country's average GDP growth between 2005 and 2010 was 4.23%, the lowest among the BRICs and the 7th in Latin America. The country's GDP growth in 2011 slowed to 2.7%, from of a high 7.5% in 2010 (see ***Error! Reference source not found.***). This growth resulted from expansion in family consumption (4.1%), followed by growth in agro-husbandry production (3.9%) and in services (2.7%). The industrial sector growth was much smaller (1.6%) and within it manufacturing industry almost stagnant (0.1%). The growth rate of the GDP per capita in 2010 was 6.5% (the highest since 1980).

The capacity of the Brazilian Innovation system seems limited in comparison to the EU, as for example reflected in expenditure on R&D by different actors in the system.[2] In 2009, total R&D intensity (GERD/GDP) was 1.17% (EU27: 2.02%). BERD went from 0.51% of GDP in 2006 to 0.56% in 2009 (EU27: 1.24%). HERD as a share of GDP equaled 0.18% in 2010 (EU27: 0.48%). Also in terms of the characteristics of the science base, business R&D

[1] The federal government is largely responsible for higher education. (An exception is the state of São Paulo, where the state-level higher education system is much larger and important than the federal one.) Primary (basic) mandatory education is a shared responsibility of states and municipalities. While municipalities are responsible for pre-school (childhood) education the states are responsible for secondary (middle school) education.
In terms of research, there is no specific responsibility for the states, but all fund S&T, mainly through scholarships and research projects, via their so-called research support foundations (FAPs). Their resources for research funding come from a state constitution mandate determining a percentage of gross fiscal revenues (in the case of the oldest foundation (1960), Fapesp of the state of São Paulo, which also receives additional revenues from a state endowment, the share is 1%). The 24 FAPs in 24 states and in the Federal District (only the two states of Roraima and Rondônia do not yet have a FAP) are usually linked to a state secretariat of S&T, development or planning. In recent years, several FAPs have also supported thematic network-based projects and even more recently, innovation projects in cooperation with universities and research organisations, or in the form of direct grants to firms. Up to March 2012, 16 states had promulgated a state Innovation Law, three had drafted a project and the Federal District is in the process of approving its law. A handful of those states established innovation funds to provide competitive grants to firms.
In 2010, the share of States' GERD of total GERD was 16% (or 0.19% of GDP; down from 16.26% in 2007 or 0.18% of GDP), but without expenditures with postgraduate education it was 5.70% (5.89 in 2007). There has been a continued effort on the part of the federal government to decentralise research and innovation funding towards the FAPs.

[2] Data for Brazil are for 2009. No recent allowing for comparison with EU data are available.

and innovation, entrepreneurship, knowledge flows and commercialization and human resources Brazil lags behind the OECD average (see Figure *1*).[3]

	2010	2011	2012	2013	2014
Real GDP growth	7.5	2.7	0.9	2.9	3.5

Table 1: Economic development in Brazil.
Note: Real GDP growth and inflation are defined in percentage change from the previous period.
Source: OECD Economic Outlook, Volume 2013 Issue 1 - No. 93

Brazil's research system is still mainly funded by the public sector (51.6% of GERD in 2009 – further to 52.7% in 2010 estimate, slightly up from 49.9% in 2006). Conversely, the share of the private sector decreased from 50.1% of GERD in 2006 to 48.4% of in 2009, and further to 47.3% in 2010 estimate. The federal government continues to be the main source of public funds with 69% in 2009 (71.2% in 2006). There have been strong efforts by the 27 units of the federation (26 states and 1 federal district) to increase R&D funding, thus their share of GERD increased from 14.4% in 2006 (or 30.4% of public expenditures to 16.0% in 2009 (same in 2010 estimate; again 30.4% of public expenditures). However, this growth was skewed, for in these states' expenditures the share of expenditures with graduate education grew considerably from 58.4%% to 61.5% over the period (reaching 64.4% in 2010 estimate. That is, their actual expenditures on R&D are declining.

Brazil has 180 universities (2010), 59 of them public federal. They conduct the majority of all research executed in Brazil (50-60% of total R&D), employing 57% of the researchers and 93% of doctorate holders. Institutional funding for public federal universities is provided by the Ministry of Education budget (€2,631m, 16% of GERD, distributed as follows: 53% public federal institutions, 40% public state institutions 7% private institutions (2010)). Private sector funding has been growing in recent years, albeit from a relatively small volume and financial base. Business expenditures on post- graduate education in 2010 were €192 (R$495m).

There are no Brazilian universities in the 2010 Shanghai top 100 HE index. The first Brazilian university to appear in the 101-150 ranking is the University of São Paulo. It is also the only one to appear in the Times Higher Education 2012 World Reputation Rankings, in the 61-70 bands. Further, in 2011, the University of Sao Paulo was the first Ibero-American institution in the Times Higher Education World University Ranking's top-200 (Position 178 in the World).

Public universities conduct the majority of all university-research.[4] Private universities are much less involved in R&D.[5] Very few of the research universities are involved in contract research for industry. In some universities some department and areas have developed stronger linkages with industry, as for example in the case of oil and gas exploration, where the leading state company Petrobrás has developed strong ties with both the federal university UFRJ, (particularly with its engineering graduate programme COPPE in ocean and platform engineering), as well as with PUC Rio (particularly in the area of computer graphics). Over the last few years, due to government university-industry research promotion programmes, the expansion of Petrobrás university cooperative programme as well as the entry of several other large, national and multinational, firms (Vale, CSN, Braskem, Oxiteno and Natura among others) and government incentives for universities to become more innovation-oriented, the number of research universities actively involved in science and technology transfer has increased.

[3] In 2008, the number of tertiary-level students (5,080,056) as a share of the population (189,613,000) was 2.68%. The preferred studies were: Social Sciences, Business and Law (42.6%), Education (16.2%), Health and Social Services (15.5%), Engineering, Industrial Engineering and Civil Engineering (9.2%) and Science, Mathematics and Computer Science (8.5%).
[4] Well known examples are: University of São Paulo USP; University of Campinas UNICAMP; UFRGS in Rio Grande do Sul; UFSC in Santa Catarina; UFMG in Minas Gerais; University of Brasilia UnB in the Federal District.
[5] The Pontifical Catholic University of Rio de Janeiro (PUC Rio) is the country's most important private research university.

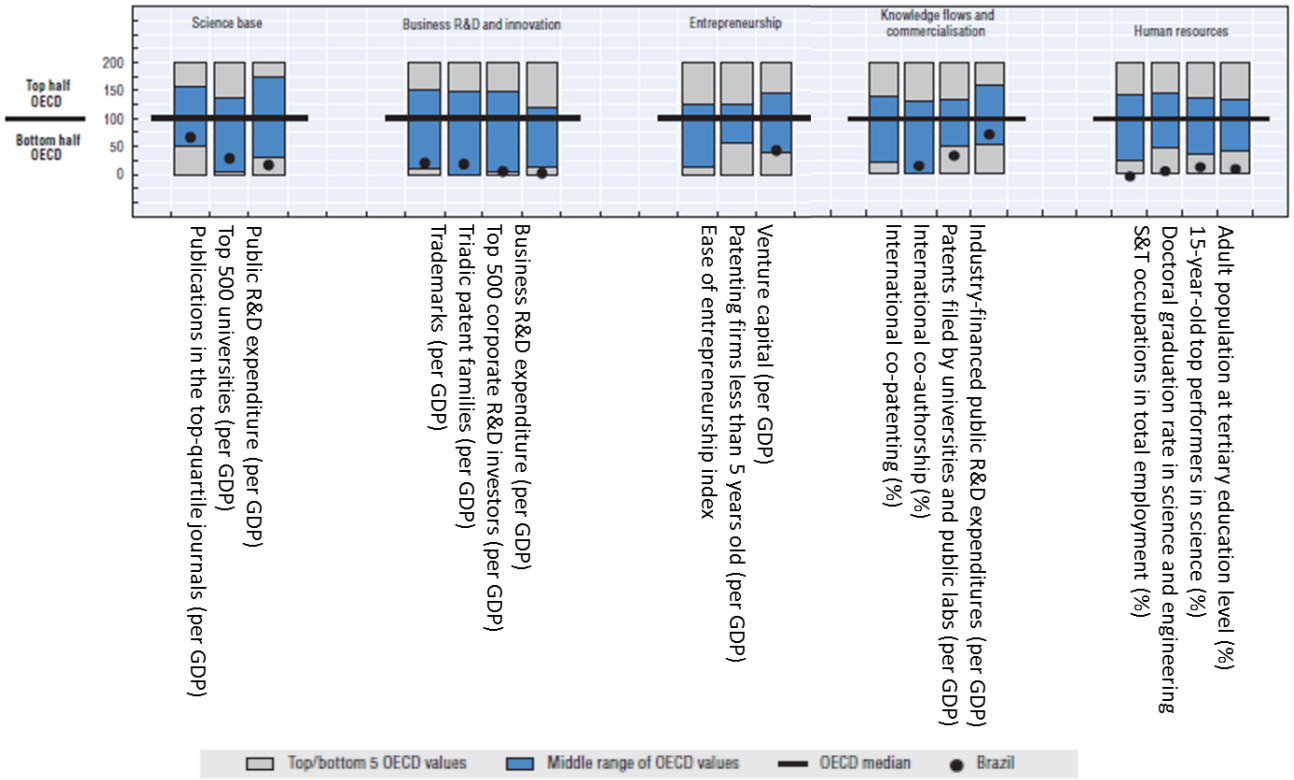

Figure 1: Science and innovation in Brazil.[6]
Note: Normalized index of performance relative to the median values in the OECD area (Index median = 100).
Source: OECD Science Technology and Industry Outlook 2012.

[6] In addition to the missing data on patenting: the number of Brazilian patents filled at the USPTO grew from 375 in 2007 to 568 in 2010 (as a comparison: Mexico 295 and India 3,789); and patents awarded from 118 to 219 (Mexico 115 and India 1,137). In 2008, Brazil had 0.2% of triadic patents (WIPO). The number of patents filed at the Brazilian intellectual property office (Instituto Nacional de Propriedade Industrial INPI) rose from 25,406 in 2006 to 28,052 in 2010.

The Brazilian innovation survey PINTEC 2008 (covering period 2005-2008) indicates a positive trend in the number of innovative firms in Brazil (in comparison to the period 2003-2005, the number of innovative firms increased from 30,377 to 38,299 in a sample of 100,000firms). The share of industrial firms developing advanced technological innovation remained quite small albeit growing from 2.7% in 2003 to 4.1%. While the number of firms doing R&D fell from about 5,000 in both 2003 and 2005 to 4,300 in 2008, the number of those doing R&D internally, continuously grew from 2,400 in 2003 to 3,000 in 2008.

Pintec 2008 also indicates that the automotive sector accounts for about one-fourth of industrial R&D and has the highest innovation rate of 83.2% (i.e. percentage of firms involved in innovation) - higher than the overall (industry and selected services) innovation rate of 38.6% and that of the industrial sector of 38.1%. The subsequent sectors are: pharmaceutical and pharmaceutical-chemical products (63.7%), other optical and electronic products (63.5%), chemical products (58.1%), communications equipment (54,6%), peripherals and information technology equipment (53.8%), machinery and equipment (51.0%) and electronic components (49.0%). Below the industrial sector average, there is only one of the medium-high sectors with transportation equipment (36.1%). All other industries belong in the low technology sectors. Those with the lowest innovation rates are extractive industries (23.7%) and wood products (23.6%).

There are furthermore different initiatives establish a link between Industry and the public research infrastructure:[7]

- The 2005 Innovation Law and subsequent modifications supported the creation of Knowledge Transfer Office (KTO) at universities (Núcleo de Transferência de Tecnologia NIT) and created the possibility for federal public academic researchers to establish a start-up firm without losing institutional tie and public employee retirement benefits.
- In 2006, MCTI supported the creation of the National Forum of KTO Managers (Fórum Nacional de Gestores de Inovação e Transferência de Tecnologia FORTEC).

Involvement of the business sector in the governance of universities and Public Research Organisations is non-existent in the public sector. There are a few exceptions in private research universities, where representatives from the private sector can join the university boards.

The Brazilian Innovation System is supported by an industrial policy called Greater Brazil Plan 2011-2014 (Plano Brasil Maior), implemented on August 4th 2011. As stated by President Dilma Roussef during its launch: “The plan reaffirms and expands the government commitment to innovation with its slogan: ‘Innovate to compete. Compete to grow.’”

This policy addresses an important issue faced by the Brazilian industrial sector, and that is the difficulty of competing with imported goods at a time when the exchange rate went as low as R$1.5359 for every US$1 or R$0.6913 for every €1. The plan’s underlying diagnostic refers to an adverse international context; global economic crisis; continuing fall in Brazilian manufacturing exports; absence of domestic sector full recovery from the 2008 crisis, with a few rare exceptions; and deepening of exchange rate war and predatory competition. Therefore its main drive is to promote Brazilian firms’ capability to develop innovative products and services, and expand technology skills rather than rely on agricultural and mineral commodities. The policy measures and programs are intended to complement government’s foreign exchange actions.

[7] Monitoring and reporting of Knowledge Transfer activities is carried out by the MCTI. Public research institutions with KTOs have the legal obligation to provide information to the MCTI on their patenting and licensing activities annually. For the few private ones which receive support this is voluntary. In 2008, of the 101 institutions that provided patenting information (82 public and 19 private) to MCTI, 67 had filed for patents (1,021 patents filled in Brazil (INPI) – versus 767 in 2007- and 112 patents filed abroad (not specified where) – versus 93 in 2007) and 31 had been granted patents (146 in Brazil – versus 122 in 2007 - and 21 abroad – versus 10 in 2007).

This industry policy (i.e. Plano Brasil Maior) is supported by a government wide dedicated R&D&I policy: the National STI Strategy 2012-2015 (*Estratégia Nacional de Ciência, Tecnologia e Inovação 2012-2015* ENCTI). The overarching strategic goal is to achieve a sustainable development with R&D&I as its main driver. The strategy addresses five challenges:

- reduce the scientific and technological gap that still separates Brazil from developed nations;
- expand and consolidate Brazilian leadership in the natural knowledge economy;
- enlarge the basis for environmental sustainability and the development of a low carbon economy;
- consolidate a new pattern of international insertion for Brazil;
- and overcome poverty and reduce social and regional inequalities.

In order to address these issues, the ENCTI identifies three main drivers addressing the abovementioned challenges: promotion of innovation, human resources training and capacity-building, and strengthening the R&D&I infrastructure. The related improvements in policy are aimed at refining the innovation regulatory framework, refining and enlarging R&D&I funding structure and strengthening the National Science, Technology and Innovation System (*Sistema Nacional de Ciência, Tecnologia e Inovação* SNCTI).

The subsequent targets of ENCTI are:

- increase GERD - in 2014 GERD/GDP index will reach 1.8 compared to 1.16 in 2010;
- increase BERD (a goal shared with the Greater Brazil Plan)– in 2014 BERD/GDP index will reach 0.9 compared to 0.56 in 2010;
- increase the innovation rate (share of industrial firms involved in innovation) in 2014 to 48.6%, compared to 38.6 in 2008 (latest year available from national innovation survey PINTEC);
- increase the number of firms doing continuous R&D to 5,000 from 3,425 in 2008 (excludes state firms. PINTEC);
- double the number of innovating firms to 12,260 by 2014 (from 6,300 in 2009-2010);
- increase the percentage of innovating firms that make use of at least one of the government innovation support measures to 30% in 2014 compared to 22.3% in 2010.

The most prominent ministry involved in the formulation of R&D&I policy in Brazil is the Ministry of Science, Technology and Innovation (MCTI), This ministry originates from 1985, and at that time focused primarily on supporting the (public) research infrastructure. Since August 2011 it also addresses innovation (and as a consequence "Innovation" was added to its name). An inter-ministerial advisory agency for industrial policy (*Agência Brasileira para o Desenvolvimento Industrial* ABDI) was created in 2006, under the executive management of MDIC to align policy supporting the Brazilian Innovation System.

The most relevant funding agency for research is the National Council for Scientific and Technological Development (CNPq). In practice, the institutional features and competitive funding pattern of the Brazilian public research infrastructure haven't changed much since the creation of CNPq in 1951.[8]
The counterpart innovation agency under MCTI is the Studies and Projects Financing Agency FINEP, which administers (since 1971) the main block fund for innovation funding, financing and risk financing: the National Fund for Scientific and Technological Development (FNDCT, created in 1969). Both agencies fall under the MCTI.

With the FNDTC, the FINEP manages the most relevant instrument addressing KETs. Under the umbrella of FNDTS, seventeen sectorial funds are in operation.[9] Thirteen of these funds allocate financial support exclusively to specific sectors and are denominated in the programmatic structure of vertical actions. Two

[8] The few changes concern a partial privatisation in the 1990s of a few public research centres in electric energy and telecommunications research.
[9] Fifteen funds are linked directly to the FNDCT and two administered by other agencies of the Federal Government (i.e. the Fund for the technological development of telecommunications (FUNTTEL) and the Audio-visual Sector Fund (FSA), to which FINEP serves as the financial agent).

funds are transversal, since they may support projects of any sector of the economy – the Yellow Green Fund (FVA) and Infrastructure Fund (CT-Infra). Of the two transversal funds, the FVA is geared to support University-business interaction, while the CT-Infra supports the improvement of infrastructure of scientific and technological institutions (ICTs).

Important to mention in this respect are also the innovation finance programmes implemented by the National Bank for Economic and Social Development (BNDES) that falls under the Ministry of Development, Industry and Foreign Trade (MDIC). These programmes are both horizontal and sectoral (for example, for the software and pharmaceuticals industries), and include a university-industry cooperation fund (Funtec), and risk financing innovation programmes, including a seed capital programme (Criatec).

ENCTI total planned public (federal and state governments – state research support foundations FAPs, and state companies) expenditures over the period 2012-2015 total €28.8b (R$74.6b) distributed according to the main sources: MCTI (39.1%), Ministry of Education MEC/Capes, higher education promotion agency (16.8%), FAPs (13.7%), Ministry of Development and Foreign Trade MDIC/BNDES, national state bank for economic and social development + Inmetro, national institute of standards and metrology (9.7%); MME/Petrobrás, oil and gas, and Eletrobrás, electricity generation and transmission state companies (8.9%), Ministry of Defence MD (5.3%), Ministry of Health MS (2.8%), Ministry of Agriculture, Husbandry and Supply MAPA/ Embrapa, state agricultural research enterprise (2.6%).

ENCTI priority programmes are: ICT, Pharmaceuticals and the Health Industry Complex, Oil and Gas, Defence Industrial Complex, Aerospace, Nuclear, Innovation Frontiers (biotechnology and nanotechnology), Promotion of Green Economy (renewable energy, climate change, biodiversity, and oceans and coastal zones) and Science, and Technology and Innovation for Social Development (ST&I diffusion and improvements in science education, productive inclusion and social technology, and technologies for sustainable cities).

Brazil's scientific cooperation with the EU is based on a Scientific and Technological Cooperation Agreement signed in 2004, confirmed in 2006, and validated in a strategic pact signed in 2007. In the second half of 2011 and again in the first half of 2012, the EU and the Brazilian government held meetings to discuss the advancement of their cooperation in the area. Since the validation of the Agreement in 2007, the EU and the Brazilian Government held meetings every year to discuss the advancements of their cooperation in the area.

1.2. Organisation of mKETs policy

As indicated above, the Brazilian government has adopted a thematic focus in R&D&I policy . The concept of KETs (or mKETs) however is not embraced as a basis for support of the Innovation System. Attention is given to enabling technologies, that are in practice also included in KETs (i.e. biotechnology and nanotechnology). Policy furthermore focusses on specific sectors in the economy, that are either strong (e.g. Oil and Gas), have an enabling character (e.g. ICT), or have an impact on a changing society (Pharmaceuticals and the Health Industry complex).

1.3. Main policies for Pilot lines

Brazil does not have a dedicated policy aimed at supporting the set-up of pilot lines. It does however have several initiatives that (could) have the potential to support pilot lines, or address barriers associated with the set-up of such facilities:

- The ENCTI is an overarching strategy with various corresponding initiatives (i.e. supporting interventions). Relevant in this perspective are the strategic activities linked to the specific challenge 'Promotion of Innovation in Firms'. Its corresponding objective is to 'Expand the business participation in the country's

technological efforts, with a view to improving the competitiveness in national and international markets'. Specifically mentioned is the expansion of links between universities, research centres and companies in the development of innovative technologies, with emphasis on the final phase of product development, mainly through the creation of an strategic institution oriented towards industrial innovation — Brazilian Research and Industrial Innovation Enterprise (EMBRAPII) – in partnership with the National Industrial Confederation (Confederação Nacional da Indústria, CNI).

- The ENCTI furthermore includes an action line referring to "Strengthening Research and Scientific and Technological Infrastructure," particularly in the North, Northeast and Midwest regions, without compromising the level of excellence achieved in the Southeast and South regions. Although funding seems to focus primarily on university research infrastructure, important to mention are the research programmes of Ministry of Mining and Energy under the responsibility of the government controlled oil and gas company Petrobrás.
- The interaction between research institutions and SMEs is aimed to improving with Sibratec programme. The Sibratec umbrella programme launched in 2007 aims to support business technological development through promotion of research and development activities for innovation and supply of metrology and technological extension, assistance and transfer services. Its operation is through different networks of local agents catering to local productive requirements. Between 2007 and 2009, with resources from FNDCT / Sectorial Funds, Sibratec invested €122.3m (R$304m) in the implementation of eight technological extension state networks, six thematic innovation centres and 18 technological services networks involving 54 institutions and 527 laboratories. Sibratec is made of three types of network.
    1) Innovation Centres, composed of universities and research institutes with experience in business interactions. Its objective is to transform knowledge into commercially feasible prototypes for the creation of new technology-based firms or incremental innovation in existing firms.
    2) Technological Services Institutes for the provision of metrology, norms, calibration, conformity analysis and essays through the articulation and modernisation of existing entities and networks.
    3) Technological Extension network to stimulate demand for specialised innovation assistance through consultants to make business diagnostics, propose solutions and prepare research projects for submission to research institutes.

2. Business perspective

The major industry sectors of Brazil are extractive industries, agriculture, forestry, textiles and aeronautics. Brazil has been able to maintain a positive trade balance since 2001, primarily driven by exports of mineral ores and agricultural products. However, the economic slowdown is taking its toll on Brazilian exports, leading to a trade deficit for the first half of 2013. As commodity prices have fallen on soft demand, the strong reliance of Brazil on worldwide consumption of raw materials, especially by China, has been particularly painful for the economy. Brazil is showing renewed interest in transitioning from a commodities based economy to a value-added, manufacturing based economy.

Brazilian businesses have traditionally been faced with complex business conditions, including high interest rates, volatile exchange rates and difficulty to access capital markets. High market volatility faced by domestic businesses interferes with the long term resource commitment required for continuous R&D&I. As a consequence, firms are often fighting to maintain market share on a first order, while innovation becomes a secondary priority.

In the context of crisis recovery, a more systematic approach of incentives to innovation has been undertaken. In 2011 the newly elected President, Dilma Roussef, launched a massive inter-ministry development program called Plano Brasil Maior, to be supported by the Brazilian Innovation Agency FINEP and the public investment bank BNDES. The business sector openly endorsed the program, especially the government intention to actively regulate interest rates, exchange rates, import duties and regulatory controls in order to provide a positive environment for domestic industries.

The Brazilian market continues to expand as the population shifts from poverty to the middle class and demand for consumer goods increases. As the standard of living improves, the expectation of the population on the level of service of government services also increases. The Brazilian government strives to provide a high level of service to populations throughout the country, even in remote areas. A major challenge for public procurement is to acquire state-of-the-art equipment and services while still supporting domestic suppliers. In healthcare, for example, most hospitals are equipped with the most recent, sophisticated medical imaging equipment, although most equipment comes from abroad. Striking a balance between level of service to the public and patronage to domestic suppliers is a continual challenge for the Brazilian public service.

2.1. Implementation of multi-KETs pilot lines

Key enabling technologies have been identified by MCTI as areas of interest for research programs, and several dedicated R&D programs are in place (nanotechnologies, biotechnologies, microelectronics, etc.) But while key enabling technologies are seen as an important element for the future competitiveness of Brazilian industry, relatively few existing pilot lines involve KETs, and even fewer could be considered multi-KETs. Most KETs activities remain at the level of R&D, while priorities for Brazilian industrial development require more macro level measures at the present time.

Nevertheless, pilot lines are an integral part of industrial development in Brazil. Most existing pilot lines identified in Brazil have been made possible through coordinated actions of public authorities. The most typical cases of pilot lines involve industry sectors that have been identified by the government as strategic, but where key competencies or resources are considered to be lacking on the part of industrial actors. In general, FINEP, BNDES and other federal government agencies are called upon to help finance the investment and structure the general implementation.

The health industry in Brazil represents 8% of the GDP, with a strong dependency on imported products which results in a trade deficit of € 6.5 billion a year (2010). A major part of this deficit, around € 3.5 billion, is for acquisition of medications. In response to the need for local production of strategic products, the Brazilian government will typically sign agreements for the development of production capability with players from the private and public sectors, including companies, foundations, universities and institutes. From 2002 to 2009, the primary focus of government actions was on developing generic drugs, first with pilot production, then engaging mass production. The National Bank for Economic and Social Development (BNDES) provided over € 1 billion to finance generic drug production facilities. Following the successful development of generic drugs, with domestic production increasing more than ten-fold from 2003 to 2009, nine new public-private partnership agreements were set in 2009 for development of other strategic medicines, an initiative that is supported by a commitment of € 1.5 billion in government purchases through 2014.

In the interest of national health, Brazil has implemented a similar strategy for the production of vaccines. In 1989, the federal government approached the Institute Butantan, a public health institute of the state of Sao Paulo dating to 1909, to inquire about supplying the government with large quantities of vaccines. Because of constraints caused by the public status and complicated investment regulations of the institute, the state decided to create a private foundation in direct relation to the Institute Butantan. The creation of the Butantan Foundation provided the legal framework for integrating large scale investment in pilot scale and later mass production for commercial exploitation of vaccines developed by the Institute. The Butantan Instititue today produces a wide array of vaccines which are provided to the Ministry of Health free of charge, with excess capacity sold to other countries through the Butantan Foundation.

A similar legal structure and operating model for production of infectious disease testing kits exists between the Foundation Oswaldo Cruz (Fiocruz) and the production of the Institute for Immunobiology (Bio-Manguinhos), which also supply the National Health System with test kits free of charge. In both cases, pilot lines have been largely financed by government agencies through the foundations.

Development of ICT (Information and Communication Technologies) represents a formal objective of MCTI, as attested by the “IC-Brazil” program which is chartered to develop Brazil’s domestic microelectronics industry. Significant progress has already been made in the past decade, including the establishment of the first pilot production line for microelectronic chips with the creation of the public Brazilian company CEITEC SA. The activity began in 2003, with the launch of the National Center for Advanced Electronics Initiative by the government to study the most efficient method to promote microelectronics industry development in the country. In 2005, a design center was co-financed in collaboration with Motorola and local and regional governments in Porto Alegre. A microelectronics pilot line was foreseen by the center as a means to validate designs on real chips, and in parallel, the national government recognized the benefit of having domestic manufacturing capability of custom microelectronic chips for national security. Consequently, a complete 6 inch manufacturing line was purchased from Motorola with national funding and transferred to Porto Alegre. Launched as CEITEC SA in 2008, the line has produced several successful chip designs, including the famous “Chip do Boi”, a bovine identification and tracking chip now in mass production at xFab in Germany. The new passport identification chip for Brazilian passports will also be designed and produced by CEITEC. The production capacity of the pilot line is currently 100 million chips per year.

Even in non-KET industries, pilot lines provide the stepping stone from prototype / early stage to the full scale production facility. A common use of pilot lines in Brazil is for the introduction of new manufacturing or assembly lines coming from foreign sources. For example, foreign automobile manufacturers will build a pilot line in Brazil through their local subsidiary to test the assembly of a new model before launching a full scale assembly plant for market introduction. The pilot line allows for qualification of the assembly process with local personnel and equipment, as well as qualification of local suppliers which can increase the “made in Brazil” content of the finished product and avoid heavy import duties.

As a general rule, pilot lines in Brazil which are successful have the following characteristics:

- The pilot line corresponds to a need identified by the government as a priority for the nation
- The ownership and decision making responsibility remain Brazilian
- The supply chain and ecosystem are to a large extent Brazilian and function with the same market conditions
- The pilot line has a very specific objective and is operated as a competitive entity
- The return on investment is first and foremost expected in Brazil

2.2. Evaluation of KET polcies/KET innovation eco-System

The innovation eco-system of Brazil is still in the "growing" stage, as would be expected for an emerging country. The majority of activity is directly dictated by government policy, with measures articulated around sectorial focused funding. Interaction between industry and RTOs/academia remains limited unless stimulated by government agencies or direct funding.

Brazil has recognized the need to improve the competitiveness of domestic companies in high tech sectors and has increased significantly the development funding of FINEP and BNDES in recent years. Nevertheless, Brazil continues to have a significant trade deficit for high tech goods and services, in particular KET based products. The new industrial policies set forth in the Plano Inova Empresa are aimed at changing this trend by focussing on innovation in a number of key sectors, backed by exchange rate and regulatory controls.

The Inova Empresa program builds on previous experience in innovation policy by bringing together the main factors which lead to successful industrial development in Brazil, including:

- Project leaders must be industrial companies of significant size (market leaders)
- Project consortia bring together all actors of the value chain (research, education/training, industry, trade associations, regulatory groups,…)
- The scope (size, budget) of projects will be quite large by comparison to previous programs
- There are no limits on the maturity of the technology, TRL levels can be high
- The objectives of the projects are market driven
- Most projects are expected to include full scale manufacturing

Initial calls for proposals were launched in early 2013 with an overall budget of € 11.8 billion (R$ 32.9 billion), including € 8.2 billion from FINEP and BNDES, of which € 7.5 billion will be low interest loans.

The plan is structured by industrial sectors, the most significant being:

a. Energy: € 2 billion
b. Oil & gas: € 1.5 billion
c. Health: € 1.3 billion
d. Agriculture: € 1.1 billion
e. Aerospace & defence: € 1 billion
f. ITCs: € 0.75 billion
g. Socio-environmental sustainability: € 0.75 billion

One of the barriers for implementing KET pilot lines in Brazil has been access to high technology, both in the form of patents and availability of highly trained personnel. The government acknowledges this shortfall and has initiated collaborations with foreign governments, RTOs and companies in efforts to overcome this handicap. Many organisations have been allowed to set up local offices and bring their know-how and

methodologies to the local Brazilian market. In most cases, the Brazilian government retains a majority share in the local subsidiary as a safeguard to proper conduct according to local customs.

In 2010, IBM opened a local research lab in cooperation with the Brazilian Government, its first research lab in Latin America and its first new one in the past 12 years. Chinese companies are also investing in R&D activities in Brazil. In 2011, also within the framework of a government agreement, the Chinese ZTE announced the construction of a 2000 person technology park in Campinas, the 'Brazilian Silicon Valley' in the State of São Paulo. In the same year, the Brazilian government signed a deal with the Chinese Academy of Sciences to build a nanotechnology center in Campinas.

European RTOs have been a prime target for integration into the Brazilian innovation system. CSEM opened an office in 2006 with majority participation from Minas Gerais. In 2011, the German public research institute Fraunhofer announced its establishment in Brazil with two offices. Scandinavian countries also increased recently the presence in Brazil with the Norwegian Sintef creating Sintef's Brazilian Research Center, the Swedish Lindholmen Science Park supporting the creation of the 'Centro de Pesquisa e Inovação Sueco-Brasileiro' (CISB) and the Finnish Technical Research Centre of Finland establishing in March 2011 VTT Brazil Ltd.

Such a rapid succession of international setup of technological research labs in Brazil, most of which are government supported, highlights the Brazilian consciousness of its need to create internal innovation capacity and leverage existing knowledge in managing innovation.

3. Conclusions

3.1. Summary of policy perspective

- The Brazilian government has adopted a thematic focus in R&D&I policy. The concept of KETs however is not embraced a basis for support of the Innovation System. Attention is given to enabling technologies that are in practice also included in KETs (i.e. biotechnology and nanotechnology). Policy furthermore focusses on specific sectors in the economy, that are either strong (e.g. Oil and Gas), have an enabling character (e.g. ICT), or have an impact on a changing society (Pharmaceuticals and the Health Industry complex).
- The research system developed into an effective system over the past decade - in spite of its still unbalanced geographic productivity and low-network based research execution. By contrast, the innovation system, which began to be structured in earnest from 2005 with the passing of the federal innovation law, still presents key structural holes such as a small number of networks involving industry, regional and local authorities, weak private sector research in terms of number of firms, own expenditures and government incentives with limited scope and reach.
- The Brazilian Innovation System does not perform well in comparison to the global leaders. The R&D&I policy subsequently focusses on improving framework conditions, and addresses the absorptive capacity of the system (e.g. expenditure on R&D, education and skills of human resources). Crossing the valley of death is not an issue for policy.

3.2. Summary of business perspective

- The most significant challenge for Brazilian industry is to increase competitiveness with respect to foreign competition. The volatility of business conditions in Brazil (interest rates, inflation, exchange rates) makes it difficult for domestic industries to maintain stable growth against competition.
- Access to innovative technologies and qualified personnel are a challenge for industry, although conditions are improving with the development of local R&D capabilities and the introduction of foreign RTOs. As access to technology becomes available, there will be an additional delay in implementation because of the need to develop the necessary ecosystem to support new technology (suppliers, subcontractors, etc.)
- Businesses which respond to a national need can be quickly financed and deployed with swift government action, provided the regulatory framework is in place.
- The most widespread and successful instrument in place is the use of low interest loans to finance new investment, capacity expansion or even new business creation. Interest rates for BNDES loans are lower than inflation, and approximately half of the overnight banking rate.

3.3. Recommendations to support pilot lines

Establishing pilot lines in Brazil is relatively straightforward and can be very effective when objectives are in line with governmental priorities. Access to financing is not considered a major stumbling block, so long as the ownership of the pilot line remains Brazilian. The ease of access to financing is a major advantage in the Brazilian system. The difficulties with pilot lines are most likely to occur with the acquisition of technology, or with the identification of trained personnel capable of executing the pilot line appropriately. Many technologies, particularly KETs, are not widely found in Brazil.

The first recommendation is to identify sources of technology that are compatible with the local economic system and which can be properly implemented and exploited. Similarly, the trained personnel for the technology must also be compatible with the local system and operations.

A second recommendation is to provide measures which encourage the development of the supporting ecosystem, including qualified suppliers, service providers and subcontractors. This is often a very difficult step for a new technology or industry to become established.

Pilot lines which succeed are those which are aimed at objectives of national interest, which in Brazil means promoting domestic industry to the forefront in the marketplace. In many ways, a major advantage of Brazilian policy is the relative lack of structure with respect to calls for projects, consortium requirements, technology maturity, etc. By keeping the constraints out of the funding program requirements, there is a large degree of flexibility and adaptability in the types of projects than can be considered for financing.

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4.1. Literature

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4.2. Interviews

Industry Related

1. Marcio Diniz Da Silva, R&D Manager General Motors Do Brazil, formely in PSA Do Brazil
2. Victor Coutinho, Innovation Director, Helibras
3. Kamel Bennaceur, Schlumberger, Vice President, Brazil Research and Geoengineering Center (BRGC)
4. Oswaldo Godoy, CTC, Project manager of the 2nd generation bioethanol pilot plant

Government Related :

5. Ronaldo Motta, prior Minister of Technology and Sciences, March 2012 – March 2013
6. Hernan Valenzuela, Brazilian Ministry of Development,Industry and Foreign Trade (Suframa, Coordination of Institutional Relations for Technological Affairs – COART)

Academics Related :

7. Cristiano Krug, Superintendent, R&D, CEITEC S.A. Semiconductors
8. Edgar Bortolini, responsible for the management of several innovative projects of the PUCRS Technology Park

Others

9. Nicolas Béroud, Vice Director, Agence D'études et de Promotion de l'Isère

5. Pilot Line Examples in Brazil

An established Brazilian printing company, Cromotransfer, was looking to expand beyond its traditional business lines of textile and packaging printing. Flexible solar cells were an area of particular interest to Cromotransfer on one hand because of compatibility with in-house manufacturing knowledge, and on the other because of the potential Brazilian market where many remote areas still do not have adequate access to reliable electricity.

The president of Cromotransfer visited several European institutes working on flexible photovoltaics during June 2012, and by September 2012 had secured government funding for a project to install a pilot line for flexible cells in Joinville, Brazil based on technology coming from Fraunhofer IAP (Potsdam-Golm). The pilot line will be a replica of the line currently in place at FhG IAP.

CSEM do Brasil, a Brazilian company co-financed by the Brazilian fund manager FIR Capital and Centre Suisse d'Electronique et Microtechnique (CSEM, Neuchâtel), has announced in June 2013 the upgrade of its Printed Organic Photovoltaic activities to include a new pilot production facility. The facility will be financed with € 15 million in funding from sources including the state of Minas Gerais, FAPEMIG, FINEP, BNDES, and FIEMG. The printed organic electronics activities of CSEM do Brasil have been under evaluation with FAPEMIG for some time and are considered worthy of further investment.

Laboratório Nacional de Ciência e Tecnologia do Bioetanol, CBTE, is a national research and development center dedicated to developing the technology for production of bioethanol from sugar cane. CBTE is part of the network of CNPEM, the National Centers for R&D for Energy and Materials, financed by MCTI. The CTBE has installed a bio refinery pilot plant for testing various feedstocks and processes as a pre-production optimization before construction of full-scale bio refineries for bioethanol production. The results of the programs of the CBTE pilot plant are directly transferred to Brazilian companies involved in bioethanol refining. CBTE received 7.7M$ from BNDES for the construction of the pilot line under the heading of FUNTEC.

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