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The role of internal capabilities and firm's environment in fostering green innovations: empirical evidence from the Brazilian electricity power sector.

Larissa Marchiori Pacheco

Advisor: Prof. Dr. Lara Bartocci Liboni

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2016

Prof. Dr. Marco Antonio Zago

Dean of the University of São Paulo

Prof. Dr. Dante Pinheiro Martinelli

Dean of the School of Economics, Business Administration and Accounting at Ribeirão Preto

Prof. Dr. Sonia Valle Walter Borges de Oliveira

Head of the Department of Business Administration

LARISSA MARCHIORI PACHECO

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Approved in:

Examination Board

Prof. Dr. ____

Institution: ______________________________ Signature: _____________________

Prof. Dr. ____

Institution: ______________________________ Signature: _____________________

Prof. Dr. ____

Institution: ______________________________ Signature: _____________________

To my mom and my sister, for their
unconditional love.

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Also, I dedicate this conquest to God, for His undeniable presence in my daily battles.

Thank you,

Larissa

Our task must be to free ourselves by
widening our circle of compassion to embrace all living
creatures and the whole of nature and its beauty.

Albert Einstein, physicist

ABSTRACT

PACHECO, L. M. **The role of internal capabilities and firm's environment in fostering green innovations: empirical evidence from the Brazilian electricity power sector.** (2016). Master Thesis – School of Economics, Business Administration and Accounting at Ribeirão Preto, University of São Paulo, Ribeirão Preto, 119p.

Green innovations can be an answer that companies develop as ways to mitigate climate change. These are driven by internal resources as well as institutional forces, and some organizational capabilities such as absorptive capacity can be relevant in spurring green innovations performance. Therefore, this study aimed at assessing empirically the relationship among institutional forces and internal capabilities in driving green innovations in the Brazilian electricity power sector. Partial Least Square Structural Modelling Equation was applied to the data collected through the survey conducted between December 2015 and May 2016. The structural model validity was validated through several tests and the results have indicated that Internal Drivers are positively related to the Institutional Forces and Absorptive Capacity, and mediate the relationship among those constructs. Also, the Internal Drivers are positively related with Green Innovation Performance in products and processes. Therefore, the study has several theoretical implications for management area, especially on dynamic capabilities, RBV and green innovation theory. Also, policy implications of the study are related to the composition of a country's policy mix in order to develop environmental regulations which favour innovation.

Keywords: Green Innovation. RBV. Dynamic Capabilities. Absorptive Capacity. Electricity Power Sector.

RESUMO

PACHECO, L. M. **O papel das capacidades internas e o ambiente da firma no fomento de inovações verdes: evidências empíricas do setor elétrico brasileiro.** (2016). Dissertação (Mestrado) – Faculdade de Economia, Administração e Contabilidade de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto, 119f.

As empresas podem responder por mudanças significativas em prol da sustentabilidade por meio de inovações, através do desenvolvimento de novas tecnologias, serviços ou produtos que se destinam a reduzir os problemas ambientais e climáticos - nomeadamente inovações verdes. Estas são conduzidas por recursos internos, bem como forças institucionais e algumas capacidades organizacionais, tais como a capacidade de absorção, podem ser relevantes em melhorar o desempenho em inovações verdes. Portanto, este estudo teve como objetivo avaliar empiricamente a relação entre as forças institucionais e capacidades internas na condução de inovações verdes no setor de energia elétrica brasileiro. A técnica de equações estruturais (PLS) foi aplicada aos dados coletados por meio de uma *survey* realizada entre dezembro de 2015 e maio de 2016. A validade do modelo estrutural foi assegurada através de vários testes e os resultados permitiram concluir que os condutores internos são positivamente relacionados com as forças institucionais e a capacidade de absorção. Ainda, estes mediam a relação entre estes construtos. Além disso, os condutores internos estão positivamente relacionados com o desempenho da inovação verde em produtos e processos. Portanto, o estudo tem várias implicações teóricas para área de gestão, especialmente em capacidades dinâmicas, VBR e teoria da inovação verde. Além disso, as implicações políticas do estudo estão relacionadas com a composição de políticas de um país, a fim de desenvolver regulamentações ambientais que favoreçam a inovação.

Palavras-chave: Inovação Verde. Condutores Internos. Ambiente Institucional. Capacidade de Absorção. Setor Elétrico.

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1. INTRODUCTION

Several questions derive from electricity production and commercialization, as mentioned by Santos et al. (2014), and pressure changes in the power sector. Concerning the Brazilian power sector, socio-environmental restrictions, energy efficiency, alternative energy sources and regulatory and political challenges (Gómez-Expósito, Conejo, & Cañizares, 2009) are the main technological and institutional issues that demand for modernization followed by innovations in each segment of the sector.

Authors like Testa, Iraldo, and Frey (2011) affirm that in regulated sectors - as the one under scrutiny-, the control exerted by the government increases the probability of investments in technology and also the chances of generating green innovations. Considering growth limitation imposed to some sectors due to environmental aspects (Medeiros, Ribeiro, & Cortimiglia, 2014), green innovations allow the creation of new markets and trends, promoting sustainability.

Those are relevant for allowing increasing production possibilities, reducing or changing the need of resources and generating new or improved environment-friendly products and services (Dutz & Sharma, 2012). Therefore, green innovations answer to products and services which aim to minimize the impact caused by business activities and reduce resource use in products' life cycle (Gilli, Mazzanti & Nicolli, 2013). Nonetheless, according to Walz and Einhhammer (2012), due to their special focus, companies need to develop certain capacities in order to foster green innovations.

However, firm resources and capacities, which are important internal drivers of innovation performance, are seldom considered in the literature (Del-Río, Carrillo-Hermosilla, Könnölä, & Bleda, 2011). Barney (1991) affirms that the resources and capabilities that a company controls and that are rare, inimitable and unique may generate sustainable competitive advantages. According to the RBV theory, these assets include management skills of a company, organizational processes and routines and the knowledge that it dominates (Barney et al., 2001).

In that sense, companies consist of a set of capabilities that together correspond to assets and competencies that are exclusive and off difficult replication (Teece, 2007). Among those, the dynamic capabilities provide companies with the possibility to reach new and innovative kinds of competitive advantage, given an innovation pathway and market position

(Leonard-Barton, 1992). Therefore, they foment the processes that can leverage green innovations performance in organizations.

According to Alves (2015), despite the generalist approach of some authors (see Teece, 2007), there is a need to identify the types of dynamic capabilities according to the strategic context in which they are being demanded and the outputs expected. One of those is the absorptive capacity, frequently considered as a relevant mediator in the innovation process (Cohen & Levinthal, 1990). For Zahra & George (2002), the absorptive capacity is a dynamic capability that favors knowledge building and application, allowing the company to identify and capitalize opportunities from emerging markets (Wang & Ahmed, 2007).

In the context of this study, the absorptive capacity determines the ability of a company to absorb external pressures and translate them into green innovations through its technological capability and available resources. Authors as Chen (2008), Triebswetter & Wackerbauer (2008), Vachon & Klassen (2008), Albino et al. (2012) and Horbach, Rammer & Rennings (2012) affirm that green innovations are both driven by internal drivers (i.e. in-house resources, firm characteristics and capabilities) and institutional forces, such as the current technology, costumer pressure and regulations. Hence, absorptive capacity mediates the relationship among external and internal drivers of green innovations and the organizational performance in green innovations.

However, studies that connect absorptive capacities and green innovations are still not deeply explored (Bhupendra & Sangle, 2015; Gabler, Richey Jr. & Rapp, 2015; Castiaux, 2012). Additionally, from available studies, it was noticed one important gap of researches which provide an understanding on the relationship among the institutional environment and internal drivers and the mediation role of absorptive capacity on green innovation performance.

The results obtained with this study can also provide legislators with an instrument to evaluate the efficiency of the current legal and institutional framework for promoting green innovations and raise reflections on the need for a change in posture of organizations in relation to those. It will also indicate the institutional forces and internal drivers that influence green innovation performance, allowing to overcome barriers and to enhance its impact in the analysed sector.

1.1 Problem statement

Greening the economy turned out to be a new strategy for enhancing well-being and diminishing environmental impacts (Barbier & Markandya, 2013), with aims to achieve sustainable development. And when it comes about green growth and sustainability issues, sector can make relevant differences. The activities in the electricity power sector, namely generation, transmission and distribution, are potential polluters and users of natural resources, according to the Brazilian Law n. 10.165/2000 (Brasil, 2000) and awaken the attention of society in terms of its environmental impacts.

Nevertheless, energy, in economic theory, is often considered one key driver of economic growth. Additionally,

> "the provision of adequate and reliable energy services at affordable costs, in a secure and environmentally benign manner, and in conformity with social and economic development needs, is an essential element of sustainable development. Energy is vital for eradicating poverty, improving human welfare and raising living standards." (Vera & Langlois, 2007).

UNEP (2011) states that two are the main investment areas of a green economy, with the aim to enhance: (1) natural capital (stocks of and flows from agriculture, fisheries, water bodies and forests); (2) energy and resource efficiency (to enable environmental technology in renewable energy, manufacturing, waste management, buildings, transport, tourism and cities). Therefore, considering that energy and resource efficiency are one of the main areas of interest with regards to sustainable development, it is of great relevance to develop studies aiming to understand the transition to more sustainable energy systems – specially in developing countries (Vera & Langlois, 2007).

According to Fraj, Matute, and Melero (2015), organizations are key players in developing strategies for environmental protection. In this sense, companies can answer for meaningful changes towards sustainability (Walz & Einhhammer, 2012) through innovations, which are crucial components for a transition to a green economy (Droste et al., 2016).

For instance, green innovations in the electricity power sector depend not only on the organizational capabilities and resources, but also on the cooperation among government, regulators, energy providers and distributors, suppliers and firms specialized in certain technologies, and even citizens (Castiaux, 2012). This complexity reinforces the need to understand how companies are answering to institutional forces for developing eco-friendly technologies and green energy solutions through capacities development.

According to Andersen (2008), the research in green innovation is still in its beginning, demanding further analysis on them in order to contribute for setting long-term goals in business and innovation policies. Wong (2012) sustains that initial studies aimed to understand the state of art and concepts, and its relation to business performance. Other studies were developed focusing in proposing an alignment between green innovations and public policy pressure and its relevance for business, sector or national competitiveness and productivity (e.g.; Porter, 1991; Esty & Porter, 2005; Lafferty & Ruud, 2006; Chapple et al., 2011; Lam & Hills, 2011; Jänicke, 2012; Fankhauser et al., 2013; Elgin & Mazhar, 2013; Peuckert, 2014; Ford, Steen & Verreynne, 2014).

Some studies on green innovation in the Brazilian context could be identified and aimed at studying the relationship among public policies and green innovations development (Barbieri, 1997; Lima et al., 2013; Oliveira, Freitas & Dantas, 2013; Porto, Kannebley & Baroni, 2013), not adding organizational antecedents or performance factors in this sense. As much as this is a research focus internationally widely explored, it is still incipient the development of empirical studies in developing countries (Cai & Zhou, 2014). Therefore, this remains an unconsolidated thematic that still requires great attention and volume of research.

Moreover, studies that connect absorptive capacities and green innovations are still not deeply explored (Bhupendra & Sangle, 2015; Gabler et al., 2015; Castiaux, 2012). From available studies, we noticed one relevant gap of researches which provide an understanding on the relationship among institutional forces and internal drivers and the mediation role of absorptive capacity on green innovation performance. Therefore, this study finds its justification in the existent gap in research related to green innovations, its antecedents and organizational capabilities, conducted with empirical data collected from companies in the Brazilian electricity power sector.

After confirming the possibility of conducting a research that can expand the knowledge in one field not deeply explored in Brazil, and considering the urgency of this issues for inserting the country in the "green race for development" (Fankhauser et al., 2013), the following research question is delimited: Does the combination of institutional forces and internal drivers impacts the performance in green innovations of companies in the Brazilian electricity power sector?

1.2 Research objectives

With the aim to establish the methodological aspects of the statistical analysis conducted in this study, it is important to resume its objective which is to assess empirically the relationship among internal drivers and institutional forces in driving green innovations in the Brazilian electricity power sector.

The specific research objectives are:

- To identify the existing relationship among the drivers of green innovations and the consolidation of the absorptive capacity in the Brazilian electricity power sector.

- To identify the relationship between absorptive capacity and performance in green innovations in the Brazilian electricity companies.

- To identify the overall connection between green innovation drivers, absorptive capacity and performance in the Brazilian electricity sector.

Table 1 consolidates the relevant aspects of the research: the research problem, the general and the specific objectives.

Table 1- Delimitating the research problem and objective

Research Problem	**General Objective**	**Specific Objective 1**	**Specific Objective 2**	**Specific Objective 3**
Does the combination of institutional forces and internal drivers lead to a better performance in green innovations in the Brazilian electricity sector companies?	To assess empirically the relationship among internal drivers and institutional forces in driving green innovations in the Brazilian electricity power sector.	To identify the existing relationship among the drivers of green innovations and the consolidation of the absorptive capacity in the Brazilian electricity power sector.	To identify the relationship between absorptive capacity and performance in green innovations in the Brazilian electricity companies.	To identify the overall connection between green innovation drivers, absorptive capacity and performance in the Brazilian electricity sector.

Source: Elaborated by the author

1.3 Definition of research terms

Aiming to consolidate the definitions of the terms used in the present research, Table 2 was elaborated and is presented above.

Table 2 – Research terms definition

Terms	Definition
Green Innovation	Innovation that reduces the negative environmental impacts or potentiates possible benefits to the environment while creating value to the market (Chen, Lai & Wen, 2006; Schiederig, Tietze & Herstatt, 2012).
Internal drivers	Resources and capabilities that a company controls and that are rare, inimitable and unique. Include management skills of a company, organizational processes and routines and the knowledge that it dominates (Barney, 1991; Barney et al., 2001).
Institutional forces	Formal and informal pressures from organizations of which firms depend on and the cultural expectations of the society in which it actuates: the government, the existent technology, professionalization and consumer market (DiMaggio & Powell, 1983).
Dynamic capabilities	Set of capabilities that together correspond to assets and competencies that are exclusive and off difficult replication (Teece, 2007).
Absorptive capacity	Allows companies to assimilate and exploit knowledge, facilitating organizational learning (Biedenbach & Müeller, 2012).

Source: Elaborated by the author.

1.4 Study organization

The present section, ended in this last item, presents the introduction and justification of the research, as well as the study's problem and objectives. In the next section, the theoretical background, theoretical references that are needed to ground the research hypothesis and for the comprehension of the discussion are discussed. In section 3 the hypothesis of this study are constructed, relating to the literature review presented in the previous section.

In section 4, is described the statistical model. The methodology for collecting data, the research type, data treatment and statistical techniques chosen to analyze them are also presented. Likewise, the constructs used for measuring each of the considered hypothesis and the statistical modeling are defined. Section 5 presents all the results founded after conducting this empirical study. Finally, the section 6 presents the conclusions, research limitations and recommendations for further studies.

2. LITERATURE REVIEW

As a basis for the hypothesis formulation of the research, it aims to understand the current state of knowledge in green innovations (considering the study limitation of not exhausting all the issues covered by it), and afterwards, to define the research constructs and the relationship between them based on the studied theory.

This first part of the literature analysis can be classified as an integrative literature review using the steps suggested by Lages Junior and Godinho Filho (2010) and Jabbour (2013), as presented in Table 3.

Table 3 - Integrative literature - steps

Step 1	To conduct an advanced research, in academic databases, on available articles on the topic that is being studied;
Step 2	To propose a classification and logic codification system of the selected articles;
Step 3	To use the proposed classification system to generate a simplified comprehension of the existing knowledge on the subject;
Step 4	To develop, from the suggested codification, a summary on the scientific production and the primary results of the articles that were identified and chosen;
Step 5	To analyse the results obtained, evaluating the existence of theoretical gaps and opportunities for conducting future studies.

A research was conducted in the following academic databases: *Scopus, ISI Web of Knowledge*, *Science Direct* and *Google Scholar*, and the key words chosen included “green innovation” combined with “dynamic capabilities”, “dynamic capabilities for green innovations” and “dynamic capabilities for eco-innovations” – also other variations of these terms were considered. Following the search for the articles that were encompassed by this review, a classification framework was created in order to facilitate the analysis of the recent works on dynamic capabilities for green innovations.

As an effort to include the maximum number of articles and guarantee a wide analysis, only the ones which had dynamic capabilities and green innovations as main topics were selected. After excluding those that were not available for download, 26 articles were selected for reading and constructing the analysis. Then, the second step was concluded by proposing a classification and codification system of the evaluated articles, based on similar works, presented in Table 3.

The system is comprised by numbers (1 to 7), which list the large areas of analysis, and letters (A to G) that classify the specific themes related to the main categories. Therefore, one study can be categorized in more than one letter code. The codes 1 and 2 incorporate general aspects as: Group 1 (codes A-C) that identifies the context - based on the classification proposed by the United Nations on development level (Nielsen, 2011) - and the quantity of countries covered by the research; Group 2 (codes A-G) associates the method, in terms of the approach and scope, applied on those.

The following groups, 3 to 6, incorporate specific details about the theme in discussion. Group 3 (codes A-C) classifies the economic sectors encompassed by the research and Group 4 (codes A-D) categorizes the thematic focus of the studies. The Group 5 (codes A-E) clarifies the capacities that are being explored in the studies and Group 6 (codes A-C) positions those in the analytical model applied in the quantitative studies.

Concerning the codes from Group 4, studies framed on "dynamic capabilities as drivers for green innovations" try to analyse the relationship among the constructs, being the capabilities predictors of green innovations development and adoption in the companies. The second classification, "sustainability as driver for dynamic capabilities" gathers studies that try to understand how sustainability drives the development of certain capabilities in the companies. "Dynamic capabilities supporting gains in eco-based competitive advantage" category is the one with studies which discuss the role of dynamic capabilities in supporting or developing an eco-based competitive advantage.

The last category, gathers studies that try to clarify the relationship among the development of dynamic capabilities and its impact on firm performance in terms of environmental, financial or innovation aspects. For the categories of the Group 5, this aims to understand if the approach is on dynamic capabilities or if it is focused in one specific capacity, such as absorptive, adaptation, innovation or alliances capacity (Schilke, 2014; Wang & Ahmed, 2007)

A synthesis is presented with the main contributions of each article, which were structured, conjointly with the descriptive analysis, to generate the discussions and the results presented above. Table 4 synthesize each of the studies that were considered in this review. The scope and main results are clarified.

Table 4 – Characterization framework synthesizing current research on dynamic capabilities for green innovations

Classification	Detailing	Codification
1	National Context	A – Developed country
		B – Developing country
		C – Multiple country
		D - Does not apply
2	Method	A – Quantitative
		B – Qualitative
		C - Qualitative/Quantitative
		D - Literature Review
		E - Case Study
		F – Survey – primary data
		G – Survey – secondary data
3	Economic sector	A – Manufacture
		B - Services
		C – Does not apply
4	Research Focus	A - Dynamic capabilities as drivers for green innovations
		B – Sustainability as driver for developing dynamic capabilities
		C – Dynamic capabilities supporting gains in eco-based competitive advantage
		D – Influence of dynamic capabilities on firm performance
5	Capacities analysed	A – Dynamic capabilities
		B – Innovative capacity
		C – Absorptive capacity
		D – Alliances capacity
		E – Adaptive capacity
6	Position in analytical model	A – Dependent variable
		B – Independent variable
		C – Mediator variable

Source: Elaborated by the author.

Table 5 – Summary of the studies analysed in the integrative literature review - continues

Article	**Brief Summary**
Bhupendra & Sangle (2015)	The paper discusses the attributes of the innovative capability required by firms to adopt pollution prevention and cleaner technology strategies. Results show that process and behavioural innovativeness are required by firms to implement a pollution prevention strategy. In addition, firms need a top management with high risk-taking ability.
Castiaux (2012)	Explores the impact of sustainability requirements on dynamic capabilities that a firm should develop and sustain to remain competitive. The author considers the dynamicity levels identified in the literature and studies what level is required for which type of sustainable innovation. Secondly, looks at the three fundamental natures of dynamic capabilities and identify typical new requirements coming from sustainability challenges.
Chassagnon & Haned (2015)	The authors use French CIS Surveys and employ a Heckman selection estimation method using a sample of 1180 firms to study which different forms of innovation leadership increase the propensity to develop environmental innovations. They find a strong impact of innovation leadership that is measured using innovation persistence.
Chen & Chang (2013)	This study explores the influences of green dynamic capabilities and green transformational leadership on green product development performance and investigates the mediation role of green creativity. The results demonstrate that green dynamic capabilities and green transformational leadership positively influence green creativity and green product development performance.
Chen et al. (2015)	First, this study finds that green absorptive capacity has positive effects on green dynamic capacities, green service innovation, and firm performance. Second, green dynamic capacities have positive effects on green service innovation and firm performance. Third, observes that green dynamic capabilities and green service innovation mediates the relation among green absorptive capacity and firm performance.
Del-Río et al. (2011)	This paper builds an integrated framework that incorporates the impact of firm's internal factors and their interactions with external drivers on the development and adoption of eco-innovations. It is shown that, while all capabilities are relevant for the development and uptake of eco-innovations, their relevance differs between different dimensions of eco-innovation.
Fraj et al. (2015)	Examines the link between proactive environmental strategies, organizational capabilities and competitiveness. A model is proposed and tested using a sample of 232 Spanish hotels. The findings confirm that a proactive environmental strategy and innovation favour organizational competitiveness.
Gabler et al. (2015)	Using survey data from marketing managers across fourteen industries, the authors estimate a Latent Moderated Structural model. Environmental orientation and organizational innovativeness are found to be predictors of the eco-capability. Also, eco-capability is positively related to market and financial performance, as well as the perceived quality of the firm's offering.
Hartmann & Germain (2015)	Drawing on data collected from 769 Russian manufacturers and using structural equation modelling, it shows that cross-functional and technological integration mediate the relationship between ecological product design and manufacturing performance.
Hashim et al. (2015)	The authors investigate whether absorptive capacity facilitates the adoption of green innovation based on a survey of 79 construction companies in Scotland. They confirm that existing knowledge utilisation, knowledge building and external knowledge acquisition are significant predictors of green process, green administrative and green technical innovation, respectively.
Hofmann et al. (2012)	This study identifies the adoption of advanced technology, experiences with inter-firm relations and capacity for product innovation as three capabilities that support firms' efforts to become 'greener'. Descriptive statistics portray the diffusion of the related management practices among 294 small and medium-sized manufacturers from the United States.
Huang & Li (2015)	This study identifies the factors influencing green innovation and examines the relationships between drivers, green innovation, and performance using structural equation modelling. The results indicate that dynamic capability, coordination capability, and social reciprocity are significant drivers of green innovation.

Source: Elaborated by the author.

Table 4 – Summary of the studies analysed in the integrative literature review

Iles & Martin (2013)	Companies are most able to develop business models when they develop and mobilize their “dynamic capabilities” around sustainability. DuPont, BASF, and Braskem have identified new market opportunities for bio plastics, designed distinctive business models to seize opportunities, and devised ways to create increased value by communicating environmental impact reduction to downstream entities.
Ketata et al. (2015)	Explores what the specific driving forces are that increase the degree of sustainable innovation within a firm's innovation activities. The authors test them empirically for more than 1,100 firms in Germany and find that firms need to invest in internal absorptive capacities and to draw both broadly and deeply from external sources for innovation.
Kiefer et al. (2015)	Elaborates a comprehensive conceptual milestone on the drivers and barriers for eco-innovation in companies. Also intends to consolidate and aggregate the past contributions through a systematic literature review. Despite the numerous works on this field, for the authors, the relationship among the mentioned factors and eco-innovations is still not clear.
Kolk & Pinkse (2008)	Explores whether an important environmental issue such as climate change can not only give multinational enterprises the opportunity to develop "green" firm-specific advantages, but also help reconfigure key FSAs viewed as the main sources of firms' profitability, growth, and survival. The authors develop two organizing frameworks and apply it using information from Global 500 firms.
Leonidou et al. (2015)	Data obtained from 102 hotel chains reveal that organizational learning, shared vision, and cross-functional integration are conducive to creating a green competitive advantage, though this is not the case with relationship building and technology sensing/response.
Rashid et al. (2015a)	The paper discusses the role of dynamic eco innovation practice in order to achieve sustainability in manufacturing industries. The outcomes describe core categories of eco innovation practices in manufacturing industry, drivers and a framework of dynamic eco-innovation practices.
Rashid et al. (2015b)	Sample data was collected from 320 respondents from an automotive industry in Malaysia. The model and related hypotheses were tested using Structural Equation Modelling. Drivers play an important role on crafting sustainability and eco product innovation efforts.
Rashid et al. (2014)	This paper provides an insight for new paradigm of eco innovation research by introducing dynamic eco innovation practices as an antecedent for eco innovation efforts and indirectly supporting eco performance in triple bottom line effect.
Stanovcic et al. (2015)	Aims to analyse whether knowledge management (KM) practices trigger environmental innovation. The econometric estimations show that the investments in KM practices trigger environmental innovation.
Thurner & Proskuryakova (2014)	Analyses the annual and environmental reports of six prominent industry actors between 2008 and 2010 in terms of their approaches to green management. Most companies start in 2009 to address environmental activities. In 2010, the environmental activities are among top priorities. Manager's own initiatives drive companies' adoption of greener technologies.
Tietze et al. (2013)	Studies how three firms have developed PSS innovations in the mobility sector. Based on semi-structured interviews with project managers, they propose a framework. Capabilities for developing and operating their network are relevant for successful PSS innovators.
Wu et al. (2015)	This study converts experts' opinions into comparable measures of eco-innovation under dynamic organizational capability. The results show that path-dependent learning is the top priority and manufactures should consider opportunity-sensing capability and integrative capability simultaneously in the operational process.
Yang et al. (2015)	Drawing on data from 272 Chinese firms, this study finds that strategic flexibility has a positive effect on the adoption of green management practices. Provides important implications for explaining how firms in emerging economies combine internal strategic flexibility and external institutional support to implement them.
Zhu et al. (2013)	Using a sample of 377 Chinese manufacturers, the findings suggest that institutions in developing countries with significant environmental concerns should support ISO 9000 implementations in local firms.

Source: Elaborated by the author.

As a second part of this review, Table 6 shows the application of the classification for the 26 selected articles. Through the literature analysis and the classification presented it is possible to identify gaps in the literature on dynamic capabilities for green innovations and to suggest paths for future research in this field. Thus, following, the categories inside the classifications that were less addressed were combined outlining a proposal for a research agenda.

In Group 1, which explores the research context, the categories "A" and "C" are the less mentioned corresponding to multiple countries and developing countries contexts, respectively. From this conclusion it is clear that there is a gap in the literature of studies that encompasses more than one country reality. This shapes the **first research suggestion**: To promote studies which explore the comparison among firms in more than one country, aiming to understand different approaches on dynamic capabilities for green innovations.

Group 2 categorizes the studies according to the research method chosen to pursue the analysis in each of them. It was verified that there is a low number of quantitative studies, using secondary data, and qualitative studies based on case studies. Additionally, the combination of qualitative and quantitative methods is also among those less applied. Thus, there is space for developing studies that deepen the analysis of dynamic capabilities and green innovations inside the firms through case studies. In addition, there is a need to explore secondary data available to pursue quantitative research.

Thus, the **second research suggestion** is: To conduct qualitative studies, based on case studies, in order to deepen the analysis of firm's specific dynamic capabilities for green innovations, contributing to the micro level research. Likewise, a **third research suggestion** is: To promote quantitative studies using the available secondary data based on country surveys, to explore the potential of firms in exploiting its capabilities and generating green innovations and to support public policy design on R&D and skill enhancement.

Table 6 – Categorization and classification of selected articles

Year	Authorship	Country	1 - Context	2 - Method	3 - Sector	4 - Focus	5 - Capacities	6 - Positiom
2008	Kolk & Pinkse	-	**D**	**B, D**	**C**	**B**	**A**	**A**
2011	Del-Río et al.	-	**D**	**B, D**	**C**	**A**	**A**	**B**
2012	Castiaux	Belgium	**A**	**B, D**	**A**	**B**	**A**	**A**
2012	Hofmann et al.	USA	**A**	**A, F**	**A**	**A**	**B, C, D**	**B**
2013	Chen & Chang	Taiwan	**B**	**A, F**	**A**	**A**	**A**	**B**
2013	Iles & Martin	-	**D**	**B, E**	**A**	**C**	**A**	**B**
2013	Tietze et al.	Multiple	**C**	**B, E**	**A**	**A**	**A**	**B**
2013	Zhu et al.	China	**B**	**A, F**	**A**	**A**	**A, C**	**6B**
2014	Rashid et al.	Malaysia	**B**	**B, D**	**A**	**A**	**A**	**B**
2014	Thurner & Proskuryakova	Russia	**B**	**B, E**	**A**	**A**	**A**	**B**
2015	Bhupendra & Sang	India	**B**	**A, F**	**A**	**C**	**B**	**B**
2015	Chassagnon & Haned	France	**A**	**A, G**	**A**	**A**	**B**	**B**
2015	Chen et al.	Taiwan	**B**	**A, F**	**A**	**D**	**A, B**	**B**
2015	Fraj et al.	Spain	**A**	**A, F**	**B**	**C**	**B, C**	**B**
2015	Gabler et al.	USA	**A**	**A, F**	**A**	**D**	**A, B**	**B**
2015	Hartmann & Germain	Russia	**B**	**A, F**	**A**	**D**	**A**	**C**
2015	Hashim et al.	Scotland	**A**	**A, F**	**A**	**A**	**C**	**B**
2015	Huang & Li	Taiwan	**B**	**A, F**	**A**	**A**	**A**	**B**
2015	Ketata et al.	Germany	**A**	**A, G**	**A, B**	**A**	**C**	**B**
2015	Kiefer et al.	-	**D**	**B, D**	**C**	**A**	**A, C**	**B**
2015	Leonidou et al.	Multiple	**C**	**A, F**	**B**	**C**	**B, C, D**	**B**
2015a	Rashid et al.	Malaysia	**B**	**A, F**	**A**	**A**	**A**	**B**
2015b	Rashid et al.	-	**D**	**B, D**	**C**	**A**	**A**	**B**
2015	Stanovcic et al.	France	**A**	**A, G**	**A, B**	**A**	**C**	**B**
2015	Wu et al.	Taiwan	**B**	**C, E, F**	**A**	**B**	**A**	**A**
2015	Yang et al.	China	**B**	**A, F**	**A**	**A**	**A**	**B**

Source: Elaborated by the author.

From Group 3, on sectors analysed, two research suggestions can be developed. The **fourth research suggestion** is to explore studies on dynamic capabilities and green innovations in the service sectors, which are less intensive in technology development but have space for green innovations in processes, for example. As few studies were not focused in analysing one specific sector of the economy, the **fifth research suggestion** is to conduct studies aiming to discuss the theoretical background of the research in this field, as a way to support the consolidation of relevant concepts and the relationship among them.

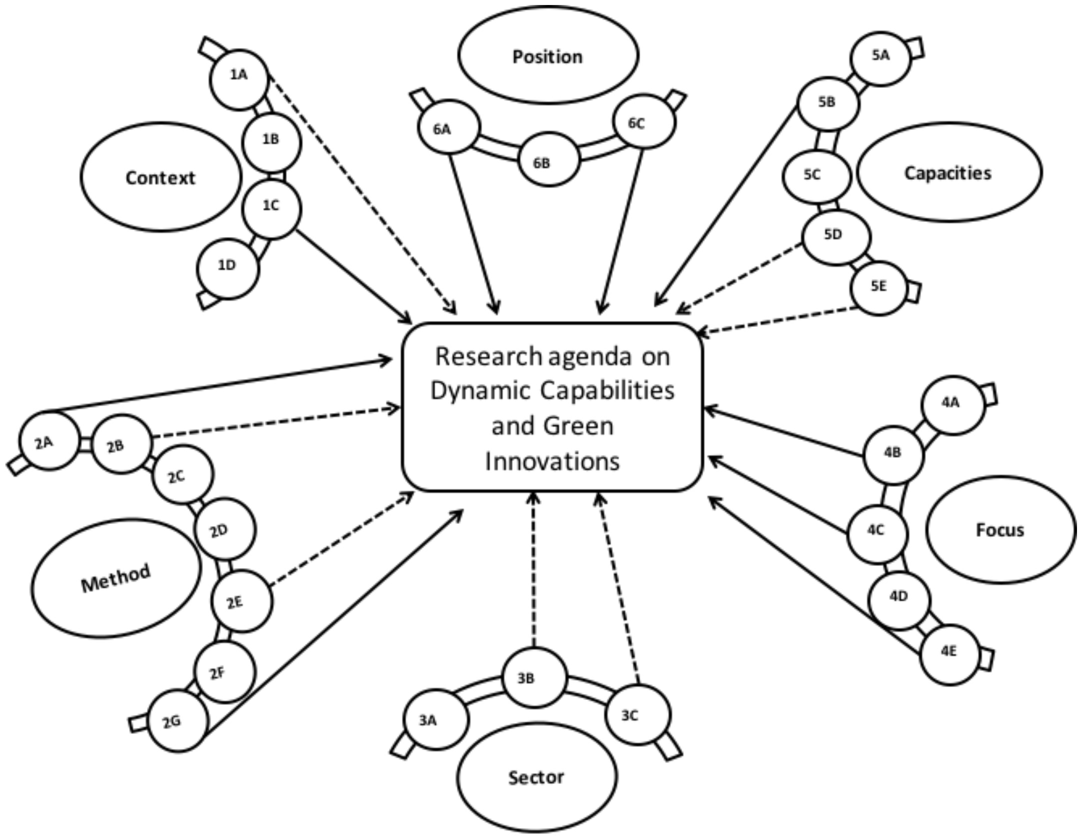
Analysing Group 4 outcomes, only 2 articles approached the development of dynamic green innovation practices. Additionally, only three of them develop the argument that sustainability issues exert the role of drivers of dynamic organizational capabilities and other three articles analyse the influence of dynamic capabilities on firm performance. From this a **sixth research suggestion** can be outlined, which is to perform studies on the new concept of green dynamic innovation practices that is being introduced in the literature, in order to understand which are the specific capacities and practices that support the development of green innovations.

Also, a **seventh research suggestion** is proposed: To conduct studies aiming to understand the role of sustainability in shaping the organizational dynamic capabilities that are developed in order to answer to its issues, through green innovations and strategies. The **eight research suggestion** is: To explore the impact of dynamic capabilities on firm performance, mainly focusing on environmental and innovation performance.

Group 5 reveals that the consideration of specific firm capacities, such as alliances and adaptive capacities are still not deeply explored in the literature relating them with green innovations. For that reason, it is suggested a **ninth research topic**, which is to perform studies on the relevance of alliances capacity, as firms that develop inter-firm collaborations tend to also create alliances to address sustainability challenges as they become more complex (Hofmann et al., 2012).

Similarly, it can be suggested a **tenth research topic**, which is to conduct studies analysing the adaptive capacity (Biedenbach & Müller, 2012) of firms and its relationship with green innovations, as this aspect was not specifically explored. The **eleventh research suggestion** is related to the position in which the dynamic capabilities are considered when related to green innovations and sustainability, and it is recommended the development of studies aiming to understand the dynamic capabilities as dependent variables.

In other words, that means to consider them in the hypotheses as a result of the pressure for organizations to answer to sustainability issues as they may need to acquire, explore or reconfigure its resources and assets, occasioning the development of new green dynamic capabilities. Finally, the **twelfth research suggestion** is to explore studies on dynamic capabilities as mediators of green innovation performance, as they may enable firms to seize opportunities from the institutional environment, through the exploitation of its resources, capacities and knowledge.



Category prioritized in the present research
Category that can be prioritized in future studies

Figure 1 – Research Agenda on Dynamic Capabilities and Green Innovations

The research recommendations aimed to create a future research agenda on the subject of dynamic capabilities and green innovations. As it can be verified in the case of the second and the fifth suggestion, most of these recommendations should be combined and jointly executed in order to achieve effective results and promote theoretical and practical advancement in the field. Figure 1 synthesizes the research agenda aforementioned.

From this integrative literature review, a set of research opportunities was ranked and considered in shaping the present study. The need for research on green innovations and absorptive capacity in developing economies context was combined with the recommendations on studying the mediation role of dynamic capabilities and their impact on firm's green innovation performance.

The theoretical review presented in the next sections does not aim to exhaust all the themes approached by it, but to present a synthetic analysis on the relationship among the concepts briefly discussed in the introduction of the present work. The aspects to be addressed are summarized in Table 7. Such matters addressed jointly underlie the hypothesis tested empirically, that are built in the following main section.

Table 7 – Themes addressed in the literature review

Themes	**Detailing**
Green innovations	Innovation in the firm context Green innovations conceptualisation
Green innovation drivers	Internal drivers Institutional forces
Dynamic capabilities	Dynamic capabilities and green innovations Absorptive capacity for green innovations
Green innovation performance	Green innovation performance in the firms

Source: Elaborated by the author

2.1 Green Innovations

2.1.1 Innovation in the firm context

Schumpeter (1961), in the 40s, started the discussion on innovations characterizing them as a creative destruction process. According to this author, capitalism encompasses an evolutionary process, which means that this does not possess in its essence a stationary character. In this sense, the author affirms that the transformations that occur in the system are not only driven by changes in the natural and social environment or the population raise or the capital, but it comes from new goods, new production methods or transportation, new markets and new ways of industrial organization created by the capitalist company.

Since then, many are the authors that are studying innovation and introduced several definitions for it. The term innovation, in a general meaning, can be understood as a process by which a person or a group of person create an idea and implements it with some aggregated value for the organization. This process has multiple stages that depend on the knowledge about consumers' needs and feedback loops in each stage (Bosh, 2000). Still according to this author, basically innovation is comprised by the generation of an idea and its conversion into business.

Consistent with Cagnazzo, Taticchi and Botarelli (2008) innovation is the encounter between a market need and a technology or a business model that creates value for both the company and its consumers. As per Kline and Rosenberg[1] (1986, *apud* VILHA, 2009, p.26), they complement that innovation is the result of the interaction among market opportunities and knowledge base and capabilities of the firm. For Quadros and Vilha[2] (2006 *apud* VILHA, 2009, p.24), technological innovation can be defined as the application of knowledge and technological, marketing and organizational expertise accumulated by the company and its partners to create new products, processes, services and businesses.

Nowadays, the formal definition used for innovation is the one proposed by OECD (Organization for Economic Cooperation and Development), which is the implementation of a new or significant product improvement (goods or service), or process, or a new marketing method, or a new organizational method in business practices, work organization or external relations (OECD, 2005). In this study the focus is on the definitions of innovations in product and services.

Product innovations are the introduction of a good or service new or significantly improved with respect to its characteristics or revised uses (OECD, 20005). In this sense, besides products with new uses or based in new technologies, the concept also considers upgrades in its use or structure. For services, the innovations can involve changes in how those are offered or in its essential characteristics. Process innovations are conducted through the implementation of improved or entirely new business methods or processes, including meaningful changes in techniques, equipment and/or software (OECD, 2005), aimed at changing or improving the production processes, quality, and even contain or reduce costs throughout the product life cycle.

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[1]Kline, S., & Rosemberg, N. *An overview of innovation.* apud Landau, R., & Rosemberg, N. (1986). *The positive sum strategy*. Washington, D.C.: NationalAcademy Press.

[2]Quadros, R., & Vilha, A. M. (2006). Tecnologias de informação no gerenciamento do processo de inovação. *Revista Fonte - PRODEMGE*, year 3, n.6.

2.1.2 Green Innovations - conceptualization

Organizations nowadays represent a relevant threat to the environment due to resource depletion, consumption and waste generation. Nevertheless, according to Fraj et al. (2015), they are key players in developing strategies for environmental protection. Therefore, companies can answer for meaningful changes towards sustainability (Walz & Einhhammer, 2012) through innovations, by developing new services, products or processes which aim to mitigate environmental and climate issues.

Additionally, in the electricity power sector, there is a concern that the technological innovations respond to environmental issues and target energy efficiency (Jannuzzi, 2005; Goldemberg & Lucon, 2007). Innovations now must answer to products and services which aim to minimize the impact caused by business activities and reduce resource use in products' life cycle (Gilli, Mazzanti & Nicolli, 2013), setting the concept of green innovations.

According to Shrivastava (1995), green innovations are unique and differ from conventional innovations as their application is broad, ranging from energy and water conservation initiatives and waste minimization, to new green products or services and recycling. They encompass the technologies that enable firms and countries to advance towards sustainable societies (Walz & Einhhammer, 2012). Bernauer, Engels and Kammerer (2006) define them as all the innovations that have a beneficial effect on the environment regardless of this being the main purpose of the innovation.

Chen, Lai and Wen (2006) define it as technological innovations that are related to energy saving, pollution prevention, waste recycling, design of green products, or corporate environmental management. Other authors complement that this is a type of innovation that reduces the negative environmental impacts or maximizes potential benefits to the environment while creating value to the market (Driessen & Hillebrand, 2002; Chen et al. 2006; Andersen, 2008; Faucheux & Nicolaï, 2011; Schiederig et al., 2012, Zhang & Liang, 2012). Chen et al. (2006) sustain that green innovations are adopted with aims to improve the performance of environmental management to meet the requirements of environmental protection. In this way, this concept represents a shift in technology whose associated risks have to be managed in order to reach economic objectives compatible with sustainable development patterns (Barbieri, 1997).

Some studies point to a classification of green innovations according to its limits: external or internal to the organization (Cheng, Yang, & Sheu, 2013); other authors, as González, Carrillo-Hermosilla and Könnölä (2010), classify them in product or process innovations, mature or immature innovations and radical or incremental innovations. Horbach (2008) and Triguero, Moreno-Mondéjar and Davia (2013), subdivide them in three types: Green product innovation, Green process innovation and Green organizational innovation.

Green innovation in product intends to offer new green products for consumers or modify an existent product aiming to reduce negative environmental impacts during any stage of the product life cycle (Zhang & Liang, 2012). In line with Chen et al. (2013) this type of green innovation is driven by advanced ecological technologies, reduction in the product life cycle and increase in competitiveness, being its greatest impact on the environment derived largely from its use and disposal and not only its production process. Examples are the solar energy for electricity power generation (Chen et al., 2013), as well as the use of wind power and the creation of green plastics, produced by byproducts of the sugarcane industry (Reis, Souza, Andrade, & Oliveira Junior, 2009).

Green innovations in processes aim to make business processes become green, from procurement to production and delivery (Chan, Chiou, & Lettice, 2012). An innovative green process is characterized by its fitness to environmental criteria established by industrial and social contexts in which the company operates as well as those set by the market and consumers which it intends to serve; full consideration of resource and energy use, human toxicity, environmental impact and sustainability issues in the development and implementation of a process/activity; and incorporation of a continuous evaluation of its impact and improvement of mechanisms within the process/activity (Chiou, Chan, Lettice, & Chung, 2011).

Rennings (2000) cites examples of green innovations in process as additive solutions (e.g. chemical filters on chimneys) or integrated into the production process by replacing raw materials, production optimization or waste management. It should be emphasized that the majority of green process innovations leads to green product innovations (Cheng et al., 2013; Wong, 2012) and also cost reduction and increase in productivity.

In short, Rashid et al. (2015a) gathers the main definitions of green process and product innovations. Green process innovations are related to: new technologies for saving energy, update of equipment to save energy, establishment of recycling systems, avoidance and/or protection against contamination of the environment and meeting environmental standards. On the other hand, green product innovation is related to: waste reduction; energy efficiency; damage by waste reduction; use of natural materials; packaging, components and construction simplification; recycling of components.

Table 8 summarizes the main definitions discussed in this section.

Table 8 – Summary table: innovations and green innovations

Authors	Definitions
Bosh (2000)	The term innovation, in a general meaning, can be understood as a process by which a person or a group of person create an idea and implements it with some aggregated value for the organization. This process has multiple stages that depend on the knowledge about consumers' needs and feedback loops in each stage
Quadros & Vilha (2006)	Technological innovation can be defined as the application of knowledge and technological, marketing and organizational expertise accumulated by the company and its partners to create new products, processes, services and businesses.
Bernauer et al. (2006)	Green innovations are innovations that have a beneficial effect on the environment regardless of this being the main purpose of the innovation.
Chen et al. (2006)	Green innovations are technological innovations that are related to energy saving, pollution prevention, waste recycling, design of green products, or corporate environmental management.
Walz & Einhhammer (2012)	Green innovations are technologies that enable firms and countries to advance towards sustainable societies.

Source: Elaborated by the author.

2.2 Green Innovations Drivers

The organizations face a major challenge nowadays for being exposed to the scientific paradigm on the limits of natural resources in the Earth, which converges to a new technological paradigm, culminating in the development of green innovation trajectories (Dosi, 1988). The organizational answer to this change in the environment can be motivated by the intense competitiveness and pressures coming from different sectors in the firm's environment. It can also result from the possession of some resources and capabilities exclusive to the organization that allow it to generate green product or process innovations, offer new values to costumers and thus develop a sustainable competitive advantage (Cheng et al., 2013).

In this sense, many are the drivers found in literature that explain the organizational behaviour towards green innovation, being the objective of the following subsections to discuss about this relationship in the light of the resource-based view and the institutional theory.

2.2.1 Internal drivers

According to the resource-based view (RBV) of the firm, certain internal features of the organization are important factors in the innovation process for being considered sources of sustainable competitive advantage, as they constitute rare and inimitable core competencies (Nelson & Winter, 1982; Barney, 1991; Barney, Wright, & Ketchen, 2001).

The researchers in the field of strategic management have long understood that the competitive advantage depends on the combination of internal organizational distinctive capabilities and the external circumstances that are in frequent change (Chandler, 1962[3] *apud* Hart, 1995; Penrose, 2006). However, only during the 80s that emerges the theory of resource-based view (RBV) of the firm that articulates the relationship between the resources the company has, its capabilities and the development of a sustainable competitive advantage.

In this time, RBV provided a theoretical model for understanding the role of resources on supporting the competitive advantage of a firm in the innovation process (Cainelli, De Marchi, & Grandinetti, 2015). Barney (1991) discuss that it comes from resources and capabilities that a company controls and that are rare, inimitable and unique. These are assets that include management skills of a company, organizational processes and routines and the knowledge that it dominates (Barney et al., 2001).

Some authors affirm that the RBV has developed as a complement to the industrial organization theory (Porter, 1979, 1981; Barney, 1986) that was focused in the structure-behaviour-performance paradigm, placing the determinants of the organizational performance outside of it, i.e. in the structure of the industry in which it operates (Mahoney & Pandian, 1992). Whereas, contrary to this, Kraaijenbrink, Spender and Groen (2010) affirm that RBV shads light to the internal resources and aims to explain why companies that operate in the same industry can have different performances.

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[3] Chandler, R. (1962). *Strategy and Structure*. Cambridge, MA: MIT Press.

Mahoney and Pandian (1992) sustain that the RBV incorporates the contribution of seminal previous works in the strategic management area aiming to explain how companies generate profit. According to Hart (1995), the theory posits that the competitive advantage can be sustained only if the capabilities that created it are based on resources that are not easily duplicated by its competitors. In this sense, follows the thought that the resources that a firm hold should create imitation barriers for the competitors, and these include both physical and financial assets as well as employees' skills and organizational processes.

Barney (1991) asserts that the RBV is based in two conjectures: the theory that assumes that companies in an industry can be heterogeneous regarding the strategic resources that they control, and also that these resources are not perfectly movable between the firms, and thus the heterogeneity can be durable. Hart (1995), in his work, presents the concept of RBV connected to the natural environment aspects in which the firm operates. According to the author, RBV states that valuable and expensive resources for other companies to imitate and its capabilities provide key sources of sustainable competitive advantage.

Penrose (2006) suggests that the companies that develop competitive advantages are those that make the best use of the available resources and not simply the ones that have the best available resources. Yet, the author reports that the heterogeneity of the production resources and services available or potentially available gives to each company its oneness. Therefore, new resource combinations in the organization are needed to achieve the goal to obtain a sustainable competitive advantage.

On the other hand, according to Mahoney (1995), if the managers are capable to estimate better than its competitors the future value of its resources – or simply have better luck than they (Barney, 1986) -, the company is able to create strong *ex ante* competitive advantages. Nevertheless, if the company develops isolation mechanisms that prevent other ways of competing, its profits above the average are a source of competitive advantage *ex post*. Therefore, in consonance with Penrose (2006), their own resources can act to limit (or not) the organizational growth.

Wernerfelt's (1984) seminal article was followed by several authors like Barney (1991), Mahoney and Pandian (1992), Hart (1995), Barney (2001), among others. As already discussed, the initial focus of the RBV was that resources and competencies which distinguish the organizations are exclusively internal to them (Wernerfelt, 1984; Barney, 1991). In recent studies, the importance of external resources – from other organizations with which a company relates – also started to be considered (Ireland, Hitt, & Vaidyanath, 2002; Sirmon, Hitt, Ireland, 2007; Cainelli, De Marchi, & Grandinetti, 2015). Cainelli et al. (2015) highlight the importance of external resources, as it is not convenient and not even possible for them to develop internally all the resources needed to compete, innovate and grow in competitive environments.

Then, with the RBV, it is clear that internal features such as strategy, structure and core competencies are relevant in driving the innovation process (Nelson & Winter, 1982). In the specific context of green innovations, this can involve both the organizational measures related to environmental issues, as environmental management systems (Rennings, Ziegler, Ankele, & Hoffmann, 2006; Wagner, 2007; Kesidou & Demirel, 2012) and factors as the presence of R&D investments (Horbach, 2008; Horbach et al., 2012; Cainelli et al., 2015).

Also, the acquisition or ownership of patents (Segarra-Oña, Peiró-Signes, Albors-Garrigós, & Miret-Pastor, 2011; Cainelli et al., 2015), cooperation and alliances (De Marchi, 2012; Horbach et al., 2012; Del-Río, Peñasco, & Romero-Jordán, 2013) and employees training (Sarkis, Gonzalez-Torre, & Adenos-Diaz, 2010; Cainelli, Mazzanti & Montresor, 2012; Cainelli et al., 2015) are widely explored as internal drivers of green innovations. Horbach et al. (2012) emphasize that technological competencies and available resources are also important in leveraging green innovation performance.

Table 9 summarizes the main definitions covered in this section about the given grounding, from the perspective of the RBV theory, for the internal drivers for green innovations in companies, highlighting its importance in this respect.

Table 9- Summary table: the resource based view and the internal drivers

Authors	**Definitions**
Nelson & Winter (1982)	The RBV affirms that internal characteristics as strategy, structure and core competencies are relevant in the innovation process.
Barney (1991)	The sustainable competitive advantage comes from resources and capabilities that a company own and that are inimitable and unique; including management skills, process, organizational routines and knowledge.
Hart (1995)	The competencies and green technologies are core capabilities that can result in sustainable competitive advantages.
Rehfeld et al. (2007)	The external factors that drive innovations are complemented by some characteristics specific to the companies.
Horbach et al. (2012)	The technological competencies and available resources are important green innovation drivers.

Source: Elaborated by the author

2.2.2 Institutional forces

Originally conceived as an alternative to theories that considered the organizations as independent rational actors (see DiMaggio & Powell, 1983; Meyer & Rowan, 1977), the institutional theory gained body and today is one organizational theory strongly established and rich in models and concepts that explain the influence of institutions on organizations (Stål, 2015). Therefore, the greatest strength of institutional theory is to explain the diffusion of organizational practices.

Glover, Champion, Daniels and Dainty (2014) assert that the institutional theory provides a theoretical approach under which is possible to identify and examine influences that promote the survival and legitimacy of organizational practices, including factors as culture, social environment, regulations, tradition and history, as well as economic incentives, while recognizing the importance of resources. According to Carpenter and Feroz (2001) the institutional theory is based on the premise that the organizations answer to the pressure of their institutional environments and adopt management structures and practices that are socially accepted due to be the most appropriated organizational choice.

As per with Fuenfschilling and Truffer (2014), the institutional theory contributes to explain certain actors key-characteristics and behaviours or the emergency and diffusion of practices by highlighting the relevance of major principles as rules, norms, conjectures or cultural belief systems. Eisenhardt (1989) suggests that business managers rely on industry norms, company traditions, and management trends, among others, to formulate their policies and define strategies; and clarifies that, largely, the organizational actions mirror a standard of doing things that evolves in a period of time and becomes legitimate.

Campbell (2007) asserts that such a perspective is important due to the fact that institutions, besides the market, are usually necessary to ensure that companies are responsive to social interests of actors than itself. This way, the social, political and economic pressures extern to the organizations influence its strategy and decision making, due to the fact that the companies seek to adopt legitimated practices or to legitimate its practices from the point of view of one or more stakeholders (Jennings & Zandbergen, 1995).

Dacin (1997), along with Carpenter and Feroz (2001), claim that the institutional arena contains a number of institutional forces that influence organizational structure and behaviour.

This includes the ones that come from sociocultural norms and the connections amid organizations, as the dependency and political pressure. Therefore, the institutionalization process is one in which the society's expectations of forms and appropriate organizational behaviours assume a status of thoughts and actions rule (Covaleski & Dirsmith, 1988).

Friedland and Alford[4] (1991 *apud* Stål; 2015) originally introduced the institutional logic issue to define the macrostructures of the society. This logic includes prescriptions related to actors in a specific industry (Greenwood & Suddaby, 2006), whereas the prevalent practices and ideas derive from it (Stål; 2015). Battilana, Leca and Boxenbaum (2009) complemented that this comprises the shared belief among industry actors concerning the goals to be pursued and how to reach them. For this reason, the sustainability agenda in many industries can be influenced by the logic of actors in the institutional environmental in which the organization operates.

The institutional environment, according to DiMaggio and Powell (1983), encompasses organizations that shape a recognized area of institutional life: the key suppliers, resources and products' consumers, regulatory agencies, and other organizations that produce similar products or services. Therefore, the changes in an organization can result from a formal and informal pressure from organizations of which the company depends and cultural expectations in the society where it operates: the government, with the legal requirements; the existing technology, which the company copies or improve; and the society, due to the change in its preferences.

The concept of isomorphism, widely discussed by DiMaggio and Powell (1983), explains the policies and behaviours that are present in one organization, this being due to a imitation process which forces a company inserted in one environment to mirror in the others that are under the same conditions. This way, the features of an organization are modified in order to match them with the environment. Three are the mechanisms that lead to the isomorphism process: coercive (political and normative pressure and the legitimacy problem), mimetic (resulted of a standard answer to uncertain situations) and normative (associated with professionalization and the market).

The coercive mechanism then deals with the influence by those in positions of power, which are crucial for example for conducting environmental management and improvements towards sustainability (Kilbourne, Beckmann, & Thelen, 2002). The mimetic occurs when

[4] Friedland, R., Alford, R.R. Bringing society back in: symbols, practices and institutional contradictions. *In:* Powell, W.W., DiMaggio, P.J. (1991). *The New Institutionalism in Organizational Analysis*. Chicago, University of Chicago Press, 232-263.

companies imitate the actions of well succeeded competitors in the industry aiming to replicate their success (Sarkis, Zhu, & Lai, 2011). The normative ensures that the organizations comply with standards to be perceived as involved in legitimate actions, due to an existing social obligation to follow the rules.

As a result, the institutional norms affect two primary dimensions: the cognitive interpretations of the founders and the resources flow. Regarding the first dimension, the institutionalized norms lead the founders to incorporate characteristics institutionally favoured, hopping their organizations to be judged as appropriated or legitimated (Meyer & Rowan, 1977). Concerning the resources flow, the institutional forces have important consequences in the resources availability for the organizations as they shape people tastes and preferences.

Barbieri, Vasconcelos, Andreassi, and Vasconcelos (2010) refers to the institutionalization of sustainable development, claiming that due to new values spread among the society, the companies are answering by adopting models and practices considered the best in a social system, translating the sustainability precepts to their activity. In doing so, the institutional theory can be used to explain how changes in social values, technological advancements and regulations affect decisions concerning green (or sustainable) activities (Ball & Craig, 2010; Rivera, 2004) and environmental management (Hoffman & Ventresca, 1999).

Specifically in the context of green innovations, those are driven by the technological development, for example, by the search for materials' efficiency, product quality improvements, energy efficiency, among others; regards to the market, the change in consumer preferences for products that are environment-friendly, the relevance of organizational image, the emergence of new markets or the need to expand the existent market; and the normative pressure, for example, by means of the country's environmental laws, health standards and work safety, among others.

Therefore, institutional forces from firm's environment can influence firm performance in green innovations, by promoting a technological change inside the firm (Berrone, Fosfuri, Gelabert, & Gomez-Mejia, 2013). These pressures help firms focusing in R&D initiatives connected to sustainability issues and influence internal resource allocations and the development of capabilities that base a firm' sustainable competitive advantage.

Table 10 summarizes the main definitions covered in this section about the grounding given, under the institutional theory perspective, for the institutional forces that conduct the companies' behaviour to promote the generation of green innovations, showing its importance in this respect.

Table 10– Summary table: the institutional theory and the external drivers

Authors	**Definitions**
DiMaggio & Powell (1983)	Companies compete not only for resources and clients, but for political power and legitimacy.
Eisenhardt (1989)	Business managers mirror in the industry norms, company traditions and management trends to establish their policies and strategies.
Jennings & Zandbergen (1995)	Social, political and economic pressures influence strategy and organizational decision making, due to that companies seek to adopt legitimate practices or legitimize their practices from the point of view of a stakeholder.
Carpenter & Feroz (2001)	The institutional theory is based on the premise that the organizations answer to their institutional environment pressures and adopt structures and management practices that are socially accepted due to the most appropriate choice.
Campbell (2007)	The institutions are required to ensure that businesses are responsive to social interests of actors than themselves.
Glover et al. (2014)	The institutional theory allows identifying influences that promote survival and the legitimacy of organizational practices, including factors as culture, social environment, regulations, tradition and economic incentives, at the same time that recognizes the importance of the resources.

Source: Elaborated by the author

2.3 Dynamic Capabilities

The RBV primarily analyses the existing resources within the company, while the dynamic capabilities emphasize the configuration of such resources (Helfat & Peteraf, 2003). The dynamic capabilities can be considered as organizational routines that affect change, based on the company resources (Eisenhardt & Martin, 2000), creating a better configuration among them and the limitation imposed by the external environment. Essentially, they are the means for activating, leveraging and protecting organizational resources.

Some authors suggest the classification of dynamic capabilities into different types of it, as not only one capability can be able to satisfy all the company needs in a dynamic environment. One of those is the Absorptive Capacity, defined according to Cohen and Levinthal (1990) as a firm ability to identify, assimilate and exploit knowledge from its dynamic environment. Stanovcic, Pekovic and Bouziri (2015) assert that green innovations are enhanced through knowledge improvement; therefore, companies should develop or improve the absorptive capacity in order to generate green innovations (Leonidou, Leonidou, Fotiadis, & Aykol, 2015).

2.3.1 Dynamic Capabilities and Green Innovations

The RBV primarily analyses the existing resources within the company, while the dynamic capabilities emphasize the configuration of such resources (Helfat & Peteraf, 2003). Based on that, Penrose (2006) suggests that companies which develop competitive advantages are those that make the best use of the available resources and not simply the ones that have the best available resources. The organizational capabilities that originate the competitive advantage are not simple assets, but a set of assets that are built over time, depending on the technological pathway (Teece, Pisano, & Shuen, 1997) and applied to a certain value added task (Hart, 1995).

Thus, according to Teece (2007), the competencies are developed when the resources are combined to create specific organizational capabilities. This approach emphasizes that not only a set of resources is relevant, but also the mechanism used by the organizations to accumulate these skills (Deeds, Decarolis, & Coombs, 1999). Companies consist of a set of capabilities that together correspond to assets and competencies that are exclusive and off difficult replication (Teece, 2007). Among these are the dynamic capabilities that stand out for providing companies with the possibility to reach new and innovative kinds of competitive advantage, given an innovation pathway and a market position (Leonard-Barton, 1992).

Considered by Schilke (2014) as an extension of the RBV theory, dynamic capabilities can be defined as organizational routines that affect the change in the company resource base (Eisenhardt & Martin, 2000), creating a better configuration among them and the limitation imposed by the external environment. Under this assumption, the organizations have to build, integrate and reshape internal and external competences to adapt to the volatile environment and create a differentiation (Cheng, Yang & Sheu, 2014; Teece et al. 1997).

Teece et al. (1997) use the concept of dynamic capabilities to explain why some companies are more successful in establishing competitive advantages than others in dynamic markets. Eisenhardt & Martin (2000) define dynamic capabilities as the process to integrate, reallocate, acquire and abandon resources in response to changes in the market. These resources can be internal to the company (Lin & Wu, 2014) or external, obtained through cooperative alliances and acquisitions (Teece et al., 1997).

Therefore, it is possible to claim that dynamic capabilities in an organization can limit or enhance business action for generating green innovations (Cai & Zhou, 2014), since its existence and strengthening will determine the company's ability in combining competences to answer strategically to internal drivers and institutional forces. Bhupendra and Sangle (2015) suggest that firms that develop capabilities which prepare them to implement environmental strategies create a potential competitive advantage against its peers. Therefore, in order to develop radical green solutions, the companies need to foment the development of dynamic capabilities.

Castiaux (2012) adds that companies with aims to develop successful environmentally innovative projects need to develop dynamic capabilities which integrate environmental dimensions. This happens as the more a company integrates environmental aspects in its strategy, the more the set of dynamic capabilities will be challenged and questioned (Chassagnon & Haned, 2015). Chen and Chang (2013) suggest that companies actually develop green dynamic capabilities, defined as the ability of a company to exploit and renew its green organizational capabilities to respond to a dynamic context.

These authors found out that those capabilities are crucial drivers of green product development performance. Also Gabler et al. (2015) suggest that companies that leverage green dynamic capabilities experiences positive gains in terms of market and financial performance. Rashid, Shamee, and Jabar (2014) posit that technology collaboration, green human resource, green innovation culture and environmental management systems are central in dynamic green practices. Tietze, Schiederig, and Herstatt (2013) complement that if companies aim to evolve in addressing sustainability in its innovation output, they should include in their assets a set of green dynamic capabilities.

Nevertheless, Hofmann, Theyel, and Wood (2012) suggest that a theoretical concept as "green dynamic capabilities" cannot be referred yet as a reference in the literature as it is still under construction. However, their work supports the relevance of specific capabilities in facilitating the implementation of green initiatives. Fraj et al. (2015) encourage the application of updated advanced knowledge to develop innovations and environmental strategies, thus creating conditions for a competitive advantage.

Huang and Li (2015) also found out that dynamic capabilities are positively related to green products and processes innovation performance and suggest managers to develop such capabilities in order to sense and seize opportunities, through new combinations of existing knowledge leading to the development of green innovations.

Table 11 summarizes the main aspects of dynamic capabilities and green innovations, discussed in this sub-section.

Table 11- Summary table: dynamic capabilities and green innovations

Authors	**Definitions**
Leonard-Barton (1992)	Stand out for providing companies with the possibility to reach new and innovative kinds of competitive advantage, given an innovation pathway and a market position.
Eisenhardt & Martin (2000)	Organizational routines that affect the change in the company resource base.
Cheng et al. (2014)	To build, integrate and reshape internal and external competences to adapt to the volatile environment and create a differentiation.
Cai & Zhou (2014)	Dynamic capabilities in an organization can limit or enhance the business action in generating green innovations, since its existence and strengthening will determine the company's ability in combining competences to answer strategically to internal and external drivers.

Source: Elaborated by the author

2.3.2 Absorptive Capacity for Green Innovations

While the concept of dynamic capabilities is still under construction in literature, Wang and Ahmed (2007) were able to congregate three main components of the dynamic capabilities: the absorptive capacity, innovation capacity and adaptive capacity.

The innovation capacity allows the generation of innovations that refine or strengthen existing products and services or transform them significantly (Subramaniam & Youndt, 2005). Whereas, the adaptive capacity, according to Wang & Ahmed (2007), refers to the competence of a company to identify and capitalize when they capture opportunities from emerging markets. The absorptive capacity is the ability of a firm to identify, assimilate and exploit knowledge from its dynamic environment (Cohen & Levinthal, 1990).

The absorptive capacity allows the company to assimilate and explore knowledge, facilitating the organizational learning (Biedenbach & Müeller, 2012). Cohen and Levinthal (1990) introduced its concept as one that permits the company to benefit of an external knowledge, i.e. the capacity to recognize new external information, assimilate and apply them with commercial purposes. For Zahra and George (2002), the absorptive capacity is a dynamic capability that favours knowledge building and application, encompassing four processes: acquisition, assimilation, transformation and exploitation.

Acquisition is related to the identification and acquisition of relevant external knowledge. According to the authors, the pathway, speed and intensity of a firm's effort to acquire external knowledge reveals the quality of this process and the direction of knowledge accumulation. Prior investments and knowledge of the firm are determinant in this process. The assimilation process is defined as the set of processes and routines which allow processing, understanding and interpreting the obtained knowledge (Szulanski, 1996).

Basically, its main role is the interpretation, comprehension and learning, promoting knowledge assimilation and facilitating its internalization. Zahra and George (2002, p.190) define the transformation process as the "firm's capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge". It aims at finding synergies among the previous knowledge base and the external information, giving new interpretation, significance and relevance for it.

Exploitation processes are related to the application of knowledge emphasized by Cohen and Levinthal (1990) in their definition of absorptive capacity. It allows firms to refine, extend and leverage its knowledge capital or to develop new competences by combining the transformed external knowledge in its operations. These processes can influence the innovation outcomes of a company, by allowing the harvesting of resources and development of core competencies (Zahra and George, 2002).

Therefore, it can be considered one of the key processes of organizational learning (Lane, Koka, & Pathak, 2006). Deeds et al. (1999) affirm that the companies accumulate knowledge, expertise and skills through organizational learning and this allows companies to perform its activities in a better way. Flatten, Engelen, Zahra, and Brettel (2014) states that the absorptive capacity makes use of external knowledge to stimulate internal innovation and Kostopoulos, Papalexandris, Papachroni, & Ioannou (2011) assure that one of the organizational outputs of the absorptive capacity is innovation performance.

Some authors support that a relevant requisite for adopting green innovations is the acquisition, processing and assimilation of new knowledge into organizational routines. Hashim, Bock, and Cooper (2015) affirm that firms should emphasise on how knowledge is used in order to improve their green practices, generating green innovations in processes and products. Kiefer, Carrillo-Hermosilla, and Del-Río (2015) also support the importance of dynamic capabilities as drivers for green innovations, emphasizing the relevance of the capacities of exploring, transforming, retaining and exploiting knowledge.

Results found by Zhu, Cordeiro, and Sarkis (2013) shows that organizational capabilities and absorbed knowledge prepare organizations to respond to institutional forces which demand for green innovations. Stanovcic, Pekovic & Bouziri (2015) assert that green innovations are enhanced through knowledge improvement; therefore, companies should develop or improve the absorptive capacity in order to generate green innovations (Leonidou, et al., 2015). Therefore, Chen, Lin, Lin, and Chang (2015) explains that companies develop green absorptive capacities if they possess the ability to recognize, value, and acquire external environmental knowledge.

Table 12 summarizes the main definitions covered in this section about absorptive capacities and green innovations, showing its importance in this respect.

Table 12- Summary table: absorptive capacity and green innovations

Authors	**Definitions**
Cohen & Levinthal (1990)	The absorptive capacity is the ability of a firm to identify, assimilate and exploit knowledge from its dynamic environment.
Zahra & George (2002)	The absorptive capacity is a dynamic capability that favours knowledge building and application, being encompassed by four processes: acquisition, assimilation, transference and exploitation.
Flatten et al. (2014)	Absorptive capacity makes use of external knowledge to stimulate internal innovation.
Stanovcic et al. (2015)	Green innovations are enhanced through knowledge improvement; therefore companies should develop or improve the absorptive capacity in order to generate green innovations.

Source: Elaborated by the author

2.4 Green Innovation Performance

Organizational performance has long been discussed in the strategy literature. From a systems perspective, Evan (1976, p.395) define performance as the "ability of an organization to cope with all four systemic processes (inputs, outputs, transformations, and feedback effects) relative to its goal-seeking" behaviour. For Miles (1980), an organization that is considered as high-performing accomplishes its main tasks and carries out its functions of maintaining and adapting the organization efficiently.

More recently, Ho (2008) and Li, Ragu-Nathan, Ragu-Nathan and Subba Rao (2006) defined organizational performance as an indicator of how efficiently an organization accomplishes its market orientation and financial goals. Chong, Chan, Ooi and Sim (2011) asserts that depending on which business processes are under scrutiny, the measurement of organizational performance may vary from financial, market, supply chain or innovation indicators.

According to Han, Kim and Srivastava (1998), innovation is an important function inside the companies as it is positively linked to business performance, as has been demonstrated by many studies since the 80s (e.g., Damanpour, Szabat, & Evan, 1989; Zahra, de Belardino, & Boxx, 1988; Damanpour & Evan, 1984; Damanpour, 1991; Perin, Sampaio, & Hooley, 2007; Chong et al., 2011). Innovative companies, as for Evan (1976), accomplish more than its main goals, creating new environments - and not only adapting to the existing-, by introducing new products and processes.

Therefore, innovation became one important independent criteria of organizational performance. In addition, Perin et al. (2007) affirm that innovation performance is one component of the organizational performance. By examining only innovation performance, according to Alegre and Chiva (2008), we are able to isolate the actions and the outputs that are exclusively related to the innovation domain.

Chen and Huang (2009), based their measurement of innovation performance on Damanpour (1991) and Ibarra (1993), using managers' perception of the extent of which firms are satisfied with their achievements in developing and implementing innovation activities. Perin et al. (2007) consider innovation performance as the success of new products in the market, and in their study performance is measured according to indicators suggested by Baker and Sinkula (2005): rate of introduction of new products, degree of success of new products, and pioneering the market with new products and services.

Alegre and Chiva (2008) used the concepts of innovation efficacy and efficiency to measure innovation performance (the first, reflecting the degree of success of the innovation and the second, the effort made to achieve the degree of success). Chong et al. (2011) suggest a measurement of innovation performance based on previous studies (e.g. Chen & Tsou, 2007; Prajogo & Sohal, 2001; Yamin, Mavondo, Gunasekaran, & Sarros, 1995) dividing it into two output categories: process innovation and product/service innovation.

Regards to green innovation performance, we noticed that few studies have developed specific indicators. In this study, based on Chen et al. (2006), we define performance on green innovations as the performance of hardware and software involved in one innovation that a company carries out, concerning green products and processes, including technological innovations that are focused in energy savings, pollution prevention, waste recycling, green product design, or environmental management. Performance in this study was also divided in two categories: performance in green product innovation and performance in green process innovation.

Performance in green product innovation is defined as the performance in product innovation that is related to environmental innovation, including product innovations which aim energy savings, pollution prevention, waste recycling, non-toxicity and green products design (Lai et al., 2013). Regards to performance in green process innovations, this is defined as the performance in process innovation that is related to energy savings, pollution prevention, waste recycling or non-toxicity.

Table 13 summarizes the important definitions of Green Innovation Performance.

Table 13- Summary table: green innovation performance

Authors	**Definitions**
Chen et al. (2006)	Performance divided in two categories: performance in green product innovation and performance in green process innovation.
Perin et al. (2007)	Consider innovation performance as the success of new products in the market.
Alegre & Chiva (2008)	Used the concepts of innovation efficacy and efficiency to measure innovation performance.
Chen & Huang (2009)	Based their measurement of innovation performance using managers' perception of the extent of which firms are satisfied with their achievements in developing and implementing innovation activities.
Chong et al. (2011)	Suggest a measurement of innovation performance dividing it into two output categories: process innovation and product/service innovation.

Source: Elaborated by the author

3. MODEL CONSOLIDATION AND RESEARCH HYPOTHESES

The literature review is not intended to exhaust all concepts relevant to the issues in research, but rather to present an overview of its evolution in time making it possible to establish important definitions for the conduction of this study, to be methodologically defined in the next section.

The crucial issue of sustainability is that its limitations are mostly determined by the existing technology. Then, it is evident the importance of technological advancement so that it can be achieved, that is, the relevance of innovation to overcome the obstacles imposed by the current technological state aiming to foster the reduction of inequalities and social issues, enhancement of environmental protection and good use of natural resources and economic growth.

In this study we consider innovation as the creation and release on the market or adoption of products, processes or technologically new or improved organizational methods. Thus, green innovations are innovations aimed at promoting sustainability, by minimizing or avoiding environmental impacts of business activities on the environment without neglecting value generation to the market.

Thus, green innovations have a peculiar importance in the readjustment of the technology and the social role of organizations that no longer restricts to its own benefits or of their shareholders, but comprises an active role in promoting citizenship and respect for the environment and social issues. In this sense, it is essential to understand to which factors organizations respond when they generate green innovations and also what capabilities are essential in this process.

Because green innovations are comparable to public goods, in economic terms, the externalities it generates distinguish those from other types of innovation. Thus, institutionally, the market and the current technology alone do not have the strength to lead their generation, making public policies and other regulatory instruments relevant in order to stimulate the creation of technology in processes or products that are aligned to the concept of sustainability.

Also, internal features of a company can be crucial in the innovation process, determining its performance in generating green innovations. Therefore, the presence of R&D investments, patents acquisition or ownership, training programs, environmental management systems and alliances with other organizations or institutes can influence the innovation process in a company, being as or more important than the institutional forces in driving green innovations. However, the existence of these resources and institutional pressures does not necessarily enable the organization to increase its performance in green innovations, being relevant the development of certain capabilities that are critical to the innovation process, as the absorptive capacity.

In such relation, it enables the company to combine competencies to better manage the institutional forces and the internal drivers, establishing a set of processes to adapt to the environment in which it operates (Leonard-Barton, 1992; Eisenhardt & Martin, 2000; Teece, 2007). The absorptive capacity refers to the company's ability to access external knowledge and absorb them into their organizational routines, developing responses to external changes through innovations. It interferes with the relationship among the internal drivers and institutional forces that drive green innovations performance, being the aim of this study to analyse them.

When combined, green innovation drivers favour the development of dynamic capabilities that lead to sustainable competitive advantages. Thus, the green innovation internal drivers intervene in the company capability to identify, assimilate and exploit institutional forces and absorb them aiming to improve the green innovation performance. Therefore, the first research hypothesis is defined.

H1: The internal drivers are positively related to the absorptive capacity.

Regards to the relationship among institutional forces and internal drivers of green innovations and the absorptive capacity, it is possible to assert that in both ways there is a positive relation. This is due the internal drivers allow the configuration of the absorptive capacity within the organization by enabling it to absorb the knowledge generated internally and externally for it to be useful in the innovation process (Cohen & Levinthal, 1990). The institutional forces create mechanisms that require the development of organizational abilities to interpret its demands and offer an answer through green innovations. In that sense, the next hypothesis is presented:

H2: The institutional forces are positively related to the internal drivers.

As the literature states, the company behaviour regarding green innovations is influenced by the institutional environment acting as an enforcement, which is comprised by the regulations, technology and market pressures. It is possible than to affirm that internal resources act as mediators in the relationship between the absorptive capacity of the company and the institutional forces, because those are rare and unique resources (Barney, 1986) which endow companies to access external information and leverage the internal knowledge capital.

Hence, another hypothesis is suggested:

H3: The internal drivers mediate the relation between institutional forces and absorptive capacity.

Finally, Zahra and George (2013) propose that companies with well-developed absorptive capacity tend to develop a competitive advantage through innovation and a superior performance. That is, a tangible output of green absorptive capacity routines is an enhanced green innovation performance. Absorptive capacity, as one type of dynamic capability, allow the reconfiguration of existing resources (Schilke, 2014), revealing the company ability to learn and process change.

Recent studies on the mediating effect of dynamic capabilities highlight even more their importance. Wu (2007) founded a positive effect of the dynamic capabilities in resources and organizational performance. Lin and Wu (2014) affirm that these are transformative, as they allow the resources conversion in organizational performance enhancement, extracting competitive combinations of them. Hence, the last research hypotheses are presented as follows:

H4: The absorptive capacity mediates the relation between internal drivers and green innovation performance.

H5: The absorptive capacity is positively related to the green innovation performance.

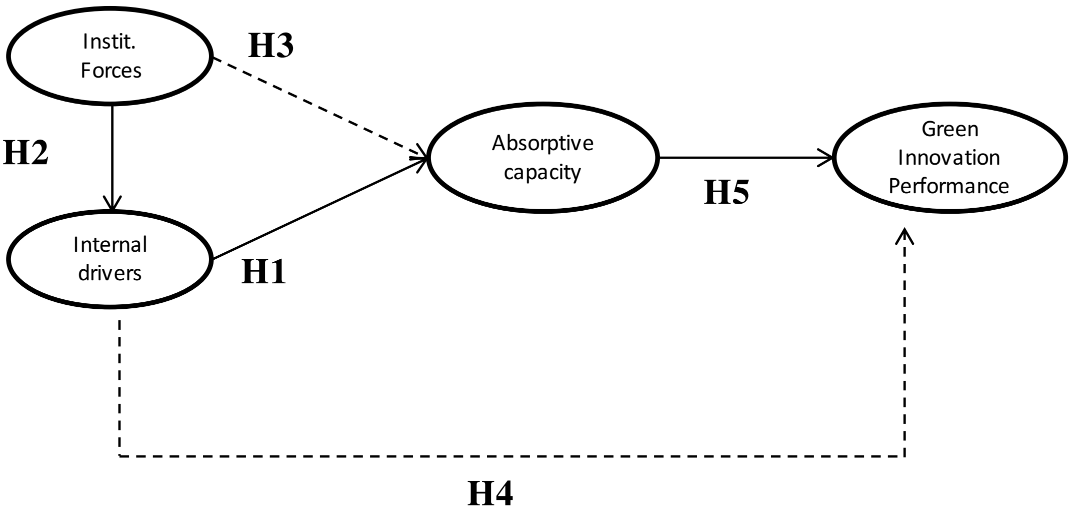
The next section deals with the classification and design of the empirical study to be conducted and the presentation of the variables and the statistical model to be checked. With the function to consolidate all research details facilitating the understanding of relationships between the problem, the research objectives and the hypotheses, Table 14 is presented.

Table 14 - Consolidation of main research aspects

Research Problem	General Objective	Specific Objectives	Hypotheses	Theoretical basement
Does the combination of institutional forces and internal drivers lead to a better performance in green innovations in the Brazilian electricity sector companies?	To assess empirically the relationship among internal drivers and institutional forces in driving green innovations in the Brazilian electricity power sector.	To identify the existing relationship among the drivers of green innovations and the consolidation of the absorptive capacity in the Brazilian electricity power sector.	**Hypothesis 1:** The internal drivers are positively related to the absorptive capacity.	Cohen & Levinthal (1990)
			Hypothesis 2: The institutional forces are positively related to the internal drivers.	Dacin (1997), Carpenter & Feroz (2001), Glover et al. (2014)
			Hypothesis 3: The internal drivers mediate the relation between institutional forces and absorptive capacity.	Barney (1986), Penrose (2006)
		To identify the relationship between absorptive capacity and performance in green innovations in the Brazilian electricity companies.	**Hypothesis 4:** The absorptive capacity mediates the relation between internal drivers and green innovation performance.	Leonard-Barton, (1992); Eisenhardt & Martin, (2000); Teece, (2007)
		To identify the overall connection between green innovation drivers, absorptive capacity and performance in the Brazilian electricity sector.	**Hypothesis 5:** The absorptive capacity is positively related to the green innovation performance.	Zahra & George (2013), Kostopoulos et al. (2011)

Source: Elaborated by the author.

The conceptual model presented bellow summarizes the relationship among the research hypothesis defined in this section and the variables, to be introduced in the next section.



Moderation relations ----------►

* instit. forces = institutional forces

Figure 2 – Research conceptual model

Source: Elaborated by the author.

4. METHODOLOGICAL ASPECTS

This chapter aims to introduce the chosen methodological procedures, including the research type, data collection instrument, measurement of constructs, delimitation of the sample, and data analysis.

4.1 Research type

This study can be defined as quantitative, since according to Byrman and Bell (2011) this research type link a collection of numerical data and seeks a relationship between theory and research, in a deductive process. That is, an assumption is deducted from theory and then tested using numerical data and statistical analysis techniques. Furthermore, it can be classified as a descriptive research, which has as main goal to describe the characteristics of a sample or target population, relying on previous hypothesis formulation (estimations of the presence of these characteristics in the population) and quantitative analysis to discover and measure relations or associations between variables (Cooper & Schindler, 2003).

The associations expressed in the hypotheses definition are relations, in its essence, not causal and which nature can be connected to a speculation (Cooper & Schindler, 2003). That is, the descriptive research demands from the researcher the study of the phenomena without the possibility to control or manipulate variables, collecting information of existing data and determining relations without inferring causality (Swanson & Holton, 2005[5] *apud* Warfield, 2005, p.29).

To collect the necessary data, a survey was carried out among the companies of the Brazilian electricity sector. The data collected was refined, analysed and statistical tests were conducted in order to measure the relations stated in the study conceptual model. For that, structural equation modelling was chosen, as Hair, Babin, Money, and Samouel (2005) affirms that it is a statistical technique that allows separating relations for each set of dependent variables.

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[5] Swanson, R.A, & Holton, E.F.III. (Eds.). (2005). *Research in organizations:* Foundations and methods of inquiry. San Francisco: Berret-Koehler.

Other techniques (e.g. multiple regressions, factorial analysis, and multivariate or discriminant analysis) share the limitation of only analysing one relation between dependent and independent variables at a time. Structural modelling allows an analysis of various simultaneous relations, being useful when a dependent variable turns into independent in subsequent dependence relations. The research design is represented in the Figure 3.

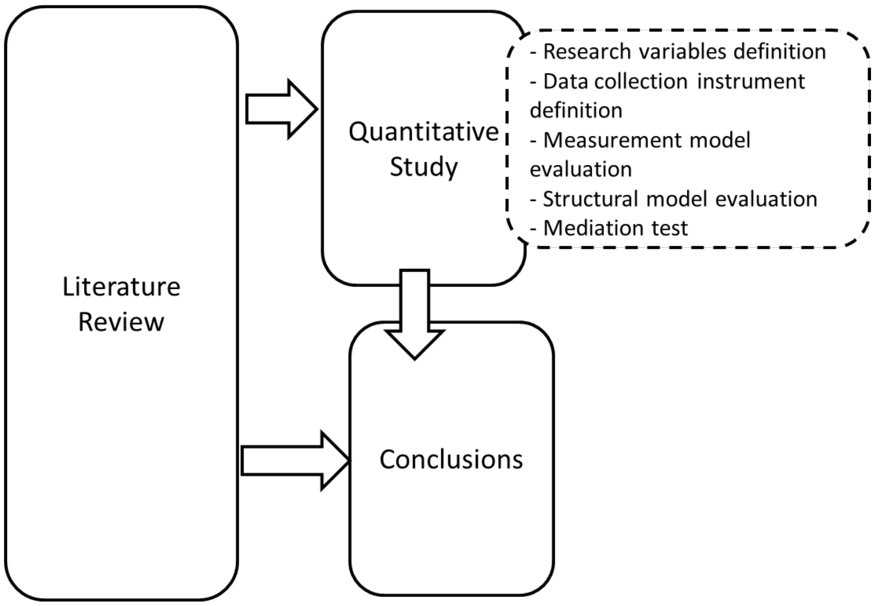

Figure 3– Research Design

Source: Elaborated by the author.

4.2 Research variables

The variables considered in the study are: (1) Green innovation internal drivers, (2) Institutional forces, (3) Absorptive capacity, (4) Green product innovation performance and (5) Green process innovation performance. In the following subsections the conceptual and operational definitions of the study variables are presented. The Appendix 1 brings the complete instrument in Portuguese, as it was applied in this idiom.

Hair et al. (2005) define some constructs as conceptual variables that cannot be measured and demand a set of indicators which allows a direct inference (observable variables). These indicators mirror the idea behind the constructs, which classifies the research model as reflexive according the aforementioned authors. It is important to highlight that this allows extracting any indicator of the set which compromises the understanding of the construct as they share the same theoretical basis. Using this definition, in our research model all the concepts analysed are considered as latent variables (constructs).

The main objective of a research model is to display the relations and interdependencies between the exogenous and endogenous variables, representing a simplified understanding of the reality. Leite (2000) classifies the variables in a model as endogenous or exogenous: the first ones are the ones explained and determined by the model and the others are explained and determined outside of it, introducing necessary external information to it.

In this research model, the exogenous variables, which explain it, are the innovation internal drivers and the institutional forces. The endogenous variables, whose behaviour we aim to understand and explain, are the absorptive capacity and green innovation performance in products and processes.

4.2.1 Green innovation internal drivers

The green innovation internal drivers were delimited in the theoretical review as the internal features of the organization that promote the development of green innovations both proactively and reactively. Maçaneiro and Da Cunha (2015) affirm that the adoption of environmental management systems can be a measure of environmental pro-activity and can lead to a better environmental performance, creating an environment inside the company that is favorable for green innovations development (González-Benito & González-Benito, 2008; Rennings et al. 2006).

Horbach et al. (2012) emphasize that technological competencies and available resources are also important drivers of green innovations, being the presence of R&D investments for green innovations an aspect that can improve environmental and innovation performances. Lastly, Carrillo-Hermosilla et al. (2009) and Ashford (2005) affirm that some other specific internal aspects of the company are essential to support the green innovations development, such as:

- supporting and promoting training of companies' employees to improve its competency base for the development of green innovations;

- exploring formal technology options that are connected to environmental issues, through knowledge sharing and patents development or acquisition;
- creating alliances and relations with other institutions or organizations to encourage the knowledge exchange;

The execution of the variable was defined based on Maçaneiro and Da Cunha (2015) and Cai and Zhou (2014) and it is shown in the Table 15. A 5 points Likert scale was used to measure the construct (1= completely disagree to 5= completely agree). The green innovation internal drivers are considered in this study as a latent and exogenous variable.

Table 15 – Green innovation internal drivers

ID1 The environmental system (e.g. ISO) used by the company contributes for the generation of product and process green innovations.
ID2 The company invests in Research & Development (R&D) projects of green products and processes (e.g. green technologies).
ID3 The company owns or enables environmental training programmes for managers and employees.
ID4 The company owns or has acquired innovation patents of green products or processes.
ID5 The company engages in collaboration with other institutions/organizations, creating strategic relations and alliances.

Source: Based on Maçaneiro & Da Cunha (2015), Cai & Zhou (2014) and Carrillo-Hermosilla et al. (2009).

4.2.2 Institutional forces

The institutional forces were delimited in the theoretical review as pressures coming from various sources that promote the development of green innovations. Due to the external impacts of environmental issues, green innovations are less internal driven, which makes the institutional environment an important force to trigger green innovations (Cai & Zhou, 2014).

Porter and Van der Linde (1995) created the Porter hypothesis, which assumes that stringent environmental policies may induce some advantages for the companies in the long term. Also, other studies confirm empirically the importance of regulations in driving the development of green innovations as companies answer to the regulatory pressure, reducing their production costs (Cai & Zhou, 2014; Dangelico & Pujari, 2010; Kammerer, 2009). It is important to highlight that environmental regulations can also create barriers for competitors to access the market, incentivising companies to invest more in technology developments to surpass them and improve their green innovation performance.

Concerning competitors, the development of new materials, new technologies or new equipment by them triggers the movement in other companies to also invest in innovations (Ball & Craig, 2010; Rivera, 2004**)**. In this case, rival firms pressure companies to innovate in order to maintain their competitiveness, which also puts pressure on the development and acquisition of capacities and resources for supporting this process.

On the other side, consumer behaviour and demands regarding environmental protection also can lead firms to develop green innovations in order to improve their environmental performance (Cai & Zhou, 2014). These forces can drive companies to adhere to certification processes and environmental management systems to comply with practices that are accepted as legitimated by its stakeholders. Therefore, this can be considered also one of the institutional forces that drive green innovations in companies.

The execution of the variable was defined based on Cai and Zhou (2014) and it is shown in the Table 16. A 5 points Likert scale was used to measure the construct (1= completely disagree to 5= completely agree). The institutional forces are considered in this study as a latent and exogenous variable.

Table 16– Institutional forces

IF1 Changes in consumer behaviour on environmental protection or increase in "green consumption" leads (or led) to the development of product and process green innovations in my company.
IF2 The discovery of the use of new materials, new technology or new equipment by competitors leads (or led) to the development of product and process green innovations in my company.
IF3 Industry regulations leads (or led) to the development of product and process green innovations in my company.

Source: Based on Cai & Zhou (2014).

4.2.3 Absorptive capacity

The conceptual definition of the variable here adopted draws back to Zahra and George (2002), which affirm that "the development of innovations depends not only on internal resources, but on a broader set of knowledge capabilities" (Gluch et al., 2009). According to those authors, the absorptive capacity is divided in two subsets: the potential absorptive capacity and realized absorptive capacity.

The first set comprises the acquisition and assimilation processes, which allows companies to adapt easily to an environment in continuous change, representing the potential absorptive capacity. On the other hand, the realized absorptive capacity gathers the processes related to interpretation and use of external knowledge for commercial endings, namely transformation and exploitation processes. Gluch et al. (2009) adapted these concepts in the model developed by Zahra and George (2002) to the context of green innovations, generating the scale that was used in this study.

Regarding the acquisition side, the processes considered are related to the conduction of initial environmental reviews, part of the routine of environmental management systems standard, and adoption of routines to comply with environmental demands and legislation. Assimilation routines are represented by the presence of environmental training programs, clear definition of environmental targets and development of plans to reach them and also the adoption of analytical tools, such as LCA (Life-cycle analysis), to assess its environmental impact.

Concerning the transformation routines and processes, the ones considered in the scale are the conduction of environmental auditing and systematic use of environmental indicators to measure and monitor environmental performance and goals. Lastly, the exploitation routines are the ones dependent of knowledge and influence of managers to create and establish organizational practices that respect environmental interests.

It is important to highlight that usually the capabilities are better captured when measured by routines and processes adopted by a company (Alves, 2015), rather than evaluating performance outputs. This is due capabilities can be evident in several organizational processes (Helfat & Winter, 2011), and to avoid vague and generic measures it is necessary to search for a set of business processes in which they manifest (Schilke, 2014). Therefore, in this study the focus was given to business processes which correspond to the green absorptive capacity of organizations.

The execution of the variable was defined based on Gluch et al. (2009) and it is shown in the Table 17. A 5 points Likert scale was used to measure the construct (1= completely disagree to 5= completely agree). The absorptive capacity is considered in this study as a latent and endogenous variable.

Table 17 – Green absorptive capacity

Acquisition
AC1 Our company has routines to ensure the observation of the environmental demands and legislations.
AC2 In our company we carry out initial environmental reviews.
Assimilation
AC3 The employees in our company participate in environmental training programmes.
AC4 Our company set up measurable environmental goals.
AC5 Our company have a plan of action on how to achieve environmental goals.
AC6 Our company has implemented Life Cycle Analysis (LCA) as a mean to identify environmental impacts from our products/services.
Transformation
AC7 Our company performs environmental audits.
AC8 Our company has implemented environmental declarations as a means to identify environmental impact from our products/services.
Exploitation
AC9 As manager I have the knowledge to influence strategic decisions so that they meet environmental interests.
AC10 As manager I have the knowledge to influence operations and practice so they develop in line with environmental interests.

Source: Based on Gluch et al. (2009)

4.2.4 Green product innovation performance

The conceptual definition of the variable to understand company results regarding green products innovations used Chen et al. (2006) scale and is shown in Table 18. A 5 points Likert scale was used to measure the construct (1= completely disagree to 5= completely agree). Green product innovation performance is considered in this study as a latent and endogenous variable.

Table 18 – Green innovations performance - products

GIP1 The company has developed new products or services of environmental management in the last two years.
GIP2 The company chooses the materials of the product that produce the least amount of pollution for conducting the product development or design.
GIP3 The company chooses the materials of the product that consume the least amount of energy and resources for conducting the product development or design.
GIP4 The company uses the fewest amount of materials to comprise the product for conducting the product development or design.
GIP5 The company would circumspectly deliberate whether the product is easy to recycle, reuse, and decompose for conducting the product development or design.

Source: Based on Chen et al. (2006).

4.2.5 Green process innovation performance

The conceptual definition of this variable to understand the company results regarding green process innovations used Chen et al. (2006) scale and is shown in Table 19. A 5 points Likert scale was used to measure the construct (1= completely disagree to 5= completely agree). The green process innovation performance is considered in this study as a latent and endogenous variable.

Table 19 – Green innovations performance - process

GIP6 The company adopts new environmental management practices when the conventional method fails.
GIP7 The productive process of the company effectively reduces the emission of hazardous substances or waste.
GIP8 The productive process of the company recycles waste and emissions that allow them to be treated and re-used.
GIP9 The productive process of the company reduces the consumption of water, electricity, coal, or oil.
GIP10 The productive process of the company reduces the use of raw materials.

Source: Based on Chen et al. (2006).

4.3 Object of study

This subsection aims to delimitate the economic sector targeted as the object of study, clarifying the reasons of its choice and presenting its main information. For conducting the research, we have chosen the Brazilian electricity power sector, for being a strategic sector to urban and industrial development of the country.

Technically, consistent with Santos, Souza and Castro (2014), electricity power systems as big as the Brazilian are divided among three segments: generation, transmission and distribution. The first segment is responsible for producing electricity power. According to Ferreira, Oliveira and Souza (2015), the Brazilian electricity power sector is among the ten largest in the world in terms of electricity generation, producing approximately 624,3 TWh (Terawatt-hour) in the year 2014 (MME, 2015). In 2014, 74.6% of the generated electricity came from renewable sources, against the word average of 23.6% and 23.1% in OECD countries. The internal offer of electricity energy in 2014 can be seen in Figure 4.

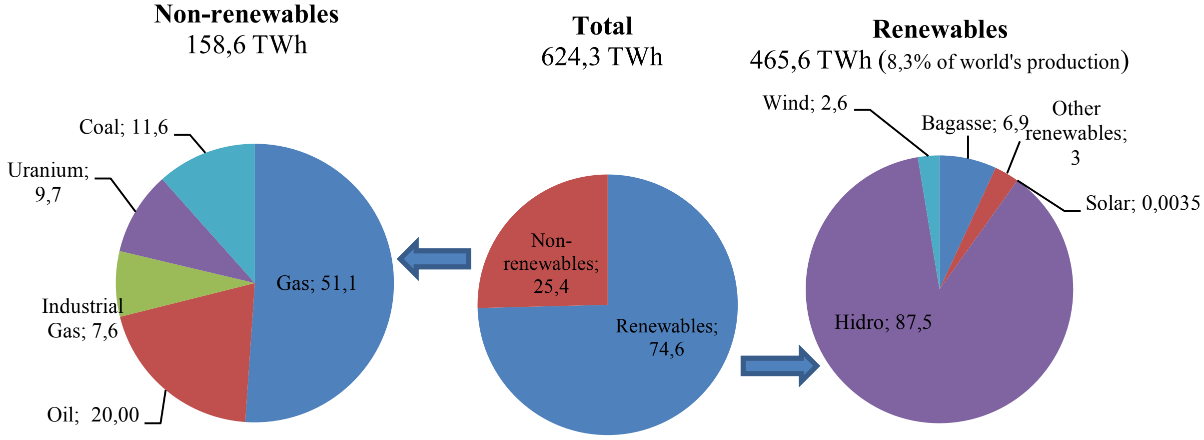

Figure 4 – Internal offer of electricity in Brazil
Source: Based on MME (2015).

Transmission is the segment responsible to transport the produced electricity to the consumption centres and, in Brazil, is comprised by more than 100 thousand km of lines managed, operated and maintained by 77 utilities (EPE, 2013). The distribution sector, however, is the segment responsible for offering electricity to the final consumer. Nowadays, 63 utilities manage the transmission lines of lower voltage (until 230KV) in Brazil, offering electricity for medium and small consumers (ABRADEE, 2016).

Several questions derive from electricity production and commercialization, as mentioned by Santos et al. (2014), and pressure changes in the sector. Socio-environmental restrictions, energy efficiency, alternative energy sources and regulatory and political challenges (Gómez-Expósito, Conejo, & Cañizares, 2009) are the main technological and institutional issues that demand for modernization followed by innovations in each segment of the sector.

4.3.1 Innovation in the electricity power sector

According to Jannuzzi (2005), radical changes in worldwide power sector systems are needed if sustainability is to be pursued. Developing countries face even major challenges such as increasing demand and access of energy combined with the maintenance of their economic development. The answer for these challenges, as suggested by Patterson, Anton and Carlos (2002), is the development of more efficient and clean technologies, supported by economic strategies to commercialize them.

Jannuzzi (2005, p.1754) complements that the energy challenges that Brazil is facing "call for a pivotal role for technologies and technology policies in finding, transforming and utilizing energy resources in an efficient, cost-effective and environmentally sound manner". Since the 90s the power sector in Brazil is being target of significant changes, such as the privatization, the introduction of competition and the establishment of regulatory agencies. This reform implemented changes in management, organization, ownership and decision-making in the Brazilian electricity power sector.

The context of the new institutional framework of the Brazilian electricity sector was needed in order to guarantee that companies, in majority controlled by foreign investors, did not take their R&D efforts out of the country (Jannuzzi, 2005). In 2000, ANEEL, the regulator agent of the electricity sector, established under the Law nº9.991 of 24th of July, a compulsory investment rule in R&D and energy efficiency projects to promote innovation in the sector - reducing dependence on companies - and to encourage the consolidation of strategic partnerships.

Regarding the categories of investment in R&D ruled by the law aforementioned, each of the twelve has sub-sections that are presented in table 20. It offers a wide range of possibilities for programs that can be developed and fitted in the norm, and the majority directly affects energy efficiency and decreasing environmental and social impacts and can be classified as process and product green innovations. It is important to point out that this law, according to Almeida, Barreto Jr. and Frota (2013), are applied not only to distribution utilities, but also companies in the generation and the transmission segment.

In 2012, according to ANEEL (2013), 521 projects were registered, which represented an amount of R$1,99 billion in investments, quantity higher than the cumulative total between 1999 and 2007 period, when 3000 projects were conducted and R$1,57 billion were invested. This call particularly aimed, among others, to deepen the discussion on better use of renewable sources underrepresented in the matrix responding to the interests of agents and the market. The inclusion of sustainability of resources and environmental conservation as a strategic issue came to reverse the perceived drop in the share of these sources in the Brazilian matrix since 2000 (Tolmasquim, Warrior, & Gorini, 2007).

Table 20 – Categories of R&D investment and its sub-categories (continues)

Categories	Sub-categories
Alternative sources of electricity generation	FA01 – Sustainable energetic alternatives for servicing small isolated systems. FA02 – Power generation from municipal solid waste. FA03 - New materials and equipment for the generation of energy from alternative sources. FA04 - Technologies for use of new fuels in power plants.
Thermoelectric generation	GT01 - Risk assessment and uncertainties of continuous supply of natural gas for thermoelectric generation. GT02 - New techniques for efficiency and decreasing pollutants emissions of thermoelectric power plants running on petroleum-based fuel. GT03 - Optimization of power generation in industrial plants: increased efficiency in cogeneration. GT04 - Residential cogeneration micro-systems. GT05 - Techniques for capturing and carbon sequestration in thermoelectric power stations.
Basin and reservoir management	GB01 - Emissions of greenhouse gases (GHGs) in hydroelectric reservoirs. GB02 - Effects of global climate change on the hydrological regime of river basins. GB03 - Integration and optimization of multiple uses of hydroelectric reservoirs. GB04 - Socio-patrimonial management of hydroelectric reservoirs. GB05 - Security management of hydroelectric dams. GB06 - Silting of reservoirs formed by hydroelectric dams.
Environment	MA01 - Impacts and socio-environmental restrictions of electric power systems. MA02 - Methodologies for economic and financial measurement of externalities in electric power systems. MA03 - Toxicity studies related to the deterioration of water quality in reservoirs.
Security	SE01 - Identification and mitigation of impacts of electromagnetic fields on living organisms. SE02 - Analysis and mitigation of electrical accidents risks. SE03 - New technologies for personal protective equipment. SE04 - New technologies for inspection and maintenance of electrical systems.
Energy efficiency	EE01 - New technologies to improve energy efficiency. EE02 - Load management on the demand side. EE03 - Definition of energy efficiency indicators. EE04 - Methodologies for evaluating the results of energy efficiency projects.
Electrical power systems planning	PL01 - Integrated planning of the expansion of electrical systems. PL02 - Integration of wind farms to the SIN. PL03 - Integration of distributed generation to electrical networks. PL04 - Market forecast methodology. PL05 - Hydrodynamic models applied in hydroelectric reservoirs. PL06 - Superconducting materials for electricity transmission. PL07 - Technologies and power transmission systems over long distances.

Table 14 – Categories of R&D investment and its sub-categories (end)

Electrical power systems operation	OP01 - Tools to support the power system operation in real time. OP02 - Load management criteria for different levels of hierarchy. OP03 - Structures, functions and operation rules of ancillary services markets. OP04 - Structural and parametric optimization of distribution systems capacity. OP05 - Reactive power sources allocation in distribution systems. OP06 - Study, simulation and analysis of power system performance. OP07 - Analysis of major disruption and impacts in planning, operation and control. OP08 - Development of models for hydrothermal dispatch optimization. OP09 - Development and / or improvement of rain prediction versus flow models. OP10 - Monitoring systems of plant operation non-dispatched by ONS.
Supervision, control and protection of power systems	SC01 - Control systems implementation (robust, adaptive and intelligent). SC02 - Dynamic analysis of real-time systems. CS03 - Efficient techniques to quickly restore large load centres. SC04 - Development of techniques for restoration of electrical systems. SC05 - Techniques of artificial intelligence applied to control, operation and protection of electrical systems. SC06 - New technologies for monitoring the supply of electricity. SC07 - Development and application of phasor measurement systems. SC08 - Fault analysis in electrical systems. SC09 - Electromagnetic compatibility in electrical systems. SC10 - Grounding systems.
Quality and reliability of electricity services	QC01 - Systems and monitoring techniques and management of power quality. QC02 - Modelling and analysis of disorders associated with power quality. QC03 - Requirements for connecting potentially disturbing loads in the electrical system. QC04 - Sensitivity curves and equipment supportability. QC05 - Economic impacts and contractual aspects of power quality. QC06 - Financial compensation for breach of quality indicators.
Metering, billing and control of commercial losses	MF01 - Economic evaluation to define the attainable minimum loss. MF02 - Estimation, analysis and reduction of technical losses in electrical systems. MF03 - Development of technologies for combating fraud and electricity theft. MF04 - Diagnosis, prospecting and reducing the vulnerability of electrical systems to theft and fraud. MF05 - Saved and aggregated energy market after fraud regularization. MF06 - Use of socioeconomic indicators, fiscal data and expenditure on other inputs. MF07 - Management of measuring equipment (quality and reduction of failures). MF08 - Impact of energy efficiency projects to reduce commercial losses. MF09 - Centralized measuring systems, control and power management for end consumers. MF10 - Charging systems and new tariff structures.
Others	OU – Other.

Source: ANEEL (2016).

Until 2013, the R&D program summed 6.629 projects, reaching R$ 4.54 billion invested by 133 companies in the electricity power sector (Santos et al., 2014). Those authors identified that the top five categories approached by the R&D projects are: supervision, control and protection of power systems, electrical power systems operation, environment, alternative sources of electricity generation and electrical power systems planning.

The law positively impacted the attitude of companies on the subject, which according to Jannuzzi (2005) led to the detection of business opportunities and drew attention to investments in new energy sources, increasing the diversification of the Brazilian energy matrix. According to Karplus (2007), in the energy sector, adopting new technologies favours efficiency while helping to reduce environmental impacts, improve workplace safety and save scarce water and land resources.

From PINTEC (2011), the national survey on innovation, 44.1% of companies in the Electricity and Gas sector are considered as innovators. Among those, 43.7% of them innovated in process, while 7.9% of the universe developed new processes only for the country. Among the R&D activities executed by the Brazilian companies in the sector, the most relevant are: training, software acquisition, external acquisition of R&D and internal activities of R&D.

Additionally, the major expenditures with R&D activities were external acquisition of R&D (0.83%) and internal activities of R&D (0.23%). Machine and equipment acquisition is on the third position, representing 0.16% of total expenditures. However, it is important to recall the mandatory investment on R&D, forced by law, that companies in the sector are subject. In this way, the 1.28% of the net revenues that are being invested in innovative activities (PINTEC, 2011) in the sector reveals that companies are not significantly exceeding the norm, which ranges from 0.5% to 1% of net revenues in R&D investments.

Regards to the impacts of innovations in the sector, the reduction of energy consumption and environmental impact, as well as framing in standards and regulations from national and international market were among the most relevant. As for the barriers for innovations, PINTEC (2011) reveals that companies in the sector mostly mention the high costs and economic risks related to innovations as well as organizational rigidity.

The electricity sector in Brazil still demands a substantial increase in innovations which aim to tackle the challenges imposed by the sustainability paradigm. This study therefore chose this sector due to its relevant on-going transition process to a greener energy system.

4.4 Sampling plan

The target sample can be characterized according to the following aspects, as established by Selltiz, Wrightsman, and Cook (1976):

- Extension: the sample extension is limited to the 192 companies encompassed in a list made freely available in the internet by ANEEL with names, telephones and email addresses of their R&D managers.

- Elements: companies of the Brazilian electricity sector, separated by the subsector in which they act (generation, distribution or transmission).

- Time: the period of analysis of this sample was between December 2015 and May 2016.

Therefore, with the aforementioned sample characterization, it can be framed as a non-probabilistic sample, for being based on a pre-existing mailing list. It can be inferred that a bias in this type of selection by convenience may occur (Cooper & Schindler, 2003), but on the other hand, the mailing list facilitated the direct contact with the companies, raising the chances for higher response rates; which in organizational studies can be less than 35% (Baruch & Holtom, 2008).

In order to estimate a minimum sample size, based on the model presented, the software G*Power 3.1.9 was applied. Two parameters are relevant for this test: the power of the test and the size of the effect (f^2). Hair, Sarstedt, Hopkins, and Kuppelwieser (2014) recommend a power of 0.80, median $f^2 = 0.15$. Combined with the latent construct which has the highest number of predictors (Green Innovation Performance – 2 predictors), the calculated minimum sample had to be 68 cases.

4.5 Data collection: instrument

To collect the necessary data, a survey was conducted among the companies of the Brazilian electricity power sector. Surveys aim to produce quantitative information from a population making use of a predetermined instrument, according to Freitas, Oliveira, Saccol, and Moscarola (2000). In this study the survey can be classified as to its purpose as explanatory (Pinsonneault & Kraemer, 1993), which aims to test causal relations based in one theory, also questioning the reason of their existence. Also, the data was collected only once, seeking to describe and analyse the state of one or many variables in a given moment (Freitas et al., 2000), which also characterizes the survey as cross-sectional.

The data analysed in this study was collected specially to solve an established problem, characterizing it as a primary data source (Teixeira, Zamberlan, & Rasia, 2009). For that, the collection instrument chosen was the questionnaire and the Appendix 1 gathers all the questions applied in this research, which was already commented on section 4.3.

The validity and reliability of the instrument are essential requirements for a measurement (Freitas et al., 2000). According to Mattar (1994), the reliability is defined as the level in which a scale produces consistent results in repeated applications with the same sample. On the other hand, validity refers to the measurement process that is immune, simultaneously, to sampling and non-sampling errors (Mattar, 1994); that is, a scale has a validity if it really measures what was proposed in the research (Freitas et al., 2000).

The preliminary assessment of the instrument was made by the author and her advisor before and after translating, using a reversal translation method (Hill & Hill, 2012). After this procedure, we conducted an interview with specialists in the field of dynamic capabilities and the electricity sector. Four researchers (one master student and three professors) were invited to read, analyze and suggest modifications in the questionnaire. Their detailed information is given in the Table 21.

Table 21– Specialists background

Specialist	**Subject**	**Experience**
Master Student	Innovation and Absorptive Capacity	2 years
Associate Professor	Sustainability and Environmental Management	More than 10 years
Assistant Professor	Sustainability and Dynamic Capabilities	More than 5 years
Assistant Professor	Innovation and Dynamic Capabilities	More than 5 years

Source: Elaborated by the author.

According to Flick (2004), this procedure exemplifies and anticipates reactions in a group or research field. This process was used to assess the content validity in the instrument. Garver and Mentzer (1999) highlights that this dimension is subjective and a statistical test cannot be applied, being generally judged by experts or researchers in the field. The main suggestions were related to the presentation of the instrument, the terms used, the amount of possible answers (it was changed from 7 to a Likert-scale of 5 possibilities), as well as to the aims of the study and the relationship among the variables. After the suggestions, the scale was revised and improved for field application.

4.6 Data collection: method

For each email obtained in the sample, one invitation to participate in the research was sent, which was developed following the instructions given by Yin (2014). Other email reminders were sent to reinforce the invitation. Also, telephone calls were added as a strategy to guarantee a higher response rate. All the data collection was made between December 2015 and May 2016. The answers were collected by electronic means.

The data collection was followed by data purification. In this step, doubtful observations that may contain errors and lead to biases in the results of the quantitative analysis were withdrawn. The data purification was made according to Hair et al. (2014), observing incomplete, duplicated, or standardized answers. The authors also add that the identification of the data pattern is important to define which statistical tests are going to be adequate.

The statistical test chosen to analyse the data was Partial Least Squares Structural Equation Modelling (PLS-SEM) (Hair et al., 2014). This method is a soft modelling approach to SEM with no assumptions about data distribution. Therefore, testes about multivariate normality are not necessary. PLS is useful when there are limited participants and the sample size is small, applications have little available theory and the data distribution is skewed (Wong, 2011). Despite its limitations, it has been applied in many fields such as behavioural sciences, organization and business strategy (Wong, 2013).

The procedure of estimation using PLS followed the guidance of Hair et al. (2014), with the support of SmartPLS® Software. SEM-PLS is analysed in two sequential steps: evaluation of the measurement model and evaluation of the structural model. The measurement model, as defined by Hair et al. (2014), specifies how to measure the latent constructs in terms of the observed variables. The structural model specifies the causal relations among the latent constructs.

4.7 Measurement model evaluation

According to Garver and Mentzer (1999), the measurement model describes how the observable variables can measure the latent variables. Hair et al. (2014) add that its evaluation comprises four steps, namely: convergent validity (for variables and constructs), discriminant validity, and internal consistency (composed reliability). The authors affirm that the algorithm convergence is obtained through the software SmartPLS® and its main objective is to evaluate if a stable result can be obtained before the maximum number of iterations possible.

In the case of the convergent validity, for Chin (1998), it is recommended that all the latent variables possess an Average Variance Extracted (AVE) higher than 50% and its outer loadings have to be significant (> 0,708). This validity aims to explain the correlation degree between the alternative measures of one construct (Hair et al., 2009).

On the other hand, to evaluate the discriminant validity means to establish the distinction level between similar concepts and it can be done through two criteria: cross loadings or Fornell-Larcker (Hair et al., 2014). The first criteria establish a comparison between the cross loadings of each variable, and the second evaluates the square root of the AVE for each construct (it needs to be higher than its correlation with other constructs).

Lastly, the internal consistency is verified through the measurement of the composite reliability and the Cronbach's Alpha, revealing the consistency level between the variables related to the same construct (Hair et al., 2009). Values higher than 0.7 and under 0.95, as suggested by Hair et al., 2014, represent a high level of reliability of the model both for composite reliability and Cronbach's Alpha. After these analyses the measurement model can be adequate to produce a real measure of the latent constructs that are modeled. Table 22 synthesizes all the criteria for evaluating the measurement model.

Table 22 - Criteria of measurement model evaluation

Evaluation	Criteria
Convergent validity	Outer Loadings > 0.708 AVE > 0.5
Discriminant validity	Fornell-Larcker (square root of AVE > correlations among constructs)
Internal consistency	0.7 < Composite reliability < 0.95 0.7 < Cronbach's Alpha < 0.95

Source: Elaborated by the author.

4.8 Structural model evaluation

The evaluation of the structural model, as defined by Hair et al. (2014), allows understanding how strong is its predictive power and the relation between the constructs. Therefore, the empirical model can be contrasted with the theoretical model, creating an opportunity to criticize and propose advancements in the theory. This process encompasses the following assessments: collinearity (significance and relevance of the constructs' relation), predictive capacity and relevance of the model (R^2 and f^2).

The aforementioned authors affirm that the collinearity can be verified by the tolerance levels and the Variance Inflate Factor. In case of tolerance levels lower than 0.20 and VIF higher than 5, the model can present collinearity problems. The significance of the relations in the context of SEM-PLS is verified through the standard error calculated by the Bootstrapping method: t-student statistical for the correlations must be higher than 1.96 or 10% ($t \geq 1.67$, $p \leq 0.10$) (Hair et al., 2014).

Concerning the predictive power, this is calculated using the statistical determination coefficients (R^2) and R^2 size effect (f^2) (Cohen, 1988). The evaluation of the causal relations among the constructs is done through analyzing the path coefficients. To assess how well the structural research model fits the data collected, the Goodness of Fit – GoF test was applied.

This index is useful in measuring the fit of both measurement and structural modes (Vinzi et al., 2010). At large, GoF results lie between 0 and 1. Talamantes-Padilla et al. (2016) suggest that GoF indexes >=0.1, >=0.25 and >=0.3 represent, in sequence, small, medium and large effect – that is, the higher the GoF, the better the model performance. All those statistics were calculated using the software SmartPLS®. Table 23 synthesizes all the criteria for evaluating the structural model.

Table 23 - Criteria of structural model evaluation

Evaluation	**Criteria**
Collinearity	VIF < 5
R^2	For social sciences, R2=2% represents a small effect, R2=13% a medium effect and R2=26% as a high effect.
f^2	0.02, 0.15 and 0.35 are considered small, medium and big effect.
Correlations significance	t-student ≥ 1.96 or 10% (t≥1.67, p≤0.10)
Path coefficients	Based on the theory used to construct the hypothesis.
GoF	>=0.1, >=0.25 and >=0.3 represent, in sequence, small, medium and large effect.

Source: Elaborated by the author.

4.9 Analysis plan

Table 24 summarizes the research objectives, hypotheses and the empirical analysis that is to be conducted in order to accept or reject them.

Table 24 – Analysis Plan

General objective		
To assess empirically the relationship among institutional forces and internal capabilities in driving green innovations in the Brazilian electricity power sector.		
Specific Objectives	**Hypotheses**	**Analysis**
To identify the existing relationship among the drivers of green innovations and the consolidation of the absorptive capacity in the Brazilian electricity power sector.	**Hypothesis 1:** The internal drivers are positively related to the absorptive capacity.	Significance of the relationship among the constructs internal drivers and absorptive capacity.
	Hypothesis 2: The institutional forces are positively related to the internal drivers.	Significance of the relationship among the constructs institutional forces and internal drivers.
	Hypothesis 3: The internal drivers mediate the relation between institutional forces and absorptive capacity.	Non-significance of the relationship among the constructs institutional forces and absorptive capacity.
To identify the overall connection between green innovation drivers, absorptive capacity and performance in the Brazilian electricity sector.	**Hypothesis 4:** The absorptive capacity mediates the relation between internal drivers and green innovation performance.	Non-significance of the relationship among the constructs internal drivers and green innovation performance.
To identify the relationship between absorptive capacity and performance in green innovations in the Brazilian electricity companies.	**Hypothesis 5:** The absorptive capacity is positively related to the green innovation performance.	Significance of the relationship among the absorptive capacity and green innovation performance.

Source: Elaborated by the author.

5 RESULTS AND DISCUSSION

In this study, the data was analysed using software SmartPLS® to test the proposed model using Partial Least Squares (PLS) method. The PLS approach was chosen due to the exploratory character of the objective of this study, particularly in the context where there is little knowledge on the relationships of the structural model. In other words, there are few theories on the drivers of green innovations and the role of absorptive capacity. Another reason for choosing this method is that it does not make assumptions on sample distribution.

The data analysis followed the steps presented above and are discussed in the following subsections.

5.1 Descriptive analysis

From a total of 192 questionnaires sent, 140 (~73%) returned. However, from those, only 78 (~41%) were considered valid for the analysis. All of those with a proportion of missing data above 10% were excluded from the analysis (Hair et al., 2014). Table 25 shows a descriptive analysis of the answers for each item of the questionnaire. As noticed, the majority of the values are between 3 and 4, showing a tendency of concordance and total concordance with the items in the questionnaire.

Regarding the construct Internal Drivers, the variables ID01 (Environmental Management Systems), ID02 (R&D projects), ID03 (Environmental Training), and ID05 (Alliances) are among the ones with higher level of positive agreement with means that range from 3.68 to 4.09. However, the variable ID04, which represents the internal driver Green Patents, shows a low level of agreement among the respondents, with a mean of 2.28. This shows that the companies in the sample have a neutral position on the acquisition of patents of green products and process as a relevant driver of green innovation performance. The other items above mentioned are considered important in this process, with emphasis to the indicator ID05 (mean of 4.09).

The variables which aim to explain the construct Institutional Forces, IF01 (Market), IF02 (Technology), and IF03 (Regulations), show means between 3 and 4, representing a positive agreement of the respondents with their relevance in driving green innovations.

Among the three, regulations have the highest mean (3.81). Concerning the indicators of the construct Absorptive Capacity, analysing the mean of the indicators representing the acquisition processes, AC01 and AC02, they possess the strongest concordance among the others (4.63 and 4.14, respectively) of the same construct.

Table 25 – Descriptive analysis of the answers - continues

	N	Minimum	Maximum	Mean	Std. Deviation
ID01	78	0	5	3,49	1,704
ID02	78	0	5	3,77	1,651
ID03	78	0	5	3,68	1,455
ID04	78	0	5	2,28	2,025
ID05	78	0	5	4,09	1,271
IF01	78	0	5	3,35	1,689
IF02	78	0	5	3,27	1,695
IF03	78	0	5	3,81	1,546
AC01	78	2	5	4,63	0,705
AC02	78	0	5	4,14	1,326
AC03	78	0	5	3,97	1,289
AC04	78	0	5	4,05	1,298
AC05	78	0	5	4	1,259
AC06	78	0	5	2,83	1,943
AC07	78	0	5	3,69	1,638
AC08	78	0	5	3,33	1,748
AC09	78	0	5	3,1	1,856
AC10	78	0	5	3,19	1,88
GIP01	74	0	5	3,36	1,627
GIP02	74	0	5	3,12	1,775
GIP03	74	0	5	3,15	1,694
GIP04	74	0	5	2,82	1,933
GIP05	74	0	5	2,99	1,955
GIP06	75	0	5	3,79	1,596
GIP07	75	0	5	3,32	1,81
GIP08	75	0	5	3,27	1,92
GIP09	75	0	5	2,97	1,91
GIP10	75	0	5	2,59	1,946

Source: Elaborated by the author.

The indicators that are related to the assimilation processes (AC03, AC04, AC05 and AC06) also show high level of concordance in the answers, excepting from A06, whose mean shows a neutral level of concordance (2.83). Companies in the sample have a neutral position on conducting Life Cycle Analysis as a mean to identify environmental impacts from their products and services. Answers for the transformation processes, measured by indicators AC07 and AC08, also have produced good levels of agreement with the Likert Scale of 5 points.

However, the indicators of Exploitation processes, AC09 and AC10, represent a more neutral position of the respondents than the previous processes, with means no higher than 3.19. These indicators are related to the role of the respondents' knowledge to influence strategies and operations so that they meet environmental interests. Therefore, the majority of managers do not agree or disagree with their role in promoting sustainability inside their companies.

Answers concerning Green Innovation Performance have, in all indicators analysed, a neutral position whose means ranges from 2.59 to 3.79. Regards to green product innovation performance, the indicator with higher level of concordance among the respondents is GIP01, which is related to the development of environmental products in the last two years. The indicator GIP04, related to materials use in product development, have the lowest mean and represent a more negative concordance level.

On green process innovation performance, it can be affirmed that GIP06 and GIP07 have a low positive agreement among the respondents. The lowest mean among the indicators is the one of GIP10, which is related to the reduction of raw-materials in the production processes. The next section presents the results found using SmartPLS® calculated with the collected data. Section 5.2 approaches the measurement model evaluation and section 5.3, the structural model evaluation.

5.2 Measurement model evaluation

Convergent validity measures the extension to which a measurement is positively correlated with other alternative measurements of the same construct. According to Hair et al. (2014), in the case of a reflexive model, where the indicators are different approaches for measuring the same construct, it is expected a convergence or high shared proportion of variance between the items of the constructs. For this, we used the Average Variance Extracted (AVE) and factor loadings (Hair et al., 2014).

The factor loadings show the reliability of the indicator and must be higher than 0.708. Figure 5 shows the measurement model, where the measurements can be analysed, showing a previous result of the model. As it can be observed, the loadings of some indicators are below 0.708. For that reason, the AVE, which measures the commonality of the construct, is expected to be lower as recommended (50% or 0.5), which can be verified in Table 26.

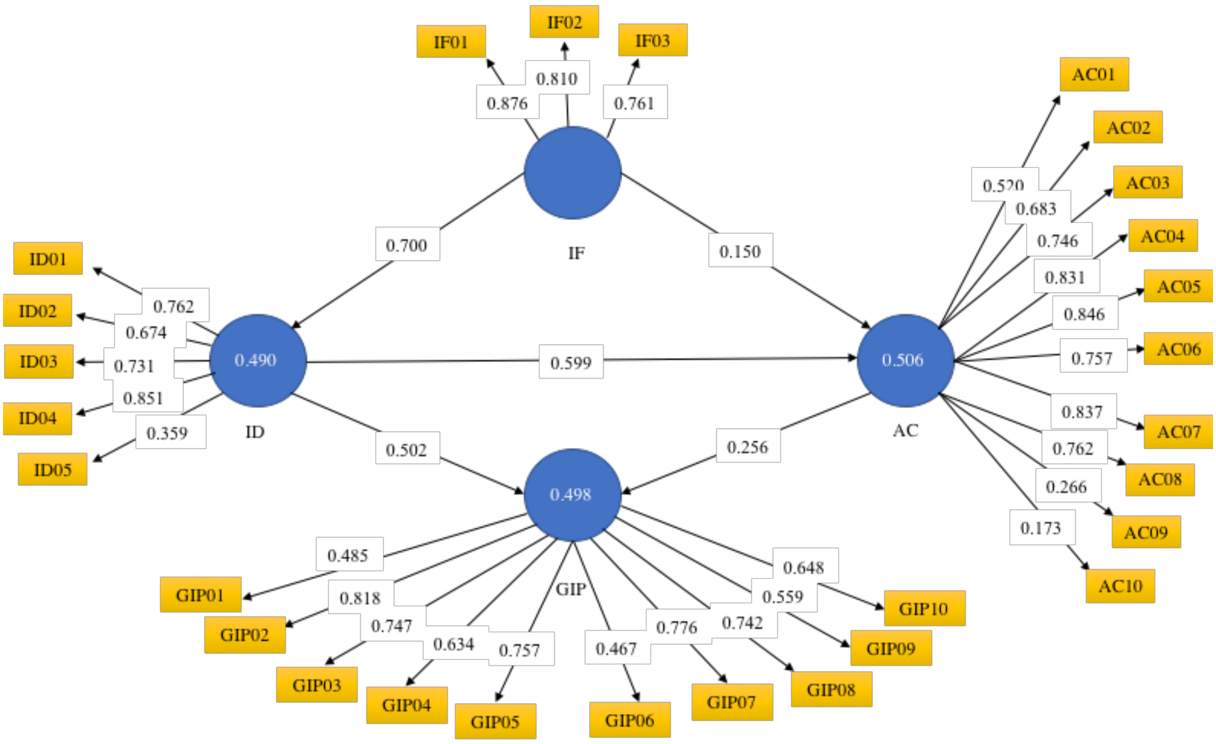

Figure 5 – Measurement model

* EF – indicators for institutional forces (external forces)
IF – indicators for internal drivers (internal forces)
Source: Elaborated by the author – output SmartPLS®

In other words, ID, GIP and AC have low convergent validity (in bold in the last column of the Table 25). The logic behind the AVE is that if it is equal or higher than 0.5, it indicates that a construct explains at least 50% of the variation among its items. If it is lower, according to Hair et al. (2014), there are more errors in the items than the variance explained by the construct.

Table 26 – Results of the measurement model

	Cronbach`s Alpha	Composite Reliability	Average Variance Extracted (AVE)
ID	0.719	0.816	**0.484**
GIP	0.861	0.890	**0.454**
IF	0.752	0.857	0.668
AC	0.855	0.885	**0.465**

Source: Elaborated by the author – output SmartPLS®

Concerning the discriminant validity, which aims to establish the distinction level between similar concepts, it was measured through the analysis of Fornell-Larcker criteria

(Hair et al., 2014): to evaluate the square root of the AVE for each construct which needs to be higher than its correlation with other constructs. Table 27 shows the relationship among the AVE square root and the correlations among the constructs.

Table 27 – Discriminant validity in the latent variables' level

Latent variable	**IF**	**GIP**	**EF**	**AC**
ID	**0.696**			
GIP	0.798	**0.674**		
IF	0.905	0.751	**0.871**	
AC	0.803	0.669	0.672	**0.682**

*the values in bold represent the square root of the AVE for each construct. The other values correspond to the correlations among the latent variables.
Source: Elaborated by the author – output SmartPLS®

The criteria analysed is that the correlations among the constructs have to be lower than the square root of the AVE. As it can be noticed, there is a low level of discriminant validity in the initial model. With few exceptions, the correlations are higher than the AVE square root. Mainly for the constructs ID and IF, the correlation is close to 1, which reveals that they are not sufficiently separated in terms of concept similarity.

Lastly, the reliability of the model is assessed through the composite reliability and Cronbach's Alpha. Their values range from 0 to 1, and above 0.7 they indicate high levels of reliability (Hair et al., 2014). Table 26 shows that all the constructs met the criteria established in the literature for both Cronbach's Alpha and composite reliability, showing a good level of reliability of the measurement level. However, due to the overall analysis, an adjusted model was tested excluding the indicators that could not meet the criteria without compromising the validity of the model.

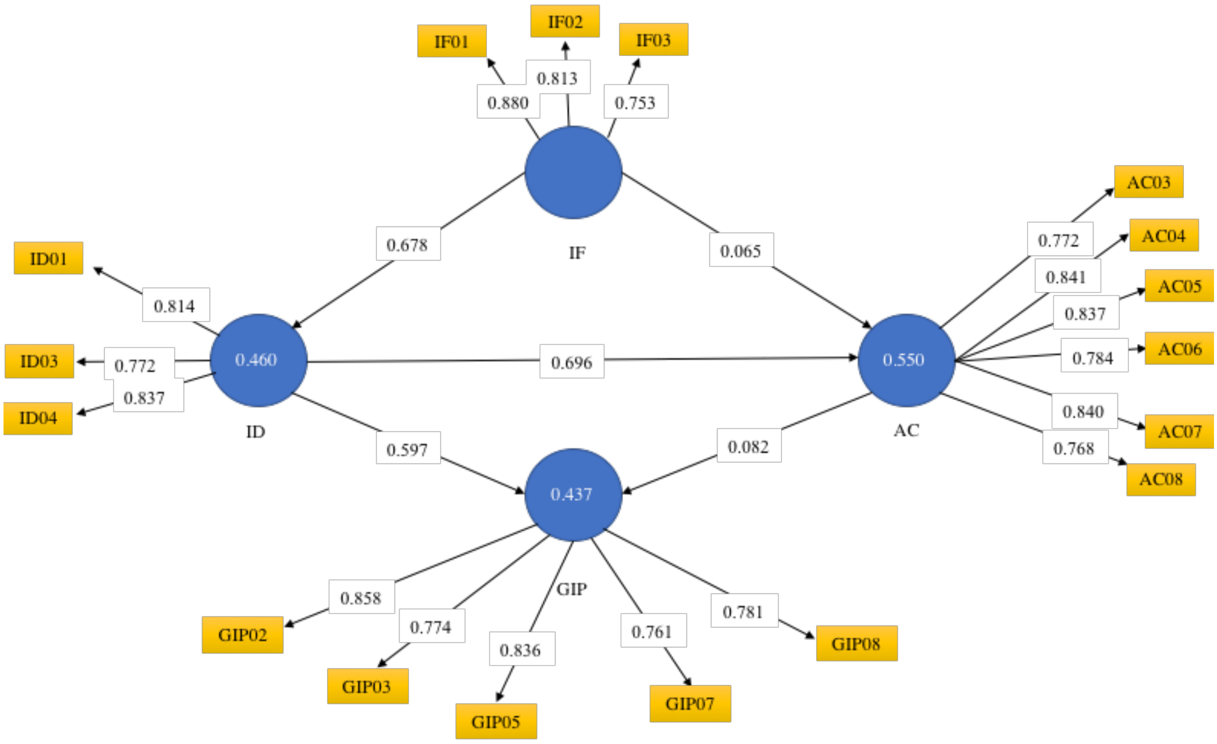

Figure 6 – Adjusted model

* EF – indicators for institutional forces (external forces) – interpreted as IF
IF – indicators for internal drivers (internal forces) – interpreted as ID
Source: Elaborated by the author – output SmartPLS®

Concerning the Construct ID, the indicators ID02 and ID05 were excluded due to its low outer loadings (lower than 0.708): 0.674 and 0.359, respectively. The same criterion was applied to the indicators GIP01 (0.485), GIP04 (0.634), GIP06 (0.467), GIP09 (0.559), GIP10 (0.648), AC01 (0.520), AC02 (0.683), AC09 (0.266), AC10 (0.173). As a result of these changes in the models, the new results and correlations are shown in Table 28 and Table 29.

Table 28 – Results of the adjusted model

	Cronbach`s Alpha	**Composite Reliability**	**AVE**	**Square root of AVE**
ID	0.735	0.850	0.653	0.808
GIP	0.861	0.900	0.645	0.803
IF	0.753	0.857	0.668	0.817
AC	0.894	0.918	0.652	0.807

Source: Elaborated by the author – output SmartPLS®

Table 29 – Discriminant validity in the latent variables' level

Latent variable	**IF**	**GIP**	**EF**	**AC**
ID	**0.808**			
GIP	0.658	**0.803**		
IF	0.678	0.569	**0.817**	
AC	0.740	0.524	0.537	**0.808**

Source: Elaborated by the author – output SmartPLS®

Using the same criteria for the measurement model, the AVE of the constructs of the adjusted model is higher than 0.5, confirming its convergent validity. Regards to the discriminant validity, it also has good levels as the correlation among the constructs is lower than the square root of the AVE for all the constructs. The model's reliability is also confirmed by the high levels of the composite reliability and Cronbach's Alpha (higher than 0.7 and respecting the limits of 0.9, as suggested by Hair et al., 2014).

Therefore, the adjusted model fits the criteria for the analysis of the structural model (*bootstrapping*), conducted in the following subsection.

5.3 Structural model evaluation

The evaluation of the structural model allows verifying how well the empirical data support the theoretical model and follows the confirmation of reliability, discriminant and convergent validity. The essential criteria for evaluating the model adjustment start with collinearity tests (R^2 and f^2) and the significance of the structural coefficients. The issues related to collinearity problems of the model were evaluated by the VIF, showed in Table 30. VIF values are all bellow 5, so the model does not present collinearity problems.

Table 30 - VIF values

	AC	EF	GIP	IF
AC			2.210	
IF		1.853		1.000
GIP				
ID		1.853	2.210	

Source: Elaborated by the author – output SmartPLS®

The value of GoF estimated in the study was 0.555, indicating a good fit of the model to the data collected. Table 31 shows R^2 values for the adjusted model and Table 32 shows the adjusted R^2 values. The R^2 evaluates the portion of the variance of the endogenous variable that is explained by the structural model. For social sciences, Cohen (1988) suggests that R^2 = 2% equals to a small effect, while 13% is equivalent to a medium effect and 26% as having large effect. For both models, the R^2 values of the constructs are classified as having a large effect. In other words, using the results of Table 31, the R^2 of GIP (Green Innovation

Performance) is 0.437, which means that the latent variables (AC– Absorptive Capacity - and ID – Internal Drivers) largely explain 43.7% of the variance of GIP.

Table 31 – R^2 values

	Original Sample	Sample Mean	Standard Deviation	T Statistics	P Values
AC	0.550	0.570	0.077	7.107	0.000
GIP	0.437	0.469	0.073	5.955	0.000
ID	0.460	0.474	0.086	5.331	0.000

Source: Elaborated by the author – output SmartPLS®

Adjusted R^2 values represent the portion of the variance of the endogenous variable that is explained by its relationship with one or more predictor variables, adjusted for the number of predictors in the model. This adjustment is relevant as the R^2 for any model always increase when a new variable is added, helping to adjust the predictors to achieve the best combinations of variables for the model. The adjusted R^2 is lower than R^2 for all the constructs, but it still represents a large effect (higher than 26%) for AC (53.8%), GIP (42.2%) and ID (45.3%).

Table 32 – Adjusted R^2 values

	Original Sample	Sample Mean	Standard Deviation	T Statistics	P Values
AC	0.538	0.559	0.079	6.771	0.000
GIP	0.422	0.454	0.075	5.600	0.000
ID	0.453	0.559	0.087	5.181	0.000

Source: Elaborated by the author – output SmartPLS®

Regards to the R^2 size effect (f^2), it shows the size effect of the constructs in the model. According to Hair et al. (2014), for its interpretation, values close to 0.02 shows that a construct have a low effect in the model adjustment, moderate the ones close to 0.15 and the values close to 0.35 have a high effect. Table 33 shows the results for this test. IF represents the construct with the highest degree of impact in the model (the effect in ID), with f^2 value of 0.853, followed by ID with a high effect in explaining AC (0.580) and ID with a medium effect in GIP (0.287). The other relationships have no significant effect in explaining the model.

Table 33 – f² values

	Original Sample (O)	Sample Mean (M)	Stand. Deviation	T statistics	P values
IF -> AC	0.005	0.025	0.035	0.144	0.885
IF -> ID	0.853	0.957	0.355	2.401	0.016
ID -> AC	0.580	0.652	0.291	1.991	0.047
ID -> GIP	0.287	0.333	0.198	1.447	0.148
AC -> GIP	0.005	0.032	0.044	0.125	0.900

Source: Elaborated by the author – output SmartPLS®

Concerning the correlations significance, the t-student statistics for the correlations must be equal or higher than 1.67 in a confidence level of 10%. For analyzing the path coefficients, which varies from -1 to +1, values close to +1 have strong positive relations. Table 34 shows that the model is adjusted for all the constructs, with the exception of the ones on H1 and H5. Based on Alpha of 5%, the hypotheses H1, H2, and H3 were statistically supported. Hypotheses H4 and H5 were not supported.

Table 34 – Path coefficients

Hypotheses		Original Sample (O)	Sample Mean (M)	Stand. Deviation	T statistics	P values	Status (α = 5%)
H1	IF -> AC	0.678	0.685	0.127	0.512	0.609	Supported
H2	IF -> ID	0.696	0.702	0.063	10.699	0.000	Supported
H3	ID -> AC	0.597	0.599	0.111	6.275	0.000	Supported
H4	ID -> GIP	0.082	0.097	0.156	3.839	0.000	Not supported
H5	AC-> GIP	0.065	0.066	0.169	0.488	0.626	Not supported

Source: Elaborated by the author – output SmartPLS®

Therefore, H1 affirms that the internal drivers mediate the relation between institutional forces and absorptive capacity. Besides showing a positive relation through the structural coefficient (0.678, close to 1), the p value (0.609) does not support the positive relation among the external drivers and absorptive capacity, which confirms the mediation role of the internal drivers. Hence, the hypothesis is supported.

H2 affirms that the institutional forces are positively related to the internal drivers. According to the results from Table 34 the structural coefficient (0.696) and the p value (0.000) support the hypothesis, therefore the institutional forces are positively associated to the internal drivers.

H3 affirms that the internal drivers are positively related to the absorptive capacity. Consistent with the results from Table 34, the structural coefficient (0.597) and the p value (0.000) support the hypothesis, therefore the internal drivers are positively associated to the absorptive capacity.

H4 affirms that the absorptive capacity mediates the relationship between internal drivers and green innovation performance. From the results, it is possible to assert that the ID are positively related to GIP (structural coefficient of 0.082 and p value of 0.000). The significance of this relationship nullifies the mediation effect of the absorptive capacity. Therefore, the H4 is not supported.

H5 affirms that the absorptive capacity is positively related to green innovation performance. Derived from the results it is possible to affirm that the p value (0.626) and the structural coefficient (0.065) do not support a positive relationship among absorptive capacity and green innovation performance. Hence, the H5 is not supported.

The set of results met the points of analysis of the structural model: the calculated values for VIF attest the absence of collinearity problems; the bootstrapping process supported three hypotheses; and the values of R^2, f^2 and GoF testify favorably to the predictive capacity and relevance of the model.

5.4 Summary of the empirical results and discussions

The sample collected was prepared for the statistical tests, resulting in a set of 78 observations. The SEM hypothesized was tested with the procedures suggested for a SEM-PLS (Hair et al., 2014). Five hypotheses were tested, three were supported (H1, H2 and H3) and two were not supported (H4 and H5).

The confirmation of **Hypothesis 1** supported the expectation that the internal drivers (ID) mediate the relationship among institutional forces (IF) and absorptive capacity (AC), due to the non-significance of the relationship among IF and AC. According to the literature, this effect occurs because the internal drivers facilitate monitoring the external environment and obtaining knowledge on relevant issues for the company, enabling it to answer for external pressures coming from the consumer market, environmental legislations and new technologies available.

As supported by H1, internal drivers prepare the company to deal with the institutional pressures related to sustainability issues, e.g. the “technology-push”, the “market-pull” and the “regulatory push-pull effect” (Horbach et al., 2012). This set of resources, combined with the external information acquired, encourages companies to develop capabilities which are related to knowledge exploitation, assimilation and transformation.

Therefore, the internal drivers are essential for endowing organizations with resources to deal with the highest level of complexity, uncertainty and novelty of green innovations (De Marchi, 2012). As stated by Cainelli et al. (2015), green innovations are placed in the technological frontier for being related to issues that companies are not fully aware (Porter and Van der Linde, 1995) as the environmental issues continue evolving, demanding new technologies in processes and products. These specific features of green innovations spur the need for a great variety of internal and external resources, mainly for expanding the company knowledge capital and competences to deal with sustainability issues.

Environmental management systems (EMS), environmental trainings and green patents of products and processes are examples of relevant internal drivers of green innovations. This is due to those being internal resources which allow the company to develop internal features that are unique supporting the development of green product and process innovations and a sustainable competitive advantage (Cheng et al., 2013).

Concerning EMS, several empirical studies in the innovation literature have found that the implementation of EMS has a positive impact on green innovations (Wagner, 2007; Horbach, 2008). According to Kesidou and Demirel, 2012, who also found this positive relation in their empirical study on manufacturing firms in UK, the organizational capabilities related to EMS are not only relevant in firm's decision to uptake green innovations activities, but they also increase the level of resources that are dedicated for this purpose.

Rennings et al. (2006) found in their study with German EMAS-validated facilities (European Management and Auditing Scheme) that the majority reports a positive influence of EMS on green process innovations. Such relation might occur as EMS aims at establishing mechanisms which allow companies to mitigate environmental damages (González-Benito & González-Benito, 2006) through improvements in organizational processes. In the present study the effect was not separated among the performance indicators for green processes and products innovations.

Concerning environmental training, Sarkis et al. (2010) affirm that employees' training is considered useful for both competence-enhancement and as a motivational factor. Cainelli et al. (2012) found the same results for 555 firms in Italy, confirming the relevance of the training coverage of a company as an important driver of green innovations. In a more recent study, Cainelli et al. (2015), the renewal of the firm's stock of knowledge through training programs positively supports the introduction of green innovations.

The authors add that "training is not only important to transmit technological knowledge but also to increase awareness about the importance of tackling environmental issues and motivating personnel at all levels to address environmental challenges" (Cainelli et al., 2015, p.218). Therefore, personnel training promotes skill enhancement and increases the knowledge stock enabling companies to improve their green innovation performance.

In contrast with what was found by Cainelli et al. (2015), the acquisition or possession of patents is identified as a relevant internal driver of green innovations. The relevance might be related to the knowledge embodied in patents (Penrose, 1959), which also represents one mode of external knowledge acquisition. Segarra-Oña et al. (2011) also confirm this relationship, asserting that patents and technology acquisition influence the green innovation orientation of companies. Finally, the mixed results found in the literature might be connected to the higher level of complexity and novelty of such innovations (Cainelli et al., 2015), which demands the development of technological competences and collaboration with external partners.

Cainelli et al. (2015) found in their empirical study with 4829 Spanish manufacturing firms that R&D capacity is positively and highly significantly correlated to the introduction of green innovations. Horbach (2008) also suggest that improving the knowledge capital through R&D triggers green innovations. Alliances and collaboration with external partners are also mentioned as critical organizational activities for green innovation performance (De Marchi, 2012; Horbach et al., 2012; De Marchi & Grandinetti, 2013; Del-Río et al., 2013). Figure 7 shows the results of H1.

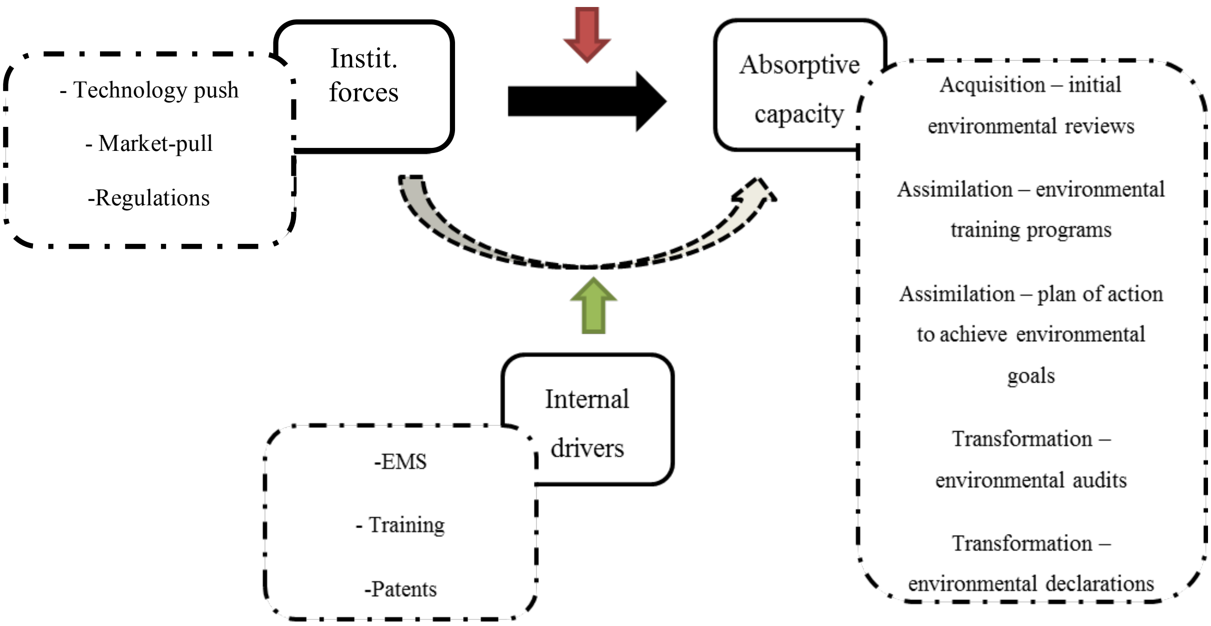

Figure 7 - Hypothesis 1 – results
Source: Elaborated by the author.

The confirmation of **Hypothesis 2** supports the statement that institutional forces have a positive relation with internal drivers of green innovations in the Brazilian electricity power sector. Concerning those, the statistical tests reinforce what is found in the literature. Regulations, technological development and the market represent institutional pressures derived from firm's environment which influence firm performance in green innovations, by promoting a technological change inside the company (Berrone et al., 2013).

As aforementioned, institutional forces help firms focusing in green R&D initiatives and influence internal resources allocation, which then mediate the development of capabilities that base a firm' sustainable competitive advantage. The emergence of new markets and updated technologies in the electricity power sector, in Brazil and other countries, pressure the Brazilian companies to be updated.

Additionally, the stricter regulatory environment due to new legislations created in the last decade in Brazil and the enhancement of customer awareness on renewable energies, energy efficiency and energy savings, led companies in the electricity power sector to demand more resources in order to answer to these inputs. These resources give organizations its singleness, generating competitive advantages in relation to its competitors. Figure 8 synthesises H2 results.

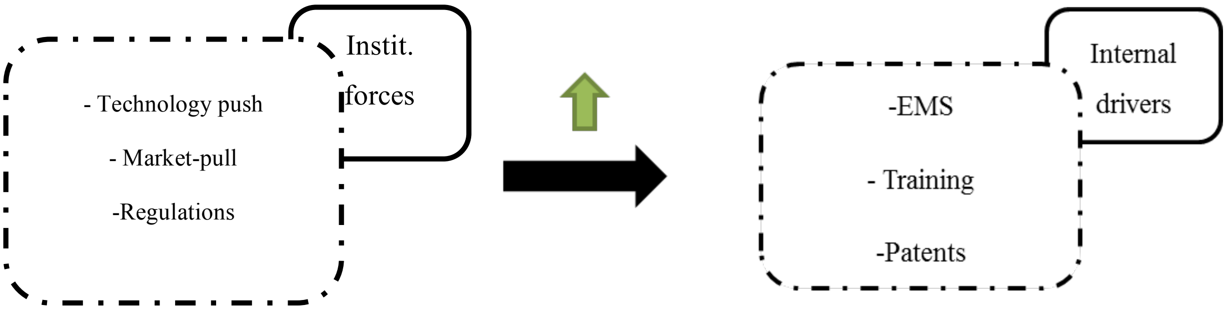

Figure 8 – Hypothesis 2 – results
Source: Elaborated by the author.

Hypothesis 3 on the relationship among internal drivers and absorptive capacity was confirmed. It supports H1, which reveals the importance of ID as mediator in the relationship among the institutional forces and absorptive capacity. Concerning the construct of absorptive capacity, in this study it was measured using a scale which adapts the processes suggested by Zahra and George (2002) to the concept of sustainability. Despite the recent discussion on this topic, this study therefore contributes to the theoretical improvement of this new conceptualization and the results go in hand with some theoretical assumptions.

The peculiarities of green innovations are related to the institutional inputs which drive the organizational engagement with environmental activities. Also, it shapes the resources needed for developing green products, green services and green processes as an answer for such pressures. However, not all resources are available inside the company requiring the contribution of external knowledge and resources (Sirmon et al., 2007, Cainelli et al., 2015), obtained e.g. through patents acquisition or ownership. Research alliances and collaboration with other stakeholders are also relevant in this process.

The absorptive capacity of a firm is related to its ability to acquire, assimilate, transform and exploit external knowledge and information (Zahra & George, 2002). Therefore, considered an important construct in the knowledge management literature, the absorptive capacity is relevant in supporting obtaining the missing skills, knowledge and technologies from external partners (Cohen & Levinthal, 1990; Biedenbach & Müeller, 2012).

In the case of acquisition, initial environmental reviews were considered a relevant process. This is an activity that is part of the routine of environmental management systems standards, recommended as a tool for determining the environmental impacts and aspects associated with the company's operations, highlighting the deficiencies and creating a roadmap for the company. However, those are not considered an audit as they only represent an initial assessment in order to create or adopt the EMS.

Generation is the activity in the sector which produces the greatest environmental impact, mainly due to emissions of hazardous materials and waste (Gómez-Expósito et al., 2009). As far as coal and oil-fired steam plants are concerned, those are amongst the most polluting and emitting industrial sectors directly contributing with greenhouse gas-induced climate change, having as a by-product acid rains, "emission of particles and heavy metals, generation of solid wastes such as fly ash and slags, the heating of river, reservoir, or sea water to cover refrigeration needs and, indirectly, the impact of mining" (Gómez-Expósito et al., 2009, p.8).

Regarding nuclear power generation, the same authors emphasize that even though the plants have guaranteed all the safety measures against an accidental catastrophe, the production of radioactive waste remains an unsolved question, limiting its sustainability potential. As for hydropower stations, it also has severe environmental impacts in its surroundings even being considered to encompass environmental-friendly technologies, as other renewable energy sources (Jannuzzi, 2005). Gómez-Expósito et al. (2009, p.8) lists its impacts: "alteration of hydrology, disturbance of habitats, or even transformation of microclimate, not to mention the risk of accidents that can spell vast ecological and human disaster".

Solar energy impacts land use and enhances pollution and waste generation derived from the production process of the components for the cells. Wind power affects the disturbance of natural habitats and generates noise. Summarily, the electricity generation activity has environmental impacts which vary from the source, the area demanded and the resources involved. Concerning the transmission activity, the transmission lines which cover the Brazilian territory have visual impacts as well as issues related to management of forests and arboreal individuals. Moreover, efficiency problems in the networks demand for investments in new technologies (Karplus, 2007).

All the impacts mentioned need to be considered by the companies in the sector in order to identify environmental issues that can hamper its operations or even create new market opportunities. Therefore, initial environmental reviews are an instrument for companies to clarify its environmental impacts and how they deal with such issues, identifying the need for external resources to be acquired in order to tackle it.

Regards to the assimilation process, environmental trainings and definition of action plans for achieving environmental goals are also relevant processes. The first identified confirms the result also found on Hypothesis 1, being the trainings offered by the companies in order to improve its knowledge capital one important internal driver of green innovations. Hence, companies use environmental trainings as a way to assimilate the external knowledge that is acquired (Cainelli et al., 2015), generating a set of resources and skills that are relevant in the innovation process for green products and processes.

Basically, the main role of assimilation process is the interpretation, comprehension and learning, promoting knowledge assimilation and facilitating its internalization. Therefore, Gluch et al. (2009) discuss in their work on the relevance of having well-working assimilation mechanisms, related to analytical routines and assessments. More important than the outcome, these tools - such as defining a plan of action to achieve environmental goals - "invite dialogue and collaborative learning" (Gluch et al., 2009) which are essential for the consolidation of firms' absorptive capacity. Furthermore, setting a plan for achieving environmental goals can stimulate employee's commitment and stress the important role of leaders in conducting the change towards sustainability inside a firm.

Zahra and George (2002, p.190) define the transformation process as the "firm's capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge". In the context of green innovations, it stimulates green innovations through auditing and monitoring environmental performance and goals. Performing environmental audits and adopting environmental declarations are examples of activities encompassed by the transformation process.

Environmental declarations are a verified and registered document which communicates transparent and comparable information about the life-cycle environmental impacts of product. As far as environmental audits are concerned, those aim at identifying environmental compliance and gaps in the implementation of EMSs. Both tools allow firms to revise and refine its processes, facilitating the recognition of opportunities (Gluch et al., 2009) and the development of competitive advantages through green innovations.

As found by Gluch et al. (2009), the transformation processes for the Brazilian electricity power sector are more emphasized than exploitation processes. As exploitation were measured by the managers' knowledge to influence strategic decisions, operations and practice, it can be suggested that the managers in the sample whether do not largely influence decisions on environmental issues related to strategies or operations, or their role on improving green innovations performance or supporting initiatives on this topic is not confirmed as relevant.

It can be acknowledged that all processes involving absorptive capacity demand knowledge and internal resources which determine the quality and depth of the initiatives in order to fully develop an absorptive capacity that can impact green innovation performance. Hence, internal resources trigger the development of a green absorptive capacity of firms in the sample. The figure 9 shows the results of Hypothesis 3.

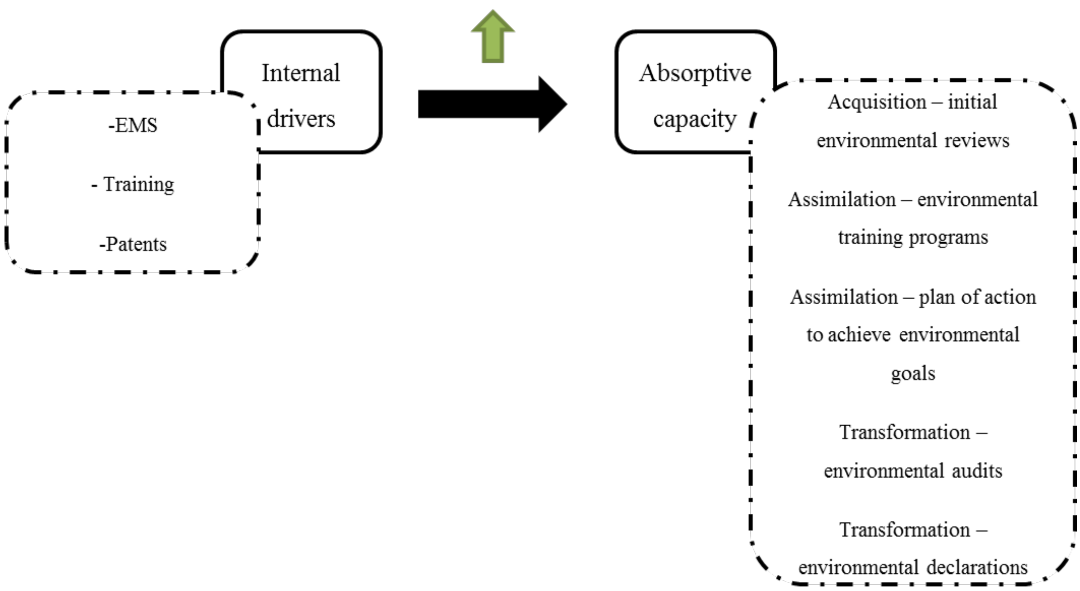

Figure 9 – Hypothesis 3 – results.
Source: Elaborated by the author.

Hypothesis 4, on the mediation role of absorptive capacity among internal drivers and green innovation performance is not supported. Studies on reflexive indicators, such as the present study, have the main goal to test theories. One test that indicates a positive association among two or more variables only provides limited insights about the model, however other assumptions can be made. Internal drivers have f^2 of 0.287, which represents a moderated effect in explaining Green Innovation Performance.

The moderation effect was not confirmed. It can be explained by two assumptions: the first is that due its complexity and the various dimensions involved in its concept, Zahra and George (2002) supports that there is not a unique way of capturing or measuring this construct. Therefore, it can be stated that the processes considered in defining the construct of absorptive capacity for green innovations are broad and have different impacts on green innovation performance. The second assumption is that the internal resources indicated as relevant in this model have more influence in driving green innovations and somehow can capture the essence of the absorptive capacity assessed in the sample firms, as the constructs are positively related.

As suggested by De Marchi and Grandinetti (2013), the absorptive capacity is a core competence for green innovators for allowing the absorption, interpretation and application of external knowledge that is relevant for tackling environmental issues. Against what was found in the literature, in this study we could not support the moderating effect of the absorptive capacity among internal drivers and green innovation performance.

However, the adjusted R^2 of GIP (Green Innovation Performance) in the model is 0.422, which means that the latent variables (AC– Absorptive Capacity - and ID – Internal Drivers) largely explain 42.2% of the variance of GIP. Therefore, the construct of absorptive capacity is relevant in the model and, by analysing the categories relevant for the firms of the sample, was partially embedded in the construct of internal factors, which influences the results found.

Environmental reviews, audits, and declarations as well as defining plan of action to achieve environmental goals prepare the company to identify environmental issues related to its core business and gaps in its strategies for dealing with those. These initiatives are also relevant processes for adopting and managing EMS, which is an internal resource relevant in spurring green innovation performance. Environmental training programs are also associated with the internal drivers, as they are considered an internal resource that is relevant in this process. Hence, internal drivers are positively related with the consolidation of absorptive capacity and it can be assumed an indirect impact of AC in supporting GIP.

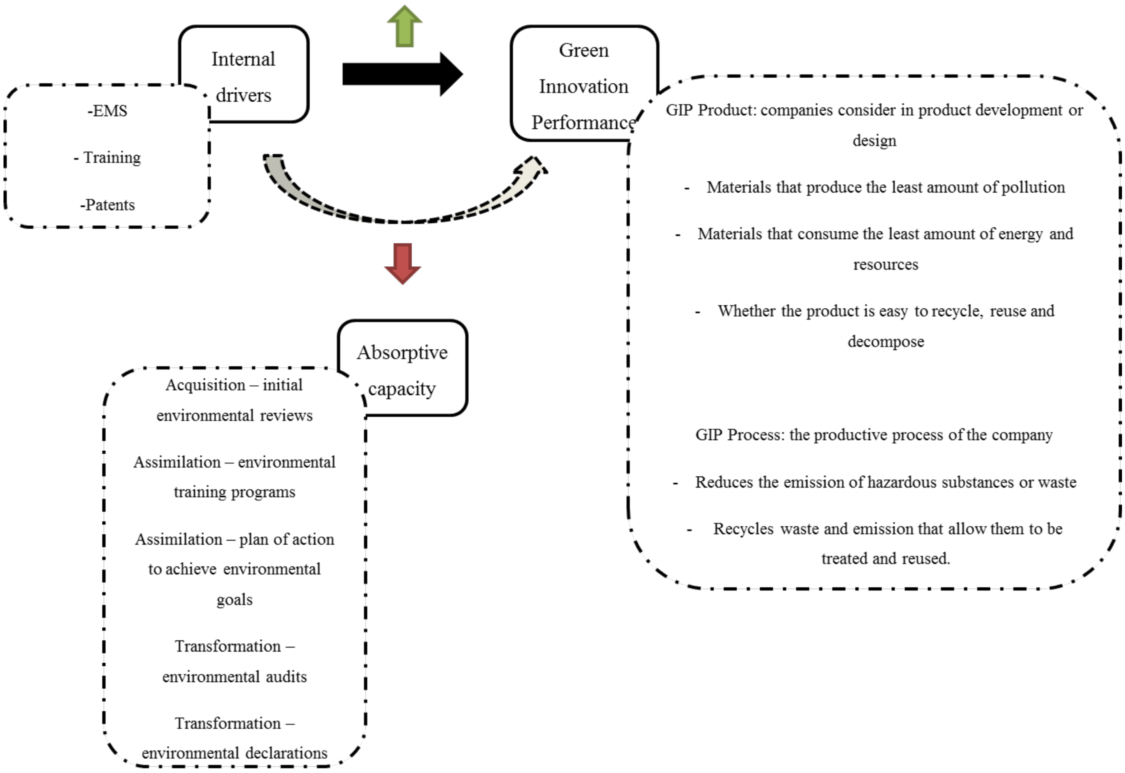

Figure 10 – Hypothesis 4 – results
Source: Elaborated by the author.

Finally, **Hypothesis 5** affirms that the absorptive capacity is positively related to green innovation performance. Derived from the results it is possible to affirm that the p value (0.626) and the structural coefficient (0.065) do not support a positive relationship among the constructs. GIP was measured according to product and process innovations related to sustainability issues and are presented in Figure 11.

On the product side, companies consider as product green innovations performance, adopting materials that produce the least amount of pollution, consumes the least amount of energy and resources and its recyclability, reusability and decomposition. Green process innovations performance is related to processes which reduces the emissions of hazardous substances or waste and which recycle waste and emissions that allows them to be treated and reused.

Companies in the electricity power sector have to follow strict regulations and pay special attention to the aforementioned environmental impacts related to their operation. Besides being very important for identifying characteristics of the process and products of a company that can endanger the environment, the absorptive capacity developed by those have also to be related to product design and process improvement.

Processes which only provide initial information about the environmental issues that the companies need to deal with are relevant but need to lead to practical results. This can reinforce the relevance to develop exploitation processes, which are closely related to the firm's ability to "harvest and incorporate knowledge into its operations and practices" (Gluch et al., 2009). In other words, the exploitation processes translate the knowledge absorbed into practical application – or green innovations in processes and products.

Another reason is the still unclear definition of indicators used for measuring firm's performance in green innovations. Several authors use different measures such as market success (Perin et al., 2007; Baker & Sinkula, 2005), managers' perception (Cheng & Huan, 2009; Damanpour, 1991; Ibarra, 1993), innovation efficacy and efficiency (Alegre & Chiva, 2008), among others (see Chong et al., 2011). However, none of those was specifically developed to measure green innovation performance. The results of H5 are shown in Figure 11.

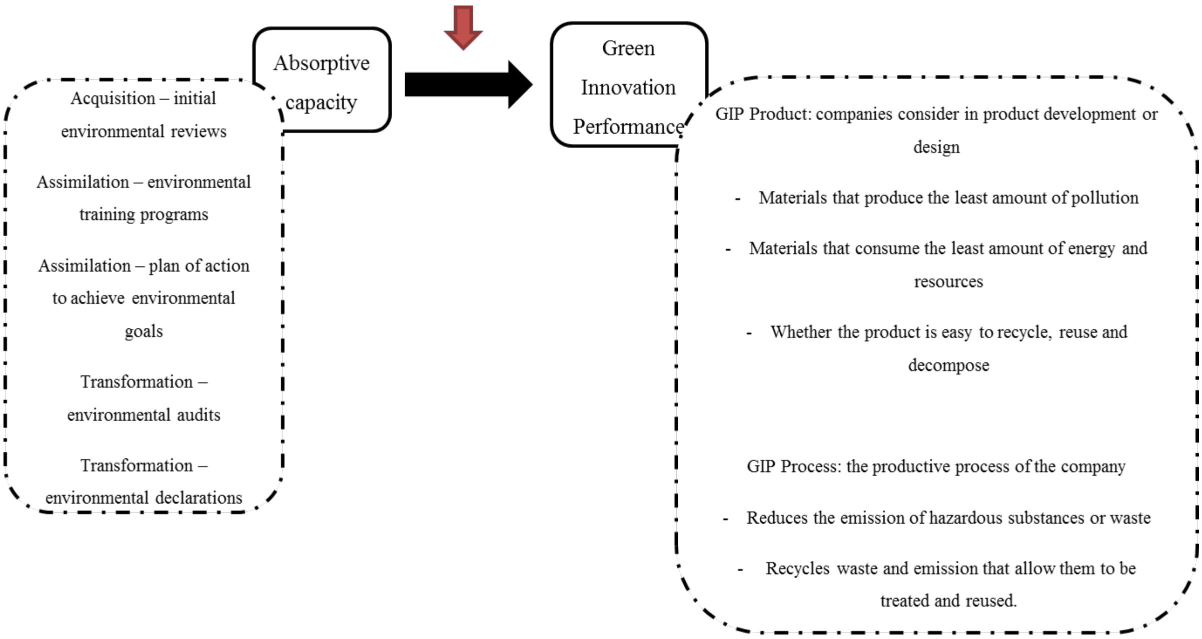

Figure 11 – Hypothesis 5 – results
Source: Elaborated by the author.

Figure 12 allows a comprehension of the final results found in this study. Therefore, Internal Drivers were found to be positively related to Institutional Forces and Absorptive Capacity and mediates the relationship among those constructs. Also, the Internal Drivers are positively related with Green Innovation Performance in products and processes. The indicators that are related to the measurement of each construct are also shown in Figure 12 and its definition can be found in section 4.2.

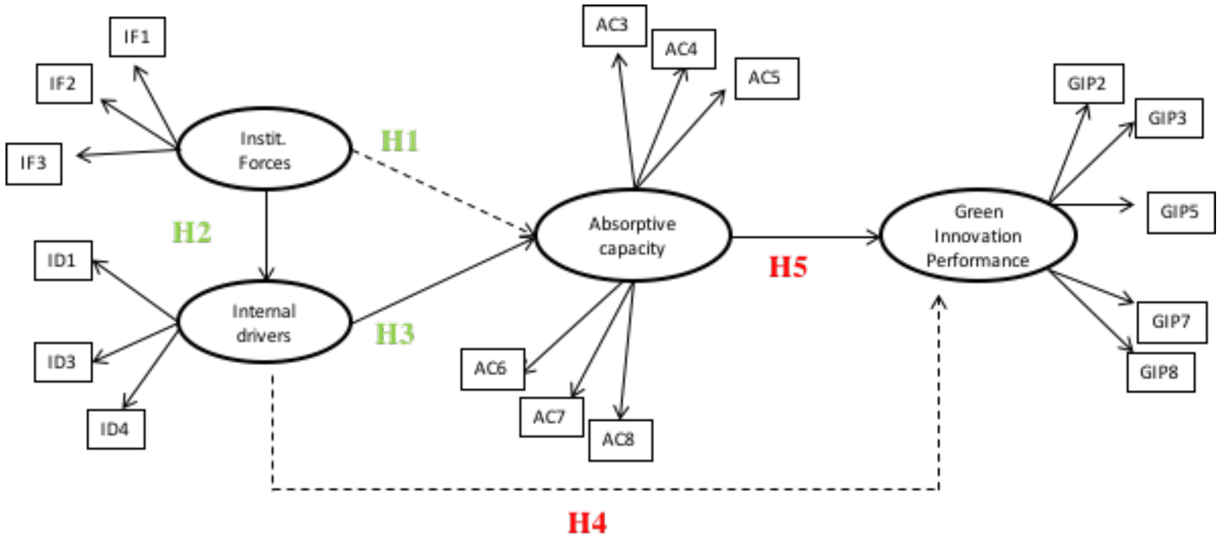

Figure 12 – Research findings – summary
Source: Elaborated by the author.

6 CONCLUSIONS

This section summarizes the main conclusions of this research regarding the research objectives, implications in theory, management practices and regulations, limitations and future studies recommendations.

6.1 Research objectives

Driven by the existent gap in research related to green innovations, its antecedents and organizational capabilities, conducted with empirical data in Brazil, this research aimed at assessing empirically the relationship among internal drivers and institutional forces in driving green innovations. The results found and the inferences made in this study come from the data collected in the Brazilian electricity power sector. Given the characteristics of the sector, the abstraction and generalization of those to other sectors should be carefully considered.

This study can be used as guide in investigating green innovations process and performance inside the companies of the electricity power sector, as well as an increment of researches in the field. Also, it can be affirmed that it contributes to the knowledge advancement on green innovations, with the definition of the constructs indicators or variables and the hypotheses tested. Its originality lies in the fact that it is an empirical study especially conceived and applied, which provides information on green innovation management and performance enhancement, as well as its drivers, allowing analysis that were identified as gaps in the literature.

The structural equation modelling (SEM) applied in the sample data confirmed that internal resources drive green innovation performance and have a positive relationship with the institutional forces. Also, they mediate the relationship among institutional forces and the absorptive capacity of the company. On the other hand, the absorptive capacity has no significant relationship with green innovation performance.

Therefore, the results suggest that green innovation drivers involve both external and internal drivers. Also, absorptive capacity can be considered as comprised by several processes which represent the potential and realized capacity, and, for the sample, is embedded in the internal drivers, indirectly influencing green innovation performance. Therefore, the objective of the research was achieved as well as the specific objectives.

6.2 Theoretical implications

Green innovations are innovations which implicate in organizational (e.g., process and product green innovations as well as the exploitation of internal drivers) and institutional changes (compliance with environmental regulations, adaptation to a new consumer market and technological roadmaps leading to greener technologies). Those demand resources and specific knowledge for dealing with issues which are not deeply mastered by the company (Porter and Van der Linde, 1995), requiring the leverage of internal resources through training or external knowledge acquisition.

These require organizations to develop learning structures and fundamental change processes, that will allow them to question and change the way they deal with environmental issues. Absorptive capacity provides mechanisms that support these processes and leverage internal resources, which likely tend to moderate the relationship between institutional influences and internal drivers, as stated by our findings.

Hence, this study sheds light on previous results on the drivers of green innovations and the role of organizational capabilities in enhancing green innovation performance (Andersen, 2008; Bhupendra & Sangle, 2015; Gabler, Richey Jr. & Rapp, 2015; Castiaux, 2012). Hereafter, the results contribute to the dynamic capabilities literature by suggesting a different logic in the consolidation of the absorptive capacity and its role in the innovation performance under the sustainability umbrella.

Also, the results support the on-going consolidation of the construct “green absorptive capacity” that is still under construction (Hofmann et al., 2012). However, it is important to highlight that the indicators used to measure the construct were specifically chosen for the research aim and the sector in focus. As several processes and routines can comprise the green absorptive capacity (Alves, 2015), the results found with the set of indicators can mislead interpretation as a different combination of organizational routines could change the relationship among the constructs.

As far as the internal drivers are concerned, the results bring contributions to RBV literature and increases the demand for studies on the specific combinations of resources that are relevant for companies in a specific sector. Additionally, it supports the relevance of increasing the knowledge capital for improving green innovation performance (Cainelli et al., 2015; Hart, 1995). Regarding the institutional forces, the drivers found on the literature are confirmed by our results (Ball & Craig, 2010; Rivera, 2004; Hoffman & Ventresca, 1999; DiMaggio and Powell, 1983).

With these reflections it can be assumed that although the results did not meet the expectations declared in our research hypotheses, different assumptions can be made and new relationships among the constructs were suggested in section 6.5.

6.3 Management implications

The managerial implications of our research are twofold: it offers managers an overview of how companies are dealing with green innovations and which competencies are being developed in order to tackle issues related to sustainability, but also sheds light on which resources are more relevant in this processes and which routines need to be adopted in order to enhance green innovation performance.

Yet, the study allowed the conclusion that companies need to develop exploitation mechanisms in order to increase the possibility of generating green innovations through the combination of internal resources and the absorbed external knowledge. This implies in having good-working mechanisms for capturing a great quantity of external knowledge, found in the firms' institutional environment, learning structures and capacity to transform this knowledge into subsidy for green innovations, but also in developing a technological capacity which allow knowledge application to tackle the environmental gaps that are identified in the firm's processes and operations.

Therefore, the model suggested in the study can serve as a framework for driving firms' efforts in the electricity power sector. Companies in Brazil are still laggards in terms of technology development and, in general, are not investing more than what is determined by law (PINTEC, 2014). However, green innovations in the sector represent market opportunities and can lead to the consolidation of a competitive advantage that can position them as leaders in embracing sustainability in their core strategy. Also, the development or adoption of such technologies in products and processes are relevant in supporting the sector modernization under the concept of sustainable development.

6.4 Regulatory implications

The inherent peculiarities of green innovations regarding the double externalities emphasizes the role of public policy and regulations in shaping a country's potential to encourage their development and adoption by its industrial sectors. The regulatory push, coming from the firm institutional environment, is therefore an important driver. However, as noticed by the results in the model, there is a particular set of mechanisms to which companies respond and processes and initiatives that companies adopt that directly affect their green innovation performance.

In this sense, policies need to take those into account, as well as the special features of the actors in the sector and its competitive environment. This research sheds light on those aspects and answers to the need to better understand green innovations, its drivers and the main capabilities that need to be developed. Such results are important in improving the current policy mixes of the country under scrutiny, providing focused governmental actions in defining an environmental policy which favours innovation in the sector, creating mechanisms for developing a learning environment among the companies in the sector and financially supporting green innovations initiatives.

6.5 Research limitations and future studies

Finally, the research limitations need to be discussed. First, those are related to the survey sample determined by convenience, as the accuracy of the findings cannot be determined. Also, other limitation refers to the fact that the questionnaires were answered by one person inside the company without any control on how it was done and which intentions were suppressed. However, in order to assure its validity and reliability, a pre-test was conducted and other precautions were taken to safeguard the methodological aspects of the statistical tests conducted.

The scale used is a result of a combination of several scales tested in previous studies, which was not developed as a specific scale for the sector in focus. This can lead to biased results, and special attention need to be given to generalizations. In order to come with specific recommendations, this model needs to be tested in other studies allowing the identification of aspects that can contribute to green innovation performance. Another limitation is related to the measurement of performance, that was based on a unique respondent opinion and not on secondary data available. Also, the variables chosen could be better arranged in order to clearly separate the constructs and enhance the results found on their relationship.

Concerning future studies recommendation, the study points out to some areas where important gaps can be identified. Further studies could focus in understanding why, in this sector or under the same circumstances, the absorptive capacity has no significant relationship with green innovation performance – as this finding contradict what the was found in the literature review. Additionally, what is the impact for consumers when companies do or do not adopt green innovations – this is, to evaluate the market performance of such initiatives.

Derived from the integrative literature review, a few research suggestions which were not explored in this research can be further applied. For instance, to conduct studies which explore the comparison among firms in more than one country, aiming to understand different approaches on dynamic capabilities for green innovations. Also, to conduct qualitative studies, based on case studies, in order to deepen the analysis of firm's specific dynamic capabilities for green innovations, contributing to the micro level research.

Another suggestion is to promote quantitative studies using the available secondary data based on country surveys, to explore the potential of firms in exploiting its capabilities and generating green innovations and to support public policy design on R&D and skill enhancement. Considering the gap of studies in the service sector, it is suggested to explore studies on dynamic capabilities and green innovations in this sector, which are less intensive in technology development but have space for green innovations in processes, for example.

Additionaly, studies with aims to discuss the theoretical background of the research in this field, as a way to support the consolidation of relevant concepts and the relationship among them, could be also explored. Regarding the position of in which the dynamic capabilities are considered in statistical models when related to green innovations and sustainability, it is recommended the development of studies aiming to understand the dynamic capabilities as dependent variables.

Also, researchers could conduct studies on the relevance of alliances capacity, as firms that develop inter-firm collaborations tend to also create alliances to address sustainability challenges as they become more complex. Lastly, it is suggested to conduct studies analysing the adaptive capacity (Biedenbach & Müller, 2012) of firms and its relationship with green innovations, as this aspect was not specifically explored.

Studies on the economic, environmental and societal effects of environmental policies combined with green innovation subsidies in the sector related to knowledge creation and exploitation, infrastructure modernization and technology development also apply. Hereafter, it is suggested the articulation among government, regulators, companies, suppliers, costumers, NGOs and other stakeholders, to discuss relevant issues for the sector in the long term, as a way to identify future challenges related to sustainability issues and create opportunities for growth.

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APPENDIX

APPENDIX A – SURVEY QUESTIONNAIRE

UNIVERSIDADE DE SÃO PAULO
FACULDADE DE ECONOMIA, ADMINISTRAÇÃO E CONTABILIDADE DE RIBEIRÃO PRETO

Este questionário faz parte de uma pesquisa acadêmica, coordenada por professor da USP, cujo objetivo é avaliar a relação de mediação da capacidade de absorção existente nas organizações entre os **fatores** que contribuem para a geração de inovações verdes e a **performance** em inovações verdes das organizações.

INSTRUÇÕES:

1. O questionário possui questões iniciais, sobre informações básicas da empresa respondente e, em seguida, questões relativas aos temas da pesquisa.
2. Você levará de 8 a 10 minutos para preencher a pesquisa.
3. Assinale as alternativas com um **x** de acordo com o seu grau de concordância com a afirmativa proposta.
4. Não é necessário nenhum tipo de identificação pessoal ou da empresa, se você assim o desejar.

OBRIGADA PELA SUA COLABORAÇÃO,
Larissa Marchiori Pacheco
Profª. Drª. Lara Bartocci Liboni Amui

QUESTIONÁRIO

Informações Básicas da Empresa

(1) O nome da sua empresa (optativo):
(2) O setor de atuação:
   a. Geração
   b. Distribuição
   c. Transmissão
   d. Comercialização
(3) O controle da empresa é:
   a. Nacional
   b. Estrangeiro
(4) O tempo de existência de sua empresa:
   a. Menos de 3 anos
   b. Entre 4-5 anos
   c. Entre 6-10 anos
   d. Entre 11-20 anos
   e. Mais de 20 anos

(5) O número de funcionários em tempo integral na sua empresa sob regime de CLT:
   a. De 10 a 49
   b. De 50 a 99
   c. De 100 a 249
   d. De 250 a 499
   e. 500 ou mais

(6) O seu cargo:

Os tópicos abaixo descrevem alguns dos fatores que podem representar importantes condutores da geração e implementação de inovações verdes pela sua empresa. Por favor, selecione a pontuação que você pensa corresponder apropriadamente à posição de sua empresa para cada afirmação.

1. Fatores internos a organização que contribuem para a performance em inovação verde

1= discorda totalmente a 5= concorda totalmente; N/A = não se aplica

O sistema de gestão ambiental (ex. normas ISO) utilizado pela empresa contribui para a geração de inovações verdes em produto e processo.	1 2 3 4 5 N/A
A empresa realiza investimentos em projetos para pesquisa e desenvolvimento (P&D) de produtos e processos verdes (ex. tecnologias limpas).	1 2 3 4 5 N/A
A empresa possui ou viabiliza programas de formação e treinamento ambiental para gestores e funcionários.	1 2 3 4 5 N/A
A empresa possui ou adquiriu patentes de inovações de produtos e processos verdes.	1 2 3 4 5 N/A
A empresa engaja-se em colaboração com outras instituições/organizações, criando relações e alianças estratégicas.	1 2 3 4 5 N/A

2. Fatores externos à organização que contribuem para a performance em inovação verde

1= discorda totalmente a 5= concorda totalmente; N/A = não se aplica

A mudança no comportamento do consumidor sobre proteção ambiental ou aumento do “consumo verde” leva (ou) ao desenvolvimento de inovações verdes de produto e processo em minha empresa.	1 2 3 4 5 N/A
A descoberta do uso de novos materiais, nova tecnologia ou novo equipamento pelos concorrentes leva (ou) ao desenvolvimento de inovações verdes de produto e processo em minha empresa.	1 2 3 4 5 N/A
As regulamentações do setor levam (ram) ao desenvolvimento de inovações verdes de produto e processo em minha empresa.	1 2 3 4 5 N/A

3. A capacidade de absorção para inovações verdes-na organização

1= discorda totalmente a 5= concorda totalmente; N/A = não se aplica

Aquisição Nossa empresa tem rotinas para assegurar a observação de demandas e legislações ambientais.	1	2	3	4	5	N/A
Em nossa empresa nós levamos a cabo revisões ambientais iniciais.	1	2	3	4	5	N/A
Assimilação Os colaboradores da nossa empresa participam de programas de treinamento ambiental.	1	2	3	4	5	N/A
Nossa empresa estabelece metas ambientais mensuráveis.	1	2	3	4	5	N/A
Nossa empresa tem um plano de ação para alcançar as metas ambientais.	1	2	3	4	5	N/A
Nossa empresa implementou análise do ciclo de vida (LCA) como um meio de identificar impactos ambientais dos nossos produtos/serviços.	1	2	3	4	5	N/A
Transformação Nossa empresa realiza auditorias ambientais.	1	2	3	4	5	N/A
Nossa empresa implementou declarações ambientais como meio de identificar o impacto ambiental dos nossos produtos/serviços.	1	2	3	4	5	N/A
Exploração Como gestor de P&D da empresa eu tenho conhecimento para influenciar decisões estratégicas para que elas satisfaçam os interesses ambientais.	1	2	3	4	5	N/A
Como gestor de P&D da empresa eu tenho conhecimento para influenciar as operações e práticas para que elas se desenvolvam de acordo com os interesses ambientais.	1	2	3	4	5	N/A

4. A performance em inovações verdes

1= discorda totalmente a 5= concorda totalmente; N/A = não se aplica

Performance em inovação verde de produto A empresa desenvolveu novos produtos/serviços de gestão ambiental nos últimos dois anos.	1	2	3	4	5	N/A
A empresa escolhe materiais que produzem a mínima quantidade de poluição para conduzir o desenvolvimento do produto.	1	2	3	4	5	N/A
A empresa escolhe materiais que consomem a mínima quantidade de energia e recursos para conduzir o desenvolvimento do produto.	1	2	3	4	5	N/A
A empresa usa a menor quantidade de materiais para compor o produto e conduzir o seu desenvolvimento.	1	2	3	4	5	N/A
A empresa delibera com cautela sobre a facilidade do produto em ser reciclado, reutilizado, e decomposto para conduzir o desenvolvimento do produto.	1	2	3	4	5	N/A

Performance em inovação verde de processo A empresa adota novas práticas de gestão ambiental quando os métodos convencionais falham.	1	2	3	4	5	N/A
O processo produtivo da empresa efetivamente permite reduzir as emissões de substâncias ou resíduos perigosos.	1	2	3	4	5	N/A
O processo produtivo da empresa possui reciclagem de resíduos e efluentes que permite como que estes sejam tratados e reutilizados.	1	2	3	4	5	N/A
O processo produtivo da empresa permite reduzir o consumo de água, eletricidade, carvão ou petróleo.	1	2	3	4	5	N/A
O processo produtivo da empresa permite reduzir o uso de matérias-primas.	1	2	3	4	5	N/A