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## **The political economy of clean energy transitions at sub-national level**

Understanding the role of international climate regimes in  
energy policy in two Brazilian states

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**Abstract:** This paper examines the political economy aspects, particularly the influence of the Clean Development Mechanism, in clean energy and climate change policies in the states of Bahia and Rio Grande do Sul in Brazil. The different mechanisms for responding to climate change are financing opportunities in some of the ‘green’ industries, but the results show a gap between the initial objectives of global policies and their results. The research identified pitfalls and opportunities for new strategies and mechanisms for boosting clean energy in Brazil and the role that the Clean Development Mechanism and future mechanisms can play in the political economy of clean energy transitions. The paper concludes with a discussion on the lessons learned from experience of the Clean Development Mechanism and its implications for the future of the Paris Agreement.

**Keywords:** clean energy, climate change, Clean Development Mechanism, Kyoto Protocol, Paris Agreement, Brazil

**JEL classification:** D78, F53, Q42, Q54

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## 1 Introduction

There is tremendous potential for investments in clean energy over the next few years to take the energy matrix in a more sustainable direction to tackle climate change and air pollution. The global bill for oil, electricity, and natural gas is around US\$5 trillion annually and investments in clean energy reached US\$230 billion in 2011. These annual investments could reach US\$500 billion in 2020 (Glemarec and Puppim de Oliveira 2012). However, much larger investments in clean energy are needed, particularly in developing economies, to change the course of unpredictable climatic change (heading towards an average temperature increase of over 2°C) in the near and medium term future. Even though, in many instances, clean energy is technically and economically viable, the political economy at the national, sub-national, and local levels does not allow the fulfilment of the possibilities for expansion in clean energy production. This could undermine the implementation of the new Paris Agreement on climate change under the United Nations Framework Convention on Climate Change (UNFCCC 2015b).

The analytical framework of this research focuses on the analysis of the political economy of clean energy transitions, particularly understanding how sub-national and local institutions for tackling climate change are established and evolve, building on previous efforts (Keohane and Ostrom 1995; Bulkeley and Betsill 2003; Puppim de Oliveira 2009, 2011). There is less research on the dynamics of domestic policies and politics, and on the nature of federal systems, in climate change discussions, as most of the research focuses on international dynamics of climate negotiations (Harrison and Sundstrom 2010). The local and domestic political economy can shed light on the factors that determine the effectiveness of international climate and energy regimes locally, and how to align international institutions to national and local institutions and context. The mismatch between the international goals and the national and sub-national institutions already in place leads to ineffective results in climate policy implementation (Puppim de Oliveira 2014). There is often a decoupling between the networks of public and private actors and institutions working on the ground and those coming from the top, particularly at the international level (Pinto and Puppim de Oliveira 2008; Andrade and Puppim de Oliveira 2015). Better connections between the international regimes in climate change and sub-national political economy could identify ways to boost clean energy sources both at demand and supply.

The objective of this paper<sup>1</sup> is to shed light on discussions about the political economy at the sub-national/local level surrounding the Clean Development Mechanism (CDM) of the Kyoto Protocol. The CDM is a good research object for looking at the political economy of clean energy transitions at sub-national level. Even though it is an international mechanism, its implementation is done at the local level and influenced by sub-national governance. Moreover, CDM can be implemented only in developing countries, where the energy demand will grow most in the next few years. We examine the main political economy obstacles, particularly at the sub-national levels, including international–national–sub-national relations, to enabling global climate initiatives, such as the Kyoto Protocol's CDM, to have a larger impact in developing countries. This enables us to recommend possible ways to overcome those obstacles, strengthen the implementation of clean energy policies, and inform the design of the implementation mechanisms for future climate change agreements. We examine the policy process for climate

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<sup>1</sup> This paper is also based on long-term research and several publications co-written by the authors, particularly Andrade, Nascimento et al. (2010), and including Andrade, Costa et al. (2010), Silva-Junior, Andrade, and Leao et al. (2013), Silva-Junior, Andrade, and Napravnik-Filho et al. (2013); Falleiro et al. (2014, 2015); and Andrade and Puppim de Oliveira (2015).

and energy policies in two states in Brazil (Rio Grande do Sul and Bahia), and, in particular, the influence of CDM in the development of those policies.

## 2 Methodology

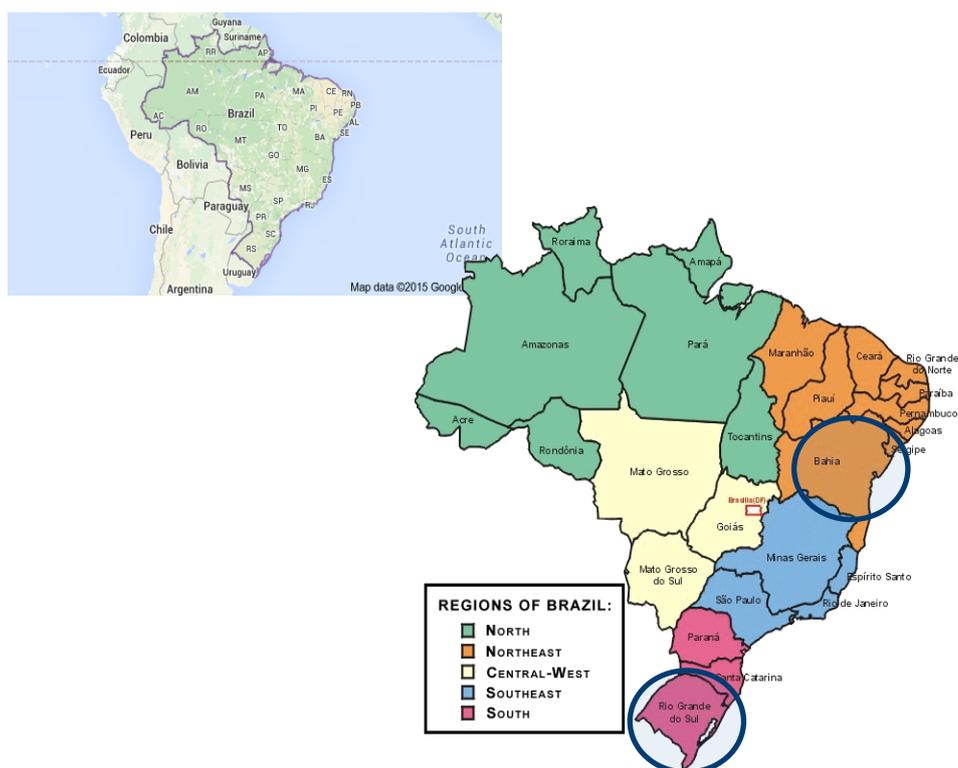
The methodology consisted of a qualitative analysis of the political economy of clean energy initiatives in the two states, including the above-mentioned CDM projects. The research uses the case study method, which is well-documented in the literature (Ragin and Becker 1992; Yin 1994). Because quantitative analyses of policy and political regimes have several limitations for the trade-off between accuracy and generalization and need to simplify data (Mitchell 2004), qualitative study was chosen for two main reasons. First, qualitative study is a good approach for analysing complex processes of decision-making, such as for clean energy initiatives, which need an in-depth understanding of the political economy involving different actors and factors not known in advance that have influenced state energy and climate policies. Second, there was not enough information and data to make, for example, a quantitative study statistically significant. A qualitative analysis gives a broad perspective on the political economy of clean energy at the various levels, enabling a comprehensive understanding of the influence of international regimes in clean energy in Brazil at the sub-national level.

The empirical research was conducted in the Brazilian states of Bahia and Rio Grande do Sul (Figure 1). The two states were chosen because they are the leading states in terms of CDM projects in their regions (north-east and south respectively) during the period of analysis. Moreover, the two states have some of the most progressive policies for climate change and renewable energy in Brazil. The authors also had good knowledge of their context and access to state information and data.

The analyses focused on examining the political economy at the sub-national level and its links to the national and international political economy. The research aimed to track the main drivers of clean energy initiatives in the two states, and how much they have been influenced by international climate regimes, particularly the CDM. Thus, besides the broad state policies and initiatives, the research analysed the CDM projects in clean energy, especially those with a long history of implementation that have already received carbon credits (Certified Emissions Reductions—CER). The research studied individual CDM projects to understand a typical local dynamic and also investigated, in greater depth, one CDM project in each state involving wind energy (Bahia) and small hydro power plant (Rio Grande do Sul). The paper examines how the electricity generation and distribution sector is evolving in Brazil and its links with climate change. The study analyses governmental programmes and provides an overview of the past, present, and future developments in wind and hydro energy in the two states and their links with national and international climate regimes, particularly those related to the UNFCCC.

We conducted document analyses using material from the UNFCCC (CDM database and *Project Design Documents*—PDD), Brazilian Ministry of Environment (MMA), the Ministry of Science, Technology and Innovation (MCTI), and the Ministry of Mines and Energy (MME) in Brasilia; and from the state environmental protection and energy agencies in the two states, among other institutions. Field research for conducting semi-structured interviews and further data collection was carried out in the two states. One CDM project in each state was selected to illustrate the CDM impact at the local level. There were also calls for interviews and email exchanges with the different organizations, such as energy companies and consultants involved in clean energy and CDM projects in 2015.

Figure 1: Location of the states of Rio Grande do Sul and Bahia



Source: Adapted from Google Maps ([www.google.com/maps](http://www.google.com/maps)) (top map) and [www.bahiamap.com](http://www.bahiamap.com) (bottom map).

### 3 National and sub-national policies for clean energy and climate change in Brazil

With the rise of scientific evidence about the causes and consequences of climate change, a variety of market and political institutions have been developed to govern those issues globally, nationally, and locally. Despite the low price of carbon, due to recent crises in the carbon market, and criticism of its ability to promote cleaner technologies and sustainable development, there is an important role for carbon markets in national and sub-national climate change regimes (Streck and Lin 2008; Okereke et al. 2012; Michaelowa 2012; CDM Policy Dialogue 2012). The Brazilian government, though not committed to compulsory targets for reducing greenhouse gas (GHG) emissions because the country is not included in Annex B of the Kyoto Protocol, enacted Law 12.187/2009, which established the National Policy on Climate Change, committing to undertake a number of sectoral actions aimed at mitigating and adapting to climate change; one of these is the rise in investments in clean energy.

The different mechanisms for responding to climate change are creating opportunities in some of the ‘green’ industries, such as renewable and clean energy. Brazil already has an outstanding share of renewable energies, dominated by its naturally endowed huge potential of hydro energy, providing a share of 65 per cent of the electricity matrix in 2012 with a total hydro power plant capacity of 85.5 GW (ANEEL 2015). The country has created some incentive mechanisms such as the Programme of Incentives for Alternative Electricity Sources (PROINFRA, Programa de Incentivo a Fontes Alternativas de Energia Elétrica) established by Law 10438/2002, which gives subsidies and incentives for clean electricity projects using the special financial mechanisms of the Brazilian National Development Bank (BNDES, Banco Nacional de Desenvolvimento Econômico e Social). However, this ‘clean’ energy profile could change considerably depending on the growth of electricity demand, the availability of resources for generation, environmental

constraints, the distribution networks, and the cost of exploiting resources. Indeed, Brazilian emissions in the energy sector have increased considerably in recent years through the use of non-renewable energy sources (MME 2015). Thus the research examines how the CDM and other markets and policies have stimulated the development of and investments in renewable energies in Brazil. By collecting and comparing different political and economic preconditions, structures, and the overall development in the two states and projects, the research identifies pitfalls and opportunities for new strategies and mechanisms for boosting clean energy in Brazil.

As part of a federal republic, the Brazilian states play a role in climate and energy initiatives, as they have a certain amount of autonomy in the way they create new policy mechanisms and implement national policies. Several states have advanced their own climate policies, stating the level of emission reductions to be made, with these sometimes being even more stringent than the national targets, and planning to establish different mechanisms such as emission trading (CNI 2011). This was particularly the case around the time of the UNFCCC COP-15 in Copenhagen in December 2009 (Forum Clima 2012)—see Figure 2. Most of the Brazilian state climate policies are a response to national directive (Law 12.187/2009, which established the National Policy on Climate Change). Only two out of 27 states—São Paulo and Santa Catarina—established their climate policies before the National Policy on Climate Change. However, recently, states have been becoming more active in climate policies. In 2015, in response to targets set nationally, 16 out of 27 Brazilian states set their own voluntary targets for emissions; four states (São Paulo, Rio de Janeiro, Mato Grosso do Sul, and Paraíba) had already defined their compulsory targets for emissions and seven others were in the process of defining their state climate policies (Forum Clima 2015).

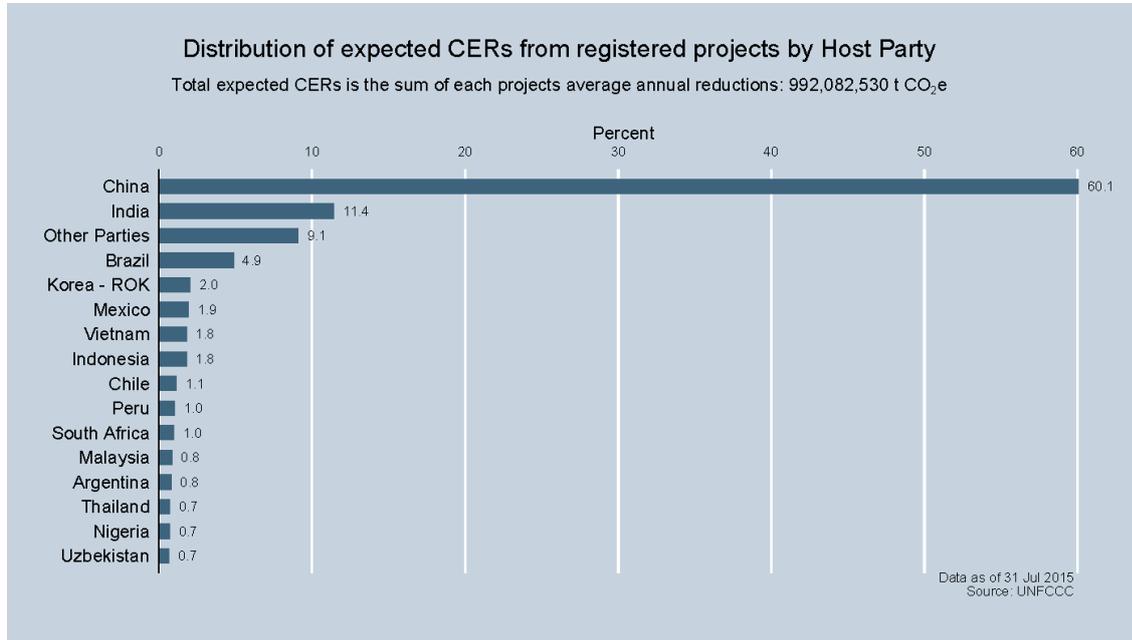
One of the main mechanisms in Brazil for motivating GHG emission reductions has been the CDM. There were more than 7,600 projects registered at UNFCCC in August 2015 (UNFCCC 2015a). Brazil registered the first CDM project in the UNFCCC and has been one of the leading countries in executing CDM projects with 330 projects at the end of 2014 (MCTI 2014)—Figure 3. In Brazil, energy projects comprise the majority of CDM projects (55 per cent, Figure 4), which are spread through various states across the country. Thus, this research seeks to understand the political economy of the sub-national clean energy initiatives in Brazil and the links with international energy and carbon mechanisms such as carbon markets and, particularly, the Clean Development Mechanism (CDM) of the Kyoto Protocol.

Figure 2: States with some intentions to control GHG emissions



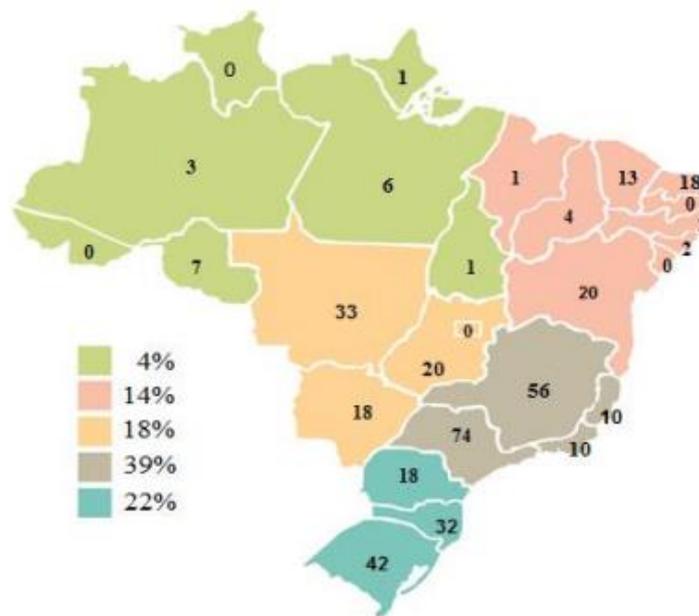
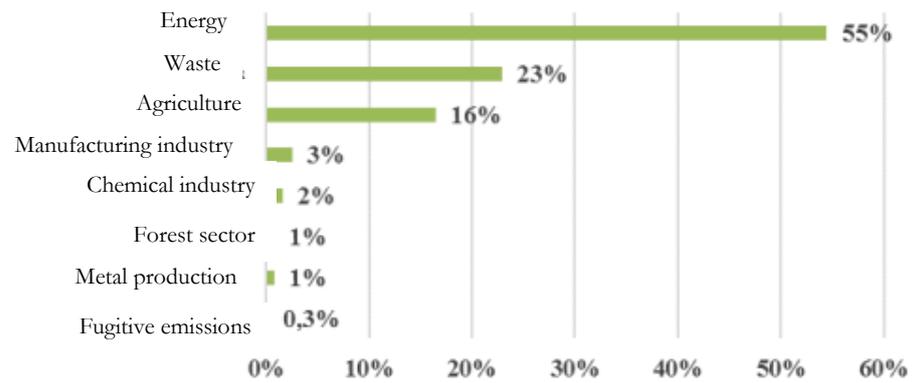
Source: Forum Clima (2012).

Figure 3: Distribution of CDM projects among countries



Source: UNFCCC (2015a).

Figure 4: CDM Projects in Brazil



Source: Both graph and map adapted from MCTI (2014).

### 3.1 The case of Rio Grande do Sul

Rio Grande do Sul is the southernmost state in Brazil, bordering Uruguay and Argentina. Although Rio Grande do Sul is one of the largest producers of coal in Brazil, it generates around 77 per cent of its electricity from renewable sources (hydro 72 per cent and wind 5 per cent)—more than the national average of 75 per cent (ANEEL 2013). The state also enacted the State Climate Change Policy Law (Law 13.594/10) in 2010, which sets out the reduction of GHGs required by 2020, proportional to what is established in the national policy. The Law also aims to promote projects to reduce emissions through CDM (article 5) (Falleiro et al. 2014).

In 2004, the state governor issued a decree (Decree 43.476) establishing a commission to study CDM and its environmental implications, already pointing to the potential of CDM to foster

opportunities in Rio Grande do Sul. The state now has the largest number of CDM projects in renewable energy among Brazilian states (using methodology ACM0002 from the UNFCCC, ‘Consolidated baseline methodology for grid-connected electricity generation from renewable sources’) in the first period of the Kyoto Protocol (between 2005 and 2012). The state hosts 19 (11 small hydro, 2 hydro, 5 wind, and 1 biomass) of the 85 Brazilian CDM projects in renewable energy (22 per cent of the total) comprising 1.9 million CERs (25 per cent of the total in Brazil from renewable energy) (Falleiro et al. 2014).

The state government has worked with other stakeholders in mapping and trying to tap the wind energy potential. The state has produced the Wind Energy Atlas to identify opportunities in wind energy and guide public policies. Wind, in particular, has an immense potential in the state as only 634 MW of installed capacity exists compared to the estimated potential of 102.3 GW. This potential is concentrated in the less economically dynamic regions and could be harnessed to generate economic development, especially taking into account the tradition of regional development policies in the state (AGDI and Eletrosul 2014).

One of the CDM projects analysed in this research is the Ferradura small hydropower plant located in Erval Seco in the north-western part of Rio Grande do Sul. The project was managed by BT Geradora de Energia Elétrica SA, a special-purpose company led by a local entrepreneur. Even though the number of jobs generated (two jobs) is small and the technology transfer limited, as it is a well-known technology, the project unexpectedly generated an area for leisure (fishing, swimming, and picnics) in a region with a lack of such facilities.

### **3.2 The case of Bahia**

Bahia is located in the north-east region of Brazil. It generates more than 83 per cent of its electricity from renewable sources (wind and hydropower), more than the national average (75 per cent). As in Rio Grande do Sul, the Bahia state has a huge wind potential of untapped electricity generation. Bahia’s Wind Energy Atlas identified only 1.2 GW of installed capacity as compared to the estimated potential of 195 GW (MME 2015).

The state only enacted its Climate Change Policy (Law 12050) in 2011, but between 2005 and 2012 it had one of the highest numbers of CDM projects in renewable energy (ACM 0002 methodology) among all Brazilian states. It hosted 12 projects: 10 wind and 2 hydro by the end of 2012 (Falleiro et al. 2015).

One of these CDM projects is the Votorantim Hydropower Plant, registered in 2006. It consists of a hydroelectric plant whose dam, reservoir, and flooded area have existed since the 1980s. The project just added sub-stations, turbines, and generators (Fernandez et al. 2014) with no local environmental impact. The hydropower plant is owned by Votorantim Cimentos Ltd and it has an installed electric capacity of 162 MW. Votorantim is one of the largest Brazilian industrial conglomerates in the fields of steel and cement. This CDM project foresees a reduction of 59,485 tons of CO<sub>2</sub>e/year (Silva-Junior et al. 2013a).

Economically, the project has contributed to the national economy and has generated tax revenues. Socially, this CDM project has generated employment, improved the public infrastructure of adjacent municipalities, and provided professional training for plant operation and maintenance. Direct jobs were created during the construction of the plant and indirect jobs for its maintenance (Fernandez et al. 2014).

During the proposal phase, the company organized public hearings and visits with diverse groups of stakeholders, mainly NGOs, local authorities, and fishermen. Environmentally, besides

GHG emissions reduction, the project has contributed to the reforestation of riparian vegetation, the conservation of flora and fauna, the recovery of degraded areas, the management of aquatic ecosystems, the monitoring of water quality, and an environmental education programme in its area of influence (Silva-Junior et al. 2013a).

Some of its carbon credits go to the Votorantim Institute, which is the company's organization for carrying out initiatives in corporate social responsibility, such as income generation projects with the communities around the dam (Fernandez et al. 2014). We also point out the main opportunities and political economy obstacles to the implementation of CDM-like projects to delivering local sustainable development in Section 4.

#### **4 Analysis of the influence of CDM in the political economy of energy transition**

In this section we analyse the impact of the CDM projects on the political economy of clean energy transitions with a focus on the two states, and also the role of the national government and the federal system (the division of responsibilities between national and sub-national entities). We examine how much CDM has been able to influence different processes and stakeholders to facilitate energy transitions domestically, including the adoption of progressive energy and climate policies, development of local technological capabilities in clean energy, and strengthening local planning processes. The research provides some insights into the political economy for managing the transition to a cleaner energy matrix in developing countries, particularly the role of international mechanisms, such as CDM.

How to make climate change goals compatible with the development agenda at the national and sub-national levels in the public and private sectors is key to the implementation of climate-related policies such as clean energy development (Pinto and Puppim de Oliveira 2008; Glemarec and Puppim de Oliveira 2012; Puppim de Oliveira 2013). The research sheds light on the role of CDM in influencing the way different clean energy and climate institutions are being built. In sub-Section 4.1, we examine in greater detail: the links between CDM and the changes in climate and energy policy and regulation (for example, many states in Brazil are adopting different climate policies and legislation to tackle climate change). We examine its influence on innovation and technological policies in sub-Section 4.2 (reducing GHGs from dissemination of innovations in clean energy) and the planning processes involved in sub-Section 4.3 (how energy planning decisions are based on local inputs and take into consideration climate change issues and the interests of future generations).

##### **4.1 CDM impacts on domestic climate and energy policies**

International market mechanisms could change the domestic political economy balance towards the adoption of more progressive climate and energy policies in developing countries. Nevertheless, the role of CDM as a global climate and energy governance mechanism seems quite ambiguous. Even though thousands of CDM projects were executed, issuing millions of carbon credits (CERs), the effect on domestic and local policies is unclear. For example, the GHGs in the main CDM host countries (China, India, and Brazil) have continued to grow in the last decade. China, the largest CDM recipient country, has increased its CO<sub>2</sub> emissions<sup>2</sup> in the 2000–13 period by 192 per cent and its CO<sub>2</sub> per capita emissions in the same period by 169 per

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<sup>2</sup> The emissions included are those from 'the fossil fuel use and industrial processes (cement production, carbonate use of limestone and dolomite, non-energy use of fuels and other combustion). Excluded are: short-cycle biomass burning (such as agricultural waste burning) and large-scale biomass burning (such as forest fires)' (EC 2015).

cent, and Brazil has increased its emissions by 48 per cent and 29 per cent respectively (EC 2015). Even though countries have enacted laws, targets, and policies on climate change, none of the large developing countries have included mandatory total emission reductions. The additionality component of CDM may even have blocked national and state legislation for controlling GHGs, as this could undermine additionality.

The federal structure of a country can influence the way international regimes influence national and sub-national policies (Harrison and Sundstrom 2010). Even though there is a high degree of decentralization in certain sectors (e.g. education and health), the autonomy of states and municipalities limits the scope of their action in climate change, particularly in clean energy supply and markets. The structure of the Brazilian federation and the utilities allow little space for strong command-and-control regulations and investment decisions at the sub-national level. Many existing state energy companies have had some of their activities privatized, federalized, or discontinued in recent decades. This is the case of the Rio Grande do Sul's State Company of Electric Energy (CEEE—Companhia Estadual de Energia Elétrica), founded in the first half of the twentieth century, which had a large part of its distribution system privatized and power plants (like coal power plants) nationalized in the 1990s (Rotulo Decuadra and Puppim de Oliveira 2008).

Thus, the policies and legislation at sub-national levels in Brazil generally mention, but give little incentive for clean energy and climate mitigation including CDM projects, and there is no obligation to achieve certain targets for clean energy generation either enforced or directly promoted by the states. Most of the incentives come from the national level, such as PROINFRA, which gives subsidized credit to energy projects.<sup>3</sup> Sub-national governments, such as the two states analysed, promote clean energy through studies to map the energy potential and try to attract energy investments from the public and private sectors. Climate change policies are more in line with the national targets, and just a few states (like São Paulo) have been more ambitious. The laws establishing those policies generally mention the intention to encourage or promote CDM, but no specific mechanisms are concretely defined. Rio Grande do Sul and Bahia have been at the forefront in attracting CDM projects, particularly in clean energy, both because of the potential they have (in hydro, wind, and also solar) and the large size of their economies and populations. CDM ends up being mostly business driven (by the private sector) leading to stiff competition among states to attract those projects, as an early decree to create a CDM commission in Rio Grande do Sul in 2004 seemed to target. Thus, the impact of CDM has been mostly to steer state and national policies towards an incentive-based approach to clean energy and to try to attract private investors to tap into the international opportunity.

#### **4.2 CDM building technological capabilities**

CDM can provide an opportunity to change the local political economy to invest in building local technological capabilities in clean energy, as it involves cooperation between developing and developed countries (the latter may provide the incentives or the technical background to build the capabilities). However, the research has not found any direct changes in the political economy to promote capability building in clean energy at the sub-national level. Even though CDM promoted the acquisition of the know-how and equipment in Brazil, the technologies were well-known, and coming from outside the state. For example, in the Votorantim CDM project in Bahia, the exogenous transfer of technology was very limited—only evident in secondary equipment purchased in Germany. Much of the machinery and know-how required for project

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<sup>3</sup> World Resources Institute website (accessed on 15 December 2015): <http://projects.wri.org/sd-pams-database/brazil/programme-incentives-alternative-electricity-sources-proinfra>

development were acquired in the domestic market. Thus, technology transfer was mainly endogenous due to Brazil's mastery in hydroelectric technology production (Silva-Junior et al. 2013b). A similar outcome developed in the Ferradura project in Rio Grande do Sul state, where the technology was already dominated by Brazilian companies. The use of well-known technologies comes about because they are tested technologies, posing less financial and technological risks to the investors and promoters of the CDM projects.

The national government is the key actor in driving technology policies in the CDM through the PROINFRA programme, which required that financed projects acquired more than 60 per cent of the equipment and technology domestically. However, PROINFRA did not foster technology development per se as a requirement for funding. On the other hand, the states have very little influence in technology policies, as the climate policies do not specify any concrete technological policies, even though promotion of clean technology is mentioned in the policies, such as the State Climate Change Policy Law in Rio Grande do Sul. The states have some science and technology funds managed by their state research foundations that have tried to promote calls for clean energy, but none of the projects seem to have used those funds.

In conclusion, the research found that the CDM projects in the two states did not contribute significantly to technological development locally. Technology transfer was also limited, but CDM projects have demanded mostly locally produced equipment that indirectly can help technological development (which would be just a spillover effect from the growing domestic demand for clean energy).

### **4.3 Local planning for sustainability**

International climate policy and market mechanisms could help local planning processes to be more sustainable by, for example, generating incentives or conditions for changing the local political economy to make planning more inclusive and participatory. The evidence collected from different sources (such as interviews, field visits, and secondary information, such as CDM reports in the UNFCCC page) shows that CDM projects in the energy sector generated little participation and local development in the long term. They just followed the common processes already in place in the two states (such as Environmental Impact Assessment) without building more participatory, engaging planning processes. Most of the projects created only a handful of direct jobs in their operations as, once installed, large parts of the operations are automated as in the case of Ferradura in RS (just two jobs), or such as was the case in Votorantim in Bahia, where the facility was already operational. The decisions on the CDM projects have indicated a prevalence of a single bottom-line profile for decision-making (financial returns from carbon market) over the long term, next generations' interests (Falleiro et al. 2015).

There is also little sign that CDM has created significant opportunities for engagement with local businesses. The direct participation of small organizations, firms, and communities in CDM projects is limited because of the high transaction costs related to all phases of the projects. The complexity of the registration process is beyond the reach of most local organizations. Nevertheless, one of the CDM projects in this research (Ferradura in Rio Grande do Sul) was led by a local entrepreneur, demonstrating the possibility for emergence of institutional arrangements that allow small local organizations to engage in CDM. Thus, a small number of consultants, mostly international or from outside the regions of the projects, dominate the services, generating few opportunities for local firms to be engaged in the projects and develop the expertise in CDM which could boost other CDM projects locally.

## 5 Conclusions

The development of large-scale clean energy initiatives in developing countries depends heavily on the local political economy, as well as the local technical capacity to carry out technical changes. International political and market mechanisms in energy and climate change regimes could be an opportunity to transform the balance in the domestic and sub-national political economy to promote clean energy initiatives. However, the results of this study showed limited evidence of the lasting impacts of CDM projects on changing the sub-national political economy to boost clean energy initiatives locally, though CDM brought resources to project implementation, mainly through private actors. The CDM projects generated sparse incentives for local climate and energy policies, had little impact on local planning processes, and showed little development of technological capabilities locally.

There are some features in Brazil that may have limited broader impacts of CDM. Countries and states with better technical capacity and more sophisticated industry can more easily adapt to changes coming from international regimes through small incentives or funding (Puppim de Oliveira 2014). The local market structure and its political economy may also influence clean energy efforts. In countries where there is more effective regulation and open competition in the local energy market, economically and technically viable solutions may win quickly without much state intervention. However, in a rigid energy market like the one in Brazil, we have seen, instead, dependence on national government interventions, as the states promote and compete to attract clean energy investments with the few resources they have. The states of Rio Grande do Sul and Bahia are those traditionally with the largest capacity to implement environmental and energy policies in their respective regions (south and north-east), and this has been reflected in the number of CDM projects they were able to attract, particularly in the area of energy.

We have witnessed the national government introducing incentives to reduce risks and make clean energy more attractive (such as PROINFRA), and CDM helped in offering greater incentives for local implementation. Sub-national governments could play a larger role in such transitions if they had more autonomy to push for different sustainable policies, but there is a mismatch between what locals could do and what the CDM projects could fund. In Brazil, urban policies, in areas such as urban transport and land use, are mostly in the hands of local governments, but there are few opportunities for CDM projects because of the difficulties of designing a methodology and transaction costs, as many projects would be small scale. Moreover, in the area of energy generation the capacity of sub-national governments in countries like Brazil are limited. The new international mechanisms in the Paris Agreement, based on the Intended Nationally Determined Contributions, could open more opportunities in those urban sectors, though there is no direct incentive yet and financial incentives would most likely have to be via national governments.

The research also provides a better understanding of the specific features of the political economy of energy transitions in developing countries, where challenges for coping with climate change and energy governance and risks are different from those of more established institutions in more developed countries. Governance aspects, such as law enforcement, inter-sectoral coordination, and participation, tend to be weaker in developing countries affecting how organizations and individuals perceive the problems and act. Even in the two leading states (Bahia and Rio Grande do Sul) there are significant obstacles to advance climate and clean energy policies. For example, there is a lack of coordination capacity between the public and private sectors in Rio Grande do Sul to define concrete targets and mobilize resources for emission reduction (Falleiro et al. 2014). Thus, priorities in capacity building in management and governance are very distinct between developed and developing countries.

The emergence of political or economic factors at the higher level can change the balance of political and economic forces at the sub-national level, which can facilitate or make difficult the dissemination of clean energy in a particular context/state. Political organizations or networks promoting clean energy can become more powerful or legitimate to pursue their actions or interests. Thus, the research also sheds light on the effectiveness of implementation of international environmental agreements adding the component to the local political economy. International regimes can be important for changing national and sub-national political and market forces to promote the objectives of the agreement. For example, the discussions leading up to Copenhagen in 2009 helped to catalyse state legislations on climate policies and GHG emission reductions in Brazil. Agreements can result in international projects or economic incentives forcing needed changes locally, such as the CDM projects. Nevertheless, in many cases the objectives of the agreement and its implementation are not completely allied to the local political economy (Pinto and Puppim de Oliveira 2008). Thus, there is a need for understanding the local political economy and creating flexible mechanisms to adapt global interests to local needs in the short and medium term.

CDM was one of the innovative mechanisms for facilitating the implementation of the Kyoto Protocol. CDM projects would engage developing countries (Non-Annex B) in carbon reduction initiatives while giving flexibility to developed countries (Annex B) to achieve the reduction targets, and at the same time encouraging technology transfer between North and South. However, even though CDM projects brought billions of dollars to projects in developing countries, it looks like they were concentrated in just a few countries and consulting companies, and the large societal goals, such as tackling climate change and promoting sustainable development, were limited.

## **5.1 Moving ahead: lessons from the Paris Agreement**

The rules for post-Kyoto (the new Paris Agreement of 12/2015) can be an opportunity to develop mechanisms to reduce overall GHG emissions by bringing development opportunities to the poorest and most vulnerable populations of developing countries. Hopefully, Paragraph 2 of Article 6 of the Paris Agreement (December 2015) established a voluntary mechanism in order to: (a) promote the mitigation of GHG while fostering sustainable development; (b) incentivize and facilitate participation in the mitigation of GHG emissions by public and private entities; and (c) contribute to the reduction of emission levels in the host countries, which will benefit from mitigation activities resulting in emission reductions that can also be used by another country to fulfil its nationally determined contribution and deliver overall mitigation in global emissions.

Policy makers need to rethink the way CDM, or its substitute mechanism post-Kyoto in the follow-ups to the Paris Agreement, can bring more development outcomes to society and build technological capabilities in poorer countries, while reducing overall carbon emissions globally. There are several alternatives for incorporating more local development goals in CDM or its follow-ups. For example, local development goals could be an integrated part of the Project Design Documents (PDD) and the final validation of the carbon credits of specific projects, including the participation of the main local stakeholders in the verification and validation processes. Governments and companies participating in carbon financing mechanisms and markets should also have overall carbon reduction goals for access to the credits, and these should not only be based on one isolated project. Moreover, the simplification of the bureaucracy could allow small firms and local organizations to engage in global carbon markets. Finally, the participation of local civil society in the decisions on carbon mechanisms could strengthen planning processes and have a better share of the economic benefits of carbon credits.

On the other hand, greater reforms in the federal systems in some countries like Brazil could encourage states and municipalities to take more responsibilities in energy and climate policies. Providing more autonomy for more stringent command-and-control regulations, incentives for local carbon and energy markets, or even direct participation in energy investments could allow more sub-national policy innovation and action in developing renewable energy generation and markets at the sub-national level. Some reforms in energy distribution and generation could help to boost cleaner energy initiatives with the participation of local actors.

The practice of CDM has been different to its original concept during the Kyoto Protocol process, and we hope this is not repeated with the mechanisms that will follow up the Paris Agreement. The credibility of international mechanisms and agreements is based on their capacity to deliver sustainable development, including reduction of total emissions. Promoters of voluntary market-based carbon initiatives like CDM have focused on making those markets work efficiently to grow in volume and financial returns, and less on total emission reduction and local development, which are the reasons they were created in the first place. National and states policies can play a key role in steering those markets to bring more societal goals, but they require concrete initiatives beyond general laws (as those we have seen in Brazilian states) without grip, or they risk losing good opportunities to boost their own clean energy initiatives.

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