Políticas de geração distribuída e sustentabilidade do sistema elétrico

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Tese de Doutorado

Brasília-DF

UNIVERSIDADE DE BRASÍLIA

CENTRO DE DESENVOLVIMENTO SUSTENTÁVEL

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RESUMO

A estrutura do setor elétrico, tanto em países desenvolvidos, quanto nos países em desenvolvimento, foi baseada em modelos de economia clássica de ganhos de escala: grandes projetos de geração de energia levados aos consumidores por meio de linhas de transmissão e distribuição. Esse modelo está sendo questionado, junto com um aumento na conscientização ambiental e social que põe em xeque os atuais padrões de produção e consumo. Em resposta, políticas de geração distribuída de eletricidade procuram uma das maneiras de suprir os seus setores elétricos de forma que contemplem a inclusão social, bem como a redução nas emissões de carbono, por ser baseado em pequenos projetos de energia renovável. O objetivo geral desta tese é analisar como a política brasileira de geração distribuída busca complementaridades ambientais e sociais. Para a estrutura da tese, optei por escrever quatro artigos. O primeiro artigo aborda a seguinte questão: o que sabemos sobre o estudo de políticas de geração distribuída de energia elétrica nas Américas? Foi feita uma revisão sistemática de literatura sobre políticas públicas de geração distribuída no continente americano. Mudanças climáticas e preocupações com o meio ambiente foram as razões mais citadas como forças motrizes. A geração de emprego e crescimento verde é um fator pouco citado nos países latino-americanos em comparação com os países norte-americanos. A diversificação da matriz energética ocupa um espaço mais importante entre países do Sul. O segundo artigo busca entender a trajetória história e institucional dos setores elétricos no Brasil e no Canadá para entender quando, como e por que a geração distribuída surge como um assunto no âmbito de planejamento e político-energético. A análise mostrou que geração distribuída é um elemento internalizado do planejamento das duas províncias canadenses contempladas, enquanto no caso brasileiro a mesma não faz parte de uma política consolidada, sendo um elemento externo com caráter apenas regulatório. Foram identificados dois fatores-chaves para a falta de incentivos no caso brasileiro; a percepção de que a expansão de grandes usinas hidrelétricas é uma maneira suficientemente sustentável para gerar energia, e que geração distribuída não oferece benefícios ambientais e sociais suficientes para justificar custos adicionais. O terceiro artigo tem como objetivo analisar o panorama político da Regulação Normativa da ANEEL 482/2012, que introduz geração distribuída no setor elétrico brasileiro. O arcabouço analítico considera três aspectos: contexto da política, o desenho de instrumentos e uma análise dos seus impactos. A ANEEL, como reguladora, entende geração distribuída dentro de uma ampla questão técnica de aprendizagem para o *smart-grid*. Por isso, o “problema” é visto como passível de soluções administrativas e normativas. A geração distribuída no Brasil não faz parte de uma política estratégica; falta financiamento e outros incentivos diretos. A análise dos impactos iniciais mostra que geração distribuída está longe de contribuir de forma intensa na matriz energética. Faço uma regressão linear para identificar os fatores determinantes para explicar a tendência de projetos agregados por unidade da federação. Os resultados mostram que tarifas altas e a exoneração de um imposto estadual, o ICMS, influenciam positivamente o número de projetos. No quarto e último artigo abordo a questão de geração distribuída como um nicho estratégico, baseado no arcabouço teórico de estudos sobre transições sustentáveis de sistemas sociotécnicos. Dois estudos de caso foram explorados: 1) duas comunidades vizinhas (Morada do Salitre e Praia do Rodeadouro) construídas no município de Juazeiro-BA, dentro do programa habitacional Minha Casa Minha Vida; 2) no centro da comunidade CEACA-Vila na favela pacificada do Morro dos Macacos–RJ. Na comparação desses dois projetos, aponto questões sobre *“ownership”* e manutenção de longo-prazo que possivelmente influenciarão em seu próprio sucesso. Diretrizes são apresentado para formular um arcabouço político para a geração distribuída dentro da perspectiva de incentivar uma transição rumo à sustentabilidade ambiental e social do setor elétrico brasileiro.

Palavras-chave: geração distribuída, energia renovável, políticas públicas, transições sustentáveis, sistema sociotécnico

ABSTRACT

The electricity sector, both in developed and developing countries is based on a classical model of economy of scale: large-scale generation is transported over long distances by transmission lines and then through distribution systems. This model has come under question, accompanied by an increase in social and environmental awareness that is re-assessing current modes of production and consumption. Policies for distributed electricity generation have arisen in this context. They look to supply the electricity sectors in a way that creates social inclusion and is low-carbon, by promoting small, renewable projects. The objective of this thesis is to analyze how the Brazilian policy for distributed generation contemplates environmental and social synergies. The thesis is structured into four articles. The first article deals with the question: what do we know about the study of distributed generation policy in the Americas? A systematic literature review was conducted for studies of public policies in the American continent. Climate change and environmental concerns were cited as the main driving forces for distributed generation policies. The question of job creation and green economic growth is cited higher in North American countries, while the diversification of the energy mix is a larger concern for Latin American countries. The second article traces the historical and institutional trajectories of the electricity sectors in Brazil and Canada in order to understand when, how and why distributed generation emerges as an issue in energy planning and policy. The analysis showed that distributed generation has been internalized into energy planning of the two Canadian provinces considered, while in the Brazilian case, it is maintained as a separate, regulatory issue. The two main reasons identified for the lack of incentives in Brazil are: the perception that the expansion of large hydro is a sufficiently sustainable means of generating electricity, and that distributed generation does not offer sufficient environmental and social benefits to justify additional costs. The third article analyzes the political landscape surrounding ANEEL's (the Brazilian Electricity Regulatory Agency) Normative Resolution 482/2012, which introduced distributed generation to the Brazilian sector. The analytical framework considers three aspects: policy context, instrument design and evaluation of impacts. ANEEL, as the regulator, understands distributed generation within the broader question of learning for the Smart Grid. For this reason, the policy problem is seen as one that can be addressed through norms and administrative solutions. Distributed generation is not part of a consolidated and strategic policy; there lacks financing as well as other direct incentives. The evaluation of policy impact shows that distributed generation is still well away from contributing in any meaningful way to the energy mix in Brazil. An econometric approach was taken; a linear regression identified some of the explanatory factors for successful projects, aggregated by state. The results show that high tariffs and the exemption of a state tax, ICMS positively influence project uptake. In the last article, distributed generation is analyzed as a strategic niche within the framework of sustainability transition studies for sociotechnical systems. Two case studies were explored: 1) adjacent communities (Morada do Salitre e Praia do Rodeadouro) in Juazeiro, Bahia, built as part of the *Minha Casa Minha Vida* program; 2) the CEACA-Vila community center in the pacified *favela* of Morro dos Macacos, Rio de Janeiro. Through the comparison of the two projects, questions of ownership and long-term maintenance and operation are raised that will possibly affect their success. Elements of a policy strategy for distributed generation are presented within the framework of transitions management and with the perspective of incenting a low-carbon and socially inclusive sustainability transition in the Brazilian electricity sector.

Keywords: distributed generation, renewable energy, public policy, sustainability transitions, socio-technical system

RESUMÉ

Dans les pays développés comme dans les pays en développement, le secteur électrique a été structuré selon des modèles classiques d'économie d'échelle: de grands projets de production qui amènent l'énergie aux consommateurs par le biais des lignes de transmission et de distribution. Aujourd'hui ce modèle est remis en question, en raison d'une plus grande conscience environnementale et sociale qui conduit à interroger les modes actuels de production et de consommation. En réponse, les politiques de production décentralisée d'électricité cherchent à alimenter leurs secteurs d'électricité de manière à ce qu'ils créent de l'inclusion sociale et réduisent les émissions de carbone, par la promotion de petits projets d'énergie renouvelable. L'objectif général de cette thèse est d'analyser comment la politique brésilienne de production décentralisée met en œuvre cette recherche de complémentarités environnementales et sociales. Pour cela, j'ai opté pour structurer la thèse en quatre articles. Le premier article naît d'une question: que savons-nous des études portant sur la production décentralisée d'énergie électrique dans les Amériques? J'ai d'abord procédé à une revue systématique de la littérature sur les politiques publiques de production décentralisée sur le continent américain. Le changement climatique et les préoccupations environnementales sont les raisons le plus souvent citées comme forces motrices. La création d'emplois et la croissance verte constituent des facteurs peu cités dans les pays d'Amérique latine par rapport aux pays d'Amérique du Nord. La diversification de la matrice énergétique est un sujet de préoccupation plus important parmi les pays du Sud. Le deuxième article cherche à comprendre l'histoire et la trajectoire institutionnelle du secteur électrique au Brésil et au Canada dans le but d'analyser quand, comment et pourquoi la question de la production décentralisée apparaît dans le contexte de la planification et de la politique énergétique. L'analyse a montré que la production décentralisée est un élément intériorisé dans la planification des deux provinces canadiennes couvertes tandis qu'au Brésil elle ne fait même pas partie d'une politique établie, et constitue seulement un élément externe de caractère régulatoire. Deux facteurs clés ont été identifiés pour expliquer le manque d'incitations fiscales dans le cas du Brésil: l'idée que l'expansion des grandes centrales hydroélectriques est une manière suffisamment durable de produire de l'énergie, et que la production décentralisée n'offre pas d'avantages environnementaux et sociaux suffisants pour justifier les coûts supplémentaires. Le troisième article vise à analyser le paysage politique de la Résolution normative 482/2012 de l'ANEEL, qui introduit la production décentralisée dans le secteur électrique brésilien. Le cadre d'analyse prend en compte trois aspects: le contexte politique, la conception d'instruments et une analyse de leurs impacts. L'ANEEL, en tant qu'agence régulatrice, aborde la production décentralisée en tant qu'élément d'une question technique plus large, d'apprentissage pour des réseaux intelligents (*smart-grid)*. Par conséquent, elle entend que le « problème » peut être résolu par le biais de de solutions administratives et réglementaires. Au Brésil, la production décentralisée ne fait pas partie d'une politique stratégique, et manque de financements et de mesures incitatives directes. L'analyse des impacts initiaux montre que la production décentralisée est loin de contribuer de manière intensive à la matrice énergétique nationale. Par le biais d'une régression linéaire, j'ai pu identifier les facteurs expliquant le succès de différents projets, à l'échelle des États fédérés. Les résultats montrent que les tarifs élevés et l'exonération d'un impôt (appelé ICMS), mis en place par les états fédérés, a une influence positive sur le nombre de projets. Dans le quatrième et dernier article, j'aborde la question de la production décentralisée en tant que niche stratégique, à partir d'un cadre théorique sur les transitions durables des systèmes sociotechnique. Deux études de cas ont été explorées : 1) deux communautés voisines (Morada do Salitre et Praia do Rodeadouro), construites dans la commune de Juazeiro (État de la Bahia) dans le cadre du programme de logement «Minha Casa Minha Vida» ; 2) le centre de la communauté CEACA-Vila, dans la favela pacifiée, Morro dos Macacos, dans l'État de Rio de Janeiro. En comparant ces deux projets, je soulève un certain nombre de questions, comme «*ownership*» e entretien à long terme, qu'en influencer leur succès. Des lignes directrices pour une stratégie des politiques de production décentralisée sont présentées dans le cadre de la gestion des transitions et la perspective de l'incitant à faible carbone et transition vers la durabilité socialement inclusive du secteur de l'électricité brésilienne.

Mots-clés: production décentralisée, énergie renouvelable, politiques publiques, transition vers la durabilité, système sociotechnique

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LISTA DE ABREVIATURAS/SIGLAS

I. Siglas de língua portuguesa:
ABINEE, Associação Brasileira da Indústria Elétrica e Eletrônica
ACR, Ambiente de Contratação Regulado
ACL, Ambiente de Contratação Livre
ANEEL, Agência Nacional de Energia Elétrica
ANEEL P&D, Fundo de Pesquisa e Desenvolvimento da ANEEL
BIG, Banco de Informação de Geração da ANEEL
BOPE, Batalhão de Operações Especiais
BNDES, Banco Nacional de Desenvolvimento Econômico e Social
BNB, Banco do Nordeste
CAPES, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior
CAR, Companhia de Desenvolvimento e Ação Regional, Estado da Bahia
CECIP, Centro de Criação de Imagem Popular
CEACA-Vila, Centro Educacional da Criança e do Adolescente Lídia dos Santos – Vila Isabel
CEF, Caixa Econômica Federal
CCEE, Câmara de Comercialização de Energia Elétrica
CGEE, Centro de Gestão e Estudos Estratégicos
CONFAZ, Conselho Nacional de Política Fazendária
COFINS, Contribuição para o Financiamento da Seguridade Social
CPF, Cadastro de pessoa física
CNPJ, Cadastro nacional de pessoa jurídica
EPE, Empresa de Pesquisa Energética
FSA/Caixa, Fundação Socioambiental da Caixa Econômica Federal
GEE, gases de efeito estufa
GDE, geração distribuída de eletricidade
GT-GDSF, Grupo de Trabalho de Geração Distribuída com sistemas fotovoltaicos
IBGE, Instituto Brasileiro de Geografia e Estatística
ICMS, Imposto sobre Circulação de Mercadorias e Serviços
IPI, Imposto sobre Produtos Industrializados
MCMV, Minha Casa Minha Vida
MCT, Ministério de Ciência e Tecnologia,
MME, Ministério de Minas e Energia
ONG, Organização não-governamental
ONS, Operador Nacional do Sistema Elétrico
PADIS, Programa de Apoio ao Desenvolvimento Tecnológico da Indústria de Semicondutores
PIS/PASEP Imposto para o Programa de Integração Social e Patrimônio do Servidor Público
PROINFA, Programa de Incentivo às Fontes Alternativas de Energia Elétrica
PDE, Plano Decenal de Energia
PLD, Preço de Liquidações de Diferenças
RSL, Revisão sistemática de literatura
SCEE, Sistema de Compensação de Energia Elétrica
SRD, Superintendente de Regulação dos Serviços de Distribuição
SEDUH, Secretaria Municipal de Juazeiro Desenvolvimento Urbano e Habitações
SEDIS, Secretaria Municipal de Juazeiro de Desenvolvimento e Igualdade Social
TUST (Tarifa de Uso dos Sistemas de Transmissão)
TUSD (Tarifa de Uso dos Sistemas de Distribuição)
UPP (Unidade de Polícia Pacificadora)

II. Siglas de língua inglesa:
BCUC, British Columbia Utilities Commission
CHP, Combined Heat and Power

DG, Distributed or decentralized generation
DOE/US, U.S. Department of Energy
DSM, Demand side management
EC&E, Electricity Conservation and Efficiency Advisory Committee of British Columbia
EDA, Exploratory data analysis
EDA, Economic Development Adder
EPA, Electricity Purchase Agreement
FIT, Feed-in-tariffs
GEA, Green Energy and Green Economy Act of Ontario
GHG, greenhouse gases
GNP, Gross National Product
HDI, Human Development Index
IADF, Institutional Analysis and Development Framework
IESO, Independent Electricity Sector Operator
IRP, Integrated Resource Plan
LDC, local distribution companies
LTEP, Long Term Energy Plan
LRP, Large Renewables Procurement
MLP, Multi-level and multi-actor perspective
NM, Net metering
NGO, Non-governmental organizations
NREL, National Renewable Energy Laboratory
OEB, Ontario Energy Board
OLS, ordinary least-square
OPA, Ontario Power Authority
OPG, Ontario Power Generation
RPS, Renewable Portfolio Standards
SOP, Standing Offer Program
Solar PV or PV, Solar photovoltaics
SLR, Systematic literature review
TAT, Transmission Availability Test
TN, Technical Note
UNDP, United Nations Development Programme
WTO, World Trade Organization

III. Siglas de outras línguas:

EEG, *Erneuerbare-Energien-Geset.* Legislação Alemã de Energia Renovável (German Renewable Energy Sources Act)

TERMOS, *Trajectoires Énergétiques dans les Régions Métropolitaines des Suds.* Trajetórios energéticos em regiões metropolitanas do Sul (Energy Trajectories in Metropolitan Regions in the Global South)

UNIDADES

- kWh, quilo watt-hora (unidade de produção ou consume de energia elétrica)
- MWh, mega watt-hora (unidade de produção ou consume de energia elétrica)
- GWh, giga watt-hora (unidade de produção ou consume de energia elétrica)
- kW, quilowatt (unidade de capacidade instalada ou potencial de produção de energia elétrica)
- MW, megawatt (unidade de capacidade instalada ou potencial de produção de energia elétrica)
- MtCO2eq, mega toneladas equivalência em dióxido de carbono
- (kWh/m^2)/dia, quilowatt-hora por metro quadrado por dia (unidade de recurso solar; radiação solar)
- m/s, metros por segundo, (unidade de velocidade de vento)

SUMÁRIO

Introdução

Como se faz uma política de energia elétrica? É apenas um ensaio de planejamento técnico? Qual é o papel do Estado nesse processo e nesse sistema complexo de linhas de transmissão que atravessam quilômetros e quilômetros, desde a geração até o consumo; de tensão alta até baixa; distribuída para cada casa em cada cidade (com a exceção de alguns casos isolados)? Para que serve essa energia? Quem consome? Quem paga e quem ganha?

Desde a última metade do século XIX, quando a eletricidade se consolidou como um setor de forma paralela na Inglaterra e nos Estados Unidos (GRANOVETTER; MCGUIRE, 1998), essa lista de questionamentos não cessa de crescer e forma um espelho da complexidade que o próprio setor vem ganhando desde então. Hoje em dia a eletricidade ocupa uma centralidade nas nossas sociedades, nas nossas vidas, nas nossas indústrias. O seu suprimento confiável, econômico e universalizado é entendido como necessário; sua "interrupção", mesmo temporária, causa desconforto ou até caos nos sistemas de computação e bancários, e também para a infraestrutura de que nossas economias e nossas sociedades dependem.

Os desafios atuais enfrentados pelo setor elétrico, tanto em países desenvolvidos, quanto nos países em desenvolvimento, são inúmeros: aumento da demanda e do consumo, mudanças climáticas, infraestrutura insuficiente ou envelhecida, universalização de acesso, novas tecnologias, dentre outros. A estrutura do setor elétrico, tanto em países desenvolvidos, quanto em países em desenvolvimento, foi baseada em modelos de economia clássica de ganhos de escala: grandes projetos de geração de energia levados aos consumidores por meio de linhas de transmissão, muitas vezes implicando perdas de energia consideráveis. No entanto, esse modelo está sendo questionado, junto com um aumento na conscientização ambiental e social que põe em xeque, de forma generalizada, os atuais padrões de produção e consumo da sociedade. Em resposta a essa onda global, alguns países veem em políticas de geração distribuída de eletricidade (PGDE) uma das maneiras de suprir os seus setores elétricos de forma que contemplem a inclusão social por meio de geração de renda e emprego, bem como a diminuição de emissões de gases de efeito estufa (GEE) e a preservação de ecossistemas (por evitar grandes empreendimentos elétricos).

A geração distribuída (ou descentralizada) de eletricidade é entendida neste estudo como eletricidade gerada em menor escala (minigeração ou microgeração), perto do (ou no próprio) lugar do seu consumo. A fonte de geração é conectada ao sistema de distribuição (e não às linhas de transmissão), permitindo que um excedente (a quantidade de energia gerada e não consumida no local) possa ser vendido para o sistema. O sistema elétrico pode ser comparado com o sistema de ruas e estradas; linhas de transmissão são como grandes rodovias de velocidade altíssima, que levam grandes quantidades de energia elétrica de alta tensão e atravessam distâncias longas. Linhas de distribuição são como ruas urbanas de baixa velocidade, que, por sua vez, levam energia elétrica de média ou baixa tensão por distâncias menores. Por sua natureza, a geração distribuída de eletricidade (GDE), conectada ao sistema de distribuição, favorece a geração de energia por fontes renováveis, como: fotovoltaica (solar ou PV), eólica em pequena escala, pequenas ou minicentrais hidroelétricas, ou biomassa. Segundo o relatório da REN2[1], a descentralização de eletricidade é uma tendência mundial que tende a crescer, mas em ritmos diferenciados, dependendo de cada país e das suas políticas (REN21; ISEP, 2013, p. 63). Trata-se de algo diferente de eletrificação rural ou de eletrificação de comunidades isoladas, em que a rede de distribuição ou transmissão não chega. Tal desafio de eletrificação rural é o objeto de análise de inúmeras outras pesquisas e artigos (VAN ELS; DE SOUZA VIANNA; BRASIL, 2012); (VAN ELS, 2008); (ROSA, 2007).

Geração distribuída em escala pequena é algo apontado em inúmeras obras como a direção do futuro dos setores elétricos. É um modelo que é vislumbrado para trazer benefícios ambientais e sociais, por ser baseado em pequenos projetos de geração de energia, que podem ser sincronizados com outras tecnologias de informação (*smart meters*, estocagem de energia etc.) e que por sua vez podem induzir padrões de consumo mais sustentáveis (LOVINS, 2011).

Lovins considera que a geração distribuída seria a base de uma transformação no setor elétrico. Além do mais, pode trazer implicações importantes não apenas para o setor, mas para a sociedade e a economia como um todo. No entanto, o autor ressalta que o ponto-chave é escolher *como* o sistema vai evoluir e, com isso, entramos na esfera de políticas, de escolhas de prioridades do aparato dos governos e do Estado (LOVINS, 2011).

Um modelo de soluções pequenas, de tamanho apropriado, é algo que o economista Schumacher popularizou no seu livro *Small is beautiful* (1973), quando postulou que, “Para cada atividade há uma escala adequada...”[2] (SCHUMACHER, 1999, p. 48). O autor aborda a questão da energia especificamente no seu livro para tratar de energia nuclear, que, segundo ele, é o exemplo emblemático da falta de questionamento sobre o paradigma de progresso econômico vigente.

O meu tema de tese abrange políticas públicas de GD. A literatura citada destaca que esse novo modelo do setor elétrico traria benefícios para o meio ambiente e para a sociedade. Um setor de eletricidade baseado em pequenas obras de geração pode trazer benefícios, como

[1] REN21: G*lobal Renewable Energy Policy Multi-stakeholder Network* é sediado em Paris, no PNUD.
[2] Traduzido do original em inglês: “*For every activity there is a certain appropriate scale”.*

a geração de renda, por meio de mão de obra qualificada (IISD; WICHMANN; GHAZAL-ASWAD, 2011), o que é apontado por Sachs (2004a) como uma forma de desenvolvimento includente. A questão é: por que estudar as políticas para esse tipo de energia (modelo de energia)? Por que essas tecnologias não conseguem ocupar um espaço nas matrizes energéticas no Brasil e no Canadá sem políticas ou regulamentações? Segundo Mallon (2002), a resposta envolve dois aspectos: i. porque o mercado tem falhas e são necessárias políticas para fomentar estas tecnologias; ii. energia renovável e geração distribuída estão entrando num mercado já suprido por energia baseada em tecnologias consolidadas, baratas, sujas ou degradadoras, e que os custos dessas externalidades não estão incorporados no seu preço. Com a falta de um acordo internacional efetivo para regulamentar as emissões de carbono, a energia renovável está numa situação desfavorável no livre mercado. Além do mais, “em geral, o mercado não conduz à sustentabilidade. É necessária intervenção reguladora do Estado” (BURSZTYN, 2001, p. 74).

Algumas perguntas ainda precisam ser feitas: como se faz uma política de geração distribuída de eletricidade? Como definir o tipo e o tamanho ideais de geração em relação ao consumo? Quais fontes de geração devem ser favorecidas e como? Essas perguntas possuem respostas apenas técnicas? Como que as políticas energéticas tratam tais questões? Quais *stakeholders* (atores) se envolvem no processo de tomada de decisão? Quais são a favor, quais contra? Quais regulamentações são mais efetivas para criar um ambiente em que GDE seja implementada de forma sustentável? Quais benefícios ambientais e sociais podem ser vislumbrados?

O objetivo geral da tese de doutorado é analisar como a política (regulamentações e incentivos associados à promoção de geração distribuída de eletricidade – GDE) no Brasil, dentro do seu contexto mais amplo e no movimento internacional, busca complementaridades ambientais (uma matriz de baixo carbono) e sociais (inclusão social). A pergunta norteadora da tese é: de que maneira uma política de geração distribuída de energia elétrica contempla sinergias positivas com políticas de inclusão social ao mesmo tempo em que contribui também para minimizar impactos ambientais?

Para a estrutura da tese, optei por escrever quatro artigos, e não o formato tradicional. Isso apresentou alguns desafios que não tinha calculado previamente, como, por exemplo, tentar evitar a repetição de alguns pontos, uma vez que as introduções e contextos dos artigos estão ligados à temática de energia renovável de pequena escala. Porém, algum nível de repetição foi necessário porque cada artigo foi escrito também para ser *stand alone*. Outro desafio foi escrever dentro do tamanho de 6.000 a 8.000 (10.000 in alguns casos) palavras, que é o padrão de vários periódicos científicos. O segundo e o quarto artigos superaram esse limite e será necessária uma revisão para formatá-los dentro dos padrões da cada revista quando forem submetidos. Para cada artigo, indico uma revista para qual pretendo mandar para o processo de *peer-review*. Além de formatação, será necessário excluir alguns elementos, como fotos e algumas citações longas, pois queria deixar registrados alguns desses detalhes na tese, mas que não necessariamente estão em conformidade com os padrões de uma revista científica internacional.

Os quatro artigos seguem uma lógica comparável ao uso de um microscópio. Com cada um, o grau de resolução aumenta, começando no nível internacional para chegar ao nível local. No primeiro artigo, começo a tese com um olhar sobre a temática de políticas de geração distribuída no nível internacional (focado no continente americano); no segundo artigo faço uma comparação entre dois países das Américas: Canadá e Brasil. No terceiro artigo, o foco está sobre a política pública brasileira de geração distribuída. Por último, eu olho para o nível local, especificamente para dois projetos pilotos em áreas urbanas, para verificar como podem se encaixar ou até propulsionar uma transição sustentável no setor elétrico brasileiro.

O primeiro artigo (*What do we know about the study of distributed generation policies and regulations in the Americas? A systematic review of literature*) aborda a questão: o que sabemos sobre o estudo de políticas de geração distribuída de energia elétrica nas Américas? Foi feita uma revisão de literatura ampla sobre políticas públicas que contemplam a geração distribuída no continente americano usando a técnica metodológica de revisão sistemática de literatura. Uma revisão sistemática de literatura, RSL é um método de localização, avaliação e sintetização da informação, utilizando critérios de exclusão/inclusão e categorização abertamente especificados, para evitar viés na pesquisa. O objetivo em geral é conhecer o estado da arte de pesquisas de tipo *peer-review* (publicadas entre 2000-2014) sobre o assunto por meio de uma meta-análise.

A RSL começou com uma busca por palavras-chaves em inglês, espanhol, português e francês em cincos bases de dados. Na segunda etapa, os títulos e resumos foram lidos e artigos que tinham um foco exclusivamente técnico foram retirados, pois o objetivo foi analisar trabalhos que contemplaram aspectos sociopolíticos e regulatórios de geração distribuída. No final, 87 artigos foram incluídos na análise (87% de língua inglesa, 6% espanhola, 5% francesa e 2% em português).

O foco no continente americano foi definido porque o artigo faz parte de um desenho de pesquisa mais ampla, que tem como objetivo a política brasileira de geração distribuída e, de maneira secundária, uma comparação entre Brasil e Canadá. Esse foco também foi justificado porque os arranjos políticos, capacidades técnicas e história dos países europeus e asiáticos em relação à energia renovável são muito distintos da realidade dos países no continente americano e uma RSL no nível global não propiciaria dados tão interessantes para contextualizar o caso brasileiro tanto quanto uma revisão restrita aos seus países vizinhos.

Informação foi extraída dos artigos e apresentado em formato quantitativo para entender as forças motrizes identificados nas publicações para a geração distribuída. O artigo também aborda como as questões sociais e urbanas de geração distribuída estão tradados pelos artigos incluídos da revisão sistemática.

O segundo artigo (*Electricity policy in Brazil and Canada: a historical and institutional perspective on the emergence of distributed generation*) busca entender a trajetória história e institucional dos setores elétricos no Brasil e no Canadá para identificar quando, como e por que a geração distribuída surge como um assunto no âmbito de planejamento e político-energético. A escolha dos estudos de casos de políticas de geração distribuída (Brasil e Canadá, com ênfase na política de GDE das províncias de Ontário e Colúmbia Britânica) é justificada dentro da perspectiva de entender o fenômeno contemporâneo dentro do seu contexto real (YIN, 1994). A escolha de mais de um estudo de caso não pode ser considerada dentro da lógica de estatística, como “amostras”, mas sim dentro do objetivo de querer explicar e testar uma hipótese mais de uma vez ou de tentar inferir uma teoria (JOHNSON; REYNOLDS, 2005, p. 87)**.**

Uma técnica metodológica de pesquisa não experimental nas ciências políticas é estudar e examinar alguns estudos de casos em detalhes, com vários métodos de coleta de dados, como entrevistas e análise de documentos. A técnica de estudo de caso é reconhecida como uma “‘forma distinta de investigação empírica’ e um instrumento importante a ser utilizada para o desenvolvimento e avaliação de políticas públicas e também para desenvolver explicações para e testar teorias de fenômenos políticas”[3] (JOHNSON; REYNOLDS, 2005, p. 84).

Os dois países foram escolhidos por ter características geográficas similares: grandes expansões de terra, o que dentro do modelo de geração centralizada obriga a instalação de linhas de transmissão através de distancias consideráveis; comunidades isoladas; desigualdades econômicas e sociais entre as suas regiões; economias altamente baseadas na exploração das suas riquezas naturais, como a mineração, dentre outros. Contudo, as estruturas governamentais e administrativas dos setores elétricos nos dois sistemas federalistas são distintas. A política de energia elétrica é uma responsabilidade exclusiva das províncias

[3] Traduzido pela autora do original em inglês: “(...)‘distinctive form of empirical inquiry’ and an important design to use for the development and evaluation of public policies as well as for developing explanations for and testing theories of political phenomena”.

canadenses, enquanto no Brasil esse domínio político é centralizado no governo federal e em suas agências. Historicamente, os setores elétricos dos casos incluídos foram baseados no aproveitamento de recursos hídricos. Atualmente, tentativas de diversificar as matrizes surgirem em todos casos, incluindo políticas de geração distribuída. Dentro desta perspectiva, a comparação serve para entender como e porque a geração distribuída surge no contexto dessa tendência recente.

Uma variável importante na análise é o atual cenário político-institucional dos setores elétricos nos dois casos, mas também a sua história ou trajetória contemporânea (que foi mudada radicalmente em alguns casos). Nos casos do Brasil e de Ontário, uma reestruturação do setor elétrico na década de 1990 fez com que os setores que anteriormente seguiam um modelo de monopólio estatal (TOLMASQUIM, 2011) tivessem uma maior participação da iniciativa privada, sob controle de regulações por agências, um fenômeno que se repetiu em muitos outros países (CHRISTENSEN, 2006).

Outra variável que foi levada em consideração consiste nos recursos disponíveis para geração de energia elétrica e sua distância dos locais de consumo. Essa variável permitiria um entendimento sobre como os aspectos técnicos atuais dos setores elétricos também influenciaram as escolhas feitas na formação da política atual de GDE.

O terceiro artigo, sob o título *Distributed electricity generation in Brazil: an analysis of policy context, design and impact*, tem como objetivo analisar o panorama político da nova modalidade de geração, que foi criada em 2012 no Brasil pela regulação normativa da ANEEL (Agência Nacional de Energia Elétrica) no. 482-2012.

O arcabouço analítico considera três aspectos distintos na análise: contexto da política, o desenho de instrumentos políticos e, por último, uma análise dos seus impactos. Ao analisar as políticas de GDE, foi necessário identificar os principais atores envolvidos e os interesses em jogo que levaram a escolha de regulamentações.

No quarto e último artigo preparado na tese, intitulado *Distributed electricity generation as a strategic niche within a sustainable and socially inclusive transition in Brazil*, eu abordo a questão de geração distribuída como um nicho estratégico, baseado no arcabouço teórico referido como “*transitions literature*”. Um corpo de literatura referida como “estudos sobre transições sustentáveis” surgiu principalmente na Holanda e na Inglaterra a partir do final dos anos 1990 e tem como objeto principal estudar o processo de mudança de sistemas sociotécnicos no ramo a sustentabilidade. Uma transição é definida como um processo de longo prazo, multidimensional e complexo, que abarca elementos sociais e técnicos da configuração de um sistema e envolve, segundo Meadowcroft, "a substituição ou modificação das estruturas tecnológicas e sociais dominantes de uma sistema"[4] (MEADOWCROFT, 2014, p. 2).

O setor elétrico é um caso interessante de um sistema sociotécnico e sua transição mostra diferenças importantes entre uma transição puramente técnica porque é necessário mudar os hábitos de consumidores e institucionais (aspectos regulatórios e culturais), além de aspectos técnicos no caminho para sustentabilidade (MARKARD; RAVEN; TRUFFER, 2012, p. 955). Dentro desse corpo de literatura existem vários autores que abordam um arcabouço chamado *multi-level and multi-actor perspective,* MLP (perspectiva de múltiplos níveis e múltiplos atores). A MLP é usada para visualizar e categorizar as interações entre três dimensões da transição: o nível do regime (as tecnologias e práticas estabelecidas e tradicionais); o nível do nicho (tecnologias emergentes) e o nível do paisagem, que são considerados as influências externas ao sistema sob análise (MEADOWCROFT, 2014, p. 1).

No meu artigo, abordo a questão de geração distribuída como o nicho estratégico no Brasil dentro dessa perspectiva MLP. Um nicho é entendido como um "espaço protegido" em que inovações possam ser desenvolvidas, independentes da pressão de seleção do regime dominante e a sua meta é provocar experiências de aprendizagem a partir de várias experimentos (MARKARD; RAVEN; TRUFFER, 2012). A gestão estratégica de um nicho é definida por Kemp et al. (1998, p. 186) "como a criação, desenvolvimento e revogação controlada de espaços de proteção para as tecnologias promissórias via experimentos. Os objetivos são i) aprender sobre os benefícios das mesmas e ii) melhorar o desenvolvimento e adoção das mesmas[5]".

Estudos sobre transições sustentáveis reconhecem que as consequências de tais mudanças muitas vezes ocorrem em resultados distributivos. A inclusão social como parte fundamental de uma transição não é abordada por esses autores de maneira explícita; por isso, escolhi analisar não um projeto qualquer, mas projetos instalados em comunidades de baixa renda e em áreas urbanas para analisar como a geração distribuída pode ser um nicho de sustentabilidade ambiental e social numa transição no Brasil. O primeiro estudo de caso que exploro é um projeto de geração de energia solar e eólica em duas comunidades vizinhas

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[4] Traduzida do original em inglês "the displacement or modification of the dominant technological and social structures surrounding a given system".

[5] Traduzida do original em inglês "the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation, with the aim of (1) learning about the desirability of the new technology and (2) enhancing the further development and the rate of application of the new technology".

(Morada do Salitre e Praia do Rodeadouro), construídas no município de Juazeiro, Bahia, dentro do programa habitacional Minha Casa Minha Vida, MCMV. O outro projeto que incluí na análise é uma instalação de energia solar feita pela organização não-governamental, ONG Greenpeace no centro da comunidade CEACA-Vila (Centro Educacional da Criança e do Adolescente Lídia dos Santos – Vila Isabel) no Morro dos Macacos, Rio de Janeiro, uma favela pacificada em outubro de 2010.

Em suma, os quatro artigos oferecem uma análise em escalas distintas sobre o tema de geração distribuída no Brasil e reflexões sobre a sua contribuição para a transição rumo à sustentabilidade de um setor altamente complexo e multidimensional. A geração distribuída, por ser baseada em escalas menores e partir de fontes renováveis oferece uma alternativa ao sistema elétrica vigente com benefícios ambientas e sociais. No entanto, a analise apresentado ao longo dos quatro artigos mostra que no Brasil a GD não faz parte de uma política energética estratégica, sendo tratado apenas como assunto regulatório. A possibilidade da GD oferecer benefícios ambientais de escala considerável e de contribuir para a inclusão social requer uma coordenação de vários atores do setor, órgãos governamentais e investimentos adequadas e direcionadas.

Artigo 1: What do we know about the study of distributed generation policies and regulations in the Americas? A systematic review of literature[6]

Abstract

Policy-makers are increasingly in search for evidence-based solutions for meeting contemporary challenges of energy services that are both low carbon and sustainable. One of the emerging trends are policies and regulations that incent distributed or decentralized generation. The question that this article addresses is: what is the current state of study on these policies or regulations in the Americas? The focus on the Americas was chosen because the article is part of a larger research project that explores the Brazilian and Canadian regulations for distributed generation. This article uses a non-traditional means for synthesizing academic work, entitled systematic literature review, SLR, which is also understood as a meta-analysis methodology to explore the current state of peer-reviewed publications on the subject. The SLR is a means of transparently locating, evaluating and synthesizing information to avoid bias in data collection. Keyword searches were conducted in English, Spanish, Portuguese and French. In total, 87 articles were included in the analysis and information was extracted regarding a set of defined characteristics and codes. Climate Change is the main driving force for distributed generation, as identified in the articles. However, when the papers were sub-divided into South versus North America, some interesting differences were noted. Job creation or the green economy was cited as a motivating factor more strongly in North America. While in the southern countries, the issue of diversifying the energy mix and avoiding infrastructure costs was more pronounced. Many articles dealt with the issue of mechanisms for incenting distributed generation (27%), and over half of these focused on aspects of Feed-in-tariffs, FITs. The findings show that there is little emphasis given in previously published works to understand social impacts and benefits of distributed technologies, an issue that policy makers will have to address if policy interventions to mitigate climate change can be fully realized. Additionally, specific urban challenges and governance at the local scale for distributed generation is not widely investigated, pointing to a need for future study that considers such institutional considerations.

[6] Proposed publication for journal submission: Renewable & Sustainable Energy Reviews (A1 Qualis ranking for *Ciências Ambientais)*

Keywords: Systematic Literature Review Methodology; Distributed Electricity Generation; Energy Policy; Electricity Regulations; North and South America

1. Introduction

> If the emergence of the mass politics of the early twentieth century, out of which certain sites and episodes of welfare democracy were achieved, should be understood in relation to coal, the limits of contemporary democratic politics can be traced in relation to oil. The possibility of more democratic futures, in turn, depends on the political tools with which we address the passing of the era of fossil fuel. (MITCHELL, 2010, p. 138 *apud* RUMPALA, 2013).

A transition to a low-carbon energy system and therefore, the 'passing of the era of fossil fuel' has received much attention by academics in the last decades; not just because the technical challenges are considerable, but also because a new energy system configuration will affect the way our societies function as a whole. If coal and the steam engine can be considered as fundamental attributes of the First Industrial Revolution (beginning in 18^{th} century Britain, later expanding to western Europe and the USA in the 19^{th} century); then the Second Industrial Revolution of the 20^{th} was made possible by petroleum, the internal combustion engine and mass electrification (RIFKIN, 2011). Rifkin, as the title of his book denotes, is concerned with what is to come afterwards, *The Third Industrial Revolution.* He asserts that it will be supported by five pillars; renewable energy; distributed generation electricity via micro-scale power plants; electricity storage technologies; integration of information technology and electricity i.e. smart grids; electrification of transportation (RIFKIN, 2011, p. 37).

The dominant configuration of the current electricity sector was consolidated in the 21st century and is based on the notion of a natural monopoly (LOVINS; ROCKY MOUNTAIN INSTITUTE, 2011, p. 173). This means that centralized generating stations (nuclear, hydroelectric or thermoelectric) produce electricity in large-scales, which are then transported over long distances via high-voltage transmission lines to industrial consumers and to urban centers, where distribution companies then deliver the electricity to various commercial and residential consumers via medium or low-voltage distribution lines. Rumpala (2013) affirms that electricity generation and distribution are centralized not only in scale, but also in terms of power and decision-making capacity, and are therefore oligopolistic configurations.

The technical, economic and social challenges associated with integrating distributed or decentralized generation, DG into our electricity sector are equally numerous and complex. Policy-makers and electricity regulators have a plethora of issues to deal with, which will require adapting or bridging existing tools as well as thinking of new ones to ensure that electricity is generated in a sustainable and reliable manner (GRAFFY; KIHM, 2014).

What is the current state of academic work regarding policies and regulations for DG in the Americas? What are the analyses focused on? How do they frame the issues at hand? What motivating factors are identified for DG? Is there consistency between studies concentrating on developed or developing countries? What issues need further academic attention? This article will explore the abovementioned questions through a systematic review of peer-reviewed academic literature published from 2000 to 2014. This study only considered peer-reviewed publications, in keeping with the intent to reduce bias in data collection. However, the study could expand to include grey literature, which is considered in section 4 would require the modification of the inclusion/exclusion criteria adopted in this case.

The geographical focus of this article is the Americas, specifically looking for works that consider the socio-political and regulatory aspects of DG as a new configuration for the electricity sector. Studies focused on European policies and regulations are purposely not included, nor are those looking at Asian countries, such as China and Japan, nor the application of distributed generation in Africa (mainly associated with energy access issues). The rationale is that the present investigation is part of a larger research design, which will focus on DG in Brazil and Canada, two large countries in the Americas that have very different geography, resource base, political arrangements, technical capacities and historical trajectories with renewable energy when compared to the European, Asian and African contexts. In addition to these factors, countries of the Americas, by-in-large, do not suffer from the same spatial constrictions or resource scarcities for electricity generation as in the European or even in some Asian contexts, which can be considered drivers at the fore of their distributed electricity policy.

2. Methodology: Systematic Review Design

A systematic review is a methodological tool that employs clearly formulated questions and explicit methods of locating and analyzing literature, which are usually summarized quantitatively. It can be understood as a meta-analysis (PETTICREW, 2001) and is a way of tracking the evolution of contemporary social phenomena and understanding variables leading to policy deployment (AULD et al., 2014); (BERRANG-FORD; FORD; PATERSON, 2011); (PETTICREW; MCCARTNEY, 2011). Furthermore, SLR is not merely an expanded form of ordinary literature review; “systematic reviews are not just big literature reviews, and their main aim is not simply to be ‘comprehensive’… but to answer a specific question, to reduce bias in the selection and inclusion of studies, to appraise the quality of the included studies, and to summarise them objectively” (PETTICREW, 2001, p. 99).

The work by King et al. *Designing Social Inquiry* (1994) insists that one of the keys of a research plan is the consideration given to data quality, recording and reporting the process of data gathering and data generation, as well as using existing data to generate unbiased inferences (KING et al., 1994, p. 23;27). For this reason, a systematic review avoids bias by explicitly stating and explaining why certain works are included or excluded in the analysis, which is not the case of a traditional literature review. Moreover, the social sciences are increasingly looking to issues of generalizability, consistency, reproducibility, precision and verification in research procedures and affirms that “qualitative methods like their quantitative cousins, can be systematically evaluated only if there canons and procedures are made explicit” (CORBIN; STRAUSS, 1990, p. 4).

Systematic reviews have a been employed more prominently in health sciences or medical sciences for their ability to support evidence based approaches to decision making (PETTICREW, 2001). However, Pettigrew states the tool has been gaining legitimacy in the social sciences since the 1960’s. In the context of climate change and environmental issues in particular, systematic reviews are increasingly viewed as a means of synthesized and unbiased scientific information to support evidence-based policy interventions (CEE, 2015)

i. Data Collection Procedures

Several keyword searches were performed to locate peer-reviewed journals in the following search engines; Web of Science, ProQuest; Scielo; CAPES Foundation journals portal; and Cairn.info (see summary in Table 1). Web of Science was selected because it is recognized as one of the “most powerful, current, comprehensive, and widely used search engines available for analysis of interdisciplinary, peer-reviewed literature” (BERRANG-FORD; FORD; PATERSON, 2011). The main weakness is that searches are limited to English-language terms, which, if used as the sole document source may result in an Anglophone bias.

In order to expand the data collection to include works published in Portuguese, Spanish and French, keyword searches were also conducted in the following databases: Scielo and the CAPES Foundation journals portal. In addition, the Cairn.info site was searched as offers a very comprehensive database of French-language literature in the social sciences and humanities, as shown in Table 1.

The timeframe selected is 2000 – 2014. This range was chosen because the upper limit; 2000 corresponds to the year that Germany introduced its well-known *Erneuerbare-Energien-Geset, EEG* (German Renewable Energy Sources Act), which sparked much interest in sustainable energy transitions and mechanisms to incent decentralized electricity generation.

ii. *Document “Inclusion or Exclusion” Procedure*

The documents located via the keyword searches were then reviewed based on their titles and abstracts. Papers that were written with authors from countries in the Americas, but that had European or Asian policies and regulations as their object of study were excluded, as well as book reviews, book chapters, and theses (even though peer-reviewed material was stipulated in the keyword search some of these documents appeared in the initial results).

Finally, papers were read in their entirety. Works that were exclusively concerned with technical aspects of DG, such as grid-interconnection issues, sizing, technological innovation, etc. were excluded since the objective of this paper is to decipher the state of research into policy and regulation considerations for DG. Papers that focused on rural electrification were also excluded since there already exist systematic reviews and analysis of these types of isolated energy access projects (BRASS et al., 2012); (SOVACOOL, 2012); (VAN ELS; DE SOUZA VIANNA; BRASIL, 2012). Distributed generation, for the purposes of this study are intended to understand how policy and regulations deal with these types of projects in places where a distribution system and infrastructure is in place rather than the apparent challenge associated with rural electrification and expanding access to areas that lack such infrastructure.

The three phases of data collection are represented in Figure 1. The remaining pool of 87 articles (listed in Appendix 1) were analyzed to identify the focuses of the articles and assign characteristics, as shown in Table 1. The articles were coded, tabulated and analyzed using Microsoft Excel.

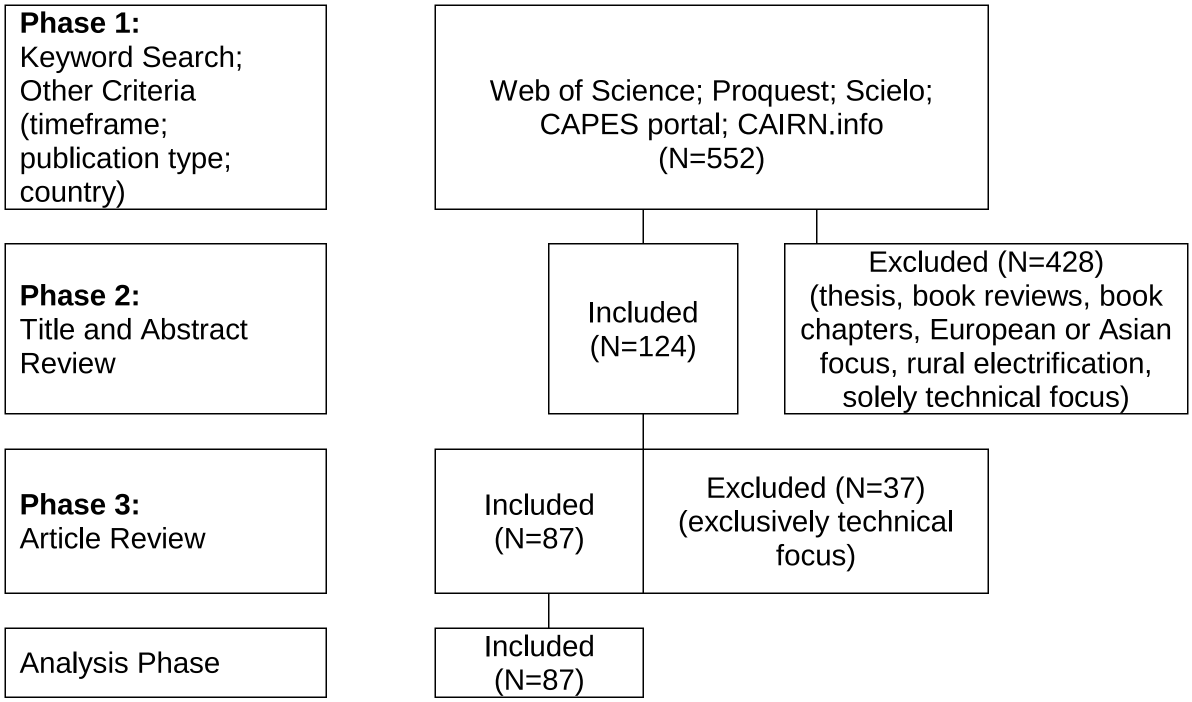

Figure 1. Flowchart of document selection (modified schematic from BERRANG-FORD; FORD; PATERSON, 2011)

Table 1. Keyword searches and results, per academic database

		Number of Results per phase		
Database	**Keyword and other search criteria**	**1**	**2**	**3**
Web of Science (English)	TOPIC: ("distributed electricity generation" OR "distributed generation") *OR* TOPIC:("decentrali* electricity generation" OR "decentrali* generation") *OR* TOPIC:("net meter*") *OR* TOPIC: ("feed in tariff" OR "feed-in tariff")[7] . Results then refined by country and research areas[8]	375	107	75
Proquest (English)	All (distributed generation) AND all ((electricity OR electrical energy)) Additional limits Date: From 2000 to 2014; Source type: Scholarly Journals, Working Papers; Language: English, French, Portuguese, Spanish	12	2	2
CAPES portal (Portuguese)	(“geração distribuída” OR “geração descentralizada”) AND (“energia elétrica” OR eletricidade) AND (regulação OR incentivo OR regulamentação OR política)	13	0	0
Scielo (Portuguese)	1.“geração distribuída”; 2. “geração descentralizada”; 3. microgeração OR micro-geração; 4. minigeração OR mini-geração	44	4	3
CAPES portal (Spanish)	1. (“generación distribuída” OR “generación descentralizada” OR “generación energética distribuída” OR , generación energética descentralizada”) AND energia electrica AND (regulacion OR incentivo OR reglamentación OR política) 2. (“produccion distribuída” OR “produccion descentralizada” OR “produccion energética distribuída” OR “produccion energética descentralizada”) AND energia electrica AND (regulacion OR incentivo OR reglamentación OR política)	31	5[9]	3
CAPES portal (French)	"production décentralisée" AND (énergie OR électricité OR politique OR régulation OR réglementation OR incitative)	8	0	0
CAIRN (French)	Votre recherche : "production décentralisée" AND (énergie OR électricité OR politique OR régulation OR réglementation OR incitative) 69 résultats	69	6	4
Total		552	124	87

[7] The “*” was used to avoid discrepancies between American or British spelling

[8] Search refinement specifications; **Document Type**: (Article OR Abstract OR Review) AND **Publication Years**: (2014 OR 2007 OR 2001 OR 2013 OR 2006 OR 2000 OR 2012 OR 2011 OR 2005 OR 2010 OR 2004 OR 2009 OR 2003 OR 2008 OR 2002) AND **Countries/Territories**: (USA OR Uruguay OR Canada OR Argentina OR Chile OR Colombia OR Brazil OR Venezuela OR Mexico OR Trinid Tobago OR Cuba OR Ecuador) AND **Research Areas**: (Science Technology other topics OR Energy Fuels OR Operations Research Management Science OR Sociology OR Environmental Sciences Ecology OR Social Work OR Behavioral Science OR Social Sciences other topics OR Government Law OR Public Administration or Public Environmental Occupational Health)

[9] One duplicate journal from Web of Science search

3. Data Analysis

Data collection and analysis are interrelated processes; open coding was performed and some codes needed to be modified as the analysis proceeded (CORBIN; STRAUSS, 1990). The final set of categories and codes are listed in Table 2. In order to achieve consistent results, a sample of 14 articles was reviewed at the end of the analysis to verify that the interpretations did not change as a sort of quality control mechanism. In other systematic reviews involving more than one researcher there are other techniques to maintain coding consistency.

Table 2. Categorization and Coding of articles

Language of Publication
Country(ies) of Authors` Institution(s)
Country(ies) corresponding to the Object(s) of Study
Definition of DG (attributes). The values of this variable were not pre-determined and open coding was applied. The results were later grouped as per Figure 6.
Type of Technology Considered (Solar PV, Wind, biomass, Hybrid, etc.)
Factors Motivating DG. The values of this variable were not pre-determined and open coding was applied. The results were later grouped as per Figure 8.
Type of Study: 1. Modeling for Policy Considerations; 2. Analysis of Policy Design and Regulations; 3. Analysis Policy Impact or Evaluation; 4. Analytical Framework Formulation
Focus: primary and secondary foci were assigned for each document from the list below: • Comparison for policy/incentives refinement • Economic competitiveness, financing considerations • Environmental Benefits and Impacts • Grid Integration • Incentive Mechanisms (other) • Incentive Mechanisms (capital incentives and FIT) • Incentive Mechanisms (NM and FIT) • Incentive Mechanisms (NM) • Incentive Mechanisms (RPS, FIT) • Incentive Mechanisms (RPS, NM, Tax, Energy Efficiency Standards) • Incentive Mechanisms (Tax rebates) • Incentive Mechanisms (FIT) • Innovation (tech and organizational) • Institutional Analysis • Policy or Regulation Adoption Factors • Proposal of technology/efficiency measures • Social Benefits and Impacts • Technology Adoption/ Penetration Factors
Scale of Focus: International, Regional, State/Provincial, Local/City

i. General attributes of the articles

The timeframe for articles included in the analysis 2000 – 2014. As previously mentioned, this range was chosen because the German Renewable Energy Sources Act was introduced in 2000, an event which sparked much attention in renewable energy incentive mechanisms (such as in Feed-In-tariffs, FIT), even though FITs had been offered in Germany since 1990 (HOPPMANN; HUENTELER; GIROD, 2014). Indeed, in their bibliometric analysis of distributed generation publications, Woon et al. (2011) note that interest in Solar PV, micro-grids/smart-grids all grow rapidly post-2000. Figure 2 shows the number of articles in the present analysis (total population of 87) per publication year. It is evident that there is a growing interest in the theme of DG in the Americas. However, over the entire period, the rate of growth in the number of articles is almost flat, yet if we look at the period post-2008, (i.e. post sub-prime economic crisis) the annual growth rate in the number of publications increases more than two-fold[10].

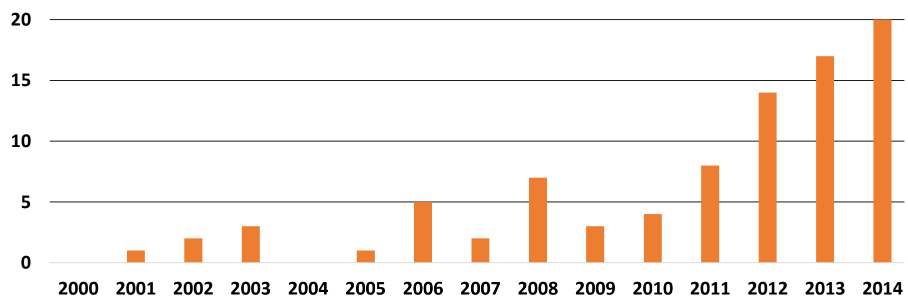

Figure 2. Date of publication of articles
(Elaborated by C.A.G. Garcez)

The vast majority of the documents considered were published in the English-language (87%, as shown in Figure 3). This is not surprising, as the United States dominates the country ranking in scientific publications, both in the general category but also in the category of energy research (SCIMAGO, 2015). Interestingly, while the number of articles included in the final analysis published in Portuguese was low[11], the number of articles published with Brazil as the corresponding author's affiliation is 13 or 15% of total articles (Figure 4), showing that the language of publication is not necessarily representative of the object of study.

[10] Trend line for period 2000-2014; Y=0.003X, R^2=0.003. Trend line for period 2008-2014; Y=2.6X; R^2=0.8073

[11] 57 articles were located in the initial Portuguese-language keyword search, but only 2 were included in the final analysis

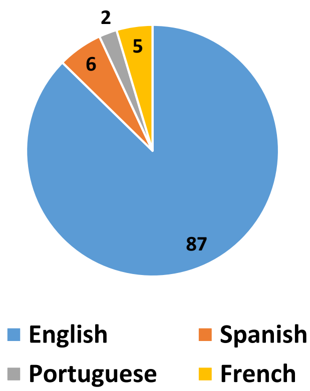

Figure 3. Language of publication (% of total) (Elaborated by C.A.G. Garcez)

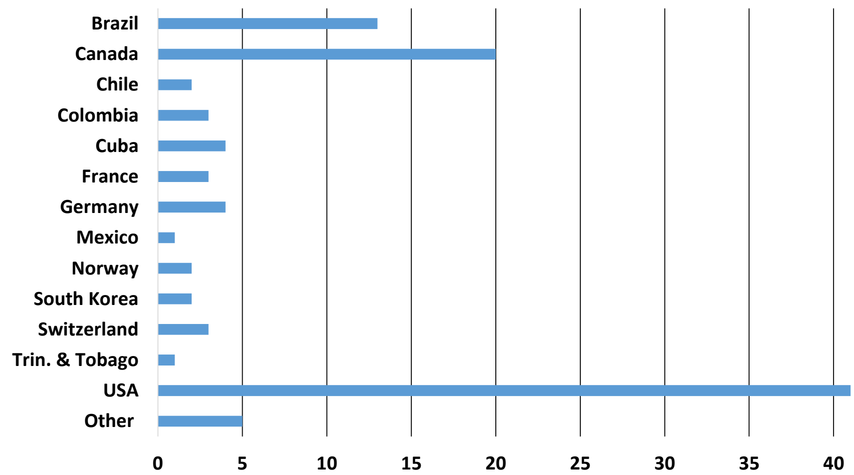

Figure 4. Author affiliation, country (Elaborated by C.A.G. Garcez)

The jurisdiction under analysis is another general characterization of the documents. It is shown graphically in Figure 5. Canada as an object of study on the national level is not present in the analysis. This was to be expected, as electricity policy is an exclusively provincial matter according to the Canadian Constitution. Of the 18 journals that consider this most northern country of the Americas, 14 focus on the province of Ontario (78%), three on Quebec and one on the province of Prince Edward Island.

Mabee et al. (2012) suggested the deficient role occupied by the federal government in promoting renewables negatively affects provinces that are being proactive and innovative, such as in the case of the Province of Ontario. Parker (2008) compares the Japanese and Australian policies and incentives for Solar PV to that of Canada. However, due to an absence of federal-level policies or incentives, the article only considers the province of Ontario. In contrast, the majority of articles that focus on the United States of America, which also has a decentralized electricity policy arrangement, do consider in some form or another the national scenario, either through the comparison of multiple state-led initiatives or federal tax incentives. Carley and Andrews (2012) argue that the challenges facing DG in the US are “not so much technological or even economic as institutional” (CARLEY & ANDREWS, 2012, p.116). This necessarily means that the federal government must play a role in the establishment of standards to minimize leakage of carbon from states with innovative policies to those with high-polluting energy mixes, establishing overarching policies such as a carbon tax, renewable portfolio standards, etc.

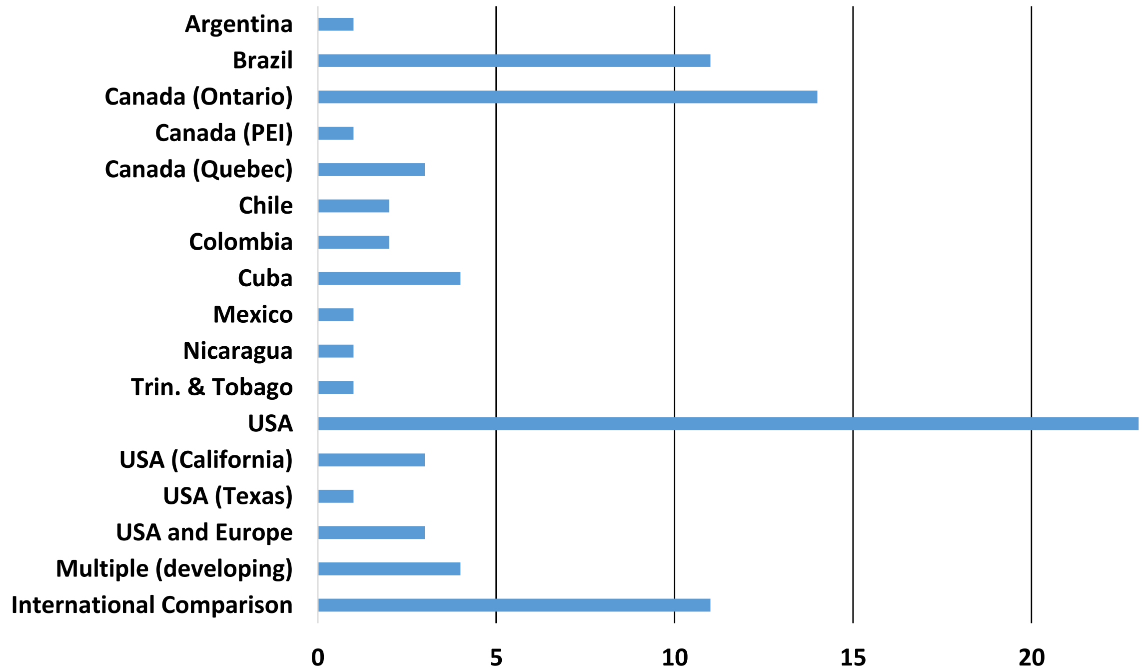

Figure 5. Object of Study, Jurisdiction
(Elaborated by C.A.G. Garcez)

ii. Definition of Distributed Generation

The National Renewable Energy Laboratory, NREL of the U.S. Department of Energy, DOE/US defines DG in general as; “an electric power source that is located at or near the point of consumption” (POWERS; NREL, 2014). Academic literature assigns various attributes to DG, which were captured through open coding. This means pre-determined values were not assigned for this variable. The responses were later grouped the terms into related categories, as can be seen in Figure 6. Many of the articles used the term distributed or decentralized generation without providing any further detail or attributes (34 of the 87 articles or 39%). As previously described in the data collection methodology, rural electrification was omitted from the analysis, so it is expected that related terms such as isolated systems or battery-back-up are not identified. The term that was observed with the largest frequency was “small-scale” generation, followed by “renewable/low-carbon” and “near consumption load”, which attests to the idea that traditional, diesel generators, which use a fossil fuel derivative for back-up power or for isolated communities, does not fit the overall conception of distributed generation.

Furthermore, Figure 7 displays the type of technology that was considered in the documents. The majority of articles (65) specified one or more type of generation technology in their analysis, while the remainder considered DG in general terms. Again, traditional diesel generators were not mentioned, nor was mini-hydro.

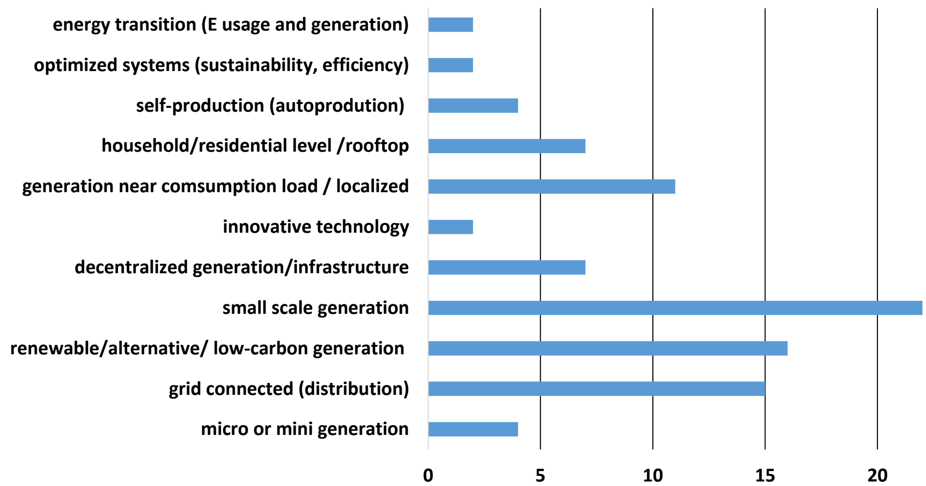

Figure 6. Attributes of distributed generation, frequency of responses
(Elaborated by C.A.G. Garcez)

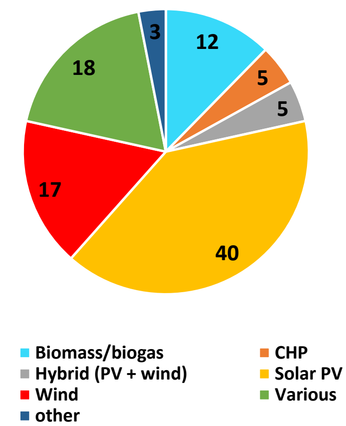

Figure 7. Technology considered, %
(Elaborated by C.A.G. Garcez)

iii. Motivating factors for Distributed Generation

The objective here is to extract the motivating factors for DG that are articulated in the publications, as well as to identify if there are differences between the factors identified in works that analyze countries in South versus North America. It is important to understand the motivating factors that spur the policy-making context for DG policies and regulations as an initial point of departure for policy evaluation (CARLEY; BROWNE, 2013).

Figure 8 is a radial diagram that displays the frequency of factors identified in the documents. The factors were grouped into three main categories; Environmental; Economic and Energy Systems. It is evident that Climate Change (freq=39) and Environmental pollution (freq=27) are the dominant motivating factors. In the economic sub-set of factors, “job creation/green growth” is the most noted (freq=13), “avoided infrastructure investment costs” and “avoided fossil fuel costs” follow (freq=12; 10, respectively). The two most popular responses in the energy systems category were “energy security” (freq=14) and “efficiency”, which includes avoided distribution system losses (freq=12).

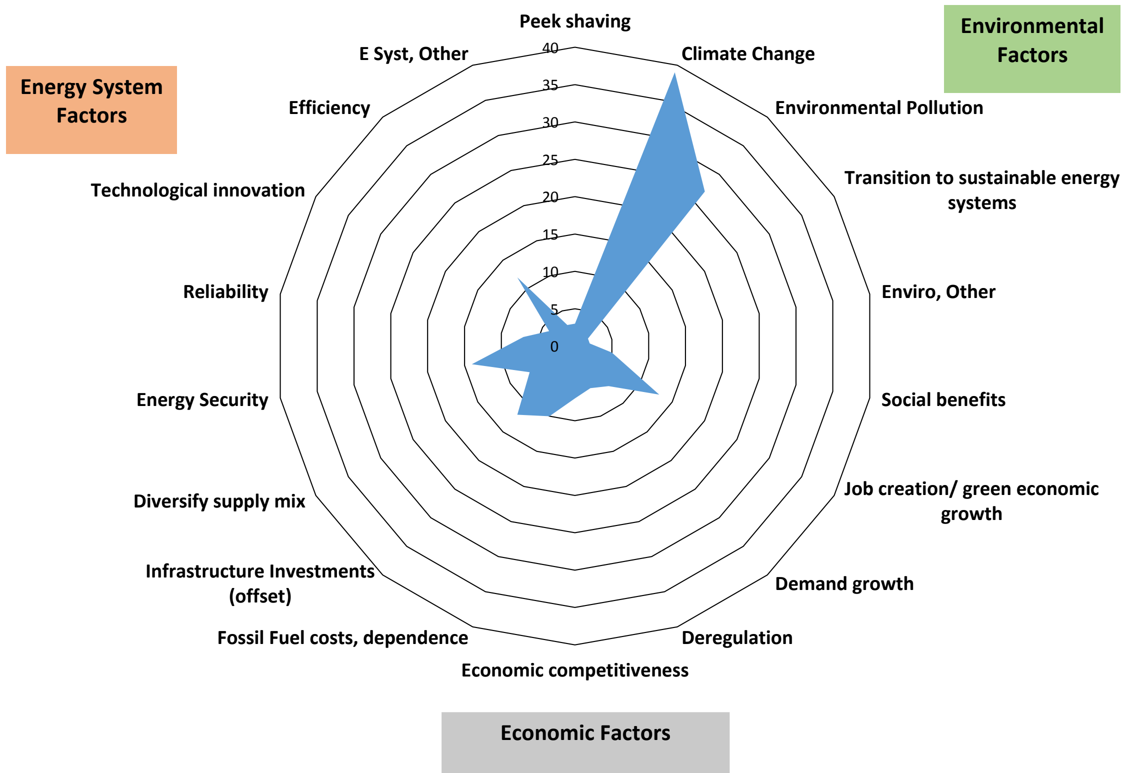

Figure 8. Motivating Factors for distributed generation, frequency of response
(Elaborated by C.A.G.Garcez)

The responses do vary somewhat when analyzed by geographic perspective, i.e. articles that have Canada and/or the USA as their object of study versus Latin American countries. Figure 9 displays the same motivation factors that were plotted in the previous radial figure by their proportional frequency (% of total responses) for each of these two groups. Environmental concerns and Climate Change continue to be the two most cited reasons for the growth of DG. The factor "job creation/green growth" represents a larger priority for journals concerned with Canada and the USA (11%), while journals that focused on countries in South America only identified this motivating factor in 3% of the cases. This is an interesting difference, which shows how energy and economic priorities (i.e. the green economy) have been incorporated into some jurisdictions in North America, most notably California and Ontario, while it seems fewer South American countries have prioritized the link between jobs and the renewable energy sector.

The diversification of the energy supply mix occupies a larger place of importance in South American studies (10%), while in articles from Canada and the USA, this item was mentioned in a small portion (4%) of the cases. A plausible explanation for this difference is that some countries in Latin America (especially those in Central America and the Caribbean) have a more pressing need to diversity their energy mixes and avoid operational costs associated with fossil fuel price volatility as well as offset infrastructure investments.

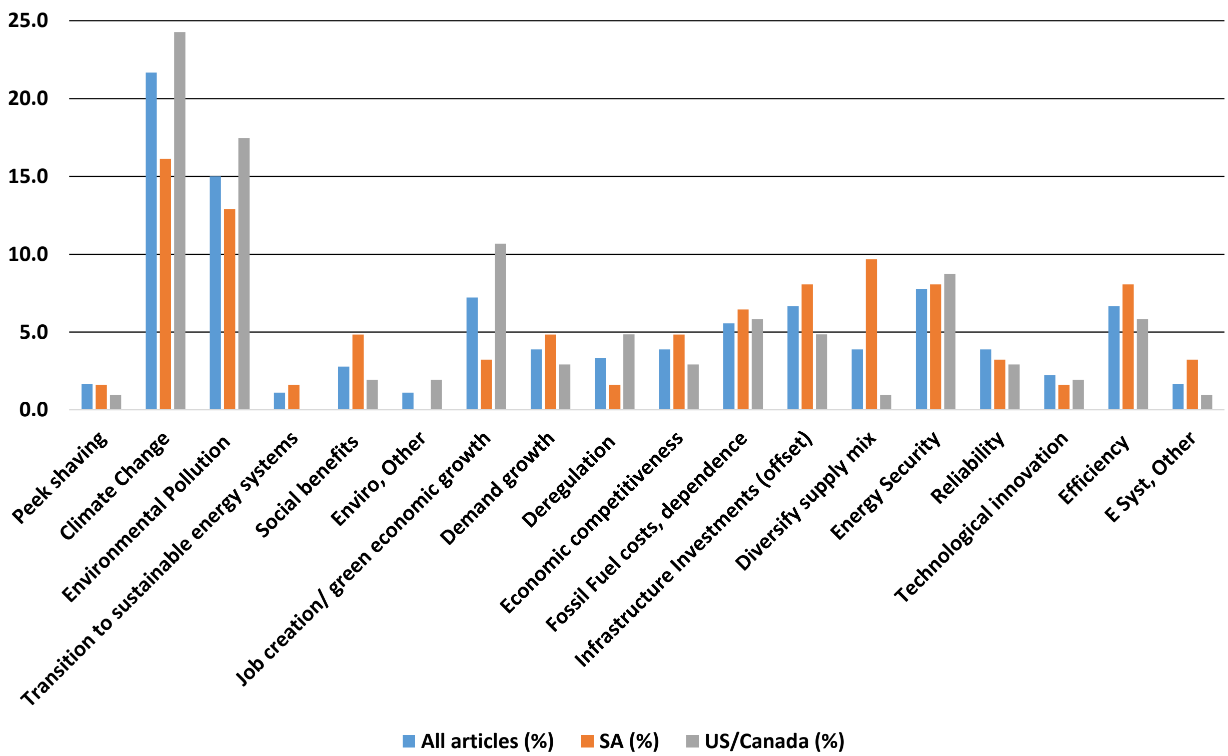

Figure 9. Motivating factors for distributed generation, by region (% of total responses), (Elaborated by C.A.G. Garcez)

iv. Document Focus

For each article, the primary and (in some cases) secondary foci are identified, as per the set of pre-determined values shown in Table 2. The list of foci ware established after Phase 2 of data collection, in which the abstracts of the articles had been read. New categories were included during the analysis to capture more accurately the intent of the documents. The results of the analysis are shown in Figure 10.

More than a quarter of the articles had either a primary or secondary focus associated with the category “Incentive Mechanisms for Distributed Generation” (27% or freq=41). Of these documents, more than half (54%) analyzed the mechanism referred to as Feed-in-Tariffs, FITs, either stand alone or in comparison to other mechanisms, as per Figure 11.

It is not surprising that such attention is given to FIT mechanisms, their design, optimization and effectiveness. FITs vary in their features, but most have the following characteristics, they combine long-term contracts with fixed-prices per unit of generation (usually differentiated by generation type), along with guaranteed grid-access. Many of the articles point to the FITs as one of the most efficient mechanisms in encouraging renewable energy deployment. According to a report prepared by the United Nations Development Programme, UNDP (GLEMAREC; RICKERSON; WAISSBEIN, 2012), 66 countries have adopted some sort of FIT mechanism.

Huenteler's (2014) article focuses on options for international support (i.e. NGOs, banks and donor countries) to cover part of the cost FITs in developing countries. While other articles propose new economic formulations to optimize FIT designs (TAHA; HACHEM; PANCHAL, 2014); (HAWTHORNE; PANCHAL, 2014); (LESSER; SU, 2008), such as that of Kim and Lee (2012), whose intention is to optimize the uptake of renewable energy while minimizing burden on rate-payers. Couture and Gagnon (2010) compare market-dependent vs. market-independent FIT models and concludes that those operating independently from the market (i.e. fixed price models) "create greater investment security and lead to lower-cost renewable energy deployment than market-dependent models" (COUTURE & GAGNON, 2010, p. 963). Other articles, focus on using FIT options to increase the economic viability of certain DG technologies (SILER-EVANS; MORGAN; AZEVEDO, 2012); (MOORE; DURANT; MABEE, 2013). Kulatilaka et al.'s analysis (2014) argues that FITs, as implemented in the USA for Solar PV, place too much risk onto the homeowner/consumer. They advocate for changes in contractual arrangements toward leasing options, which would aid in scaling-up DG deployment.

The effect of FIT policies is also the topic of several articles, Smith and Urpelainen (2014) conduct a causal analysis of the effects of FITs on renewable electricity generation in 26 industrialized countries. They concluded that national shares of renewable electricity increase by a factor larger than the sample mean for every cent (0.01US$) per KWh increase in FIT offer prices.

Various articles (especially in the USA) are concerned with the comparison of different types of mechanisms, such as Renewable Portfolio Standards, RPS, tax incentives and FITs. Schmalensee (2012) identifies RPS as the mechanism of choice in the USA because the "quantity goal" seems more attractive to states, while the FIT mechanism is more widely adopted abroad because it removes investment risk for renewables. Carley and Browne (2013) reiterate this policy choice, stating that RPS seem to be more politically palatable and provides symbolic legitimacy for the state legislature, "even if the renewable energy mandate or goal is small, this policy can still indicate that states are in favor of renewable energy development" (CARLEY & BROWNE, 2013, p. 493). The authors also indicate net metering, NM and interconnection standards are one of the most common incentive mechanism in the USA, which they consider crucial to removing market barriers for DG.

The analysis shows that the choice of incentive mechanisms varies and is dependent on the policy goal or landscape in the jurisdiction. In the USA, Renewable Portfolio Standards have been favored, while in many other contexts, Feed in Tariffs, first introduced in Europe have been implemented with the intention of rapidly increasing the uptake of decentralized and renewable generation. However, there is increased concern on designing or modifying FITs in such as to reduce the burden on the overall market or ratepayers, while reducing the risk on the residential or small scale investor through leasing options.

Another category of articles included in the coding was "comparison for policy/incentives refinement". For example Mabee et al. (2012) compare Ontario and German FIT (introduced in 2008 and 2000, respectively), with the intention of identifying points Ontario could refine based on learning from the German experience (for instance decreasing rates over time). The German policy is often used as a reference in comparisons; Kissel et al. recognize that the German FIT resulting from EEG spurred interest in South America, first in Brazil in 2002 with PROINFA, the Electric Energy Renewable Sources Incentive Program (KISSEL et al., 2009, p. 3624). They consider that FIT mechanisms can be effectively applied in the case of emerging markets that have higher degrees of macroeconomic instability if modified accordingly. Some of the points raised in their article are nationalization targets and special financing conditions through national development banks. In an earlier publication, Kissel and Krauter (2006) also compared German and Brazilian FIT (PROINFA) rates and remark that large capital investment in Wind, along with high interest and inflation rates need to be taken into account in the design of the incentives, especially looking and the reduction in rates when capital repayments have been amortized in the Brazilian case.

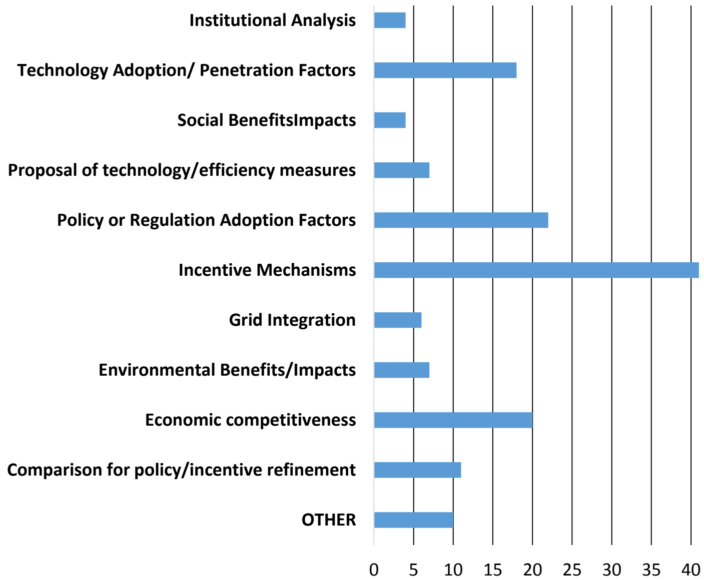

Figure 10. Focus of document, frequency of responses
(Elaborated by C.A.G. Garcez)

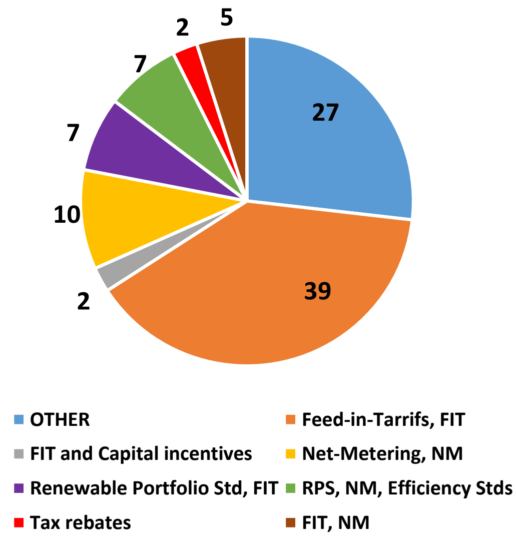

Figure 11. Incentive mechanisms subset, types considered
(Elaborated by C.A.G. Garcez)

v. Urban or Local Focus

Nine of the articles included in the analysis focus specifically on urban or local scale, however their research objectives are quite heterogeneous. Howard et al. (2014) analyze the potential of the mature technology, Combined Heat and Power, CHP in the context of New York City. As a member of the C40, an initiative which seeks to bring municipal governments as active participants of GHG emission reductions, the city has committed to reduce its emissions by 30% by 2030 (NYC, 2007 *apud* HOWARD et al. 2014) and includes targets for distributed generation, including CHP. According to Howard et al.'s analysis, applications of CHP at the building level and micro-grid (block scale) would result in 2.3 million metric tons and 5.0 million metric tons, respectively. This corresponds to a GHG reduction of 4% and 9% for the city as a whole (HOWARD et al. 2014, p. 453). One of the main hurdles that they cite is financial burden associated with navigating various permitting processes and recommend the city assist in this process by providing guidance via a handbook to facilitate the implementation of the technology. Siler-Evans et al. (2012) are also concerned with CHP in the neighboring city of Newark, New Jersey. Their focus is economic competitiveness evaluation under various scenarios of carbon pricing, net metering and well as Feed-in-Tariff design to reduce investor risk.

In the context of Latin America, Caballero et al.'s article (2013) aims at providing policy recommendations by designing a small, grid-connected Hybrid (Solar PV and Wind) system for a block of homes in Hanga Roa city of Easter Island, Chile. The case they analyze is serviced by utility generation and therefore their analysis does not require energy storage via batteries. The rationale is that the current generation capacity of six diesel generators (installations of the utility) are more expensive due to volatile fossil fuel prices. The analysis contains various scenarios for reducing the life cycle cost, including the options of net billing and net metering. Casillas and Kammen's work (2011) is concerned with providing an alternative power system to two communities in Nicaragua that are connected to a utility grid currently served with diesel generators. The overarching goal in the two articles that consider the Latin American countries of Chile and Nicaragua is to question the current configuration or regime paradigm for electricity provision (i.e. diesel), while contemplating economically viable ecological alternatives. Indeed Casillas and Kammen summarize this:

> Cheap capital costs and the prevalence of well developed supply chains make diesel generators a common choice for providing power to isolated communities. However, the long-term volatility of diesel prices and the negative environmental externalities resulting from the production of carbon dioxide provide two important reasons for reducing diesel dependency in these electric systems. This study demonstrates that there are many currently available opportunities for rapidly and cost effectively transitioning to the delivery of low-carbon energy services in rural communities. In order to make the persuasive case to policy makers, government officials, and funders, it is critical to present the costs and benefits of the decisions in consistent and rigorous manners (CASILLAS; KAMMEN, 2011, p. 4527)

A third article with a similar theme was prepared by Rodrígues Gámez et al. (2013) for the city of Havana, Cuba. Theirs is also a feasibility study for Solar PV generation connected to the distribution system, with the objective of providing solutions for energy policy and planning. They consider factors such as solar radiance optimized with respect to proximity to the existing distribution grid in Cuba, which covers 97% of consumers in the island-country (SUÁREZ et al., 2012, p. 2724). The benefits that Rodrígues Gámez et al. considered are directly related to the GHG reductions associated with displacement of thermoelectric generation. Currently, Cuba's electricity mix is dominated by thermoelectric stations using both imported and domestically produced petroleum derivatives, i.e. 79% oil-fired or fuel oil; 13% gas-fired; 6% diesel-fired (SUÁREZ et al., 2012, p. 2724).

Two Brazilian papers also focused on local/municipal applications for DG. Urbanetz et al. (2012) analyzed the grid integration of solar PV. Although it is one of the more technical papers, it was included in the analysis, because its objective was to guide policy in understanding if PV in a city such as Florianopolis could be integrated in a strategically sited manner and lead to the efficient operation of a distribution grid. The results of their modeling showed that Solar PV could result in factors important to the distribution system, such as better voltage profile and loss reductions, which they conclude could result in the postponement of system upgrades. The other

Brazilian paper authored by Mitscher and Ruther (2012) present an economic competitiveness analysis of five Brazilian State capitals. They show that rooftop Solar PV has reached grid parity in Belo Horizonte (due to high residential tariffs) and they affirm that if lower interest rates became available for this technology, Solar PV would also be economically attractive in other capitals such as Brasília, São Paulo and Florianópolis.

The three papers that study DG applications in Cuba, Nicaragua and Chile focus on the displacement of diesel, both for cost reduction (due to dependence on volatile fossil fuel generation), but also GHG reductions. While the Brazilian examples don't point to the low-carbon potential of the technologies as a priority, but rather to the optimization of the distribution system and economic considerations such as offsetting infrastructure costs. This is to be expected as Brazil's energy mix involves a higher participation of large, hydroelectric stations and is considerably lower in carbon content.

In contrast to the articles explored above, which have been dedicated to providing models of technically and economically feasible solutions for DG development, the remaining two documents focus on institutional aspects of the energy transition within an urban scale. Both of the articles are fruit of a project that was led by S. Jaglin entitled Energy Trajectories in Metropolitan Regions in the Global South (*Trajectoires Énergétiques dans les Régions MétrOpolitaines des Suds, TERMOS*) from 2011-2013.

The first article (JAGLIN; VERDEIL, 2013) explains how urban energy issues in emerging countries are evolving and how local actors and governments are influencing the transitions towards sustainable energy systems. Common amongst the cities considered (Buenos Aires, Argentina; New Delhi, India; Cape-Town, South Africa; Istanbul, Turkey; and Sfax, Tunisia) are the following characteristics: growing demographics, a strong increase in energy consumption, significant social contrast and high rates of poverty in their urban population. They depart from a broad literature on socio-technical transitions and seek to show how local and national interest play out within this urban scale transition. The authors conclude that although a discourse in favor of low-carbon and sustainable energy system is identified, there were no real urban "green" coalitions observed between economic and political actors. Their research did not locate organized civil society groups that could push the low-carbon energy agenda forward. They did observe urban energy issues being given increased interest at the national governance level; however, there is an increased politicization of energy issues at the city level.

The second article of the TERMOS project, describes specifically the case of Buenos Aires (PRÉVÔT-SCHAPIRA; VELUT, 2013). The authors assert that the term "energy transition" does not have a place in public policy in Argentina; only the related term of energy efficiency is identified[12]. The main concern in the Argentinian capital is to control electricity rates for political advantages, but the authors question the sustainability of such a practice. The artificially low tariff stipulated for the city, the authors argue, does not allow for improvements in service delivery to be made, nor for efficiencies or the development of new generating sources.

vi. Social aspects

It is clear that environmental factors are the main driving force for DG, but in a continent with large regional inequalities, the question remains, how do these articles address social or socio-economic benefits of the technologies? We have already seen that the driving force or "green economic growth" or job creation is much stronger in the articles that deal with Canada and US than in South America. In the larger body of documents included in the analysis, there are only five articles that were coded as having "social benefits/impacts" as either their primary or secondary focus.

Schelly (2014) is concerned with the practices or behaviors of residents that adopted solar energy in the States of Wisconsin and Colorado. Her objective is to identify the accrued social and environmental benefits beyond that of policy adoption. In the case of Wisconsin, homeowners who adopted Solar PV through the State's FIT policies pointed toward the impetus for energy conservation. The increased savings translated into increased income via energy generation (paid out at higher FIT rates). What is interesting is that the majority of the respondents did not declare environmental reasons for joining the FIT program, but that the incentive mechanisms induced energy conservation as a result. In comparison, Colorado has a larger PRS but it does not apply to all utilities and there is a strict sizing limit to solar PV, this policy inconsistency, as well as unfavorable rates (wholesale rates are offered, rather than retail or premium rates, such as FITs) caused unintended consequences for that States policy. The sizing restrictions in Colorado (based on household consumption) caused respondents to increase their consumption prior to applying for the program so that they could justify either installing a larger system, with the intention of purchasing electric vehicles or heating appliances, to offset natural gas. The result was less electricity conservation than in the case of Wisconsin. Ironically, in comparison to Wisconsin, almost all Colorado interviewees cited environmental reasons for adopting Solar.

Krupa (2013) deals with suggestions for improving a mechanism incorporated into the Canadian province of Ontario's FIT offer prices for decentralized renewables; the Aboriginal Adder. The Ontario Green Energy Act (2009) includes an additional $0.015 per kWh price adder

[12]Original citation in French, "En Argentine, le terme de «transition énergétique» n'appartient pas au vocabulaire des politiques publiques, à la différence de celui d'«efficience énergétique»".

for renewable energy projects that included Aboriginal economic participation. Krupa argues that the current “Aboriginal Adder” is a first step in promoting the participation of this historically marginalized and vulnerable population in the energy sector. However, if Ontario and Canada are to truly engage in a sustainable energy trajectory, Aboriginal involvement in should be further expanded. An example Krupa offers is the creation of a price adder for transmission project in Ontario, as well for this approach to be emulated by other Canadian provinces.

The analysis of Ontario’s Green Energy Act, GEA by Yatchew and Baziliaukas (2011) also points out that the Province was strongly motivated by socio-economic factors when designing the policy. The authors assert that the GEA and the FIT program were designed to be the “cornerstone of the Ontario government’s Green Economy plan. The government has indicated that the new Act will create 50,000 well-paying jobs in the first three years” (YATCHEW; BAZILIAUSKAS, 2011, p. 3887). The authors also elaborate on the sense of urgency in Ontario at the time of policy design to adopt aggressive incentive measures, as a means of securing itself as a leader in the renewable energy industry in North America. One could consider this an example of “competition amongst states” inducing the diffusion and adoption of DG policy in the case of Ontario (BERRY; BERRY, 2014).

Juárez-Hernández and León (2014) are concerned with wind development in the Isthmus of Tehuantepec in the State of Oaxaca, Mexico. Their analysis concludes that the current development model contains significant information asymmetries, both concerning the local indigenous communities, but also involving the landholders that will be directly affected by developments. In addition, little benefit is materialized in terms of generating skilled, local employment, seeing that the majority of components are manufactured abroad (JUÁREZ-HERNÁNDEZ & LEÓN, 2014, p. 155). These factors, the authors assert, have resulted in a development paradigm for wind generation that is receiving increased social resistance by local communities in Mexico.

Rumpala (2013) has a very different focus than the others concerned with social benefits of DG. His work is not empirically based, as in the case of the others dealing with social benefits/impacts of DG. The focus of Rumpala’s article is to provide a theoretical framework for dealing with the central question of how technological changes will also induce social reconfigurations. The author affirms that in the current configuration of the energy sector, electricity generation is centralized not only in scale, but also in terms of power (oligopolistic) and decision-making capacity. He maintains that DG opens is the possibility of increased community cooperation through smaller-scale and renewable projects.

vii. Brazil and Canada in comparison

The present analysis, as previously mentioned, is part of a larger research project regarding DG in Brazil and Canada. These two large and resource rich nations of the Americas will be further compared with relation to their historical and institutional trends of electricity generation and the context in which distributed generation emerges. For this reason, some of the characteristics of the documents included in the analysis that deal with these two jurisdictions will be highlighted. There are 11 articles have Brazil as their object of study, while 14 articles deal specifically with the Canadian province of Ontario.

The motivating factors for DG that the two sets of articles identified are shown in Figure 12. It is quite evident that there are contrasting motivating factors for the deployment of DG in the two cases. In Ontario, socioeconomic factors such as job creation and social benefits are quite strong, while they are completely absent in the Brazilian sub-set. By contrast, the Brazilian articles point to issues of energy system optimization and economic competitiveness as the main driving forces (which are absent for the Ontario sub-set).

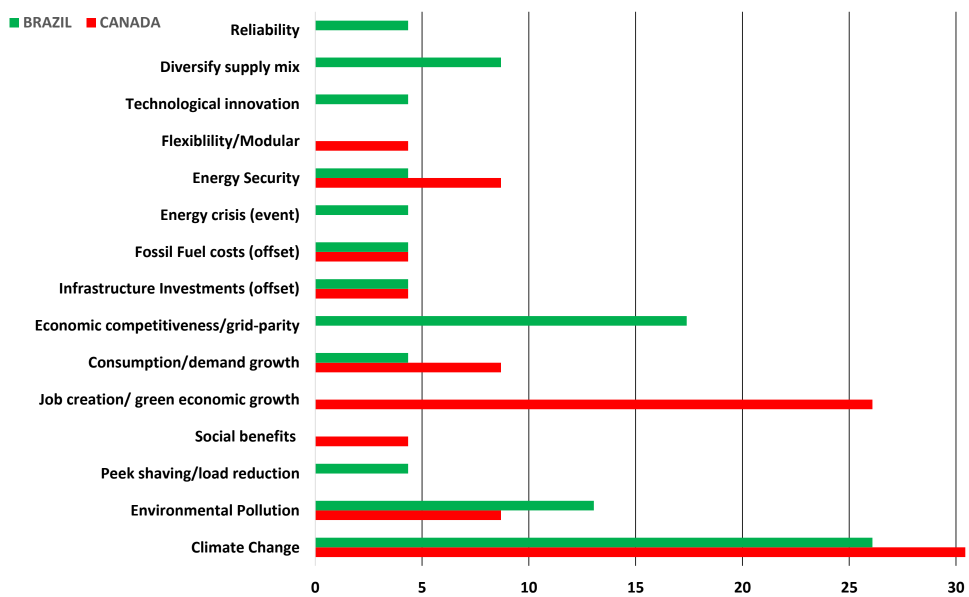

Figure 12. Motivating factors for DG (% of responses), Canada (Ontario) and Brazil (Elaborated by C.A.G. Garcez)

The Ontario policy and regulations designed to incent distributed generation were introduced in 2009, while the current regulation in Brazil that applies to mini and micro generation was published in 2012. For this reason, the types of articles are also quite different; two thirds of the articles in the Brazilian sub-set are concerned with modelling for policy considerations, while only four articles (36%) deal with policy analysis (one of which deals with a policy is no longer active: PROINFA). In the case of Ontario, four articles are characterized as “modeling for policy considerations”, while five papers deal with policy evaluation and another five are focused on aspects of policy design. This analysis shows that there is large void in peer-reviewed literature and therefore a need to research the policy design aspects of the Brazilian regulation for distributed generation.

4. Final Considerations

The objective of a systematic review is to answer certain questions via meta-analysis of a body of peer-reviewed works in an unbiased and transparent manner. Systematic reviews are not “infallible approach[es] to discerning broad findings from a body of scientific work” (AULD et al., 2014, p. 448), as there are instances for error due to interpretation inconsistencies. This analysis was guided by a specific question: What is the state of study on regulations and policies for distributed generation? This is a key differentiation between systematic reviews and others, and aligns to the technique adopted by the International Panel on Climate Change, IPCC, for reviews that seek to understand knowledge in a specific topic.

With regards to improving the meta-analysis, a possible solution is to include “grey literature” into the review. This would allow for a comparison between data extracted from peer-reviewed documents and other sources. In this case, certain precautions would need to be taken. This study was limited to peer-reviewed literature because it is considered to be “a widely accepted and scientifically rigorous source” (BERRANG-FORD; FORD; PATERSON, 2011, p. 26). Reports prepared by international organizations such as the International Energy Agency, IEA of the OECD, the International Renewable Energy Agency, IRENA of the United Nations, and other renewable energy organizations or research institutions would certainly enrich the analysis. However, caution would be warranted since they are not scrutinized through the peer-review process and may present preferences associated with the institution (BRASS et al., 2012). DG is a relatively new policy, especially in the case of some jurisdictions in the Americas. Peer-reviewed studies, being subject to rigorous review can also involve lag-times up to 2 years, for this reason grey-literature could enhance the analysis

The results of this analysis will be useful as a springboard for future study. The larger research plan with a comparison of Canada and Brazil as objects of study will benefit from the characteristics identified, such as a large discrepancy in motivating factors in the two cases for DG. Overall, the findings of the systematic review show that there is little emphasis given in previously published works to understand social impacts and benefits of distributed technologies, an issue that policy makers will have to address if policy interventions to mitigate climate change can be fully realized. Additionally, specific urban challenges and governance at the local scale for distributed generation is not widely investigated, pointing to a need for future study that considers such institutional considerations.

The systematic review is novel means of conducting a literature review, one that avoid bias in data analysis but also lends itself to comparison. The methodology could be easily applied to another geographical region, such as Africa, Asia or Europe allowing for comparison and therefore global insights into the problematic of small-scale generation.

Artigo 2: Electricity Policy in Brazil and Canada: A Historical and Institutional Perspective on the emergence of Distributed Generation[13]

Abstract

The purpose of this paper is to analyze how the current electricity policies for distributed generation in Brazil and in the Canadian provinces of Ontario and British Columbia emerged and how they are contemplated within a broader perspective on energy planning and governance of electricity expansion. The article also provides observations about the extent to which distribution generation (DG) has the potential to penetrate the Brazilian electricity market in a sustainable and equitable way. In the case of Brazil, in particular, the analysis identified two main reasons for the lack of strong incentives for DG: first, the existing policy which views hydroelectric generation as an economic and sufficiently sustainable way of expanding supply; and second, the view that DG provides little in the way of social and environmental benefits. Brazil's energy plan is more expansionist in nature, than the two Canadian provinces, as could be expected of an emerging economy. Future steps in this research include an analysis of policy options for DG in developing countries, as well as a causal analysis for existing DG projects in Brazil to identify barriers and explanatory variables for successful project deployment.

Keywords: energy policy; renewable energy; distributed generation; sustainability; Canada; Brazil

1. Introduction

Energy policy-making has become a challenging endeavor, especially over the last decades in which complex, inter-related dimensions have come to compete amongst themselves within electricity governance (GATTINGER, 2012). How are electricity policies addressing what is often referred to as the "policy trilemma", i.e. trade-offs or synergies between energy security, social equity and environmental impact mitigation?

One of the many strategies to promote sustainable infrastructure, reduce greenhouse gases and allow for increased public participation in the sector is distributed electricity generation or distributed generation, DG. DG can be understood as electricity generated on a small scale at (or

[13] Proposed publication for journal submission: Studies in Comparative International Development (*não está no Qualis ranking de Ciências Ambientais)*

very close to) the location of consumption. This decentralized model of energy production and consumption is cited in literature as holding great potential for maximizing both environmental and social benefits. DG employs renewable technologies (solar, wind or biomass) at an appropriate scale and can generate opportunities for decent job creation and income (FERROUKI et al., 2013); (IISD; WICHMANN; GHAZAL-ASWAD, 2011), which is cited by Sachs as a form of inclusive development (SACHS, 2004b).

How is DG different from the current model of centralized electricity generation? The electricity system can be compared to a system of roads and hi-ways (freeways). The transmission lines are comparable to the hi-speed freeways that transport large quantities of electric energy (electricity or power) over long distances at high-voltages. The distribution system can be compared to city roads; they deliver smaller quantities of power over shorter distances at medium or low voltages to commercial and residential customer. Distributed generation inserts itself here, within the distribution system. Through this physical configuration, DG favors small-scale renewable energy sources, such as rooftop solar photovoltaics (solar PV), small wind, small hydro, biomass, at or close to the location of consumption. This allows the consumer of the electricity to become also the generator of electricity, and possibly transform a sector that has been based on large, centralized and distant generations for the last century. It is also different because it allows for two-way flow of energy, forming the basis for smart grid configurations.

Distributed (or decentralized) electricity generation is often cited as a future tendency for the electricity sector. In his book, *Reinventing Fire* (2011), Lovins emphasizes the importance of policy choices to prioritize distributed electricity generation as a means of creating the basis of sustainable infrastructure, of green and inclusive growth. This vision of small-scale solutions, using socially appropriate technologies was called for by influential economist E.F. Schumacher in his 1973 book, *Small Is Beautiful*.

Through the comparison of Brazil and Canada, two large and resource rich countries with high penetrations of large and centralized hydroelectric generation, this paper will look at the historical and institutional arrangements that characterize this sector to then understand the peculiarities of each case and how distributed generation emerges in each context. The analytical framework for the comparison is described in the next section, one that has at its core, seeking to understand how policy choices and priorities influence policy design and what alternative options may be available in the Brazilian case.

2. Analytical Framework

The framework adopted for this paper is a comparative, historical analysis of the institutional arrangements for electricity planning/policy in Canada and Brazil. A historical perspective of the structure of the electricity sectors is a common approach to understand how new configurations may emerge. The advent of a new system configuration is the main object of interest for scholars of transitions literature. Therefore the historical analysis of the socio-technical systems, i.e. the electricity sectors or electricity regimes are necessary: to “uncover technological stability as a precondition for understanding change, and all argue that this stability has technological as well as financial, social, and institutional components (VAN DER VLEUTEN; RAVEN, 2006).

Collier insists on the importance of the comparative method: “comparison is a fundamental tool of analysis. It sharpens our power of description, and plays a central role in concept-formation by bringing into focus suggestive similarities and contrasts among cases” (COLLIER, 1993, p. 105), while Sartori also affirms that “comparing is ‘learning’ from the experience of others and, conversely, that he who knows one country only knows none” (SARTORI, 1994, p. 16).

The comparison of Brazil and Canada is especially applicable to the study of energy or natural resource policy. They share many characteristics such as their size and resource base. At this point, an important distinction must be made regarding the cases included in the analysis. The object of this paper is electricity policy, which is a provincial matter in Canada. For this reason, two Canadian provinces have been chosen to compare to the Brazilian case. To facilitate this choice, a diagnostic table was prepared (Table 3), which served as an exercise of identifying two key variables for the preliminary characterization of the electricity sectors in the Canadian provinces and territories; *1. Structure of the Electricity Sector*; 2. *Electricity production and generation sources* (i.e. resource base); and subsequently, how these variables influences the DG Policy mechanism.

Satori explains the most common research designs in comparative analysis: *most similar system* or *most different system.* In the first design, cases are chosen that are similar except for the phenomenon under analysis. In the second, the cases are different, while the phenomenon or variable under analysis is similar (SARTORI, 1994, p. 22). In the case of the institutional structure and contemporary reforms of the electricity sectors in Brazil and in Ontario, these two cases fit the most similar case design. Brazil and Ontario underwent restructuring and privatization efforts almost simultaneously in the late 1990s. In both cases, we see that the electorate chose opposing parties to succeed the governments responsible for such reforms; these latter administrations resumed central energy planning as an important part of their current electricity sector configurations. While in British Columbia, the vertically structured utility underwent some minor restructuring, but resisted forces for privatization and maintains in control of the generation, distribution and energy planning process. However, what is paramount to this article is identifying the loci of decision-making for distributed generation, DG and understanding how DG fits into the larger energy plans of the jurisdiction. To this end, Brazil and British Columbia can be seen as a most similar case, since their supply mix are dominated by hydro power and their DG mechanisms both originate from a regulatory body.

The comparison between Brazil (a nation-state) and Ontario and British Columbia (sub-national entities) could be interpreted as an obstacle, presenting some practical research difficulties; however, it does not render the research unfeasible. Additionally, it is not the Canadian Federal Government but the provinces that have the responsibility and the appropriate authority to handle issues related to electricity policy, according to division of powers under the Canadian Constitution. Dogan affirms that within the comparative method what is of utmost importance is the political structure and process of decision making and not the size of the state entity (DOGAN, 1994, p. 52).

The data for the analysis was collected from official plans and documents of the corresponding energy ministries or regulating entities. This documental data was complemented through in-depth and semi-structured interviews (samples are shown in Appendices 10 – 25) conducted with various sector stakeholders and agencies (see in Annex 1).

Table 3. Characterization of the Brazilian and Canadian Electricity Sectors (2011)

		Brazil	Canada	BC	AB	SK	MB	ON	QC	NB	NS	PEI	NFL	YK/NWT/NVT		
Electricity production (GWh)		531,758	617,787	70,074	76,759	19,772	35,059	150,490	199,484	11,871		12,092	41,406	780		
Generation sources (%)	Hydro	81.9	60.2	87.7	2.7	22.8	97.7	23.2	95.1	31.4		5.1	96.4	29.2		
	Thermal	14.9	23.3	9.9	93.6	74.6	0.6	20.5	0.9	62.2		84.3	3.3	65.3		
	Nuclear	2.7	14.1	0	0	0	0	52.5	1.8	0		0	0	0		
	Wind	0.5	2.4	1.4	3.7	2.6	1.9	3.5	2.2	6.4		10.6	0.3	2.8		
	Outros	0	--	--	--	--	--	0.3	--	--		--	--	--		
Structure of the Electricity Sector		Some state-owned generators / LDCs auctions for generation and transmission regulated by ANEEL	Distinct sectors by province; NEB (National Energy Board) regulated international or interprovincial trade.	BH Hydro publicly-owned utility, also procures independent production, regulated by BCUC (British Columbia Utilities Commission)	Competitive market regulated by AUC (Alberta Utilities Commission)	SaskPower and some independent generation, Regulated by: Saskatchewan Utilities Commission	ManitobaHydro) and some IPPs. Regulated by: Manitoba Public Utilities Board	OPG and IPPs, procurement through Ontario Power Authority, OPA . Regulation by Ontario Energy Board, OEB	HydroQuebec); Regulated by: La Régie de l'énergie du Québec	NBPower, Regulated by New Brunswick Energy and Utilities Board	NSPower Regulated by NSUAR (Nova Scotia Utilities and Review Board)	Maritime Electric Regulated by IRAC (Regulatory and Appeals Commission)	NLHydro Regulated by PUB (Public Utilities Board)	Yukon Energy Corp.	NWT Power Corp.	Qulliq Energy
DG Policy mechanism; And year		Yes, 2012; *Net-metering*	NA	Yes; 2004; *Net-metering*	Yes, micro-generator reg.	Yes, *Net-metering*	Yes, DRIP, Dist. Resource interconn. Procedure	Yes; 2009; F.I.T. *Feed-in-tariffs*	Yes *Net-metering*	Yes; 2011; *Net-metering*	Yes; 2011; F.I.T *Feed-in-tariffs*	Yes; 2005; *Net-metering*	No	No	No	No

Abbreviations: BC-British Columbia; AB-Alberta; SK-Saskatchewan; MB-Manitoba; ON-Ontario; QC-Quebec; NB-New Brunswick; NS-Nova Scotia; PEI-Prince Edward Island; NFL-Newfound Land; YK – Yukon; NWT-North West Territories; NVT – Nunavut

Sources: MME/EPE; StatisticsCanada; CanWea)

3. Brazilian Electricity Sector

i. From local to central

At the end of the 19th century, Brazil was home to several privately owned hydroelectric stations, strictly for local interests, especially in the southeast region of the country and by 1915, 84% of the total electricity supply was generated through hydroelectric dams, consolidating a trend that continues until today (LEITE, 2009, p. 4-5). At that time, there was an absence of legislation in Brazil for the provision of electric power services. Electricity became a government priority only in the 1930's, during the military and later democratically-elected administrations of President Getúlio Vargas (1930-1945; 1951-1954) and his industrialization projects.

In 1934 the Brazilian central government took charge of all of the phases of the electricity industry (TOLMASQUIM, 2011, p. 4). In 1938, the National Water and Electric Power Council was deemed responsible for electricity policy. Later in 1952, the National Economic Development Bank, was founded, which administrated the Federal Fund for Electrification (FFE). Electricity policy and investment, as part of a larger, central government strategy for industrialization and growth continued into the Kubitschek administration (1955-1961), absorbing a large quantity of his economic development plan. Kubitschek also created the Ministry of Mines and Energy (MME) in 1960 (LEITE, 2009, p. 12).

Centralized control of the industry continued during the two decades of military rule in Brazil, 1964-1985. Leite cites some policy miscalculations during this period, which will set the stage for the restructuring of the sector in the decade that follows. His list includes the adoption of a uniform national tariff, a large nuclear program and other large-scale hydroelectric undertakings, such as Itaipú and Tucuruí, which required investments larger than resources available (LEITE, 2009, p. 18). Another emblematic project constructed during the military regime was the Balbina Dam (construction began in 1981, operation achieved in 1989). The dam's reservoir resulted in the flooding 2360 km^2 of tropical forest (vegetation was left to decompose in the river) near the state capital of Manaus, causing important environmental and social impacts (FEARNSIDE, 1989). These large-scale megaprojects were not exclusive to Brazil, but were part of a global trend in the 1970's in resource development, which involved huge monetary sums for investments (SEWELL, 1987).

ii. Restructuring and privatization

With the return to a civilian government, the short-lived Collor administration (1990-1992) had to deal with the economic turmoil and hyperinflation that dominated the Brazilian political climate. Subsequently, Fernando Henrique Cardoso's (FHC) two consecutive administrations (1995-2002) are most noted for the *Plano Real* (designed to stabilize the country's currency and control inflation) and the partial execution of the National Privatization Program (*Program Nacional de Desestatização*), laid out by Law 9.491/1997 (which modified the Law 8.031/1990 passed during Collor's administration). During FHC's government, the electricity sector underwent "institutional reform and simultaneous privatization of state-controlled companies with the objective of introducing competitive markets" (LEITE, 2009, p. 23). Although most of the electrical companies were under the central governments' control prior to Law 9.491/1997, some (especially distribution companies) were under the control of the state-level administrations. The privatization of these companies were incented through the Federal Government`s Program to Stimulate the State-owned Privatization (*Programa de Estimulo às Privatizações Estaduais, PEPE*) (TOLMASQUIM, 2011, p. 6)[14] .

In 1996, in anticipation of the re-structuring of the electricity sector, the National Electricity Regulatory Agency, ANEEL (*Agência Nacional de Energia Elétrica*) was created. Its objective is to regulate generation, transmission, distribution and commercialization of electricity in Brazil. Meister (2010) asserts that the switch to regulatory agencies with high degrees of independence from the Executive and Legislative branches of government, represented an important shift in the locus of power in Brazil. Meister also adds that ANEEL, as in the case with most of the other Brazilian agencies "can support government decisions since, using a bottom-up approach, they are closer to the sector agents. Ideally, they are meant to balance the interests of the diverse players (government, the business sector, consumers), while reassuring private investors" (MEISTER, 2010, p. 34).

The year 2001 is referred to in Brazil as the "*ano do apagão*" or the year of the great blackout. Its causes date back to the privatization efforts. The intention of the "market-oriented reform based on short-term marginal pricing" (BATLLE; BARBOSO; PÉREZ-ARRIAGA, 2010, p. 7155) was to attract private investments into the sector, specifically to increase generation capacity. However, this did not materialize (VAN ELS; DE SOUZA VIANNA; BRASIL, 2012); (TANKHA, 2009). In 2001, the results of insufficient investment in additional capacity and a

[14] Currently in Brazil there are 47 distribution companies that are privately owned, 3 municipally-owned, 8 state government-owned, and 6 owned by the federal government.

drought that affected the output of Brazil's hydroelectric plants caused a severe supply crisis. The electricity operator, ONS (*Operador Nacional do Sistema Elétrico)* created in 1998 to be an independent, non-profit body for the technical operation of the system rationed electricity in the magnitude of 20% to 25% in the Southeast, Central West and Northeast regions of the country. This had serious economic consequences for Brazil (in fact, the growth of the industrial Gross National Product, GNP was negative in 2001). Rationing of electricity ended the following year, in February 2002 (TOLMASQUIM, 2011, p. 17).

iii. The current model

At the beginning of the Lula administration (2003-2011), the electricity sector underwent yet another set of reforms. They were headed in part by the current president, Dilma Rouseff, then Minister of Mines and Energy. Various reforms were implemented under the title of the New Model for the Electricity Sector (*Novo Modelo do Setor Elétrico*). The main changes are summarized by Tolmasquim as: 1) return of energy planning to a central and government-led role through the creation of the Energy Research Company, EPE; 2) the creation of the Electricity Sector Monitoring Committee; 3) changes to the roles and responsibilities of the ONS and the Chamber for Commercialization of Electrical Energy, CCEE (TOLMASQUIM, 2011).

In 2003, Federal Law No. 10.438 was approved and created the PROINFA, Electric Energy Renewable Sources Incentive Program. The goal of the program was to contract 3,300 MW of renewable energy from wind, biomass and small hydroelectric sources, which had to be constructed and operating by 2008. The power was purchased by Eletrobrás at preferential prices (or Feed-In-Tariffs, FITs) for a period of 20 years. Brazil has now moved away from the FIT policy to a system of auctions (RICKERSON et al., 2012, p. 14), as a strategy to reduce costs.

Under the current model, electricity is traded in one of two markets: Regulated or ACR (*Ambiente de Contratação Regulado*) and Free or ACL (*Ambiente de Contratação Livre*). In the ACR, energy procurement for most new and reserve electricity generation projects participate in auctions, *Leilões* (some of which are carried out for specific and targeted energy sources, including wind and other renewable energy sources). These result in long-term power purchase agreements (PPAs) between sellers (i.e. generators, independent power producers) and buyers (i.e. distribution companies). The auctions are organized by the regulatory agency, ANEEL (IEA; IRENA, 2013). In contrast, the ACL allows for free negotiations between generators and free consumers, in which contracts are governed by bilateral agreements (DEVIENNE FIHO, 2011).

iv. Current directives in energy planning

EPE's first energy plan (released in 2006), was published along with a handbook outlining how socio-environmental questions are incorporated and addressed within their planning process. The main directive is to incent the use of alternative sources of energy while prioritizing the immense hydroelectric potential (EPE, 2006, p. 17). Indeed, the handbook explains that the 10-year plan is elaborated through various studies, the first of which are based on the long-term use of hydroelectric potential. Options are compared that can provide maximum energy benefits, while minimizing costs and socio-environmental impacts. In order to support EPE's work in preparing the 10-year plans a committee was formed specifically to address socioeconomic aspects (*Comitê de Estudos Socioambientais do Plano Decenal*), in which various utilities participated (EPE, 2006, p. 127), but no industry or consumer groups.

What is striking about the handbook is that it identifies the exhaustion of hydroelectric potential in the South, Southeast, and Northeast regions of Brazil, where the largest consumer-centers are located, and the exploration of unused potential in the Amazon region as a necessary endeavor for Brazil. EPE estimates that there are 108 GW of unexplored potential in the region, corresponding to 41% of the country's total hydroelectric potential (EPE, 2006, p. 26).

One of the diverging features of Brazil's planning horizon to that of Ontario and British Columbia is the anticipated growth in demand. As an emerging economy, Brazil is planning for growth. The most recently published 10-year energy plan by the EPE, *Plano Decenal de Expansão de Energia* 2023 or PDE2023, estimates that the country's demand will increase by the average, annual amount of 3,000 MW (EPE/MME, 2014a, p. 69), representing an expansion rate of 4.3% per year during its 10-year planning horizon (EPE/MME, 2014a, p. 35).

Demand growth will be met through planned expansion, mainly through new hydroelectric dams in the North region as well as some conservation efforts. The growth projection corresponds to a total of 92,714 MW in installed capacity for the entire national electricity system in 2023 from the capacity of 65,830 MW installed as of 2013 (EPE/MME, 2014a, p.41). The same report outlines that from 2014 to 2018; 16,090 MW of hydroelectric energy will come online, 15,605 MW (97%) of which is in the North region of the country; 11,000MW of which is the Belo Monte Dam on the Xingu River in the state of Pará. Within the timeframe of 2019 to 2023, an additional 14.679 MW of hydroelectric capacity is to be built, 78% in the North of the country (EPE/MME, 2014a, p.41, p. 79-81). The previous year's plan; PDE2022 even refers to the Amazon region as the 'frontier for hydroelectric power in the country' (EPE/MME, 2013, p. 349). Abramovay quotes Michael Cernea, as referring to rhythm of new hydroelectric constructions in the Amazon as "a tsunami of dams" (ABRAMOVAY, 2014).

The PDE2023 briefly describes efforts that are being made in neighboring countries such as Peru, Bolivia, Guiana and Argentina to explore their underutilized, low-carbon and low-cost hydro capacity (EPE/MME, 2014a, p. 70). Bermann (2012) asserts that the planning and construction of hydro dams to supply the increase in Brazilian electricity consumption, especially in the Amazon region, has expanded beyond the national borders and has acquired a regional character, as seen the in the most recent energy plan.

In the section of the PDE2023 dealing with socio-environmental considerations, the GHG emissions associated with the electricity sector and the economy as a whole are presented. Current GHG emissions from electricity are expected to rise from 64 MtCO2eq in 2014 to 73 MtCO2eq in 2023, while the entire economy emissions will rise from 483 to 660 MtCO2eq (EPE/MME, 2014a, p. 359).

Distributed generation first appeared as a consideration in the 10-year plans in 2013, with the publications of the PDE2022. In that report, an entire section deals with actions by end-users to induce energy efficiencies and decelerate the expansion of centralized generation (EPE/MME, 2013, p. 324). The most recent 10-year plan, PDE2023 acknowledges that historically in Brazil, large industrial sectors such as steel, chemicals, pulp and paper, sugar and alcohol, have invested in larger-scale distributed generation, where electricity is generated on or near the site through small hydro or burning of by-products for their own consumption (*autoprodução*). For small-scale distributed generation projects, the plan points to solar PV as the source that is seen as having the best potential to penetrate the market within the timeframe considered, reaching 664 MW of total installed capacity by 2023 (EPE/MME, 2014a, p. 352). EPE has also prepared two additional reports in 2014 on the subject of DG by solar PV technology, using economic models and various scenarios to show the possible uptake of projects. However, they caution that for DG to be adopted at a more rigorous pace, it must be treated politically, rather than just a regulatory matter (EPE/MME, 2014b).

v. Distributed Generation in Brazil

This section will elaborate on the most recent initiative to regulate distributed generation in Brazil: ANEEL's Normative Regulation 482 (ANEEL, 2012b) and Normative Regulation 517 (ANEEL, 2012d). Resolution 482 permits DG in Brazil through a mechanism of net metering to a maximum of 1 MW installed capacity for solar PV, small hydro, wind, biomass or qualified co-generation projects. It grants access to the distribution grid for projects with due connection requirements on residential properties or commercial buildings. The DG projects do not have to sign commercialization contracts, operating license are issued to the consumer.

This process for regulating DG was led by the sector responsible for distribution services (*Superintendente de Regulação dos Serviços de Distribuição – SRD)* of ANEEL in what can be considered a bottom-up process, as it was not mandated by the Executive Branch. The electricity regulator, being an independent entity was in a position to regulate the issue of DG and tried to balance the respective interests of the sector's agents (MEISTER, 2010, p. 34). Meister goes on to say that, this role of the regulator is often difficult due to low social participation. However, DG sparked the interest of many non-traditional actors in the sector. During the process of regulation, (2010-2012) ANEEL held one public consultation (written submissions) and two public town-hall meetings to collect contributions from interested parties, ANEEL was surprised to receive a larger than expected interest from a broader audience, including university students, architects, non-governmental organizations, NGO's, among others[15].

Previously, there existed patchwork of regulations and incentives for DG in Brazil. The first Technical Note that ANEEL published to open the consultation process (*Nota Técnica* n° 0043/2010) elaborated upon them. One such initiative was the requirement for distributors to procure 10% of their electricity through distributed generation, called "*Chamadas Públicas*" (as per Presidential Decree No. 163/2004). It is similar to a mechanism called for in the 2002 BC Energy plan, which sparked their net metering program, and will be elaborated upon later in the article. ANEEL reported that only eight of the 64 distributors had followed the directive and concluded that this mechanism was not sufficient to attract small generation. Above all, ANEEL had previously committed itself in their Regulatory Agenda of 2010 to "diminishing obstacles for the access of small generators to the distribution system grid" (ANEEL, 2010, p. 15-16).

In their various technical notes, ANEEL refers to the international scenario and drivers for a growing number of policies to incent small scale renewables. In Technical Note 0025/2011, ANEEL makes an important distinction between the approach taken abroad and that of the Brazilian case, citing that "the generation of electrical energy from renewable sources is a tendency in many countries. What is different in these cases to the Brazilian scenario is the strong incentives given for small-scale distributed generation, including projects connected to low voltage grids"[16]. It is clear that ANEEL shares the same understanding of the renewable energy industry that the international trend for DG is growing.

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[15] *Consulta Pública* 15/2010 received 577 contributions from 39 parties; *Audiência Pública* 42/2011 received 403 contributions from 51 parties; and *Audiência Pública* 100/2012 received 162 contributions from 42 parties.

[16] Translated from original in Portuguese: *A geração de energia elétrica a partir de fontes renováveis é uma tendência em diversos países... O que diferencia esse movimento internacional do cenário brasileiro é o*

ANEEL emphasized (*Nota Técnica* n° 0020/2012) that the mechanism of net metering does not intend to stimulate excess electricity generation. Project sizes are limited to the quantity of electricity consumed in the establishment. For this reason, the credits that the dwelling accumulates have an expiration date of 36 months (SILVA FILHO et al., 2012) . In contrast to the program in British Columbia, the credits are not purchased by the utility.

ANEEL has created, within its competencies, a regulation that has stirred the electricity sector. It has introduced a mechanism, albeit very cautiously, which allows both residential and commercial consumers to produce their own electricity on site. Distributed generation, as a policy however, is lacking incentives, government financing, communication outreach, as well as the exemption of the ICMS tax (SALES, 2014; Greenpeace, 2013).

In comparison with the cheaply available hydroelectric power in Brazil, Vieira points out that DG is simply a more expensive option and "there would be no strong reason for extra expenditure of public funds to support DG" (VIEIRA, 2011, p. 9–10), especially in light of recent government efforts to significantly reduce electricity tariffs in Brazil (ANEEL, 2012e). The issue of how to justify government incentives or cover the costs of the distribution system among the non-participating ratepayers remains a sticky issue. DG could even be viewed as an elitist policy (VIEIRA, 2011, p. 30) within the context of a developing nation, allowing those of the more wealthy class with access to capital to install projects and then pass along the cost to all of the ratepayers. In other studies in Latin America, solar PV deployment has been viewed by the upper-middle and affluent class as status symbols, while the poorest segments of society lack access to capital to benefit from it (CORSAIR; LEY, 2008).

4. Canadian Electricity Sector

The political jurisdiction within Canada regarding energy policy can be considered as the most divided and decentralized arrangement of western federal countries (DOERN; GATTINGER, 2003, p. 23). This stems from Article 92 of the Constitution, which was included in the 1982 revision of the original 1867 British North America Act. The Constitution lays out, in a systematic manner, the division of responsibilities between the respective levels of governmental. Electric energy is clearly an exclusive responsibility of the provinces, within their own borders: (CANADA, 2012a).

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fato de haver forte incentivo para a geração distribuída de pequeno porte, incluindo a conectada na rede de baixa tensão.

Electricity in Canada has historically been considered a natural monopoly, often characterized by significant economies of scale. During the first period of energy policy analyzed by Doern and Gattinger (post-WWI until 1973), this view created pressure for public ownership of electricity companies. In Ontario, provincial ownership dates back even further to 1904. Electricity has been seen as a significant tool of development for the provinces, specifically concerning pricing policy.

At this point, a separate analysis of the contemporary historical events shaping the electricity governance, planning and policies for distributed generation for the two provinces of Ontario and British Columbia will be explored.

5. Ontario's electricity sector

i. Central starting point

Ontario's starting point for the electricity sector is a centralized industry, of state ownership and control. "In the first half of the twentieth century inexpensive hydroelectric power from the Niagara river provided low-cost electricity" to the province (DEWEES, 2009, p. 72). In the 1950s and 1960s, coal-fired generation stations were added and then a decade later nuclear facilities became part of the province`s supply mix. Ontario Hydro was the Crown Corporation re-branded in 1972 according to the Power Corporation Act of the same year. The publicly owned and controlled utility provided power at cost, paid no taxes and generated no profits. It also set its own rates, which were not subject to review by the Ontario Energy Board, OEB.

During the second period of regulation history that Doern and Gattinger consider (1974-1984), Ontario Hydro made its extensive movement into nuclear power, becoming Canada's main nuclear province. The province's system became a nuclear-dominated one resulting from the investment of tens of billions of dollars, based on an assumption of steady growing electricity demands (an average of 7% per year). However, in the 1980s and 1990s, due to economic recession and a transformation of the province's manufacturing-based economy into service-based, Ontario saw declining electricity demand result in a large debt for the provincial utility, which in turn translated into increased electricity rates for consumers.

ii. Restructuring

In 1997, the Harris Conservatives announced their decision to dismember Ontario Hydro and introduce competition in electricity supply in the province. The four main drivers were outlined in their White Paper as: deregulation in the US, economic competitiveness, technology, financial soundness (DOERN; GATTINGER, 2003, p. 36). In his analysis of electricity restructuring in Canada, Dewees (2009) explains that restructuring is usually based on the premise that competitive markets increase efficiencies. He asserts, however, that this is fundamentally flawed because electricity markets are not freely competitive at all;

> competitive electricity markets are artificial markets with extensive rules for all participants arising from the complex interconnections of the electricity network. Governments or regulatory agencies oversee market design and the operation and maintenance of the market, so market design is necessarily a political process involving technical and political capacity (DEWEES, 2009, p. 71).

Schott argues that the one of the key ingredients for a sustainable electricity sector is long-term investment, one that considers social and external costs (SCHOTT, 2005, p. 175). In theory, an electricity market could reduce the inefficiencies related to operating and administration costs of a state ownership, but only if there are a large number of firms that cannot influence the price of electricity in a sufficient way, i.e. market concentration or gaming. In his analysis of privatization of UK and California as well as in Alberta and Ontario, Schott (2005) finds that the private sector did not make the optimal capacity investment decisions from a societal perspective.

In 2002, Ontario saw electricity rates rise significantly after the newly formed market was inaugurated. The design of which was based on a “smoothed” spot market price, which rose significantly on hot summer days, leading even to outages (YATCHEW; BAZILIAUSKAS, 2011). Harris’ Tories were faced with the unpopular reality of their electricity sector reforms and feared retribution in the upcoming election so they set a price cap of 4.3 cents/kWh in efforts to thwart volatility and stabilize rates (MARTIN, 2007). The Tories were never able to implement completely the reforms they envisioned. Ontario Power Generation (OPG)[17] inherited Ontario Hydro’s generation assets and remains the largest generation company under provincial ownership, while HydroOne owns and operates the high-voltage transmission lines it inherited from Ontario Hydro. It is also the province’s largest distributor of electricity.

In 2003, Dalton McGuinty of the Liberal Party was elected “on a platform [of] committing to phase out coal power plants and increase renewables to 5% of the total capacity by 2007, all while reducing electricity consumption and nearly meeting Canada’s Kyoto Protocol GHG reduction targets” (STOKES, 2013, p. 492). This opened yet another chapter in the reform of Ontario’s electricity sector, which will be elaborated upon in the next section.

[17] At the time this article was prepared (April 2015), the current provincial administration of K. Wynne of the Liberal Party has signaled that they wish to sell the provinces shares in the two corporations as a means of combating the deficit.

iii. Current model

In 2004, Ontario’s provincial government passed the Electricity Restructuring Act, creating the Ontario Power Authority, OPA. Its role is to perform long-term planning and procurement in the province, a similar approach taken in Brazil in the same year with the creation of the EPE. The OPA is the newest agency in the sector; the Minister of Energy chooses its board members. The OEB must approve the OPA's fees and its integrated power system plan and procurement process (OEB, 2010). Presently, the Electricity Act allows the Minister of Energy to issue policy directives regarding planning to the OPA, which it previously did directly to Ontario Hydro.

The Electricity Act was modified in 2004 with the passage of the Electricity Restructuring Act. It outlines the roles and responsibilities of the IESO, OPA, HydroOne, and OPG. The Ontario Energy Board, OEB has varying degrees of regulatory authority over all of the entities, as well as the local distribution companies, LDC’s in the province. The OEB Board was created in 1960, but its mandate was only expanded to include regulation of the electricity sector in 1998 with the passage of the Energy Competition Act. It members are appointed by the Lieutenant Governor. The IESO is the independent, non-for-profit agency that manages the Ontario's electricity system and operates the wholesale electricity market[18]. It can be considered as the parallel to the electricity operator, ONS in Brazil. There are currently 75 local distribution companies (LDCs) in Ontario, a mix of private and publicly owned companies, represented by the Electricity Distribution Association, EDA.

In 2004, the McGuinty Liberals also announced their ambitious goal to phase out all thermoelectric generation from coal in an original time horizon of three years. Stokes considers this a “critical decision that reoriented the policy landscape. It also coincided with a massive infrastructure renewal within the electricity sector, since Ontario had not reinvested in its electricity supply mix for several decades” (STOKES, 2013, p. 492).

iv. Energy Planning with a Regional focus

The most recent Long Term Energy Plan, LTEP released in 2013 updates the previous, 2010 edition. The LTEP 2013 was prepared through a new Regional Planning process, in which the OPA and Ministry of Energy consulted and engaged with local distribution companies, LDC and the public through various meetings and an online survey. The goal of the process is to give greater consideration to local priorities in the location of generating facilities and the development of a standardized procurement process for generation, including consultation (ONTARIO, 2013,

[18] The OPA has recently (2015) been amalgamated with the IESO.

p. 63). The new regional focus was outlined in the IESO/OPA report, *Engaging Local Communities in Ontario's Electricity Planning Continuum* (August 2013), in which 21 electricity region boundaries were draw-up. A draft of the 2013 LTEP was also placed on the Environmental Registry[19] (from July 10, 2013 to September 16, 2013) for public comment and review before its release on December 2, 2013.

This approach has its origins in an initiative started by the regulatory body, the OEB, in 2001 called *Regional Planning for Electricity Infrastructure; EB-2011-0043.* This can be viewed as yet another example of how regulatory agencies can assist in policy making through a bottom-up approach; identified by Meister with regards to the role that ANEEL plays in the Brazilian electricity sector (Meister, 2010, p. 34).

It is evident that the LTEP gives conservation a place of importance, which would seem natural for a jurisdiction that has to deal with declining demand. This is a very different scenario from that of Brazil. The report estimates that renewable sources (including hydro) will grow to 46% of the total installed capacity. Hydro will remain relatively constant in terms of participation in the overall mix (it is 22% of the total installed capacity in 2013 and will drop slightly to 21% in 2032). In terms of installed capacity, it will grow from the current level of 8,000 MW to 9,300 MW by 2025. The details of where the expansion will go are not provided in the plan. Only one project is specified: a 25 MW project with the Taykwa Tagamou First Nations (New Post Creek hydro-electric generating station).

Overall, the tone of the LTEP 2013 is much less technical than the Brazilian plan, PDE2023. Not only does the Ontario document provide targets for the province's energy planning, but it also highlights progress made in certain areas, such as the coal phase-out[20] achievements and investments in the smart grid. It also appears to have been written for a broad audience, with the intention of dialoguing with the general public and providing, even if somewhat rhetorical, the message that a wide variety of factors (environmental, social, technical) are being addressed so that the jurisdiction may advance with an innovative and secure energy future. In reaction to this most recent LTEP, the Pembina Institute stated that "Given all of these [competing] interests [i.e.

[19] The Environmental Registry (now online; www.ebr.gov.on) is a transparency mechanism for public participation in environmental matters in the province of Ontario. It was created in 1994, through the passage of the Environmental Bill of Rights.

[20] The report states that Ontario has almost completely eliminated coal-fired generation, which stems back to a 2004 commitment to close or refurbish its coal-fired thermoelectric plants (OPG, [s.d.]). This decision was made based on climate change considerations but also because of impacts on human health. In 2008 the Canadian Medical Association estimated that the Ontario public health system spends CND$ 3,6 billion per year due to air pollution (CMA, 2008, p. 28).

reducing GHG, keeping prices low, addressing ageing infrastructure] in a market with declining demand, in many ways [the LTEP] offers a reasonable approach" (WEIS, 2013).

v. Green Energy Act - FIT and microFIT programs

In 2009, the Legislature of the province of Ontario passed the Green Energy and Green Economy Act, GEA. This legislation created the first, large-scale Feed-in-Tariff, FIT program in North America. The bill was drafted by the Ministry of Energy, a clear "top-down" policy initiative, contrary to the "bottom-up" regulation spearheaded by ANEEL in Brazil. Stokes (2013) points out that when the GEA was introduced there was little opposition to the FIT and microFIT programs, which she attributes to the large participation of the provincially owned utility in the electricity market. Indeed, the FIT and microFIT program was greeted with a very positive supply response, and "within the first year of their inception, the Ontario Power Authority received applications totaling over 15,000 MW, equivalent to about 43% of current Ontario electricity generating capacity" (YATCHEW; BAZILIAUSKAS, 2011).

Two of the motivating factors for the GEA are: 1) job creation, 2) environmental concerns and the need to make up the supply gap from the decision to close coal-fired generation. Ontario has historically been the manufacturing heart of Canada, but it has suffered from layoffs due to international competition. Incenting renewable energy is seen by the province as a means of creating jobs to combat this trend, thereby creating new economic development through energy and industrial policy (STOKES, 2013, p. 494).

One of the most important events related to the GEA legislation is referred to as the Korean Consortium (or Samsung) Agreement. In January of 2010, the province signed the Green Energy Investment Agreement with a Korean consortium involving Samsung. In the Agreement, Samsung was to build 2,500 MW of renewable energy generation, for which it will be paid a premium investment adder to the FIT price schedule: the Economic Development Adder, EDA, which was estimated at CND$ 437 million. Samsung will receive the adder in exchange for arranging for the installation of four new factories in Ontario to produce renewable energy infrastructure equipment. This highlights once again the main driver of the province: job creation. The results, however, have not met the initial expectations, Samsung has re-negotiated the EDA with the province, reducing its initial estimate of energy projects from 2500 to 1368 MW (STINSON, 2013), and the job figures were also reduced. Steve Cho (Vice President of Samsung in February, 2015) stated that company's investments have created 1000 manufacturing jobs in the province. In terms of institutional capacity, Yatchew and Baziliauskas (2011) caution that the Samsung Agreement is an example of how the OPA has lost some of its autonomy and is heavily subjected to the politics of the energy-related decision making in the province via ministerial directives.

At the heart of the job creation strategy of the GEA was the domestic (or local) content requirements. This meant that a minimum percentage of goods, services or labor must be sourced within Ontario. On an international scale, this brought very harsh reactions. Ontario's policy was challenged at the World Trade Organization, WTO by the European Union and Japan, who argued that "renewable energy policies based on trade protectionism should not be tolerated" (STOKES, 2013 p. 498). The WTO ruled in their favor, which according to Sinclair's analysis, was based on a very narrow interpretation of international trade law and that it "undermined support for one of the most innovative green energy policies in North America, during a period of rapidly rising greenhouse gas emissions (GHG) and dangerous global climate change" (SINCLAIR, 2013, p. 14).

Interestingly, Brazil had a FIT program with similar features to that of the Ontario GEA, Proinfa, although it did not apply to solar-PV. The impetus for Proinfa is distinct to that of Ontario, as it was linked to the supply crisis experienced in Brazil (*apagão*). It also included a capacity objective (which the Ontario FIT programs did not and) and was not renewed as the central planning in Brazil changed to auction system in order to reduce energy costs.

The original FIT design was divided into two categories; 1) microFIT for projects small than or equal to 10 kW connected to the distribution system, and 2) FIT for projects larger than 10 kW connected to the transmission system. Although the objective of this paper is on distributed generation, the FIT program will also be included in this analysis as some of the projects that fall within this category can also be considered as fitting within a broader definition of distributed generation. For project larger in size, Ontario recently established a procurement process entitled the Large Renewables Procurement, LRP.

The microFIT program targets residential, small commercial, farms, schools or other properties and offers a streamlined administration process for project approvals, with guaranteed service times. In 2010, the province noted that commercial entities were dominating the applications and decided to limited their participation in favor of other non-commercial entities as outlined in the proponent eligibility schedule (OPA, 2010). Projects must be generated from bioenergy (biogas, biomass, and landfill gas), solar-PV (rooftop or ground- mounted), waterpower or wind. The microFIT program's annual procurement target for 2014 is 65.3 MW (OPA, 2013). The FIT program was originally conceived for projects larger than 10 kW. FIT projects were subject to a Transmission Availability Test, TAT to ensure that they could be connected to the existing IESO-operated grid. If the TAT was negative then HydroOne and the OPA would conduct an economic assessment of transmission expansion for the project.

There have been recent changes to the FIT program, namely the designation of an upper limit for the project size (500 kW) and a yearly procurement cap of 150 MW, along with the new price schedules. The price schedule has changed significantly since the program's inception. This is especially true for solar projects. In 2009, the microFIT rate was 80.2 cents per kWh, which was then reduced to 64.2 cents per kWh in 2010, prior to the planned 2-year review period. In response to concerns from rural voters, the government introduced changes to limit ground mounted PV on agricultural lands (BENTLEY; ONTARIO, 2012) as well as placed a moratorium on off-shore wind.

FIT adders for aboriginal, community, municipal or public sector were also established, which increase the scheduled prices by 1.5 – 1.0 cents/KWh (OPA, 2014a). Krupa (2013) asserts that the aboriginal adder is first step in promoting the participation of this historically marginalized and vulnerable population in the energy sector. The province also initiated additional support mechanisms, such as the Aboriginal Loan Guarantee, Aboriginal and Community Energy Partnerships Program designed to facilitate the participation of these actors in the development of renewable energy (OPA, 2010).

In terms of policy impacts, the OPA (now merged with the IESO), does not release microFIT data per municipality or region, however as of 2014 there were a total of 17,773 approved applications across the province, corresponding to 158 MW of installed capacity (OPA, 2014b).

6. British Columbia's electricity sector

i. Brief History: Private to Public to hybrid

In 1961, the government of British Columbia bought the largest private utility in the province (BC Electric) and merged it with the Power Commission to create the Crown Corporation, BC Hydro. The main driver for this was to enable development of projects on the Peace and Columbia Rivers. This sort of hydro-industrialization (SEWELL, 1987, p. 521) was part of a larger trend in resource development during the 1970's, which was also identified in the Brazilian case. Indeed, in the 1960s and 1970s BC Hydro took "on some of the most ambitious hydroelectric construction projects in the world" (BC HYDRO, [s.d.]). Sewell describes that the large quantities of power produced at these sites were made available to large industrial consumers at attractive rates, thereby propelling the industrial output of the province. Haley (2014) points out that hydroelectricity in Canada has often been developed so to incite and support the extraction of other resource, which are often energy intensive industries.

Prior to 1980, when the British Columbia Utilities Commission (BCUC) was created, BC Hydro planned and managed the electricity sector in the province (DUSYK et al., 2009). The establishment of the BCUC ushered in a new period that would impact BC Hydro's planning process by bringing it to formal public and regulatory scrutiny.

As seen in the cases of Brazil and Ontario, the 1990's was a decade in which centralized (or vertically integrated) monopolies were faced with profound change: dismantling, privatization, creation of competitive markets, etc. This trend was true not only for the Americas, but globally (COHEN, 2002, p. 3). BC Hydro was very uncertain about its future during this period, not only because of global neoliberal tendencies, but also because there had been a lack of construction activity during the 1980's and the provincial utility was faced with the challenge of meeting the electricity needs of a growing economy (JACCARD, 2001). During the 1990's, Jaccard argues that BC Hydro acted as a "manager" of the electricity sector in the province, maintaining its central role by negotiating and purchasing power from independent power producers. Under the Harcourt administration (1991-1996) the government asked the BCUC to provide recommendations on market reform of the electricity sector. The commission recommended that efforts should be made to dismantle the monopoly. However, the administration could not maintain a consistent vision for the utility and in the end "explored ways of achieving some degree of market reform, primarily in terms of competitive generation and customer access" (JACCARD, 2001, p. 61).

In 1996, Glen Clark was elected. He was the former Minister of Energy and a strong proponent of maintaining government control over the monopoly. Later in 2001, the newly elected Liberal government of Gordon Campel (2001-2011) created a Task Force on Energy Policy, which released an interim report in November 2002, advocating for a deregulated system based on market prices and a dismemberment of the provincial utility into separate entities for generation, transmission and distribution (COHEN, 2002). Some of the steps have been taken in this regard, with the creation of the BC Transmission Corporation in 2003, albeit still under provincial ownership.

ii. Current Structure

The BCUC is the independent regulator in the province. Its roles are established in the Utilities Commission Act, the Lieutenant Governor appoints the Commissioner. The commission is responsible for the general supervision of all public utilities and may make orders and set standards about various physical aspects, safety, and services of the utilities, such as the filing of rate schedules.

The Hydro and Power Authority Act (originally published in 1996) created the British Columbia Hydro and Power Authority, BC Hydro. BC Hydro is a provincial Crown corporation with a mandate to generate, manufacture, conserve, supply, acquire and distribute electrical energy. BC Hydro serves 95 per cent of the province's population (BC HYDRO, 2013). In essence, BC Hydro is the equivalent to the combination of Ontario's OPG, IESO, OPA and LDCs and is the equivalent to the combination of Brazil's ANEEL (except for rate/tariff approvals), EPE, Eletrobrás plus other generators and local distributors in Brazil.

BC Hydro enters into Electricity Purchase Agreements (EPAs) with Independent Power Producers, IPPs in the province. As of August 2013, there were 81 IPPs in operation providing about 20 per cent of the electricity, which the provincial utility then distributes to its customers (BC HYDRO, 2013, p. 10). The BC Transmission Corporation, created in 2003, is another publicly owned Crown corporation. It operates, maintains, and plans BC Hydro's transmission assets and according to the Energy Plan of the province is also "responsible for providing fair, open access to the power grid for all customers" (BRITISH COLUMBIA, 2007). It is also subject to the review and approvals by the BCUC.

The public ownership of these two corporations is highly valued in the province, as expressed in the 2007 energy plan: "BC Hydro and the BC Transmission Corporation are publicly-owned crown corporations and will remain that way now and into the future" (BRITISH COLUMBIA, 2007).

iii. Energy Planning

The 2007 BC Energy Plan lays out the following two objectives for the province's electricity sector: achieving energy sufficiency by 2016 and reducing greenhouse gas emissions, GHGs. Building on the direction of the previous plan (published in 2002), the most recent version also recommits to the ban on nuclear electricity.

In addition, the report states that the main environmental goals of the electricity sector are to ensure that all new electricity generation projects will have zero net GHG emissions while existing thermal generation plants will become net zero GHG by 2016 through the implementation of clean coal sequestration technology (BRITISH COLUMBIA, 2007, p. 3, 13). Conservation and energy efficiency are also key focus points of the report as the government plans to acquire 50 per cent of BC Hydro's incremental resource needs through conservation by 2020.

To address such goals, BC Hydro has formed a "permanent stakeholder advisory committee called the Electricity Conservation and Efficiency Advisory Committee (EC&E) whose 23 members represent civil society, government, First Nations, the business community, and the energy sector" (DUSYK et al., 2009, p. 400). The EC&E is addressing conservation and efficiency in a three level strategy (individual, market, society), which differs from traditional approaches of only looking at demand side management, DSM for large customers. The net metering and distributed generation initiatives of the province fit within this structure. The Plan directed BC Hydro to create the Standing Offer Program, SOP for projects smaller than 10MW, as a means of filling in until investments in long-term generation and transmission will come to fruition with small, non-emitting electricity production (British Columbia, 2007, p. 10). Much like the Ontario document (LTEP), the BC Energy Plan (2007) is a broad strategy, rather than the technical energy plan like Brazil's EPE PDE2023. Various times the document speaks of partnerships with the First Nations people on hydro developments or community power projects, investments made in technology innovation and even an entire section on labor and skills development to maintain global competitiveness.

The provincial legislature passed the Clean Energy Act (BRITISH COLUMBIA, 2010), which specifies some similar targets set in the 2007 BC Energy Plan. It requires BC Hydro to submit an Integrated Resource Plan (IRP) to the Minister of Energy. The main goals of the IRP are set out as: 1) achieving electricity self-sufficiency by 2016 through generating at least 93 per cent of all electricity from clean or renewable sources within the province; 2) meeting at least 66 per cent of the expected increase in demand through conservation and efficiency by 2020 (BC HYDRO, 2013, p. 3).

Chapter 8 of the IRP deals with the "Clean Energy Strategy", which elaborates upon the net metering program as well as other procurement policies, such as the SOP. The IRP does specify that even while conservation and upgrading existing generation is important, new hydroelectric generating facilities will be needed to meet growing demand. BC Hydro plans to build a third dam on the Peace River, which the report insists "provides the best combination of financial, technical, environmental and economic development attributes and is the most cost-effective way to meet the long-term need for energy and dependable capacity" (BC HYDRO, 2013, p. 3). The dam is projected with a nameplate capacity of 1,100 MW or a firm production of 4,700 GWh/year.

The Site C megaproject on the Peace River is not a new proposal. In 1980 BC hydro released its Energy Blueprint in which the site was chosen based on technical merit to meet the projected growing demand for power in the province. In 1981, the newly created BCUC began reviewing the proposal and questioned whether the benefits would exceed the cost and whether it was indeed the appropriate source of supply. A formal hearings process was conducted and opposition surfaced, mainly because of the projected inundation and loss of some 2000 hectares of agricultural land. In 1983 the BCUC concluded that the Site C project would not proceed and that there was sufficient generating capacity in the province (SEWELL, 1987, p. 524). Currently, the project is undergoing another environmental assessment and is facing significant local opposition (JOHANNSON, 2015).

iv. Distributed Generation in BC

BC's net metering, NM program was established in 2004 by BC Hydro and is set out in *Rate Schedule 1289 - Net Metering Service* (BC HYDRO, 2012). The NM structure is similar to the one ANEEL set forth for Brazil: the consumer pays the net amount of electricity it consumes at a regulated rate. If the distributed generation facility generates more electricity than it consumes from the grid then BC Hydro issues the consumer a credit. However, here is the important distinction between the Brazilian and BC model: at the end of a 12-month cycle (or anniversary date of the project), any excess electricity credits are paid out by BC Hydro at a rate of 9.99 cents per kWh (i.e. they do not expire as in the ANEEL regulation). This rate is consistent with the Standing Offer Program, SOP (FRASER; BC HYDRO, 2013, p. 5). However, more than 95% of the net metering projects do not generate sufficient amounts to receive payment for additional credits.

The objective of the NM program is to allow residential or commercial customers to offset their loads, yet in the case of the BC program, the DG generator size is not limited to the size of the load (FRASER; BC HYDRO, 2013, p. Ap. D), as in the Brazilian case. In the third report on the progress of net metering prepared by BC Hydro (which stems from a BCUC order no. G-57-12 of 2012), the history of the policy in the province is outlined: the 2002 BC Energy Plan included a Policy Action No. 20, which stated that electricity distributors pursue a voluntary goal of acquiring 50% of new supply from clean electricity over the next 10 years. This is a similar mechanism as was in place in Brazil in 2004, previously elaborated upon called "*Charades Publicans*" by the distributors.

In 2002, several parties asked the BCUC to require that BC Hydro implement a simple form of net metering (FRASER; BC HYDRO, 2013, p. 3) using as a justification, the policy action No. 20 in the BC Energy Plan of the same year. Here we see that in BC, as opposed to the Brazilian case, the question of DG is linked to a larger policy objective determined by the executive branch. The Commission then directed BC Hydro to prepare an application for a net metering tariff. BC Hydro is also required by the BCUC to conduct customer outreach to educate the consumer-base on the NM program through flyers or through information included on paper bills. This could be an interesting approach for the Brazilian case, as lack of technical knowledge in small-scale consumers has been identified as a barrier for the expansion of distributed generation in Brazil (SALES, 2014); (GREENPEACE, 2013).

The results of the BC Hydro net metering program show that the regions with the largest number of projects, the Lower Mainland and Vancouver Island, are also the regions with the largest urban centers in the province (FRASER; BC HYDRO, 2013, p. 10), which is to be expected for a program that targets residential installations.

7. Discussion

As previously discussed in the Analytical Framework section, the comparison of Brazil to the Canadian province of British Columbia and to Ontario follows the: *most similar system* or *most different system* design often applied in comparative research. Through this design, it was possible to identify the importance of the two key variables; *1. Structure of the Electricity Sector*; 2. *Electricity production and generation sources* (i.e. resource base); on the emergence and type of DG policy in the jurisdictions.

In the three jurisdictions considered, large-scale and centralized electricity generation in the early part of the 20th century was often developed by governments or agencies as part of efforts to attract industrial development. Large-scale megaprojects, which were largely hydro in BC and Brazil as well as Nuclear in the case of Ontario (and two examples in Brazil), were part of a global trend in resource development at that period of time. These developments involved the investment of huge monetary sums, by the state as a means of inciting and supporting the development of other energy-intensive industrial activities in resource extraction.

The electricity sectors in the cases presented were historically natural monopolies, characterized by significant economies of scale and under state ownership and control. The costly investments, lack of third party oversight and an international wave of neoliberal thinking in the latter part of the same century set the stage for significant changes in the sectors in all of the cases. Both Brazil and Ontario underwent a similar set of reforms in the electricity market, during administrations guided by similar neoliberal principals. Ontario's reforms began in 1997 with the Harris administration and Brazils began in 1995 during the FHC (see Appendix 2 for a timeline). They resulted in the creations of regulation agencies ANEEL (Brazil) and extending the jurisdiction of the already existing OEB to cover electricity (Ontario). Interestingly, the reforms were both short-lived as the market-based structures were insufficient to attract investment and the lack of centralized planning long with natural circumstances resulted in significant black outs in 2001 and 2002 in the jurisdictions.

In British Columbia, the monopoly of BC hydro on the electricity sector was also put into question during the later-half of the century; however, although state ownership remains of a now dismantled sector, third party regulation was achieved with the BCUC and a number of Independent producers are also active in the province.

Both Ontario and Brazil underwent a second round of institutional restructuring in the subsequent administrations, and some similar features in the cases include the return to centralized planning and procurement procedures. Another interesting feature in the three jurisdictions is the presence of independent regulatory boards, (ANEEL, OEB and BCUC) which were fundamental in influencing DG and also in the regional planning process in Ontario, again pointing out how regulatory agencies can assist in policy making through a bottom-up approach.

The analysis herein suggests that the resource base available for electricity generation in the three cases, noted by availability of resources to generate hydroelectric power (or lack thereof in the case of Ontario) play a key role in the government's decision to incent distributed power. The regulatory governance around DG in the three cases was very much shaped by the nature of energy resources and endowments within the jurisdictions analyzed (EBERLEIN; DOERN, G. BRUCE, 2009).

In order to provide a brief summary of the three cases analyzed in this paper, key features of the DG policy mechanisms were included in Table 4. By organizing the data in this manner, it becomes evident that what is lacking in the Brazilian case is the insertion of the DG regulation into a larger policy framework and energy strategy.

Table 4. Summary of Distributed generation
Elaborate by C.A.G.Garcez
Sources: (ANEEL, 2012a); (OPA, 2013); (FRASER; BC HYDRO, 2013)

	Brazil	**British Columbia**	**Ontario**
Mechanism	Net Metering	Net Metering	Feed-in-Tariff, FIT
Year	2012	2004	2009
Institutional origin	ANEEL	BCUC; elaborated by BC Hydro	Ministry of Energy; elaborated by OPA
Size of projects	Micro - 100kW Mini - 1000kW	50 kW *proposal for 100kW*	microFIT 10kW FIT 10 - 500kW

Sources permitted	Solar-PV, small hydro, wind, biomass, qualified co-generation	Solar-PV, small hydro, wind, biomass, biogas, landfill gas	Solar-PV, small hydro, wind, biogas, biomass, geothermal heat, ocean
Linked to Ministry plans/policies	No	Yes	Yes
Number of projects (year)	318 (2015)	228 (2013)	17,773 (2014, microFIT only)

The likelihood that distributed generation would receive a more strategic role in electricity policy and planning in Brazil is dependent on the perceived social and environmental benefits that it could provide. At present, the predominant opinion is that only those with access to capital or financing would likely benefit from DG. The Brazilian central government does not want to be seen as promoting an elitist policy, with little or no chance for the poorest segments of the population to take advantage of it. Within the present political climate, Brazil cannot seem to find a good justification for incenting DG since the current electricity policy is highly focused at providing low cost electricity to support industrial growth and to maintain its affordability for low-income households.

The provision of electricity supply is also not equal among the three cases analyzed. The Canadian provinces of Ontario and British Columbia consumed 11.4 Mwah per capita and 15.5 Mwah per capita respectively in 2011, while Brazil's consumption was 2.8 (see Appendix 3 for socioeconomic data). Brazil energy plan is more expansionist in nature, while the plans of Ontario and British Columbia emphasize to a greater degree conservation and energy efficiency. This is not unusual for an emerging economy; especially considering its electricity consumption per capita is 4 times lower than in Ontario and 5 times lower than in British Columbia.

8. Final Considerations

The institutional and historical analysis of the electricity sectors of three cases elaborated on how, when, and why (or why not) distributed generation emerges as an issue within energy planning and energy policy agenda. In Brazil, it is found that one of the main reasons for not incenting DG is the strong perception that hydroelectric generation is a sufficiently sustainable means of expanding electricity supply. Brazilian energy institutions voice confidence in the procedures in place through the environmental approval and licensing processes to provide satisfactory safeguards for any environmental or social damages caused by such hydroelectric expansion. DG remains an issue treated within the regulatory regime and lacks various incentive to be considered as part of a broader energy policy or strategy.

In British Columbia, the hydro megaproject of Site C is included in the planning horizon of BC Hydro; however, the provincial 2007 Energy Plan does try to balance this aspect by placing emphasis on alternatives, such as efficiencies, refurbishments and conservation. The dominance of the hydro-electric regime, which is seen as sufficiently low-carbon in BC and Brazil likely influences the choice of the net metering mechanism and weak direct incentives for DG, in comparison to the Ontario. While in the case of Ontario, Climate Change and local environmental concerns, along with the aging infrastructure of nuclear and a strong economic component of job creation lead the province to adopt a more aggressive strategy for inciting distributed generation, involving Feed in Tariffs and other support mechanisms.

The analysis of the policy/regulation impacts in the three jurisdiction corresponds to broader academic understanding that the net metering mechanism does not appear to be as effective to drive market growth for DG (RICKERSON et al., 2012, p. vi). The FIT policy adopted by Ontario has resulted in more aggressive penetration of DG projects, which is the case of other European countries. In the Brazilian case, future desire to incentivize DG such that it becomes part of a larger energy policy and strategy should look to providing alternative incentives for the projects, however, direct incentives such as a microFIT seem to have low political saliency. In the Ontario case, FIT was enabled by a strong vision of environmental and industrial policy. Another possibility for Brazil would be to look to complementary elements of net-metering utilized in the province of British Colombia; in which credits generated through NM do not expire, rather are paid a SOP rate and mandatory information campaigns are conducted to inform the public of their options.

Artigo 3. Distributed electricity generation in Brazil: An analysis of Policy Context, Design and Impact[21]

Abstract

This paper analyzes the policy landscape of a new configuration for the electricity sector, distributed electricity generation, DG, which was regulated in Brazil in 2012 by the National Electricity Agency, ANEEL. The analytical framework outlines three aspects of the study: policy context, design and an impact evaluation. DG is supported through a mechanism of net metering on residential or commercial buildings for renewables, as specified in ANEEL's Normative Resolution 482/2012. The Resolution addressed interconnection and administrative issues to reduce barriers for small-scale projects to access the grid. However, a lack of direct incentives for DG, which is tied to an overarching energy policy that prefers low-cost and large-scale hydroelectric projects, has resulted in a feeble project uptake. As of April 2015 (which marks the 3 year anniversary of the Resolution), 318 projects were registered on ANEEL's generation database, with the vast majority (295) being solar PV. A liner regression model was used to explore the determinants of successful residential PV projects aggregated by state. The analysis showed that high residential electricity rates and the exemption of a state tax, ICMS are significant variables for explaining project uptake, while the strength of solar resources did not statistically affect the trend of project development.

Keywords: Distributed electricity generation, net metering, Policy analysis, Policy impacts, Brazil

1. Introduction

Distributed Electricity Generation, DG of modern and renewable energy technologies, also referred to as decentralized or localized generation is a new configuration for the electricity sector. It is stark contrast to the centralized and distant generating stations that produce electricity on a large scale, which is then fed into transmission and distribution systems. In Brazil, as in the case with many countries, there are examples of small hydroelectric or thermoelectric stations used to exclusively serve specific industries, but the historical tendency has resulted in a sector with

[21] Proposed publication for journal submission: Energy Policy (A1 Qualis ranking in for *Ciências Ambientais)*

consolidated generation via large hydroelectric dams, complemented by thermoelectric stations and some nuclear facilities.

Brazil has, by-in-large, universalized electricity access in the last half-Century, through various policies and initiatives, the most recent being Light for All (*Luz para Todos*), which began in 2003 (DINIZ et al., 2011); (OBERMAIER et al., 2012). To date, the program has resulted in providing electricity to over 15 million inhabitants. It was extended until 2014 when the 2010 Census demonstrated that 716,000 households remained without grid-electricity access (MME, 2014). The 2013 PNAD Study (National Household Sample Study conducted by the Brazilian Institute for Statistics and Geography, IBGE) showed that there were still about 1 million Brazilians[22] without access to electricity in 2012 ; almost half of which are located in the Northeast of the country and the remainder in the Amazon (IBGE, 2013).

In April of 2012, the National Electricity Regulation Agency, ANEEL published a Normative Resolution No. 482/2012, creating a new class of generators/consumers: distributed micro and mini generation. It also established corresponding interconnection standards streamlined for these projects. In essence, small-scale electricity generation (solar, wind, hydro, biomass and Combined heat and power, CHP) can connect to distribution systems across the country through a net metering mechanism without the cumbersome need to register as an energy market participant with the CCEE (*Câmara de Comercialização de Energia Elétrica*).

Previous works on DG in Brazil have focused largely on the technical aspects of the Normative Resolution 482/2012 (PINTO; ZILLES, 2014). Afonso (2013) focused on the economic viability of the current net metering, NM mechanism versus other forms of incentives for distributed generation. The present analysis, by contrast, focuses on the policy landscape surrounding the policy problem definition and the subsequent policy goals. The policy context surrounding DG in Brazil is analyzed within the broader scope of electricity planning goals. The design of the NM mechanism and the impact of the Resolution in terms of the number and spatial distribution of the projects across states are also explored. Lastly, an econometric approach is taken by creating a linear regression model to decipher the determinants of successful policy deployment between states. The linear regression shows that the electricity rates have an important impact, while the application of a state tax ICMS has negative effects on project uptake.

[22] Total Brazilian population is around 200 million.

2. Analytical framework

A simplified version of the analytical framework that has been widely applied to policy analysis (AULD et al., 2014), (PAL, 2010), (HOWLETT; LEJANO, 2013) is applied. The framework breaks down policy analysis into three components: policy context, design and evaluation, as shown in Figure 13. The evaluation of the policy deals with impacts achieved at the time of the three-year anniversary of the publication of ANEEL`s Normative Resolution 482/2012 (i.e. April 2015).

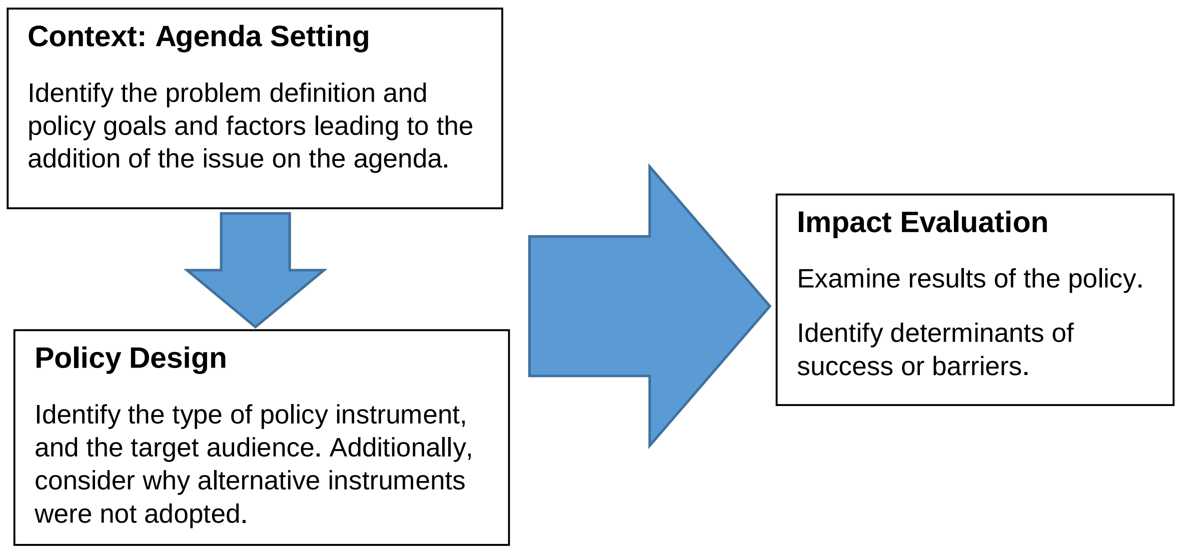


Figure 13. Analytical framework for policy analysis, adapted from AULD et al., 2014.

Data was collected from documents relevant to various normative resolutions published by ANEEL, supporting technical notes and submissions provided by stakeholders during public consultations. This analysis was complemented with semi-structured and in-depth interviews with relevant industry stakeholders, listed in Annex 1. Finally, for the policy evaluation section, data on DG projects was collected from ANEEL`s Generation Database, BIG (*Banco de Informação de Geração*) and analyzed through exploratory statistics and an econometric approach of linear regression, using the Stata software.

3. Policy Context

The process of regulating DG in Brazil was initiated and led by the department responsible for distribution services (*Superintendente de Regulação dos Serviços de Distribuição, SRD)* of the national electricity regulator, ANEEL. In 2010 SRD published the Technical Note, TN No.43/2010, to open the formal process of public consultation (*Consulta Pública* 15/2010) for discussing possibilities for regulating access to the distribution grid by small-scale generation projects. The NT explained that there already existed a patchwork of norms for small-scale generation in Brazil, but that they were not sufficient to address the needs of a simplified and streamlined process that would reduce transaction costs and be technically appropriate for the case of the distributed generation. The context within which the policy design is initiative is important because it molds the supporting rationale and problem definition, which are "inextricably bound to policy goals" (PAL, 2010, p. 8). Indeed, ANEEL's goal regarding DG is a direct consequence of the problem they identified. In the same TN (43/2010), SRD explains that it has included the goal of "diminishing obstacles for the access of small generators to the distribution system grid*"* in its yearly Regulatory Agenda (CASTRO, 2010). Their regulation efforts therefore, focused on the technical and administrative obstacles for allowing small-scale projects access to the distribution grid.

The 2010 TN also points to a growing and international tendency for increased renewable energy generation, highlighting an exogenous factor that influenced the policy context in Brazil. In the following year, ANEEL published another Technical Note (No. 25/2011) to notify of the public meeting (*Audiência Pública*) for discussing details of the DG regulation. This TN refers to the international and exogenous factor even more directly by making an important distinction between the Brazilian approach for inciting renewables and the approaches taken by other countries, justifying the need to regulate DG by stating: "the generation of electrical energy from renewable sources is a tendency in many countries…what is different in these international efforts to the Brazilian scenario are the strong incentives given for small-scale distributed generation, including projects connected to low voltage grids"[23] (ANEEL, 2011).

The international context for renewable energy incentives, especially after the 2008 sub rime crisis and its long-standing effects on the global economy is a factor that has arisen in the interviews conducted with sector participants. Referring to this scenario, one of the electricity

[23] Translated from original in Portuguese: *A geração de energia elétrica a partir de fontes renováveis é uma tendência em diversos países... O que diferencia esse movimento internacional do cenário brasileiro é o fato de haver forte incentivo para a geração distribuída de pequeno porte, incluindo a conectada na rede de baixa tensão.*

sector stakeholders states that foreign interest in the renewable energy market in Brazil has increased since the 2008 crisis by saying; “the difficulty, possibly, to expand their business in Europe and the interest to look to Brazil and recognize that here there are 70 million customers, there’s sun and there’s wind”[24] (Brasilia, 2014). Brazil is, indeed, an interesting market for modern forms of renewable energy generation, especially solar PV and wind, which has spurred interest not only in European firms, but also in also Chinese manufacturers[25].

ANEEL’s reasoning for regulating DG, by highlighting the lack of incentives for small-scale generation in Brazil, contrary to an international tendency, can be understood within a perspective of international policy diffusion. Policy diffusion models postulate that states emulate each other for three main reasons: to learn from successful innovations; to compete with each other; and to appease internal public pressure to adopt policies (BERRY; BERRY, 2014). Or more eloquently put, “in the field of public policies, the adage ‘very little is created, almost everything is copied’ seems to be valid” (BURSZTYN, 2008, p. 35).

In the case of ANEEL’s regulation for DG, evidence has been found to support the notion that policy diffusion in Brazil was predominantly spurred by the first and last items on Berry and Berry’s list, rather than by competition with other nations. ANEEL’s motivation for regulating distributed generation is linked to an overall agenda of learning for smart grid applications, evident in their support for research and development projects in this area (KAGAN et al., 2013), (DUTRA et al., 2013). Distributed generation, which allows for two-way flow of energy and possible storage, is expected to be a key ingredient for smart grid architecture. Furthermore, the image of ANEEL as one with an innovative culture, especially with regards to smart grid activities was raised in interviews held with stakeholder of the electricity sector.

With regards to the third item on Berry and Berry’s list; public pressure, this has been observed in Brazil through various actors advocating for the central government to prioritize modern forms of renewable energy, albeit, with a larger emphasis on solar PV. The source of this pressure is from a heterogeneous group, which cannot be considered to form a well-defined coalition. Environmental NGOs such as Greenpeace, are calling for an energy revolution in the country (BAITELLO; TINOCO, 2010). Social groups such as the “Energy for Life” (ENERGIA PARA A VIDA, [s.d.]) and the Movement of Peoples Affected by Dams (*Movimento dos Atingidos*

[24]Translated from original in Portuguese: *A dificuldade, de repente, de expandir mais os negócios na Europa e o interesse de olhar para o Brasil e falar assim, ‘Aqui tem 70 milhões de consumidores, tem sol, tem vento’.*

[25] Two Solar-PV panel manufacturers will be installing locations in Brazil in 2015; BYD (China) in Campinas-SP (LAGUNA, 2014) and Brasil Solair in partnership with Linuo (China) in João Pessoa-PB (BRASIL SOLAIR, 2014). Additionally there is one factory already in operation in Campinas-SP; Thechnometal, of Brazilian and Germany origins.

por Barragens, (MAB, [s.d.]) are calling for a new direction in energy planning away from large hydro and nuclear, by prioritizing social aspects of energy production and use. In the economic sphere, various industry groups have described a retreating "window of opportunity" for Brazil to consolidate a national and innovative PV sector, especially considering the abundance of tropical sunlight (ABINNE, 2012); (COGEN, 2012). Reports prepared by public institutions, such as the *Centro de Gestão e Estudos Estratégicos* (CGEE) of the Ministry of Science and Technology, MCT (CGEE, 2012), (MOEHLECKE et al., 2010) and the *Grupo de Trabalho de Geração Distribuída com Sistemas Fotovoltaicos, GT-GDSF* of the Ministry of Mines and Energy, MME (MME, 2009) attest to growing interest in supporting renewable energy innovations in Brazil.

Even if environmental, social, and economic/strategic concerns have been voiced in Brazil in support of DG, the policy problem, as defined by ANEEL is a technical one of reducing barriers for small-scale generation to access the distribution grid. For this reason, the policy goals are related to interconnection standards, administrative procedures and tariff considerations. This is not surprising since ANEEL is the electricity regulator and not the energy policy-maker in Brazil. Furthermore, in their NT 43/2010, the expected benefits of DG, as expressed by ANEEL, are almost entirely related to technical or economic benefits for the electricity system, as listed below:

> delaying investments in for the expansion of distribution and transmission systems; low environmental impact; short implementation time; reduced loads on the grid; decrease in distribution losses, improved voltage in the grid during peak times; provision of ancillary services such as reactive energy; increased reliability in service delivery, since isolated generation could continue in the case of system failures; and the diversification of the energy mix (SRD/ANEEL, 2010, sec. 13).

4. Policy Design & Instrument Choice

ANEEL`s Normative Resolution 482/2012 (ANEEL, 2012b) and Normative Resolution 517 (ANEEL, 2012d) currently set out the regulatory basis for DG in Brazil. Resolution 482 permits DG through a mechanism of net metering, NM (*Sistema de Compensação de Energia Elétrica, SCEE*), which is sub-divided by size: micro-generation up to 100kW and mini-generation up to 1000kW (1MW), for the following sources: hydropower, solar, wind, biomass, or cogeneration. These are referred to as incentivized sources (*fontes incentivadas)* and are defined by Federal Law 9.427/1996, the same law that created the electricity regulator, ANEEL.

ANEEL published a parallel resolution 481/2012 that gave solar energy the same discounts enjoyed by other "*fontes incentivadas",* for two electricity system fees: TUST *(Tarifa de Uso dos Sistemas de Transmissão*) in the case of transmission lines and TUSD (*Tarifa de Uso dos Sistemas de Distribuição*) in the case of distribution lines. The discount corresponds to 80%

of the fees during the first 10 years of operation, which reduced to 50% upon the 11th year of operation (ANEEL, 2012a).

Distributed generation projects are permitted on residential properties (ownership by a *pessoa física*) or non-residential location (ownership by a *pessoa jurídica,* such as schools, research institution, sports complex, commercial buildings, etc.). Resolution 482/2012 grants access to the distribution grid for projects with due connection requirements and required that all distribution companies make changes to their internal procedures to comply with the regulation within 240 days of its publication. The DG projects do not have to sign commercialization contracts or register with the CCEE; instead, operating licenses are issued to the consumer.

ANEEL emphasized (in Technical Note No. 20/2012, which analyzed the contributions of the public meeting No. 42/2011) that the mechanism of net metering is not intended to stimulate excess electricity generation. For this reason, project sizes are to be limited to the quantity of electricity consumed in the establishment. The accumulated credits will expire after 36 months (SILVA FILHO et al., 2012), removing any incentive to over-size the project. In essence, the net metering allows consumer to offset their electricity consumption (PINTO; ZILLES, 2014). The reasons for the sizing stipulation and credit expiration, again, are linked to a choice made by ANELL through the net-metering mechanism, not to provide any economic incentive to produce excess electricity from the DG projects that would then feed into the grid. This is a policy feature that will be explored further in the article, but can act as a hindrance to DG economic viability and project uptake.

The mechanism chosen to enable DG is an important feature of the policy analysis. The two most common instruments for DG found in literature are: net metering, NM and Feed-In-Tariffs, FITs. Net metering is considered a more straightforward mechanism; the consumer uses the energy produced by their DG facility, if there is excess power produced then it will flow into the power grid and the consumer will be credited for the amount, (i.e. met metering offsets behind-the-meter loads). During the periods in which the DG facility is not producing electricity, energy flows from the power grid for their consumption. At the end of a pre-determined period, either the consumer is compensated for any unused credits or the credits may simply expire. Net metering, as opposed to FIT involves an electricity bill credit rather than an incentive payment or long-term contract, which is cited as a barrier to securing financing for the projects. Finally, NM “is typically enacted in combination with other incentives such as rebates or grants since net metering on its own has historically been insufficient to drive market growth” of renewable energy (RICKERSON et al., 2012, p. vi). In the Brazilian case, future desire to incentivize DG beyond that of the ANEEL regulation, this issue will have to be addressed.

Resolution 517/2012 was published by ANEEL to further clarify Resolution 482/2012 in an effort to have DG be exempted from the state tax, ICMS (*Imposto sobre Circulação de Mercadorias e Serviços*). ANEEL emphasizes that NM is not a commercialization of energy, but rather an arrangement in which active energy is injected into the distribution system by means of a free loan to the distribution company. The generator will be credited for the energy, which will subsequently be discounted from their energy consumption bills. Furthermore, the changes introduced by Resolution 517 removed the possibility of virtual net metering, indicating that the generation credits could only be used by the a consumer with the same social security number, CPF (*cadastro de pessoa física*) or corporation number, CNPJ (*cadastro nacional de pessoa jurídica*) as registered to the DG facility. ANEEL explains the reason for this change Technical Note No. 163/2012, indicating that it was made in reaction to a communication the agency received (October 11, 2012) by the Council of State Finance Secretaries, CONFAZ, stating their intent to apply the ICMS tax to energy produced from distributed generation projects.

Even with the updates made in Resolution 517, the CONFAZ council maintained their position, as specified in the "*Convênio ICMS 6/2013*", that net metering is indeed an operation of selling and purchasing energy and that states can collect the tax over the amount (CONFAZ, 2013). All but one State, Minas Gerais was acting in accordance to the CONFAZ understanding. Minas Gerais has exempted the energy generated from micro and mini projects that adhere to the Resolution 482 from the ICMS tax for a period of 5 years (MINAS GERAIS, 2013). Other states are debating the issue, such as Tocantins and Rio de Janeiro. ICMS is a key feature that will be explored in the article during the evaluation of the preliminary results of DG in Brazil. The Brazilian agency associated with the Ministry of Mines and Energy that is charged with producing energy planning studies, EPE (*Empresa de Pesquisa Energética*) has stated that net metering in Brazil has been "doubly punished", by not allowing for virtual net metering arrangements, while continuing to be taxed the ICMS amount (EPE/MME, 2014b, p. 10–11). On April 22, 2015 CONFAZ finally did authorize the exemption of the ICMS state tax on the internally consumed portion of energy generated from DG project registered under ANEEL 482 (CONFAZ, 2015), however, since it is a confederation of finance ministers, it lies with the individual states to adhere to the new understanding or not.

Interestingly, in Brazil there is an innovative and successful example of states utilizing the ICMS tax to induce environmental conservation. The economic instrument has come to be known as the "green ICMS" (*ICMS Ecológico*). In essence, the state redistributes the ICMS tax revenues based on environmental criteria, rewarding municipalities that perform better at forest or water conservation (YOUNG, 2005). The possibility of including DG as a criteria within the "green ICMS" scheme could be a promising policy intervention at the state level.

ANEEL recently began the process of public consultation to increase the allowed size of net-metered projects from 1MW to 5MW (*Consulta Pública*, CP 5/2014). The consultation was spurred by a request from the association of cogeneration industries, COGEN, citing the benefits of cogeneration in Brazil if the limit for DG was increased. There has been no decision as of yet, the issue is scheduled to be debated on 2015 in the format of a public meeting (*Audiência Pública*). Although the CP 5/2014 was not intended to discuss the ICMS tax, the issue was once again raised as a barrier for DG in Brazil (SRG-SRD/ANEEL, 2014).

Pal would characterize the conflict between the view held both by ANEEL and EPE, which considers that DG has been penalized by ICMS, and on the other had the position taken by CONFAZ to continue applying the tax; as a lack of vertical consistency in the policy. Vertical consistency deals with the expectation that "programs and activities undertaken in its name are logically related to it" (PAL, 2010, p. 12), which is different than internal consistency, in which the policy elements; definition, goals and instruments are coherent.

Pinto and Zilles (2014, p. 47) speculate that net metering was chosen instead of a feed-in-tariff, FIT in the Brazilian case because solar PV has already (or will soon likely) reach grid parity in most distribution areas and a FIT "means a subsidized cost, which is against the current energy policy of the country". ANEEL's Technical Note No. 25/2011 included an analysis of economic competitiveness for solar PV projects. They considered that at the levelized cost of $R 500-600 per MWh, grid parity is reached for some nine distributors (there are 47 in total in Brazil). EPE's analysis is more conservative, their most recent report estimates that the currently levelized cost for solar PV projects are between $R670-$630/MWh. Considering an average residential tariff in Brazil, grid parity will be reached in 6-7 years i.e. around 2021- 2022 (EPE/MME, 2014b, p. 27).

The same EPE report points to the main factor for the lack of incentives for small-scale renewables, especially solar PV in Brazil; "it is important to highlight that direct incentives for solar energy, which exist in many countries, are the consequence of a need to increase the participation of renewable sources in their energy mixes, which is not the case for Brazil"[26] (EPE/MME, 2014b, p. 54). The allegation that Brazil already has a low-GHG electricity mix is echoed repeatedly and is the result of decades of investments made in numerous, large-scale dams on many of Brazil's

[26] Translated from original in Portuguese: é importante destacar que os incentivos diretos para energia solar, existentes em diversos países, são consequência de uma necessidade de incremento da participação de fontes renováveis na matriz elétrica, fato que não acontece no Brasil.

important rivers. In the last few years, however, Brazil has suffered from low rains and unfavorable reservoir levels. A report published by the Ministry of Energy/EPE (EPE 2014) shows that hydroelectric generation decreased by 6,3% due to low water levels and that the gap was filled by an increase in thermoelectric generation, mainly natural gas. In the electricity sector in 2013, the increase in greenhouse gas emissions, GHG emissions (relative to 2012) was 82.5% (EPE/MME, 2014c, p. 6) , while in 2012, the sector's emissions were up by 92% (relative to 2011) (EPE, 2013, p. 15–16)**.**

According to an article published by Vahl and Casarotto (2015), the increase in GHG emissions from the electricity sector is an unfortunate beginning of a new technological path dependency on more thermoelectric generation in Brazil:

> Such path dependence will drive the Brazilian energy transition away from desired GHG reduction targets and stakeholders' needs. Alternative greener technological paths may be created, through incentives for renewable and distributed generation adoption and smarter use of natural gas, although these must match large industries' interests. (VAHL; CASAROTTO FILHO, 2015, p. 228)

In addition to the environmental benefits of DG being viewed as week by decision-makers in comparison with low-carbon hydro, Brazil is also extremely concerned with providing low-cost electricity to incent a growing, competitive and emerging economy. Brazil's official energy planning document is anticipates a growth in electricity consumption in average of 4.3% per year during its 10-year planning horizon (until 2023) (EPE/MME, 2014a, p. 35). This projection corresponds to a growth to 92,714 MW in installed capacity for the entire national electricity system in 2023 from the present capacity of 65,830 MW (EPE/MME, 2014a, p. 41). The same report explains that between 2014-2018; 16,090 MW of hydroelectric energy will come online, 15,605 MW (97%) of which is in the North region of the country (primarily in the Amazon biome); 11,000 MW of which is specifically from the Belo Monte Dam on the Xingu river in the state of Pará. Within the timeframe of 2019 to 2023, an additional 14.679 MW of hydroelectric capacity is to be built, 78% in the North of the country (EPE/MME, 2014a, p. 79-81). Brazilian economist, Ricardo Abramovay quotes anthropologist Michael Cernea, referring to the rhythm of new hydroelectric constructions in the Amazon as "a tsunami of dams" (ABRAMOVAY, 2014).

Within this expansionist scenario, it is seems unlikely that DG will receive strong incentives, also because the very fundamentals of the current Brazilian electricity policy is "*modicidade tarifária*", which can be understood in English as affordable or low rates. Brazil has pursued this objective aggressively. For example, in 2012, the Executive branch introduced the temporary measure, *Medida Provisória* 579 (BRASIL, 2012), later became Federal Law 12.783/2013 (BRASIL, 2013). The objective was to reduce electricity tariffs by anticipating and negotiating the renewal of long-term generation and transmission contracts. As a result of this initiative, electricity tariffs were reduced by an average of 20% (across all consumer types for the entire country), while residential rates were reduced by an average of 18% (ANEEL, 2013).

There are some United Nations sponsored reports that try to address the issue of how a developing country can recover the increased costs of renewables by recommending that they take advantage of international funds or suggest recovering costs from the national budget rather than affecting the rate-payers (RICKERSON et al., 2012, p. 80); (FULTON, 2011). Furthermore, a recent study by the Inter-American Development Bank, IDB insists that accounting for societal benefits more than makes up for the traditional economic imbalance which often disfavors renewable energy deployment. This can include avoided pollution, avoided ecosystem impacts and job creation (VERGARA et al., 2014).

André Gorz (1923-2007)'s prognosis for the fate of small-scale electric technologies, in relation to the predominant regime he analyzed in France is poignant for the Brazilian case (by considering that parallels can be drawn between large-scale hydro and nuclear in terms of political and economic interests). According to Gorz, small-scale projects circumvent and threaten the very logic of capitalism:

> The development of light technologies relying on geothermal and solar energy would have an entirely different economic nature, and are thus of no interest to capital. For investment would be decentralized, and the technology could be learned and used by even small communities or individuals. There would be no need to transport energy (especially solar energy), and large units would have no advantage at all over small ones. Thus no firm, no bank, no government body would be able to monopolize these technologies. They would give local groups and not-yet-industrialized nations a high degree of independence, and they would make a completely different kind of development possible. This is the "alternative" that capitalism fights with all its might, Le Suvage, April 1975. (GORZ, 1980, p. 113).

In summary, ANEEL has created, within its competencies, a regulation for the net metering of small-scale, decentralized generation in Brazil. It has incited much interest in the country and appeals to a large and heterogeneous group of stakeholders, including NGOs, industries, etc. Distributed generation, as a policy however, is lacking direct incentives based on current directives in electricity policy, which favors large-scale hydroelectric generation at low-costs to consumers, as described by Gorz. Issues of indirect incentives as well as communication outreach will be further explored in the next section.

4a. Complementary Incentives

Through the mechanism of net metering, DG is not receiving strong direct incentives in Brazil. There are some additional direct and indirect economic incentives that deserve to be highlighted within the broader context analyzing the public policy for DG, which will be explored in this section.

i. Federal Taxes

There are various federal taxes and tax programs that have established special rates or full exemptions from industrial or import taxes for equipment associated with renewable energy generation technology. They are not, however, not specific to distributed generation. These tax incentives can be considered as indirect incentives for DG, as they reduce the cost of equipment, but not necessarily the final cost of the DG system (which includes other items such as financing, installation, etc.):

- The PADIS program *(Programa de Apoio ao Desenvolvimento Tecnológico da Indústria de Semicondutores)*, which specifies full exemption of PIS/PASEP (*Patrimônio do Servidor Público*) and COFINS (*Contribuição para o Financiamento da Seguridade Social*) as well as the Industrialization tax, IPI (*Imposto sobre Produtos Industrializados*) and includes import tax (Imposto de Importação) (AFONSO, 2013, p. 86; SILVA, 2015, p. 34);
- A Federal Law regarding informatics (*Lei da Informática*), No. 12.431/2011, which laid out various tax incentives for the production of equipment related to electricity generation.

ii. Financing for small-scale projects

Considering that the intended market for DG is mainly small businesses or households, the question of providing small-scale loans is an issue that has been raised as an important challenge for its successful deployment. The economic analysis provided by ANEEL and EPE has dealt with the issue of reaching grid parity between rising electricity tariffs and reductions in the levelized costs of solar PV systems. However, Silva (2015) asserts that "it is not enough for the distributor's rates to justify investment by the consumer, it is necessary to have favorable financing conditions[27] (DA SILVA, 2015, p. 31)

The Brazilian Development Bank, BNDES (*Banco Nacional de Desenvolvimento Econômico e Social*) offers various lines of credit for energy efficiency and renewable energy (*Projetos de Eficiência Energética, PROESCO* and *INOVA Energia*), as well as a specific line of credit associated with the FundoClima program of the Ministry of the Environment. These,

[27] Translated from original in Portuguese: "não basta que a tarifa da distribuidora justifique o investimento pelo consumidor; é necessário financiamento em condições favoráveis".

however, are loans at special rates to developers of large-scale projects[28]. The Development Bank for the Brazilian Northeast, BNB (*Banco do Nordeste*) also funds larger-scale projects, through the FNE Verde program.

Currently, two lines of credit were identified for residential-scale projects (*pessoa física*) in Brazil, which to do not offer such advantageous rates when compared to those from BNDES or FundoClima;

- Caixa Econômica Federal (CEF) allows for the purchase of Solar-PV or small-scale wind equipment via their "ConstruCard" line of credit, which charges approximately 1.85% per month depending on the payment period (CAIXA/CEF, [s.d.]).
- Banco do Brasil offers the *Crédito Material de Construção*, interest rates vary from 2.72% per month to 3.21%, depending on the payment period (BANCO DO BRASIL, [s.d.])

The issue of financing again highlights the question of policy consistency that Pal (2010) raises: the supporting features of the DG policy are not in harmony with the goal of reducing barriers for small-scale generation. If the target of DG is intended to be predominantly households or small businesses, then the lack of incentives or viable financing for the scale of projects that they can develop is an impediment to the deployment of DG in Brazil.

iii. Information campaigns

There is indication in Brazil that the public misunderstands (to a certain extent) what DG is. Specifically, in a study conducted by the *Instituto IDEAL*, they identified a lack of understanding between solar water heating technologies in Brazil and solar PV panels used to generate electricity (GTZ; INSTITUTO IDEAL, 2010). Furthermore, there is a sense within public institutions, even at the federal level, that DG is a synonymous with that rural electrification, an issue that Brazil has already tackled through previous policies. To this end, various targeted information campaigns have been developed to promote DG and orient consumers about the Normative Resolutions. Table 5 shows some of these campaigns. Two of which were developed by the Instituto IDEAL in partnership with ANEEL, another was published exclusively by Greenpeace. Targeted information campaigns are identified as policy persuasion instruments in Howlett's taxonomy (2009).

The complementary policy elements elaborated upon in this section do not correspond to a coherent policy for DG in Brazil, but rather a list of initiatives that enable, without strongly

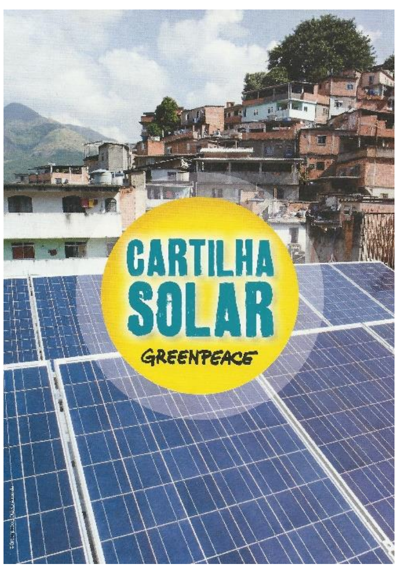
[28] 9% per year for the PROESCO line and 5% per year for the FundoClima line (MME/EPE, 2012)

supporting DG deployment. This is an issue that even EPE has recognized in its most recent report dealing with small-scale solar PV installations in Brazil; “In order to have a more accelerated trajectory of solar PV penetration, distributed generation and photovoltaics, must be treated outside the regulatory environment and be considered within the formation of national energy policies”[29] (EPE/MME, 2014b, p. 54).

Table 5. Information campaigns to support distributed generation in Brazil

(AMÉRICA DO SOL; INSTITUTO IDEAL)

(INSTITUTO IDEAL, [s.d.])



(Greenpeace, 2013)

(ANEEL, 2014b)

[29] Translated from original in Portuguese: “Para que haja uma trajetória mais acelerada de penetração da geração fotovoltaica é preciso que a geração distribuída, e a fotovoltaica, deixe de ser tratada somente no âmbito do agente regulador e passe a ser considerada na formulação das políticas energéticas nacionais”

5. Evaluation of preliminary policy impacts

The objective of the remaining portion of the article is to evaluate the preliminary results of the Normative Resolutions that regulate DG in Brazil. Here, data available on the DG projects in Brazil as well the determinants of successful project adoption are explored. Data was taken from ANEEL`s Database on Generation, (*Banco de Informação sobre Geração,* BIG) in April 2015, which corresponds to the 3rd anniversary of the publication of the resolution.

5a. Exploring the data

Exploratory data analysis, EDA is a tradition that stems from the seminal work by statistician John W. Turkey, who often "likened EDA to detective work" (BEHRENS, 1997). The emphasis here is to focus on a substantive understanding of the data, which can lead to tentative model building by determining plausible relations between explanatory variables (SELTMAN, 2012).

ANEEL provides the following information for each of the DG projects in their public database: location (municipality and state), technology type, installed capacity, and name of project developer. From this data, two dependent variables were created: aggregated number of project by state and aggregated project capacity (in kW) by state, as seen in Table 6. Independent variables were included in the model such as, the electricity rate or tariff, which, as described previously in the article is a fundamental economic competitiveness consideration for DG. In order to account for natural resources, i.e. solar radiance and wind speed, the data was taken from the RETScreen software package. Furthermore, the municipal Human Development Index, HDI for the projects was obtained from the UNDP in order to serve as a proxy to socioeconomic status for the specific location of the project. When the data was aggregated to the state level, the Brazilian Statistical Agency, IBGE was also consulted to obtain income per capita, population and population density. The data was analyzed using the Stata 14 software package.

Table 7 summarizes the DG projects. It is quite apparent that solar PV installations are the most common, both in number of projects as well as in cumulative installed capacity. The results also shows that the non-residential applications are much larger in capacity, which is intuitive, as they are installed in commercial applications as well as some public institutions (schools, research institutions and government buildings). This group of projects also includes several sports complexes e.g. Arena Pernambuco with 967kW, Maracanã with 360 kW. It is a highly heterogeneous group. Curiously, only three biogas projects and no combine heat and power, CHP or small hydro projects that are registered. Detailed project data per state is included in Appendix 4.

Table 6. List of variables

Variable	**Description (Unit)**	**Data Source**
Dependent variables		(ANEEL, 2015a)
CapInst	Aggregated capacity (KW) per State	
NumProj	Aggregated number of project per State	
Independent variables		
TechType	Projects were categorized as; Solar-PV (1); Wind (2); biogas (3)	(ANEEL, 2015a)
PropType	The value of 1 was assigned to residential installations; the value of 2 for non-residential	
ICMS	A binary or *dummy* variable. It represents a piece of qualitative information, which (WOOLDRIDGE, 2011, p. 215) indicates are used to represent choices that are made by individuals or other economic entity. The value of 1 is attributed to the for the cases that Brazilian States have chosen to continue charging the ICMS tax on DG, while the value of *zero* indicates that ICMS is not being charged.	(EPE/MME, 2014b)
HDI	Municipal Human Development Index, 2010	(UNDP et al., 2013)
ElecRate	Residential Electricity Rate ($R/MWh). The data collection and assignment presented a challenge because in some states, there are multiple distribution companies and the location of each project had to be traced back to a certain concession or regulation area in order to assign the appropriate tariff.	(ANEEL, 2015b); (ANEEL, 2004)
Resource	Resource Solar (kWh/m2/d); Wind (m/s) The data was obtained from the RETScreen/NASA built-in database of climate conditions for sites around the globe. However, for some smaller cities not listed in the database, approximated values were used.	(CANADA, 2012b)
Pop	Estimated Inhabitants in 2014	(IBGE, 2014)
popden	Population Density (inhab/km²)	
income	Income Per Capita, monthly 2014 ($R)	

Table 7. Summary of DG projects by technology and ownership type
Source: (BIG/ANEEL, 2015), elaborated by C.A.G. Garcez

Type	**Ownership**	**Installed Capacity (kW)**	**Number of Projects**
Solar PV	Residential (PF)	831.71	209
	Non-residential (PJ)	3,117.61	86
Wind	Residential (PF)	29.03	12
	Non-residential (PJ)	22.78	8
Biogas	Residential (PF)	242	2
	Non-residential (PJ)	35	1
Total		**4278.13 4.3 (MW)**	**318**

When compared to the outlook for electricity expansion in Brazil or even present installations of 126,743 MW (EPE/MME, 2014c, p. 44), the amount of DG projects and associated capacity listed in Table 7 do not represent very much at all. To quote one of the stakeholders interviewed: “C*omo se diz aqui no Brasil, isso nem dá cosquinha*” (As we say here in Brazil, this is not even a little tickle).

The distribution of solar and wind projects by state is shown in Figure 14, while the Figure 15 shows the same distribution by installed capacity. Two States dominate the preliminary data in terms of number of projects, Minas Gerais and Ceará. Almost all of the projects in Minas Gerais (50 of the 51) are Solar-PV. Ceará has a very different type of division; 15 of the total 41 DG projects in state are small wind. Ceará is home to 26% of the operating wind farms in Brazil (68 of 265 projects in the BIG/ANEEL database). It is a state with very good and constant wind speeds, as shown in Appendix 5 (AMARANTE et al., 2001), which is a plausible explanation for the corresponding number of small wind in the State. In terms of natural resource for Solar-PV, Minas Gerais does not have the best solar radiances in the country (see Map in Appendix 5), a factor, which will be further explored in the regression analysis for residential PV projects in the next section of the article. Figures 16 and 17 show project uptake by technology and ownership type. In terms of installed capacity, there are a few, larger commercial projects that influence the distribution shown in Figure 15, namely; the sports complexes of Arena Pernambuco (967 kW) and Maracanã in Rio de Janeiro (360 kW).

Only three biogas projects were registered in ANEEL’s BIG database, two of which are in the State of Paraná, a large agricultural and pork producer, while the other is in the state of Minas Gerais.

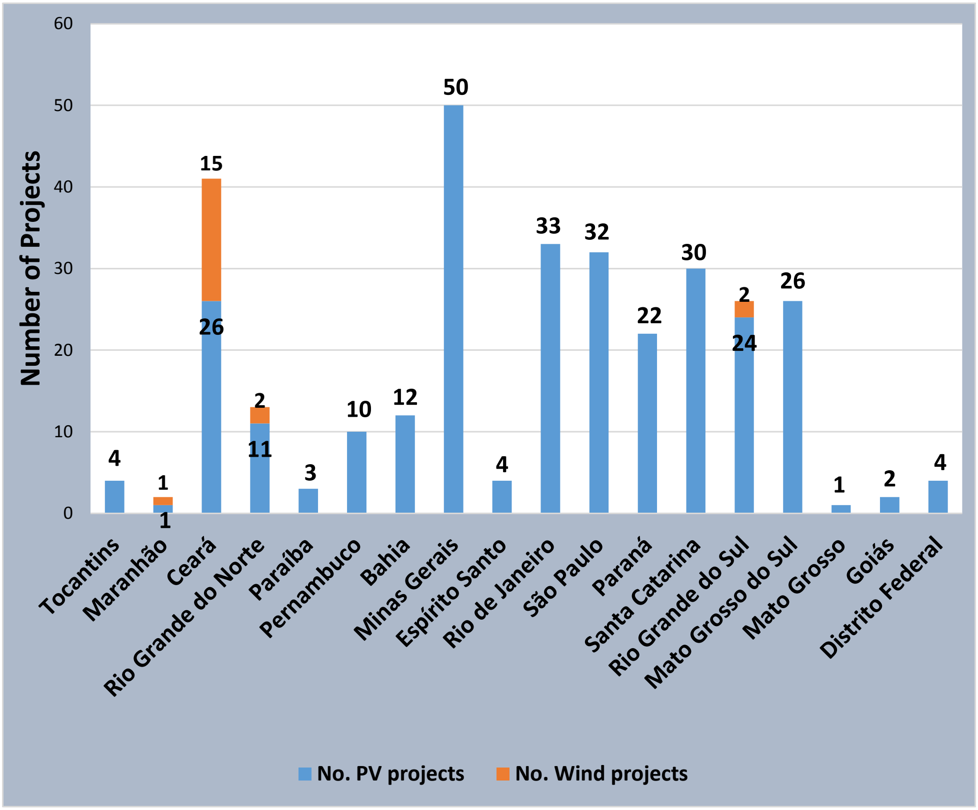


Figure 14. Distributed generation projects (solar and wind), by state
Source: (BIG/ANEEL, 2015), elaborated by C.A.G. Garcez

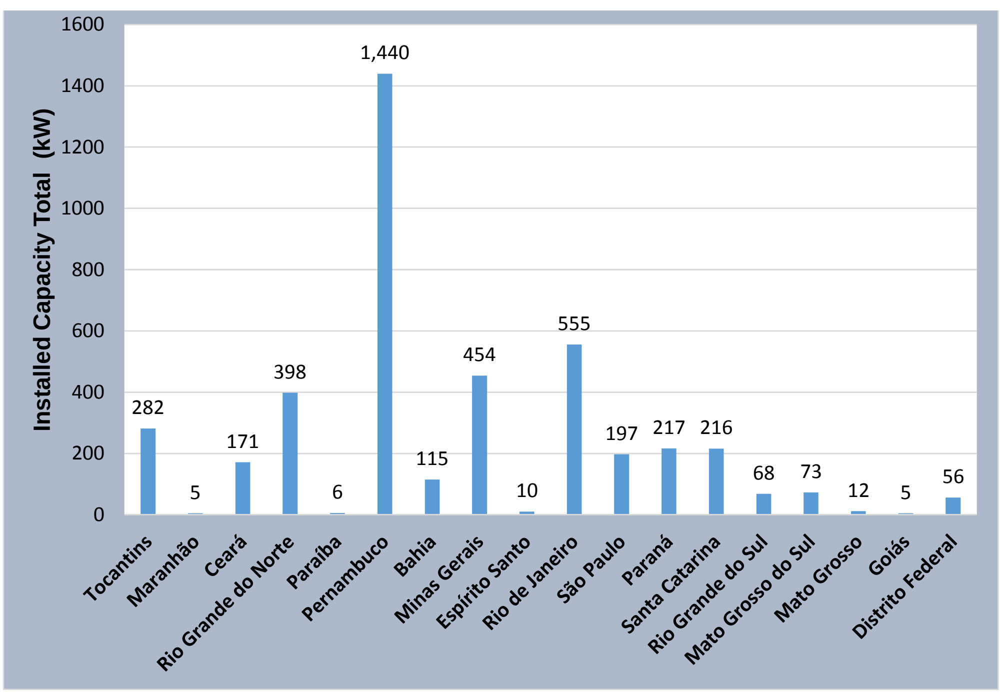


Figure 15. Distributed generation projects, total installed capacity (kW) by state
Source: (BIG/ANEEL, 2015), elaborated by C.A.G. Garcez

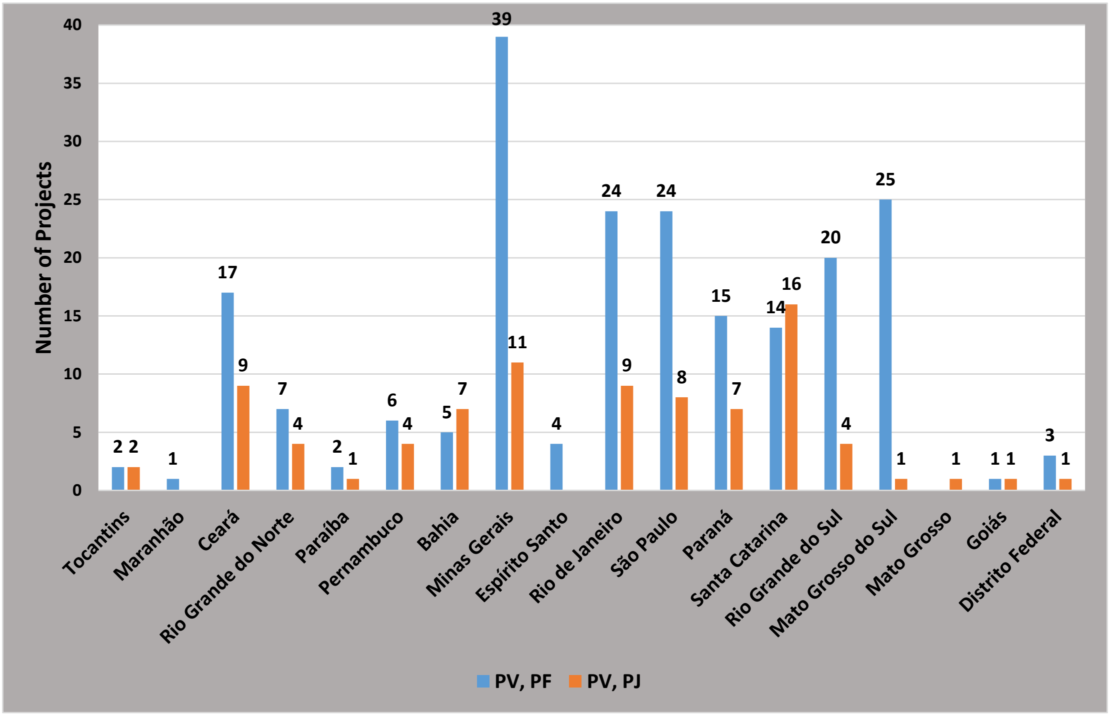


Figure 16. Solar PV projects at household (pessoa física, PF) and commercial installations (pessoa jurídica, PJ)

Source: (BIG/ANEEL, 2015), elaborated by C.A.G. Garcez

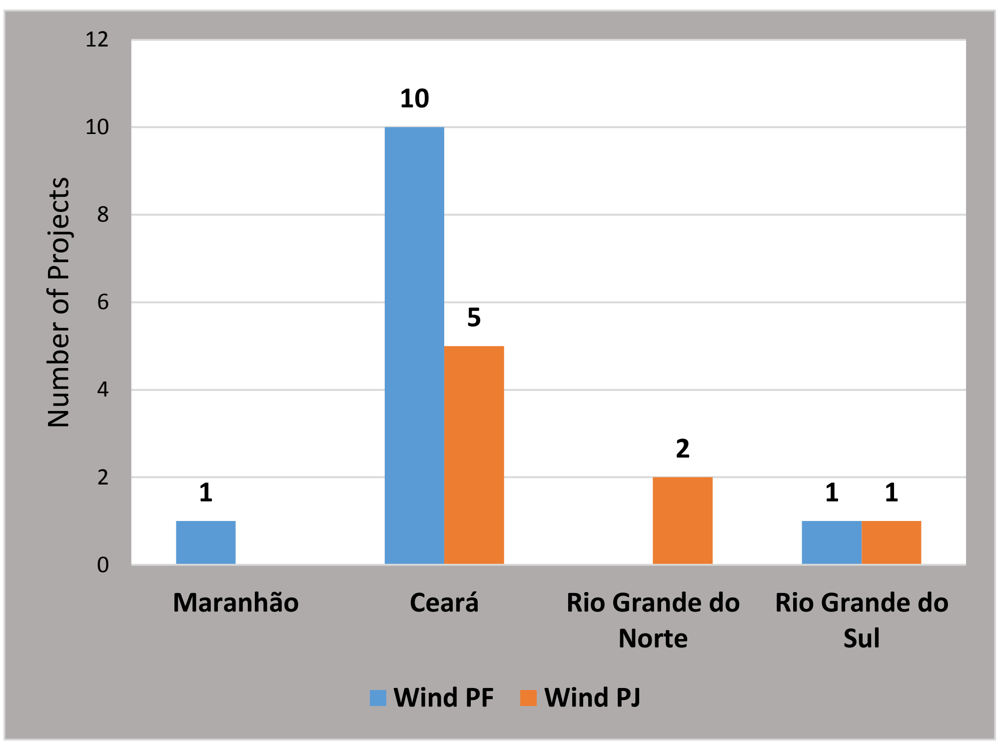


Figure 17. Small wind projects at household (pessoa física, PF) and commercial installations (pessoa jurídica, PJ)

Source: (BIG/ANEEL, 2015), elaborated by C.A.G. Garcez

One of the most standard techniques of exploratory data analysis is to compute the Pearson correlation coefficients, PCC (with values ranging from -1 to 1) for the variables in the dataset. This is helpful in providing initial indications of relations between variables. The coefficients are not a measure of causality, but of the strength or magnitude in the linear relationship between two variables. The PCCs for all the variables in the model (specified in Table 6) were calculated in Stata and are shown in Table 8. Along the diagonal of the matrix the values are 1, as expected.

Table 8. Pearson correlation coefficient matrix for all variables

	CapInst	NumProj	ICMS	HDI	ElecRate	Resource	Pop	popden	income
CapInst	1.0000								
NumProj	0.8767	1.0000							
ICMS	-0.7733	-0.6181	1.0000						
HDI	0.0414	0.2323	-0.0637	1.0000					
ElecRate	0.4415	0.6111	-0.4888	0.4887	1.0000				
Resource	-0.1819	-0.4115	0.0935	-0.6305	-0.6692	1.0000			
Pop	0.6201	0.5578	-0.2618	0.2087	0.1536	-0.2370	1.0000		
popden	0.0499	0.0464	0.1246	0.3665	-0.1569	-0.0839	0.1604	1.0000	
income	0.1574	0.2512	-0.0188	0.7101	0.1797	-0.4283	0.2314	0.6887	1.0000

From Table 8, it is evident that the dependent variable NumProj is most closely correlated with independent variables ICMS, ElecRate and Population. While the other dependent variable CapInst, is also most closely correlated to the same independent variables. ICMS, a dummy variable, is negatively correlated to the two dependent variables. This means that applying the ICMS tax affects negatively the number of projects or accumulated installed capacity.

Solar radiance represented by the variable ‘Resource’ also a negative correlation with both dependent variables, which is not intuitive. Common sense indicates that high resource (i.e. strong solar radiance) would result in higher rates of project adoption, but the data show that this is not the case. This is an interesting feature raised in a previous comparative study of renewable energy adoption in across five countries (Ireland, UK, Spain, China, Japan, US), in which the market intervention policies were determined to be a much more important feature for guaranteeing successful deployment of solar generation than the availability of sunshine (MCCORMACK; NORTON, 2013, p. 291).

To further investigate the correlation between the two candidate independent variables and the dependent variables, the correlation coefficients are computed along w their p-values (those higher than 0.05 are considered significant). In Table 9, the Stata output places the p-values directly below the correlation coefficient, without brackets. This analysis was useful for establishing a model of linear regression, which will be explained in the following sub-section of the article.

Table 9. Correlation coefficients and associated p-values

	CapInst	NumProj	ICMS	ElecRate	Pop
CapInst	1.0000				
NumProj	0.8767	1.0000			
	0.0000				
ICMS	-0.7733	-0.6181	1.0000		
	0.0003	0.0082			
ElecRate	0.4415	0.6111	-0.4888	1.0000	
	0.0761	0.0092	0.0465		
Pop	0.6201	0.5578	-0.2618	0.1536	1.0000
	0.0079	0.0200	0.3101	0.5560	

5b. Exploring the Determinants for Project Deployment

Various studies are concerned with analyzing policy impacts of renewable energy penetration, especially considering the difference in project uptake in different US states. Borchers et al.'s analysis (2014) found that net metering and interconnection policies increase the likelihood of renewable energy adoption of farms. Carley and Browne (2013) analyze factors that lead to state-level policies as well as the effects associated with certain instruments, such as Renewable Portfolio Standards, RPS and Net metering. Rai and Robinson (2013) look at the factors influencing solar PV adoption in households in Texas and show that leasing options increase the likelihood of project development, along with factors such as peer effects, which they attribute to increased confidence and trust in the technology. Alagappan et al. (2011) analyze a sample of 14 jurisdictions in North America and Europe and identified the following factors that have that have led to high renewable energy penetration: FIT programs, facilitated electricity grid access and charges. While Carley (2009) took an econometric approach through a linear regression model to explain which motivating factors lead actors to adopt DG projects in the US.

In Brazil, there has yet to be a similar analysis or state-level comparison for DG. There are many reasons for this; one is that electricity policy and regulation are centralized in the Brazil. There are however, some state-specific characteristics that can contribute to DG deployment, such as: residential electricity tariffs that vary significantly among distribution companies, and the state tax ICMS is not being applied uniformly across the country.

The purpose of the regression analysis that is presented in this paper is to verify the effect of the abovementioned characteristics on distributed generation in Brazil. The analysis in this section is dedicated to exploring the determinants of project deployment by state, or in other words attempting to explain which factors have affected in a significant manner the data extracted from ANEEL's BIG database. The data is treated as a cross-section, which is considered to be a valid assumption since time frame is only three years since publication of the resolution 482, the energy system and borrowing costs can be considered to be constant over the period. The model only considers the sub-set of data for solar PV at residential installations. This is done for a few reasons, the most important of which is because it is largest number of observations that can be aggregated by state in order to make for a meaningful analysis. Secondly, the non-residential applications are highly heterogeneous. Impacts of outlier values, such as the large installation in sport stadiums would skew results, and these types of projects are not subject to the same electricity tariff (i.e. some would fall under public institution, while other commercial rates), which would make for a difficult comparison.

From the outset, the model is limited by a small set of observations (only 17 of the 27 Brazilian States have projects listed in ANEEL's database). This issue will be addressed in the interpretation of the regression results. For this reason, exploratory data analysis was first completed and aided in determining some suggestive relationships used in the model.

When calculating the correlation coefficients in the above section, the dependent variable had not yet been selected for the regression model (i.e. NumProj or CapInst). Testing for their distribution type was a key determinant in the selection since one of the central assumption for ordinary least-square, OLS regression is that the dependent variable follows a normal distribution (MUELLER, 2006). In order to verify which of the two candidate dependent variables best obeyed this assumption, skewedness and kurtosis was calculated (NIST, 2012)[30]. The NumProj variable followed more closely a Gaussian (or normal) distribution than the variable representing aggregated installed capacity. The scatter plot and Stata output used to test for the normal distribution of the NumProj variable are shown Appendix 6.

The generic mathematical model for a linear regression with multiple variables is shown as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \mu \text{ (Equation 1)}$$

[30] Skewedness (close to O) and kurtosis (higher than 3) are ideal values.

Where:

- Y, the dependent variable is NumProj, an aggregate of the total number of residential, solar PV projects by state
- β_0, is the intercept and shown in the Stata output as "_const"
- X_1, is the independent variable, ICMS, a dummy variable (explained in Table 6)
- β_1, is the beta coefficient, indicating the effect of changing the independent variable X_1 (ICMS) on the dependent variable, Y (NumProj), while maintaining all other factors constant
- X_2, is the independent variable, ElecRate, electricity tariff (explained in Table 6)
- β_2, is the beta coefficient, indicating the effect of changing the independent variable X_2 (ElecRate) on the dependent variable, Y (NumProj), while maintaining all other factors constant
- μ , is the error term

Initially, regressions were calculated for two cases: one having three independent variables (ICMS, ElecRate, Pop) and for the second case, number of independent variables are reduced to only two; ICMS and ElecRate. The results of the regression analysis can be seen in tables 10 and 1 at 90% confidence intervals.

Table 10. Regression results for case 1 (three independent variables)

```
. regress NumProj ICMS ElecRate Pop, level (90)

      Source |       SS           df       MS      Number of obs   =        17
-------------+----------------------------------   F(3, 13)        =      8.69
       Model |  1323.4301         3  441.143368   Prob > F        =    0.0020
    Residual |  660.099307        13  50.7768698   R-squared       =    0.6672
-------------+----------------------------------   Adj R-squared   =    0.5904
       Total |  1983.52941        16  123.970588   Root MSE        =    7.1258

------------------------------------------------------------------------------
     NumProj |      Coef.   Std. Err.      t    P>|t|     [90% Conf. Interval]
-------------+----------------------------------------------------------------
        ICMS |  -14.59863    8.62431    -1.69   0.114    -29.87171    .6744451
    ElecRate |   92.62787   43.35408     2.14   0.052     15.85068    169.4051
         Pop |   4.50e-07   1.80e-07     2.50   0.027     1.31e-07    7.70e-07
       _cons |  -17.55214    23.4113    -0.75   0.467    -59.01199     23.9077
------------------------------------------------------------------------------
```

Table 11. Regression results for case 2 (two independent variables)

```
. regress NumProj ICMS ElecRate, level (90)

      Source |       SS           df       MS      Number of obs   =        17
-------------+----------------------------------   F(2, 14)        =      7.21
       Model |  1006.61821         2  503.309103   Prob > F        =    0.0070
    Residual |  976.911205        14  69.7793718   R-squared       =    0.5075
-------------+----------------------------------   Adj R-squared   =    0.4371
       Total |  1983.52941        16  123.970588   Root MSE        =    8.3534

------------------------------------------------------------------------------
     NumProj |      Coef.   Std. Err.      t    P>|t|     [90% Conf. Interval]
-------------+----------------------------------------------------------------
        ICMS |   -19.2635   9.870203    -1.95   0.071    -36.64798   -1.879006
    ElecRate |   95.92992    50.7994     1.89   0.080     6.456425    185.4034
       _cons |  -9.899315   27.20852    -0.36   0.721    -57.82196    38.02333
------------------------------------------------------------------------------
```

Although the regression results for case 1, with the additional independent variable representing state population 'Pop' yields a higher the R^2 value (i.e. indicating the fit of the model is better), the Beta Coefficient is so small ($4.5x10^{-7}$) that is quite insignificant. Furthermore, the p-values (at 90% confidence) showed that it is not significant (i.e. would not be able to reject the null hypothesis). For this reason, the model that is retained for the analysis corresponds to case 2, with two independent variables.

The results (shown in Table 11) of the regression analysis for case 2 show an R^2 and adjusted R of similar value, as would be expected for a model with a small number of independent variables. The R^2 value demonstrates that about 51% of the variability in the dependent variable (number of projects) is accounted for by the model. In essence, the model can only "explain" about half of the reasons for increased project adoption by state. This limitation is discussed in the following sub-section. The Beta coefficients show that charging the ICMS tax has a negative effect on the number of projects, which was expected. While the electricity rate has a large positive effect on the number of projects, which is also expected since grid-parity is the main economic driver for DG projects and is more likely to be achieved with higher electricity rates.

Other variables included in the model (see Table 6) in order to test for their explanatory power, such as income per capita, resources (solar radiance and wind speeds) and the HDI-municipality were omitted from the regression analysis since preliminary runs showed that they were not statistically significant. Standard statistical tests for the regression, such as: multicollinearity and heteroskedasticity were completed (see Appendix 6). They showed no significant indications of the two features, which would render a linear regression model incoherent.

5c. Limitations of the Analysis

This analysis likely suffers from a few limitations, including the small number of observations and omitted independent variables.

A small number (17) of observations for the dependent variable, NumProj, which represents the aggregate number of Solar-PV projects at households (total = 209), per state. This is a “small N” is a problem, which is likely to have affected the linear regression results. A future analysis may choose to aggregate the number of projects by Distribution Company, rather than state to increase the number of observations. However, this would not increase the N be any order to magnitude, since most Brazilian states are served by one company. Depending on the progression of DG uptake in states where multiple distribution companies operate, namely São Paulo, Rio Grande do Sul and Rio de Janeiro, this type of analysis may be a useful indicator to decipher differences. Repeating the analysis in the future would also likely capture developments in the additional Brazilian states, thereby increasing the number of observations.

Omitted variables is also a limitation for the model, which is a concern for all causal analysis (DOWD; TOWN, 2002). Variables considered to have plausible explanatory power but were omitted from the analysis because they could not be measured with present resources include: equipment cost; installation costs; and household income at the project level, rather than state aggregate. In order to capture such variables, a survey of the project owners would have to be conducted. Additional omitted variables could possibly include items such as the presence of technical schools in the municipality, historical experience with the use of Solar-PV for rural electrification, ownership of Distribution Company (state versus private) and other state-led initiatives to incite renewable energy deployment.

Future study to decipher the determinants of DG project uptake in Brazil should also involve surveys with the DG project proprietors. This would allow the data listed above to be captured, as well as qualitative data such as ideological considerations for adopting DG.

6. Final Considerations

The penetration of DG in Brazil, both in terms of number of project and capacity installed, is quite weak. Some of the barriers identified for this are: lack of direct incentives (the net metering mechanism relies on the issue of grid parity for economic viability); current directives in energy planning in Brazil which focus on large-scale, low-carbon hydroelectric generation; lack of viable financing; application of a state tax, ICMS and no possibility for virtual net metering or leasing options.

Even with the feeble results marking the 3rd anniversary of Resolution 482/2012, DG has been receiving much attention and interest in Brazil for various reasons, such as the international movement for increasing small-scale and localized generation (especially in the case of solar PV), its application into a Smart Grid architecture and environmental considerations such as Climate Change.

Project uptake variables were modeled though a linear regression, and show that the electricity rates have an important impact, while the application of ICMS has negative effects. These two independent variables “explained” 51% of the variance in the dependent variable. Future studies are expected to include surveys with project proprietors in order to assess additional quantitative and qualitative variables on DG adoption. Solar radiance, an indicator of the strength of sun resources was not a statistically significant variable. Furthermore, the correlation coefficient suggested that negatively affects the aggregate number of projects.

Artigo 4: Distributed electricity generation as a strategic niche within a sustainable and socially inclusive transition in Brazil

> We went there to show what solar energy really is, which until then, for most of us, was only for the more affluent class or even for some people who lived in rural areas and didn't have access to energy[31]. *Síndica*, Juazeiro, November 2013

Abstract

A transition to low-carbon energy systems is widely accepted as a necessity for mitigating climate change. Distributed electricity generation, DG is a growing trend for incenting renewables and increasing energy efficiency in electricity sectors and is expected to play an important role in this transformation. Sustainability transition literature provides a framework for analyzing changes in socio-technical systems. It is recognized that transitions have distributional consequences, but how social inclusion becomes one of the core attributes of a transformation in the electricity sector has yet to be adequately addressed for the case of an emerging economy, such as in the case of Brazil. Through the study of two pilot projects in low-income and urban communities (Juazeiro, Bahia and Rio de Janeiro), the paper investigates how a renewable energy policy in a developing country may contemplate positive synergies with social policies and can be interpreted as a strategic niche within a the Multi-Level Perspective, MLP. Through the comparison of the two projects, the paper draws attention to lessons for the strategic management of the niche and a conceptual model for DG policy interventions so that it may contribute to a sustainable and socially inclusive transition in the country.

Keywords: sustainability transition, socio-technical system, distributed electricity generation, urban infrastructure, social inclusion

1. Introduction

The need to transition to a low-carbon and sustainable economy though the reduction of greenhouse gas emissions, GHG is a pressing issue at the forefront of international, national and

[31] Translated from interview in Portuguese: "Nós íamos lá mostrar, realmente, o que era a energia solar, que até então, pra gente, só era pra classe mais elevada ou então pra algumas pessoas que moravam no interior, que não tinha energia".

sub-national policy (UNFCC, 2014). The World Bank report: *Turn Down the Heat: Why a 4°C Warmer World Must Be Avoided* (WORLD BANK, 2012), highlights the necessity to take concrete steps to address carbon-intensive economies. The United Nations Development Programme, UNDP, in its report on the Millennium Development Goals also stresses the urgency to create policies that will attract investment in clean energy development as a means to combat climate change (UNITED NATIONS, 2011). Policies and investment strategies that support renewable energy should be seen as a choice for the future, for a sustainable infrastructure for our societies (RUBIN, 2009). Brazilian economist, Abramovay analyzes the concept of “unburnable carbon” if humanity is to mitigate the effect of climate change and advocates for low-carbon development rather than the present strategy adopted by some countries of fighting to occupy “carbon space” in international negotiations (ABRAMOVAY, 2014).

One of the many strategies gaining global appeal as a means of promoting sustainable energy infrastructure and reducing GHGs is distributed electricity generation, DG. DG can be understood as electricity generated on a small scale at (or very close to) the location of consumption. This decentralized model of energy production and consumption is cited in literature as holding great potential for maximizing both environmental and social benefits. DG employs appropriate technologies (solar, wind or biomass) and can generate opportunities for decent job creation and income (IISD; WICHMANN; GHAZAL-ASWAD, 2011), which is cited as a form of inclusive development (SACHS, 2004a).

According to the recent REN 21 (Global Renewable Energy Policy multi-stakeholder network) there is a growing, global tendency towards decentralized electricity generation, however, the rate of this growth depends on the national or sub-national policies in place (REN21; ISEP, 2013). For the purposes of this article, rural electrification of isolated communities where distribution or transmission lines are not yet in place will not be considered. The challenges related to rural electrification are the object of a number of other studies (VAN ELS; DE SOUZA VIANNA; BRASIL, 2012); (VAN ELS, 2008); (ROSA, 2007).

2. Analytical Framework: Transitions Literature

Sustainable transitions literature is concerned with the process of change or transformation in conventional or traditional socio-technical systems to more sustainable modes of production and consumption. Transitions can be defined as long-term, multi-dimensional and complex processes, which deal with the social and technical elements of a system configuration and involve “the displacement or modification of the dominant technological and social structures surrounding a given system” (MEADOWCROFT, 2014, p. 2). The electricity sector is an interesting case of a socio-technical system, which can highlight the difference between a purely technological transition because it also requires “changes in user practices and institutional (e.g., regulatory and cultural) structures, in addition to the technological dimension” (MARKARD; RAVEN; TRUFFER, 2012, p. 955). Within the body of literature concerning sustainability transitions, the multi-level and multi-actor perspective, MLP, is used to “conceptualize the change and the dynamic interactions among three dimensions: a regime level made up of established technologies and practices, a niche level of emerging innovations, and a landscape of external influences” (MEADOWCROFT, 2014, p. 1).

In the electricity sector, sustainability challenges are particularly impacted by strong path-dependencies and technological lock-ins, which characterize the incumbent regimes (MARKARD; RAVEN; TRUFFER, 2012). Abundant hydropower or coal deposits are two such examples, which tend to exclude alternative system configurations. Dosi explains this as a technological paradigm or regime, which has “a powerful exclusion effect: the efforts and the technological imagination of engineers and of the organisations they are in are focused in rather precise directions while they are, so to speak, 'blind' with respect of other technological possibilities" (DOSI *apud* KEMP et al. 1998, p. 176). Raven’s analysis of energy transitions summarizes the established regime architecture of electricity sector, which is in stark juxtaposition to the “niche” of decentralized or distributed generation;

> Electricity regimes, for example, have been developing along incremental trajectories towards ever-larger power plants, mainly based on fossil fuels, and connected to nationwide AC grids. Institutional arrangements and ever-growing demand for power were important [historical] drivers in that process. This has led to carbon lock-in of electricity regimes…since the 1970s and 1980s this development process has been increasingly criticised and arguments and advances have been made towards alternative, more environmentally sound (and often decentralised) electricity regimes (RAVEN, 2007, p. 2391)

Distributed generation can be understood as a niche within the MLP framework. A niche is a key concept in transition studies and has been explained as a “protected space” in which innovations “can develop without being subject to the selection pressure of the prevailing Regime…[with the ultimate goal of provoking] social learning across multiple experiments” (MARKARD; RAVEN; TRUFFER, 2012, p. 957). Niche management, defined as: "the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation, with the aim of (1) learning about the desirability of the new technology and (2) enhancing the further development and the rate of application of the new technology" (KEMP et al. 1998, p. 186). The authors assert that this is different from 'technology-push' approaches because it is not concerned solely with the creation of a ‘showpiece’ for a promising technology, but rather, the aim is to involve a broad network of actors, such as users, etc. into an interactive process and results in the adaptation of an institutional framework to ensure the economic and social success of the new technology.

Figure 18, adapted from Geels and Schot (2007) offers a visual representation of the MLP. It shows that the landscape (or exogenous) factors can affect the transition by “opening up” an opportunity to allow for niche technologies (or configurations) to break through the incumbent regime. Simultaneously, niche technologies or actors can exploit landscape factors, which may also lead to the breaking through the dominant regime.

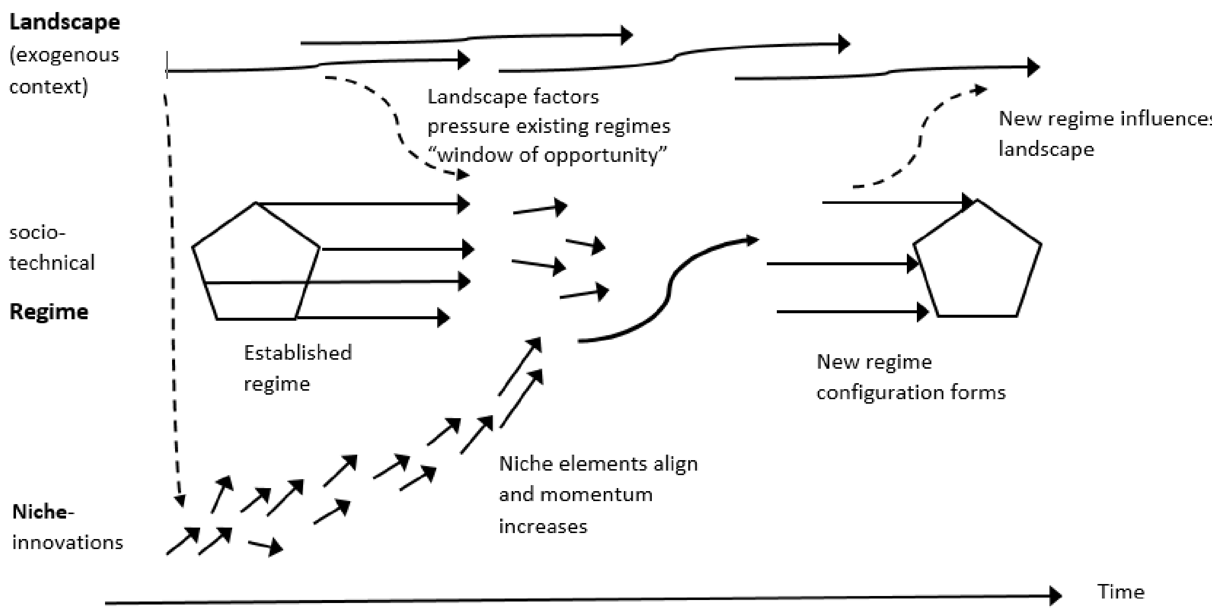


Figure 18. Sustainability Transitions and the Multi-level Perspective, adapted from GEELS & SCHOT, 2007

3. Transitions within the context of the Brazilian electricity sector

Niches can be considered as important components of intentional transitions and transformations (KEMP et al. 1998), while Markard et al. (2012) emphasizes that there is a need and a role for learning from empirical lessons on strategic niche management in order to understand “the development and implementation of new policy frameworks to render transition initiatives pursued at local, regional, national, and international levels more effective” (MARKARD et al. 2012, p. 962). Through the study of two pilot projects of distributed electricity generation in Brazil, it is the intention of this paper to offer recommendations for a policy framework to guide in a sustainability transition in the electricity sector in the country.

In previous investigations into the Brazilian electricity sector, Garcez (2014) explored the current regime formation, which is dominated by centralized planning and prioritizes large, hydroelectric projects. A technological and institutional paradigm or regime can have powerful exclusionary effects (KEMP et al., 1998). This is particularly evident in the Brazilian case, where hydroelectric generation is responsible for more than two thirds of the national production and its prioritization dominants both the planning and operation protocols.

Landscape factors, which are by definition as exogenous to the electricity sector and place pressure on the incumbent regime, have the effect of creating a "window of opportunity" in a transition process. Garcez (2014) considered four such factors, which compelled the National Electricity Regulator, ANEEL to regulate DG through the Normative Resolution 482/2012 (ANEEL, 2012b). The first is that of international policy diffusion; there is a growing international tendency to incent small-scale renewables. The recognition of this trend is one factor that spurred the ANEEL regulation. The second landscape factor is the weak international economic scenario post 2008, which led to manufacturers of renewable energy technologies (both European and Chinese) to search out new and emerging markets, such as Brazil. Thirdly, ANEEL's regulation for distributed generation is linked to an overall agenda of learning for smart grid applications, evident in their support for research and development projects in this area. Finally, some local industry and societal pressure, especially in the case of Solar-PV has sparked interest in DG.

An additional landscape factor that was not considered in the previous analysis, but will be at the crux of the present investigation is related to the social development agenda in Brazil and the Federal Government's efforts to support policies for a socially inclusive democracy. This broad social agenda was set by the former Present, Luis Ignacio Lula da Silva during his two back-to-back mandates (2003 - 2011) and has continued by his successor; Dilma Rouseff.

President Lula's agenda is summarized by Baer as having two major goals, "the pursuit of a macroeconomic policy orthodox enough to win the approval of the international financial community and the achievement of a greater degree of socioeconomic equality" (BAER, 2014, p. 162). Lula ran (in 2002) on a platform in which social development was placed as a core component of economic growth, rather than merely being a residual outcome. Roett explains that Lula's economic orthodoxy can be understood within an international context, namely the 1998 Russian and 2001/2 Argentinian default (ROETT, 2010, p. 105), combined with the inheritance from the administration of his predecessor Fernando Henrique Cardoso, FCH, in which the economic situation was still delicate. However, one of the key contrasts of Lula to FHC as highlighted by Baer is related to energy regulation:

> Whereas under the previous administration regulatory agencies set out to generate tariff conditions favorable to various private, domestic, and foreign concessionaires, the Lula administration adopted a posture that was much less favorably disposed to the claims of privatized firms. This may be most clearly seen in the New Energy Model, passed by congress in March 2004. The model explicitly favors the award of future public utility concessions on the basis of the proposed tariffs to benefit lower-income groups (BAER, 2014, p. 162).

Two concrete actions taken by the Lula Administration with regards to the social equality and energy policy in Brazil are notably: i) Biodiesel policy, which was intended to include family farmers in the production chain and ii) the social tariff for electricity, which was introduced for low-income families. The Brazilian Program for the Production and Use of Biodiesel, PNPB was created in 2004 and was intended to include smallholder farmers in the supply chain of biodiesel production, with less than desired results as soybean dominate the feedstock (LIMA, 2013); (GARCEZ; VIANNA, 2009). The other action is the social tariff for electricity. Families that are registered in the unified social assistance registry, *Cadastro Unico* and consume between 30 and 100 kWh per month benefit from the “social tariff”, or a 40% reduction in their residential electricity tariff (ANEEL, 2011).

This article will explore two pilot projects of distributed electricity generation, DG to illustrate its role as a strategic niche, in so far as it demonstrates that a transition in Brazil will be not only low-carbon, but also socially inclusive. In both cases, it has been observed that the landscape factor of social inclusion played an important role in the niche development.

The issue of social inclusion in “green” or environmental issues has traditionally been a marginalized. Cook asserts that there is a fairly widespread agreement that global challenges require a transition, especially in the case of the energy sector which has high environmental impacts; however, “social issues are seen as residual to economic and environmental concerns, market-based green economy solutions tend to dominate policy and discourse, while redistributive or rights-based alternatives remain on the margin (COOK; SMITH; UTTING, 2012, p.7). Vallance et al. (2011) reiterate this sentiment in their analysis of studies on social sustainability:

> A re-statement of the importance of social development, and the adverse impacts some eco-strategies have on already disadvantaged groups, combined with a better understanding of the ways in which technical aspects of sustainability resound in everyday life, are central to a smoother and more equitable transition from less to more sustainable futures (VALLANCE et al. 2011, p. 347).

3a. Urban, low-income strategic niches in Brazil

In Latin America, “urbanization is, decidedly, the principal social transformation of our time” (SACHS, 2007, p. 152). The challenges of urbanization in Brazil are contemporary and of considerable magnitude, both in terms of physical infrastructure but also regarding issues of chronic poverty. The World Bank estimates that in Brazil “for every one chronic poor household in rural areas, there are two that live in urban areas” (VAKIS; RIGOLINI; LUCCHETTI, 2015, p. 31). Urban population, according to the Brazilian Statistical Agency, IBGE, represented at 84% of the country’s total in 2010. This is in stark contrast to Brazilian demographics of a few decades ago (in 1960 only 45% was considered urban, in 1970, 55.9% and 1980, 67.6%) (IBGE, 2010). Sachs points out that because of its natural resources (i.e. arable, tropical land), Brazilian development in agribusiness has resulted in excessive rural exodus and there is an urgent need for appropriate policies for urban populations, such as employment and equitable access to services (SACHS, 2009, p. 339). In addition to the natural resources that Sachs identified, the rural exodus in Brazil is a complex process that has political and socioeconomic origins (PERZ, 2000); (CHASE, 1999). Intense capital investment into mechanized farming and the contradictions of modernization in the region resulted in migration to urban centers either in search of better opportunities or because of lack of alternatives to continue traditional rural livelihoods. Urban issues, however, have often been eclipsed in the developing world, and in the case of Brazil, this is no exception. Urban poverty and environmental degradation have “not received emphasis in the analysis of Third World environmental problems. This may be due to the fact that in industrial countries similar problems were solved many generations ago with public health policies, and that the environmental impact of poverty has localized effects, as opposed to the deforestation of the Amazon, or instance, which may have global implications” (BAER, 2014, p. 162).

A sustainable transition in Brazil is one that will not likely be propelled by technological solutions alone. Brazil has high technical competencies in energy generation, mining, among other sectors. Furtado poignantly summarizes this reality in Brazil, a country that has historically excluded a large portion of the population from benefiting from technical advances:

> The Brazilian economy is interesting example of how a country can move forward in the industrialization process without abandoning its core characteristics of underdevelopment: large productivity gap between rural and urban areas, a great majority of the population living at a level of physiological subsistence, growing numbers of underemployed people in urban areas, etc. .... the most significant feature of the Brazilian model is its structural tendency to

> exclude the mass of the population from the benefits of accumulation and of technical progress[32] (FURTADO, 1974)

Furtado's preoccupation with the systematic exclusion of the poor in Brazil from the benefits of innovation is at the crux of this paper. The analysis of two pilot projects in urban and low-income communities is concerned with identifying how DG innovations can be conceived as a strategic niche within a low-carbon and socially inclusive transition in Brazil. The choice of a research design based on case study analysis is justified within the perspective and goal of understanding a contemporary phenomenon through empirical study (YIN, 2014)**.**

The cases that are presented in this article were chosen because they fulfilled the two research design criteria: i) low-income communities in urban settings; ii) pilot projects of renewable decentralized electricity generation projects. The projects were identified during interviews conducted into the regulation of distributed generation in Brazil. In addition to these, and with the objective of ruling out selection bias, various additional sources were consulted to identify other projects that could be studied (KING; KEOHANE; VERBA, 1994). The sources searched (listed below) did not result in the identification of other projects that satisfied both the selection criteria.

- The INOVA ENERGIA line of credit operated by the FIEP foundation of the Brazilian Ministry of Science and Technology, MCT; (www.finep.gov.br)
- The Brazilian Environment Fund (FNMA, *Fundo National de Meio Ambiente*), operated by the Brazilian Ministry of the Environment, MMA;
- The Climate Fund (*Fundo Clima*), operated by the Brazilian Ministry of the Environment, MMA;
- The Research and Development Program of the National Electricity Regulator, *ANEEL P&D*;
- The Social Technology (*Tecnologias Sociais*) database maintained by the Fundação Banco do Brasil (www.fbb.org.br/tecnologiasocial);
- The Urban Leds initiative of UNHabitat, which involves several Brazilian cities (www.urban-leds.org);
- The databases and publications of the international organization: Local Governments for Sustainability, ICLEI (www.iclei.org/sams/portugues); and
- InterAmerican Dev Bank, IDB and other International donors; UsAID, DFAIT-Canada, British Aid, AFD-France.

The two projects herein presented offer different examples of DG configurations; in terms of size, technology, regulatory arrangements and socioeconomic benefits generated (as shown in the summary Table 12). Within the perspective of strategic niche management, this offers lessons for broad learning for DG into a socio-technical system, involving user practices, institutional arrangements, among others.

[32] Translated from original in Portuguese by C. A. G. Garcez

4. Pilot Project "Projeto de Geração de Energia e Renda - Juazeiro", Bahia

The first case study that is presented in this paper involves two adjacent, low-income housing complexes; *Morada do Salitre* and *Praia do Rodeadouro*, which were constructed as part of Brazil's *Minha Casa Minha Vida* Program, MCMV in the municipality of Juazeiro in the state of Bahia in November 2011. They are located in the city's outskirts, approximately 9 km away from the center, off the BR 407 highway that connects Juazeiro to the State capital of Salvador, 520km to the South (map included in Appendix 7). The MCMV program is a community housing and mortgage policy that was established in 2009 by the Brazilian Federal Government. Its purpose is to fill the large gap of affordable housing for low-income families (with an income lower than 10 minimum wages[33]). According to the public, federal bank, CAIXA, which is the main financier of the program, over one million houses and apartments have already been built and the goal is to construct an additional two million dwellings (CAIXA, 2013).

Each of the two communities in the pilot project has 500 houses and an estimated, total population of four thousand inhabitants. According to a study by a local university, UNEB (*Universidade Estadual da Bahia*), the two communities exist as such only in an administrative sense, they are one neighborhood with no physical division (SILVA, 2012). The families that today reside in the communities came from various neighborhoods in the city of Juazeiro. The Municipal Secretary for Development and Social Equality (*Secretaria de Desenvolvimento e Igualdade Social,* SEDIS) was responsible for the administrative task of registering the needy families in the municipality, while the project design was centralized by CAIXA, as is the case for all projects in Brazil.

It has been argued that the main goal of the MCMV program (which was established just after the 2008 sub-prime mortgage crisis in the USA) is to foster economic growth. It has been argued that the economic objective is complementary to the social one (D'AMICO, 2011), while other authors question the execution of the program, one that offers little in terms of public involvement in the design of the communities and minimal space (VALENÇA; BONATES, 2010). Furthermore, a working paper by the Brazilian Institute for Applied Economic Research, IPEA found that:

> MCMV is not being primarily guided by the housing deficit… the production of housing units for low-wage families [up to three minimum wages] is basically located in sites where land costs are lower and production of estates is easier for entrepreneurs. Additionally, comparing MCMV's production aimed at low-wage families with that aimed at middle-wage families [up to 10 minimum wages], we find that the program is more adherent to the latters' housing demand, than to the formers' housing deficit (KRAUSE; BALBIM; NETO, 2013, p. 8)

[33] The minimum wage in 2014 was R$724 or US$323.

Juazeiro falls within the semiarid region of Brazil, within the Caatinga Biome. It is located in the San Francisco river basin of the state of Bahia, on the river's edge. The human development Index of the municipality, which has increased from 0.396 in 1991 to 0.677 in 2010, shows that there has been a significant improvement in living standards. However, Juazeiro still falls below the national average on indicators such as life expectancy and child mortality (UNDP et al., 2013). The city of Juazeiro (population 216, 580) is somewhat of an anomaly within the semi-arid, as it has been benefited by various public initiatives to promote irrigated agriculture of fruits, mainly for export (CORREIA; ARAÚJO; CAVALCANTI, 2000). These large-scale irrigation projects began in the late 1960's and have transformed the agricultural landscape. The city's port dynamics also changes significantly after the 1978 the construction of the Sobradinho hydro-dam on the São Francisco river (NASCIMENTO; BECKER, 2010). The effects of the Sobradinho dam have been estimated at displacing 120,000 people, while only "variable compensation and/or settlement solutions for perhaps half of this number" was provided (HALL, 1994, p. 1796).

This paper is concerned with the analysis of a pilot project of distributed electricity generation, DG involving both wind and solar PV technologies, installed in the abovementioned MCMV communities (photographs shown in Figures 19-21). The project was funded by the *Fundo Socioambiental da Caixa Econômica Federal* (CAIXA) and was developed and executed by Brasil Solair. It was named: "*Projeto de Geração de Renda e Energia – Juazeiro*". Approximately 9500 solar panels were installed along with two wind towers with a rated capacity of 2 kW each and four wind towers with a rated capacity of 5kW each. Field visits were conducted on two occasions; November 2013 and March 2015. The solar PV portion of the project has been operating since February 2014. At the latest field visit, the wind portion had not yet been connected to the distribution grid. During both visits, in-depth and semi-structures interviews were conducted with representatives from the municipality (SEDUH, SEDIS), local university, community leaders, staff of the community associations, representatives from the project developer; Brasil Solair, project maintenance staff, FSA-CIAXA, and the state agency, CAR (*Companhia de Desenvolvimento e Ação Regional, Bahia*). A brief conversation was also held with the local distribution company, COELBA.

Figure 19. View of solar PV panels and inverters installed in Juazeiro
Source: C.A.G.Garcez
Date: November 2013

Figure 20. View of small wind tower installed in Juazeiro
Source: C.A.G.Garcez
Date: November 2013

Figure 21. View of distributed generation project (solar and wind) in Juazeiro
Source: C.A.G.Garcez
Date: March 2015

In October of 2012, Brasil Solair and CAIXA signed a cooperation agreement for the project. CAIXA invested 6.2 million Brazilian Reais in the pilot project (CAIXA, 2012). The installation of the solar panels occurred in May 2013 and later in August the wind turbines were erected, showing a large lag-time for arriving at full operation (recall: solar PV portion was inaugurated in February 2014 and the wind portion was still not functioning as of March 2015).

The pilot project in Juazeiro also incorporated the objective of job-creation into its mission. Brasil Solair trained and employed local community members to install both the solar and wind portions of the project. In total, 40 members from the community were selected. Six men desisted, and of the 34 remaining team members, 17 were women. Brasil Solair also indicated in (November 2013) that six of the team members continue to be employed by the company in the development of other distributed energy projects in the region (which fall under the ANEEL 482/2012 resolution). In March 2015, only two of the women were employed to clean the surfaces of the solar panels. By in large, the sentiment in the community regarding the training provided by Brasil Solair was positive:

> Brasil Solair trained, professionally, these people to work with solar energy. We, here in the community have trained personnel. Today, trained to work and install solar panels…He turned these people into professionals. They don't remember this, one of the things that during the inauguration, I made a point to highlight, that this is the legacy that this project left with our community, not just money. The question of professionalization and to show that a woman is capable of doing work such as this[34]. (March 2015)

According to ANEEL's Normative Resolution 482/2012, distributed generation is allowed through a mechanism of net metering and to a maximum of 1 MW installed capacity (ANEEL, 2012b). The Juazeiro project does not fall within the Resolution's definition of distributed generation, instead ANEEL granted the operational license for the pilot project whereby the energy produced will be metered and commercialized in the non-regulated market or *Ambiente de Contratação Livre, ACL*. CAIXA, as a partially "free" consumer (*consumidor parcialmente livre*) will consume the energy produced by the pilot project in their headquarters in Bahia's capital of Salvador (ANEEL, 2012c).

The project developer, Brasil Solair conducted a socioeconomic diagnosis of the two communities prior to the installation of the project, and it is the intent of CAIXA to complete another

[34] Translated from original in Portuguese: A Brasil Solair capacitou, profissionalmente, essas pessoas para trabalharem com energia solar. Nós da comunidade temos pessoas treinadas. Hoje, capacitadas, para trabalhar, montar placas solares... Ele tornou essas pessoas profissionais. Eles não lembram disso, que é uma das coisas que, lá na inauguração, faço questão de visar, de colocar o que foi o legado que deixou esse projeto para nós da comunidade, não é só dinheiro. É a questão da profissionalização e mostrar até que a mulher é capaz de fazer um trabalho como esse.

such survey after the project completes 2 years of operation. Their reports give some important insights into the communities, such as the level of education (see in Figure 22).

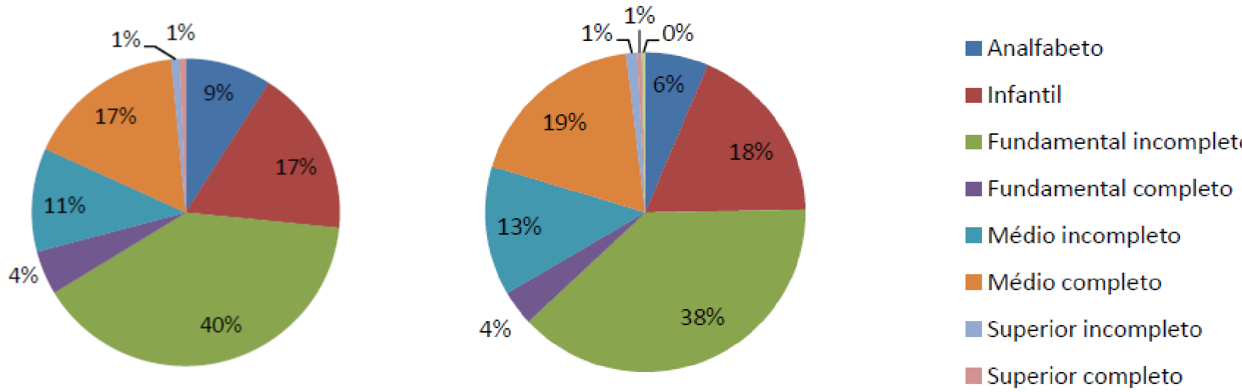


Figure 22. Level of education completed; Praia do Rodeadouro (left); Morada do Salitre (right). Source: (BRASIL SOLAIR; CAIXA, 2013a); (BRASIL SOLAIR; CAIXA, 2013b)

This is a similar cross section of Brazilian society as a whole, according to IBGE (2011) 15% of the population has no formal education, 31.5% incomplete primary-level, 10% completed primary level, 3.9% secondary school incomplete, 24.5% secondary school complete, 3.4% college or university incomplete and 11.5% college or university completed.

In the community of Priaia do Rodeadouro, 458 of the 500 families, surveyed (92%) declared to receive only one minimum wage, and only 47% of the adults surveyed declared to have formal employment. The community of Morada do Salitre displayed similar trends; 91% of families declared to have an income of up to one minimum wage and only 35% are formally employed (BRASIL SOLAIR; CAIXA, 2013a); (BRASIL SOLAIR; CAIXA, 2013b).

4a. Discussion of the Environmental and Socio-economic benefits of the project

The municipality of Juazeiro is in a good location with respect to wind and solar resources (DO AMARANTE et al., 2001); (PEREIRA et al., 2006). The municipality of Juazeiro has an annual average daily solar radiation of 5.72 (kWh/m^2)/day (CANADA, 2012b). While the average solar potential for Freiburg, the well-known model-PV city in southern Germany (ROHRACHER; SPATH, 2014); (KRONSELL, 2013), is only 3.08 (kWh/m^2)/day. According to the RETScreen/NASA database, the municipality of Juazeiro has an annual average wind speed of 4.0 m/s measured at 10m, an appropriate height for gauging small wind towers, SWT potential.

The anticipated carbon savings of the project were calculated using the RETScreen software, based on the carbon intensity of the Brazilian electricity sector assuming that the energy would displace natural gas generation, which has become the default source for peek-hours in Brazil or in cases where there are weak rains and therefore low water levels in the hydroelectric dams. RETScreen assigns an emission factor of 0.424 tCO2eq/MWh for natural gas generation in this case. The results of the carbon savings simulation can be seen in Appendix 8. Over the lifetime of the project, it was expected that quantity of carbon abated would be equivalent to taking 31,000 cars off the road for the reference case (30% capacity factor for wind and 15% capacity factor for solar) over the 25 year lifetime of the project.

The electricity generated from the solar cells is sold in the wholesale electricity market (*Ambiente de Contratação Livre, ACL),* as previously explained, this project does not fall under the net metering mechanism created by ANEEL in 2012. As such, the regulator granted a special authorization (*Resolução Autorizativa* 4.385/13) to Brasil Solair, which will be re-evaluated after 2 years' time (CCEE, 2014). Before the project began operation in 2012 CAIXA is cited as saying that the estimated monthly income per household would approximately R$110 (CAIXA, 2012), a year later, another report which stated that the families should expect to receive R$90 (TRINDADE, 2013). The news of this additional income was welcomed in the community:

> They [the CAIXA team] approached us, showed us the project. I was excited about the response it would give to the community members. Here we have people that are in need, low income…I really fell in love with it[35]. Síndica, November, 2013

The solar portion of the project began producing energy and injecting electricity into the local distribution grid operated by COELBA in February 2014 even though construction was complete in May 2013. When the first field visit was conducted, this lag time and lack of coordination amongst various authorities was cited as sources of frustration for the community. In the following quote, one of the community leaders explains that the entire distribution system needed to be re-wired to deal with the generation of electricity, which was not included in the original project of the neighborhood:

> The company [Brasil Solair] paid them [COELBA] to re-wire the network. They put lots of wires, wiring, changes the wires, changed everything and we remained in anticipation of the inauguration, because the final objective is to receive income. The people are insisting. They,

[35] Translated from original in Portuguese: Nós procuraram [equipe da CAIXA], mostrando todo o projeto. Eu fiquei encantada pela resposta que ia dar para o morador. Aqui, a gente tem pessoas que realmente precisa, de baixa renda...Eu fiquei encantada, eu vesti a camisa mesmo.

> “where is the inauguration?" And the expectation is that President Dilma will come and inaugurate the pilot project[36]. November 2013

According to data obtained from the community leaders (there are two elected leaders or s*índicas,* in Portuguese) during the second field visit, the total energy generated from the solar panels between February to December 2014 was 2,417 GWh. The average monthly electricity production over the 10 month period (considering that February only generated 6.61 MWh as the first test month) was 241.7 MWh/month, with production peeking in August (260.67 MWh). When compared to the energy model simulation conducted using RETScreen (Appendix 8), the actual production of the solar PV system corresponds to a capacity factor of approximately 15%, attesting to the sound operation of the system and good climatic conditions.

The energy that was sold in the ACL was receiving the average, short-term market price or PLD (*Preço de Liquidações de Diferenças*), which varied between $412.60 and $756.37 per MWh (for the months of February to August 2014). Consequently, the income that the families received during the period for the sale of the electricity varied between R$ 102.45 and R$ 43.83 per month, reflecting the oscillating PDL prices (June 2014 was the lowest with a PLD of R$ 412.60 per MWh). According to a document prepared by CAIXA on the one-year anniversary of the operation of the project, the average monthly income over period (February to December) was in the amount of R$ 88.50 (MOTTA; BENEVIDES, 2015).

In order to put these additional income values into perspective, it is important to remember that the minimum wage in Brazil was R$ 724.00[37] (in 2014); *Bolsa Familia*, a conditional cash transfer program varies between R$ 32.00 and R$ 306.00 per month. The monthly repayments for the *Minha Casa Minha Vida* program vary significantly, depending on the household income[38]. These figures show that the income generation from the pilot project is meaningful for the families in the communities and will likely benefit their economic well-being.

The internal condominium rules of the communities were established in June 2014 (*Regimento Interno do Condomínio Praias do Rodeadouro e Moradas do Salitre de Governança*

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[36] Translated from original in Portuguese: A empresa [Brasil Solair] pagou e eles [COELBA] refizeram toda rede. Colocaram muito fio, fiação, mudaram a fiação, mudaram tudo e a gente na expectativa de inauguração, porque o grande projeto é receber o dinheiro. O povo é o que cobra. A gente, "Cadê a inauguração?" E a expectativa da Presidente Dilma de vir inaugurar, montar um projeto piloto.

[37] The monthly minimum wage in Brazil in 2014 was R$724.00 (Brazilian Reais) or approximately US$323. It was raised to R$788.00 in January 2015 (MTE, 2015) but with current exchange rates, the 2015 minimum wage represents US$245 (BCB, 2015).

[38] According to the community leaders, the monthly repayments may vary between R$30 and R$120 (Brazilian Reals, or Reais).

e Destinação de Recursos da Micro Geração de Energia Solar). They specify that the profit of the energy sale is divided in the following manner: 30% is placed into a common fund for investments in the community (*Fundo de Investimento do Condomínio*); 10% is placed in a fund for maintenance of the energy system; and the remaining 60% is distributed equally amongst the households in the community.

Towards the end of 2014, ANEEL took steps to re-calculate the minimum and maximum values of PLD for 2015. The decision was made to reduce the upper limit of the PLD by more than half to be R$ 388,48/MWh (from R$ 822,83/MWh in 2014), while the lower limit was raised to R$ 30,26/MWh (ANEEL, 2014c). As a consequence, in 2015, the price that the solar energy from the Juazeiro project was receiving in the ACL had been drastically reduced. The domino effect is a lower monthly income in the community, which generated much frustration and anxiety on the part of the families as well as sense of mistrust in their elected, community leaders (*síndicas*). In an effort to mitigate the effects of the information asymmetries and misunderstanding of the function of the electricity market, one of the *síndicas* prepared a communiqué to circulate in the community (included in Appendix 9).

The reason ANEEL chose to recalculate the PDL was to limit financial risk in the short-term electricity market. According to their Technical Note No. 86/2014-SEM/ANEEL, which initiated public consultation (9/2014) regarding the revision of PLD calculations, ANEEL explains that the methodology of determining upper limit of the PLD is related to an appropriate remuneration of thermoelectric plants of “significant” size. However, since the Brazilian electricity system is dominated by large hydroelectric stations, with storage capacity, the mathematical models used to determine market price are programed to optimize the present benefit of using water against the future benefit of storing it. This optimization takes into account an estimate of the fuel savings used in thermoelectric stations. Since Brazil found itself in an extremely low rain situation with low hydroelectric reservoirs towards the end of 2014, sector participants and ANEEL decided that the PLD (which in 2014 was set to a max of R$ 822.83/MWh needed to be re-calculated), as expressed below:

> Thus, in times of imbalance, caused, for example, by the lack of supply or shortage of rain, a maximum value of PLD, which is lower that the calculated marginal operating cost reduces the financial exposure of the market participants. This, incidentally, is exactly the reason many are pointing to in order to justify the need to reduce the current PLD_max, with the claim that at the current price level, business is unsustainable and may lead some to bankruptcy[39].

[39] Translated from Original in Portuguese: “Assim, em momentos de desequilíbrio, ocasionados, por exemplo, pela falta de oferta ou escassez de chuvas, um limite máximo de PLD abaixo do CMO calculado reduz a exposição financeira dos agentes de mercado. Essa, aliás, é exatamente a razão apontada por

ANEEL's new methodology for calculating PLD was influenced by concerns of low water levels and the price of thermoelectric generating stations. The solar generation project of Juazeiro, which was selling into the ACL was definitely not of primary concern nor was part of the decision-making processes. However, ANEEL's decision introduced much risk for the economic viability of similar distributed generation projects, if they came to fruition in Brazil. Alternate configurations for the sale of small-scale electricity generation that involve low-income families, such as in the case of the Juazeiro project should be considered, both in terms of viability and mitigating volatility. Examples of options that have been created in other jurisdictions are Feed-In-Tariffs, FITs or virtual net metering (i.e. leasing options).

Within the perspective of a strategic niche, the project does offer some interesting benefits, beyond that of the abovementioned income an employment generation. The communities in Juazeiro, organized with their internal condominium rules, now have a source of common income that is being invested on shared infrastructure. This is unique to the MCMV reality, as low-income households rarely have enough disposable income to participate in such common-pool investments. Indeed, in comparison to the other MCMV communities built in the city of Juazeiro (there are four communities that have been built in the city) the two involved in the pilot project are the only ones that have been able to organize into formal community associations or undertake any communal infrastructure projects, to date. The Municipal Secretary in charge of social housing, SEDIS indicate that that other 2 communities have not established any type of local management (*gestão local*), and that lack of common funds is likely one of the reasons.

At the time of the second field visit (March 2015), two community centers were under construction that will be used to offer capacity-building courses or to have spaces to allow for comradery and leisure. Shaded bus waiting areas had also been built with the common fund. The *síndicas* also spoke of other shared infrastructure projects that they have in mind, but will have to be agreed upon by the community, such as a daycare, improved fencing and public lighting to increase security in the peripheral areas of the communities, contingent upon the wind generation portion of the project coming into operation. The issue of ownership associated with the delay in operation of the wind towers is discussed in Final Considerations section.

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muitos para justificar a necessidade de redução do PLD_max atual, com a alegação de que esse preço, no patamar atual, torna seus negócios insustentáveis, podendo levar alguns à falência" (SEM/ANEEL, 2014).

The DG project also highlighted some gaps in the prevision of other basic public services, such as lack of public lighting to the main highway, healthcare services, distance to schools and lack of public transportation options. The precarious delivery of these are the subject of continual grievance by the community, as expressed in one interview:

> Getting sick here at night is a problem. You would have to call an ambulance. There is nowhere to buy medicine. You would have to go into the center, it's a hindrance. Don't think of it. I hope this energy project bring with it a special observation for our community, not just about the project, but about the other necessities[40]. November 2013

In the words of the developer, Brasil Solair, this project has to be part of a larger plan for socioeconomic development. It was not intended to solve all the challenges associated with the social inclusion of low-income families into the broader economy, however it did show a promising path that could be followed:

> We would be part of a global solution. We would be a grain of sand or a bean the *feijoada*, but would not solve the problems of all. But we could show a path that was possible and then go to the community with other projects. There is human capability there for you to develop other economic activities. No use to talk about entrepreneurship, if you do not give conditions for the guy to be an entrepreneur[41]. November, 2013

The Juazeiro pilot project is a good example of the type of multi-level and multi-actor learning that is to be gained from strategic niches, which involves technical issues related to the distribution grid, institutional arrangements regarding the commercialization of small scale projects and social aspects of local management. The generation of income provides a good option for social inclusion, but there still remain questions regarding project ownership and long term maintenance, which will be elaborated in the discussion section.

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[40] Translated from original in Portuguese: Adoecer alguém aqui, à noite, é um problema. Tem que chamar o SAMU. Você não tem onde comprar um medicamento. Tem que ir para o Centro, é um estorvo. Não pensam. Espero que esse projeto de energia traga um olhar para essa comunidade, não só nesse projeto, mas também em outras necessidades.

[41] Translated from original in Portuguese: Seríamos um grão de areia ou um feijão na feijoada, mas também não iríamos resolver o problema de todos. Mas podíamos mostrar um caminho que era possível e poderá ir a comunidade para outros projetos. Tem material humano lá dentro para você desenvolver outras atividades econômicas. Não adianta você falar em empreendedorismo, se você não dá condições para o cara ser empreendedor

5. Pilot Project *“Juventude Solar”*, Rio de Janeiro

The second pilot project that was studied is a rooftop solar PV project installed on a community center, CEACA-Vila (*Centro Educacional da Criança e do Adolescente Lídia dos Santos – Vila Isabel*) in Morro dos Macacos, Rio de Janeiro (see Figure 23 for a photograph of the system). The rooftop installation consists of 20 solar PV panels with a total rated capacity of 4.6kW (the technical specifications are listed in Appendix 8). The project was developed by Greenpeace with a total investment of R$ 36,800.00. The technical design of the project was completed by *Solar Energy do Brasil*. It was inaugurated on July 25, 2013 but officially connected to the distribution grid (operated by the distribution company LIGHT) in August 2014, highlighting again a considerable lag-time in the coordination of energy sector actors. The project was approved by ANEEL under the newly created net metering regulation (Normative Resolution 482/2012), which allows for offsetting electricity consumption through distributed generation (but not energy commercialization).

This project differs from the Juazeiro project as it does not create income for the community center, but rather offsets their consumption, which prior to the pacification had not been metered and was unknown to the staff. Similar to the objective of the Juazeiro project, Greenpeace involved and trained 16 young community members to assist in the project’s installation, as well as organized various information events for the community to increase awareness of renewable energy technologies. Greenpeace chose this location because it satisfied the following characteristics: pacified community, easily accessible, solid roof structure, solar radiance and shade considerations, and the place of operation is a legitimate NGO (rather than a commercial operation).

The “*Juventude Solar*” project is part of a larger strategy adopted by Greenpeace to include youth in renewable, solar energy projects and increase the visibility of these energy technologies, with the ultimate goal of getting the issue into a place of prominence in the political agenda. With slogans such as; “Within reach of everyone” (a*o alcance de todos)* and “The sun rises in Rio for everyone, I also want to take advantage of it” (*o Sol nasce no Rio de Janeiro para todos, eu também quero aproveitar),* Greenpeace is adopting the landscape narrative that renewable energy can be compatible with the inclusion of low-income communities.

Morro dos Macacos is a *favela* located in the neighborhood of Vila Isabel in the north section (*zona norte*) of city of Rio de Janeiro. The community leader of CEACA-Vila moved to the area in the 1950’s, at which time it was not urbanized: “*aqui não tinha nada, era tudo mato (*there was nothing here, it was all vegetation*)*”. Siqueira and Amaral (2011) indicate that the expansion of the *favela*, Morro dos Macacos was considerable in the 1980's, along with increased drug trafficking and violence in the region. Freeman (2014) points out that since the 1980's the armed gangs and drug traffickers have filled the void of state abandonment in the favelas, which he characterized as the "housing option of last resort for the poorly-paid workers who make the marvelous city go round" (FREEMAN, 2014, p.8).

In October of 2010, the community of Morro dos Macacos was occupied by a special regiment of the Military Police of the State of Rio de Janeiro, BOPE (*Batalhão de Operações Especiais*) with the intention of installing a police pacification station, UPP (*Unidade de Polícia Pacificadora*)[42]. A study realized in 2013 by a local NGO; CECIP (*Centro de Criação de Imagem Popular*) in Morro dos Macacos identify that the *favela*'s image was strongly related to that of drug trafficking prior to the UPP. The community was placed under heavy media attention due to an event in October 2009, in which a helicopter of the Military Police was shot down and exploded by a local drug cartel of the favela. That event, along with burning of various buses in other parts of the city occurred within weeks of Rio de Janeiro being officially chosen to host the 2016 Olympics (JAGÜARIBE, 2011, p. 328). According to the same author, these events served as a reminder that the city, which had been idealized and branded as the "*Cidade Maravilhosa*", is one that has lived a reality of daily violence and insecurity associated with drug trafficking, especially since the 1980's. Jagüaribe's analysis points out that the objectives of the UPP's are not just about the urgent need for attention to the social agenda, but also as a strategy to promote the image of the city of Rio de Janeiro as one linked to the favelas, as a way of reinventing the city as an "integrated" one (JAGÜARIBE, 2011, p. 343).

Pérez et al. (2013)'s investigation showed that the installation of the UPP had positive impacts, translated into an increased sense of security enjoyed by the residents to circulate freely. They found, however, that there is an unmet expectation within the community, that the establishment of the UPP would improve the delivery of basic services not directly related to security policy, i.e. basic sanitation, regular garbage collection, amongst others to guarantee quality of life, which has not materialized (PÉREZ et al., 2013, p. 20). In their analysis, they also noted a preoccupation amongst the residents in relation to the rise in cost of living, due to the fact they didn't previously pay for cable TV, water or electricity (which was consumed either for free via illegal connections or "*gato*" or at a flat rate, see Figure 25 for an example of these types of connections).

[42] The UPP of Morro dos Macacos is the 13th installed in the City of Rio de Janeiro, the first UPP was installed in 2008 in the community of Morro Santa Marta.

The population of Morro dos Macacos, according to the Municipality of Rio, is 5,072, which corresponds to 1,384 households (DE OLIVEIRA, 2010). The 13th UPP, located in Morro dos Macacos also covers the neighboring favela of Parque Vila Isabel, which has a larger population of 14,007 and 4,045 households bringing the entire "*Complexo*" of Macacos to 19,079 (see Map in Appendix 7).

For the purpose of the present analysis, a field visit was made to the community in February 2015. During the visit, interviews were conducted with: the community leader at CEACA-Vila, staff of the community center, staff of a local cultural center CCCria, the project developer from Greenpeace, staff of the distribution company LIGHT, a representative of the local electricity workers union (*Sindicato dos Trabalhadores nas Empresas de Energia do Rio de Janeiro e Região, Sintergia-RJ*), a local university; UFRJ, as well as with staff from the Brazilian energy planning agency, EPE.

5b. Discussion of the Environmental and Socio-economic benefits of the project

Solar Energy do Brasil (headquartered are in Campo Grande, Mato Grosso do Sul) prepared the technical design, installation and initial maintenance of the project, it also meters and accompanies remotely the operation of the system, as shown in Figure 24.

Figure 23. View of rooftop solar-PV installation in Morro dos Macacos,
Source: C.A.G.Garcez
Date: February 2015

Figure 24. View of metering and monitoring equipment installed by Solar Energy do Brasil in CEACA-Vila,
Source: C.A.G.Garcez
Date: February 2015

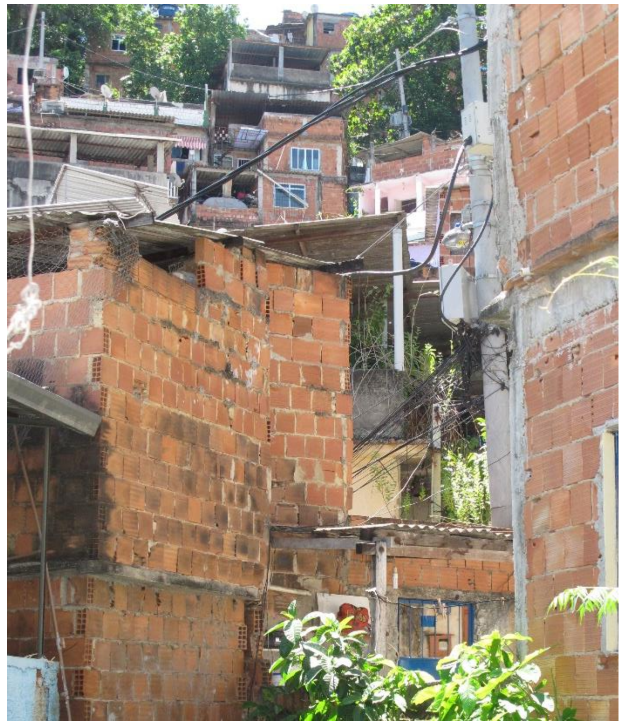

Figure 25. View of distribution connections (some irregular) in Morro dos Macacos,
Source: C.A.G.Garcez
Date: February 2015

The RETScreen software was used to calculate the anticipated energy generation and carbon savings over the lifetime of the project by using the technical specifications provided by the developer (see Appendix 8). In a moderately-conservative generation scenario (capacity factor of 15%), the system will likely generate 6 MWh per year or 500 KWh per month. The solar radiance for the city of Rio de Janeiro, 4.49 (kWh/m2)/day is lower than that of Juazeiro (5.72 (kWh/m2)/day), however it is still much better than that enjoyed in European countries of more northern latitudes.

Brazil's electricity mix is low in carbon intensity, six times lower than that of Europe and eleven times lower than that of China (EPE/MME, 2014b, p. 51). In order to estimate the environmental benefits of the project, the assumption is that the DG system will displace natural gas generation used at peak times. This means that over the lifetime of the project (25 years), 64 tons of CO_2-eq will be saved, which corresponds to taking 13 cars off the road. This is not a huge impact, but neither is the size of this rooftop project, with only 4.6 kW installed capacity. What is interesting is to consider the potential for the proliferation of this type of distributed generation, which EPE has done in a recent technical analysis for the time horizon of 2023. They estimate that the uptake of residential scale, distributed solar PV in Brazil will result in an accumulated amount of avoided carbon in the order of magnitude of 500 thousand tons, corresponding to the emissions of a 140 MW thermal generation plant operating at 90% capacity (EPE/MME, 2014b).

The actual generation of the system in Morro dos Macacos was not known to the CEACA-Vila staff at the time of the field visit, for reasons that will be describe in the following paragraphs. It is known, however, that the system will not be operating at its optimal level since there are 4 panels (of the 20 in total installed) that were damaged by local community members who threw stones during an altercation with the police in 2014. Greenpeace is currently in the processes of determining if there are budgetary means to replace them, even though the system has been donated to CEACA-Vila and per the agreement, the later entity is now responsible for the system's maintenance.

The first normalized electricity bill that CEACA-Vila received from the distribution company LIGHT was at the beginning of 2015. Previously, before the UPP was installed and the community was not considered "safe", LIGHT did not meter the electricity and the majority of the connections in the community were illegal "*gatos*". In the case of the community center, they paid a fixed monthly fee in the sum of R$ 35.00. For this reason, CEAVA-Vila did not know what their historical consumption was. Greenpeace approached the community with the proposal of a project that was intended to deliver approximately 600 kWh per month, as described in the interview:

> When the UPP came in, they began to straighten things up, remove the illegal connections and install the correct meters for each house. During this period, Greenpeace arrived and installed the solar panels. We were overjoyed because it would reduce our consumption costs[43]. Interview with CEACA-Vila staff, February 2015

The first bill that CEACA-Vila received was in the amount of R$ 1,815.00 (Jan/2015), which is 52 times higher than their previous flat rate. The second bill was reduced to R$1,090.00, with the DG in operation under the net metering scheme (approximately 40% of the center's consumption was off-set by solar panel generation). The tariff that the community center pays is 54 cents/kWh and there average consumption was around 1000 KWh per month. CEACA-Vila, which operates in its present location since 1983 offers computer and other training courses at no cost to the residents, meaning the electricity consumption of the computers, along with air conditioning and lights is high. The intended effect of the "normalization" efforts by the electricity distribution company, meaning the installation of meters to charge for actual consumption, is to

[43] Translated from original in Portuguese: Quando entrou a UPP, eles começaram a endireitar, tirar os gatos e começou a colocar os relógios certos em cada casa. Nesse interim chegou o Greenpeace, que instalou as placas solares. A gente ficou radiante porque iria reduzir o nosso gasto.

induce new behaviors, reducing wasteful and non-efficient habits; however, the current bill of CEACA-Vila also raises the question of affordability and fairness. The community center, and the community as a whole, has expressed a difficulty in paying the electricity bills, and there is indication that clandestine connections, *gatos*, are once again on the rise.

The distribution company, LIGHT, regulated by ANEEL, recognizes the enormous challenge that the lies ahead in formalizing services to low-income communities pacified by the UPPs. They completed a project under ANEEL's Research and Development Fund (ANEEL P&D) in order to identify strategies in this regard (DE MELLO et al., 2011). The main findings are that formalized electricity services (involving metering and payment for electricity consumption) can be effectively achieved if the following issues are addressed: support income generation and increased capacity to pay; create "Social Pacts" through education on energy consumption and efficiency; establish a policy of micro-credit or financing schemes specifically for this sector; improving energy efficiency standards for the civil construction industry; install anti-fraud technologies; and finally strengthen regulation for formalizing electricity distribution in harmony with social policy. These proactive recommendations are a stark contrast to the highly technical solutions previously studies in other ANEEL P&D projects dealing with the same issues of loss reduction in the case of irregular and illegal connections. DG is not explicitly listed as a solution in the De Mello et al. report; however, it has the possibility to act as in a transversal fashion, encompassing many of the recommendations listed.

An economic benefit that DG projects could provide to the distribution company, in addition to contributing to what De Mello et al. calls "increasing the capacity of consumer to pay", is the reduction of distribution system losses. In the most recent regulatory procedure to establish Light's electricity rates, ANEEL set the company's non-technical line losses at 40.41% (ANEEL, 2014a, p. 4 Art.). Non-technical losses include items such as metering uncertainties, temporary services and illegal connections and theft. Under normal conditions, non-technical losses are expected to be in the order of magnitude of 10-15%, indicating that there is a large potential to reduce system losses if DG projects were expanded in low-income settings, such as recently pacified *favelas* in the city of Rio de Janeiro.

6. Discussion

The two projects represent distinct archetypes of distributed generation, as shown in Table 12. Not only do they differ in scale but also in the regulatory arrangement and socioeconomic benefits generated. Within the perspective of strategic niche management, the two offer lessons for broad learning of across horizontal aspects but also vertically, as they involve many actors on the state, municipal and federal level, such as the CCEE, ANEEL, CAIXA, and the Ministry of Cities, etc.

Table 12. Summary of pilot projects

Project	***Projeto de Geração de Energia e Renda*** **Juazeiro, Bahia**	***Projeto Juventude Solar*** **Rio de Janeiro**
Broader social policy	Public housing, MCMV	Pacification, UPP
Project Developer Financier	Brasil Solair FSA/ Caixa Econômica Federal	Solar Energy do Brasil Greenpeace
Installed capacity	2,185 kW (9500 solar panels) 24 kW (small Wind)	4.6 kW (20 solar panels)
Installation location	1000 residential rooftops and common community infrastructure	CEACA-Vila community center
Total investment	R$6,200,000	R$36,800
DG regulation mechanism	Special energy commercialization authorization granted by ANEEL	Standard DG regulation for net metering (ANEEL 482/2012)
Construction date	May 2013 (solar) August 2013 (wind)	July 2013
Operation date	February 2014 (solar)	August 2014
Socioeconomic benefits	Income generated: R$88.50 per month per family (average for 2014)	Avoided energy costs: R$725 (Jan, 2015)
	34 community members trained, employed and executed installation	16 community youth trained to accompany installation
Environmental benefits of avoided emissions GHG (tCO_2eq) Cars	 30,455 (solar); 670 (wind) 5,575 (solar); 123 (wind)	 65 13

Galleger's book (2014) on the penetration of renewable energy technologies on a global scale criticizes the formation of niches, and advocates for market creation mechanisms because according to her analysis (focused on China), that is the only way for a middle income economy to rapidly address climate change mitigation at a rate that is necessary. In the Brazilian case, Galleger's argument does not apply as strongly, since the country does have a low-carbon electricity mix. In Brazil's case, the present analysis argues that strategic niche management is an appropriate mechanism for incentivizing DG within a sustainable transition. Beyond this, the transition that is being considered in this work is not just low-carbon, but also socially inclusive. The scale that Galleger advocates for renewable energy deployment, such as large wind and solar farms are questionable in terms of the social benefits they provide (JUÁREZ-HERNÁNDEZ; LEÓN, 2014).

According to Sovacool's (SOVACOOL, 2012) analysis of energy governance of small-scale projects, successful projects are treated as socio-technical. He calls for radical re-assessment of energy development assistance programs, which have traditionally supported highly technical and economic research, while politics and culture often take "a back seat". To this end, two issues that Sovacool raises: ownership and maintenance will be elaborated upon in the context of the pilot projects studied in Brazil.

i. Questions of ownership; impacts on long-term and broad financial viability

Both of the pilot projects that are considered in this paper were, as Sovacool cautions, "give aways". This raise the significant concern of ownership, which is recognized as creating implications for long-term viability of the projects themselves, but also with regards to broadening DG deployment in Brazil. Bursztyn points out that ownership is a fundamental aspect of governance; "ownership (a feeling of belonging) constitutes a key element in the success of local level projects. In this case, it is not enough that the decision be considered legitimate. It is necessary also that the actors see the decision as their own" (BURSZTYN, 2008, p. 13). The issue of lack of ownership has been identified largely in the Juazeiro project and has been manifested concretely in actions such as the vandalism of small wind tower components as well as approximately 40 solar PV panels, as explained in a conversation with two community member held in March 2015:

> "They already stole two batteries, the ones from the breaking mechanism [of the small wind tower]"… "Yeah, to see if they can get some money, these troublemakers (*malandragens*) that are around here"… "They stole them to see if they can trade them for something, drugs, or something else, they'll try for anything"[44] March 2015

In order to expand the development of DG projects in the MCMV program in a viable fashion, they should transition to an ownership model that is "one of cost-sharing rather than give aways"

[44] Translated from original in Portuguese: "É, roubaram já duas baterias, para poder freiar [mecanismo de freagem da torre eólica]" ... "roubam para poder ver se vendem"... "É, para ver se fazem um dinheirinho, essas malandragens que ficam por aí."... "Roubam porque querem trocar por alguma coisa, drogas ou qualquer outra coisa, eles tentam fazer qualquer coisa"

(SOVACOOL, 2012, p. 290). To this end, a solution that is being tested in Juazeiro, but is not yet widely implemented, is using the income generated by the sale of renewable energy to pay off the mortgage loans. Not all residents have signed the necessary paperwork for the bank; CAIXA to process this transaction automatically, as one of the *síndicas* explained:

> In my bill it is already discounted. My house payments are up to date, thank God, I don't have any late payments. The money is already discounted. The Caixa bank is encouraging us, saying "put it in automatic debit to be discounted already"[45] March 2015

The solution currently being tested in Juazeiro can also been seen as a mechanisms of increasing the capacity of the community to repay loans, especially considering the high default rates currently being experienced in the MCMV program. According to data prepared by the Brazilian newspaper, *Valor Econômico*, based on data received from the Ministry of Cities, the average national default rate is 16.7% for families that fall into the "*faixa 1*" range (monthly income that is up to three minimum wages or $R 1,600.00) (SIMÃO, 2014). The same article estimates that this is 8 times higher than in the default rate of the Brazilian real estate market as a whole. Default in the mortgage loans of the MCMV program vary between states; Acre being the highest at 36.71%, Alagoas the lowest at 4.67%, while the state of Bahia, where the current case study is located is 19.03%. Bahia is also the state with the largest number (in absolute terms) of housing units built for families that fall under the "*faixa 1*" income range.

Furthermore, mechanisms to reduce the income volatility in DG schemes such, as the one in Juazeiro, should be investigated. Various mechanisms could be considered, such as, establishing contracts (FIT's), thereby avoiding the short-term market volatility (as discussed regarding the PDL price) or virtual net metering (leasing arrangements), which a recent EPE report indicated was removed from the original net metering regulation published by ANEEL in order to avoid taxation (EPE/MME, 2014b, p. 11).

In the case of Rio, where efforts are being made to convert clandestine connections into normalized ones, distributors have taken efforts to increase energy efficiencies, such as through programs to exchange old appliances at no cost to the residents. To compliment this approach, local distribution companies themselves could take the lead in increasing the capacity of the households to pay for energy by installing DG systems. This also has the potential of reducing system losses, as previously explained. Silva points out that 60% of the funds that distribution

[45] Translated from original in Portuguese: No meu já vieram descontado. A minha casa está em dia, graças à Deus, não tenho uma prestação atrasada. O dinheiro cai lá e já desconta. Tanto que a Caixa vem colocando e a gente dizendo, "Coloque no débito automático para ir descontando já".

companies invest in energy efficiency projects are to be directed to the consumers paying the "*Tarifa Social*" i.e. low-income families. These investment have typically been used to replace refrigerators and incandescent bulbs, however, she recommends that the same funds should be used to support distributed generation projects in the low-income communities; "this is an opportunity to create a win-win partnership between the consumer and distributor, as well as the country as a whole"[46] (DA SILVA, 2015, p. 31–32).

ii. Built, and then what? After-installation services and maintenance

Sovacool (2012, p. 288-9) recommends that small-scale renewable energy projects, in order to be successful in the long run, must "strongly emphasize after-sales services and maintenance". This lesson has been previously raised in Ostrom's analysis (1993) on infrastructure policies in developing country contexts. In both of the pilot projects considered in this paper, uncertainty regarding the long-term maintenance of the projects has been raised by the community members.

In the case of Morro dos Macacos, Greenpeace indicated that they have already "donated" the system to the CEACA-Vila and the responsibility for its maintenance now lies with the community center. However, in an interview with the community center staff, it was apparent that there are still doubts in this regard. In Juazeiro, the *síndicas* indicated that the long-term operation and maintenance was a concern for them, especially since they had not yet signed a "donation agreement". Uncertainty regarding the future roles of the community association and project developer have stalled investments in repairing damaged equipment (such as the wind-tower batteries and broken solar panels).

7. Guidelines and elements for the governance of distributed generation in Brazil

The primary motive of strategic niche experimentation within an analytical framework of transitions management is to gain lessons for policy interventions and structural conditions to intentionally guide or orient the socio-technical system toward a desired path or outcome (VOß; SMITH; GRIN, 2009). Shove and Walker (2007) alert that this desired path or outcome is may be difficult to obtain or gain consensus on, which is an important consideration included in the conceptualization phase.

[46] Translated from original in Portuguese: Trata-se de uma oportunidade de se criar uma parceria entre o consumidor e a distribuidora de energia elétrica em que ambas ganham, junto com o País.

Previous analysis presented in the paper argue that the desired outcome for the electricity sector (as the socio-technical system) in the Brazilian context is not only related to climate change mitigation and incenting low-carbon generation sources but also a transition that is inclusive of low-income populations, aligned to existing social protection polices (IIED, 2014) and economic development instruments.

Drawing from works concerned with the analysis of development project life cycles (BRIERE; PROULX, 2013); (KHANG; MOE, 2008) and energy governance (SOVACOOL; DRUPADY, 2012) and reflective governance (VOß; SMITH; GRIN, 2009), elements that should be considered for distributed generation programs/projects in Brazil has been formulated and can be seen in Figure 26. The phases of program/policy design as well as desired outcomes are shown, not in a purely linear fashion, but one that intentionally views policy design as reflective, gaining insights on how projects work out in practice and then re-design them based on evaluations made by a diversity of stakeholders. Moreover, VOß et al. indicate, “In dealing with transition management, we need to understand design as a process of moving back and forth between conceptual analysis and practical experimentation” (2009, p. 292).

i. Conceptualization Phase

The first stage of the program/project life cycle is that of conceptualization, in which a larger vision for distributed generation in Brazil must be established and shared amongst the stakeholders, with regards to the appropriate technical and services encompassed within DG. Additional elements include that of institutional diversity and political support. In the case of Brazil, DG can build upon the institutional infrastructure initiated by the ANEEL regulation, but additional actors from other levels of government; states and municipalities must be included to reflect the polycentricity of the electricity system. The institutional diversity also implies the involvement of non-state actors/private sector. The diversity of actors requires some sort of coordination in which roles and responsibilities are distributed among the different partners, which Sovacool and Drupady (2012) asserts shares risks and create checks and balances. This is an item that repeats within the Implementation Phase.

Within the element of political support, which is related to that of institutional diversity and shared vision, Sovacool and Drupady (2012) emphasize through their case study research that DG needs to have a dedicated or experienced implementation agency or project champion.

ii. Design

The element entitled “Net beneficial energy service” is related to that of appropriate technology and services. It has been adapted from Sovacool and Drupady (2012) lessons of energy governance in isolated energy systems. This focus is on improved service delivery which can be envisioned at various levels. In the case of the micro-level (i.e. for the Favela of Morro dos Macacos) it can improve access to regular service, while at the meso-scale of the distribution company, it can improve the reliability of the grid. This element envisions spill-over of effects that improve lives through job creation and perspectives for future micro economy of the community where the project is installed.

The element of “Project commitment” enters as a consideration in the implementation phase as well (clear roles and responsibilities for manager and stakeholders). In the design phase, commitment must be established through come cost-sharing structures. Community ownership/operation/participation can be designed through either monetary contributions and affordable financing schemes (CAMARGO; WWF-BRASIL, 2015) or could also involve non-monetary contributions (time, labor, land, materials). Again, Sovacool and Drupady emphasizes, “Having local communities pay for renewable energy projects with their own funds means they express interest and responsibility in how they perform; they become not only passive consumers, but active participants” (2012, p. 259). The item of commitment is highly related to that of “Affordability”. Specific mechanisms to induce affordability have been previously cited in the previous section.

The element of capacity building on an institutional level is included in three phases; design, implementation and closure, as well as a key outcome. It is key to ensuring the long-term success of the projects as well as being related to the item of non-paternalistic or dependence of the community involved in the project. Capacity building refers to the strengthening the technical and managerial capacity of domestic and local institutions.

iii. Implementation

Project management literature gives practical consideration to establishing and monitoring clear timelines during the implementation phase, however, on a more conceptual level and related to the idea of reflective governance, the element of flexibility is key. Flexibility refers to the ability to adapt to the local circumstance by adjusting expectations, timelines or even technologies, as needed. The lack of flexibility to local circumstances and needs is highlighted as one of the key lessons for project failure (SOVACOOL; DRUPADY, 2012, p. 281).

iv. Closure and Monitoring phases

The element of “After-sales services” is a key consideration in these two phases, and should be related to program design, including reserving funds for maintenance. Monitoring the completed project involves practical items such as evaluation reports, etc. In terms of reflective governance, it is also related to the idea that lessons can be learned and revisions made. The outcomes of the process are both tangible (reports) but also intangible such as that of strong local project ownership.

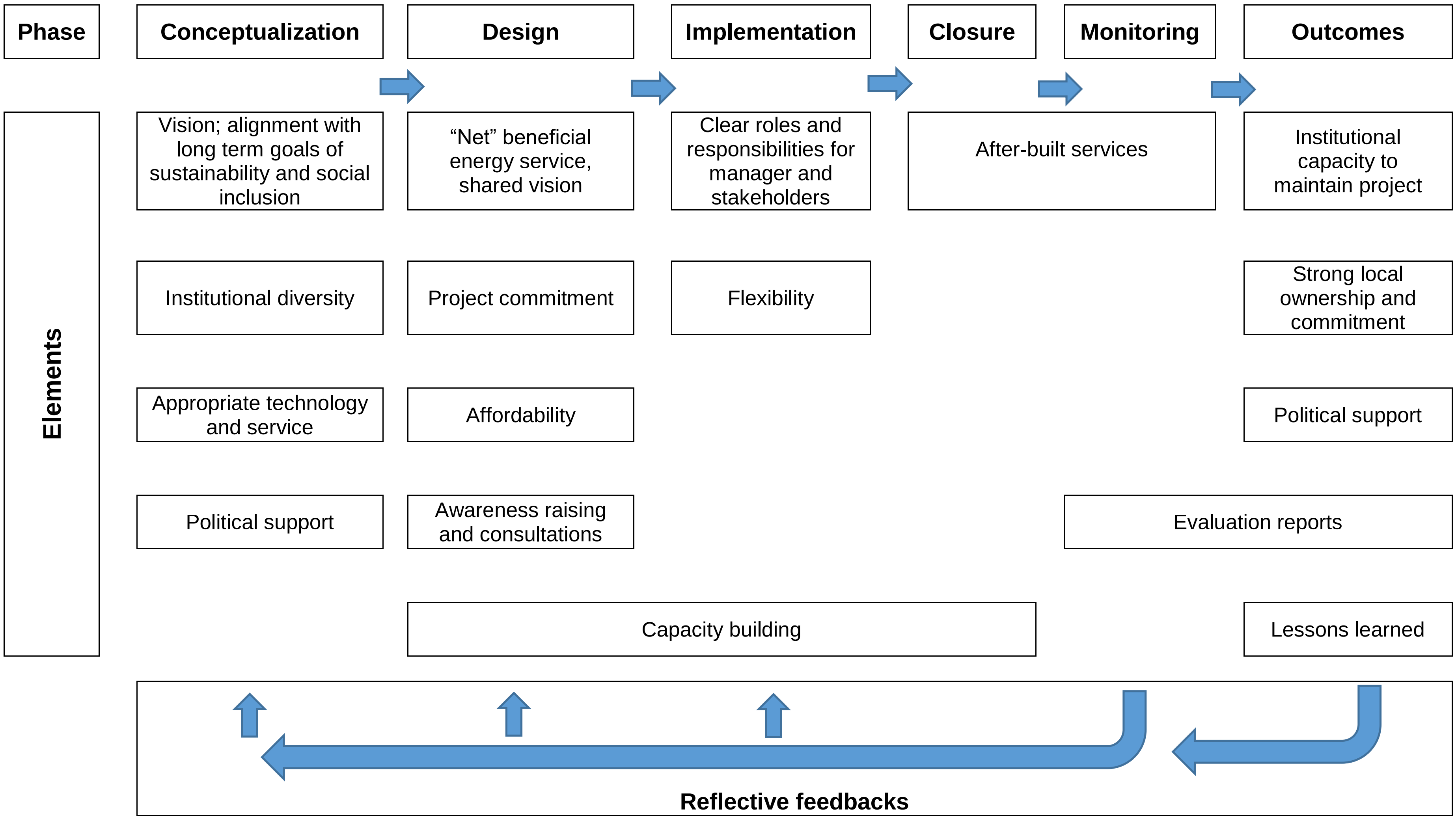

Figure 26: Elements for the reflective governance of a distributed generation program/project
Elaborated by: C.A.G.Garcez

8. Conclusion

The analysis presented in the paper demonstrated that there is emerging but convincing evidence that environmental and socioeconomic benefits are to be gained in the distributed generation projects, especially in low-income and urban communities in Brazil. These benefits extend beyond those for the communities themselves (income and job generation), but also apply to local distribution companies and financial institutions. This finding is in stark contrary to narratives present in the dominant electricity regime, which consider that distributed generation should be incented only in cases where countries need to reduce the carbon-intensity of their electricity market, which is not that of Brazil. Within the perspective transition management, it will be necessary to align DG to existing polices and initiatives under a systematic and coordinated approach, thereby supporting DG as a policy choice rather than the regulatory approach currently in place in Brazil. Elements for the development of a DG program in Brazil have also been presented, within the framework of reflective governance.

CONCLUSÃO

O processo de tomada de decisão sobre questões energéticas é uma tarefa com desafios inúmeros, é um assunto técnico englobado por interesses políticos e econômicos muitas vezes conflituosos com a sustentabilidade socioambiental. Ultimamente, os desafios do setor elétrico multiplicaram em número e também em complexidade. O suprimento confiável, econômico e universalizado de energia elétrica é entendido como essencial para o funcionamento da economia e da sociedade. No entanto, os impactos ambientais causados pela sua geração, transmissão e distribuição estão sendo questionados, abrindo um espaço para um modelo alternativo aos grandes centrais, que é o da geração distribuída (ou decentralizada), conforme mencionado na literatura

O objeto desta tese foi de analisar esta nova configuração de geração e consumo de energia elétrica: a geração distribuída. O objetivo geral da tese de doutorado foi de entender como a política no Brasil, dentro do seu contexto mais amplo e no movimento internacional, busca complementaridades ambientais (uma matriz de baixo carbono) e sociais (inclusão social). A pergunta norteadora que a tese buscou responder em quatro artigos foi: de que maneira uma política de geração distribuída de energia elétrica contempla sinergias positivas com políticas de inclusão social ao mesmo tempo em que contribui também para minimizar impactos ambientais?

O primeiro artigo abordou a questão: o que sabemos sobre o estudo de políticas de geração distribuída de energia elétrica nas Américas? Foi feita uma revisão de literatura ampla e sistemática das políticas públicas que contemplam a geração distribuída no continente americano. A análise mostrou que as forças motrizes mais citadas para a adoção de políticas de geração distribuída são as mudanças climáticas e preocupações com o meio ambiente. No entanto, foi evidenciado que os incentivos à economia verde e a geração de empregos são fatores mais importantes no Canadá e nos Estados Unidos que nos países latino-americanos. Por outro lado, a diversificação da matriz energética e os custos evitados de investimentos em infraestrutura ocuparam um espaço mais importante como força motriz entre países latino-americanos do que nos países norte-americanos.

Os focos proeminentes dos artigos analisados na revisão sistemática foram os mecanismos de incentivo para geração distribuída, com destaque para um mecanismo chamado tarifas-prêmios ou também conhecido em inglês como *feed-in-tariffs*, FITs. A literatura o aponta como um mecanismo que contribui significativamente para o crescimento de energia de fontes renováveis em escala global. O Brasil não escolheu este mecanismo, mas sim o *net metering* ou sistema de compensação de energia elétrica para projetos de geração distribuída. Os motivos desta escolha são abordados no terceiro capítulo, tais como: a falta de autoridade na parta da ANEEL de estabelecer incentivos ou instrumentos econômicos para a comercialização de energia gerada a partir de projetos de GD, algo que cabe ao poder executivo (MME) formular.

De modo geral, a revisão sistemática mostrou que as questões sociais e urbanas não são frequentes nos estudos. Também foi notada uma lacuna sobre o papel de geração distribuída na transformação do setor, no caminho para a sustentabilidade, que contemple a incorporação de energia renovável de forma socialmente justa e inclusiva.

O segundo artigo buscou entender a trajetória histórica e institucional dos setores elétricos no Brasil e no Canadá para identificar quando, como e por que a geração distribuída surgiu como um assunto no âmbito de planejamento político-energético. A escolha destes dois casos é justificada, pois os dois países possuem características geográficas similares: grandes expansões de terra, o que dificulta a instalação de linhas de transmissão; comunidades isoladas; desigualdades econômicas e sociais entre as suas regiões; economias baseadas na exploração das suas riquezas naturais, como a mineração, dentre outros. Contudo, as estruturas governamentais e administrativas dos setores elétricos nos dois sistemas federalistas são distintas. Por isso, as duas províncias canadenses de Ontário e Colúmbia Britânica foram escolhidas para comparar com o caso brasileiro baseada nas duas variáveis: 1) estrutura político-institucional dos setores elétricos, e 2) recursos disponíveis para geração de energia elétrica.

Nos casos do Brasil e de Ontário, uma reestruturação do setor elétrico aconteceu paralelamente na década de 1990 e fez com que os setores que anteriormente seguiam um modelo de monopólio estatal passassem a ter uma maior participação da iniciativa privada, reguladas por agências recém-criadas e independentes. Este fenômeno se repetiu em muitos outros países. A Colúmbia Britânica, manteve seu setor verticalmente integrado e sob controle do Estado, tem uma matriz energética bastante parecida com a do Brasil, já que mais de 80% da sua geração vem de grandes usinas hidroelétricas, enquanto a matriz de Ontário depende mais de usinas nucleares e termoelétricas.

A análise mostrou que geração distribuída é um elemento internalizado do planejamento de política energética das duas províncias canadenses; enquanto que no caso brasileiro, a GD não faz parte de uma política consolidada, mas é um elemento externo que se tornou um assunto regulatório. Em Ontário e na Colúmbia Britânica, as forças motrizes, por apoiar e incentivar a geração distribuída, são relacionadas principalmente às questões ambientais locais e com estratégias para a geração de emprego. No caso brasileiro, foram identificadas dois fatores-chaves para a falta de incentivos para geração distribuída. Primeiro, há uma percepção por parte dos tomadores de decisão de que a construção de grandes usinas hidrelétricas é uma maneira suficientemente sustentável para expandir a oferta de energia elétrica, devido ao seu baixo teor de emissões de carbono. Em segundo lugar, a geração distribuída não é vista como uma opção que oferece benefícios ambientais e sociais suficientes para justificar custos adicionais em equipamentos predominantemente importados.

No terceiro artigo, a análise é focada especificamente no contexto do Brasil. O artigo apresenta o panorama político (contexto da política, o desenho de instrumentos políticos e uma análise dos seus impactos) da nova modalidade de geração elétrica que foi criada em 2012 no Brasil pela regulação normativa da agência reguladora ANEEL No. 482.

Esta resolução foi elaborada pela Superintendência de Regulação dos Serviços de Distribuição, SRD da ANEEL e tem como objetivo diminuir as barreiras técnicas-administrativas para que projetos de pequena escala se conectam aos sistemas de distribuição no País. Foram identificados dois principais motivos que levou SRD/ANEEL a regular a geração distribuída no Brasil: a difusão de políticas internacionais e a aprendizagem para a instalação de um *smart-grid* no Brasil. O artigo conclui que a geração distribuída no Brasil não faz parte de uma política estratégica, mas é tratada apenas como um aspecto regulatório. Faltam linhas de financiamento adequada para a escala dos projetos pequenos de GD e outros incentivos diretos e indiretos para que tal modalidade contribua de maneira significativa na matriz energética brasileira.

No segundo parte do artigo, os impactos iniciais da resolução a partir dos dados disponíveis pela BIG/ANEEL são analisados. Apenas 318 projetos foram registrados em todo o País nos primeiros três anos da vigência da Resolução 482. A grande maioria são de geração solar (93%). Uma regressão linear foi feita para identificar os fatores determinantes que possam explicar a tendência do número de projetos de geração solar em residências, agregados por unidade da federação. Os resultados da análise mostram que tarifas residenciais altas influenciam positivamente o número de projetos. Este resultado era esperado uma vez que não existem outros incentivos, o único fator na viabilidade econômica dos projetos é alcançar ou não a paridade tarifária (ou seja, se o custo nivelado do sistema de GD é igual ou inferior às tarifas pagas pelos consumidores por energia elétrica). Outro fator estatisticamente significativo foi a exoneração de um imposto estadual, o ICMS. Isso significa que a cobrança desse imposto influencia negativamente o número de projetos de geração distribuída por estado. A análise também apresentou que a disponibilidade de recurso natural, representado pela radiação solar, não afeta positivamente e nem de maneira estatisticamente significante o número de projetos. Isso não é necessariamente intuitivo, pois o senso comum é que investidores querem instalar projetos aonde há condições naturais favoráveis. No entanto, esta análise está consistente com outros estudos internacionais, que também apontam que as condições climáticas não são fator chave para a inserção de energia renovável em matrizes energéticas, mas sim a presencia de políticas adequadas.

No último artigo, a questão de geração distribuída como um nicho estratégico dentro do setor elétrico brasileiro é abordada. Vê-se que é um bom exemplo de um sistema sociotécnico, baseado no arcabouço teórico referido como "*sustainability transitions literature*". A inclusão social como parte fundamental de uma transição não é algo abordado dentro desta literatura, mas será fundamental para uma transição rumo à sustentabilidade no Brasil e em outros países emergentes. Por isso, identificou-se dois projetos instalados em comunidades de baixa renda e em áreas urbanas, para analisar como a geração distribuída pode ser um nicho de sustentabilidade ambiental e social numa transição no Brasil. O primeiro estudo de caso é um projeto de geração de energia solar e eólica em duas comunidades vizinhas (Morada do Salitre e Praia do Rodeadouro), construídas no município de Juazeiro no estado da Bahia, dentro do programa habitacional Minha Casa Minha Vida, MCMV. O outro projeto incluído na análise é uma instalação de energia solar feita pela Greenpeace no centro da comunidade CEACA-Vila (Centro Educacional da Criança e do Adolescente Lídia dos Santos – Vila Isabel) no Morro dos Macacos, Rio de Janeiro, uma favela pacificada em outubro de 2010.

Os dois projetos são configurações distintas de geração distribuída que geram benefícios diferenciados, como foi mostrado na Tabela 11. Dentro da perspectiva de uma gestão de um nicho estratégica (*strategic niche management*), ambos oferecem lições abrangentes para a aprendizagem por partes dos vários atores que participam do setor elétrico. No primeiro caso de Juazeiro, o projeto recebeu uma autorização especial da ANEEL para a comercialização de energia solar no Ambiente de Contratação Livre, ACL. Uma porção da venda de energia é dividido com os moradores, que gerou uma renda média mensal por família de R$ 88.50 (durante o período de fevereiro a dezembro de 2014). Outra porção é depositado em um fundo para infraestrutura compartilhada e administrada pela gestão local das comunidades. Por participar do ACL, o projeto e a renda gerada ficam vulneráveis à volatilidade dos preços de mercado, algo que gerou preocupações por partes das comunidades. Enquanto no caso do projeto de energia solar no Rio de Janeiro, o modelo de geração distribuída segue a regulação vigente no Brasil de *net metering* ou compensação de energia (ANEEL Resolução Normativa 482/2012). Este modelo não permite a comercialização ou venda de energia gerada, mas apenas compensa o consumo do centro comunitário aonde foi instalada, reduzindo seus gastos operacionais.

Nos dois projetos, os benefícios ambientais foram calculados em termos de emissões evitadas (CO2eq, equivalência em dióxido de carbono) com o software RETScreen, considerando que os sistemas fotovoltaicos substituíam geração diurna por termoelétricas a gás. Os benefícios refletem as escalas dos projetos; em Juazeiro as emissões evitadas durante a vida útil do projeto de 25 anos foram estimadas em 30.455 tCO_2eq (equivalente a retirada de 5.575 carros de circulação), enquanto no Rio de Janeiro o pequeno projeto de 4,6 kW evitará a emissão de 65 tCO_2eq ou 13 carros. A possibilidade de expandir a geração distribuída e seus benefícios ambientais depende de muitas variáveis. A análise de cenários ou projeções futuras não foi objeto desta tese, no entanto, para ter uma noção dos potencias benefícios ambientais de GD, o estudo feito pela Empresa de Pesquisa Energética para a expansão de geração distribuída no Brasil até 2023 mostrou que projetos residenciais poderiam resultar (no cenário de *business as usual*) na redução de 500 mil toneladas de CO_2eq (ou seja, evitar as emissões de uma termelétrica com uma capacidade instalada de 140 MW operando com 90% de capacidade) (EPE/MME, 2014b). Qualquer cenário de penetração mais acelerada de geração distribuída dependerá de incentivos ausentes no cenário político atual.

No que diz respeito a inclusão social, os dois projetos incorporaram este fator motriz ou "fator de paisagem" dentro dos seus objetos. Em Juazeiro, 34 membros da comunidade foram treinados e contratados para realizar a instalação dos sistemas fotovoltaica e eólica. No Rio de Janeiro, 16 jovens da favela de Morro dos Macacos foram treinados para acompanhar a instalação (feita pela empresa Solar Energy do Brasil). Os efeitos decorrentes de tal não foram mensurados neste artigo, algo que necessita um acompanhamento de longo prazo.

A experiência de Juazeiro de geração de renda segue uma tendência no Brasil, e em outros países emergentes, de incentivar inclusão social por transferência de renda, o programa mais emblemático desta é a Bolsa Família no Brasil. No entanto, o modelo de compensação de energia, no caso da favela pacificada no Rio de Janeiro, possa ser interpretado como uma maneira de aumentar a capacidade dos moradores de pagar suas contas (especialmente em lugares aonde a regularização e cobrança de serviços é algo recente). Os dois casos oferecem exemplos de maneiras de popularizar tecnologias de geração de energia elétrica por fontes renováveis e modernos, algo que é associada na literatura muitas vezes às classes com poder aquisitivo mais alto.

Na comparação desses dois projetos, consigo apontar questões que possivelmente influenciarão não apenas em seu próprio sucesso no longo prazo, mas também em lições para a sua ampliação, tais como: em ambas as comunidades existem questões de *ownership*, o processo de internalização ou adoção dos projetos percebido como algo pertencendo a eles, principalmente porque nos dois casos os projetos foram doações. Uma maneira de trabalhar essa questão que a literatura aponta é implementar futuros projetos com formas de compartilhamento de investimentos ou despesas (*cost-sharing)* dentro de outras estratégias que abordo no artigo. A literatura também aponta a questão da manutenção de longo prazo como sendo fundamental no sucesso de projetos de energia renovável. Portanto, a pesquisa aponta que em ambos os casos existem entendimentos diferenciados entre as comunidades e os agentes de desenvolvimentos sobre o papel e obrigações dos atores, no que diz respeito à manutenção de longo prazo dos sistemas.

Os quatro artigos oferecem uma análise em escalas distintas sobre o tema de geração distribuída no Brasil e reflexões sobre a sua contribuição para a transição rumo à sustentabilidade de um setor altamente complexo e multidimensional. A geração distribuída, por ser baseada em escalas menores e partir de fontes renováveis oferece uma alternativa ao sistema elétrica vigente com benefícios ambientas e sociais. No entanto, no Brasil a GD não faz parte de uma política energética estratégica, sendo tratado apenas como assunto regulatório. No que diz respeito a uma transição sustentável do setor, a possibilidade da GD contribuir para uma matriz de baixa carbono e a inclusão social requer uma coordenação de vários órgãos governamentais e investimentos adequadas e direcionadas.

Por último, foram apresentados elementos para guiar a governança refletiva de um programa ou projeto de geração distribuída no Brasil. Fundamentalmente, o objetivo de uma governança refletiva é de aprender lições a partir de experiências reais que possam auxiliar no desenho e implementação de políticas públicas. Os diretrizes foram baseados nos conceitos de gestão de projetos e programas para o desenvolvimento, governança de projetos de energia e gestão de transições de sistemas sóciotécnicos. Os resultados (*outcomes*) esperados de um programa ou política de geração distribuída podem ser considerados tangíveis (relatórios de monitoramento e impactos) e intangíveis, conceitos a serem construídos ao longo do processo, como por exemplo, *ownership.* Acima de tudo, a governança requer uma visão compartilhada e estratégica do setor elétrico, uma escolha intencional de investir em políticas que possam nortear uma transição rumo à sustentabilidade ambiental e social. Furtado, num discurso intitulado "Os Desafios da Nova Geração", descreve a importância desta escolha intencional para o desenvolvimento:

> ...*o crescimento econômico*, tal qual o conhecemos, vem se fundando na preservação dos privilégios das elites que satisfazem seu afã de modernização; já o *desenvolvimento* se caracteriza pelo seu projeto social subjacente. Dispor de recursos para investir está longe de ser condição suficiente para preparar um melhor futuro para a massa da população. Mas quando o projeto social prioriza a efetiva melhoria das condições de vida dessa população, o crescimento se metamorfoseia em desenvolvimento.
>
> Ora, essa metamorfose não se dá espontaneamente. Ela é fruto da realização de um projeto, expressão de uma vontade política. As estruturas dos países que lideram o processo de desenvolvimento econômico e social não resultaram de uma evolução automática, inercial, mas de opção política orientada para formar uma sociedade apta a assumir um papel dinâmico nesse processo (FURTADO, 2004, p. 2).

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Anexo I. Lista de entrevistas, list of organizations where interviews conducted

Organização/ Organization
Abinee, Associação Brasileira da Indústria Elétrica e Eletrônica
ABRADEE, Associação Brasileira de Distribuidores de Energia Elétrica
Agência National de Energia Elétrica, Serviços de Distribuição, SRD
Associação dos Empregados de Furnas (Asef) e Sindicato dos Trabalhadores nas Empresas de Energia do Rio de Janeiro e Região (Sintergia-RJ)
Banco do Nordeste do Brasil, Célula de Meio Ambiente, Inovação e Responsabilidade Social
BC Agricultural Research and Development Corp.
BC Hydro
BC Ministry of Energy
BCSEA, British Colombia Sustainable Energy Association
Brasil Solair
British Columbia Public Interest Advocacy Centre
BYD (Fabricante de Paineis Solares, Matriz Chinesa)
Caixa Econômica Federal, GN Sustentabilidade e Responsabilidade Socioambiental
Canadian Association of Physicians for the Environment
CAR, Companhia de Desenvolvimento e Ação Regional do Estado da Bahia
CEB - Distribuidora
Centro Brasileiro de Energia e Mudanças Climaticas, Salvador
Centro Comunitário Lídia dos Santos e Centro Educacional de Ação Comunitária da Criança e do Adolescente, CEACA-Vila, Complexo do Morro dos Macacos – Vila Isabel
Centro Cultural da Criança, CCCria, Complexo do Morro dos Macacos – Vila Isabel
Clean Energy Canada
COELBA Distribuidora
Condomínio Moradas do Salitre
Condomínio Praia do Rodeadouro
Consultor Legislativo, Recursos Energéticos, Câmara dos Deputados
COPPE, UFRJ
EPE, Empresa de Pesquisa Energética
Fundação Banco do Brasil
GIZ, Agência Alemã de Cooperação Internaciona; Director of Sustainable Infrastructure programme
Greenpeace Brasil
Greenpeace, Youth on the Roof
ICLEI Local Governments for Sustainability
Independent Electricity Systems Operator Ontario, IESO
Instituto Ideal para o desenvolvimento de energias alternativas na America Latina
Light Serviços de Eletricidade S.A,
microFIT, Ontario Power Authority, OPA
Ministério das Cidades, MCT, Secretaria Nacional de Habitação (SNH)
Ministério de Desenvolvimento Social
Ministério de Desenvolvimento, Indústria e Comércio Exterior, Departamento de Competitividade Industrial / Secretaria do Desenvolvimento da Produção
Ministério de Meio Ambiente, Fundo Clima
Ministério de Minas e Energia
Ontario Ministry of Economic Development
Ontario Sustainable Energy Association
Secretaria Municipal de Desenvolvimento e Igualdade Social, SEDIS-Juazeiro, Juazeiro, Bahia
Secretaria Municipal de Desenvolvimento Urbano e Habitação, SEDUH de Juazeiro, Bahia
Secretaria Municipal de Meio Ambiente de Juazeiro, Bahia
Solar Share (Renewable Energy Co-op)
UNEB, Centro de Agroecologia (CAERDES)
UNEB, Departamento de Ciências Humanas
Women in Renewable Energy

Appendix 1: Articles included in the systematic review (N=87), page 1 of 2

Authors	Title	Year	Publication
Huenteler, Joern	International support for feed-in tariffs in developing countries-A review and analysis of proposed mechanisms	2014	RENEWABLE & SUSTAINABLE ENERGY REVIEWS
Mallikarjun, Sreekanth; Lewis, Herbert F.	Energy technology allocation for distributed energy resources: A strategic technology-policy framework	2014	ENERGY
Taha, Ahmad F.; Hachem, Nadim A.; Panchal, Jitesh H.	A Quasi-Feed-In-Tariff policy formulation in micro-grids: A bi-level multi-period approach	2014	ENERGY POLICY
Giraudy Arafet, et al	Factibilidad de instalación de sistemas fotovoltaicos conectados a red	2014	Ingeniería Energética
Rowlands, Ian H.; Kemery, Briana Paige; Beausoleil-Morrison, Ian	Managing solar-PV variability with geographical dispersion: An Ontario (Canada) case-study	2014	RENEWABLE ENERGY
Hawthorne, Bryant; Panchal, Jitesh H.	Bilevel formulation of a policy design problem considering multiple objectives and incomplete preferences	2014	ENGINEERING OPTIMIZATION
Borchers, Allison M.; Xiarchos, Irene; Beckman, Jayson	Determinants of wind and solar energy system adoption by U.S. farms: A multilevel modeling approach	2014	ENERGY POLICY
Kulatilaka, Nalin; Santiago, Leonardo; Vakili, Pirooz	Reallocating risks and returns to scale up adoption of distributed electricity resources	2014	ENERGY POLICY
Schelly, Chelsea	Implementing renewable energy portfolio standards: The good, the bad, and the ugly in a two state comparison	2014	ENERGY POLICY
Holdermann, Claudius; Kissel, Johannes; Beigel, Juergen	Distributed photovoltaic generation in Brazil: An economic viability analysis of small-scale photovoltaic systems in the residential and commercial sectors	2014	ENERGY POLICY
Pal, Rajib	Has the Appellate Body's Decision in Canada - Renewable Energy/Canada - Feed-in Tariff Program Opened the Door for Production Subsidies?	2014	JOURNAL OF INTERNATIONAL ECONOMIC LAW
Smith, Michael G.; Urpelainen, Johannes	The Effect of Feed-in Tariffs on Renewable Electricity Generation: An Instrumental Variables Approach	2014	ENVIRONMENTAL & RESOURCE ECONOMICS
Fernando Yanine, Franco; Caballero, Federico I.; Sauma, Enzo E.; Cordova, Felisa M	Building sustainable energy systems: Homeostatic control of grid-connected microgrids, as a means to reconcile power supply and energy demand response management	2014	RENEWABLE & SUSTAINABLE ENERGY REVIEWS
Choi, Hyundo; Anadon, Laura Diaz	The role of the complementary sector and its relationship with network formation and government policies in emerging sectors: The case of solar photovoltaics between 2001 and 2009	2014	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE
Howard, Bianca; Saba, Alexis; Gerrard, Michael; Modi, Vijay	Combined heat and power's potential to meet New York City's sustainability goals	2014	ENERGY POLICY
Pinto, Aime; Zilles, Roberto	Reactive power excess charging in grid-connected PV systems in Brazil	2014	RENEWABLE ENERGY
Zhang, Xianjun; Karady, George G.; Ariaratnam, Samuel T.	Optimal Allocation of CHP-Based Distributed Generation on Urban Energy Distribution Networks	2014	IEEE TRANSACTIONS ON SUSTAINABLE ENERGY
Sergio Juárez-Hernández y Gabriel León	Energía eólica en el istmo de Tehuantepec: desarrollo, actores y oposición social	2014	Revista Problemas del Desarrollo: Revista Latinoamericana de Economía
Elisabeth Graffy, Steven Kihm	DOES DISRUPTIVE COMPETITION MEAN A DEATH SPIRAL FOR ELECTRIC UTILITIES?	2014	ENERGY LAW JOURNAL
ABRAMOVAY, RICARDO	INOVAÇÕES PARA QUE SE DEMOCRATIZE O ACESSO À ENERGIA, SEM AMPLIAR AS EMISSÕES	2014	Ambiente & Sociedade
Rodríguez Gámez, María; et al.	Sistemas fotovoltaicos y la ordenación territorial	2013	Ingeniería Energética
Moore, Steven; Durant, Vincent; Mabee, Warren E.	Determining appropriate feed-in tariff rates to promote biomass-to-electricity generation in Eastern Ontario, Canada	2013	ENERGY POLICY
Caballero, F.; Sauma, E.; Yanine, F.	Business optimal design of a grid-connected hybrid PV (photovoltaic)-wind energy system without energy storage for an Easter Island's block	2013	ENERGY
Vahl, Fabricio Peter; Ruether, Ricardo; Casarotto Filho, Nelson	The influence of distributed generation penetration levels on energy markets	2013	ENERGY POLICY
White, William; Lunnan, Anders; Nybakk, Erlend; Kulisic, Biljana	The role of governments in renewable energy: The importance of policy consistency	2013	BIOMASS & BIOENERGY
Krupa, Joel	Realizing truly sustainable development: A proposal to expand Aboriginal 'price adders' beyond Ontario electricity generation projects	2013	UTILITIES POLICY
Carley, Sanya; Browne, Tyler R.	Innovative US energy policy: a review of states ' policy experiences	2013	WILEY INTERDISCIPLINARY REVIEWS-ENERGY AND ENVIRONMENT
Krasko, Vitaliy A.; Doris, Elizabeth	State distributed PV policies: Can low cost (to government) policies have a market impact?	2013	ENERGY POLICY
Stokes, Leah C.	The politics of renewable energy policies: The case of feed-in tariffs in Ontario, Canada	2013	ENERGY POLICY
Islam, Towhidul; Meade, Nigel	The impact of attribute preferences on adoption timing: The case of photo-voltaic (PV) solar cells for household electricity generation	2013	ENERGY POLICY
Cowart, Richard; Neme, Chris	CAN COMPETITION ACCELERATE ENERGY SAVINGS? OPTIONS AND CHALLENGES FOR EFFICIENCY FEED-IN TARIFFS.	2013	ENERGY & ENVIRONMENT
Jannuzzi, Gilberto de Martino; de Melo, Conrado Augustus	Grid-connected photovoltaic in Brazil: Policies and potential impacts for 2030	2013	ENERGY FOR SUSTAINABLE DEVELOPMENT
Rai, Varun; Robinson, Scott A.	Effective information channels for reducing costs of environmentally-friendly technologies: evidence from residential PV markets	2013	ENVIRONMENTAL RESEARCH LETTERS
Avaci, Angelica B., et. Al.	Avaliação econômico-financeira da microgeração de energia elétrica proveniente de biogás da suinocultura	2013	Revista Brasileira de Engenharia Agrícola e Ambiental
Jaglin, S; Verdeil, E	Énergie et villes des pays émergents: des transitions en question. Introduction	2013	Flux
Marie-Hélène Zérah, Gautier Kohler	Buenos Aires : l'introuvable transition énergétique d'une métropole fragmentée	2013	Flux
Yannick Rumpala	Formes alternatives de production énergétique et reconfigurations politiques. La sociologie des énergies alternatives comme étude des potentialités de réorganisation du collectif	2013	Flux
Filgueiras Sainz de Rozas, Miriam L.; Castro Fernández, Miguel	La capacidad de absorción para la innovación: estudio de caso en la Generación Distribuida Cubana	2012	Ingeniería Energética
Urbanetz, Jair; Braun, Priscila; Ruether, Ricardo	Power quality analysis of grid-connected solar photovoltaic generators in Brazil	2012	ENERGY CONVERSION AND MANAGEMENT
Schmalensee, Richard	Evaluating Policies to Increase Electricity Generation from Renewable Energy	2012	REVIEW OF ENVIRONMENTAL ECONOMICS AND POLICY
Ben Amor, Mourad; Pineau, Pierre-Olivier; Gaudreault, Caroline; Samson, R.	Assessing the economic value of renewable distributed generation in the Northeastern American market	2012	RENEWABLE & SUSTAINABLE ENERGY REVIEWS
Kim, Kyoung-Kuk; Lee, Chi-Guhn	Evaluation and optimization of feed-in tariffs	2012	ENERGY POLICY
Mitscher, Martin; Ruether, Ricardo	Economic performance and policies for grid-connected residential solar photovoltaic systems in Brazil	2012	ENERGY POLICY

Appendix 1 continued (page 2 of 2)

Authors	Title	Year	Publication
Mosher, J. N.; Corscadden, K. W.	Agriculture's contribution to the renewable energy sector: Policy and economics - Do they add up?	2012	RENEWABLE & SUSTAINABLE ENERGY REVIEWS
Wiener, Joshua G.; Koontz, Tomas M.	Extent and types of small-scale wind policies in the U.S. states: Adoption and effectiveness	2012	ENERGY POLICY
Antonio Suarez, J.; Anibal Beaton, P.; Faxas Escalona, R.; Perez Montero, O.	Energy, environment and development in Cuba	2012	RENEWABLE & SUSTAINABLE ENERGY REVIEWS
Carley, Sanya; Andrews, Richard N.	Creating a sustainable U.S. electricity sector: the question of scale	2012	POLICY SCIENCES
Lieben, Ivan; Boisvert, Ian	Making Renewable Energy FIT: A Feed-in-Tariff Certifying Body Could Accelerate Renewable Energy Deployment in the United States	2012	NATURAL RESOURCES JOURNAL
Dong, C. G.	Feed-in tariff vs. renewable portfolio standard: An empirical test of their relative effectiveness in promoting wind capacity development	2012	ENERGY POLICY
Siler-Evans, Kyle; Morgan, M. Granger; Azevedo, Ines Lima	Distributed cogeneration for commercial buildings: Can we make the economics work?	2012	ENERGY POLICY
Mabee, Warren E.; Mannion, Justine; Carpenter, Tom	Comparing the feed-in tariff incentives for renewable electricity in Ontario and Germany	2012	ENERGY POLICY
Blechinger, Philipp Friedrich Heinrich; Shah, Kalim U.	A multi-criteria evaluation of policy instruments for climate change mitigation in the power generation sector of Trinidad and Tobago	2011	ENERGY POLICY
Alagappan, L.; Orans, R.; Woo, C. K.	What drives renewable energy development?	2011	ENERGY POLICY
Darghouth, Naim R.; Barbose, Galen; Wiser, Ryan	The impact of rate design and net metering on the bill savings from distributed PV for residential customers in California	2011	ENERGY POLICY
Casillas, Christian E.; Kammen, Daniel M.	The delivery of low-cost, low-carbon rural energy services	2011	ENERGY POLICY
Yatchew, Adonis; Baziliauskas, Andy	Ontario feed-in-tariff programs	2011	ENERGY POLICY
Hernandez, J. A.; Velasco, D.; Trujillo, C. L.	Analysis of the effect of the implementation of photovoltaic systems like option of distributed generation in Colombia	2011	RENEWABLE & SUSTAINABLE ENERGY REVIEWS
Carley, Sanya	The Era of State Energy Policy Innovation: A Review of Policy Instruments	2011	REVIEW OF POLICY RESEARCH
White, Andrew J.; Kirk, Donald W.; Graydon, John W.	Analysis of small-scale biogas utilization systems on Ontario cattle farms	2011	RENEWABLE ENERGY
Ben Amor, Mourad; Lesage, Pascal; Pineau, Pierre-Olivier; Samson, Rejean	Can distributed generation offer substantial benefits in a Northeastern American context? A case study of small-scale renewable technologies using a life cycle methodology	2010	RENEWABLE & SUSTAINABLE ENERGY REVIEWS
Wiginton, L. K.; Nguyen, H. T.; Pearce, J. M.	Quantifying rooftop solar photovoltaic potential for regional renewable energy policy	2010	COMPUTERS ENVIRONMENT AND URBAN SYSTEMS
Couture, Toby; Gagnon, Yves	An analysis of feed-in tariff remuneration models: Implications for renewable energy investment	2010	ENERGY POLICY
Barin, A.; Canha, Luciane N.; Magnago, Karine F.; Abaide, A.da Rosa	SELECAO DE FONTES ALTERNATIVAS DE GERACAO DISTRIBUDA UTILIZANDO UMA AN ALISE MULTICRITERIAL BASEADA NOM ETODO AHP E NA LOGICA FUZZY	2010	Revista Controle & Automacao
Albadi, M. H.; El-Saadany, E. F.	The role of taxation policy and incentives in wind-based distributed generation projects viability: Ontario case study	2009	RENEWABLE ENERGY
Kissel, Johannes M.; Hanitsch, Rolf; Krauter, Stefan C. W.	Cornerstones of a renewable energy law for emerging markets in South America	2009	ENERGY POLICY
Carley, Sanya	Distributed generation: An empirical analysis of primary motivators	2009	ENERGY POLICY
Stoutenborough, James W.; Beverlin, Matthew	Encouraging pollution-free energy: The diffusion of state net metering policies	2008	SOCIAL SCIENCE QUARTERLY
Mills, Andrew; Wiser, Ryan; Barbose, Galen; Golove, William	The impact of retail rate structures on the economics of commercial photovoltaic systems in California	2008	ENERGY POLICY
Parker, Paul	Residential solar photovoltaic market stimulation: Japanese and Australian lessons for Canada	2008	RENEWABLE & SUSTAINABLE ENERGY REVIEWS
Felder, Frank A.; Haut, Ruthanne	Balancing alternatives and avoiding false dichotomies to make informed US electricity policy	2008	POLICY SCIENCES
Lesser, Jonathan A.; Su, Xuejuan	Design of an economically efficient feed-in tariff structure for renewable energy development	2008	ENERGY POLICY
Cadena, Angela Ines	Regulacion para incentivar las energias alternas y la generacion distribuida en Colombia	2008	Revista de Ingenieria
Orrego, Lina María Bastidas; Montoya, Santiago F.; Henao, Juan D. V.	¿Hacia dónde irán los sectores eléctricos de los países de la región Andina?	2008	Cuad. Adm.
Sovacool, Benjamin K.	Coal and nuclear technologies: creating a false dichotomy for American energy policy	2007	POLICY SCIENCES
Coll-Mayor, Debora; Paget, Mia; Lightner, Eric	Future intelligent power grids: Analysis of the vision in the European Union and the United States	2007	ENERGY POLICY
Kissel, Johannes M.; Krauter, Stefan C. W.	Adaptations of renewable energy policies to unstable macroeconomic situations - Case study: Wind power in Brazil	2006	ENERGY POLICY
Mueller, Steffen	Missing the spark: An investigation into the low adoption paradox of combined heat and power technologies	2006	ENERGY POLICY
Vachon, Stephan; Menz, Fredric C.	The role of social, political, and economic interests in promoting state green electricity policies	2006	ENVIRONMENTAL SCIENCE & POLICY
Hughes, L; Bell, J	Compensating customer-generators: a taxonomy describing methods of compensating customer-generators for electricity supplied to the grid	2006	ENERGY POLICY
Stuart, EK	Energizing the island community: a review of policy standpoints for energy in small island states and territories	2006	SUSTAINABLE DEVELOPMENT
Allison, Juliann E.	Distributed Generation of Electricity: The Role of Academic Research and Advice in California's ''Clean DG'' Policy Network	2005	International Environmental Agreements
Filgueiras, A; Silva, TMVE	Wind energy in Brazil - present and future	2003	RENEWABLE & SUSTAINABLE ENERGY REVIEWS
Bourgeois, TG; Hedman, B; Zalcman, F	Creating markets for combined heat and power and clean distributed generation in New York State	2003	ENVIRONMENTAL POLLUTION
Karl Moore et Mark Johnson	LE DILEMME DE L'INNOVATEUR: DEUX EXEMPLES DU QUÉBEC	2003	Gestion
Allison, JE; Lents, J	Encouraging distributed generation of power that improves air quality: can we have our cake and eat it too?	2002	ENERGY POLICY
Dondi, P; Bayoumi, D; Haederli, C; Julian, D; Suter, M	Network integration of distributed power generation	2002	JOURNAL OF POWER SOURCES
Payne, A; Duke, R; Williams, RH	Accelerating residential PV expansion: supply analysis for competitive electricity markets	2001	ENERGY POLICY

Appendix 2: Timeline of significant energy-related political events (1990-2015)

Canadá		Ano	Brasil	Eventos Internacionais
BC	ON			
	Administração de Bob Rae (New Democratic Party; de centro-esquerda) - 1990-1995	1990	-Administração de F. Collor; 1990-1992; -Programa Nacional de Desestatização	
Administração do New Democratic Party, (de centro-esquerda) que trocou de líder 4 vezes entre 1991-2001		1991		
		1992	Administração de Itamar Franco; 1992-1994	Cúpula da Terra da ONU no Rio
		1993		
		1994		UNFCCC é criada
	Administração de Mike Harris (Progressive Conservatives, de direita) - 1995-2002	1995	Administração de FHC (PSDB); 1995-2002. (Em seus mandatos diversas empresas estaduais do setor elétrico foram privatizadas)	
		1996	ANEEL é criada	
		1997		Protocolo de Kyoto é assinado
	IESO (Independent Electricity System Operator) é fundada	1998	ONS (Operadora Nacional do Sistema Elétrica) é fundada	
	Estatal OntarioHydro é desmembrada em 5 empresas; algumas privatizadas	1999		
		2000		-Legislação de Energia Renovável da Alemanha introduz mecanismo de FIT; -Metas de Desenvolvimento do Milênio, ONU
Administração de Gordon Campel (Liberal Party, de centro)- 2001-2011		2001	Ano do Apagão	
	Apagão prolongado durante o verão	2002		
	Administração de Dalton McGuinty (Liberal Party de centro) 2003-2013; Governo decide fechar todas as usinas termoelétricas a carvão até 2013 (operados pela empresa estatal, OPG)	2003	Administração de Lula (PT); 2003-2010	Regional Greenhouse Gas Initiative (RGGI) é criada (Northeastern US States)
	Ontario Power Authority, OPA é criada	2004	Leis 10.847/10.848sobre o novo Modelo do Setor Elétrico Brasileiro (SEB)	

			Programa Proinfa é encerrado	
		2005		
		2006		
Columbia Britânica participa do Western Climate Initiative, WCI; BC Energy Plan		2007	Programa de Aceleração ao Crescimento, PAC	Western Climate Initiative, WCI é criado; Itália introduz FIT para GDE
	Ontario participa no WCI	2008		Israel, Espanha, Califórrnia introduzem FIT para GDE
	Green Energy Act Programas de FIT e microFIT estabelecidos	2009	Primeiro Leilão Eólico	
Clean Energy Act	Long Term Energy Plan	2010		
Administração de Christy Clark (Liberal Party, de centro); 2011-presente		2011	Administração de Dilma Rouseff (PT); 2011-presente	ONU: Sustainable Energy for All Initiative; Desastre de Fukoshima de energia nuclear
		2012	Resolução 482 da ANEEL criando o instrumento de *net-metering* para GDE	ONU: Rio+20; Espanha declara moratória de incentivos para energia renovável
	Administração de Kathleen Wynne (Liberal Party, de centro); 2013-presente	2013	A barragem de UHE Belo Monte está sendo construído	
O “Site C” está em processo de avaliação para o licenciamento ambiental		2014	Primeiro Leilão de E. Solar	
	OPA é amalgamado com o IESO	2015	Presidente Dilma (PT) toma segundo mantado CONFAZ libera a não cobrança do ICMS para GD	(Dezembro) COP sobre mudanças climáticas UNFCCC em Paris

Appendix 3: Additional Socioeconomic and Energy Data; Canada and Brazil

Table 13. Electricity consumption per sector, Source: MME-BEN 2013; NRCAN 2013

Consumption of electricity (% of total)	Brazil (2012)	Canada (2011)	Ontario (2011)	British Columbia (2011)
Energy sector	5.3	--	--	--
Residential	23.6	29.5	24.2	33.9
Commercial	16.0	25.9	40.8	25.4
Public sector	8.0	2.4	1.0	1.7
Agriculture	4.7	1.8	1.7	1.3
Industrial	42.1	39.7	32.2	36.7
Transportation	0.7	0.7	0.1	0.9

Table 14. Socioeconomic indicators for Brazil and Canada

Indicator	Brazil[47]	Canada[48]	Ontario	British Columbia
GINI index (2000-2010)[49]	54.7	32.6	N/A	N/A
Human Development Index[8]	0.730	0.911	N/A	N/A
GDP per capita (2005 PPP $)[8]	10,278	35,716	N/A	N/A
Energy consumption per capita (Kg oil eq.)[50]	882	6,948	N/A	N/A
Electricity consumption in 2011 (MWh per capita)	2.8	18.1	11.4	15.5
GHG emissions; (metric tons) (metric tons per capita)	368,016,000 1.9	556,884,000 16.9	N/A	N/A

[47] IBGE http://www.ibge.gov.br/home/geociencias/areaterritorial/principal.shtm;
[48] StatsCan: http://www40.statcan.gc.ca/l01/cst01/phys01-eng.htm; http://www40.statcan.ca/l01/cst01/demo02a-eng.htm
[49] UNDP Human Development Report, 2013
[50] UN World Statistics Pocketbook, 2010

Appendix 4: Distributed generation projects in Brazil, aggregated by state (part 1 of 2)

Project Type	State	Installed Capacity (kW)	No. Projects	State	ICMS	Residential Electricity Rate ($R/MWh)	Resource *Solar (kWh/m2/d); Wind (m/s)*	Population (2014)	Population Density (inhab/km²)	Income *Per Capita*, monthly 2014 ($R)
						Note: 1	Note: 2	Note: 3		
PV_PF		19.96	2							
PV_PJ	Tocantins	261.75	2	Tocantins	Yes	0.43728	5.30	1,496,880	4.98	765
State Total		281.71	4							
PV_PF		2.10	1				4.92			
W_PF	Maranhão	2.60	1	Maranhão	Yes	0.43104	3.90	6,850,884	19.81	461
State Total		4.70	2							
PV_PF		39.25	17							
PV_PJ		93.47	9				5.58			
W_PF	Ceará	24.20	10	Ceará	Yes	0.39122		8,842,791	56.76	616
W_PJ		14.20	5				4.70			
State Total		171.12	41							
PV_PF		31.54	7							
PV_PJ	Rio Grande do Norte	359.75	4	Rio Grande do Norte	Yes	0.35072	5.58	3,408,510	59.99	695
W_PJ		6.60	2				4.10			
State Total		397.89	13							
PV_PF		3.60	2				5.89			
PV_PJ	Paraíba	2.35	1	Paraíba	Yes	0.37956	5.50	3,943,885	66.7	682
State Total		5.95	3							
PV_PF		83.63	6				5.82			
PV_PJ	Pernambuco	1,355.94	4	Pernambuco	Yes	0.35565	6.01	9,277,727	89.32	802
State Total		1,439.57	10							
PV_PF		32.34	5				5.36			
PV_PJ	Bahia	82.90	7	Bahia	Yes	0.35195	5.35	15,126,371	24.82	697
State Total		115.24	12							
PV_PF		199.28	39				4.87			
PV_PJ	Minas Gerais	92.76	11	Minas Gerais	No	0.50974	5.01	20,734,097	33.41	1049
Biogas		162.00	1							
State Total		454.04	51							
PV_PF	Espírito Santo	10.47	4	Espírito Santo	Yes	0.45312	4.51	3,885,049	76.25	1052
State Total		10.47	4							
PV_PF		88.11	24							
PV_PJ	Rio de Janeiro	467.20	9	Rio de Janeiro	Yes	0.46181	4.53	16,961,173	365.23	1193
State Total		555.31	33							

Appendix 4, Continued: Distributed generation projects in Brazil, aggregated by state (part 2 of 2)

Project Type	State	Installed Capacity (kW)	No. Projects	State	ICMS	Residential Electricity Rate ($R/MWh)	Resource *Solar* *(kWh/m2/d); Wind (m/s)*	Population (2014)	Population Density (inhab/km²)	Income *Per Capita*, monthly 2014 ($R)
						Note: 1	Note: 2	Note: 3		
PV_PF	São Paulo	107.52	24	São Paulo			4.87			
PV_PJ		89.65	8		Yes	0.41653	4.93	44,035,304	166.23	1432
State Total		197.17	32							
PV_PF	Paraná	41.42	15	Paraná			4.25			
PV_PJ		60.14	7		Yes	0.43037	4.05	11,081,692	52.4	1210
Biogas		115.00	2							
State Total		216.56	24							
PV_PF	Santa Catarina	39.81	14	Santa Catarina			4.32			
PV_PJ		175.96	16		Yes	0.42881	4.30	6,727,148	65.27	1245
State Total		215.77	30							
PV_PF	Rio Grande do Sul	48.55	20	Rio Grande do Sul		0.47411				
PV_PJ		15.33	4				4.48			
W_PF		2.23	1		Yes	0.45662	4.30	11,207,274	37.96	1318
W_PJ		1.98	1				3.70			
State Total		68.09								
PV_PF	Mato Grosso do Sul	70.15	25	Mato Grosso do Sul			5.09			
PV_PJ		2.40	1		Yes	0.46636	5.10	2,619,657	6.86	1053
State Total		72.55	26							
PV_PJ	Mato Grosso	11.52	1	Mato Grosso	Yes	0.46520	5.09	3,224,357	3.36	1032
State Total		11.52	1							
PV_PF	Goiás	2.16	1	Goiás						
PV_PJ		2.40	1		Yes	0.43831	5.28	6,523,222	17.65	1031
State Total		4.56	2							
PV_PF	Distrito Federal	11.82	3	Distrito Federal						
PV_PJ		44.09	1		Yes	0.36931	5.28	2,852,372	444.66	2055
State Total		55.91	4							
PV_PF	**Brazil**	831.71	209							
PV_PJ		3,117.61	86							
W_PF		29.03	12							
W_PJ		22.78	8							
Biogas		277.00	3							
National Total		**4,278.13**	**318**							

Note 1: Rates are weighted average, ANEEL;
Note 2: Weighted annual averages, RETScreen/Nasa;
Note 3: Source www.ibge.gov.br/estadosat

Appendix 5: Solar and Wind Resource Maps, Brazil

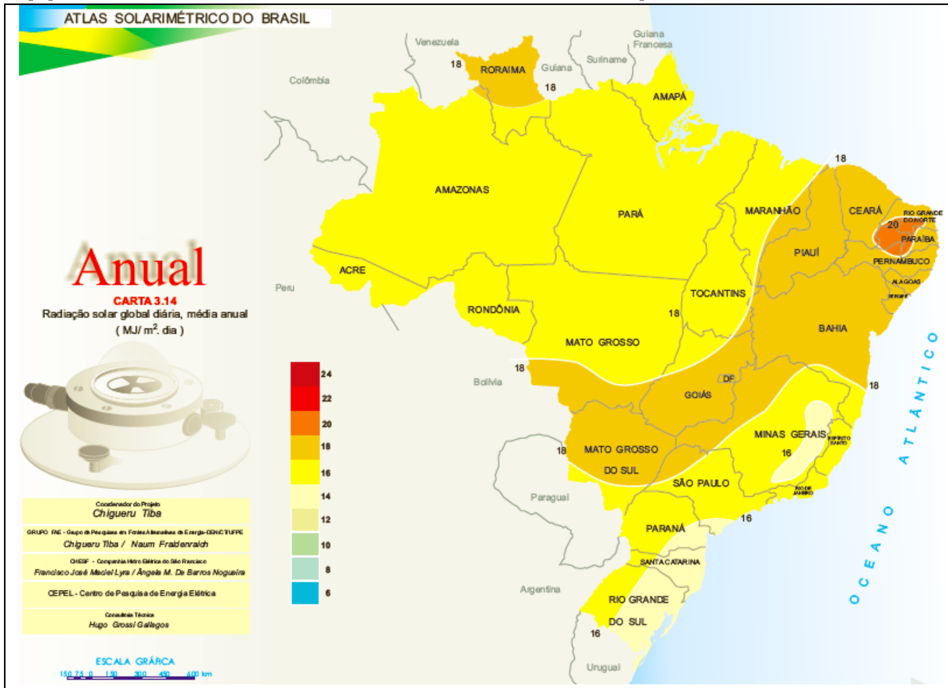
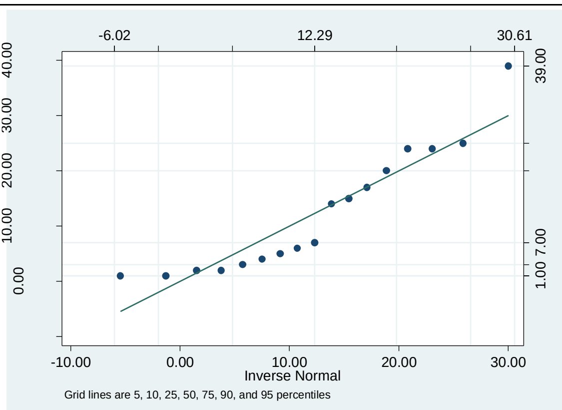


Figure 27. Average Annual Solar Radiation, Brazil (TIBA, 2000, p. 59)	Figure 28. Average Annual Wind Speeds, Brazil (AMARANTE et al., 2001)

Appendix 6: Statistical testing of regression model

Table 15. Testing for normal distribution of dependent variable; NumProj



NumProj

	Percentiles	Smallest		
1%	1	1		
5%	1	1		
10%	1	2	Obs	17
25%	3	2	Sum of Wgt.	17
50%	7		Mean	12.29412
		Largest	Std. Dev.	11.13421
75%	20	24		
90%	25	24	Variance	123.9706
95%	39	25	Skewness	.8247318
99%	39	39	Kurtosis	2.803101

Multicollinearity was tested using the VIF, variance inflation factor in Stata, indicating that 1/VIF is below the threshold of 0.8 (CARLEY, 2009) for the two dependent variables included in the linear regression; ICMS and ElecRate.

Table 16. Multicollinearity test

. vif

Variable	VIF	1/VIF
ElecRate	1.31	0.761034
ICMS	1.31	0.761034
Mean VIF	1.31	

A graphical test for is displayed in Figure 29, which shows that there is “no pattern to the residuals plotted against the fitted values”, and heteroskedasticity can therefore be ruled out (IDRE/UCLA, [s.d.])

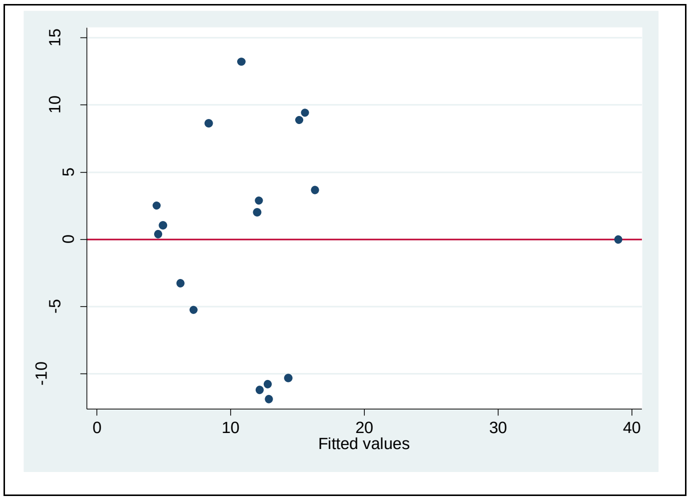


Figure 29. Graphical test for heteroskedasticity

Appendix 7: Locations of pilot projects; Juazeiro and Rio de Janeiro

Figure 30. Map of Municipality of Juazeiro and location of the MCMC communities involved in the pilot projects (red oval), Source: Google Maps

Figure 31. Map of UPP of *Complexo dos Macacos*.

Source:(INSTITUTO PEREIRA PASSOS; PREFEITURA DA CIDADE DO RIO DE JANEIRO, 2014)

Appendix 8: Energy and carbon modeling for pilot projects using RETScreen

The RETScreen tool was used to estimate the environmental benefits and energy production of the two projects studied. It is a freely-available energy analysis package that was developed and maintained by Natural Resources Canada. The models attempt to approximate the energy production to the real-world characteristics and conditions of the pilot project in Juazeiro and Rio de Janeiro (via the built-in database of climate conditions for sites).

For the Juazeiro project, the data for the neighboring city of Petrolina, Pernambuco were used. The modeled pilot project is a wind-solar hybrid project. There were two, 2kW wind towers installed and four, 5kW wind towers. The solar portion of the product was modeled as 9500 poly-Si panels of Chinese origin, (the actual model of which was not provided). The product specifications included in the RETScreen model are shown in Table 18, while the summary of the energy production calculations are shown in Table 17. For each technology, a reference case was chosen for the capacity factor; 30% in the case of wind and 15% in the case of solar. A sensitivity analysis also included two additional capacity factors, as shown in the table.

Table 17. Summary of Energy production for the Juazeiro project

	Installed Capacity (kW)	Energy production (kWh/month)		
		Capacity factor		
		30%	*20%*	*40%*
Wind 1: 2 towers of 2kW	4	833.33	583.33	1,166.67
Wind 2: 4 towers of 5kW	20	4,416.67	2,916.67	5,833.33
		15%	*11%*	*19%*
Solar: 9500 panels, 230W each	2,185	239,250.00	175,416.67	303,000.00
Project Total	2209	244,500.00	178,916.67	310,000.00
Total per house	2.21	244.50	178.92	310.00

Table 18. Assumed technologies and specifications for the energy/carbon model, Juazeiro project. Source: RETScreen

Wind, 2kW towers	Wind, 5kW towers	Solar PV
Manufacturer: ReDriven Hub height: 16m Rotor diameter: 3.6m Swept area per turbine: $10.18m^2$	Manufacturer: ReDriven Hub height: 18m Rotor diameter: 6.4m Swept area per turbine: $32.17m^2$	Manufacturer: ChinaSunEnergy Type: poly-Si Capacity: 230 W/unit Frame area: 1.62 m^2 Efficiency: 14.17%

Table 19. Carbon savings from Juazeiro project, (moderate capacity factor)

	Installed Capacity (kW)	Carbon Savings (tCO_2/year)	Total Carbon savings (tCO_2)	Total Carbon savings (cars)
Wind 1: 2kW towers	4	4.5	112.5	20
Wind 1: 5kW towers	20	22.3	557.5	103
Solar PV	2185	1218.2	30455	5575
Project Total	2209	1245.0	31125	5698
Total per house	2.21	1.2	31.1	--
Income from carbon credits ($R) per household				
Case 1: 10.08 £/tCO_2	3.66			
Case 1: 24.62 £/tCO_2	8.94			

For the rooftop solar project in Morro dos Macacos, Rio de Janeiro, the project specification are as follows: (SOLAR ENERGY DO BRASIL; GREENPEACE BRASIL, 2013).

Table 20. Technologies and specifications for the energy/carbon model, Morro dos Macacos project

Solar PV
Manufacturer: Yingli Type: Si-cristaline Capacity: 230 Wp/unit Frame area: 156 x 156 mm Efficiency: 14.17% ("A" rating from InMetro)

Table 21. Summary of Energy production for the Morro dos Macacos project

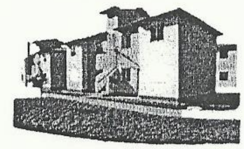
	Installed Capacity (kW)	Energy production (kWh/month)		
		Capacity factor		
		15%	*11%*	*19%*
Project Total (20 panels)	4.6	500	367	642

Table 22. Carbon savings from Morro dos Macacos project, (moderate capacity factor)

	Installed Capacity (kW)	Carbon Savings (tCO_2/year)	Total Carbon savings over 25-year life (tCO_2)	Total Carbon savings (cars)
Solar PV	4.6	2.6	65	13

Appendix 9: Communiqué explaining the reduced income from the sale of electricity, Juazeiro

CONDOMÍNIO RESIDENCIAL PRAIA DO RODEADOURO



PREZADOS CONDOMÍNOS,

VIEMOS INFORMAR QUE POR DETERMINAÇÃO DA ANEEL OS VALORES DA VENDA DE ENERGIA FOI TABELADO PREJUDICANDO A COMUNIDADE.

A ANEEL, AGÊNCIA DE ENERGIA DO GOVERNO, FIXOU O VALOR DE VENDA DA ENERGIA EM NO MÁXIMO R$388,48.

ANTES VENDIAMOS A ENERGIA NO VALOR EM MÉDIA DE R$700,00 O MWH E AGORA (JAN-2015) ESTÁ SENDO VENDIDO PELA BRASIL SOLAR NO VALOR DE R$ 390,00;

O REPASSE PARA CADA MORADOR CAIU DE R$ R$ 82,36 PARA R$ R$ 43,87.

A GERAÇÃO DA ENERGIA CONTINUA EM PERFEITO ESTADO, O PROBLEMA ESTÁ CENTRADO NO PREÇO ENCONTRATO NO MERCADO PELA BRASIL SOLAR.

POR ORDEM DA CAIXA ECONÔMICA CABE A BRASIL SOLAR NEGOCIAR A ENERGIA NO MELHOR VALOR E REPASSAR PARA CONTA DO REPASSE.

CABEM AS SÍNDICAS SOMENTE TRANSMITIREM OS DADOS PARA CAIXA ECONÔMICA RELAIZAR A TRANSFERÊNCIA PARA CONTA DE CADA MORADOR.

LEMBRANDO QUE A RESPONSABILIDADE DE VENDER É DA BRASIL SOLAR E A RESPONSABILIDADE DE PAGAR É DA CAIXA ECONÔMICA FEDERAL.

Juazeiro/BA, 20 DE FEVEREIRO DE 2015.

Appendix 10. Semi-structured interview questions for a member of the GT-GDSF

Modulo I: Grupo de Trabalho de Geração Distribuída com Sistemas Fotovoltaicos – GT-GDSF

1. O Sr. Pode me contar um pouco sobre a formação e objetivos deste grupo. Edison Lobão como Ministro publicou a portaria, porque?

2. No relatório, estão apresentadas medidas para ações no curto e médio prazo para incentivar energia solar no país, Sr. Pode comentar sobre algumas chaves que o Sr. Considere que ainda estão faltando, porque:

5.1.1 Curto prazo:

a) Criar um grupo de acompanhamento para dar continuidade às propostas do GT-GDSF;
b) Solicitar à ANEEL a análise da viabilidade da inserção da geração distribuída solar fotovoltaica no âmbito do PRODIST;
c-f) projetos de pesquisa...
*g) Apresentar, no âmbito do CT-ENERG, um Programa de **Treinamento de pessoal**, nos*
*i) Identificar, em diversas áreas de governo, **programas sociais** onde a energia fotovoltaica possa ser solução viável e promover sua aplicação;*
*j) Estudar e promover condições de **acesso a créditos especiais para financiamento** de compra e instalação de sistemas fotovoltaicos pelos consumidores;*

Longo Prazo

*a) Estabelecer, em conjunto com o MDIC, uma estratégia de **fomento à indústria nacional** fotovoltaica, focando na isenção de tributos, créditos especiais e em parcerias internacionais;*
c) Desenvolver a tecnologia de purificação e beneficiamento do Silício,
*d) Inserir a geração distribuída fotovoltaica no contexto do **planejamento energético** decenal e de longo prazo, a partir dos resultados obtidos nas fases anteriores.*

Planejamento energética – agora solar pode entrar nos leilões, isso é suficiente?

Modulo II: Projetos de Pesquisa-Pilotos

1. Quais são os projetos pilotos-pesquisa que o Sr. Está envolvida?
2. Na sua opinião, E solar e Eólica de forma distribuída, é viável tecnicamente e economicamente?

2. No Seu CV consta a sua participa. O Sr. Participa no –BNDES, existem interesse em expandir linhas de financiamento de eficiência energética para geração distribuída?
3. Luz para todos: o Sr. Possui experiência em eletrificação rural, porque geração distribuída ou mini-grids não foram instaladas ou projetadas no caso brasileiro?
4. Qual foi o papel do Sr. no Projeto de Brasil Solair em Juazeiro?
    1. Como foi o processo de escolher Juazeiro como local do projeto?
    2. Como foi o processo de escolher os condomínios de MCMV para o projeto?
    3. Qual foi a interação/participação do Município de Juazeiro no projeto?
    4. Como foi a recepção inicial dos moradores dos condomínios?
    5. Como foi feita a escolha das capacidades instaladas de energia solar e energia eólica?

Modulo III: Aspectos regulatórios/políticos

1. O Sr. se manifestou nas audiências públicas feitas pela ANEEL referente a formulação da Resolução 482? Se for sim, quais?

2. Qual é a sua opinião deste regulamento para a expansão de geração distribuída no Brasil?

3. Porque o net-metering foi escolhida e não FIT?

4. Como responder as preocupações das reguladores de garantir a "qualidade de energia" E se a penetração de GDE aumenta, como financiar os sistemas de distribuição?

5. Quais são as “prospectivas” de FIT no curto ou médio prazo....

6. Como que FIT pode ser implementado FIT sem aumentar o preço que o consumidor paga por energia elétrica

7. Legislação vs. Regulamentação – qual será mais efetiva, porque já não há mais

8. Qual é a sua opinião sobre PROINFA, porque encerrou

9. Quais desafios que a distribuidora energia distribuída encontra no Brasil? Impostos, mão de obra...

10. Porque a indústria de E Solar no Brasil ainda está na sua infância?

Appendix 11. Semi-structured interview questions for Brasil Solair

Roteiro de Perguntas:

Modulo I: Histórico da Empresa e do Projeto em Juazeiro

1. Como foi o processo de escolher Juazeiro como local do projeto?
2. Como foi o processo de escolher os condomínios de MCMV para o projeto?
3. Qual foi a interação/participação do Município de Juazeiro no projeto?
4. Como foi a recepção inicial dos moradores dos condomínios?
5. Como foi feita a escolha das capacidades instaladas de energia solar e energia eólica?

Modulo II: Aspectos regulatórios/políticos

1. Brasil Solair faz parte de uma associação industrial de energia renovável no Brasil?
2. Brasil Solair se manifestou nas audiências públicas feitas pela ANEEL referente a formulação da Resolução 482? Se for sim, quais?
3. Qual é a opinião da empresa da regulamentação para a expansão de geração distribuída no Brasil?
4. Qual é o papel da COELBA no projeto?
5. Qual é a maneira com que o excedente está sendo comercializado (o site indica que a própria CEF compra o excedente)? Durante quantos anos?
6. Foi necessário interagir com a Câmara de Comercialização de Energia Elétrica?
7. Como foi o processo de licenciamento ambiental do projeto?
8. Quais outros projetos de geração distribuída que a empresa está desenvolvendo?

Modulo III: Perguntas específicas sobre o projeto em Juazeiro:

1. Quantos painéis solares estão instalados em cada comunidade?
2. Quando foram instalados?
3. Quantas pessoas foram empregadas para a fase de instalação dos painéis?
4. Quem instalou os painéis?
5. Como foi o processo de escolher e treinar a mão-de-obra?
6. Os painéis são da empresa chinesa Linuo? Qual é a tecnologia (mono-Si, Poli-Si, outro)?
7. Qual é a vida útil dos painéis?
8. Qual é a eficiência dos painéis?
9. Qual é o destino dos painéis após sua vida útil?
10. Quanto custaram?
11. Os inversores são da empresa KLNE?
12. Qual é vida útil dos inversores?
13. Qual é a eficiência dos inversores?
14. Qual é o destino dos inversores após sua vida útil?
15. Quanto custaram?
16. De onde vem as turbinas eólicas (fabricante, país)?
17. Quem fez a instalação das turbinas?
18. Quantas pessoas foram empregadas para a fase de instalação de energia eólica?
19. Quem instalou os painéis?
20. Como foi o processo de escolher e treinar a mão-de-obra?
21. Quanto custaram as turbinas?
22. Qual é a vida útil das turbinas?

23. Os moradores assinaram algum tipo de contrato com Brasil Solair referente este projeto?

24. Como é medida a produção e consumo de energia? Por residência ou no condomínio como todo?
25. Como é calculada a renda por família pela venda de energia elétrica?
26. Qual (em média) é a produção mensal de energia solar em cada comunidade?

27. Qual (em média) é produção mensal de energia eólica em cada comunidade?
28. Qual (em média) é o excedente mensal de energia solar em cada comunidade?
29. Qual (em média) é o excedente mensal de energia eólica em cada comunidade?

30. Quais dificuldades/desafios foram encontrados nos projetos?
31. Como foram superados?

Appendix 12. Semi-structured interview questions for CAIXA

I: Histórico do Projeto em Juazeiro

1. Como foi o processo de escolha de Juazeiro como local do projeto?
2. Como foi o processo de escolha dos dois condomínios de MCMV para o projeto?
3. Qual foi a interação/participação do Município de Juazeiro no projeto?
4. Como foi a recepção dos moradores dos condomínios ao projeto?
5. Como foi feita a escolha das capacidades instaladas de energia solar e energia eólica (desenho do projeto)?
6. Qual é o papel da COELBA no projeto?
7. Como foi o processo de licenciamento ambiental do projeto?
8. Quais dificuldades/desafios foram encontradas nos projetos?
9. Como que tais foram superados?

II: Perguntas específicas sobre a produção de energia e renda para a comunidade

1. De que maneira com que o excedente está sendo comercializado (o site indica que a própria CEF comprará o excedente)? Durante quantos anos?
2. Como é calculada a renda por família pela venda de energia elétrica?
3. Qual (em média) é a produção mensal de energia solar em cada comunidade?
4. Qual (em média) é o excedente mensal de energia solar em cada comunidade?
5. Como será gerenciada a renda pela venda de energia no caso de moradores dos condomínios que não são as famílias originais contemplados pelo programa MCMV da CEF?
6. Como será feito a recuperação dos custos da compra de equipamento e do investimento da FSA-CEF? Haverá desconto de renda mensal das famílias?

III: Diagnóstico socioambiental das comunidades e avaliação do projeto

1. Quais eram os objetivos do diagnóstico socioambiental das comunidades que foi feita antes da instalação do projeto de energia renovável?
2. Quanto que será feito o diagnóstico socioambiental das comunidade posterior a operação do projeto?
3. A CEF pode compartilhar os dados dos diagnósticos com a Universidade de Brasília?
4. A CEF está investindo em outros projetos de geração distribuída?
5. A CEF pretende replicar este tipo de modelo em outros projetos de MCMV?

Appendix 13. Semi-structured interview questions for ABINEE - Associação Brasileira da Indústria Elétrica e Eletrônica

1. Na página 10 do relatório é colocado: "Fica evidente que a energia solar fotovoltaica ainda não está sendo considerada adequadamente no nosso planejamento energético".

O Sr. Considere esta colocação ainda válida hoje? Do lado da "Demanda" houve mudanças como a regulação 482 da ANEEL e as leilões 10 e 09/2013 que permitiam a participação de projetos de energia solar (fotovoltaica e termo solar).

2. Na página 10 do relatório é colocado: "Brasil corre o risco de perder a oportunidade de se posicionar como um ator dentro de uma indústria altamente estratégica"

O Sr. Considere esta colocação ainda válida hoje? O poder público compartilha essa visão?

3. Do lado da "Oferta", o relatório destaca várias ações que possam ser feitas para fortalecer a indústria, como;

-tornar investimentos da cadeia de purificação de silício, indústria de semicondutores de sílica mais atraentes...
- a estrutura tributária e os custos de transação da economia brasileira,
- o custo do crédito (BNDES analisando possibilidade de linhas de crédito?)
- falta de políticas microeconômicas voltadas para incentivo da indústria local.

4. Como que o relatório foi divulgado aos Ministérios? Qual foi a recepção de tais as ideias colocadas no relatório?

5. Como que a Abinee percebe o efeito do crescimento da indústria asiática (principalmente a chinesa) na temática de energia solar no Brasil? Muitas vezes a escala produtiva foi colocada como o fator decisivo, já está se fechando a janela de oportunidade para o Brasil construir uma indústria robusta de PV, especialmente com a dominação dos chineses?

6. Do lado de incentivos à demanda de energia PV, o relatório dívida os possíveis mecanismos em energia de grandes escalas (leilões) e energia distribuída. O relatório mencionou mecanismos já existentes em outros países como; FIT (tarifas prêmios), leasing, usinas comunitárias...qual foi o feedback que Abinee recebeu da ANEEL ou outros órgãos do governo ao respeito as essas ideais?

7. Em termos de geração de emprego de mão de obra qualificada para apoiar o setor, o relatório menciona tal necessidade e oportunidade:

"O desenvolvimento destes mercados exige a formação de mão de obra qualificada para a adequada projeção, instalação, manutenção dos sistemas e tratamento dos resíduos" p. 35

a. Existe hoje um déficit de mão de obra qualificada? Existem tentativas junta a SENAI ao respeito? Existem interesse em Ministérios como Min Trabalho, etc. a possibilidade de geração de emprego do setor PV?

b. Em termos dos resíduos, quais desafios que a Abinee prevê?

8. Em termos dos atores da indústria elétrica que tem se manifestados desfavorável ou cautelosas a inserção de PV no sistema elétrica, o relatório menciona as Distribuidoras, com a preocupação de perda de receita, dentre outros.

   Na sua opinião, quanto isso pesou na formação da reg. 482 e outras tentativas de inserção de geração distribuída?

9. O relatório coloca que a resolução 482 da ANEEL possibilita a conexão de PV mas não a comercialização. Qual é o papel da Câmera de Comercialização de EE nas próximas etapas no caminho para a inserção de PV no setor E no Brasil?

10. O relatório também coloca que a questão da padronização dos procedimentos de licenciamento ambiental para empreendimentos solares ainda não está bem resolvida P. 47-8. O Abinee fez contato com MMA ao respeito?

11. Tarifas binômias – Abinee recomendou à ANEEL, não foi contemplada, porque? “é possível que em algum ponto no futuro as tarifas passem a ser binômias, com esses consumidores pagando uma tarifa mensal fixa relativa aos investimentos realizados na rede, calculada com base em seu consumo máximo permitido, e uma tarifa de energia destinada a remunerar energia efetivamente consumida.” p. 100

12. Em termos de apoio a etiquetagem (p. 112), o relatório coloca que há necessidade de priorizar recursos financeiros para temas estratégicos, tais como: “Estabelecimento e fortalecimento das NBRs (normas técnicas) para o setor fotovoltaico; Apoio à constituição de laboratórios públicos e privados para qualificação e certificação; e melhor equipar os laboratórios existentes no país; Aperfeiçoamento do PBE/INMETRO com inclusão das NBRs.”

    –isto está sendo feito, se não, porque?

13. Várias vezes ao longo do relatório a Abinee coloca que é necessário adotar uma agenda estratégica para que o setor PV possa ser inserido ao setor EE, gerando emprego, para que o Brasil se posiciona como um país pioneiro em termos de energia solar.

Abinee considere que isso é uma prioridade do governo atual? Porque sim, ou não?

14. Abinee está interessada em energia eólica de pequeno porte para geração distribuída?

Appendix 14. Semi-structured interview questions for SRD-ANEEL

<u>1– A motivação de iniciar o processo</u> das Consultas e Audiências Públicas que resultou em REN 482 e 517;
Na Nota Técnica n° 0043/2010-SRD/ANEEL que serviu como abertura para a Consulta Pública 15/2010 sobre geração distribuída de pequeno porte foi mencionada que em janeiro de 2010 ANEEL aprovou a Agenda Regulatória Indicativa da SRD com a item de "*Diminuir os obstáculos para o acesso de pequenas centrais geradoras aos sistemas de distribuição"*

1ª. Em que medida este item foi influenciado pelo relatório do Grupo de Trabalho de Geração Distribuída com sistemas fotovoltaicos (GT-GDSF) do MME para possibilitar especificamente geração fotovoltaica?
1b. Será certo deduzir que a inserção de PV, principalmente, foi a força motriz deste processo? Os resultados até hoje dos projetos REN 482, a maioria são PV, alguns eólica de pequeno porte e um de biogás...

<u>2- Contexto internacional</u>
A nota técnica 43/2010 também coloca que "A geração de energia a partir de fontes alternativas de energia é uma tendência e necessidade em diversos países no mundo"...A Nota Técnica n° 0025/2011 coloca que "A geração de energia elétrica a partir de fontes renováveis é uma tendência em diversos países... **<u>O que diferencia esse movimento internacional do cenário brasileiro é o fato de haver forte incentivo para a geração distribuída de pequeno porte</u>**, incluindo a conectada na rede de baixa tensão."
Question: quanto estas tendências internacionais influenciaram o colocaram GD na pauta de discussões no Brasil... (i.e. de fora para dentro?)

3- Participação nas CP e AP
Durante os anos 2010 na 2012 houve 1 consulta pública e 2 audiências públicas que resultou no REN 482 e 517, dentre outros, Qual é a sua opinião sobre o nível interesse e participação dos atores do setor nos fóruns públicos sobre o assunto de geração distribuída (em relação aos demais processos sob a competência da SRD)? i.e. número de atores menor, maior, igual, nada especial.....percentagem de contribuições pertinentes

A. Consulta Pública 15/2010 resumida na Nota Técnica n° 0004/2011-SRD/ANEEL, "Foram recebidas 577 contribuições de 39 agentes"
B. Audiência Pública 42/2011 resumida na NT 0020/2012 Foram recebidas 403 contribuições de 51 agentes. Destas, foram aceitas 59 contribuições, 49 parcialmente aceitas, 248 não aceitas e 47 não se aplicam. Assim, desconsiderando aquelas que não se aplicam, foram aceitas totalmente ou parcialmente aceitas 30% das contribuições.
C. Audiência Pública 100/2012 resumida na NT 177/2012. Foram recebidas 162 contribuições de 42 agentes, incluindo distribuidoras, consumidores, fabricantes, associações, consultores, acadêmicos, estudantes e demais interessados no tema. Desse total, 6 eram comentários ou dúvidas, restando 156 contribuições aplicáveis, das quais cerca de 40% foram aceitas total ou parcialmente.

4 – Impacto do desconto na TUSD:

Com a elevação dos descontos na TUSD, algumas contribuições da primeira CP argumentam que haveria impactos nas tarifas dos demais consumidores, isto está acontecendo de fato após a adoção da REN 482?

Outra contribuição sugeriu a criação de um fundo para absorver o impacto dos descontos aplicados nas tarifas de GD (ou usar a Conta de Desenvolvimento Energético – CDE), isto está sendo analisado no MME? Quem? Tem contato?

5 - Considerações Livres (NT 0004/2011-SRD)

Contribuições fora do alcance da competência da ANEEL: várias contribuições colocaram que há necessidade de uma formulação de uma política energética direcionada para a geração distribuída de pequeno porte, que há necessidade de incentivos adicionais (tarifa *Feed-in*, subsídios, reduções fiscais e etc.) para o desenvolvimento sustentável da geração distribuída de pequeno porte no país, e que o sistema *Net Metering* não seria suficiente para garantir isso.

Porque ANEEL incluiu isto na nota técnica? ANEEL compartilha esta opinião? Queria destacar isso para MME? É comum para ANEEL incluir nas suas notas técnicas contribuições que vão além da própria competência da ANEEL?

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6 - projeto piloto 120 telhados

Nota Técnica n° 0025/2011.
Assunto: Proposta de abertura de Audiência Pública (042/2011)

Menciona o projeto piloto 120 telhados da Secretaria de Planejamento e Desenvolvimento Energético do MME; SRD participa deste projeto? Está em qual estado atualmente? Quem é o contato no MME?

<u>7 – Limitando o tamanho dos projetos</u> (se estiver tempo...)

Foi enfatizada na Nota Técnica n° 0020/2012-SRD/ANEEL (Análise das contribuições recebidas na Audiência Pública nº 42/2011) que o sistema de compensação (Net-metering) de energia elétrica <u>não visa estimular a instalação de centrais geradoras superdimensionadas</u>, que excedem em muito a carga instalada da unidade consumidora. O objetivo desta resolução é reduzir barreiras para a central geradora de pequeno porte instalada em unidades consumidoras.... 25. Por isso, ... os créditos devem ter prazo de validade. Para o empreendedor que tenha interesse em instalar uma central geradora para comercializar energia, já há regras definidas para autoprodutor e produtor independente de energia.

From REN 482..... §1º A potência instalada da microgeração ou minigeração distribuída participante do sistema de compensação de energia elétrica fica limitada à carga instalada, no caso de unidade consumidora do grupo B, ou à demanda contratada, no caso de unidade consumidora do grupo A. (Incluído pela REN ANEEL 517)

Q: Porque é importante limitar o tamanho dos projetos a carga instalada (grupo B) ou demanda contratada (grupo A)?

<u>8 – ICMS</u>

Q: Após as modificações apresentados no Res. 517, em que ANEEL esclarece que geração distribuída no sistema de compensação é um "empréstimo de energia"
a CONFAZ continua com o mesmo entendimento de que atividade de compensação de energia elétrica é uma operação de compra e venda, é portanto o ICMS será aplicada? Eu sei que isso é fora da competência da ANEEL mas qual é o contato da ANEEL com CONFAZ ao respeito?

<u>11 – Monitoramento, resultados e revisão</u>

"Art. 15. A ANEEL irá revisar esta Resolução em até cinco anos após sua publicação."
RESOLUÇÃO NORMATIVA Nº 482, DE 17 DE ABRIL DE 2012

1. será mais provável esperar até 5 anos ou já há indicações que há necessidade de revisão mais cedo? Se for sim, quais?

2. as informações enviadas das distribuidoras também inclui projetos não aprovados? Esse informação pode ser compartilhado comigo (deixando anônimo o ID do proponente)? Para entender melhor o tamanho da procura e as principais razões do não-aprovação.

3. ANEEL considere que os resultados já no primeiro ano eles correspondem a o que foi esperado? Sim, Não (são maior, menor?)

PV	40
Eolica	7
Biogas	1
PCH	0
Outros?	1
Total	49

-segundo o Banco de Informação de Geração

4. A ANEEL possuiu informações mais detalhadas do que estão disponibilizados no BIG que podem ser compartilhadas comigo, como por exemplo: especificações técnicas das tecnologias dos projetos?

5. por exemplo, tem um projeto que me interesse (não está dentro do REN 482), é a Usina Sol Moradas Salitre e Rodeadouro em Juazeiro-BA é capaz de gerar 2.103 kW de potência.

É listado como UFV, mais tem aero-geradores também, e um projeto hibrido…como BIG trata este dado ou outros projetos híbridos

O Sr. Acha que a GD há uma tendência ou risco de ser algo das elites no Brasil, não só no lago sul, mas em vários bairros nas grandes cidades brasileiras aonde tem renda alta?

1. O Sr. Colocou que as usinas de *suco energéticas no Brasil têm muito interesse em participar do mecanismo do* Net-Metering, mas atualmente ANEEL decidiu não permitir.

Quais são as principais preocupações da ANEEL em permitir que estas usinas termoelétricas participam de net-metering ou como fora de geração distribuída; tamanho, não poder despachar pelo ONS, etc?

Appendix 15. Semi-structured interview questions for Distribution Company CEB

I. CEB e Abradee e iAbradee
O Sr. Pode me contar um pouco a CEB? E interesse/atividades do CEB no Inst. Abradee em Geração Distribuída anterior a Res 482?

II. RESOLUÇÂO 482

O Sr. Pode me contar um pouco sobre a interação da CEB com ANEEL na formulação da Resolução 482? (A Abradee participou na Audiência Pública Nº 042/2011 em Brasília no 6/10/2011).

a. Como que o Sr. caracteriza a política/regulamentação de geração distribuída no Brasil ?

b. Na sua opinião, qual é o objetivo brasileiro em GD, Porque ANEEL decidiu regular isto?

c. Como o Sr caracteriza o interesse nacional durante a regulação ANEEL 482?

d. Porque o Sr. acha que o Brasil não optou para outros mecanismos de apoio a GD, como FIT?

III. Implementação de 482

1. Quais barreiras ainda existem para GD no Brasil? Ao seu ver, eles estão sendo trabalhados? (Financiamento, burocracia, falta de conhecimento tech do consumidor, falta de conhecimento tech por parte do regulador, DISTRIBUIDORAS)

2. Quais reclamações/preocupações CEB está recebendo dos consumidores? Falta mão obra....

3. O que precisa ainda ser resolvida para net-metering funcionar bem no Brasil?

IV. Próximos passou para GD no Brasil:
- Houve a Nova chamada publica da ANEEL? Projetos maiores a 1MW

V. Projetos de GD em BSB:
-quantos pedidos receberem?

Appendix 16. Semi-structured interview questions for Centro Comunitário Lídia dos Santos

-História do Centro, o que fazem/oferecem, aonde vem recursos para as operações, etc.
-História do Projeto Juventude Solar – primeiro contato, etc....
-Como foram escolhidas as participantes
-Como está indo a operação
-Como foi o contato com Greenpeace/Light/ Instaladora/ órgãos estaduais ou municipais
-Quanto está produzindo de energia?
-Quanto que o centro gata/gastou na conta de luz?

Appendix 17. Semi-structured interview questions for Greenpeace

-História do Projeto Juventude Solar – primeiro contato, etc....
-Como foram escolhidas as participantes
-Quem fez o treinamento?
-Como está indo a operação do projeto
-Como foi o contato com Light/Instalador/órgãos estaduais ou municipais
-Quanto está produzindo de energia?
-Seu papel no projeto/trabalho com Greenpeace
-Seus projetos de crowdfunding (e.g. comunidade de quilombolas), porque escolheu este
-Quais desafios para geração distribuída/geração solar no Rio e no Brasil
-Acompanhou/participou no regulamento da ANEEL 482?
-Conhece outros projetos de E solar, geração distribuída que não conseguiram sair do papel, implementaram?

Appendix 18. Semi-structured interview questions for Sintergia

- Quais desafios para geração distribuída/geração solar no Rio e no Brasil
-Acompanhou/participou no regulamento da ANEEL 482?
-Conhece outros projetos de E solar, geração distribuída que não conseguiram sair do papel, implementaram?

Appendix 19. Semi-structured interview questions for Distribution company Light

I. Light e Abradee e iAbradee
O Sr. Pode me contar um pouco a Light? E interesse/atividades do Light no Inst. Abradee em Geração Distribuída anterior a Res 482?

II. RESOLUÇÂO 482

O Sr. Pode me contar um pouco sobre a interação da Light com ANEEL na formulação da Resolução 482? (A Abradee participou na Audiência Pública Nº 042/2011 em Brasília no 6/10/2011).

a. Como que o Sr. caracteriza a política/regulamentação de geração distribuída no Brasil?

b. Na sua opinião, qual é o objetivo brasileiro em GD, Porque ANEEL decidiu regular isto?

c. Como o Sr caracteriza o interesse nacional durante a regulação ANEEL 482?

d. Porque o Sr. acha que o Brasil não optou para outros mecanismos de apoio a GD, como FIT?

e. Como que o Sr. caracteriza a influência internacional nesta política

III. Implementação de 482

1. Quais barreiras ainda existem para GD no Brasil? Ao seu ver, eles estão sendo trabalhados? (financiamento, burocracia, falta de conhecimento tech do consumidor, falta de conhecimento tech por parte do regulador, DISTRIBUIDORAS)

2. Quais reclamações/preocupações Light está recebendo dos consumidores? Falta mão obra....

3. O que precisa ainda ser resolvida para net-metering funcionar bem no Brasil?

IV. Próximos passou para GD no Brasil:
- Houve a Nova chamada publica da ANEEL? Projetos maiores a 1MW, q

V. Projetos de GD em Rio:
- BIG mostra apenas 19 UFV na cidade do Rio e 33 no Estado dos 317 existente no pais, como Light considera este tipo de penetração?
-Quantos pedidos receberem?

-Projeto do Greenpeace? Como foi a implementação? Dificuldades?
-Conhece outros projetos de E solar, geração distribuída que não conseguiram sair do papel, implementaram?

Appendix 20. Semi-structured interview questions for Ministério das Cidades

Desde quando existe a *Agenda Minha Casa + Sustentável*?

Quais foram os ímpetos para a sua criação?

Quais aspectos de eficiência energética estão sendo contemplados no âmbito dos programas habitacionais sociais sob gestão da SNH?

Existem projetos pilotos que o departamento DICT poderia me indicar como estudos de casos/protótipos?

A Sra. mencionou o projeto de Juazeiro; o departamento DICT está contemplando a reprodução deste tipo de projeto de geração de energia elétrica (solar ou eólica) no âmbito dos programas habitacionais da SNH?

Se for sim, em princípio, os projetos venderão energia no ACL (mercado livre), como foi no caso do projeto de Juazeiro ou os projetos funcionarão com o sistema de compensação de energia (resolução ANEEL 482/2012)?

Quais outros Ministérios estão envolvidos na Agenda Minha Casa + Sustentável? O Fundo Clima/MMA também é parceiro?

Appendix 21. Semi-structured interview questions for EPE

1. Qual foi o motivo principal que levou à preparação e publicação da Nota Técnica, NT: ?Análise da Inserção da Geração Solar na Matriz Elétrica Brasileira??

2. O EPE acompanhou/participou na chamada pública e na audiência pública da ANEEL relacionadas à Resolução 482? Se for sim, em que função?

3. O EPE participou/acompanhou o trabalho do Grupo de Trabalho de Geração Distribuída com Sistemas Fotovoltaicos (GT-GDSF do MME) que publicou em 2009 ?Estudo e propostas de utilização de geração fotovoltaica conectada à rede, em particular em edificações urbanas?? Se for sim, em que função?

4. Em página 2 da Nota Técnica é colocada que: ?a presente Nota Técnica tem como objetivo subsidiar o MME no processo de decisão quanto a estratégia para a continua inserção da fonte solar na matriz de geração elétrica brasileira?. Qual é o status atual das discussões entorno à inserção de PV como fonte de geração distribuída no EPE/MME?

5. O EPE/MME pretende publicar estudos para outras tecnologias que possam ser aplicadas de forma distribuída como: biomassa, biogás, eólica de pequeno porte?

6. Na NT é colocada que; ?Importa destacar que, em razão da característica de seu ciclo diário, limitado ao período diurno, a geração fotovoltaica não substitui investimentos na ampliação da capacidade instalada do sistema elétrico, mas pode ser vista como uma fonte ?economizadora? de combustíveis de maior valor econômico? p 15. Isto refere a possibilidade de utilizar o PV para diminuir geração termoelétrica durante os horários de peak? O EPE está estudando isto ou acompanhando os projetos de 482 para verificar isto?

7. Várias opções de incentivos para PV foram apresentadas na Tabela 13 de página 38 da NT, quais foram discutidos no MME/EPE?

8. No Plano Decenal de Energia (PDE 2022) a geração distribuída é abordada no mesmo capítulo que eficiência energética tanto para as aplicações de grande porte quanto do médio/pequeno porte.

8a. Porque apenas PV foi considerada para as classes residencial e comercial?

8b. O biogás ou biomassa não foram contempladas na análise para autoprodução de agricultores (salve autoprodução no segmento de açúcar e álcool) porque?

Appendix 22. Semi-structured interview questions for Fundo Clima-MMA

Tipo de Financiamento disponível p projetos reembolsáveis?

Quais os requisitos de um proponente?

Quais os requisitos de um projeto? Tamanho?

PAAR (PLANO ANUAL DE APLICAÇÃO DE RECURSOS) 2014:

http://www.mma.gov.br/apoio-a-projetos/fundo-nacional-sobre-mudanca-do-clima/plano-anual-de-aplicacao-de-recursos

3.1. Recursos Não Reembolsáveis

2014 - Área 1 com dois tipos de projetos, a saber:

• Tema: Incentivo à eficiência energética e ao desenvolvimento e aplicação de fontes de energia de menor contribuição para produção de gases do efeito estufa direta ou indiretamente. Tipos de projeto 1: Projetos e Estudos para Aproveitamento energético do biogás (aterros sanitários, defejos da pecuária) e da energia solar: previsão de lançamento de dois editais de livre concorrência, respectivamente, para biogás e energia solar. Tipos de projeto 2: Promoção da Eficiência Energética e uso sustentável da biomassa pela indústria de cerâmica e gesso no nordeste: previsão de lançamento de dois editais de livre concorrência, respectivamente, cerâmica e gesso

3.2. Recursos Reembolsáveis

3.2.2. Área 2 – Energias Renováveis Possui três temas. (PAAR 2013 tmb) • Desenvolvimento tecnológico (energias solar, eólica, hidráulica, biomassa e dos oceanos) e da cadeia produtiva para a difusão do uso de energia solar e dos oceanos, cujo objetivo é apoiar o desenvolvimento tecnológico das mencionadas formas de energia renovável e da cadeia produtiva dos setores de energia solar e dos oceanos. Sua abrangência territorial é nacional; • Geração e distribuição local de energia renovável, que tem por objetivo apoiar investimentos em geração de energia eólica ou hidráulica até 1 MW, ambas apenas em sistemas isolados, energia a partir do uso de biomassa, exceto cana-de-açúcar, da captura da radiação solar e dos oceanos; • Racionalização da limpeza urbana e disposição de resíduos preferencialmente com aproveitamento para geração de energia, que tem por objetivo apoiar projetos de racionalização da limpeza urbana e disposição final de resíduos sólidos preferencialmente com aproveitamento para geração de energia, excetuando-se a incineração de resíduos sólidos urbanos.

3.2.5. Área 5 – Cidades Sustentáveis e Mudança do Clima Possui um tema: • Apoio a projetos que aumentem a sustentabilidade das cidades, melhorando sua eficiência global e reduzindo o consumo de energia e de recursos naturais. Apresenta abrangência nacional e apoia projetos de investimento em: i) tratamento ou reciclagem de resíduos da construção civil; ii) implantação de logística e manufatura reversa; iii)eficiência energética em prédios públicos ou em iluminação pública (quando os beneficiários forem entes públicos) e implantação da cadeia produtiva de lâmpadas de LED/OLED; iv)implantação de centros de inteligência de informações que contemplem diferentes sistemas integrados e que permitam a tomada de decisões e realização de ações; v) cadeia produtiva de equipamentos e sistema para Smart Grid.

Banco de dados de projetos antigos -

2012 - http://www.mma.gov.br/images/arquivos/apoio_a_projetos/fundo_clima/projetos_2012%20-%20atualizado.pdf

Projeto Semi-arido, Indústrias dos setores têxtil, cerâmico e de produção de cal que façam uso intensivo de lenha e carvão provenientes da Caatinga como insumo de sua matriz energética – MAIS detalhes sobre este projeto?

Appendix 23. Semi-structured interview questions for GIZ in Brazil

I. INTRO - GIZ no BRASIL

1. O Sr. Pode me contar um pouco sobre o trabalho e objetivos do GIZ no Brasil, especialmente no que tange geração distribuída?

II. RESOLUÇÂO 482

2. O Sr. Pode me contar um pouco sobre a interação do GIZ com ANEEL na formulação da Resolução 482?
    a. O Sr. e outros membros do equipe GIZ participou na Audiência Pública Nº 042/2011 em Brasilia no 6/10/2011
    b. Como que o Sr. caracteriza a política/regulamentação de geração distribuída no Brasil (ousada, cautelosa, coerente ou não, etc). PORQUE?
    c. Na sua opinião, qual é o objetivo brasileiro em GD – segurança energética, des. Tecnológico, etc.?
    d. Quais barreiras ainda existem para GD no Brasil? Ao seu ver, eles estão sendo trabalhados? (financiamento, burocracia, falta de conhecimento tech do consumidor, falta de conhecimento tech por parte do regulador, DISTRIBUIDORAS)
    e. Qual previsão o Sr. tem para GD no Brasil nos próximos 10 anos?
    f. Como o Sr caracteriza o interesse nacional durante a regulação ANEEL 482? Muito/pouco; Polêmico ou não
    g. Porque o Sr. acha que o Brasil não optou para outros mecanismos de apoio a GD, como FIT?
    h. Como que o Sr. caracteriza a influência internacional nesta política (forte, fraco, bem-vindo ou bem-recebido não)
    -quanto estas tendências internacionais influenciaram o colocaram GD na pauta de discussões no Brasil... (i.e. de fora para dentro?)

3. Qual é a interação do GIZ com EPE?

4. Qual é a interação do GIZ com outros ministérios MME/MCT/MIDC/MDS, etc. ?

5. Como que o Sr. caracteriza a sua experiência pessoal como micro gerador 1.

O Sr. Acha que a GD há uma tendência ou risco de ser algo dos elites no Brasil, não só no lago sul, mas em vários bairros nos grandes cidades brasileiras aonde tem renda alta?

Appendix 24. Semi-structured interview questions for MME

MME – Roteiro de Perguntas

Modulo I: Grupo de Trabalho de Geração Distribuída com Sistemas Fotovoltaicos – GT-GDSF

3. O Sr. Pode me contar um pouco sobre a formação e objetivos deste grupo. Edison Lobao como Ministro publica a portaria, porque?

1b. influência internacional

Question: quanto estas tendências internacionais influenciaram o colocaram GD na pauta de discussões no Brasil... (i.e. de fora para dentro?)

4. No relatório, estão apresentados medidas para ações no curto e médio prazo para incentivar energia solar no país, Sr. Pode comentar sobre alguns chaves que o Sr. Considere que ainda estão faltando, porque:

5.1.1 Curto prazo:

a) Criar um grupo de acompanhamento para dar continuidade às propostas do GT-GDSF;
b) Solicitar à ANEEL a análise da viabilidade da inserção da geração distribuída solar fotovoltaica no âmbito do PRODIST;
c-f) projetos de pesquisa...
g) Apresentar, no âmbito do CT-ENERG, um Programa de **Treinamento de pessoal**, nos
i) Identificar, em diversas áreas de governo, **programas sociais** onde a energia fotovoltaica possa ser solução viável e promover sua aplicação;
j) Estudar e promover condições de **acesso a créditos especiais para financiamento** de compra e instalação de sistemas fotovoltaicos pelos consumidores;

Longo Prazo

a) Estabelecer, em conjunto com o MDIC, uma estratégia de **fomento à indústria nacional** fotovoltaica, focando na isenção de tributos, créditos especiais e em parcerias internacionais;
c) Desenvolver a tecnologia de purificação e beneficiamento do Silício,
d) Inserir a geração distribuída fotovoltaica no contexto do **planejamento energético** decenal e de longo prazo, a partir dos resultados obtidos nas fases anteriores.

Planejamento energética – agora solar pode entrar nas leilões, isso é suficiente?

Modulo II: Aspectos regulatórios

11. O MME acompanhou/participou nas audiências públicas feitas pela ANEEL referente a formulação da Resolução 482? Se for sim, em que capacidade/função?

12. Em que medida o processo da REN482 foi influenciada pelo relatório do Grupo de Trabalho de Geração Distribuída com sistemas fotovoltaicos (GT-GDSF) do MME para possibilitar especificamente geração fotovoltaica?

    2b. Será certo deduzir que a inserção de PV, principalmente, foi a força motriz deste processo? Os resultados até hoje dos projetos REN 482, a maioria são PV, alguns eólica de pequeno porte e um de biogás...

13. Qual é a sua opinião deste regulamento para a expansão de geração distribuída no Brasil?

14. Porque o net-metering foi escolhida e não FIT?

15. Porque a PROINFA – uma programa de FIT não foi renovada? Ou ate expandida?

III. Nota Técnica – EPE Sobre PV

1. Qual foi o motivo principal que levou à preparação e publicação da Nota Técnica, NT: ?Análise da Inserção da Geração Solar na Matriz Elétrica Brasileira?? Maio 2012

4. Em página 2 da Nota Técnica é colocada que: “a presente Nota Técnica tem como objetivo subsidiar o MME no processo de decisão quanto a estratégia para a continua inserção da fonte solar na matriz de geração elétrica brasileira”. Qual é o status atual das discussões entorno à inserção de PV como fonte de geração distribuída no EPE/MME?

5. O EPE/MME pretende publicar estudos para outras tecnologias que possam ser aplicadas de forma distribuída como: biomassa, biogás, eólica de pequeno porte?

7. Várias opções de incentivos para PV foram apresentadas na nota, como: Tarifa-premio, Cotas), Subsidio ao investimento inicial, Deducao no imposto de renda, Incentivo a aquisicao de eletricidade “verde”, Obrigatoriedade de aquisicao de FV, Fundos de investimentos para FV, Padroes em edificacoes sustentáveis. quais foram discutidos no MME/EPE?

8. Existe uma linha de financiamento oferecido pelo BNDES, abordado na Nota Tecnica – Fundo Clima para projetos de Energia Renovável; o MME está envolvida nesta iniciativa? Poderia me passar mais informações sobre o andamento/contato no BNDES?

IV. PDE 2022

9. No Plano Decenal de Energia (PDE 2022) a geração distribuída é abordada no mesmo capítulo que eficiência energética tanto para as aplicações de grande porte quanto do médio/pequeno porte.

8a. Porque apenas PV foi considerada para as classes residencial e comercial?

8b. O biogás ou biomassa não foram contempladas na análise para autoprodução de agricultores (salve autoprodução no segmento de açúcar e álcool) porque?