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Renewable energy and technology development and transfer: The case of wind energy deployment in Brazil

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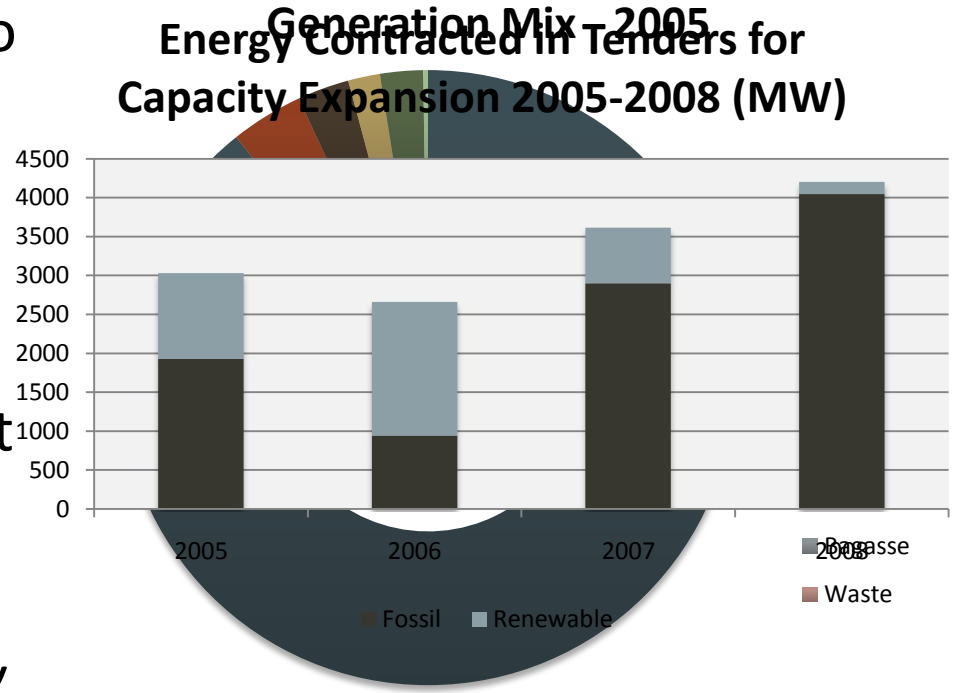
Introduction

- Technology development and technology transfer
- Challenges to overcome for successful technology transfer
- Challenges to renewable energy deployment
- Wind energy deployment in Brazil: a case that illustrates the challenges to achieve LCS in developing countries

Trends in Brazil's Power Sector

- Brazil's grid will remain predominantly hydro, but rely on plants with small/no reservoirs - requires more complementary energy
- Most recent trend in contracting oil/gas plants not sustainable but also not wholly indicative of future
- Last long term plan for energy expansion cites *only* 3.3 GW more wind capacity installed through 2030.



Source: 1) Plano Nacional de Energia 2030
2) Viega, 2009

Wind Potential in Brazil

- National wind potential resource study (2001) cites technical potential in Brazil as 143 GW. Wind speeds measured at 50m altitude. Towers at that time were about 30-40 m tall.
- **Potential given tower heights today could surpass 250 GW. New national atlas to be complete in two years.**
- Wind patterns make it **highly complementary** to the hydro resource in the Northeast region, along the year.

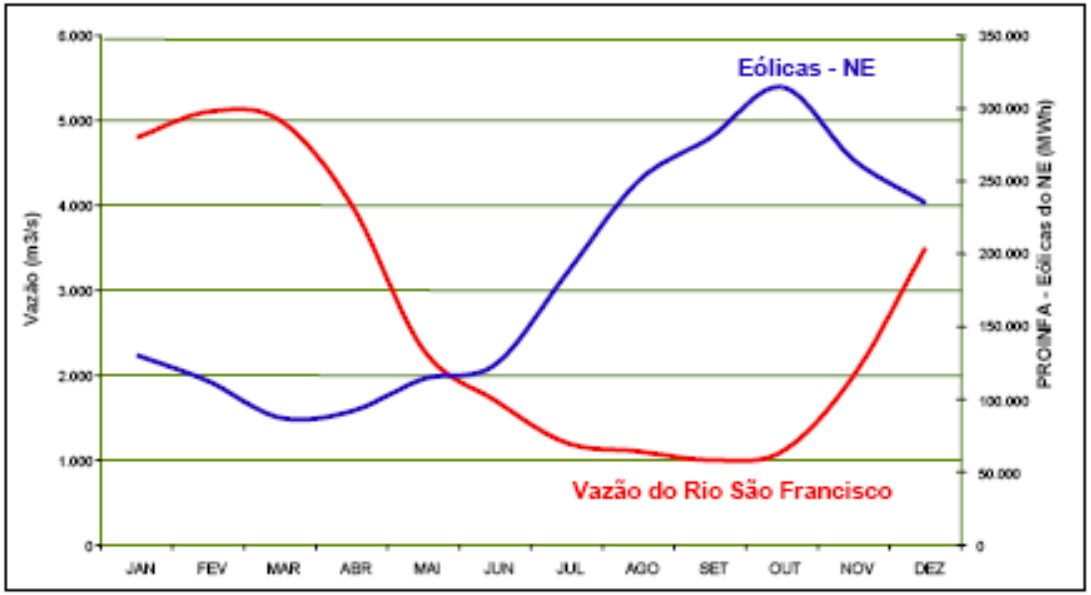
Wind-Hydo complementarity:

Blue line represents the projected generation of wind farms in the NE based on wind speeds there.

Red line represents the flow in the San Francisco River, extremely important for power supply in the Northeast.

X-axis: Flow (m^3/day). Y-axis: MWh of plants

Source: Eletrobrás, 2005



Wind: Background

- PROINFA I: Essentially a Feed-In Tariff with pre-set goal to contract 3,300 MW of wind, small hydro and biomass. Contracted 1,446 MW of wind.
- PROINFA II would have set quota of 10% renewables* by 2020 but was not implemented.
- Without progress towards PROINFA II, there was no long-term prospect for a market to spur new entrants to invest in turbine manufacturing in Brazil.
- Learning experience: 37% of PROINFA-contracted wind MW are operating, three yearsafterdue date. Why?
  - Nationalcontentrequirement of 60% - Nationalindustrywasnot prepared to supply in such short orderandmanydelays in ordering.
  - National content index protected domestic producers, also allowed them to charge above-market prices.
  - Projectswerechosenbasedon date ofenvironmentallicensewhichdidnotprioritizestrongest candidates.

Wind: Looking Forward

- 427 MW of wind capacity expected to be installed by the end of 2009 and 648 by the end of 2010, according to Minister of Energy.
- Government announced first tender to award long-term contracts (PPA's) to new wind generators in November.
- Enormous interest – 441 projects registered to participate!
  - 73% of total projects are in the Northeast, where resource is strongest
- About 50-60% of the projects use imported equipment.
  - Originally a ban on imported turbines below 2.0 MW was changed last-minute to below 1.5 MW. Also added an import tariff of 14%.
- Tender designed to provide flexibility to generators in terms of over/under-generation given that one year of wind data is not perfect indicator of long term performance.
- Includes provisions for sharing cost of grid connection between a cluster of wind farms.

Current Incentives & Policies for Wind

Brazil has moved from a FIT (PROINFA) paying US$150/MWh for wind to…

Tender System:

- First wind tender (Nov) for 20-year contracts at fixed price.
- Price ceiling expected to be about R$200/MWh (US $111).
- US $111 is roughly $US 40 above the average price for new hydro generation and $US50 above new fossil fuels plants.
- Contract terms in tender designed with wind in mind.

Additional Incentives:

- R&D funding via CT-Energia and FINEP to develop domestic industry and innovation capacity.
- At least 50% discount of transmission usage fees for RE.
- Tax relief from certain taxes.
- Projects with PPA enjoy good financing terms from Brazilian National Development Bank (BNDES).

Note: PROINFA price corrected for inflation with the ICP-M index resulting in value of $R270/MWh converted at excnage rate of 1.8.

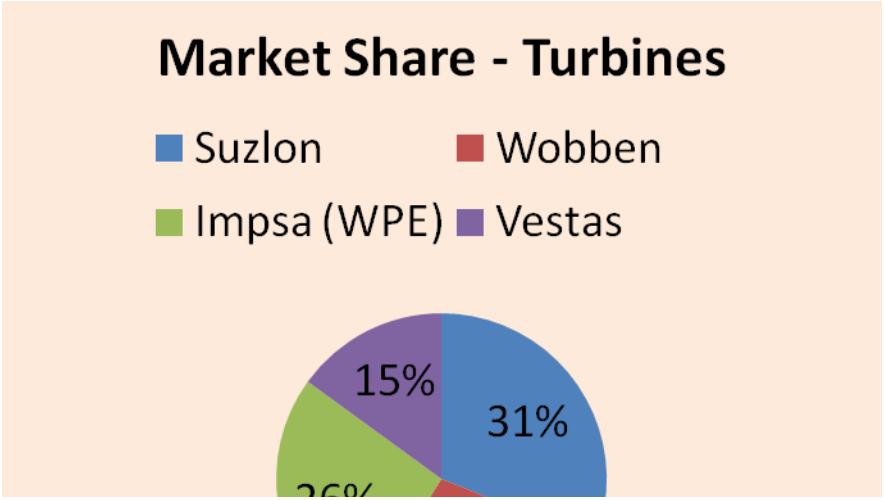
Domestic Manufacture vs. Imports

Made in Brazil (Turbine-generators)

1. WobbenWindpower (subsidiary of ENERCON – German). Until 2008 only domestic manufacture of turbine-generators. 70% national content.
2. Wind Power Energia (IMPSA - Argentina). Produces with licensed German Vensys technology and developing own.
3. ENERSUD (small scale turbines only)

Other parts:

- TECSIS (100% domestic capital, manufacturesblades). Has not sold any to domestic market because too small to be of interest. 2nd in global blade market.
- GE – Blade factory in Brazil manufactures 60% of GE´s blades, as of now has not signed any supply contracts in Brazil.



GE to push ahead with plans to build turbines in Brazil

US engineering giant GE will push ahead with plans to build wind turbines in Brazil as the South American country gears up for its first wind energy tender in November, according to industry sources.

Suzlon estuda implantar fábrica no Brasil

Companhia tem encomendas, somente para o Brasil, de 182 aerogeradores para dez parques eólicos localizados no Ceará.

Barriers – Developer's Perspective

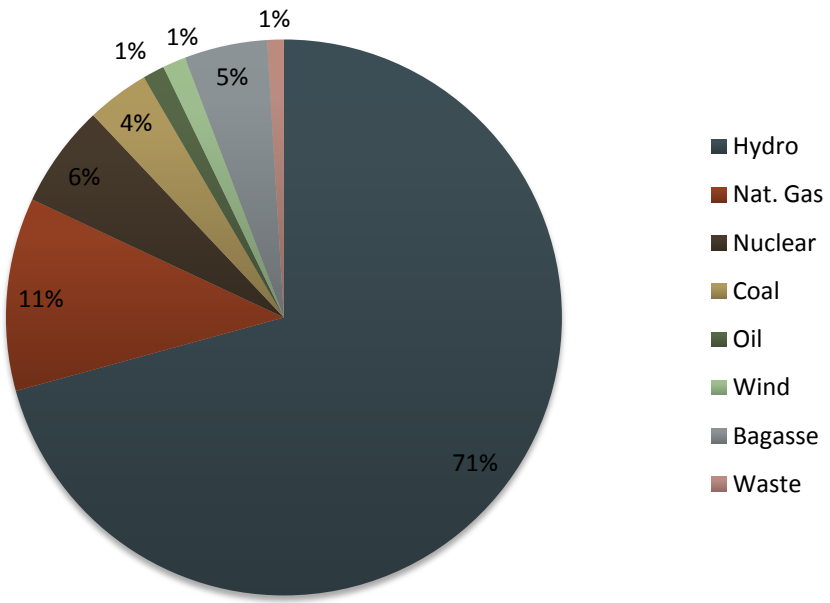
- Uncertainty of price-ceiling in Nov. and schedule of any subsequent tenders make expansion activites risky.
- Different to the PROINFA feed-in tariff, the quantity (MW) to be purchased in tender is not known ahead of time. Projects must bid for the lowest price, rather than knowing their fixed price ahead of time.
- Developers report: difficulties aquiring land rights, frustration with changes in rules for environmental permits and rules for the tender, high taxes on the power sector.
  - National content requirement (was 60%) has been removed and substituted with ban on imports for turbines under 2.0 MW. Ban on imported turbines below 2 MW was later raised to those larger than 1.5 MW.
- Connection to the grid is costly and logistically difficult – can represent up to 10% of total investment cost.
- Domestically manufactured turbines are limited in supply because only two in-country suppliers.

Barriers – Energy Planners' Perspective

- Cost of wind is on the order of 70% higher than hydro and government is already under criticism for high electricity prices.
  - Incremental abatement cost of installing wind relatively high.
- Difficulty accounting properly for the value of wind within Brazil's hydro-fossil grid mix because of lack of quality resource data to use in grid system simulations.
  - Results in undervaluing of wind in the tenders and planning process.
- How to stimulate/protect domestic industry without creating oligopolistic pricing power?
  - Imported turbines cost significantly less, in part because of high domestic production tax. However, reliance on imports creates exposure to foreign exchange risk and is politically unpopular.
- How to create enough scale of domestic production and expand models offered to reduce costs?

Case Study

- Brazil's 2007-2030 energy plan envisions that coal, nuclear, and natural gas will increasingly be needed to meet demand in absence of hydro.



Brazil's national climate change plan states that it will *"Look to maintain the elevated participation of renewable energy in the electricity mix, preserving the international leadership position that Brazil has always shown".*

WHAT IF WIND ENERGY WAS SCALED UP TO REPLACE (SOME) EXPANSION OF GAS, OIL, AND COAL?

Three Scenarios for Wind

% Represents wind energy as % of new generation (2013-2030).			
% Wind in expansion	5%	8%	10%
tCO2 Reduced	162.1 $mTCO_2$	217.5 $mTCO_2$	245.2 $mTCO_2$
Cost of Scenario – High ($US billion)	8.1	12.5	15.2
Cost of scenario – Low ($US billion)	3.2	5.0	6.1
CDM as % Total Cost Standard Grid Factor	7%	7%	7%

Scenarios model insertion of wind displacing the fossil fuel generation planned between 2013-2030 (MWh for pre-2013 already contracted). Displaces oil, coal, gas (in that order) and maximum limit is 15%. Scenario costs are $US2009 constant (not discounted). Exchange rate 1.8R:USD. High cost scenario = $R250/MWh and low is $R200/MWh. CDM Revenues calculated as % of total program cost (average of high and low scenarios) assume a carbon price of $US15 and a methodology that credits only 0.14 tCO2/MWh per standard grid emissions factor meth, but NAMA would aim to reduce fossil fuel expansion.

Possible NAMA for Wind in Brazil

- Brazil's national climate plan notes that regular tenders are important for RE. Commitment to wind tenders for 10 years would be a start for a national wind program.
- Scenario 3 (10% of expansion 2013-2030) would increase the marginal cost of expansion by at most 8% in highest year.
- Total incremental cost of the program is estimated at $6-15 billion over 2013-2030, or annually about 340m-840m. CDM revenues would only cover about 7% of this, given standard crediting methodologies for RE, because of the low emissions factor of Brazil's hydro-dominated grid.
- 10% scenario would entail slow ramp up of 200-300 MW/yr to 2020 and then quicker growth of 1.8 GW/yr between 2020-2030. Installation would not have to follow this trajectory, but fossil fuel expansion expected mainly after 2020.

Possible NAMA for Wind – CDM Support Limited

- CDM grid emissions methodologies not compatible with a NAMA that specifically aims to replace expansion of fossil fuels with wind.
- At most, one could use CDM revenues to re-invest in more MW, which would firm the offer of wind and make displacement of fossil fuels easier.
- Brazil relies on thermal generation to meet gaps in dry hydro years – wind complementary but not firm. Wind would have to displace fossil on > than 1:1 ratio.
- Total displacement of fossil fuel growth (as in the 10% scenario) is an extreme example.

Using CDM to subsidize a NAMA		Notes
$US/tCO2 earned from CDM – Standard methodology	$2.71	Brazil has low average grid emission factor (0.14tCO2/MWh in 2008)
$US/tCO2 Abatement cost replacing only fossil fuels	25.1-62.1	High cost – R$250/MWh Low – R$200/MWh
Additional MWh funded by CDM subsidy	1.2 TWh/yr	US$15/tCO2 MWh cost avg.$R230
Additional MW funded by CDM subsidy	450 MW (Small vs. Total goal).	Assumes 30% CF

Policy Options to Achieve Wind Goal

Market-Pull

- Brazil needs a long-term stable policy which ensures a market for wind energy. Proinfa II would have provided that - What now?
- **Annual tender can be effective if done consistently. A FIT was reasonable at small scale, now move to more efficient policy.**
- Is a schedule of tenders with a MW purchase target (under a ceiling price) the best option?
- Manufacturing industry will only be drawn by long-term market.

Technology-Push

- Identify Transmission corridors to groups of wind plants. Line could be paid with public investment per competitive bid.
- Ex) Ceará state – R$600m line.
- Public investment in R&D for more domestic manufacture.
- Tax relief for projects and entire productive chain would reduce generation costs and stimulate investment in the technology.
- Improve technical capacity for process control and data collection/usage.

What is Tech Transfer for wind in Brazil?

- CDM sometimes promotes technology transfer – was acheived in about half the CDM wind projects. German technology & know-how most common.
  - Germany has a strong influence on wind technology in Brazil. Licenses tech. to the two domestic producers, KfW $135 million in finance cooperation for BNDES.
- In emerging economies with high wind potential, TT should be more extensive than via CDM. TT can be impeded by conflict of interest but can create confluence of interest and opportunities for new markets. Requires a regulatory framework which creates a stable market as well as international cooperation.
  - PROINFA I used national import requirement (60%) to try to force technology transfer. “Stick approach” had serious problems, now looking for carrot approach.
  - Carrot – Implement policies which create incentives for TT (not just equipment manufacture, but software, design knowledge, adaptation of technology).

Technology Transfer Barriers

Supplier-side	Recipient-side
Lack of interest from large players in global wind industry thus far. GE, Siemens, Suzlon have expressed some interest in manufacturing in Brazil – is it serious?	Visa requirements make it difficult to send staff from companies abroad. Onerous shipping requirements (vessels must have Brazilian flag, restrictions on partial shipping of components). Lack of predictable domestic market.
Financial	**Technical**
Wind energy technology is expensive compared to Brazil´s current hydro-thermal mix and even its bagasse generation. BNDES offers attractive financing line for high national content turbines. Imports are more complicated because of foreign exchange risk.	Most recent national wind resource assessment is 8 years old and does not represent current technical potential because technology has changed (taller towers). Blades/rotors manufactured there not designed to perform optimally in Brazil. Wind patterns in Brazil are steadier than in EU. Optimization can add 9% generation.

Int'l Cooperation – Potential Support for Wind Tech Transfer in Brazil

Financial Support

- More financing programs (like KfW) to offer grants & soft loans and reduce cost of capital. Risk guarantees useful for currency risk if imported equipment.
- Financial assistence buying down cost of technology licensing. Domestic party (Brazilian company) purchases license for production of wind turbine from technology owner. Licenser must offer the know-how to produce, producer can only exports to markets where licensed.

Capacity Building

- Policy optimization: International/Bilateral cooperation sharing lessons and advising on optimizing policy design for Brazil's situation.

Int'l Cooperation - Potential Support for Wind Tech Transfer in Brazil

Technology & Technical Cooperation

- International or bilateral participation in joint wind R&D.
- Technical support with more frequent and accurate resource measurement studies.
- Bilateral cooperation in Joint Ventures to produce wind equipment in Brazil. Foreign party uses technology as equity and domestic party uses production facilities/cash as equity. Allows for adaption of technology for local resource conditions.
- Potential project: Innovation Park for wind R&D as well as commercial production. Brazilian govt. would offer full tax relief on equipment developed there, would require Joint Venture to ensure technology transfer. Facilitate coordination with private sector and national reference centers to gather improved data on wind conditions and optimize turbines to those conditions.