Financing, Carbon Emission Trading CDM

Adaptation of Support Schemes for Renewable Energies to Inflation in Countries with an unstable Macroeconomic Situation – Case study: Wind Power in Brazil

Johannes M. Kissel,
Federal University of Rio de Janeiro, Technical University Berlin
Rua Sá Ferreira 228, Apto. 1036
CEP. 22071-100-RJ, Copacabana, Brazil
Tel.: 0055-21-25226634, Fax: 0055-21-25182220
e-Mail: jo.kissel@gmx.net

Stefan C.W. Krauter
State University of Ceará, Departamento de Física
Av. Paranjana 1700 – Campus do Itaperi, Fortaleza 60740-000 CE, Brasil
Fax: ++55-85-29 92 804
krauter@uece.br

Abstract:

Despite the massive cost reduction in the last decade, wind power generation is in general still more expensive than conventional energy sources which take advantage by the exclusion of external costs. Support policies for Renewable Energies guarantee the economic viability of this type of electrical power generation in many countries in Europe. Brazil has become the pioneer state in Latin America with the implantation of the PROINFA programme that supports, among others sources, wind power development of 1,100 MW. The present work gives an overview about the differences between German and Brazilian wind power compensation systems with a special focus on the adaptations of PROINFA to the unstable macroeconomic situation in this country. Especially adaptations of wind power compensation to high inflation in Brazil in have been examined.

Key words: Renewable energy policy, Wind power, PROINFA, German Renewable Energy Law (EEG)

1. Introduction

In the last decade of the 20th century the development of a competitive renewable energy industry sector in Europe was triggered by the implantation of different kinds of support policies. The countries where feed-in-systems were introduced, e.g. Spain and Germany, have demonstrated major advances in the development of renewable energy application than countries with other support systems. Main instrument of feed-in-systems are special tariffs for energy generated by renewable energy sources. These tariffs, above the market price, in combination with long-term Power Purchase Agreements (PPA), form the main instrument of feed-in-systems and encourage investments in this industry sector. One important characteristic of European feed-in-systems consists of their low expenditures for permission and control.

In emerging countries, such as China, India and Brazil, the energy consumption is supposed to increase considerably during the next decades. Brazil pretends to cover the additional demand in part by renewable energy sources. After the energy crises in 2001, the then Brazilian Government introduced the PROINFA, a support instrument based on the European feed-in-systems. PROINFA, modified by the current government in December of 2003, is the first support scheme for grid-connected systems in Latin America and also the largest of all the support policies in the region with a scope of 3,300 MW (1,100 MW small hydro power, 1,100 MW biomass, 1,100 MW wind power) (Law no. 10438, 2002, Law no. 10762, 2003). Economic frameworks and energy policies of Brazil and the EU-countries differ fundamentally in many aspects. A part of these differences was considered in the policy design of PROINFA. In this paper the author focuses on the adaptations of Brazilian PROINFA to the unstable macroeconomic situation, concentrating on high inflation rates in comparison to European standards. In view of this aspect has been realized a comparison of the Brazilian and German compensation systems for wind power.

2. Comparison of wind electricity compensation in Germany and Brazil

2.1 Wind power compensation in Germany

Even the German Renewable Energies Law of 2000 (EEG 2000) established exclusive feed-in-tariffs for electrical energy generated by wind power plants to be paid during a compensation period (CP) of 20 years. The new law, brought into force in August of 2004 (EEG 2004), did not changed the duration of the PPA and the Basic Compensation (BC) for on-shore wind power, fixed in 53.9 € / MWh for the year 2005 (fig.1). In addition, a supplementary Initial Compensation (IC) of 31.4 € / MWh for new connected on-shore wind power plants has been introduced. The Compensation Period (CP)[1] of this extra IC depends on the Reference Output (RO)[2] of every power plant. The lower the Reference Output, the longer is paid the IC (Tab. 1).

Reference output (RO)	=150	149.25	148.5	147.75	147	144	141	138	etc.
Duration of IC payment (month)	60	62	64	66	68	76	84	92	...

Tab. 1: Relation between RO and IC payment fixed by EEG 2004 (p. 1922) (own elaboration).

The payment of a variable IC aims to secure the economic viability also for wind power plants in less favorable locations, helps facing the elevated interests on capital in the first years after the investment and to reduce the investor risk. The compensation of the wind power plants is influenced by two effects during the 20 years of PPA:
1. The actual value is reduced by the inflation rate, 2. After the suspension of the IC the compensation drops abruptly to the BC. These effects are visualized in chapter 3.

[1] The specific period of IC payment can be calculated by the following linear function:
CP_y (month) = 60 + ((150-RO_x)/0.75)* 2; (RO_x =150).

[2] The determination of the Reference Output (*Referenzertrag)* of a wind power plant is specified in EEG 2004, p. 1929.

The German Renewable Energies Law (EEG 2004) regulates the development of feed-in-tariffs for a number of years, pretending to be a stable framework. In this framework the feed-in-tariff for new wind power plants depends on the year of the power plants operation beginning, decreasing 2% annually in addition to inflation, concerning the advances in cost reduction and the increase in productivity. Example: A wind power plant starting operation in 2005 receives the BC of € 53.9 / MWh during 20 years. At least during the first five years the supplementary IC will be paid, summing up a total nominal feed-in-tariff of € 85.3 / MWh in this period (fig. 3).

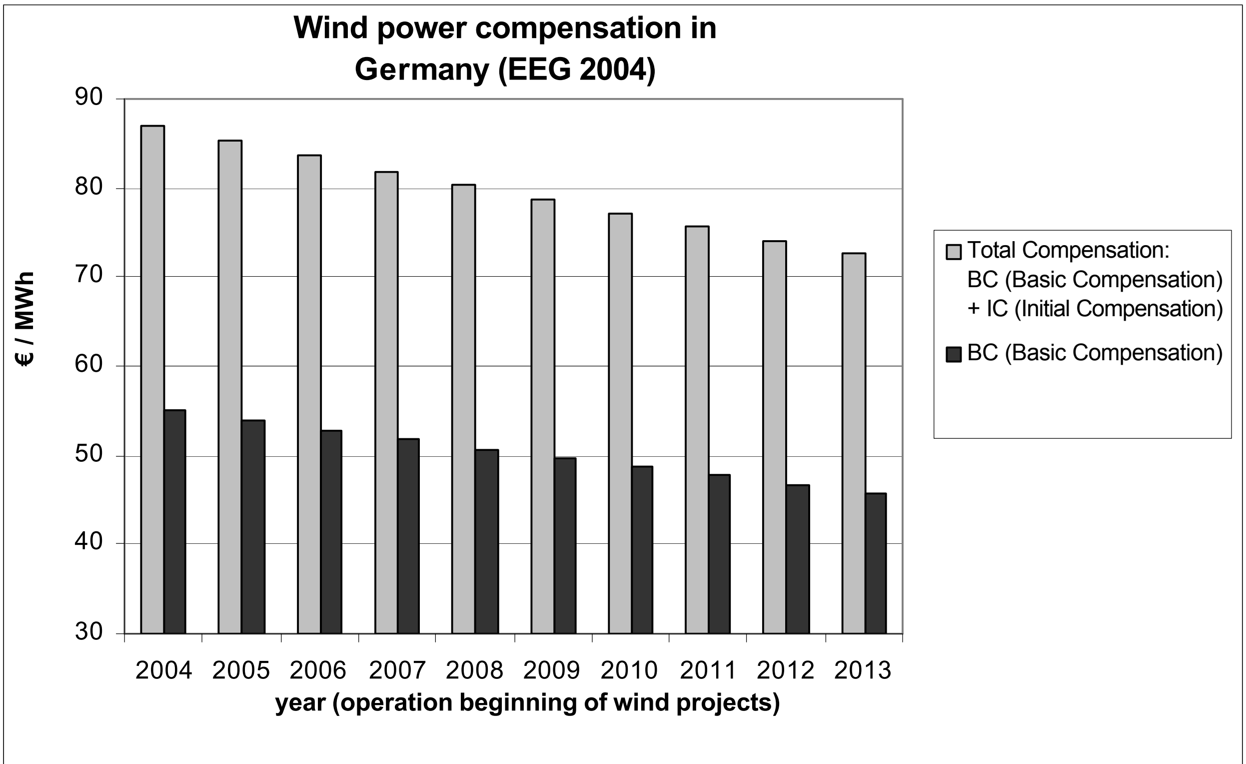

Fig. 1: Nominal feed-in-tariffs for wind power electricity in Germany, depending on year of wind park inauguration (EEG 2004, p.1922) (own elaboration).

2.2 Wind power compensation in Brazil

The Brazilian Incentive Programme for Alternative Sources of Electrical Energy PROINFA limits the support to 1100 MW of wind power plants within the first phase of the programme until 31/12/2006. For the second phase no regulations have been established yet, but probably an energy auction will be established. PROINFA does not establish a BC for wind energy generation like the German EEG. The compensation (VE= *Valor Econômico*) depends on a Capacity Factor (CF) calculated for each wind power plant (MME 2004)[3]. The higher the CF, the lower the VE. The VE is rising linearly from R$ 180.18 for power plants with the Maximum Capacity Factor (CF_{max}) up to R$ 204.35 for power plants characterized by Minimum Capacity Factor (CF_{min}) (Tab. 2)[4].

[3] CF is calculated by the following function: CF= [RE*(1-LG/100)-LO]/(P*8760),
RE=Reference Energy of wind power plant fixed by ANEEL Resolution, LG=Energy losses until grid connection, LO = Losses of generated energy by consumption of wind power plant, P=Installed power (MW)

[4] The VE is calculated by the following linear function:
$VE_y(R\$) = VE_{max} – [(VE_{max}-VE_{min}) / (CF_{max}-CF_{min})] * (CF_x- CF_{min})$ (MME 2004).

CF = Capacity Factor	0.419347 (CFmax)	0.4	0.38	0.36	0.34	0.324041 (CFmin)
VE = Valor Econômico (R$/MWh)	180.18 (VEmin)	185.09	190.16	195.23	200.3	204.35 (VEmax)

Tab.2: Relation between CF and VE fixed by Ministry of Mining and Energy (MME 2004) (own elaboration).

The CF of each wind farm will be revised periodically and VE adapted consequently, probably causing considerable changes of compensation during the 20 years of PPA.
The differentiation of the VE that relates on the CF aims to guarantee the economic viability of the wind project as well as to avoid an over-compensation of electricity generation in excellent wind locations. This rule also encourages the development of wind projects in favourable wind locations where compensation is higher, additionally supported by the 220 MW wind power state limit implemented by PROINFA. With this regulation of major dissemination of wind power generation in Brazil, the Brazilian Ministry of Mining and Energy (MME) pretends to avoid grid bottlenecks. The best location, in view of wind conditions, is the North-East of Brazil, but in this region the electrical transmission infrastructure is not well developed. Besides the periodical adaptations of CFs during the 20 years of PPA, the VEs suffer the devaluation effect by inflation, which is the focus of the next chapter.

3. Adaptation of wind power compensation to inflation

The macroeconomic situations of Germany and Brazil are very different. Low interest rates and a low rise in prices as well as a low country risk characterize the German framework in comparison with high interest rates, a relatively high inflation and an elevated country risk of the Brazilian economy.

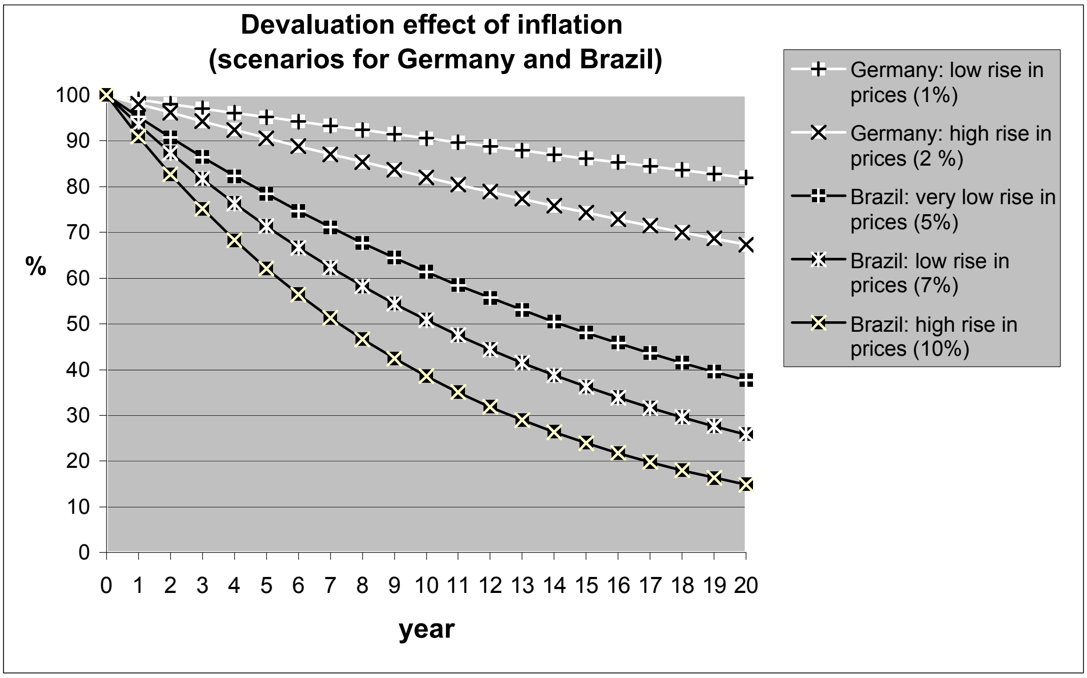

Fig.2: Examples for devaluation effect of actual value according to German and Brazilian patterns of rise in prices (own elaboration).

These differences have a significant impact on long-term investments. In the following, the characteristics of inflation of both countries and the effect of the compensation of wind power electricity will be examined.

3.1 Repercussion of rise in prices to German wind power compensation

In the German EEG, feed-in-tariffs are not readjusted during the 20 years of their payment. The face value of BC on the first day of PPA is the same as on the last day. The same happens to IC in the period of its payment. In the last ten years the rise in consumer price index in Germany has never surpassed 2% per year and has been in the interval between 1 and 2 % during the last four years (Deutsche Bundesbank 2004, Statistisches Bundesamt 2003).

The effect of rise in prices to the actual values is described by fig. 2. After 20 years of operation, the actual value of the feed-in-tariff will be about 82.0% of the nominal value according to a yearly devaluation of 1% and about 67.3% in case of a constant annual devaluation of 2% (fig. 2).

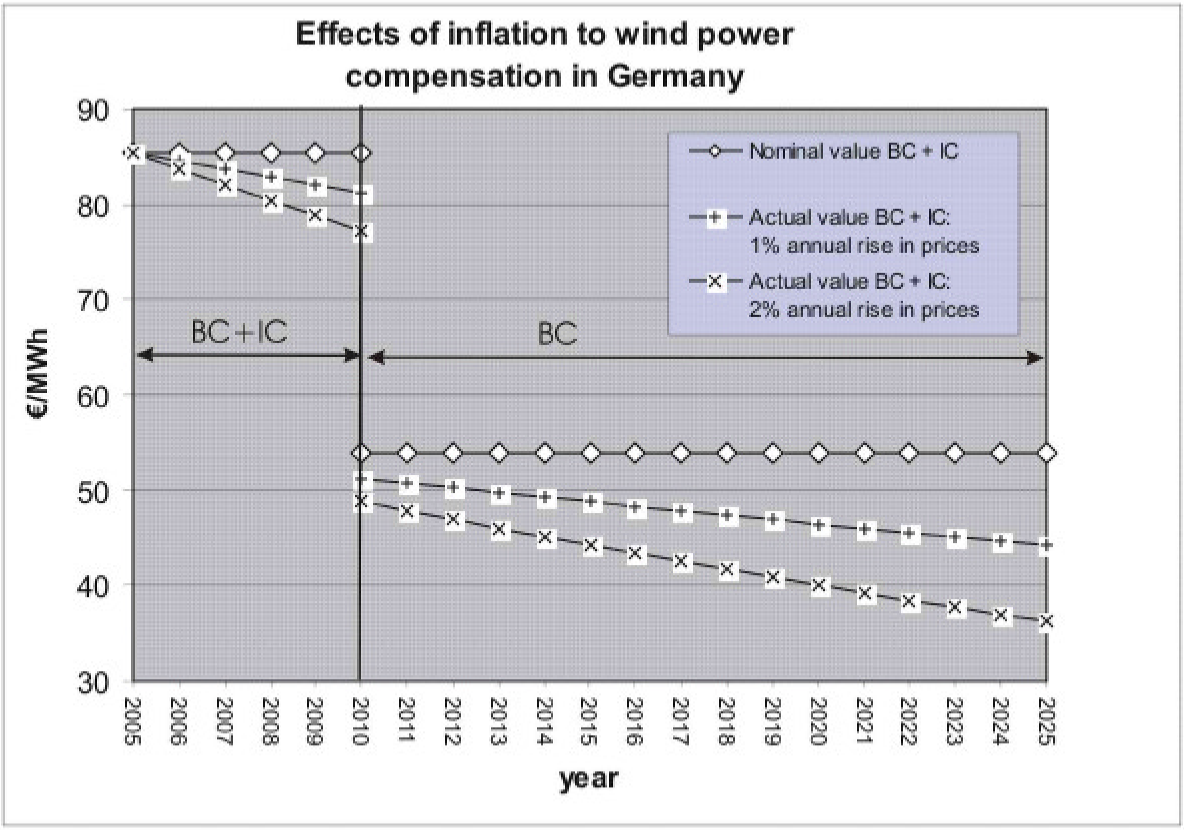

Fig. 3: Nominal and actual values of EEG wind power feed-in-tariff (tariff 2005) for a wind power plant with an exemplary Reference Output (RO) of 150 and corresponding 60 month of IC payment (EEG 2004) (own elaboration).

In addition to the inflation effect, the compensation of wind power suffers an abrupt change of nominal value after the suspension of IC, according to the German EEG (fig. 3). Including this second effect, the actual value of the feed-in-tariff after 20 years is about 51.8% and 42.5% of the value in the first year of compensation respective to annual devaluations of 1% and 2%.

3.2 Adaptations of wind power compensation to inflation in Brazil

Brazil has progressed considerably in the control of inflation since the set-up of the "Plano Real" in 1994. Nevertheless, the average of rise in consumer prices has been between 9 and 10% annually during the last ten years, falling slowly to 8 to 8.5% in average for the last five years (IPCA + IPC-M, fig. 4). Without a readjustment of the tariffs the inflation would cause a devaluation of the compensation of almost 50% in ten years and more than 70% until the last year of PPA, with a supposed annual inflation of moderate 7% (fig. 2).

3.2.1 Price indices as reference for readjustment

In Brazil readjustments of energy tariffs are common. In new contracts the IPCA-Index, the National (Broad) Consumer Price Index (*Índice Nacional de Preços ao Consumidor Amplo*), is the relevant price index for readjustments (CanalEnergia, 2004), but PROINFA-Tariffs will still be readjusted by the IGP-M, the General Market Price Index (*Índice Geral de Preços do Mercado),* the former index for these types of readjustments. IPCA is a consumer index differing fundamentally from the IGP-M, which consists of three components: 1. Wholesale Trade Market Price Index (IPA-M) (60%), 2. Consumer Market Price Index (IPC-M) (30%) and 3. National Construction Cost Index (INCC-M) (10%) (FGV 2004). In fig.4 the two consumer price indices IPCA and IPC-M show a similar development, but IGP-M differs considerably.

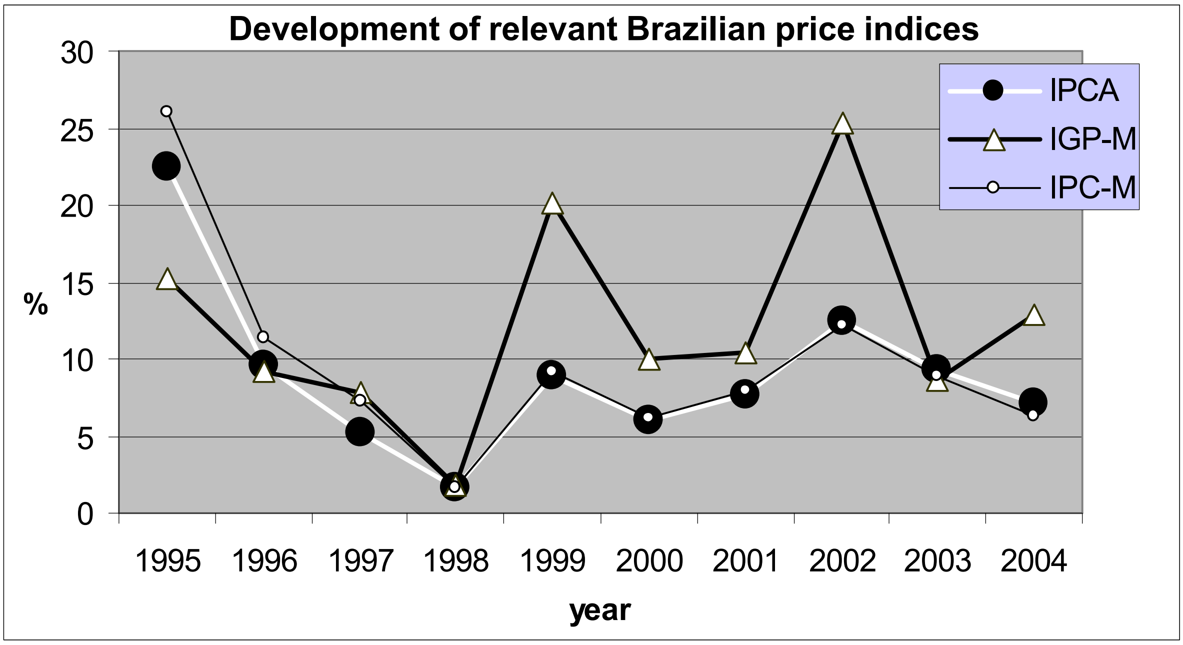

Fig. 4: Price index development of three relevant indices since *Plano Real* stability act (IBGE 2004, FGV 2004) (own elaboration).

Since 1997 the IGP-M has risen stronger than the consumer price indices, but long term observation of CBIEE, the Brazilian Chamber of Investors in Electric Energy (*Câmara Brasileira de Investidores em Energia Elétrica*), show that the development of IGP-M and IPCA has not demonstrated considerable differences during the last 40 years (Machado, 2004).

3.2.2 Suitability of IGP-M and IPCA for readjustments

The "Financial Support Programme for investments in alternative sources of electric energy in the scope of PROINFA" (*Programa de apoio financeiro a investimentos em fontes* *alternativas de energia elétrica no âmbito do PROINFA*) of BNDES forms a fundamental part to achieve the economic viability of the projects, because it offers loans with interest rates much lower than on the free market (BNDES 2004b). Due to this programme BNDES, Brazilian Bank of Economic and Social Development, will be the most important financer of the Brazilian wind projects. Depending on the nationalization quota BNDES will cover up to 70% of the investment costs. BNDES applies the TJLP, the Long term interest rate (*Taxa de Juros de Longo Prazo*) to the loans for PROINFA projects as reference interest rate. The TJLP is much lower than the interest rates of conventional financing institutions in Brazil, turning the BNDES into a fundamental institution for long term investments in general. The TJLP is recalculated every three months by the following formula: TJLP = I (inflation goal for the next 12 months) + R (risk premium). The inflation goal (I) is fixed by the National Monetary Council (*CNM=Conselho Monetário Nacional*) using the broad consumer price index (IPCA) as reference. R is composed by the current international interest rate and the country risk in a middle and in a long term perspective (BNDES 2004a). Therefore the debts to BNDES, the probably most important cost factor of wind projects in the first years, have a direct relation to IPCA in opposite to IGP-M, the reference index for readjustments of the PROINFA tariffs.

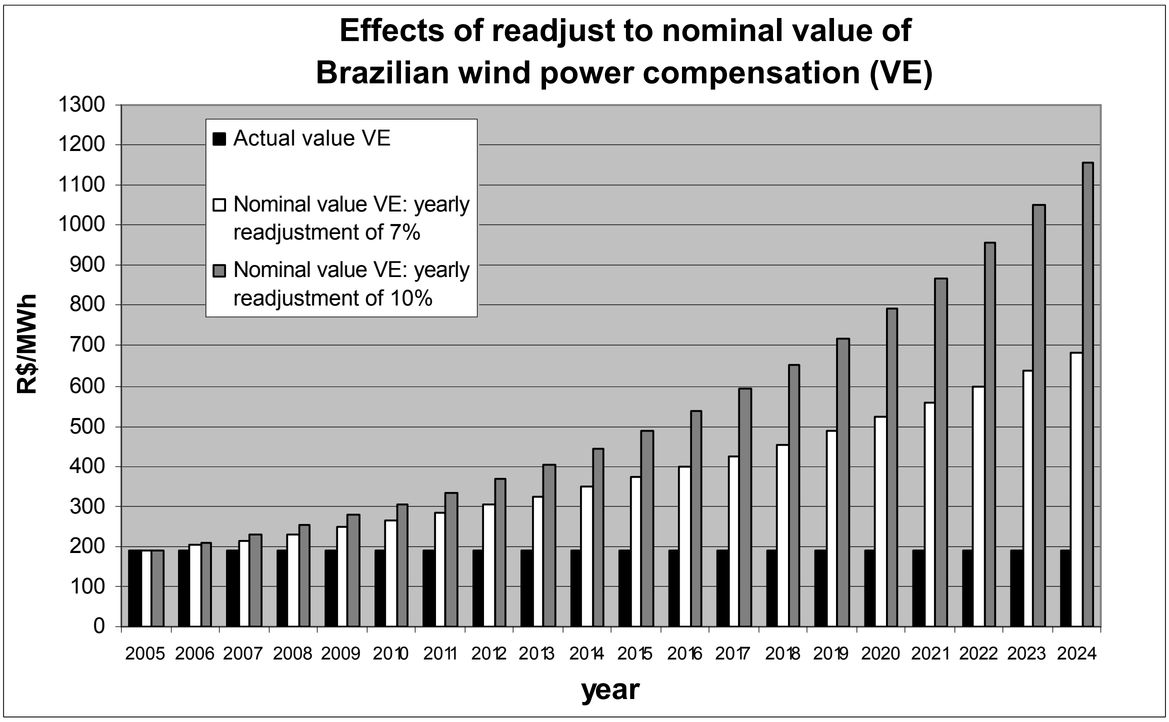

Fig. 5: Example for readjustment of VE for a wind power plant with CF=0.3845683333 and corresponding VE of R$ 189.00 / MWh [R$ 189.00 = € 54.00 (€ 1.00 = 3.6 R$)] (own elaboration).

The remaining part of investment cost has to be financed by other development banks or by own capital. Loans from the free Brazilian finance sector will probably not play an important role in the financing of the wind projects due to the high interest rates (Banco Central do Brasil 2004). The Brazilian EcoEnergia Fund, that also considers PROINFA projects, focuses on small hydropower plants, which promise a higher return rate and fewer risks.

3.2.3 Effects of readjustment to nominal values of compensation

In the following it is supposed that the yearly readjustment by IGP-M is identical to the rise in the relevant prices for the wind projects, guaranteeing a stable actual value of wind power compensation during the period of the PPA.[5]

In fig. 5 two examples for a possible readjustment of tariffs (7% and 10%) are visualized. The nominal value rises more than 250% in the moderate case and more than 1000% in the case of high readjustment patterns of annually 10%.
It is important to point out the primary difference between the German wind power feed-in-tariff and the Brazilian compensation system: In PROINFA a mechanism was implemented with the goal to stabilize the actual value of the compensation during entire running time of PPA, unlike in the German EEG where no readjustment of the tariffs to inflation is considered, but where an initial supplement (IC) is paid, increasing the income of the wind electricity producer considerably in the first years and supporting the decrease of compensation caused by rise in prices over the time. In the following chapter the cost curves of the projects show the importance of a high compensation especially during the first years of operation.

4. Adaptation of compensation to cost structure of wind farms

The present data about cost structure of wind power generation in Brazil is not representative, because of the low number of 28 MW of wind projects presently realized (ANEEL 2004). Most of the 47 PROINFA wind projects, totaling 1,100 MW, have not applied for the BNDES credits yet, and therefore in many cases it seems to be to early for a consolidated evaluation of the cost structure (BNDES 2004c).

4.1 Comparison of cost structure of wind projects in Brazil and Germany

The present knowledge of total wind power costs in Brazil and Germany allows at least a basic analysis of the cost distribution as a function of time (from the viability study of the projects until the end of PPA). Fig. 6 contrasts relative costs (not considering capital costs) and relative compensation in Brazil and Germany in a simplified way.
German compensation for instance suffers from an annual devaluation of 1.5% by inflation. The viability study and development of the wind farm projects are estimated to take three years with constant costs in this period. The construction and additional infrastructure set-up is expected for the fourth year. Beginning of operation is foreseen for the fifth year. The annual costs up from the fifth year are expected to remain stable during the whole running time of the PPA[6].
In Germany 59.2% of the gross costs have to be raised in the first four years, contrasting to 63.9% in Brazil. The relative annual costs vary between 1.80% in Brazil and 2.04% in Germany (fig. 6).

[5] Actual value will not be totally adjusted, even if the readjustment stays congruent to the rise in relevant prices, since the readjustment is done annually and not constantly.
[6] O&M (Operation & Maintenance), as part of the annual costs, are lower in the first two years of operation when the warranty of equipment is still valid (Molly 2003, p.37). The constant use of the equipment is supposed to lead to a rise in O&M costs after a few years. These two effects are not considered in fig. 6, where average annual costs are applied.

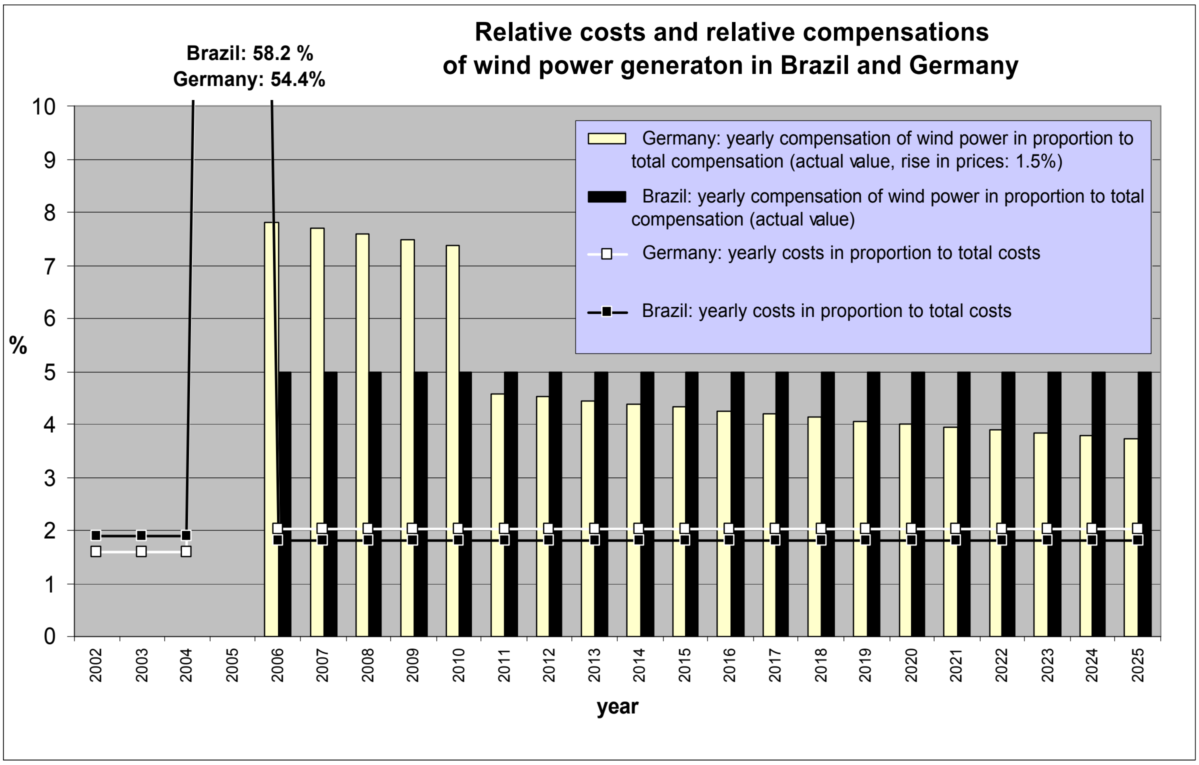

Fig. 6: Relative average costs (without capital costs) and relative compensations in the different "life-cycles" of a wind power plant in Brazil and Germany as a function of time (Molly 2003, Molly 2004, EEG 2004, MME 2004) (own elaboration).

4.2 Proposals for adaptations of wind power compensation to cost structure in Brazil

In comparison with gross costs, relatively high investment costs lead to considerable capital costs in the first years after the construction of wind farms. The German curve of wind power compensation appears more adapted to this fact than the Brazilian one (fig. 6).

Nomenclature and abbreviations:

BC = Basic Compensation
BNDES = Banco Nacional de Desenvolvimento Econômico e Social
(Brazilian Bank of Economic and Social Development)
CF = Capacity factor
CP = Compensation Period
EEG = Erneuerbare-Energien-Gesetz (Renewable Energies Law)
I = Inflation goal for the next 12 months
IC = Initial Compensation
IGP-M = Índice Geral de Preços do Mercado (General Market Price Index)
IPC-M = Indice de Preços ao Consumidor (Consumer Market Price Index)
IPCA = Índice Nacional de Preços ao Consumidor Amplo (National Broad Consumer Price Index)
PPA = Power Purchase Agreement
PROINFA = Programa de Incentivo às fonts alternatives de energia elétrica
(Incentive Programme for Alternative Sources of Electrical Energy)
R = Risk premium
R$ = Real (Brazilian Currency)
RO = Reference Output
TJLP = Taxa de Juros de Longo Prazo (Long term interest rate)

The Brazilian framework, with high expected return rates of investments as well as high interest rates shows the importance of a high compensation of wind power especially in the loan amortization period.
The probably inexact adaptations of VEs to inflation create an additional risk for investors to the general high risk of investment in the new energy source, wind power, in Brazil. A relative higher compensation within the first years after the investment makes sense, because capital cost, the most important cost factor in this period, turn to zero until the amortization of debt. After amortization of loans the compensation could be significantly lower, because the primal cost factor does not exist any more.

Acknowledgements:

The author is very thankful for the financial support of DAAD of the investigation in Brazil. Special thanks to Uta Woiwod, Felicia Müller-Pelzer, Dr. Christian Wenge and Matthias Kissel for their critical reviews.

References:

ANEEL (Agência Nacional de Energia Elétrica) 2004. Banco de Informações de Geração (BIG). Available: http://www.aneel.gov.br (Access date: 29/11/2004)

Banco Central do Brasil 2004, Histórico das taxas de juros fixadas pelo Copom e evolução da taxa Selic. Available: http://www.bcb.gov.br/?COPOMJUROS (Access date: 03.12.2004).

BNDES (Banco Nacional de Desenvolvimento Econômico e Social) 2004a. Taxa de Juros de Longo Prazo – TJLP. Available: http://www.bndes.gov.br/produtos/custos/juros/tjlp.asp (Access date: 30/11/2004)

BNDES (Banco Nacional de Desenvolvimento Econômico e Social) 2004b. Programa de apoio financeiro a investimentos em fontes alternativas de energia elétrica no âmbito do PROINFA. Available: http://www.bndes.gov.br/programas/infra/fontes_alternativas.asp (Access date: 29/11/2004)

BNDES (Banco Nacional de Desenvolvimento Econômico e Social) 2004c. Interview with Laura Matos, Programa de apoio financeiro a investimentos em fontes alternativas de energia elétrica no âmbito do PROINFA/BNDES. 03/11/2004

Deutsche Bundesbank 2004. Monatsbericht November 2004. S.65. Available: http://www.bundesbank.de/statistik/statistik_aktuell_konjunkturindikatoren.php (Access Date: 04/12/2004)

EEG 2004. Gesetz zur Neuregelung des Rechts der Erneuerbaren Energien im Strombereich. Bundesgesetzblatt Jahrgang 2004 Teil I Nr. 40. 31. Juli 2004. Bonn. Available: http://www.eeg-aktuell.de (Access date: 17/11/2004)

FGV (Fundação Getulio Vargas) 2004. Índices Gerais de Preços. Available: http://www.fgv.com.br (Access date: 17/11/2004)

IBGE (Instituto Brasileiro de Geografia e Estatística) 2004. Sistema Nacional de Índices de Preços ao Consumidor. Available: http://www.ibge.gov.br/ (Access date: 28/11/2004)

IPEA (Instituto de Pesquisa Econômica Aplicada) 2004. *Price Index data.* Available: http://www.ipeadata.gov.br/ (Access date: 28/11/2004)

Law no. 10438 (Lei No. 10.438). 26/04/2002. Available: http://www.eletrobras.gov.br/EM_Programas_Proinfa/proinfa.asp (Access date: 23/11/2004)

Law no. 10762 (Lei No. 10.762). 11/11/2003. Available: http://www.eletrobras.gov.br/EM_Programas_Proinfa/proinfa.asp (Access date: 28/11/2004)

Machado, O., 2004. MME confirma IPCA como índice dos contratos de venda de energia. Decisão, tomada em conjunto com Ministério da Fazenda, desagrada investidores. Newsletter CanalEnergia. 20/10/2004.

MME (Ministério de Minas e Energia) 2004: Portaria No. 45. 30/03/2004. Available: http://www.eletrobras.gov.br/EM_Programas_Proinfa/proinfa.asp. (Access date: 23/10/2004)

Molly, J. P., 2004. Economics of Wind Farms in Brazil.Viabilidade Econômica de Centrais de Energia Eólica no Brasil. DEWI Magazin Nr. 25, 10/2004, p 50-62. DEWI Wilhelmshaven

Molly, J. P., 2003. Condições técnicas e econômicas da Energia Eólica no Brasil, DEWI Wilhelmshaven. Junho 2003

Statistisches Bundesamt 2003. Preise. Verbraucherpreisindex und Index der Einzelhandelspreise. Lange Reihe ab 1948 bis 2003. Berlin