METHODOLOGY
for the
TECHNICAL - ECONOMIC ANALYSIS
of the
FEASIBILITY OF ENERGY PROJECTS
(using the software Decidix)

Presented by Sergio Feitoza Costa

Cognitor – Consultancy R&D and Training
HOW TO GET A COMPLETE AND FREE COPY OF THE DECIDIX SOFTWARE

Click here to read in English
http://www.cognitor.com.br/c_Feasibility_Analysis.htm

Clique aqui para ler em Português
http://www.cognitor.com.br/c_ViabilidadeEnergiaEletrica.htm

Haga clic aquí para leer en Español
http://www.cognitor.com.br/c_Viabilidad.htm

Cliquez ici pour lire en Français
http://www.cognitor.com.br/c_Faisabilite.htm
The program of the course

1) General view of business and projects in the electric and energy sector (purchase and sales of energy, auctions for grants in generation, transmission and distribution, legislation, programs of incentives, risks of the business and others)

2) Technical fundamentals related to technologies for power plants, transmission and distribution installations and lines. This include renewable and nonrenewable energy (small to big hydro power plants, thermal generation, cogeneration, wind, solar, distributed generation, fuel cells);

3) Methodology for the technical - economic analysis of the feasibility of energy projects (using Decidix)

4) Case studies

5) Advanced topics

We are here
<table>
<thead>
<tr>
<th></th>
<th>Pulverized Coal</th>
<th>Alternative Motor</th>
<th>Gas turbine</th>
<th>Combined Cycle</th>
<th>Micro Turbine</th>
<th>Fuel Cell</th>
<th>SUN</th>
<th>WIND</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW</td>
<td>200 a 400</td>
<td>0,008 a 10,0</td>
<td>2 a 50,0</td>
<td>250 a 400</td>
<td>0,03 a 0,2</td>
<td>0,003 a 0,1</td>
<td>0,001 a 0,1</td>
<td>0,7 a 5,0</td>
</tr>
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</tr>
<tr>
<td>Efficiency %</td>
<td>32,4 a 35</td>
<td>38 a 45</td>
<td>21 a 42</td>
<td>46,7 a 60</td>
<td>22 a 30</td>
<td>40 a &gt;60</td>
<td>NA</td>
<td>NA</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation cost (U$/KW)</td>
<td>900 a 1539</td>
<td>300 a 900</td>
<td>650 a 900</td>
<td>350 a 566</td>
<td>500 a 1000</td>
<td>1500** a 4000</td>
<td>1000 a 5000</td>
<td>1100 a 1400</td>
</tr>
<tr>
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<td></td>
<td></td>
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</tr>
<tr>
<td>O&amp;M (U$/MWh)</td>
<td>5 a 8,1</td>
<td>5 a 15</td>
<td>3 a 8</td>
<td>2 a 3,7</td>
<td>3 a 10</td>
<td>5 a 10</td>
<td>8 a 12/ano</td>
<td>20 a 30/ano</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Fuel</td>
<td>Coal a U$ 0,93 /MBTU e fc=0,85</td>
<td>Diesel a U$ 5,0 /MBTU e fc=0,85</td>
<td>Natural Gas U$ 2,3 /MBTU e fc=0,85</td>
<td>Natural Gas U$ 2,3 /MBTU e fc=0,85</td>
<td>Natural Gas U$ 3,3 /MBTU e fc=0,85</td>
<td>Natural Gas U$ 3,3 /MBTU e fc=0,85</td>
<td>Sun Fc=0,25</td>
<td>Wind Fc=0,35</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U$/MWh at cmpc 12,9%</td>
<td>58,5</td>
<td>64,0</td>
<td>41,6</td>
<td>34,3</td>
<td>52,5</td>
<td>120,0</td>
<td>400,0</td>
<td>70,0</td>
</tr>
</tbody>
</table>
# Electricity Residential Prices x Taxes and Tributes

LOW LEVEL OF AVERAGE EDUCATION = HIGH TAXES + LOW PRODUCTIVITY + HIGH CORRUPTION

INVEST MOST OF THE COUNTRY MONEY IN EDUCATION FOR 7 YEARS

<table>
<thead>
<tr>
<th>Country</th>
<th>Price (**) U$ / MWh</th>
<th>Taxes + Tributes</th>
<th>Participation: Generation – 47,8% Transmission 4,6% Distribution / Commercialization 17,9% Taxes 29,7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>187</td>
<td>9,1</td>
<td>4,9</td>
</tr>
<tr>
<td>USA</td>
<td>101 a 194</td>
<td>7,7 a 11,7</td>
<td>4,7 a 7,6</td>
</tr>
<tr>
<td>UK</td>
<td>92 a 106</td>
<td>4,4 a 5,6</td>
<td>4,8</td>
</tr>
<tr>
<td>Germany</td>
<td>134 a 141</td>
<td>18,5 a 19,5</td>
<td>13,8</td>
</tr>
<tr>
<td>France</td>
<td>115</td>
<td>6,0</td>
<td>5,2</td>
</tr>
<tr>
<td>Brazil</td>
<td>162</td>
<td>&gt;40,0</td>
<td></td>
</tr>
</tbody>
</table>

(***): 2003: Municipalities 1,5% States 68,8% Federal Government 29,6%
Year by year Revenues and Expenses
- “Book life” of a project
- “Life time” of a power plant
- Time period to calculate indicators: Return Tax, Net Present Value, Breakeven Point.

- 3 to 4 years on an independent power producer
- 4 to 8 years for an auto – producer
- 12 to 20 years for a government company
### Financial Mathematics

<table>
<thead>
<tr>
<th>Year</th>
<th>Investment (-)</th>
<th>Expense (-)</th>
<th>Revenue (+)</th>
<th>Balance</th>
<th>Accumulated balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1° (const.)</td>
<td>-1000</td>
<td>-100</td>
<td>450</td>
<td>-1000</td>
<td>-1000</td>
</tr>
<tr>
<td>2°</td>
<td>-100</td>
<td>-100</td>
<td>450</td>
<td>350</td>
<td>-650</td>
</tr>
<tr>
<td>3°</td>
<td>-100</td>
<td>-100</td>
<td>450</td>
<td>350</td>
<td>-300</td>
</tr>
<tr>
<td>4°</td>
<td>-100</td>
<td>-100</td>
<td>450</td>
<td>350</td>
<td>50</td>
</tr>
<tr>
<td>5°</td>
<td>-100</td>
<td>-100</td>
<td>450</td>
<td>350</td>
<td>400</td>
</tr>
</tbody>
</table>

**Graph:**
- Investment (-) in black, Expense (-) in magenta, Revenue (+) in green, Balance in red, Accumulated balance in blue.
Net Present Value

of the balance for a discount tax (cost of the money) of 10 % per year

\[
\begin{align*}
(1 + 0.1)^1 & \quad + \quad (1 + 0.1)^2 & \quad + \quad (1 + 0.1)^3 & \quad + \quad (1 + 0.1)^4 & \quad + \quad (1 + 0.1)^5 \\
-909 & \quad + \quad 289 & \quad + \quad 263 & \quad + \quad 239 & \quad + \quad 218 \\
= & \quad + \quad 100
\end{align*}
\]
Internal Return Tax

Is the value of $Y$ which makes the net present value calculated below equal to zero

$$Y = 0.15 = 15\%$$
## COST OF THE MONEY AND DISCOUNT TAX

<table>
<thead>
<tr>
<th>Source</th>
<th>Share (%)</th>
<th>Annual cost (%)</th>
<th>Share x Annual cost (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debt</td>
<td>70</td>
<td>12 (interests)</td>
<td>8.4</td>
</tr>
<tr>
<td>Equity</td>
<td>30</td>
<td>15 (return expected for own money)</td>
<td>4.5</td>
</tr>
<tr>
<td>Cost of the money</td>
<td>--</td>
<td>--</td>
<td>12.9</td>
</tr>
</tbody>
</table>
Pay Back is the year in which the ACCUMULATED BALANCE reaches, by the first time, the value ZERO.

In the case above is ~4 years.
Revenue Requirement: levelized value of the “sales price” for which the “Internal Return Tax” is equal to the “Average weighted Cost of Money”

Book Life of the project
Revenue Requirement:
Example for a transmission line public grant (30 years)

Request
Autorization
Grant
Energization

Public auction

2 years
30 years
End of grant period

Revenue = 50 millions per year in the first 15 years

Revenue = 25 millions per year From year 16 to 30
Equivalent time for Revenue Requirement (example)

Revenue requirement produce the same Present Value that

87.2 U$ / MWh during 6 years

49.5 U$ / MWh during 20 years
The year by year flux of revenues and expenses

Sales of the product or service (+)
Operational expenses (-)
Taxes over the sales (-)

Operational Revenue (=)

Taxes over the Operational Revenue (-)
Net Operational Revenue (=)
Other expenses (-)

Balance of the year (=)
Accumulated balance (=)
Typical Expenses

Always included
- Interests and main debt
- Depreciation and similar (in + out)
- Taxes
- Insurance and property taxes
- Operation and maintenance
- Expenses with fuels
- Transmission and distribution transport and connection costs + Use of Public Good

Sometimes included
- ENERGY NOT SUPPLIED
- FINES BY NON AVAILABILITY

Rarely included
- Environmental Externalities
- Value of Employment Generation
Typical Revenues

- Electric energy sales
- Heat or cooling sales (cogeneration)
- Sub-products sales
Installation and Screens of the free Decidix Software

After having the installation file (file size is approximately 4.5 MB) save it in some directory of your computer.

To install Decidix just click on the file and give OK to all the questions.

The installer will create in your computer only one directory named c://SergioFeitoza

If it was not created please create a short cut in the desktop for the file C:\SergioFeitoza\Decidix.exe

The *.exe file, the tables with the database and all the few files will be installed in this directory. No other file or directory will be created anywhere

It is not expected to occur but if you have any problems with the installation please send me an email from your private email to the email sergiofeitoza@cognitor.com.br informing what happened.

Please do not use the LinkedIn group for this or for questions about Decidix. Unfortunately we cannot provide free support but for the installation I can help
This version is complete and there is no function locked. For some functions, data entry wrongly written can generate error messages.
The functions that let you do sensitivity analyses, to create scenarios for trends in time and decisions based on Knowledge Rules should not be used by people who have not had training.
On the screen that appears after pressing the Start button it is possible to make most of the analyses required in daily life.

We apply in Company trainings about the concepts and use of the software. Ask for the program and prices by email sergiofeitoza@cognitor.com.br.
Training may be applied in English, Spanish and Portuguese. We can communicate also in French.

For COMPANIES: we can adapt and customize this software to your specific usages.
It is possible to acquire the complete SOURCE CODE in Delphi but only associated to a specific training.

INTERPRETATION OF RESULTS: to do this the user need to have good understanding of the concepts and methods used.
RESPONSIBILITY: the program was not formally validated and may be used at your own risk and we are not responsible for any results or for any use which may be given to the results.
OPERATION MANUAL: the program does not have a book of instructions but putting the mouse over the data entry boxes you can read some basic instructions on how to use them.

Read the text inside the white box above and, if you accept the use conditions, uncheck this box to continue.

After clicking in the file C:\SergioFeitoza\Decidix.exe this screen will appear. Read the text and uncheck the box.
The right side white box will appear. The items are the types or classes of projects. Check one of them, for example natural gas, and you will see, in a blue box which will appear, some existing “test cases”.

Select a project class in the right side, mark one or more projects (blue boxes) and click the START button.
The items in this blue box are already created cases. You can delete or modify existing ones or create new ones. To go ahead select at least one. If you need to see simultaneously the results of two or more different cases you may check several boxes. For the moment check just one.

After selecting one case (or more) click the button Start.
This is the screen used to input or change data. In the next pages you will find explanations about each one.
Investments in equipment (A=depreciable and C = not depreciable), construction & others
Electricity sales price, power of the plant, number of units
Capacity factor, number of interruptions per year, and duration of interruptions
- Operation and maintenance expenses (fixed and variable). Three different ways of to insert. The sum of the 3 values is the relevant one.

- Other revenues and expenses
  . 1 and 2 occur in all the years
  . 3 and 4 occur between any two pre-defined years
If applicable input here the price of the fuel and plant efficiency (and steam / heat if cogeneration).
Economic data for debt and equity

Taxes applicable to the sales or to the balance (revenues – expenses). All values in %
Results of the “analysis criteria” They are also showed in the “Sensitivity Analysis” and “Compare Results “ tab.
Visualization of each component of the flux year by year

Select or not items that you want to be considered (or not)

Click the title of the column of the table to make more visible the item in the graph
<table>
<thead>
<tr>
<th>#</th>
<th>Projeto</th>
<th>TIR (%)</th>
<th>Receita requerida ($) / MWh</th>
<th>PayBack (anos)</th>
<th>VPL (1000 $)</th>
<th>Opinião</th>
<th>TIR esp</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cogen_FuelCell_2</td>
<td>20.1</td>
<td>79.7</td>
<td>7.69</td>
<td>284</td>
<td>10</td>
<td>21.4</td>
</tr>
<tr>
<td>2</td>
<td>Cogen_MotorGas</td>
<td>21.5</td>
<td>60.5</td>
<td>6.22</td>
<td>15.1</td>
<td>10</td>
<td>35.3</td>
</tr>
<tr>
<td>3</td>
<td>Cogen_TurbGas_2</td>
<td>19.6</td>
<td>59.9</td>
<td>7.2</td>
<td>149</td>
<td>10</td>
<td>23.5</td>
</tr>
<tr>
<td>4</td>
<td>Cogen_TurbGas_45</td>
<td>19.9</td>
<td>61.8</td>
<td>7.87</td>
<td>2,92E3</td>
<td>10</td>
<td>23.6</td>
</tr>
</tbody>
</table>

See the results of several projects in just one screen.

Legend:
- Receita requerida = Revenue requirement
- Valor Presente Líquido = Present Value ($)
- Opinião = Expert Opinion
- Taxa Interna de retorno = Internal Return Tax (%)
- Pay-Back (Years)
- TIR esp = Mathematical hope of the Internal Return Tax

Unit of the results (put the mouse over to read): USD
Sensitivity analysis of several projects (for internal return and payback)

Vertical axis = result of the criteria (P.U.)

Horizontal axis = value of the input variable you choose in the right side (P.U.)
Analysis with variable time scenarios and trends (this part and the one with Decision Rules for the prioritization of Projects is not simple enough to describe here). Only with person to person training.
Some recent publications by Sergio Feitoza Costa

1) VALIDATION OF SIMULATIONS OF ELECTRODYNAMICAL FORCES, TEMPERATURE-RISE AND INTERNAL ARC TESTS IN SWITCHGEAR (and main parts of a code to do them)


2) SWITCHGEAR, BUSBAR SYSTEMS and ITS BUILT-IN COMPONENTS: SOMETHING IS MISSING IN IEC and IEEE STANDARDS

3) SIMULATION, IEC STANDARDS AND TESTING LABORATORIES: joining pieces for high quality substations


4) Simulations and Calculations as Verification Tools for Design and Performance of High-Voltage Equipment (with several co-authors)

5) Recent proposal to IEC about the use of simulations min technical standards

Paper: A "Standard Guide" for the use of calculations and simulation of laboratory tests for increasing the competitiveness of the electric industry.
Experience of Sergio Feitoza Costa

• Design team of the high power and high voltage testing laboratories, testing engineer and manager of 14 big testing laboratories of CEPEL - Brazil.
• Member of IEC WG SC 17 C / WG31: Guidelines for extending the validity of tests in metal-enclosed switchgear
• Member of the CIGRÈ WG A3. 24 : Tools for Simulating Internal Arc and Current Withstand Testing
• Consultant for manufacturers of equipment for substations and development of customized software for equipment design and testing simulations (high and low voltage).
• He also chaired groups the area of generation and cogeneration from renewable and non renewable
• Training and consultancy in equipment and substations design and specification and others

• In the free time Sergio is a musician, composer and singer (here you can hear are the songs of his 2nd CD http://palcomp3.com/sergiofeitoza/ clicking in the titles of the songs in the right side)

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