RENEWABLE ENERGY AND ENERGY EFFICIENCY IN BRAZIL

Prof. Dr.-Ing. João T. Pinho

Estimated Solar Power over the Brazilian Territory

Total: 3,893,400 GW

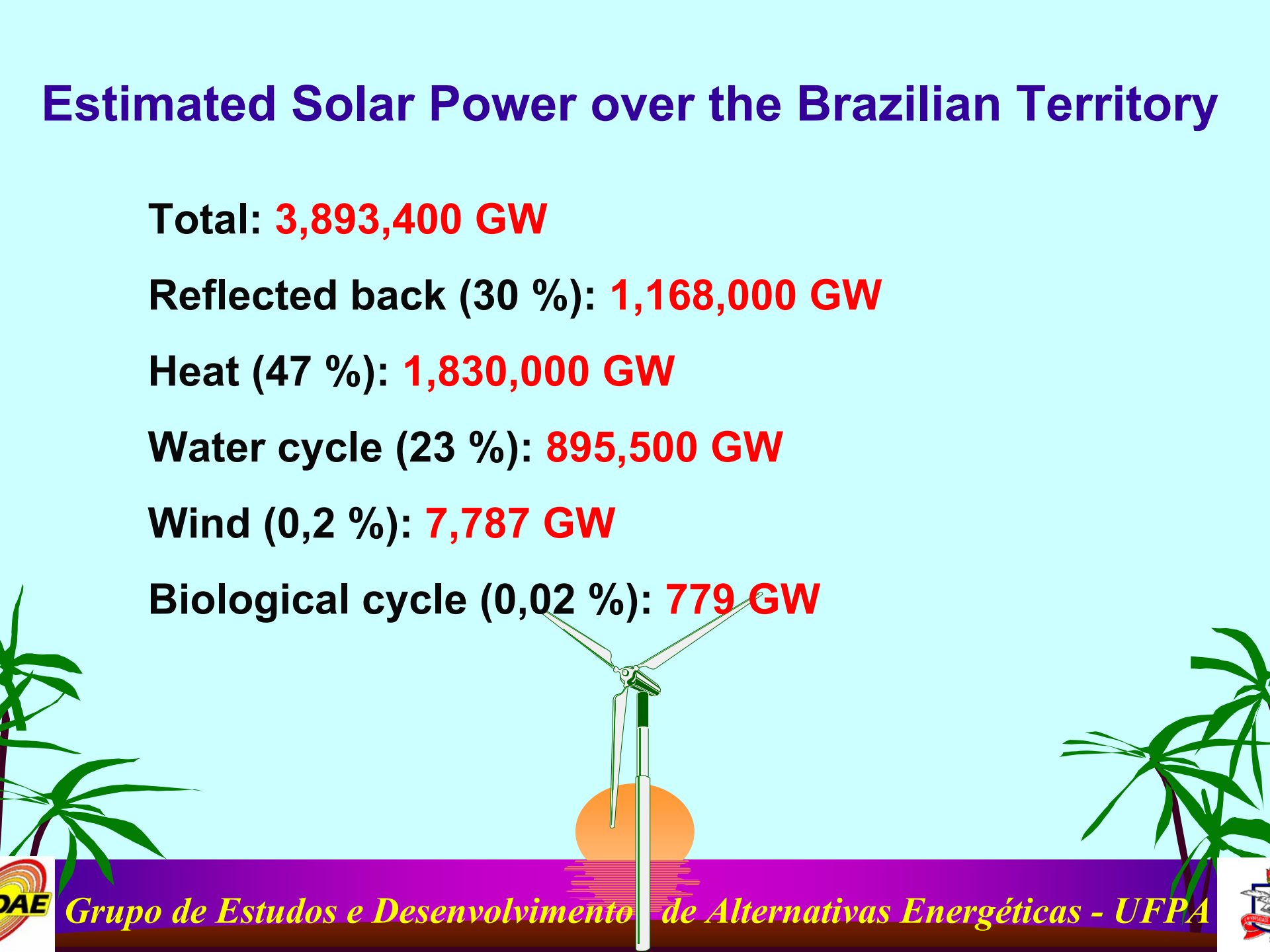
Reflected back (30 %): 1,168,000 GW

Heat (47 %): 1,830,000 GW

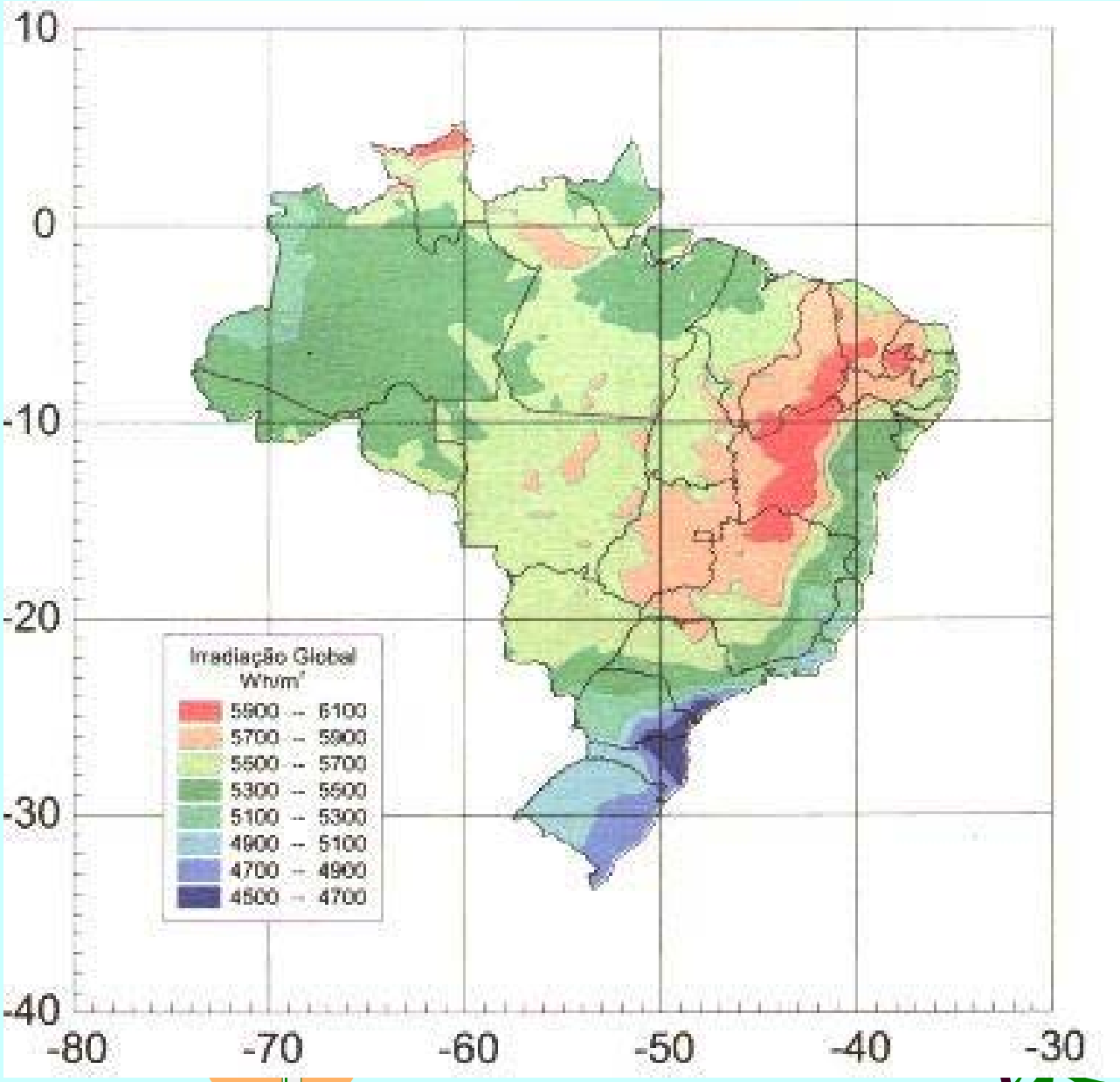
Water cycle (23 %): 895,500 GW

Wind (0,2 %): 7,787 GW

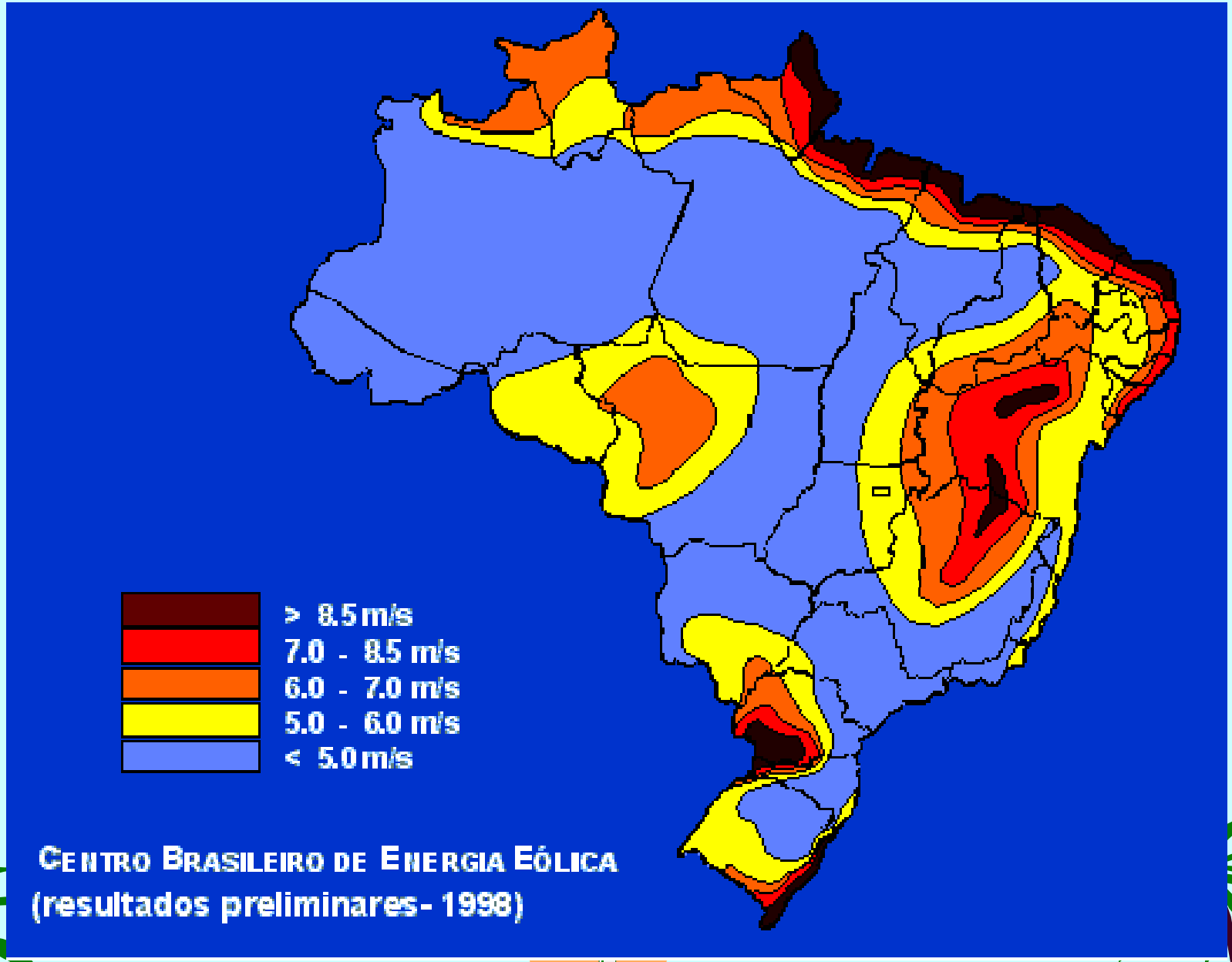
Biological cycle (0,02 %): 779 GW

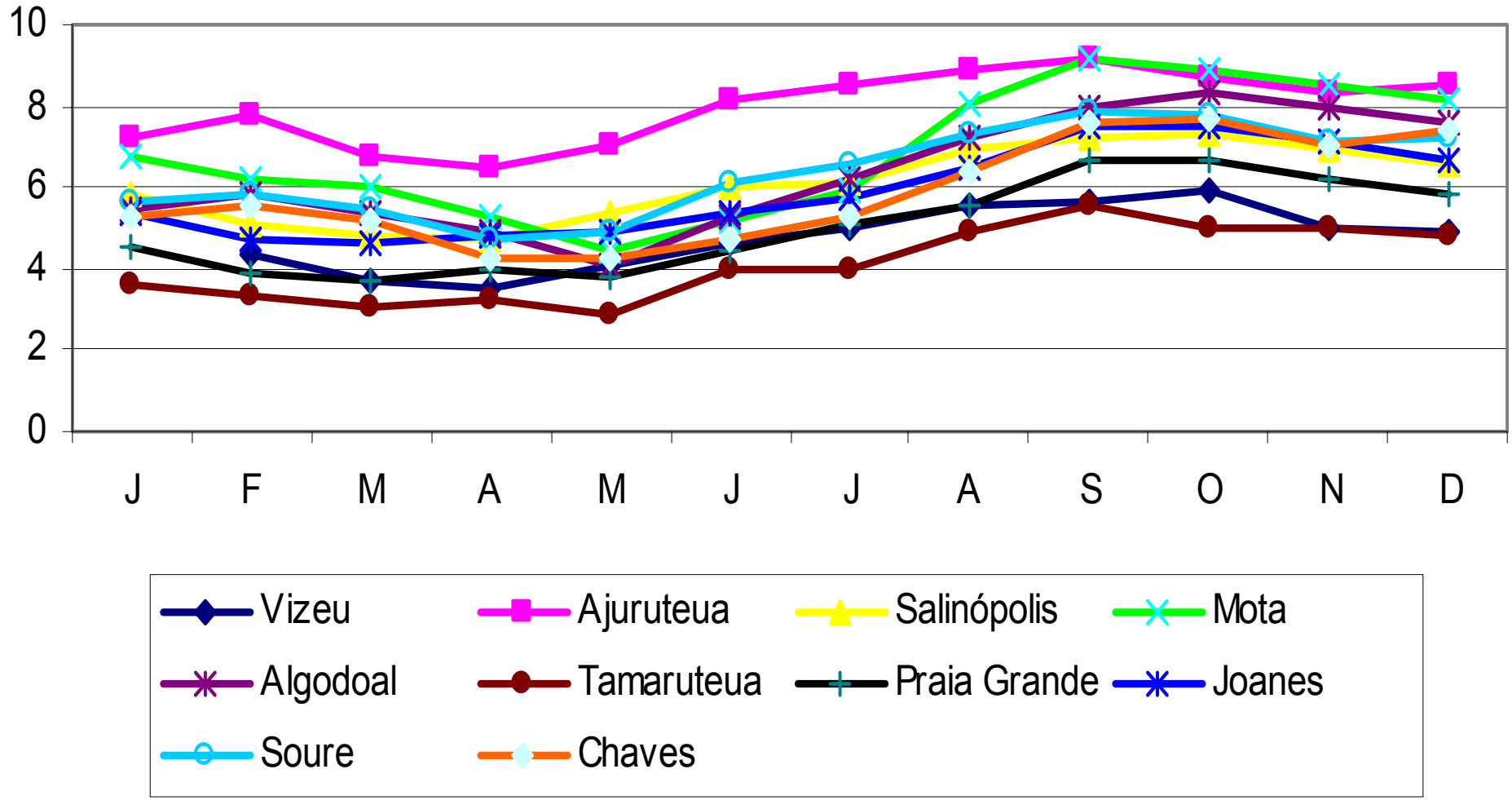


Mean annual Irradiation



Source: LABSOLAR


> 8.5 m/s
7.0 - 8.5 m/s
6.0 - 7.0 m/s
5.0 - 6.0 m/s
< 5.0 m/s
CENTRO BRASILEIRO DE ENERGIA EÓLICA
(resultados preliminares- 1998)



At 30 m height

Grupo de Estudos e Desenvolvimento de Alternativas Energéticas - UFPA

Potencial de geração de energia elétrica através do aproveitamento de cana-de-açúcar (GWh/ano)

- mais de 5.000
- 1.000 a 5.000
- 200 a 1.000
- menos de 200

Potencial de geração de energia elétrica através do aproveitamento de resíduos agrícolas (GWh/ano)

- 1.400 a 1.800
- 500 a 1.400
- 50 a 500
- menos de 50

Potencial de geração de energia elétrica através do aproveitamento de resíduos de madeira (GWh/ano)

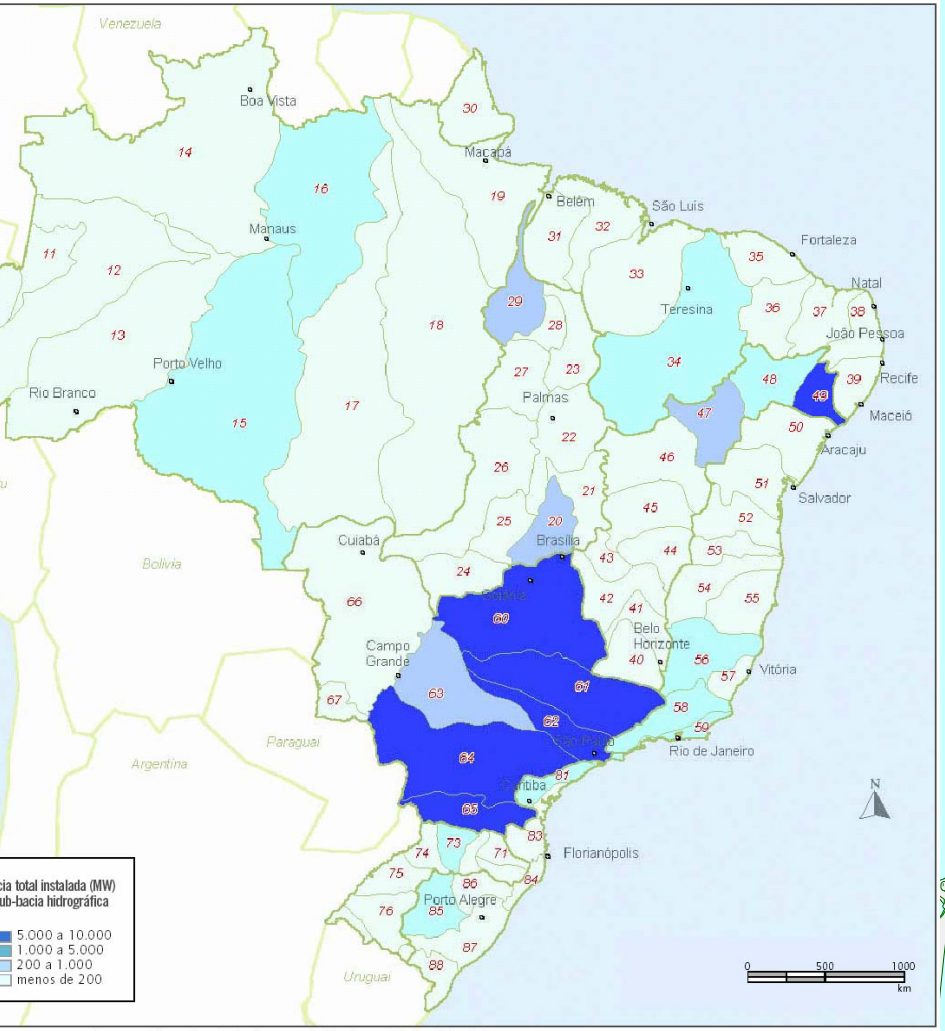
- 500 a 600
- 200 a 500
- 50 a 200
- menos de 50

Potencial de geração de energia elétrica através do aproveitamento de óleos vegetais (GWh/ano)

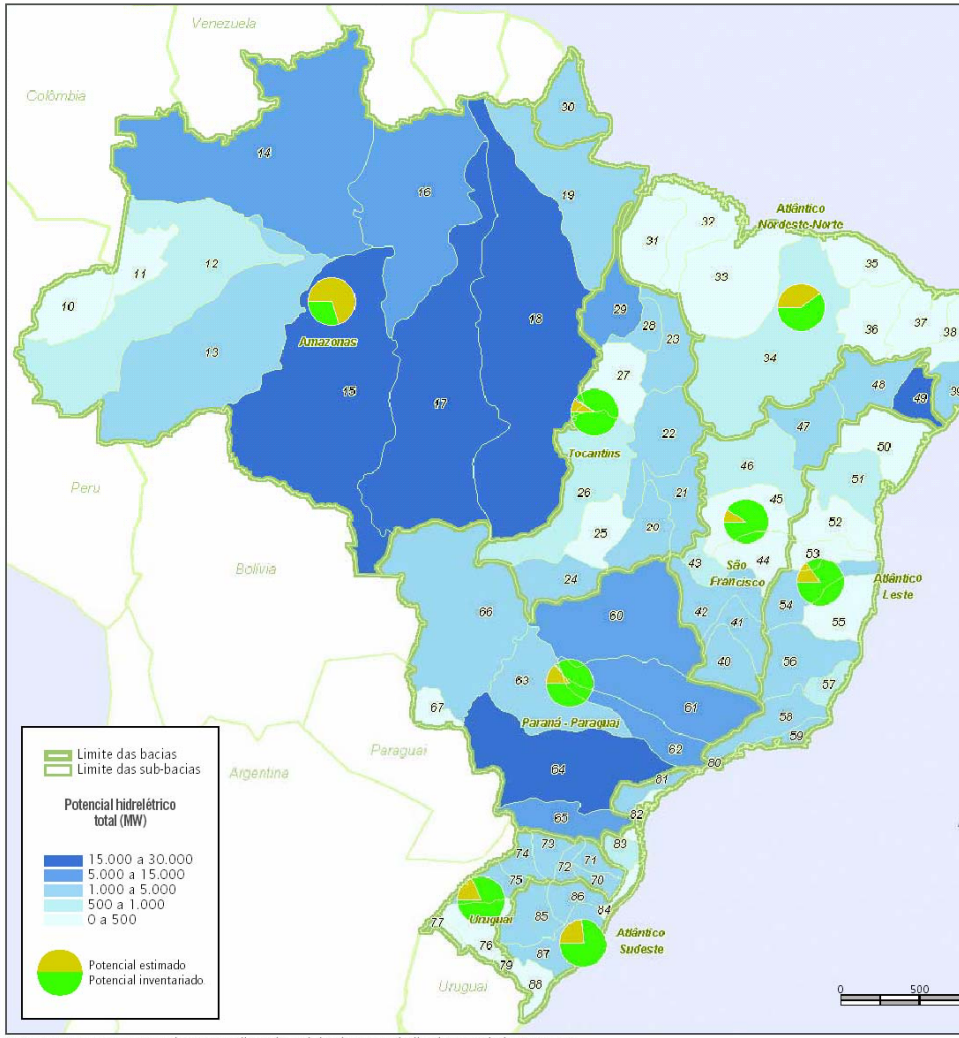
- 10 a 100
- 2 a 10
- menos de 2

Fonte: CENBIO, 2000.

Hydroelectric Potential (MW)



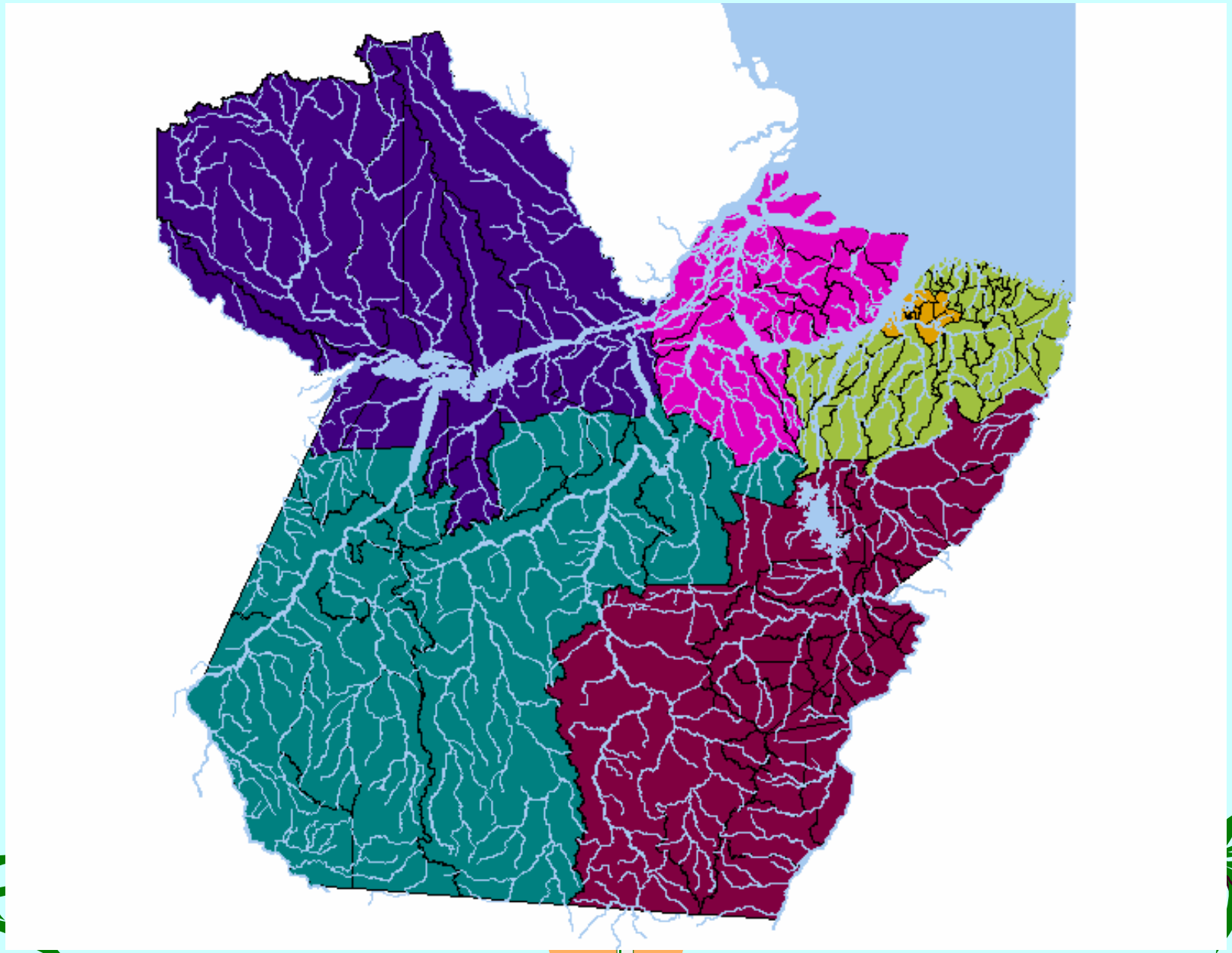
neros correspondem aos códigos das sub-bacias, como indicado nas Tabelas 3.2 e 3.4.

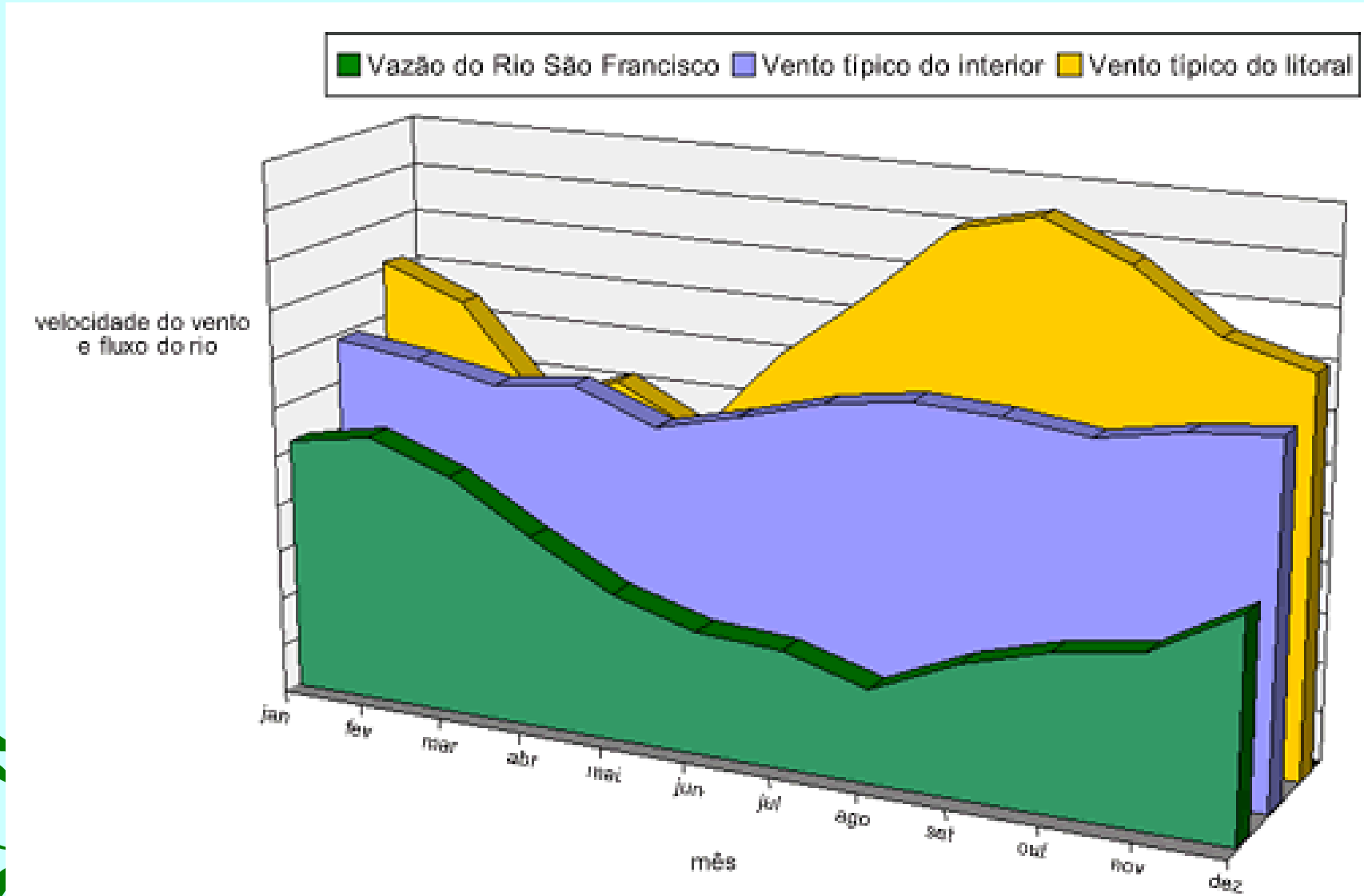


Nota: os números correspondem aos códigos das sub-bacias, como indicado nas tabelas 3.2 e 3.4.

Installed

Possible

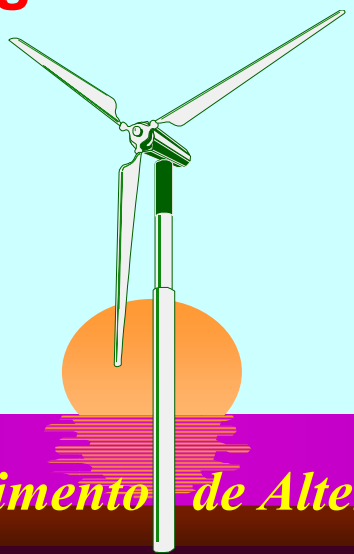



Vazão do Rio São Francisco
Vento típico do interior
Vento típico do litoral
velocidade do vento
e fluxo do rio
jan
fev
mar
abr
mai
jun
jul
ago
set
out
nov
dez
mês

SWERA Project

Bangladesh, Brazil, China, Cuba, El Salvador, Ethiopia, Ghana, Guatemala, Honduras, Kenya, Nepal, Nicaragua, Sri Lanka

Its geospatial tools allow the combination of solar radiation and wind maps with distribution grids and other information, to supply data which support the development of energy planning politics, reducing the renewable energy risks and the project schedules



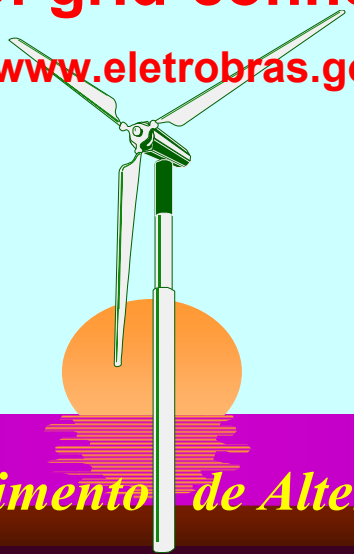
Governmental Programs

- **PRODEEM** (Initiated in 27/12/1994, with the goal of supplying poor isolated communities – 9,000 systems; 37.2 million dollars; more than 5 MWp)

- **PTU** (Promoted three programs to supply isolated communities with renewable sources - 1995, 1997, 2000)

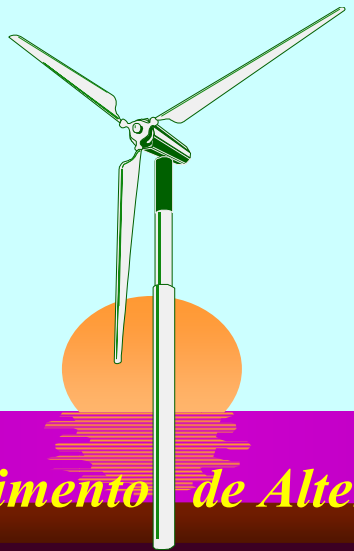
- **PROEOLICA** (1,050 MW of wind power to be connected to the grid until December 2003) – was not successful

- **PROINFA** (3,300 MW of grid-connected Wind, Small Hydro, and Biomass) - www.eletrobras.gov.br/EM_Programas_Proinfa



Governmental Programs

PROBIODIESEL (develop the production technologies and the consumption market of bio-fuels; establish the "National Bio-diesel Net"; develop and unify the specifications of the new fuel for Brazil; and prove the technical, economic, social, and environmental feasibility through laboratory and field tests)



Bio-diesel Sources

Species	Oil Origin	Oil Content (%)	Harvest Months	Oil Yield (t/ha)
Dendê (*Elaeis guineensis N.*)	Nut	26	12	3.0-6.0
Babaçu (*Attalea speciosa M.*)	Nut	66	12	0.4-0.8
Girassol (*Helianthus annus)*	Seed	38-48	3	0.5-1.5
Colza (*Brassica campestris*)	Seed	40-48	3	0.5-0.9
Mamona (*Ricinus communis*)	Seed	43-45	3	0.5-1.0
Amendoim (*Arachis hipogaea*)	Seed	40-50	3	0.6-0.8
Soja (*Glycine max*)	Seed	17	3	0.2-0.6

Importance of regional products and by-products

Source: Prof. Horta Nogueira

8 million liters/year

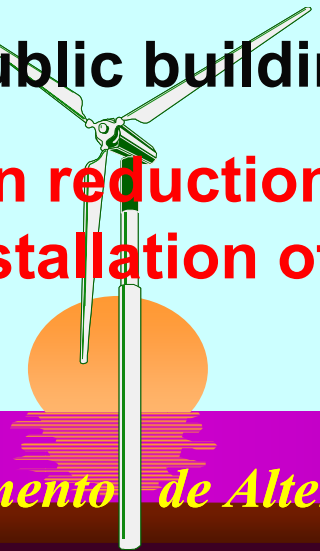
Governmental Programs

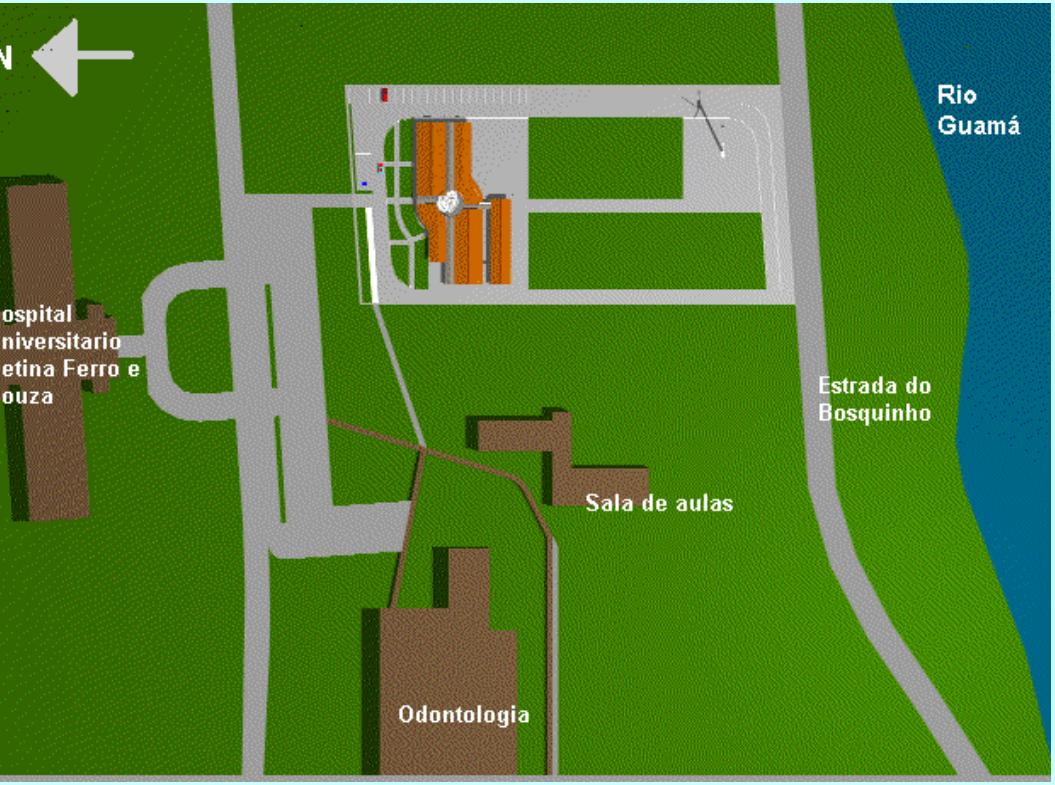
PROCEL - http://www.procel.gov.br

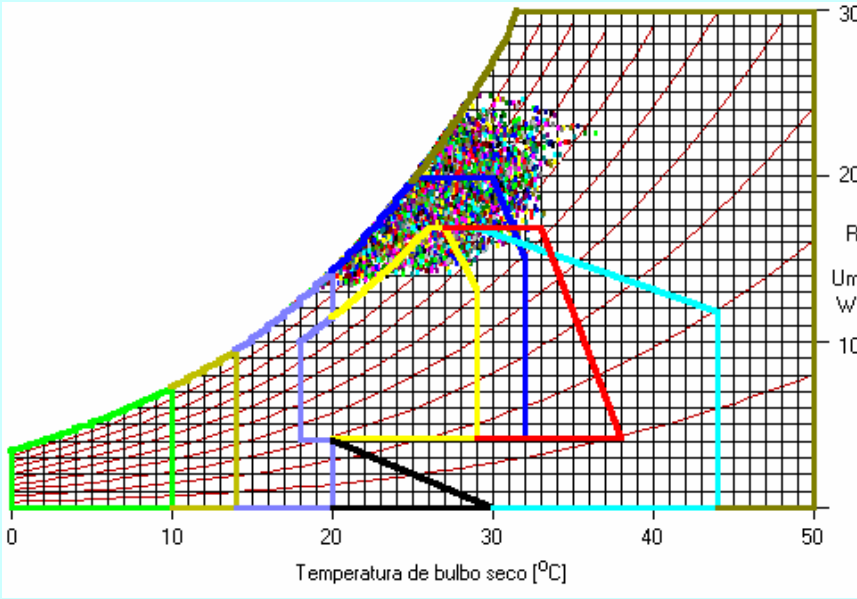
(promotes the rational production and consumption of electrical energy to eliminate waste and reduce costs and investments)

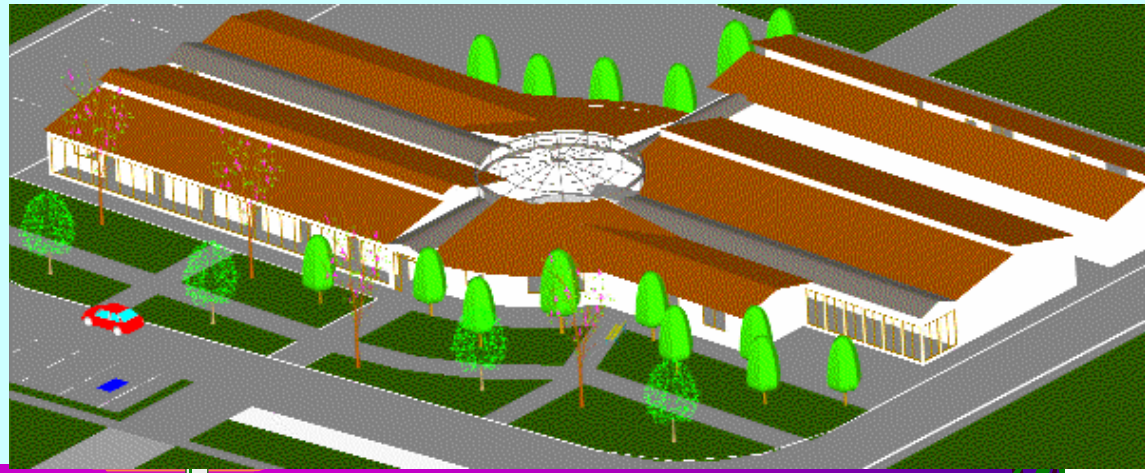
- **Lamp exchange project**
- **Procel in the School**
- **Energy efficient buildings**
- **Energy efficiency in public buildings**

Foresees a consumption reduction of 130 billions of kWh in 2015, avoiding the installation of 25 GW of electric power




Rio
Guamá
ospital
niversitario
etina Ferro e
ouza
Estrada do
Bosquinho
Sala de aulas
Odontologia


0
10
20
30
40
50
Temperatura de bulbo seco [°C]



Governmental Programs

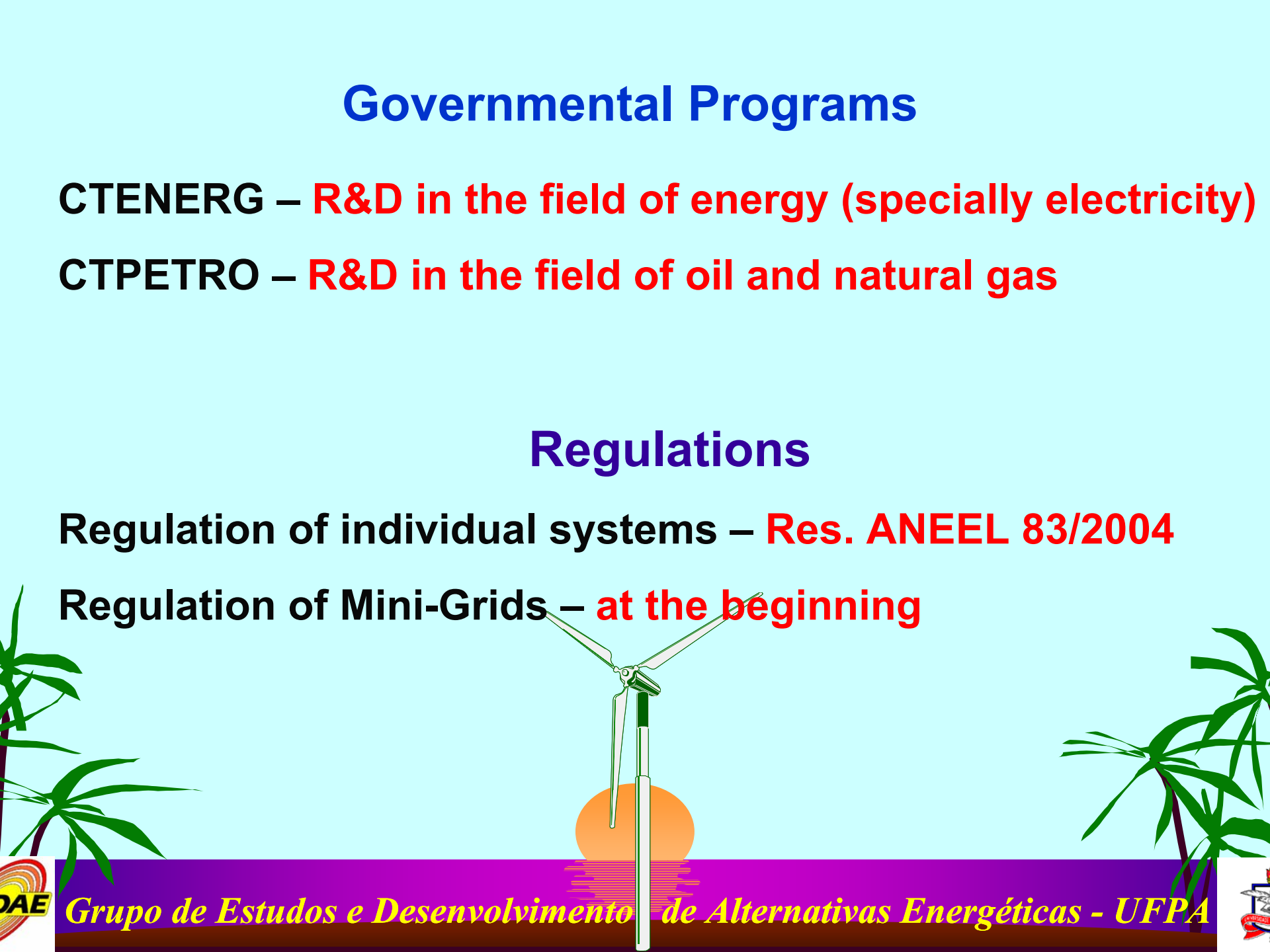
CTENERG – R&D in the field of energy (specially electricity)

CTPETRO – R&D in the field of oil and natural gas

Regulations

Regulation of individual systems – Res. ANEEL 83/2004

Regulation of Mini-Grids – at the beginning



Communities in the neighborhood of the Ferreira Penna Research Center (Caxiuanã National Forest)



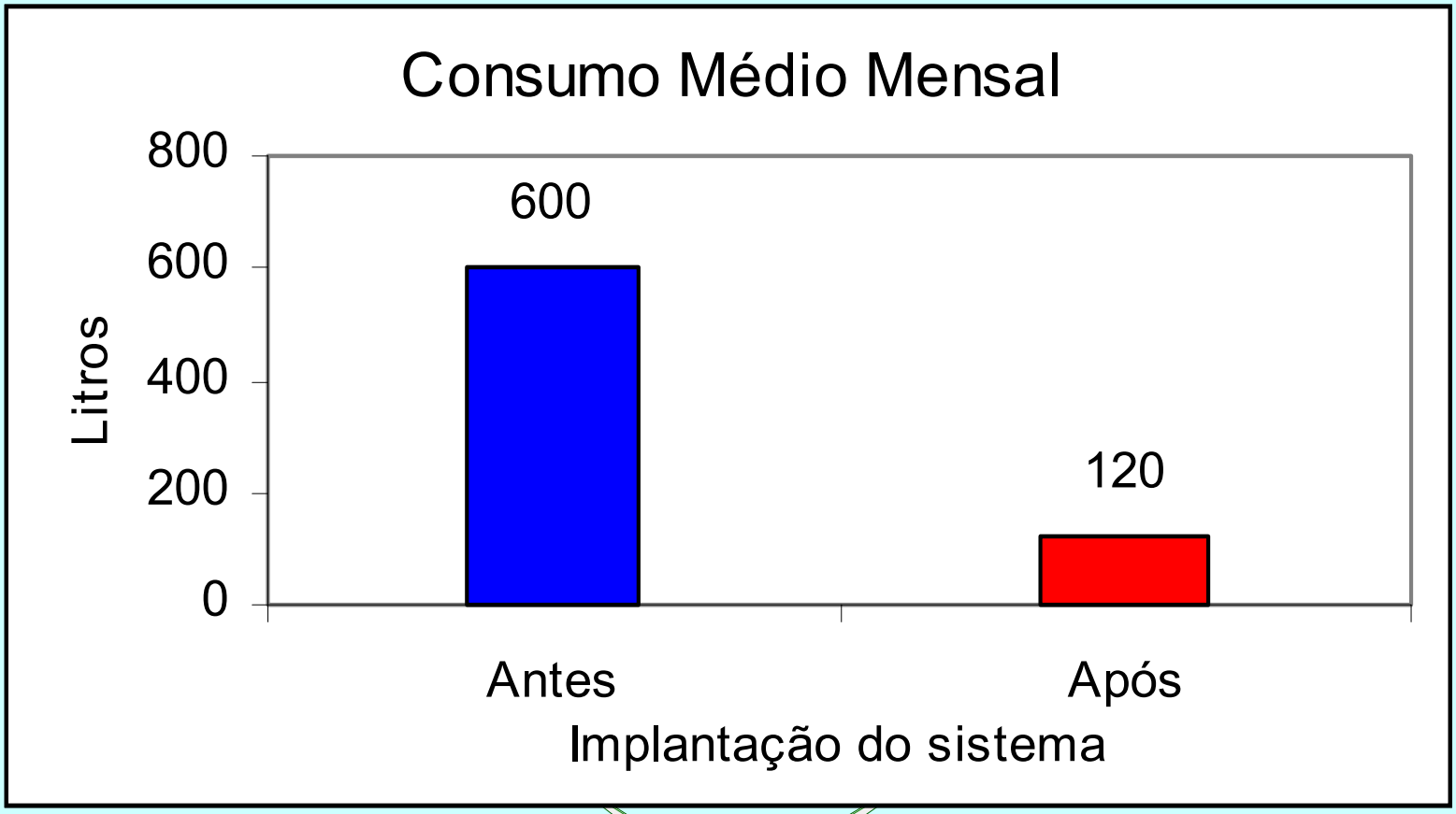
11/98



Tamaruteua

06/99

PTU

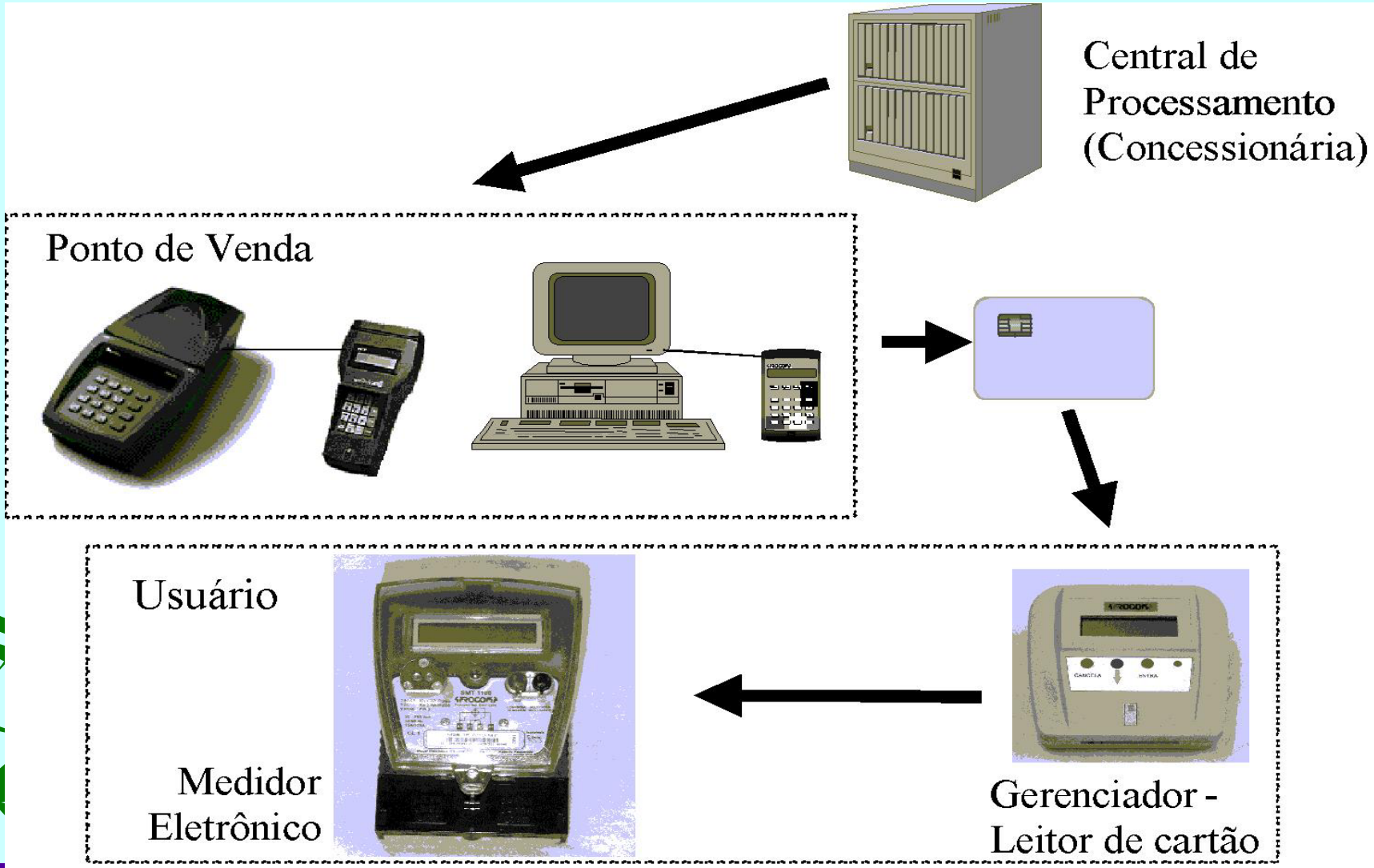


Diesel consumption before and after the hybrid system

São Tomé

09/03

Pre-paid systems seems to match the local population characteristics



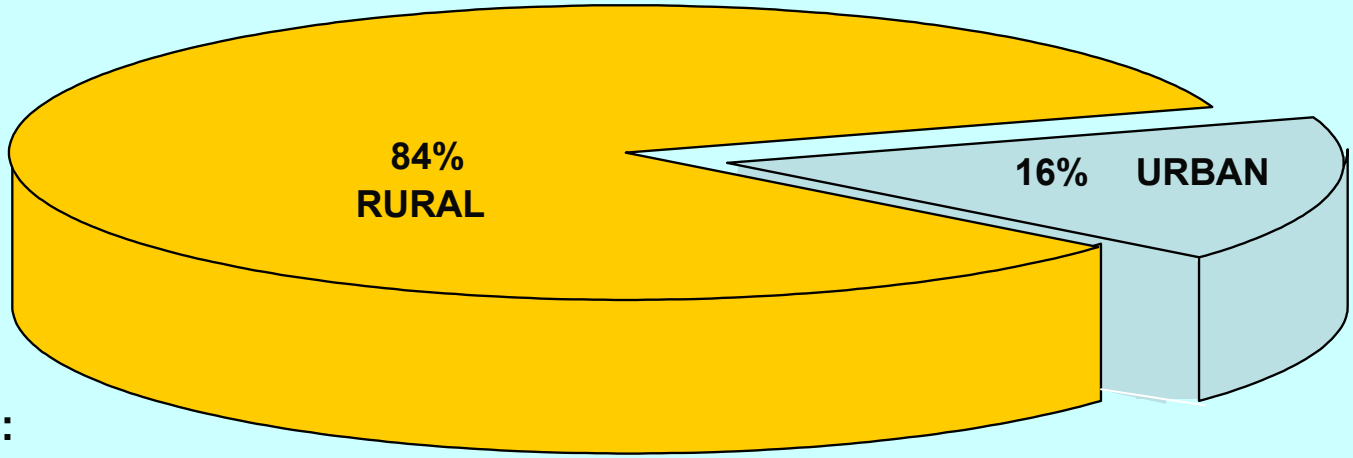
Programa
LUZ
para todos

Light for all

Guarantee the access and use of electrical energy to all Brazilians until the end of 2008

- **Grid extension, with low cost technology**
- **Decentralized generation systems, preferably with local renewable sources**

TOTAL: 12,023,703



Total people:
10,091,409

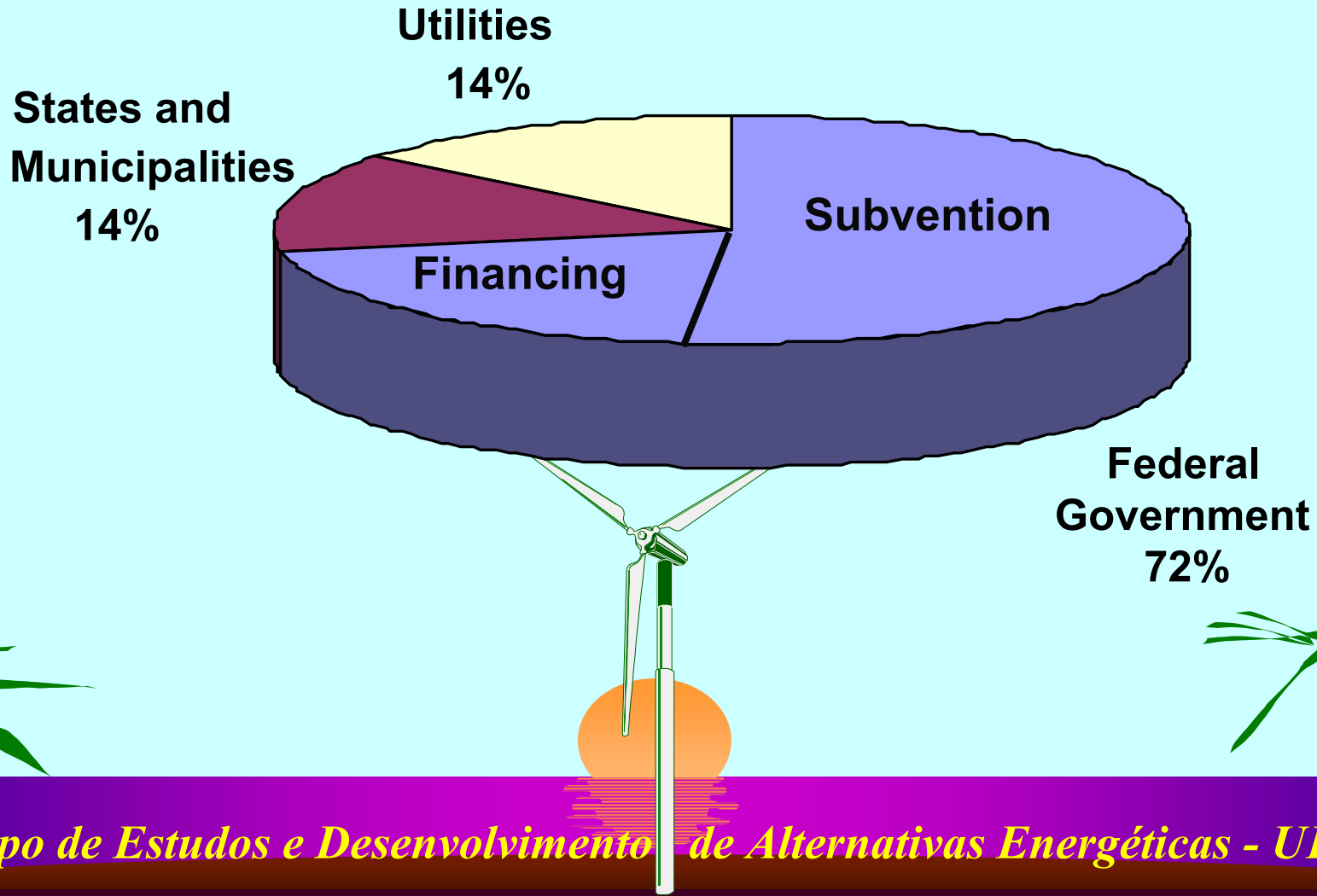
Total people:
1,932,294

RURAL Scenario	
Central-Western Region	4%
Northern Region	25%
Northeastern Region	58%
Southern Region	5%
Southeastern Region	8%

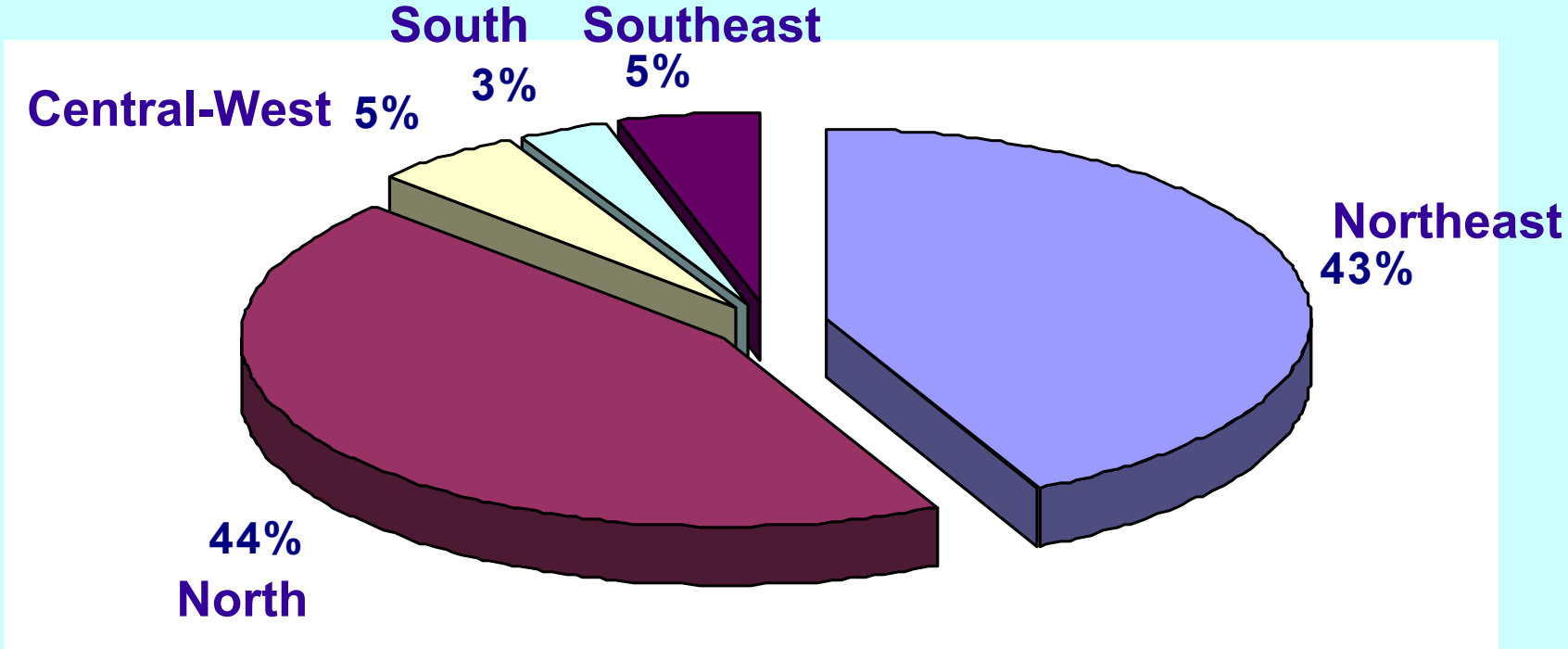
URBAN Scenario	
Central-Western Region	6%
Northern Region	13%
Northeastern Region	42%
Southern Region	9%
Southeastern Region	30%

Financing Sources

Total Estimated Budget: R$ 7.5 billions (9.5 billions)



Destination of Subvention Funds



Objective: reduce the possible impact on the tariff

www.mme.gov.br/luzparatodos

Amazon Region

- ~ 60% of the Brazilian territory
- ~ 10% of the Brazilian population
- occupation model:
  - few big cities
  - thousands of small villages
- difficult access conditions
- lack of electricity supply to satisfy the basic needs of health, sanitation, production, education, communication, entertainment, etc.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THANKS FOR YOUR ATTENTION!
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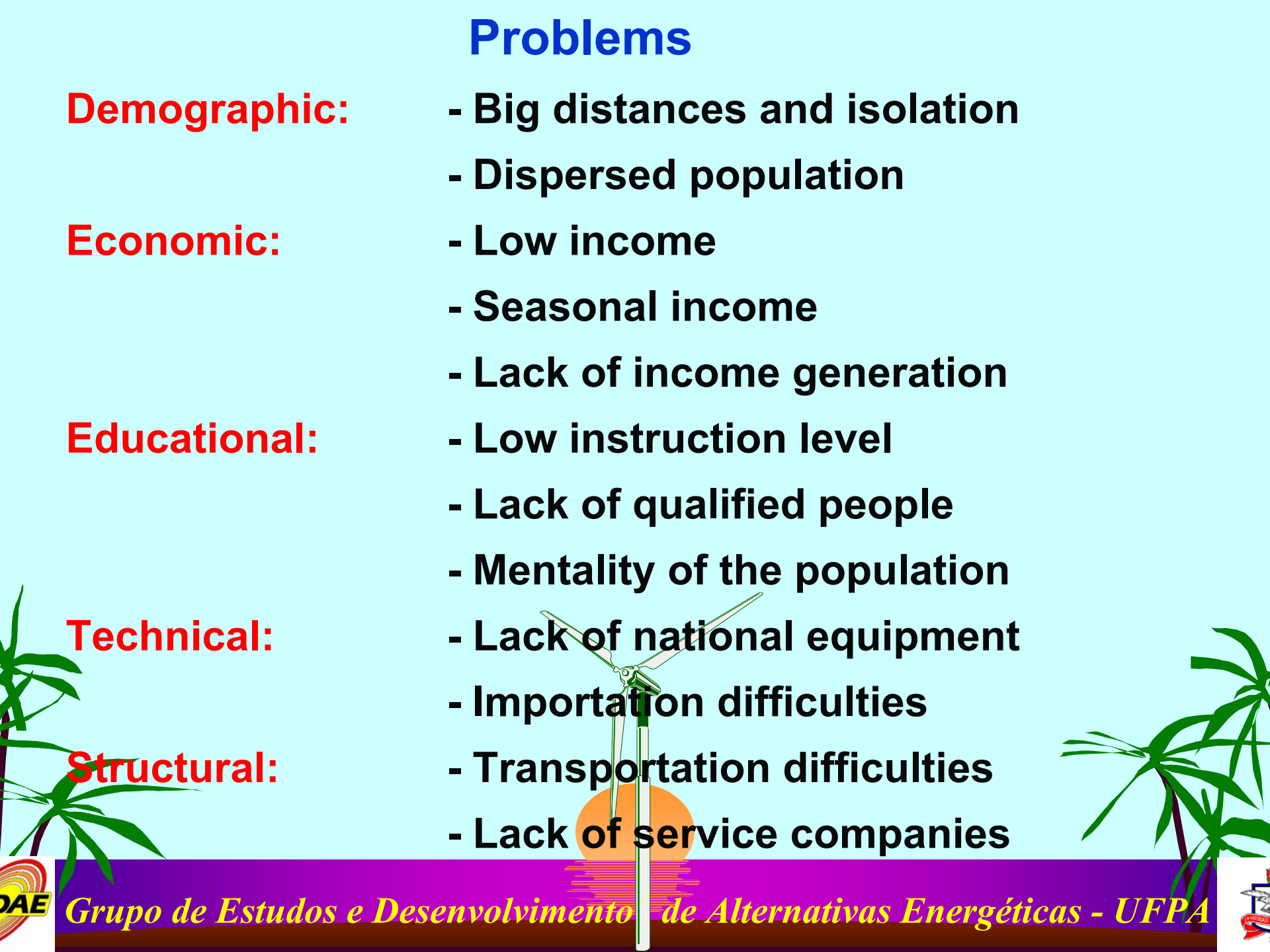
GRAZIE PER L'ATENZIONE!
www.ufpa.br/gedae

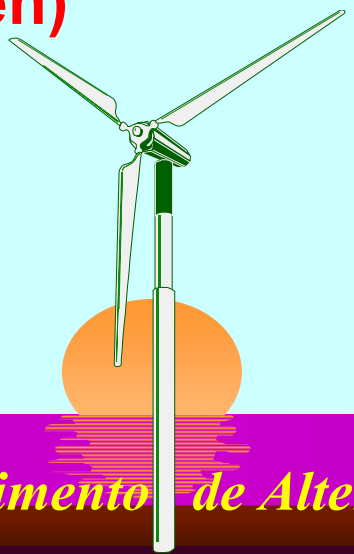
Problems

Demographic:	- Big distances and isolation
	- Dispersed population
Economic:	- Low income
	- Seasonal income
	- Lack of income generation
Educational:	- Low instruction level
	- Lack of qualified people
	- Mentality of the population
Technical:	- Lack of national equipment
	- Importation difficulties
Structural:	- Transportation difficulties
	- Lack of service companies

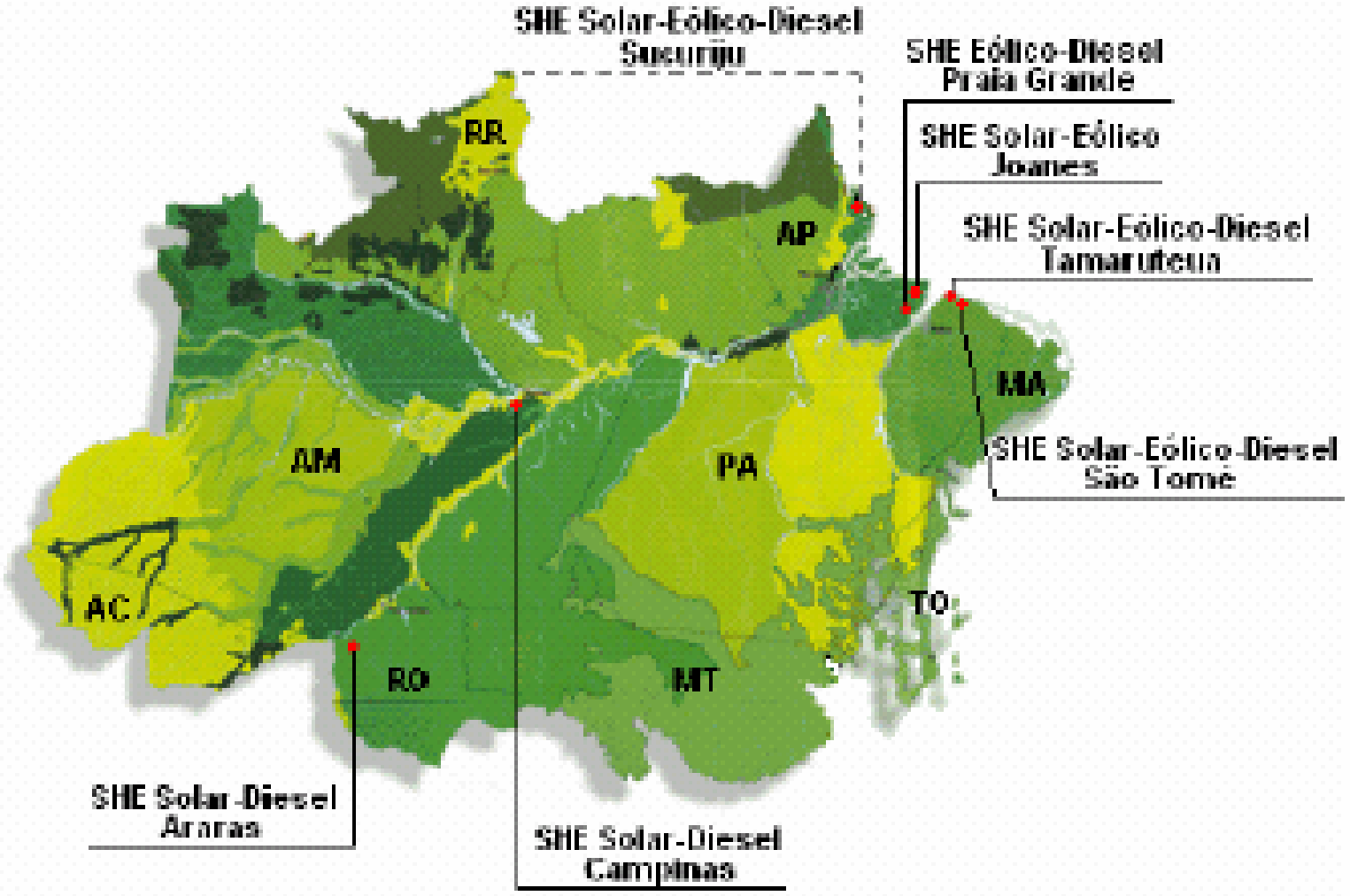


Generation Possibilities

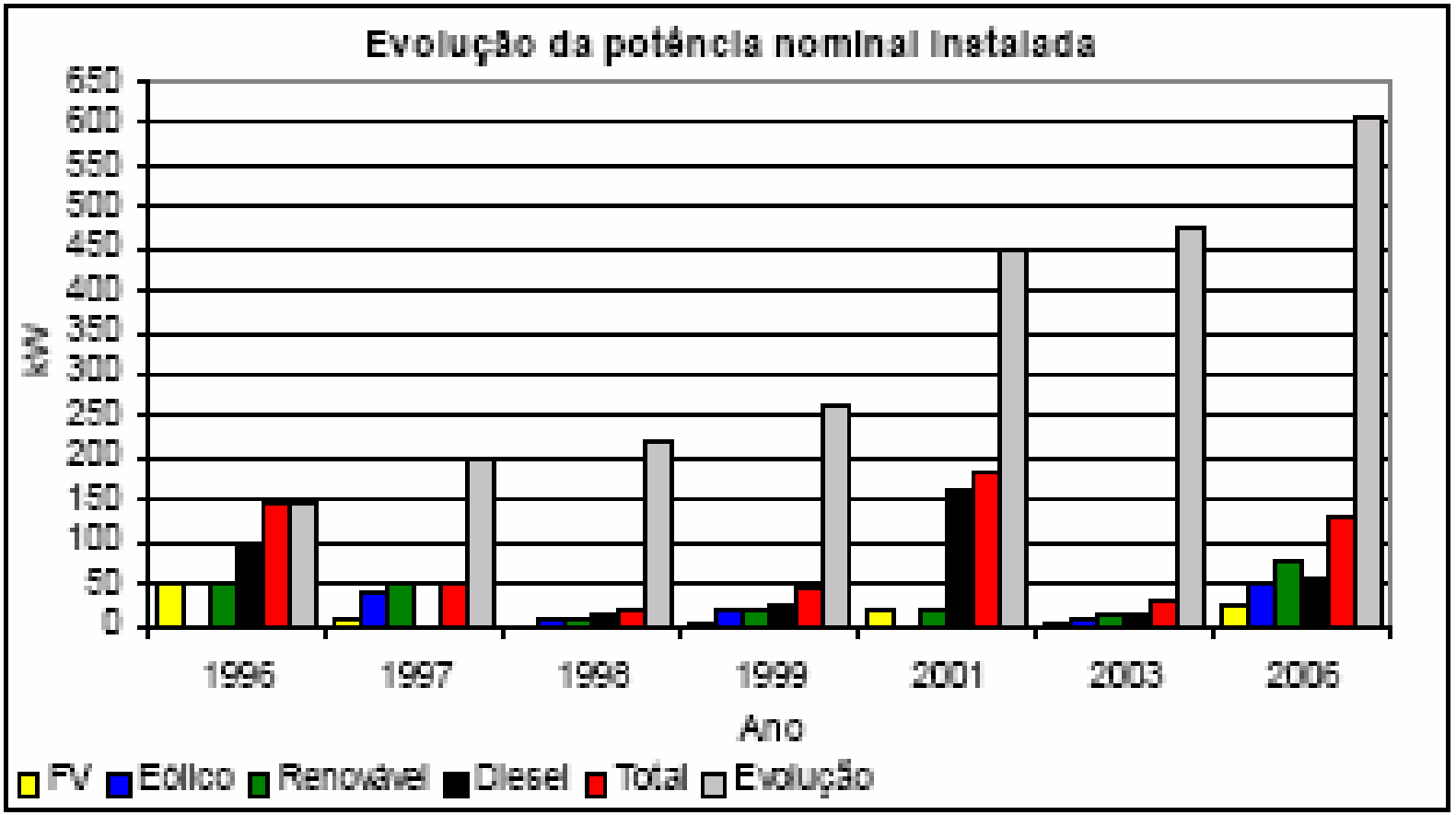
- Diesel
- Natural gas
- Hydro (large and small scales, hydrokinetic)
- Solar (photovoltaic and thermal)
- Wind (large and small scales)
- Biomass (combustion, gasification, oils, residues)
- Fuel cell (Hydrogen)
- Tidal (?)
- Geothermal (??)
- Nuclear (???)



Hybrid Systems



Hybrid Systems



Ferreira Penna Research Center

05/99

11/00

* Expanded to 8 kWp until the end of 2005

PV Water pumping systems

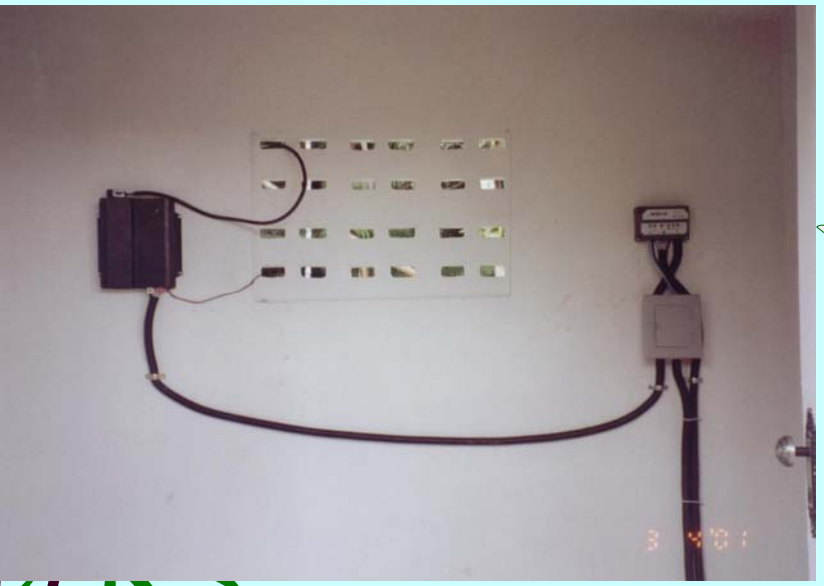
Pedra Branca
(Cotijuba Island)

05/00

Santo Antônio Bay
(Mosqueiro Island)

05/01

Boa Vista

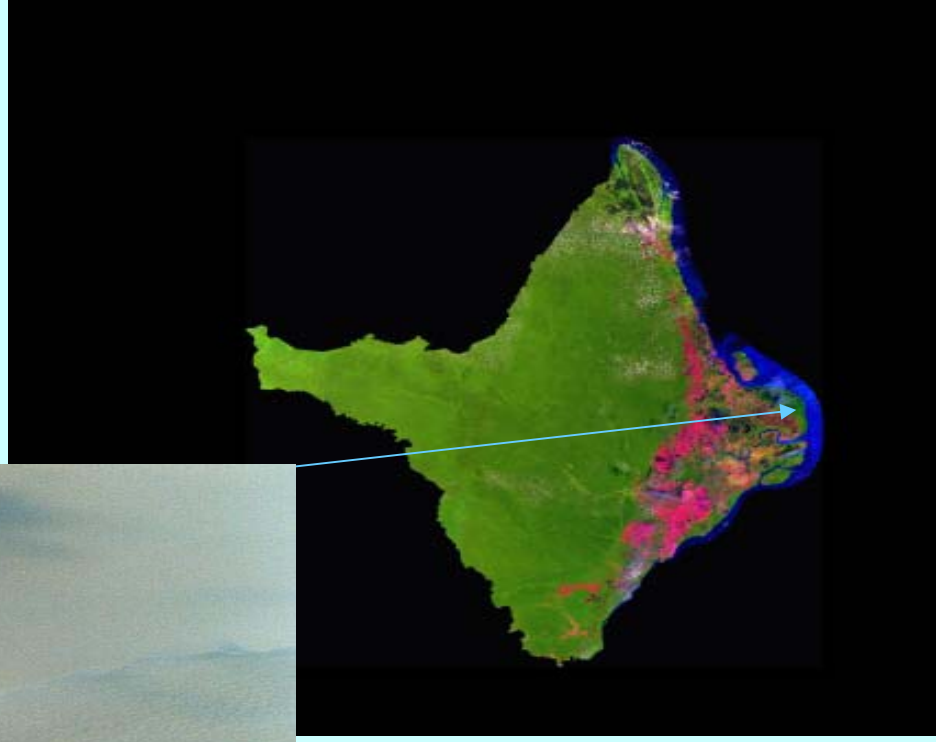


PRODEEM / FUNTEC

Sucuriju/AP

(PV-Wind-Diesel)

CBEE/UFPE



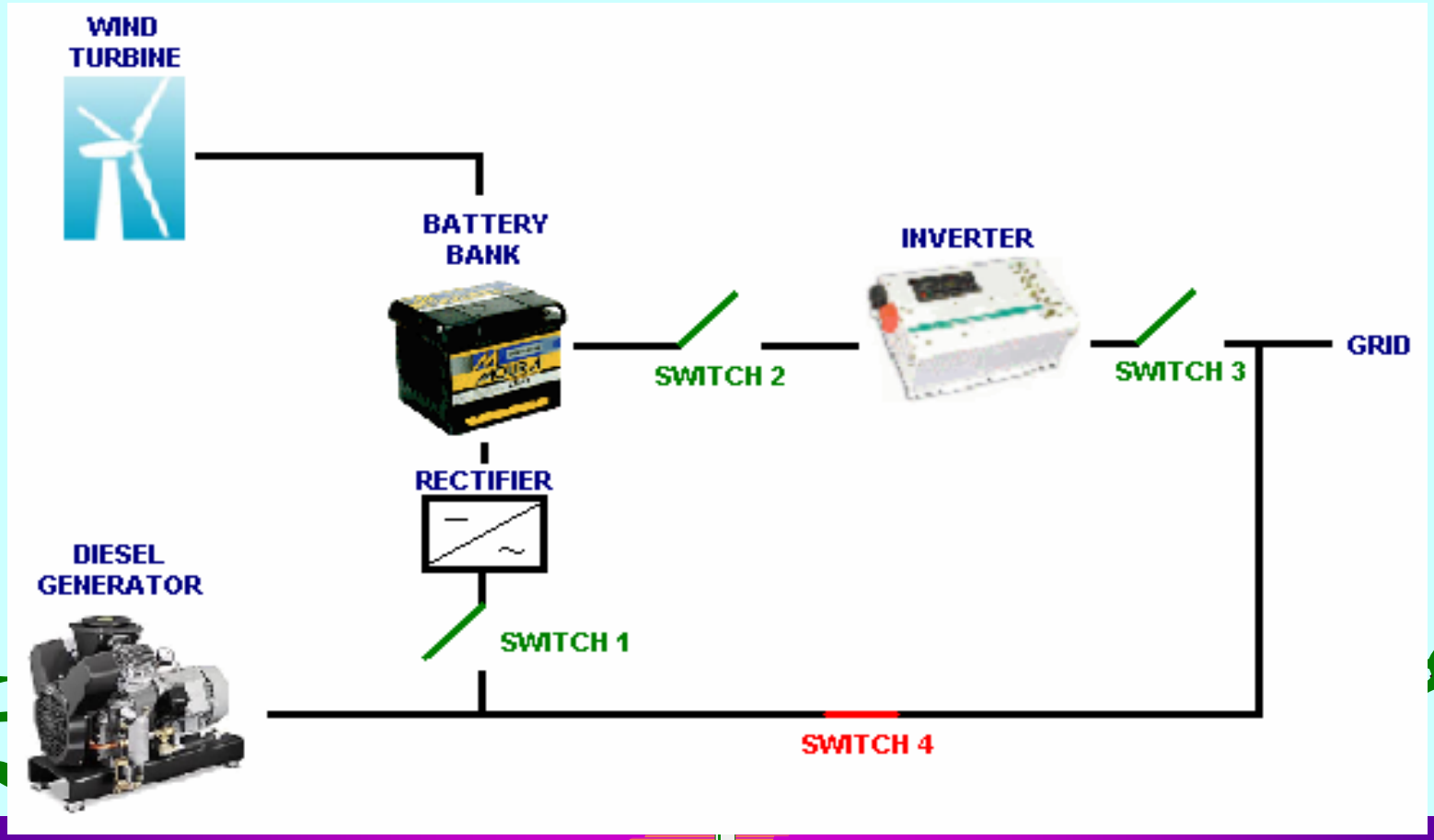
Cardoso Island/ Cananéia/SP

(PV-Wind-Diesel)

IEE/USP

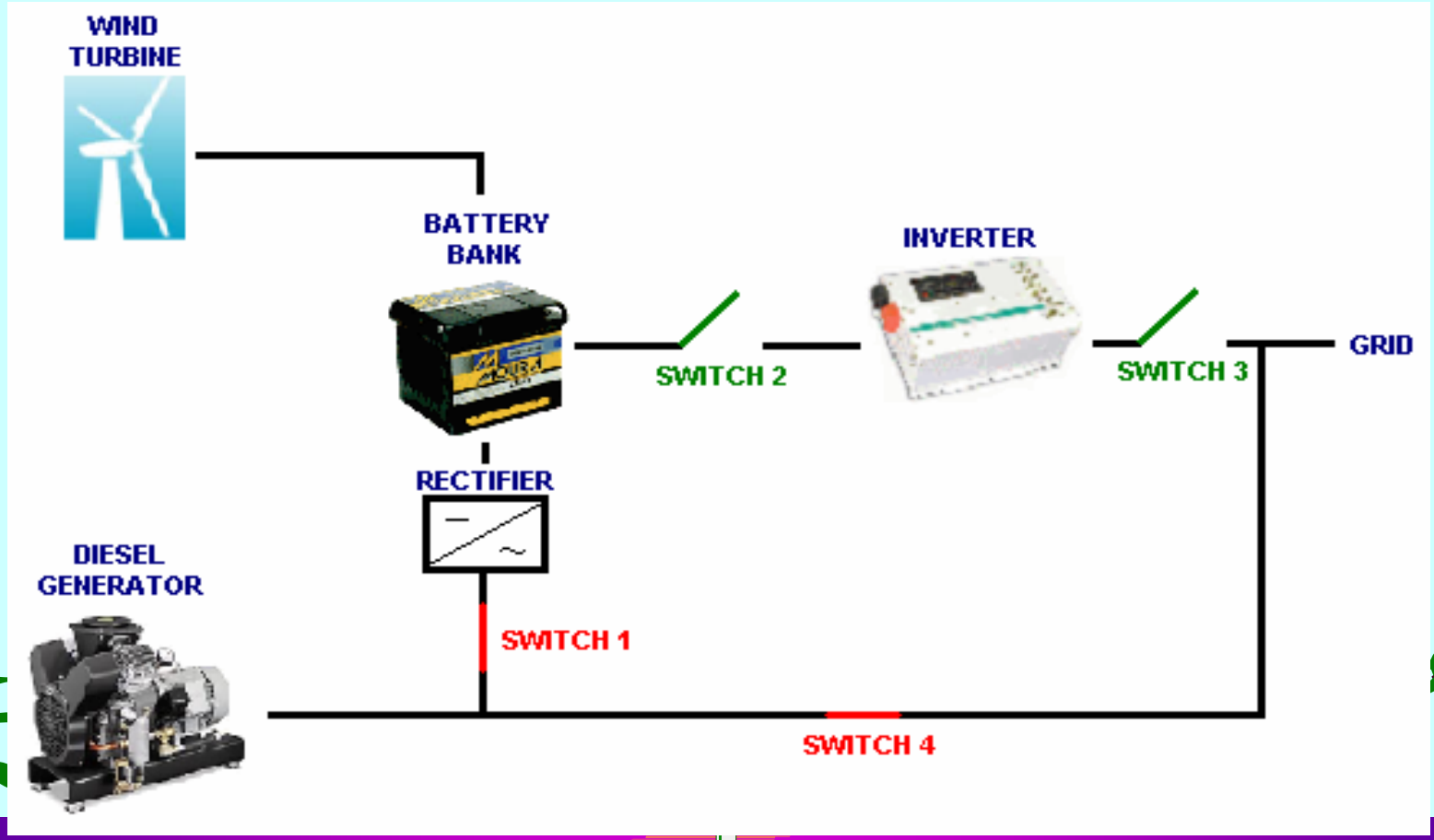
OPERATIONAL STRATEGIES

Case 1: The diesel generator supplies the load and the wind generator is responsible by the power injection into the battery bank. The inverter is not in operation.



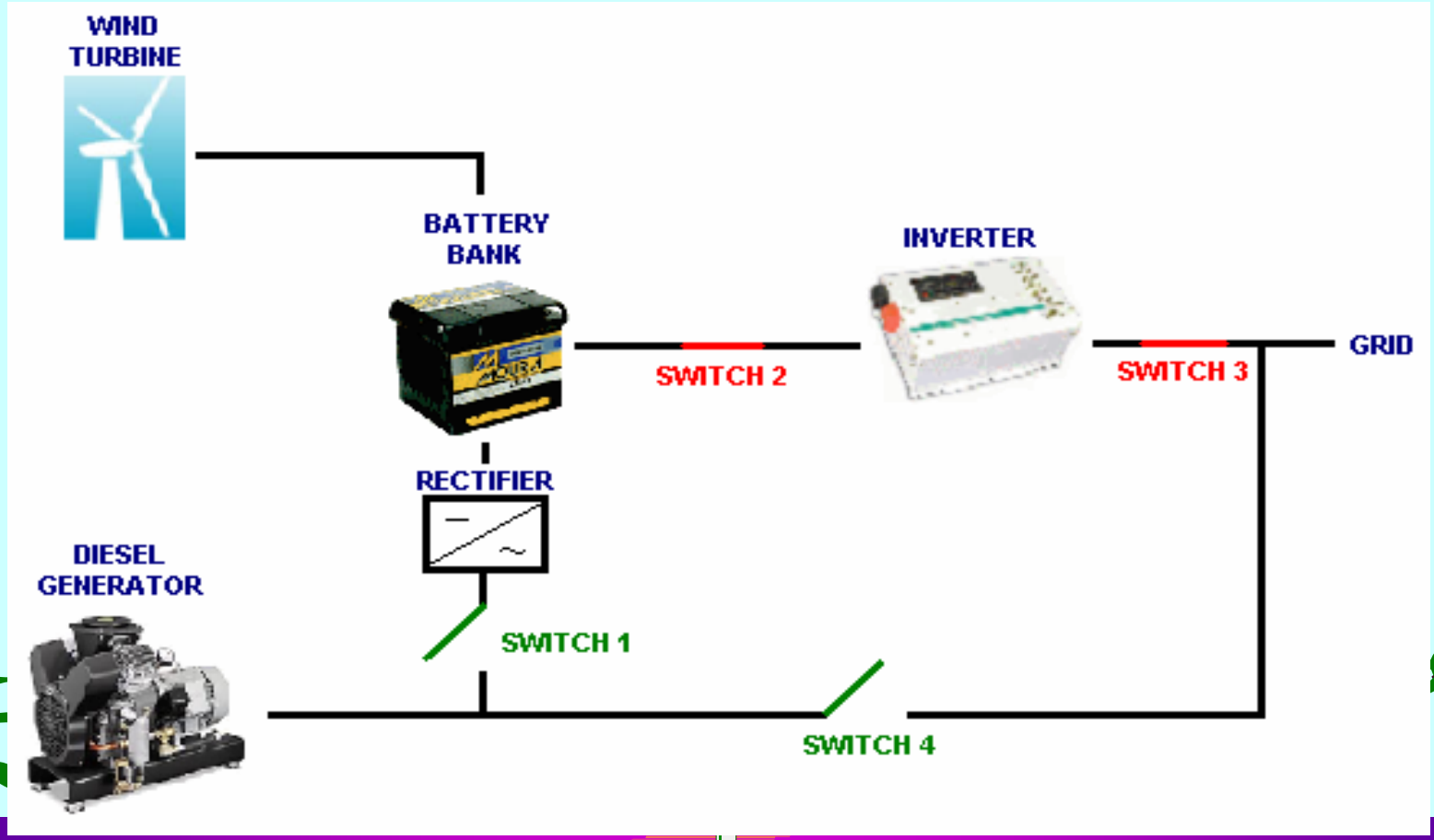
OPERATIONAL STRATEGIES

Case 2: The diesel generator supplies the load and injects powe into the battery bank through a rectifier in parallel with the wind generator. The inverter is still not in operation.



OPERATIONAL STRATEGIES

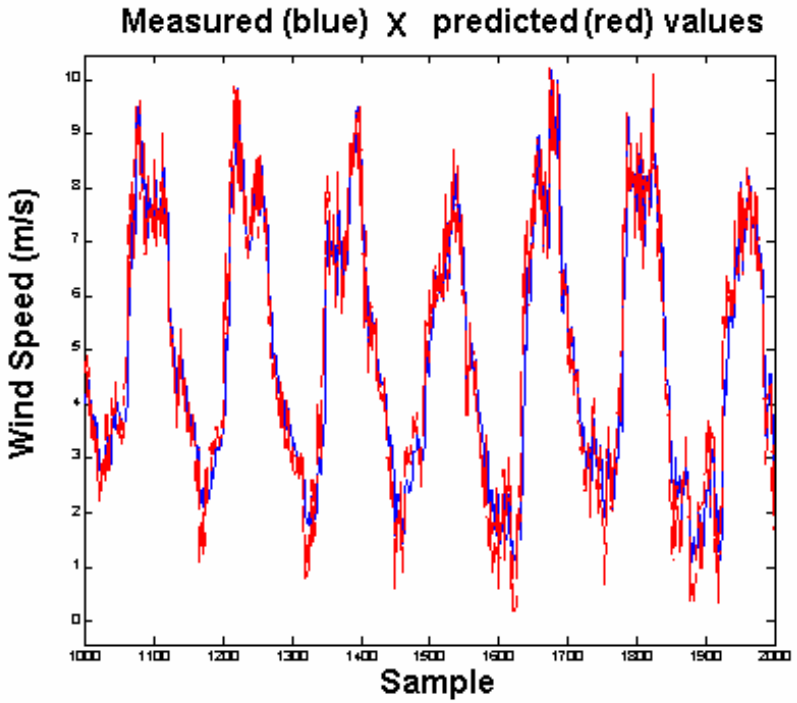
Case 3: The wind generator injects power into the battery bank and supplies the load through the inverter connected to the grid. In this case, the diesel generator is completelly inoperant.



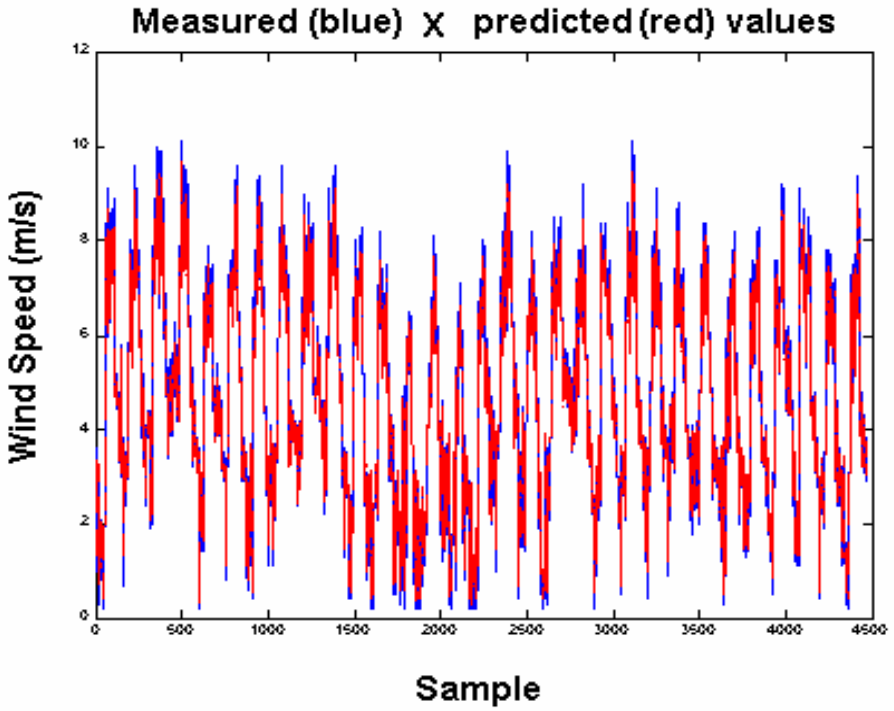
NEURAL NETWORK

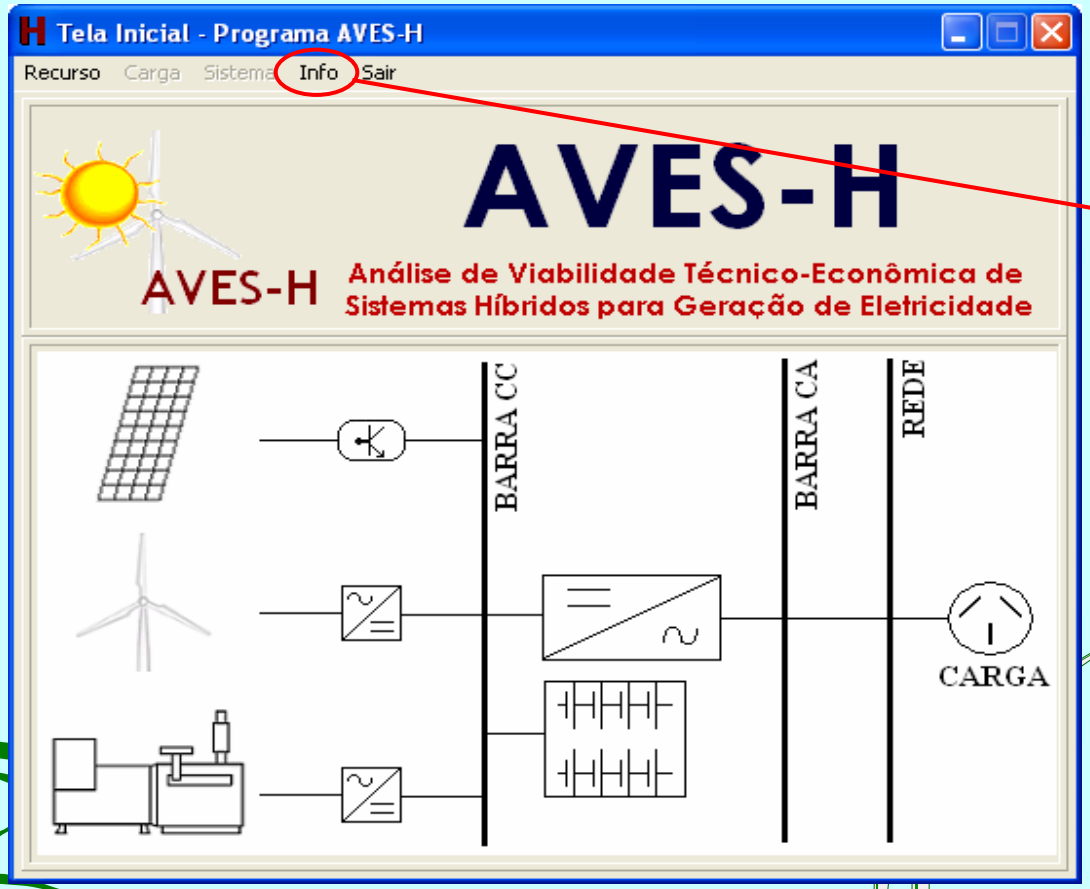
Validation for a countryside location (São Tomé) of the state of Pará-Brazil

September/03



October/03




Tela Inicial - Programa AVES-H
Recurso
Carga
Sistema
Info
Sair
AVES-H
AVES-H
Análise de Viabilidade Técnico-Econômica de Sistemas Híbridos para Geração de Eletricidade
BARRA CC
BARRA CA
REDE
CARGA


Sobre o programa...
AVES-H
Programa para Análise de Viabilidade Técnico-Econômica de Sistemas Híbridos para Geração de Eletricidade
Versão 1.0 - Março/2005
GEDAE
Desenvolvido por:
Luis C M Blasques, Eng.
Sob a Orientação de:
João Tavares Pinho, Prof. Dr.-Ing.
Grupo de Estudos e Desenvolvimento de Alternativas Energética
Universidade Federal do Pará
OK

Economic Analysis of Technologies for Electrification of Small Isolated Villages in the Amazon