8. Application of Solar Photovoltaic and Wind Energy in the North Region of Brazil

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1 - Introduction

Present Situation

- **more than 300 Diesel systems operating**
- **very high energy cost (up to 500 US$/MWh)**
- **difficult O&M**
- **unreliable, low quality service**
- **no energy conservation**

introduction

Solar Resource

generally good, near 5 kWh/m^2 .day

Wind Resource

potentially good areas near the cost and in the savannas north of Boa Vista, RR

2 - Solar Photovoltaic (PV)

Basic Characteristics

- **modular technology**
- **present cost of energy - 300 US$/kWh**
- **near future - 50% cost reduction in 5 years**
- **very low O&M**
- **no pollution**

PV

Aims of the Project

- **demonstrate technical and economical feasibility of PV in concentrated small remote villages and in distributed stand alone applications**

- **gain the know how to design, operate and maintain the systems with optimized cost**

- **introduce basic procedures for energy conservation**

PV

Mile Stones

- **select villages**
- **design systems**
- **install**
- **access field performance**

estimated equipment cost - US$ 1,650,000

Total estimated cost - US$ 2,224,700

PV Cost Share

JICA

Japanese experts - 120,000US$ = 8 man month

training - 30,000US$ = 3 month in Japan

equipment - 900,000US$ = PV + electronics

Brazil

labor - 194,000US$ = 45 man month

equipment - 750,000US$ = batteries + BOS

others - 168,500US$ = logistic costs

trips to the north - 62,200US$ = 40 trips

PV

part 1 - concentrated village systems

installations

- **8 villages (1 in each state)**
- **average of 25 kWp per village**
- **AC operation**

PV installations

state	village	power (kWp)
Pará	Urucuriteua	32
Amazonas	Sacambú	40
Mato Grosso	Paredão Grande	30
Roraima	Contão	20
Amapá	Macedônia	20
Acre	Santa Rosa	20
Rondônia	Nazaré	20
Tocantins	Escola Brasil	25

PV

Preliminary sizing of village power

load	average home unit power W	energy/day Wh
4 lamps	20	200
TV	50	250
radio	10	100
refrigerator	-	500
others	-	150
Total	-	**1,200**

PV

monthly consumption of average house

30 x 1.2 = 36 kWh

insolation assumed as 5 kWh/m^2.day

technical margin 1.4

public loads considered equivalent to 10 houses

Example: village with 50 houses

Total Power = ((50+10) x 1.2/5) x 1.4 = <u>20 kWp</u>

Estimated equipment cost 7.000 x 20 = 140.000 US$

PV

Pay Back

(values per house)

features	Diesel	PV
installed power	1 kW/house	0.4 kW/house
installation cost	1,000 US$	2,800 US$
O&M cost	400 US$/year	100 US$/year
pay back	-	**6 years**

PV

part 2 - Small isolated systems

300 dc powered houses - 100 Wp each

10 ac powered community centers - 500 Wp each

These systems should provide a moderate comfort at a much lower cost

Example: village with 50 houses

((50 x 100) + 500) x 7 = 38,500 US$

3 - Wind

Basic Characteristics

- **cost of energy - 60 US$/kWh in special places**
- **strongly dependent on location (~ V^3)**
- **low O&M**
- **no pollution**

Wind

Aims of the Project

- **Access the wind resource in places where there are good indication**
- **gain the know how to design, install, operate and maintain small and mid-size wind power plants**

Wind

Mile Stones

- **select sight for wind measurement**
- **install data acquisition system**
- **select location for wind power installation**
- **access field performance**

estimated equipment cost - US$ 330,000

Total estimated cost - US$ 650,000

Wind Cost Share

JICA

Japanese experts - 120,000US$ = 8 man month

training - 30,000US$ = 3 month in Japan

equipment - 270,000US$ = gen. + DAS

Brazil

labor - 87,000US$ = 23 man month

equipment - 60,000US$ = BOS

others - 33,000US$ = logistic costs

trips to the north - 50,000US$ = 25 trips

Wind

Data acquisition Systems

20 computerized anemometers

state	number of DAS
Pará	10
Roraima	5
Amapá	5

Wind

Installation of mid-size wind turbine

after 1 year of wind data collection, a location will be selected for the installation of a wind generator of approximately 150 kW rated power

4 - Conclusions

Through these two projects PV and wind technologies will be tested in a very important region, not only for Brazil but for world.

The specific situations to be faced will probably lead to a significant development and technology transfer, between, Japanese experts, Brazilian researchers and local utilities technical staffs.

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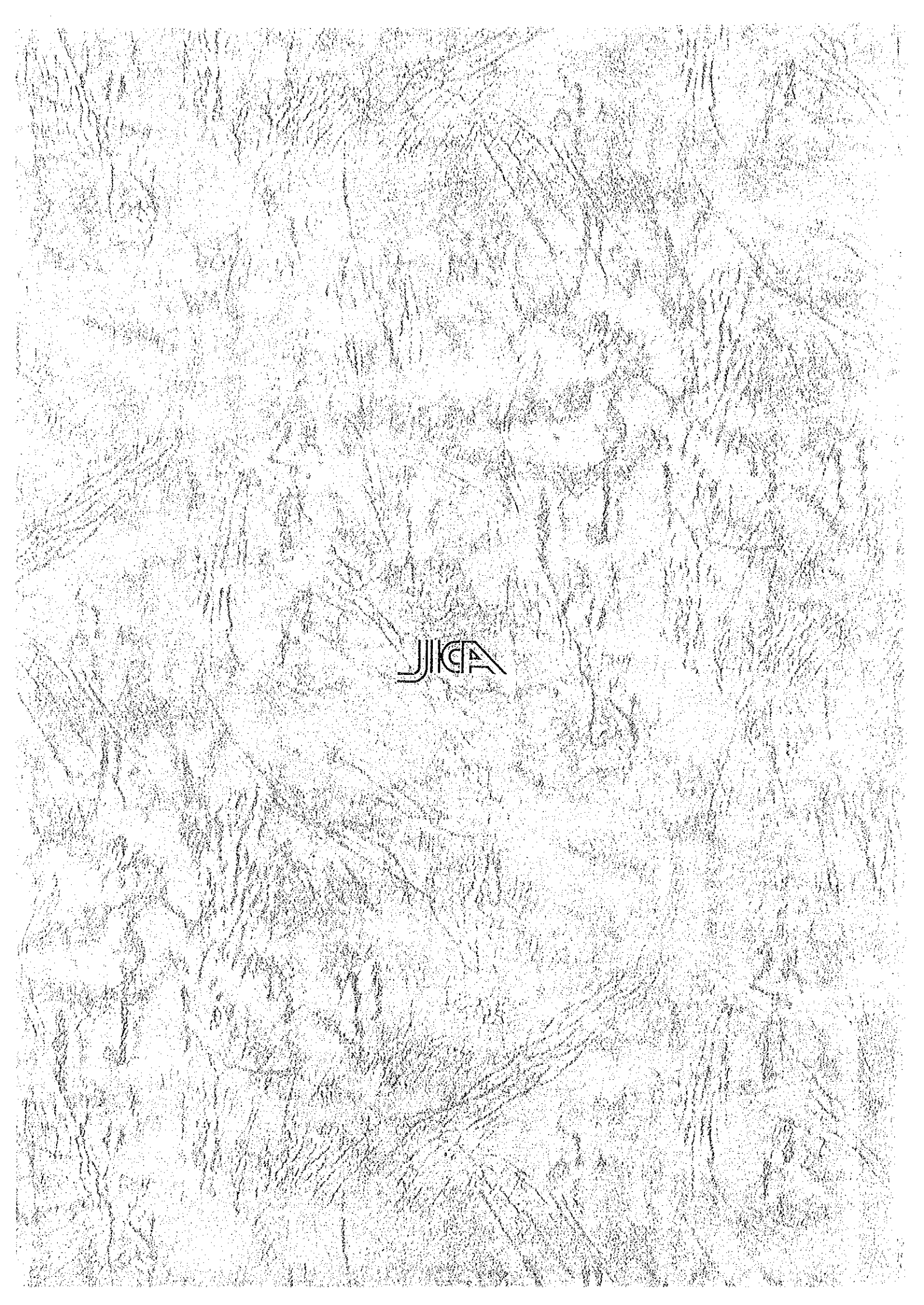
(1) Balanço Energetico Nacional 1993（ブラジルのエネルギー指標）

(2) Resoluções CONAMA 1984 a 1991 （環境関連法）

(3) Legislação Ambiental do Estado de Santa Catarina - FATMA 1991.07
（サンタカタリーナ州の環境基準）

(4) Codigo de Mineração （ブラジルの鉱業法）

以上すべてポルトガル語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