

MICROGRIDS IN BRAZIL

JEJU 2011 SYMPOSIUM ON MICROGRIDS

Seogwipo KAL Hotel, Jeju Island, Korea

Thursday & Friday, 26 & 27 May 2011

Objects of Interest

- Islanded distributed generation operation
- Isolated Micro and Mini systems
- Individual Electricity Generation Systems with Intermittent Sources



Regulatory Environment

Brazilian Electricity Regulatory Agency – ANEEL

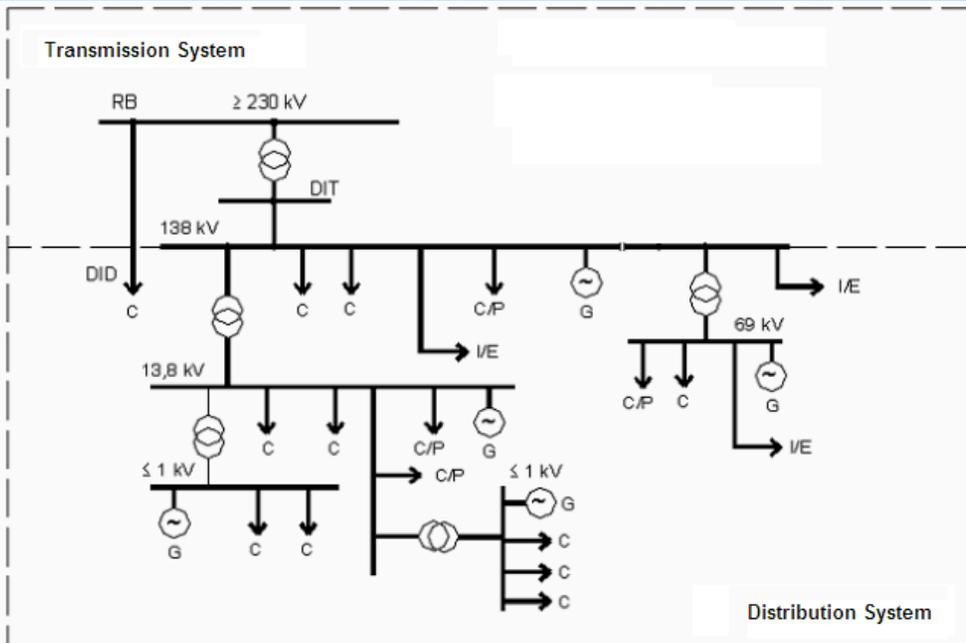
ANEEL PRODIST (Procedures for Distribution) MODULE 3 –
Distribution System Access (Distributed Generation)

NORMATIVE RESOLUTION N°83, Sept. 20th, 2004: Defines
operational procedures for Individual Electricity Generation
Systems with Intermittent Sources (SIGFI)

NORMATIVE RESOLUTION DRAFT: Isolated Electricity
Generation and Distribution Mini-System (MIGDI)

ANEEL PRODIST – Module 3

(reviewed in 08/11/2007)

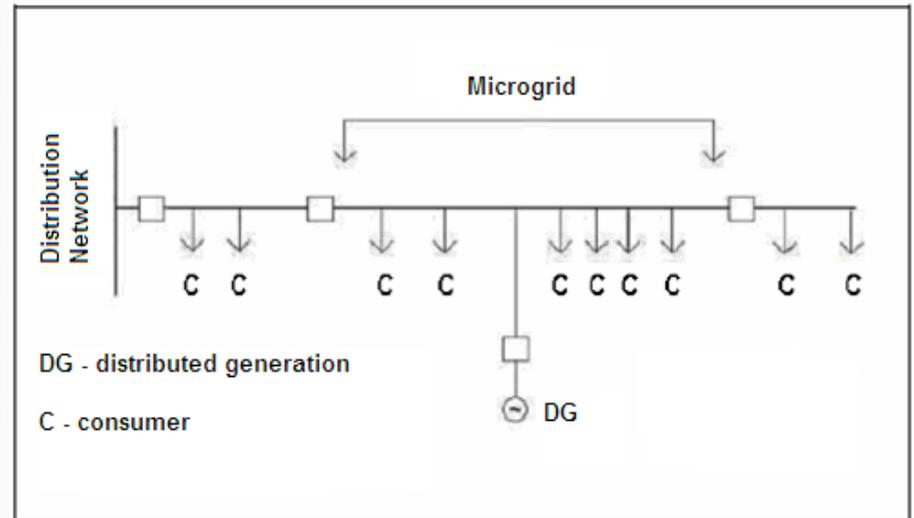


- C - consumers
- G - Generators
- C/P - Distribution companies
- I/E - Import/Export agents
- DID - Other distribution systems (≥ 230 kV)
- RB - Basic network
- DIT - Other installation systems (≤ 230 kV)

Simplified Distribution System Diagram

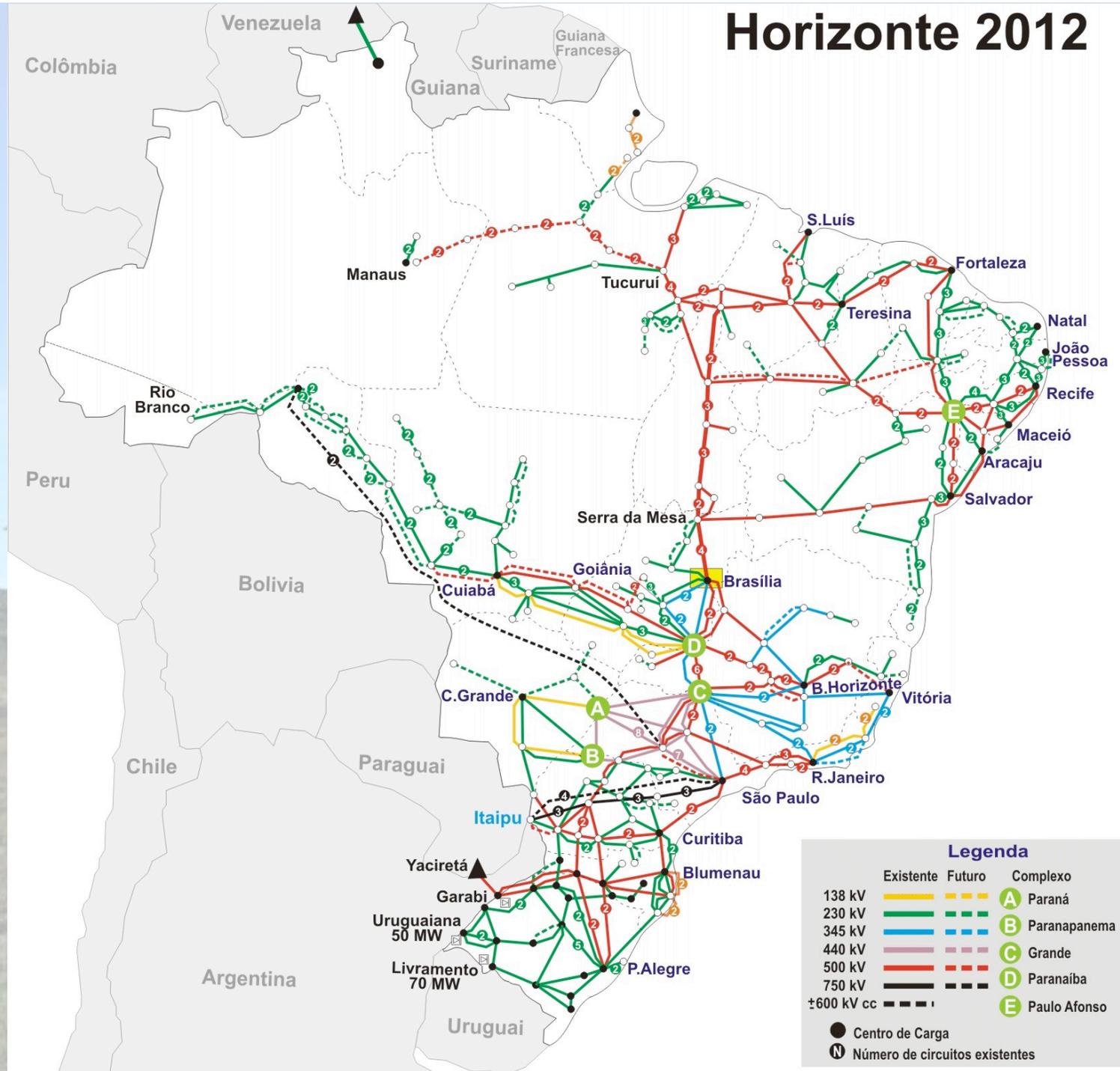
Islanded Operation

Microgrid with distributed generation



DG - distributed generation

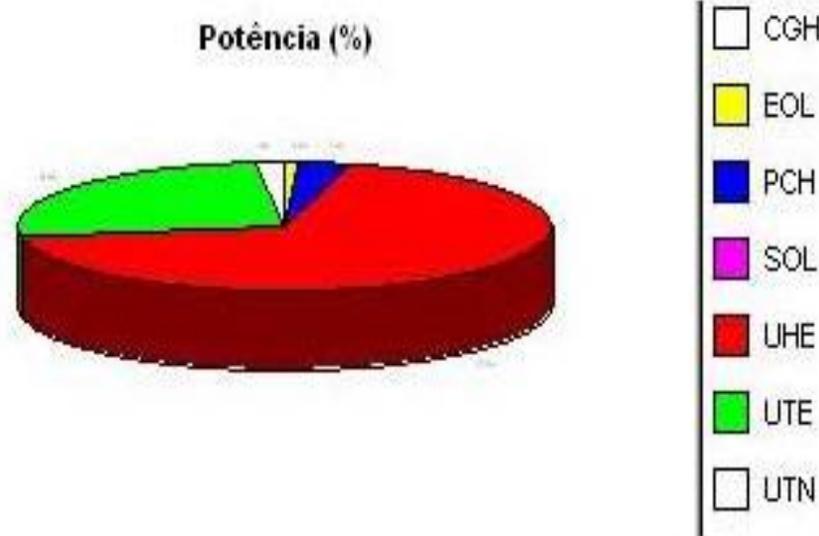
C - consumer



Brazilian Generation Matrix

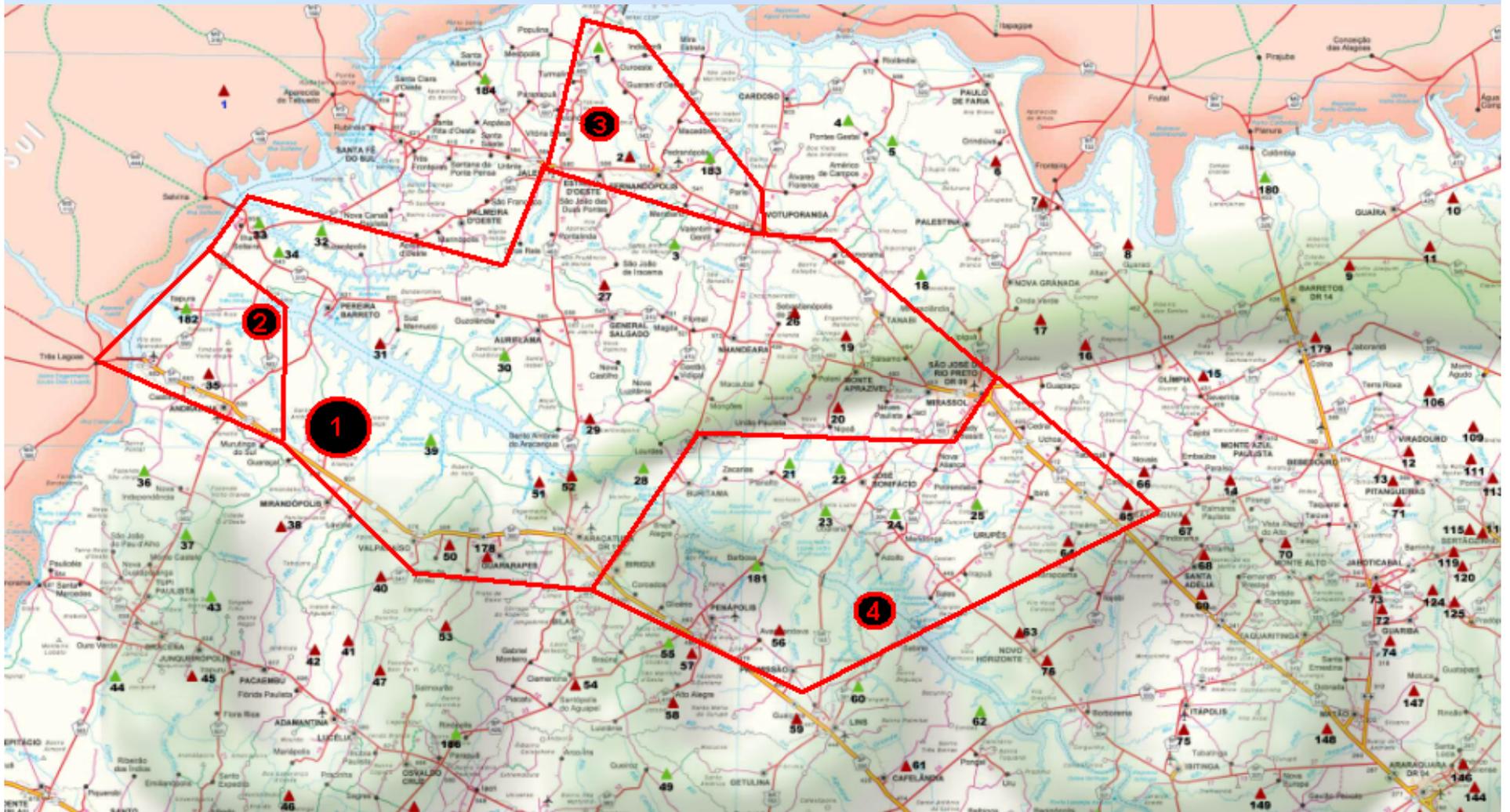
(source ANEEL)

Empreendimentos em Operação				
Tipo	Quantidade	Potência Outorgada (kW)	Potência Fiscalizada (kW)	%
CGH	334	191.146	188.701	0,17
EOL	49	936.332	928.536	0,81
PCH	398	3.586.951	3.537.132	3,10
SOL	5	87	87	0
UHE	176	78.926.687	77.426.314	67,75
UTE	1.436	32.363.567	30.192.756	26,42
UTN	2	2.007.000	2.007.000	1,76
Total	2.400	118.011.770	114.280.526	100



Islanding Systems

Potential Biomass Thermolectric Generation in São Paulo State (distributed generation)

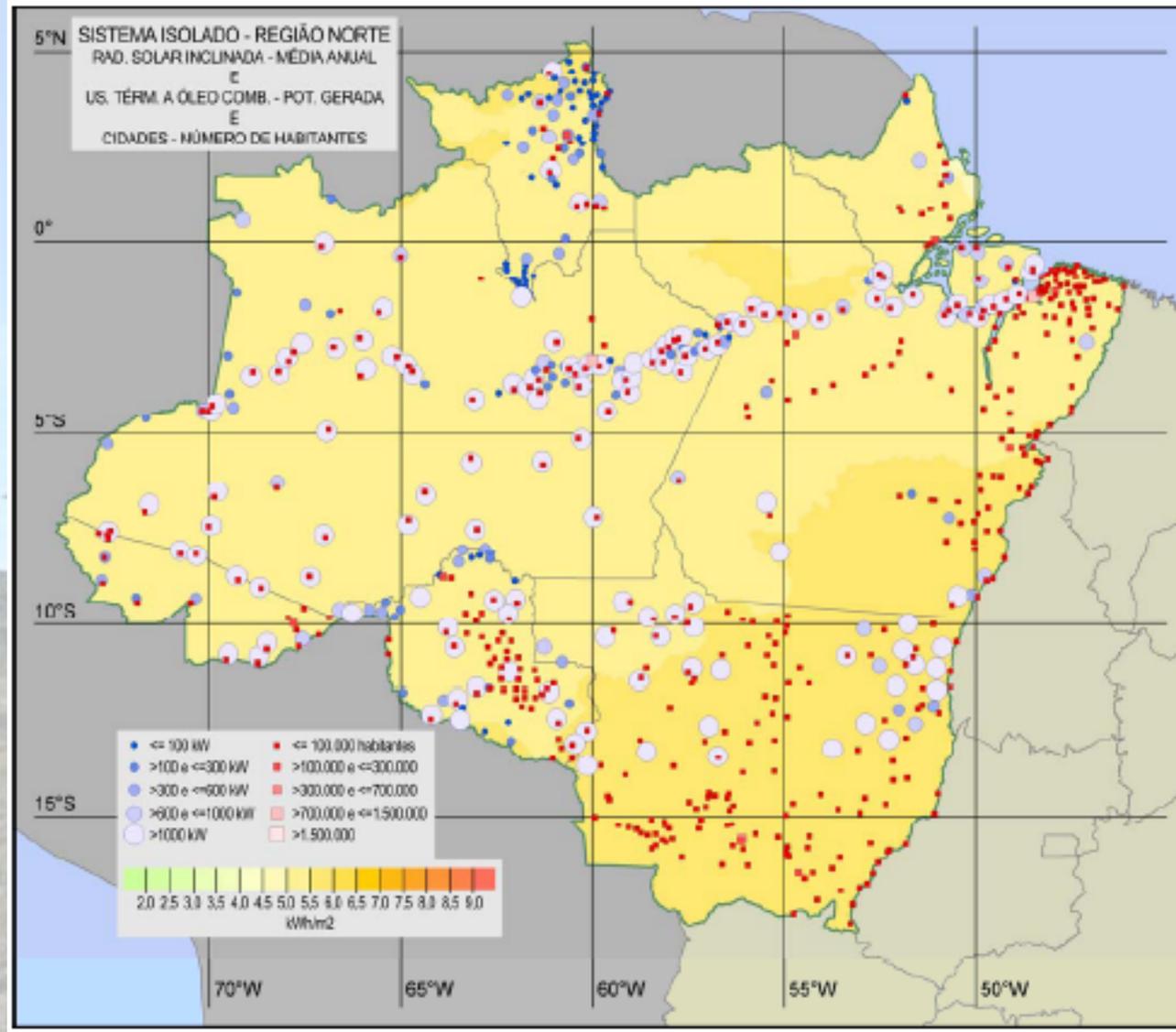


Isolated Mini-systems

Diesel thermoelectric Installed in the Amazon Region

State	Installed power	Diesel Thermoelectric Unities	< 1 MVA Diesel Thermoelectric
Acre	29,224	16	9
Rondonia	96,795	56	43
Amazonas	149,824	86	32
Pará	89,691	46	28
Amapá	15,655	7	5
Roraima	12,031	69	67
Total	393,220	280	184

Source: RÜTHER, R.; MONTENEGRO, A.A.. Design and Preliminary Performance Results of the First Hybrid Diesel / Photovoltaic System Without Storage for Isolated Mini-Grids in the Brazilian Amazon Region. Proceedings of ISES 2001 Solar World Congress, v. 1. p. 11-20, 2001, Adelaide - Australia.



Source: Prof Ricardo Rütger, UFSC

NORMATIVE RESOLUTION N°83 (20/09/2004)

- **“Luz para todos” Program (“Light for All” Program- universal access to electricity). Goal: 5 millions of Brazilian consumers until 2010**
- **Individual Electricity Generation Systems with Intermittent Sources (SIGFI) – generation for single consumer unity**
- **Alternating current feeding (local consumer nominal voltage)**
- **Up to 50 kW: investment comes from Electric Utilities**
- **For energy < 30kWh month: charge of about R\$ 3.00 (US \$ 1.86)**
- **Electric Utility is responsible for equipment and circuit safety and security (including insurance)**

General technical description for SIGFI

Service class	Daily Demand Reference (Wh/day)	Minimum autonomy (days)	Minimum Available Power* (W)	Monthly Energy Availability (kWh)
SIGFI13	435	2	250	13
SIGFI30	1000	2	500	30
SIGFI45	1500	2	700	45
SIGFI60	2000	2	1000	60
SIGFI80	2666	2	1250	80

*Local nominal voltage

SIGFI Quality Standards

Indicator	Reference Standard (hour)
Monthly DIC*	216 = 9 days
Annual DIC*	648 = 27 days

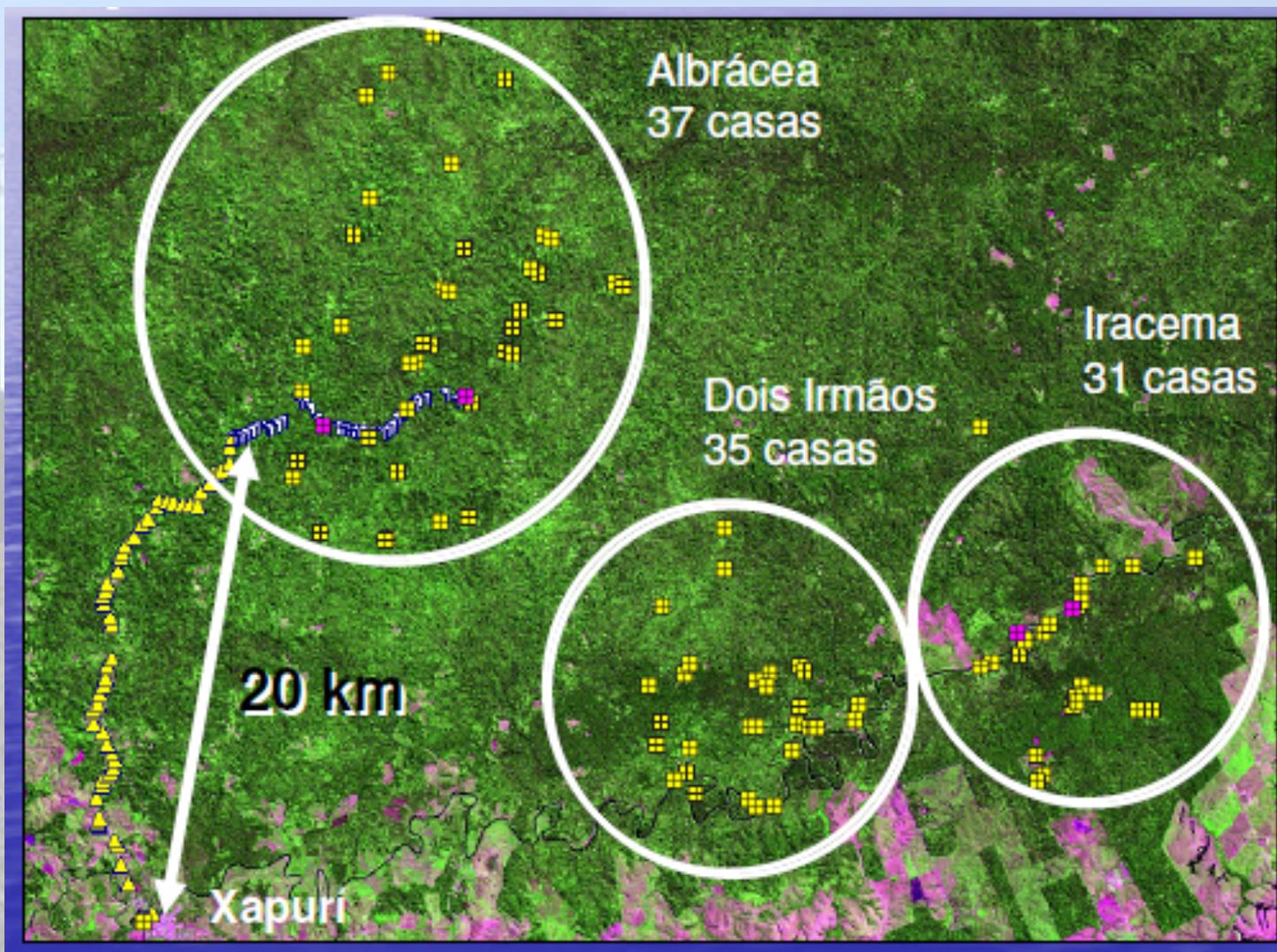
*DIC – Interruption Period per Consumer Unity

Coelba Experience (Bahia Electricity Company)

- 10,133 installed photovoltaic systems
- Free installation
- Consumer pays for 13 kWh monthly (US\$ 1.86)
- More than 75% satisfied costumers
- Batteries replacement each 4 year (displacement managed by the Company)

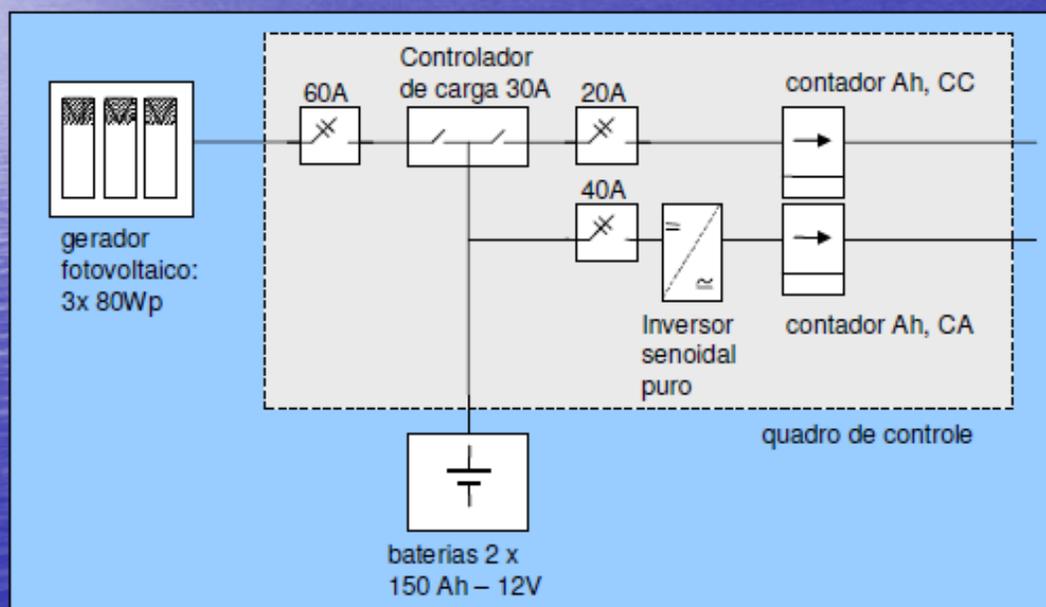
Projeto Xapuri Chico Mendes Reserve

(Source: CLÁUDIO MONTEIRO (Eletrobras), DENNYS SENNA (Eletroacre), NADMA KUNRATH (Acre Government), TORSTEN SCHWAB (GIZ) - 2º Seminário Monitoramento MME-Eletroacre – May/2007)



- 3 X 80Wp fotovoltaic modules;
- 2 X 150Ah/12Vcc stationary batteries
- 1 X 30A charge controller
- 1 X 300W inverter
- 1 X Install kit

Sistema Híbrido – Iluminação (CC) e Tomadas (CC e AC)



Custo do Sistema: R\$ 7.100,00 (SIGFI 13)

Maio/2007

Comunidade São Francisco do Aiucá – AM

(source: Roberto Zilles, USP)

- Mamirauá Sustainable Reserve Community
- By river only access
- 160 residents e 25 homes
- Straight family relationship
- Resident's association
- 1 teacher and 1 doctor
- Life depends on river cycles



Instalação dos SFDs em Mutirão



Colocação de telhas nos abrigos de baterias.



Montagem dos geradores fotovoltaicos nas estruturas de alumínio.



Fixação dos módulos fotovoltaicos no poste.



Comunitários levantando um poste com gerador fotovoltaico.

Ilha da Ferradura



6 fishermen homes



1 X 70 Wp Photovoltaic panel (solar incidence: 4 a 6kWh/m²)

1 X 150 Ah, 12V storage system (lead-acid battery)

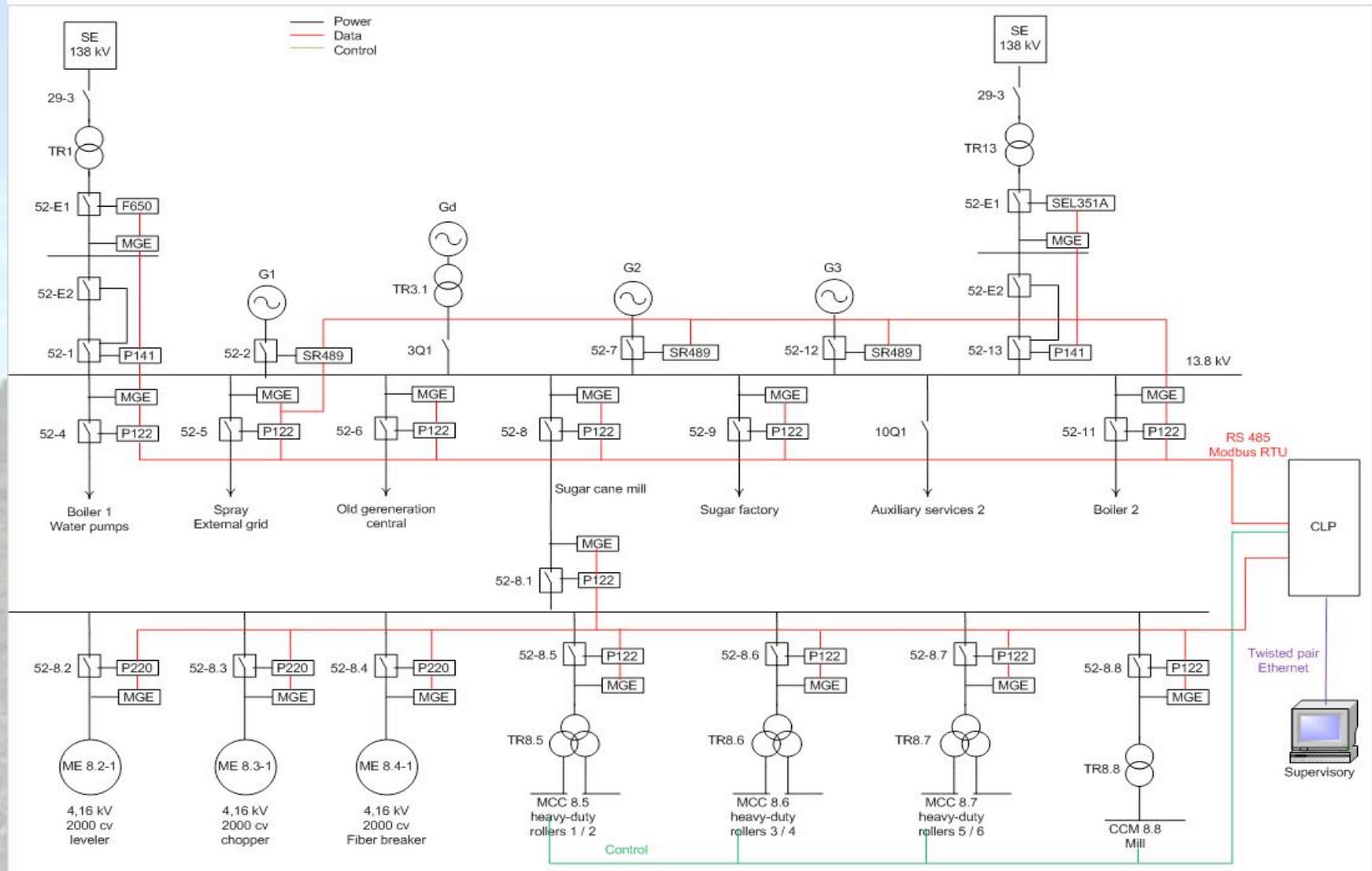
1 X quasi-sinusoidal 140 W, 110 Vac inverter

1 X charge controller



Microsystems Modelling

The Sugar/Ethanol Microsystem model



Conclusions

- Research and development opportunities for:
 - Islanded distributed generation operation
 - Isolated Micro and Mini systems
 - Individual Electricity Generation Systems with Intermittent Sources
- on:
 - Legal Regulation
 - Micro and mini systems modelling
 - Microsystems planning and projects
 - Power quality

Thank you!

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São Paulo Research Foundation

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