Federal University of Santa Catarina
Power Electronics Institute

The Challenges of Renewable Energy Sources and the Modernization of Brazil's Electrical Power System

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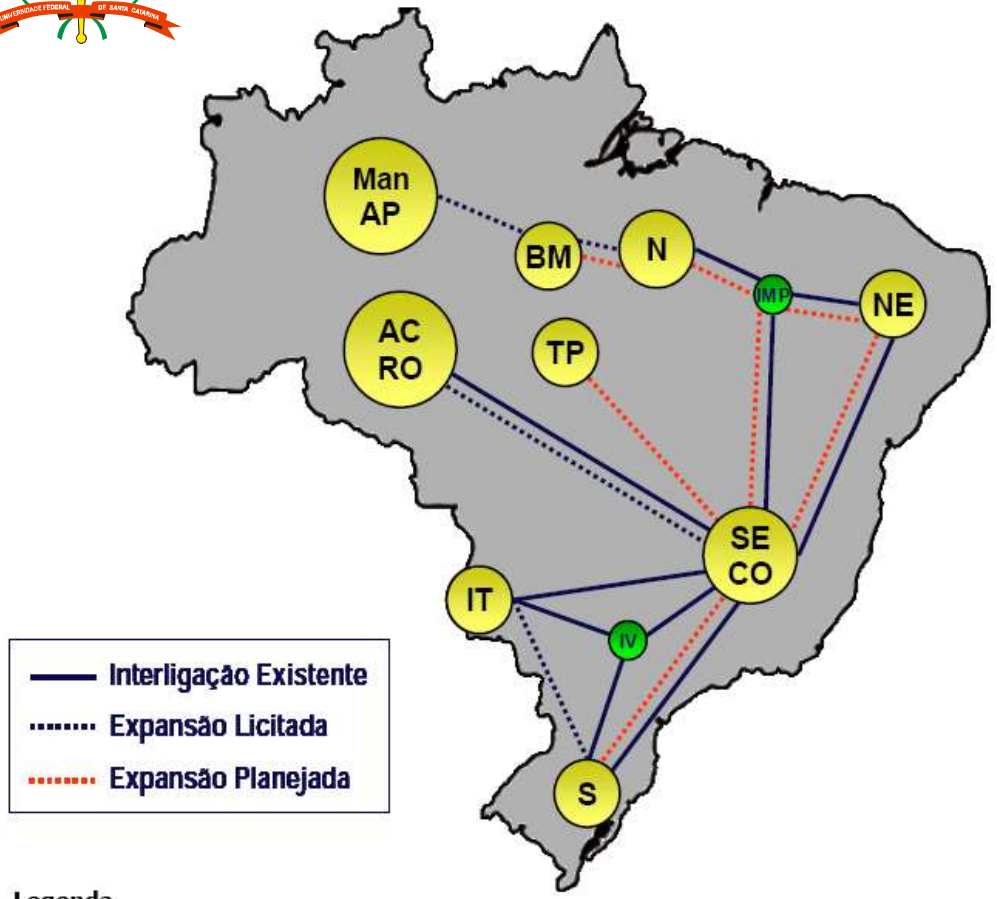
INEP – Power Electronics Institute

Interconnections of the National Integrated System



Legenda

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Figura 3 – Representação Esquemática das Interligações entre Subsistemas

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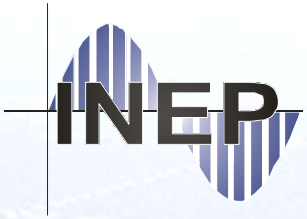


Research and Future Perspectives on Power Electronics

Denizar Cruz Martins

Introduction: Power Electronics ⇒ Industrial Electrical Sector

- Energy Conservation.
- Renewable Energy Processing.
- Large-Scale Energy Storage.
- Development of Electrical Vehicles.
- "Smart" Electrical Power Systems.

Introduction: Power Electronics ⇒ Industrial Electrical Sector

- Processing Versatility.
- Flexibility of use.
- High Efficiency in Energy Processing.

- **Power Semiconductors Devices.**
- **"Smart" Electrical Grids**
  (Advancement and Modernization of the Power Electrical System).

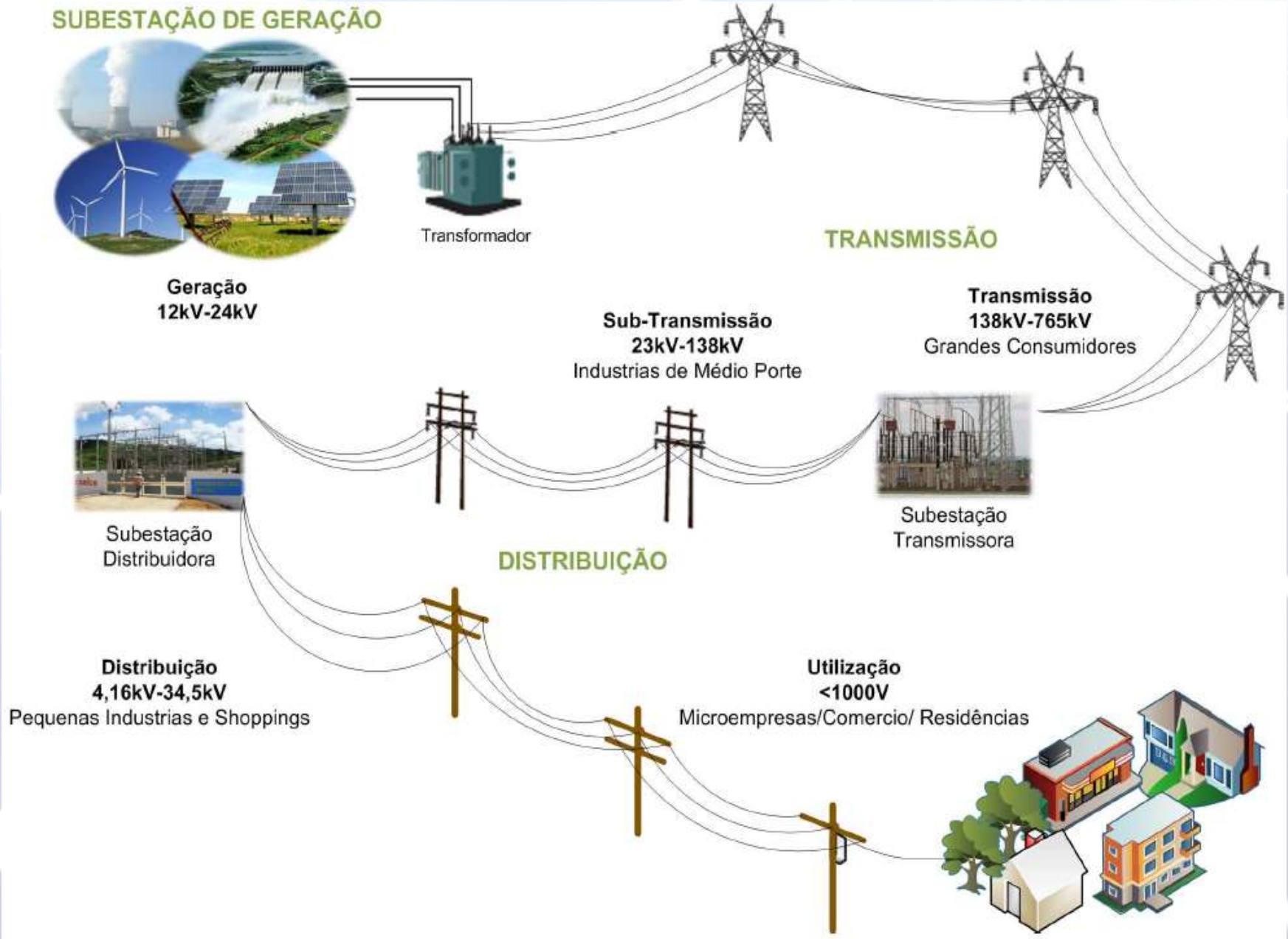
Smart Electrical Grids include:

- New ways of generating renewable energy.
- Connected electric vehicles.
- Large-scale **“smart”** energy storage.
- Possibility of communication among all of them.

Modernization of the Power Electrical System.

- Power Electrical System.
  - Improving power quality
  - Diversification of the energy matrix
  - Operation stability
  - System reliability
- Power Electronics.
  - Interconnection of different systems (generation, consumption and storage of energy)
- Telecommunications and Computer Science.
  - Intelligence (exchange of information and knowledge)

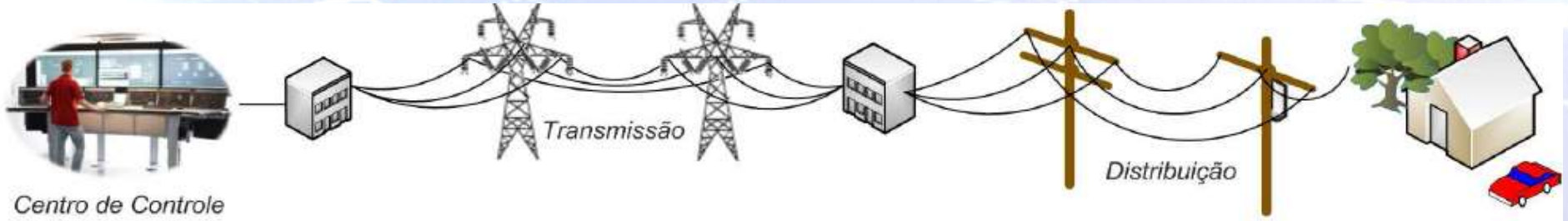
Sectors of the Brazilian Power Electrical System.



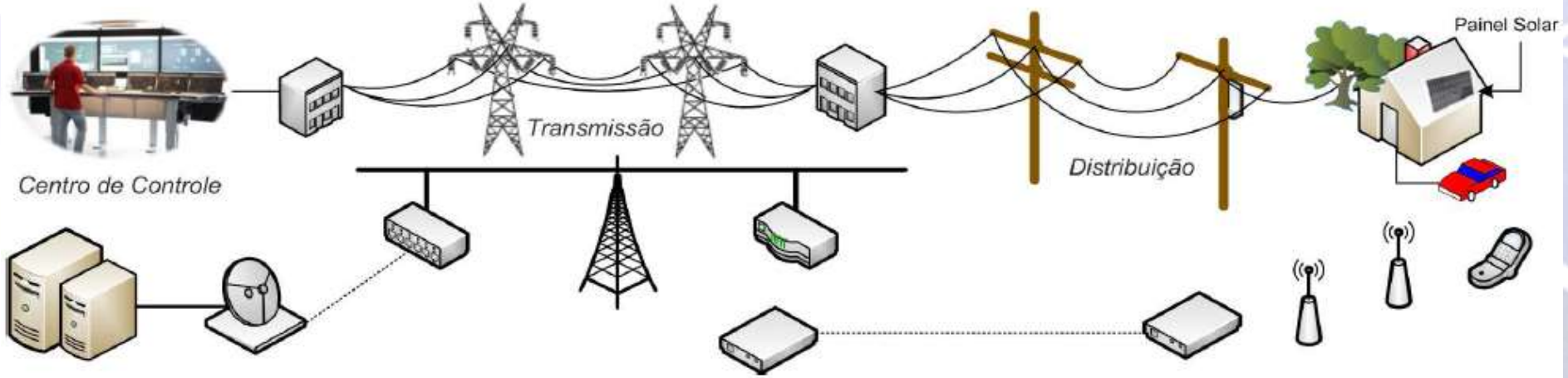
Sectors of the Brazilian Power Electrical System.

Unsolvable pole mess: cost US$ 4 bi (Dez/2022)

Power Electrical System with Intelligence.



(a) Rede elétrica atual.



(b) Rede elétrica inteligente, com amplo suporte de telecomunicações.

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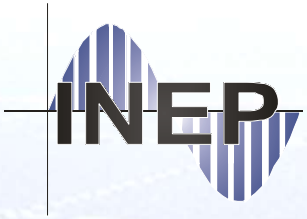

The Electrical Power System Paradigm of the Future (Perspectives e challenges)

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☞ Introduction of DGs

- Greater reliability for EPS
- Diversification of the energy matrix
- Improve power quality
- Reduce electricity costs

Microgrids emerged from DGs.

- Adding energy storage systems to DGs.
  - Batteries
  - Supercapacitors
  - Flywheels

- Microgrids (inverters and specific controls) ⇒ Active Distribution Networks (ADNs).

- ADNs managed through an adequate communication and control system ⇒ "*Smart" Grids*.

We have to evolve, a lot, in the following major areas.

- **Intelligent energy storage systems that allow:**
  - Low level of pollution;
  - High service life;
  - Minimal maintenance;
  - Renewable feature;
  - High power density;
  - Low cost.

We have to evolve, a lot, in the following major areas.

- **Wireless high power transmission system (Wireless Power System).**
  - This will be, perhaps, the biggest evolution in the way of processing (generation and consumption) of electrical energy on a large scale.

- **Insertion of the water in the planet's energy matrix**, with the same concerns about efficiency and intelligent consumption.
  - Note: We can live without electricity (without internet), but it is not possible to live without water.

Sectors of the Brazilian Power Electrical System.

Unsolvable pole mess: cost US$ 4 bi (Dez/2022)

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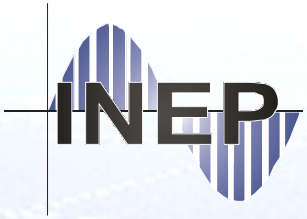

The Issue of Water Shortages in Hydroelectric Power Plants in Brazil

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Introduction: Rainfall Seasonality in the Southeast and South Regions from Brazil

- Impacting the water level in the reservoirs of Brazilian Hydroelectric plants.
- This is an issue that must be taken into account when planning and managing our energy matrix and, above all, in the expansion and/or diversification of electrical energy generation in these regions.
- The absence of rain is a legitimate concern and should be treated seriously.
- However, most of the time the issue is not the absence of rain, but the fact that precipitation is occurring in another region.

Introduction: Rainfall Seasonality in the Southeast and South Regions from Brazil

- Why not use aqueducts to carry flood water to hydroelectric plant reservoirs?

- Natural response:
  - * Technically very complex;
  - * Very expensive investment.

- Without a careful and professional study, I tend to disagree with this answer, for the reason that I'll analyze below.

BOLIVIA-BRAZIL GAS PIPELINE

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Bolivia-Brazil gas pipeline

- Natural gas between Bolivia and Brazil.
- 3150 km long.
- 557 km in Bolivia territory.
- 2593 km in Brazilian territory.

Bolivia-Brazil gas pipeline

Bolivia-Brazil gas pipeline: Building the Gas Pipeline

Final look of the project.

Bolivia-Brazil gas pipeline: Drawbacks.

- Forrest devastation and environmental aggression are not everything.
- The issue of security is another important item.
- The possibility of a leak in the gas pipeline represents a real danger for the population around the gas pipeline.

Gas line: Danger underground pipeline.

Gas leak causes fire.

FLOODS IN SOME LOCATIONS IN THE SOUTHEAST AND SOUTH REGIONS OF BRAZIL

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Vila Mariana west of São Paulo (March 1, 2022).

Floods in São Paulo: Significant volume of water.

Distance from São Paulo to the Itaipu Hydroelectric Plant: 1067 km.

São Paulo, SP

Usina Hidrelétrica de Itaipu, Paraguai

13 h 39 min (1.067,1 km) via BR-374

Rotas

Final considerations.

- **If it is possible to bring natural gas from Bolivia (covering 3,150 km, of which 2,593 km are in Brazilian territory), with all the security issues and deterioration of the environment (attack the native forest), why is it not possible to use aqueducts to transport floods water from Brazilian regions for the reservoirs of our hydroelectric plants?**

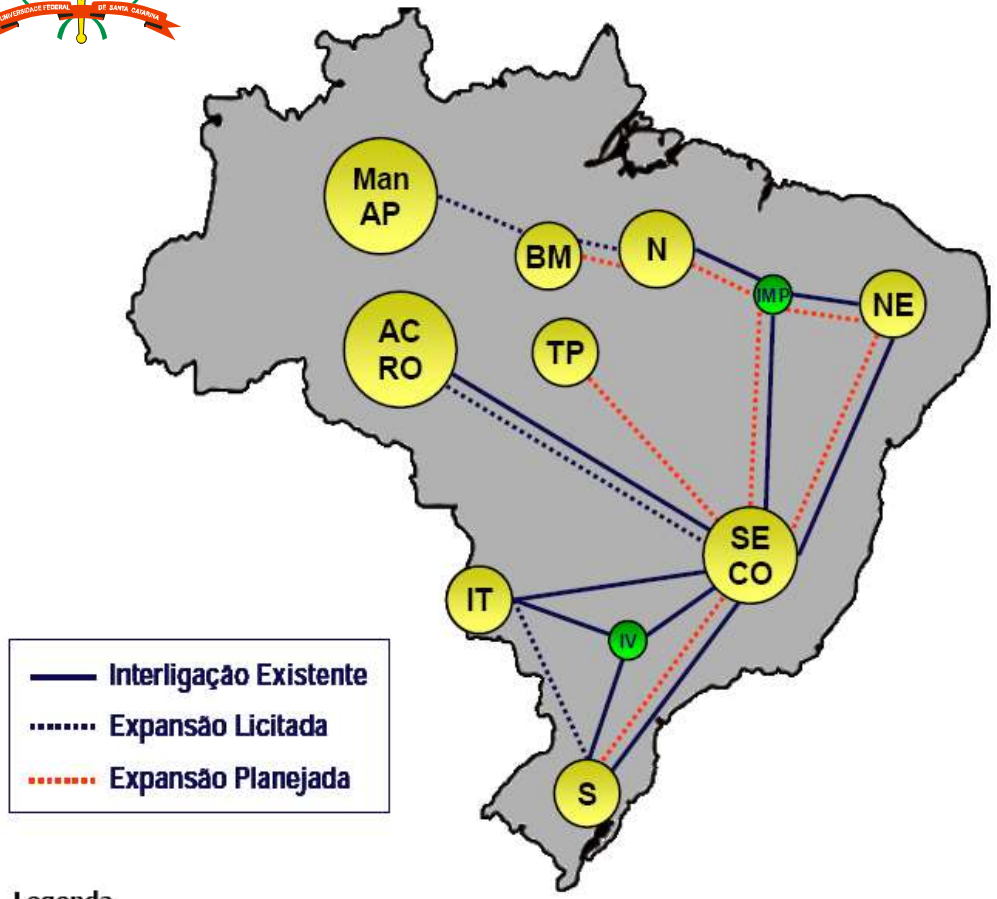
If the floods are controlled the following gains are obtained:

- Energy demand is maintained through hydroelectric plants, which; are cheaper and have almost zero pollution;
- The entry into operation of thermoelectric plants is postponed, which are expensive and cause high levels of pollution;
- Traffic disruptions due to floods in the affected regions are avoided;
- Prevents diseases caused by contaminated water, for example, leptospirosis;

If the floods are controlled the following gains are obtained:

- Avoid destroying sidewalks, vehicle traffic routes, asphalts, etc., which cause great damage to city halls;
- Flooding of homes, generally those most in need, is avoided, solving an important social problem;
- The destruction of homes, which causes significant material damage, is avoided;
- The loss of human life, which destroys families, is avoided, this being a legitimate argument.

Interconnections of the National Integrated System



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Proposal for Construction of Aqueducts and Swimming Pools in Brazil.

Reflections on important topics.

- Pollution generated by fossil fuels harms the environment and degrades the population's quality of life, but so do floods, and at the same levels of concern and costs;

- Hydroelectric plants floods large areas, which can be interpreted as a major inconvenience, in addition to destroying the native vegetation, flora and fauna of the region. However, it must be noted that flooded areas can be used in the following situations:
  - As a source of income and survival for riverside communities, using fishing (source of food);
  - As leisure (bathing, sailing, sport fishing, etc.);
  - Large non-polluting battery $\Rightarrow$ Dispatchable power source.

Reflections on important topics.

☞ It is worth remembering that the following forms of energy also deactivate large areas without any compensation in return:

- Solar PV plants: Do not operate in the absence of the sun.
  - Visual pollution;
  - Not Dispatchable: require batteries;
  - Deforestation: destruction of native vegetation and fauna.
- Wind Power Plant: Do not operate in the absence of wind.
  - Not Dispatchable: require batteries;
  - Death of animals: buts and birds $\Rightarrow \uparrow$ pests;
  - Deforestation: destruction of native vegetation;
  - Visual and noise pollution (emission of noise from propellers).

UFV de 420 MW em Arinos, norte de MG

French Company (Voltalia) ⇒ US$ 280 mi

Reflections on important topics.

- Flood waters, in addition to supplying HPP reservoirs, can also supply water sources for the region's population.
- It is possible to design a system of canals (aqueducts) that keeps the HPP reservoirs full.
- In the eventuality that all reservoirs are full, the excess water could be used to feed water sources for the population (potable water).
- In the eventuality that all water sources are filled, the excess water could be diverter to the sea, so that in any situation the damaging effect of flood would be minimized.

Contact

THANK YOU FOR YOUR ATTENTION

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