

Solar Energy Resource Assessment in Brazil

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Summary

- Rationale
- Background (economic and energy information)
- Methods
- Results
 - Renewable Energy Resource Maps
 - Renewable Energy Scenarios in Brazil
- Products

Rationale

- Scientific survey for alternative energy resources has been stimulated:
 - by the growing demand of energy (mainly in developing countries like Brazil, China and India);
 - the need to increase the energy security
 - by reducing dependence on fossil fuels;
 - by diversifying the energy sources in country energy matrix
 - by the concern with the preservation of the environment
 - global warming and climate change
 - air pollution

Rationale

- Significant business opportunities will result from near term potential for renewable energy and related new industries:
 - Potential investors tend to avoid the risk of investments in RE projects where reliable and sufficiently detailed data are non existent.

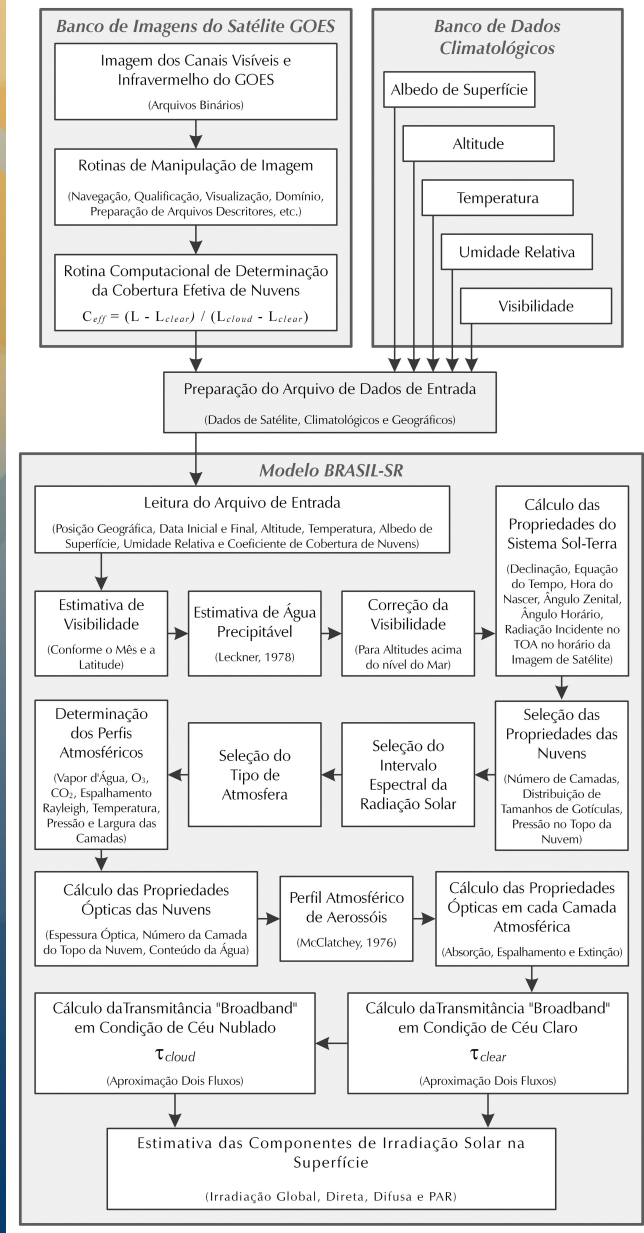
The background of the slide is a stylized illustration. It features a large, bright yellow sun in the upper left corner. In the foreground and middle ground, there are several wind turbines of varying sizes, rendered in a light blue-grey color. The sky transitions from a pale yellow at the top to a deep blue at the bottom. The overall style is clean and modern, with a focus on renewable energy.

Background

Solar Energy Assessment



Model BRASIL-SR



- ✓ The required database comprises:
 - air temperature, surface albedo,
 - relative humidity, atmospheric visibility,
 - surface elevation and effective cloud coverage.
- ✓ Employs the continental profile of aerosols corrected for the first 5km through visibility data.
- ✓ The cloud coverage is formed by a single type of cloud - Altostratus - distributed in 2 atmospheric layers.
- ✓ The solar irradiation on a tilted plane was obtained by using Perez et al. (1987).
- ✓ DNI is estimated by assuming that the solar radiation transmittance in clouds may be added to the clear sky transmittance.

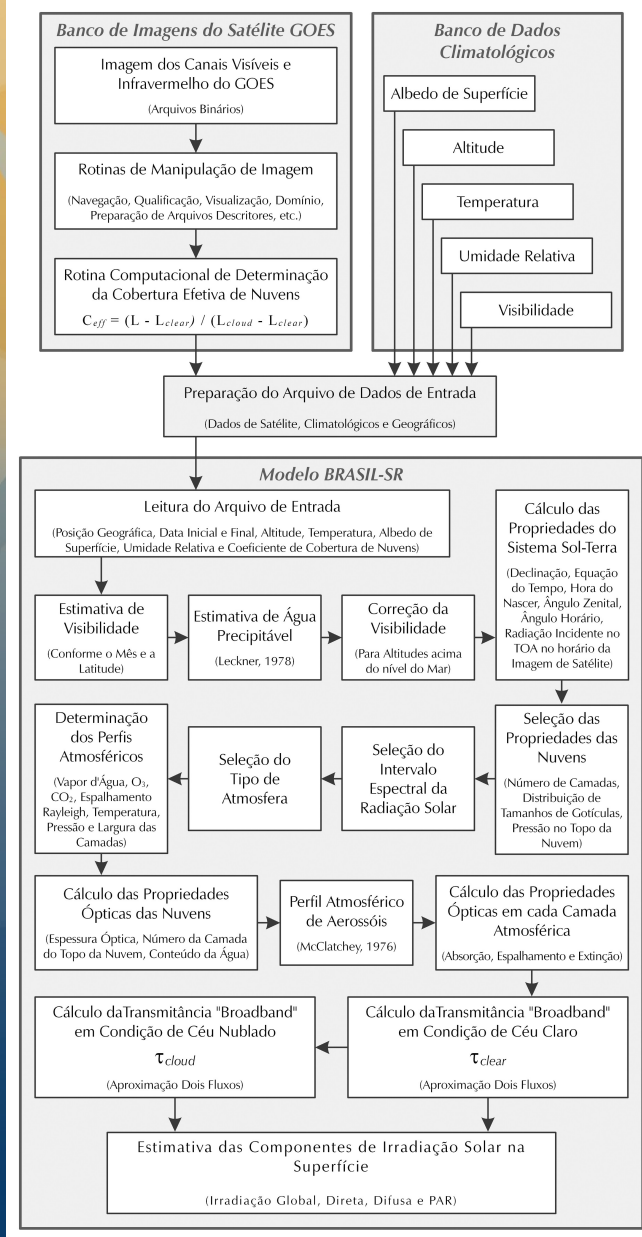
Solar Energy Assessment

The reliability of the solar estimates were performed in two tasks:

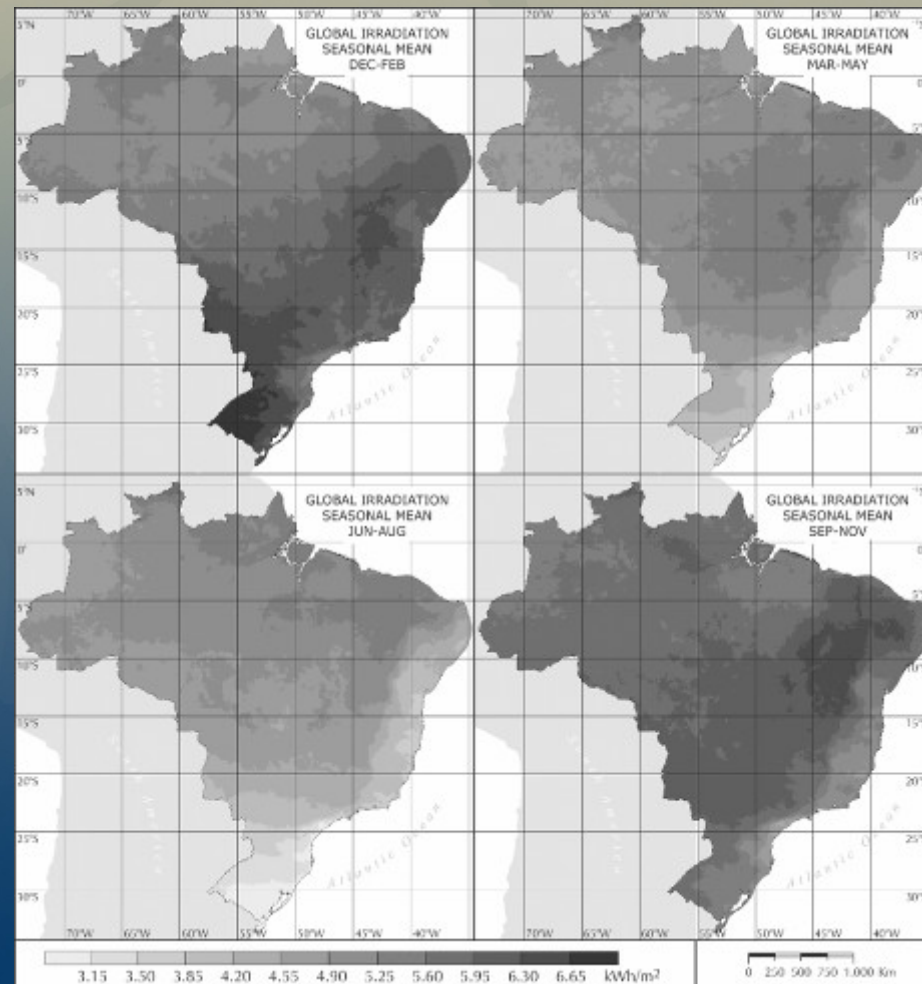
- comparison with estimates provided by the other models adopted in SWERA to map the solar energy in other countries; and
- comparison among the estimates with ground data acquired along Brazilian territory – **SONDA** network.

Main Conclusions:

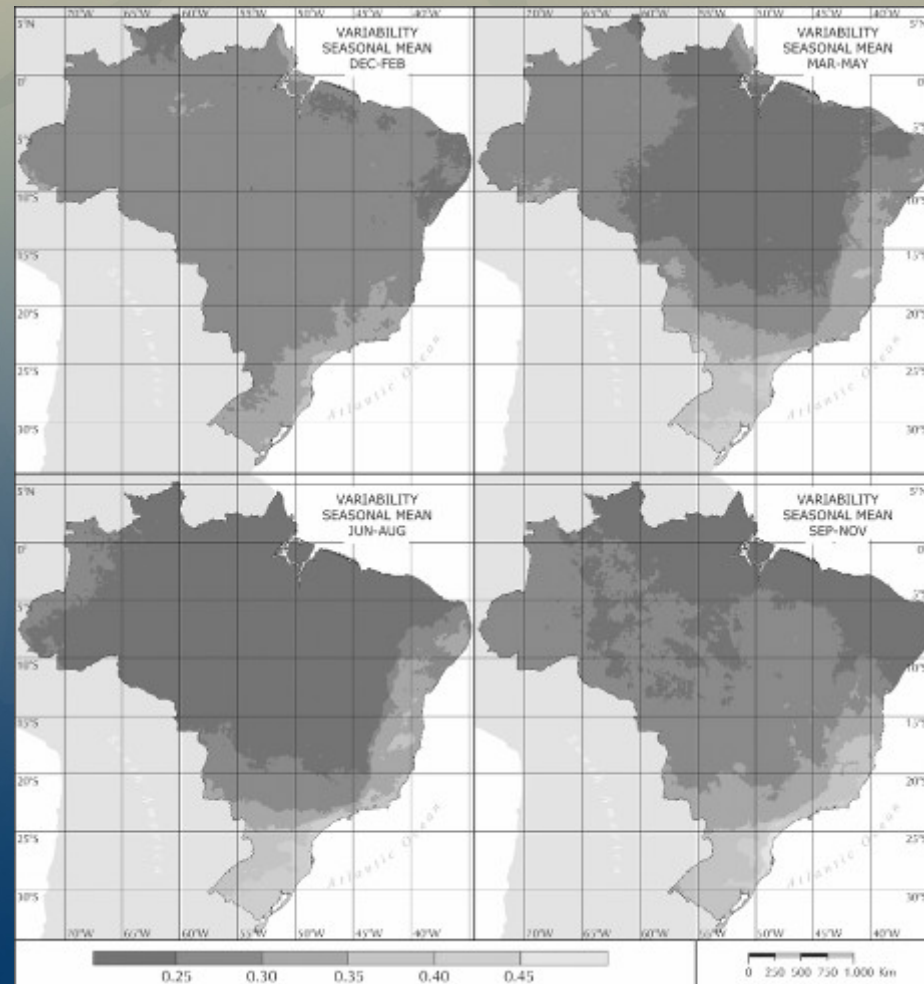
- BRASIL-SR presents similar performance as any other model adopted in SWERA;
- BRASIL-SR achieved a similar performance in all geographic regions of the country with a slight overestimation of the solar flux - roughly 5% and the root mean square error was about 13% all around Brazilian territory
- Larger deviations were observed in the Amazon region which presents larger precipitation all along the year



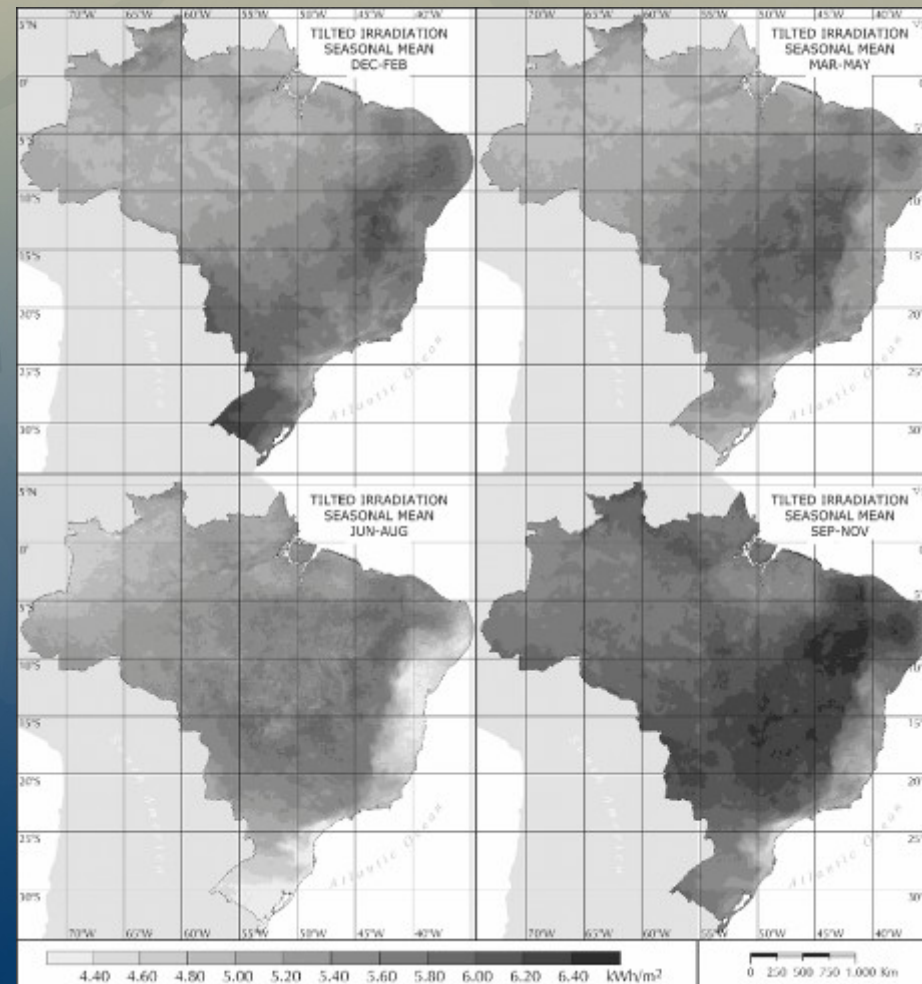
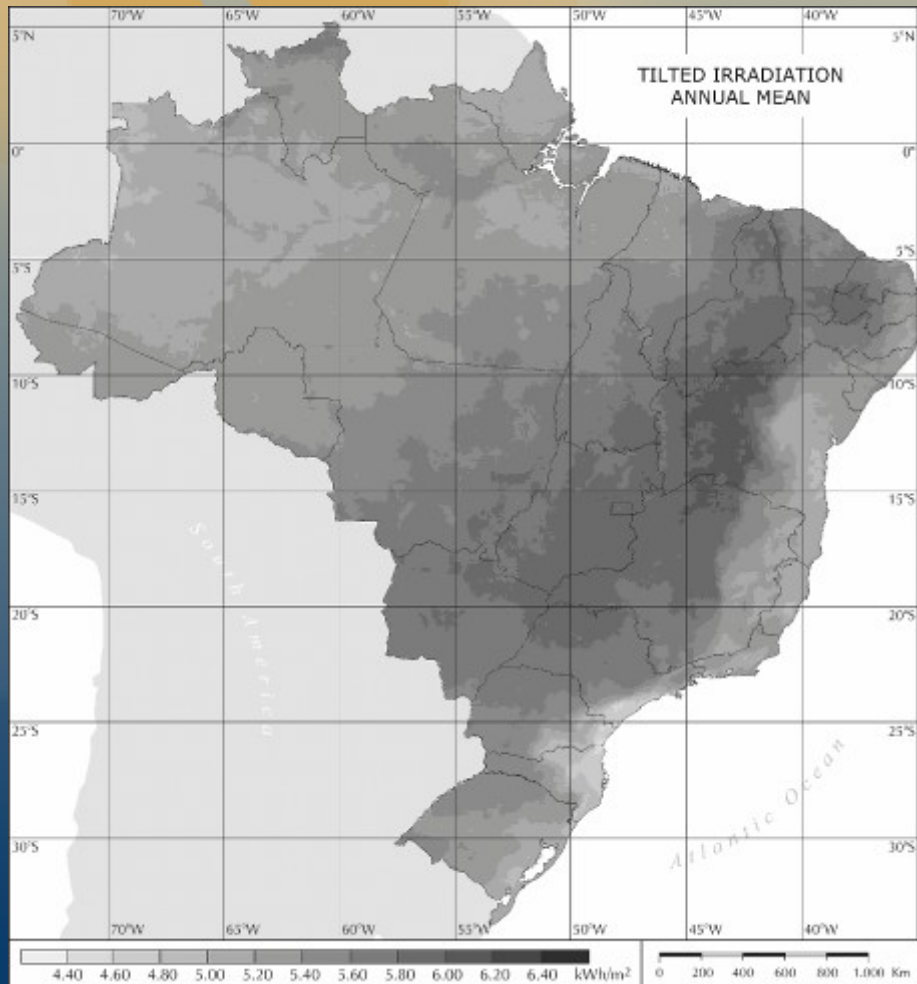
Solar Energy Assessment



Solar Energy Assessment



Solar Energy Assessment





The background of the slide is a stylized illustration. It features three wind turbines in shades of grey and blue, set against a gradient background that transitions from a warm orange at the top to a deep blue at the bottom. A large, bright orange sun is positioned in the upper left quadrant, partially obscured by the blades of the first wind turbine.

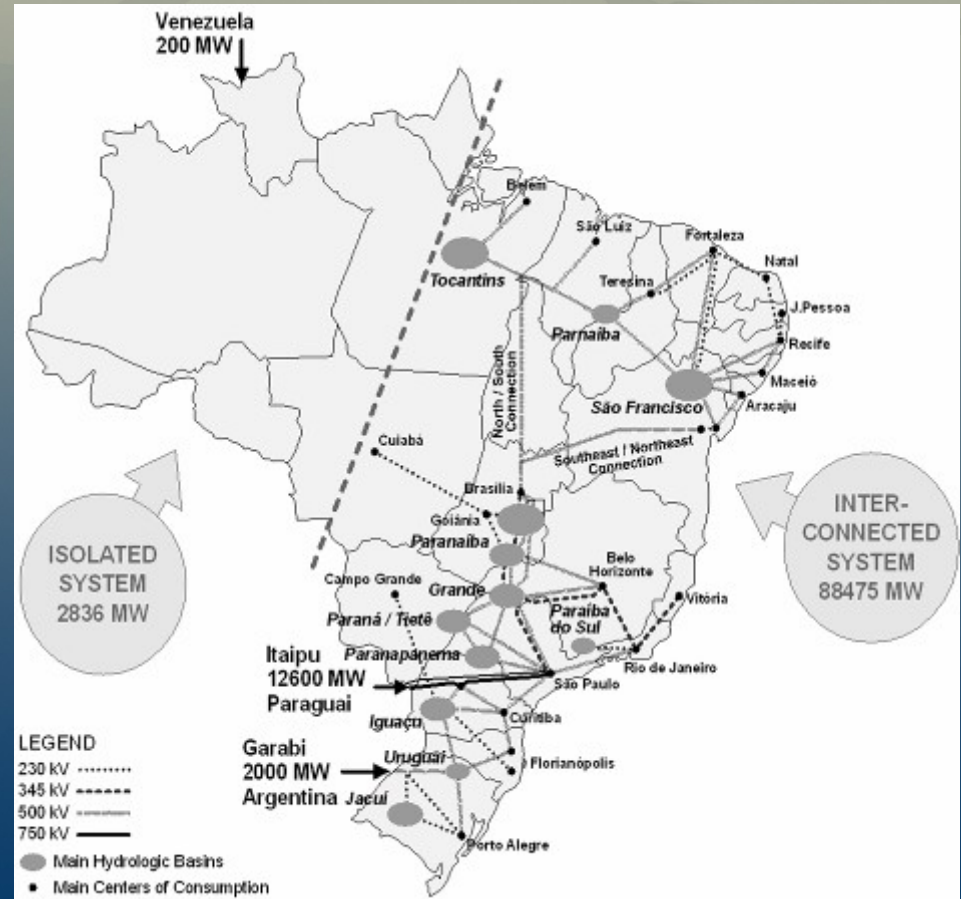
PRODUCTS

SOLAR and WIND ENERGY ASSESSMENT



- Numerical models development
 - stochastic models
 - physical models
 - artificial neural network
- Geographical Information Systems
 - Integration of renewable energy data together with socio-economic information
 - renewable energy scenarios

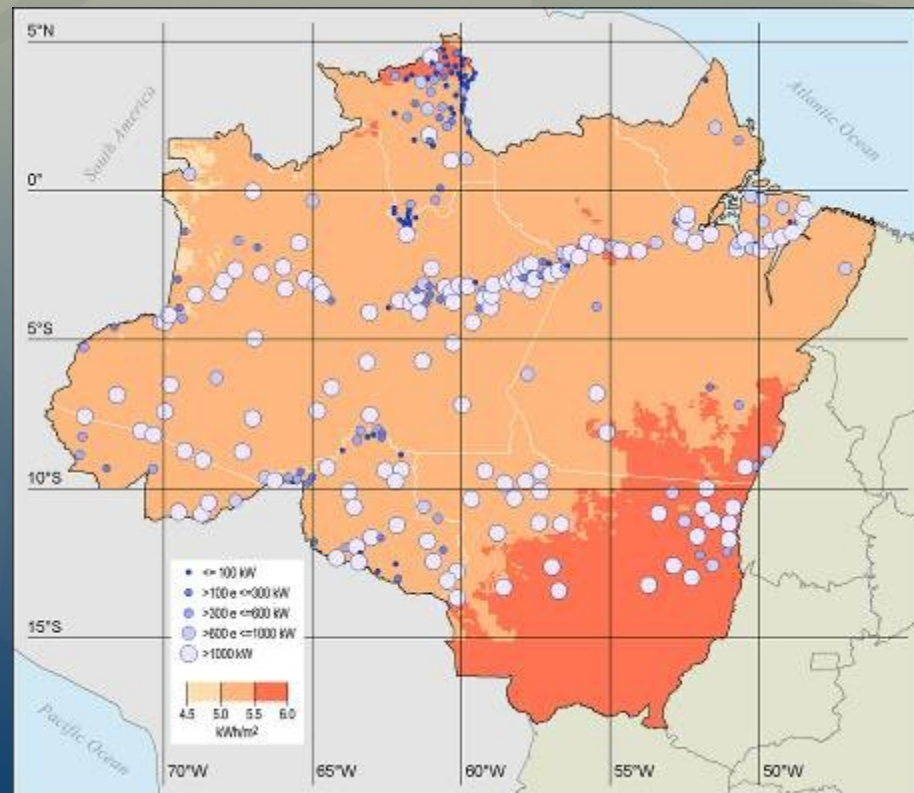
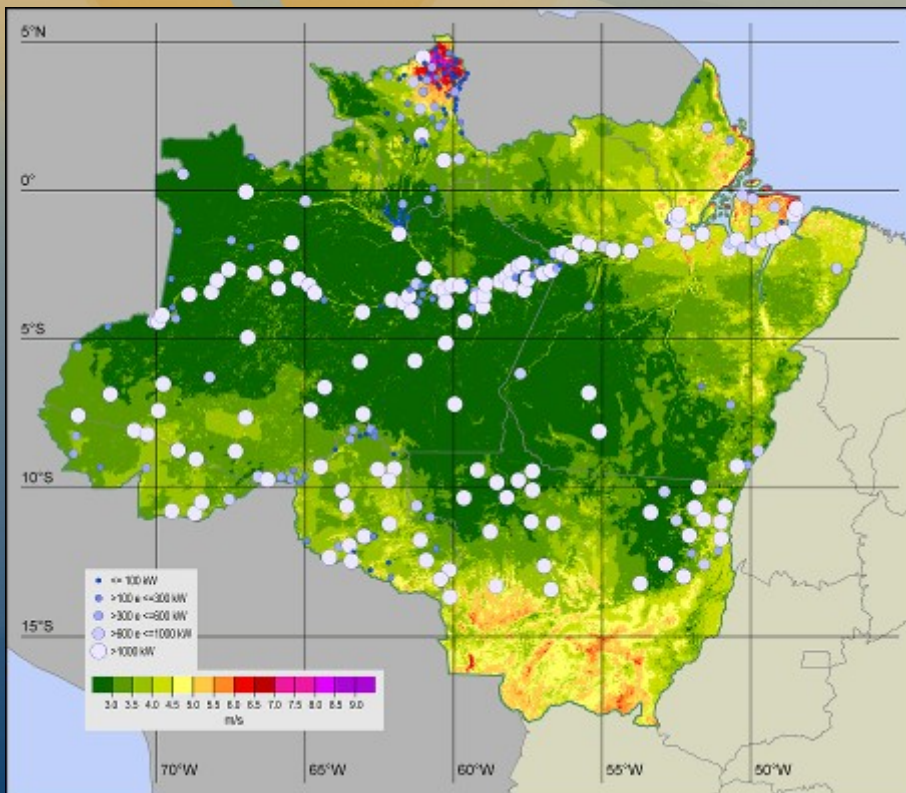
Solar and Wind Energy Scenarios



Electricity Distribution System.
Source: ANEEL, 2005.

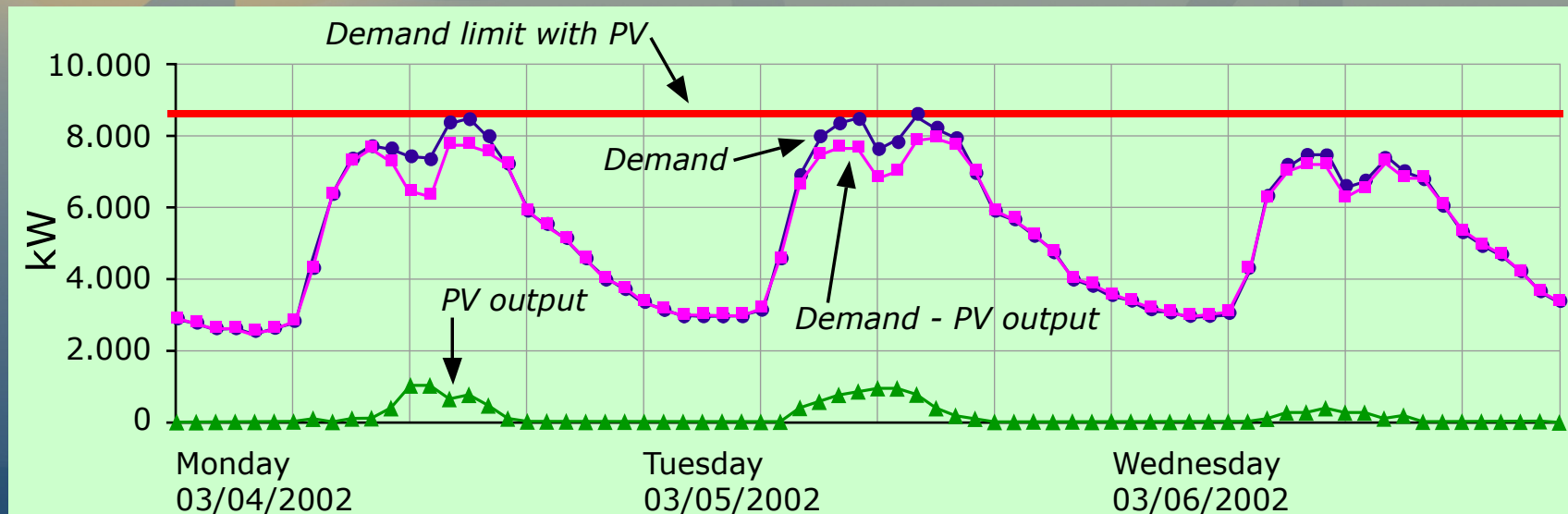
PV Scenarios

Isolated systems

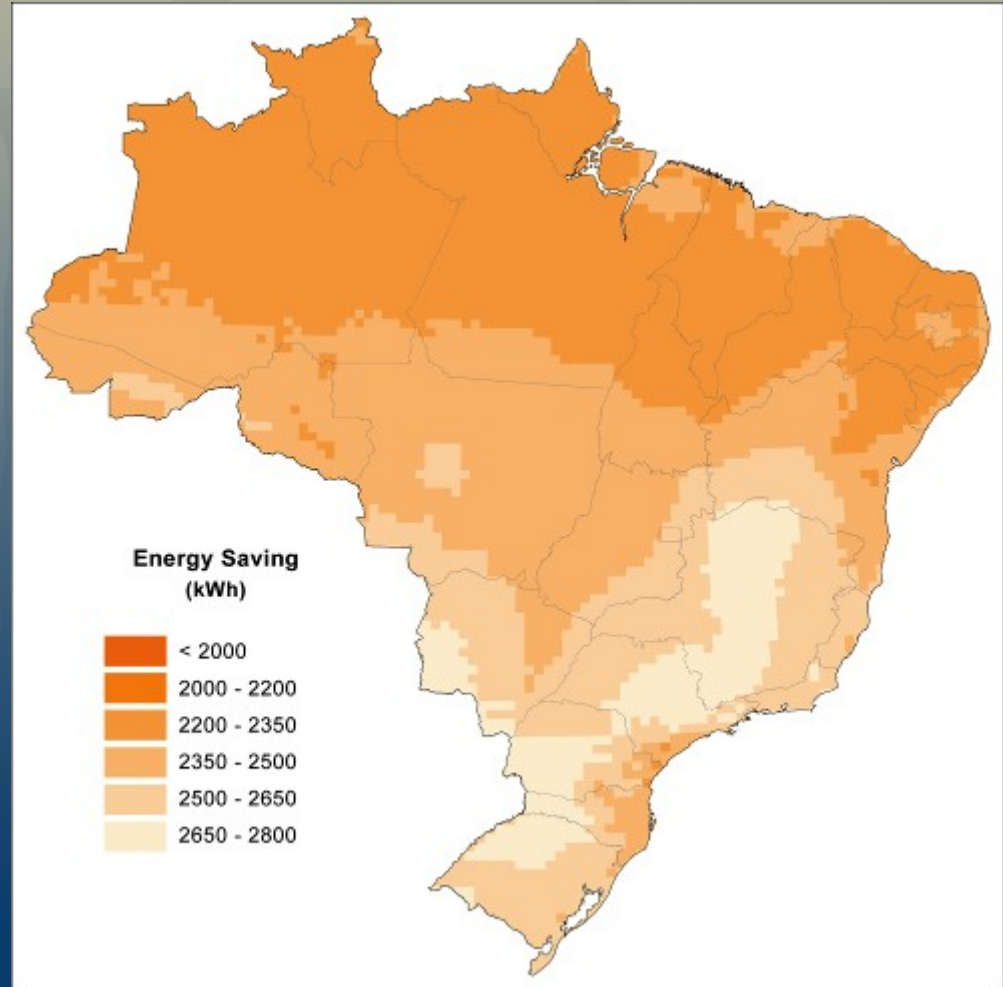


PV Scenarios

Grid-connected systems

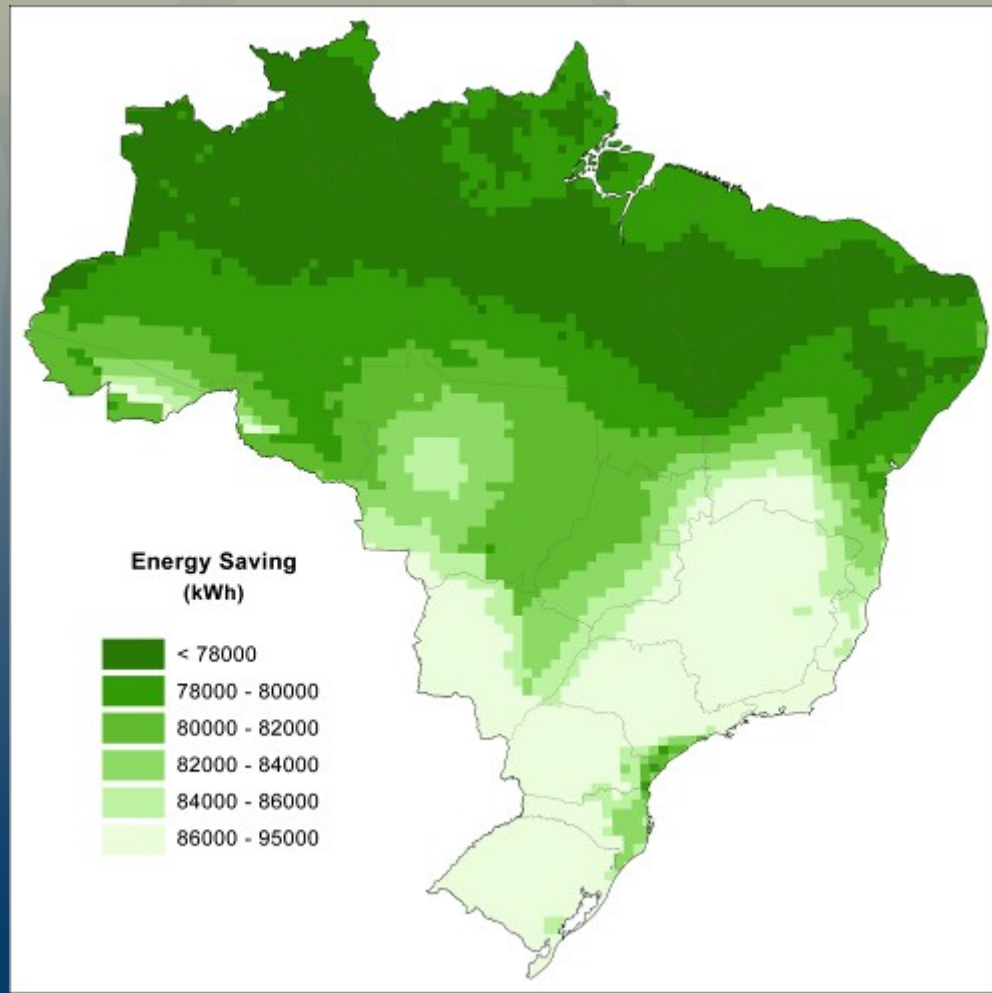


Solar Heating Scenarios



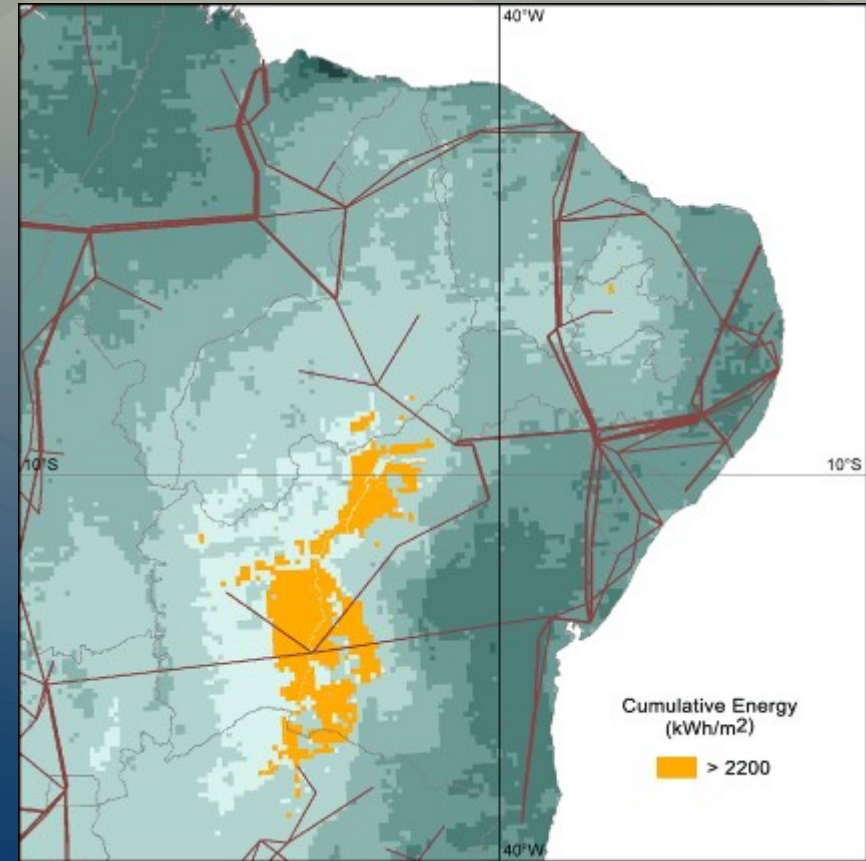
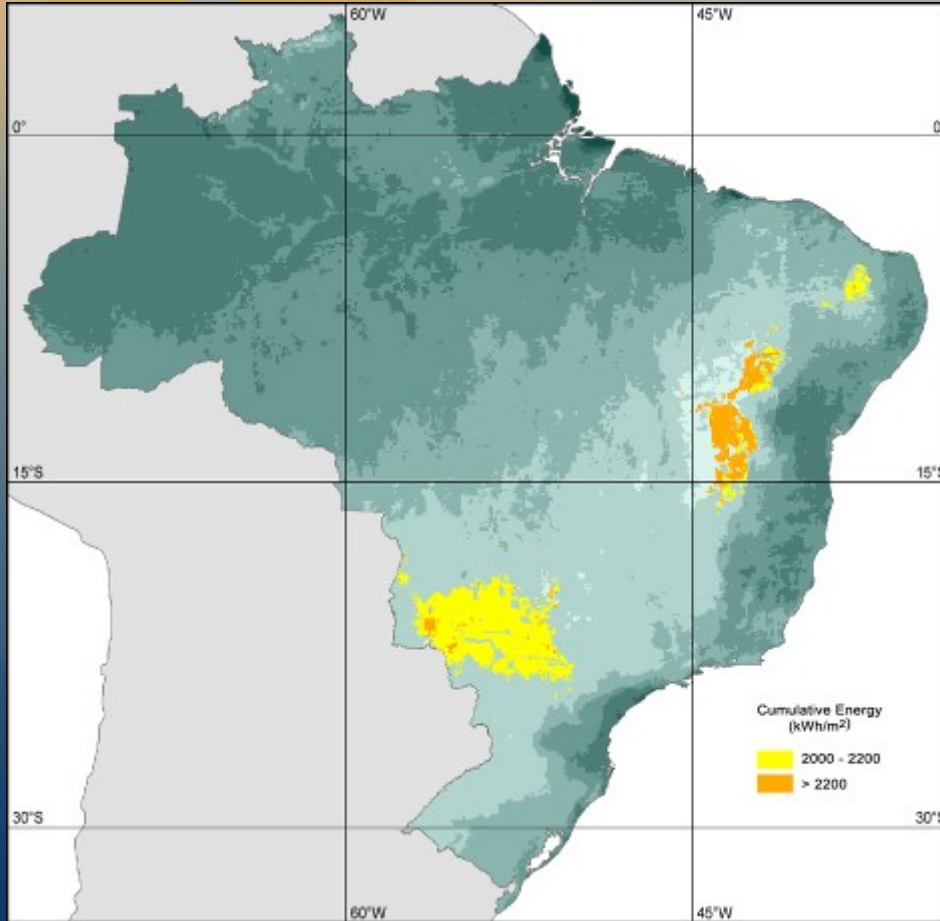
Yearly energy savings of a typical residential heating system in Brazil

Solar Heating Scenarios



Yearly energy savings per square meter of collection panels for large-sized systems.

CSP Scenarios



New Researches

- Aerosols impacts
- Atmospheric and radiative modeling
- Ensemble modeling
- Improvement of Cloud Cover determination from satellite images
- Climate Change influence

Contacts

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Discussion and Conclusions

- The Northern region receives lower solar irradiation during the summer than the South region in spite of its closer location to the Equator due to climate features in Amazon region - a larger cloud coverage and rainfall during the summer
- The Central region of Brazil gets a larger incidence of solar radiation during the dry season, mainly between July and September when the precipitation is low and the number of clear sky days is greater.
- The Southern region exhibits greater inter-seasonal variation due to the temperate climate and the influence of the cold systems that contributes to enhance the nebulosity, mainly in winter months.

The background of the slide is a stylized illustration of a wind farm. It features several wind turbines of varying sizes and orientations, set against a gradient background that transitions from a bright yellow sun in the upper left to a deep blue sky and a dark blue ground. The sun is a large, glowing circle. The turbines are rendered in shades of grey and blue, with some appearing more prominent than others.

Thanks ...