

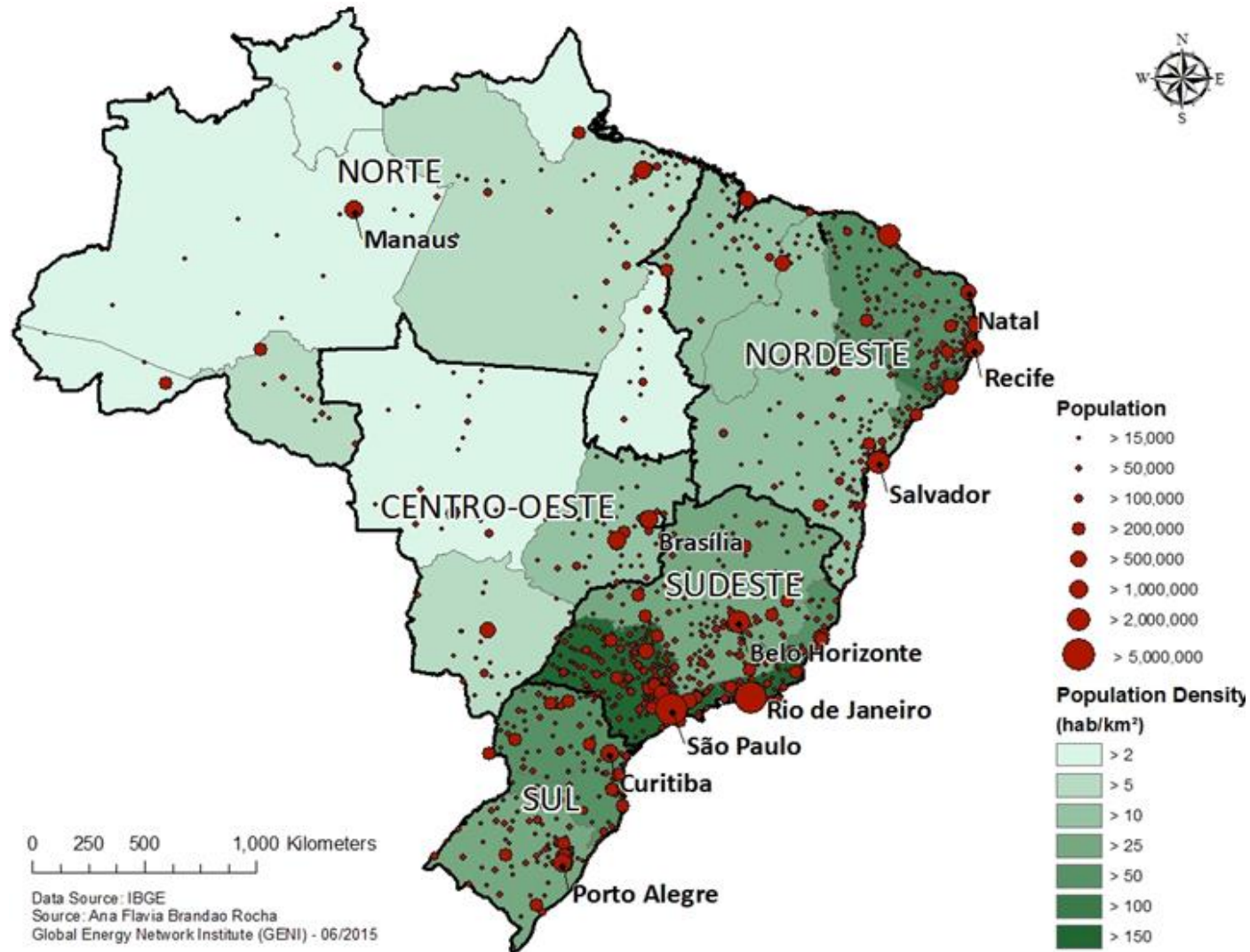
# Brazil

## Presentation 5



*Presented by*  
Ana Flavia Rocha  
Leticia Carvalho  
Renan Micha

# Population Distribution

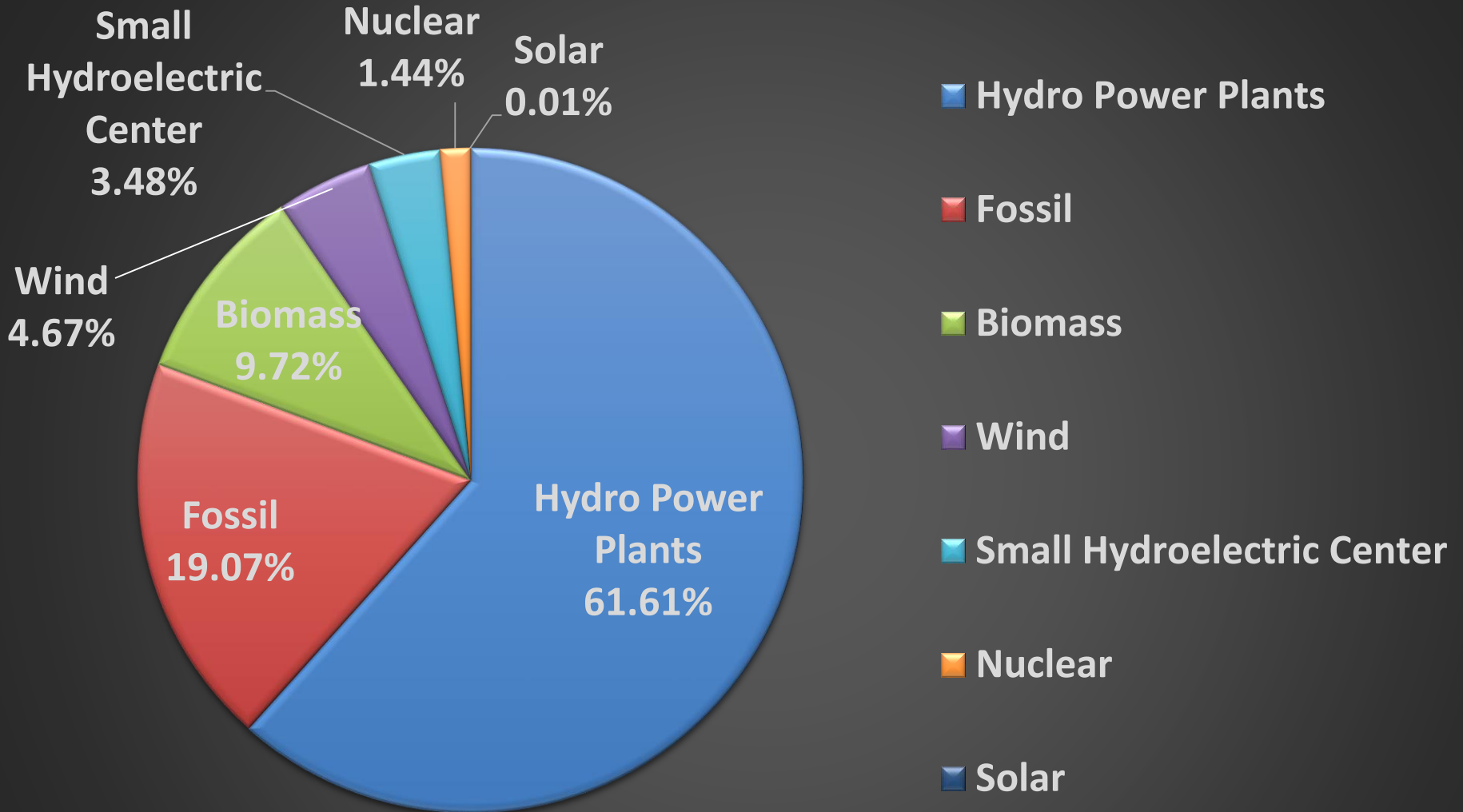


• Now: 204 million population

• In 2050: 226 million population

Source: IBGE

# Electric Generation



Most of the energy in Brazil is produced by Hydro, making the energy matrix vulnerable because of dependence on rainfall.

Source: ANEEL (Agência Nacional de Energia Elétrica)



# Sustainable & Renewable Sources for Energy

Wind



Small Hydro



Biomass



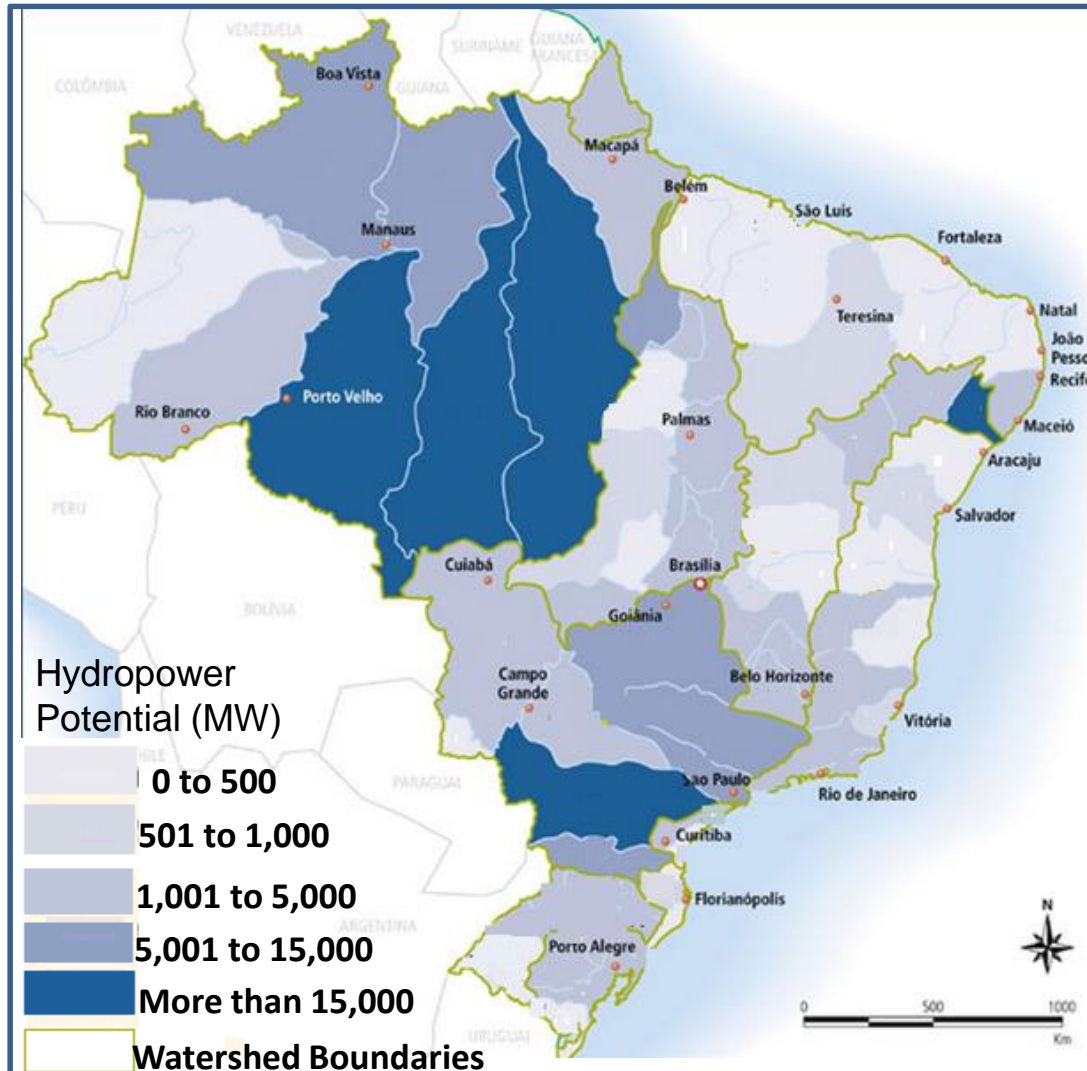
Solar



Hydro Power causes environmental and social impacts.

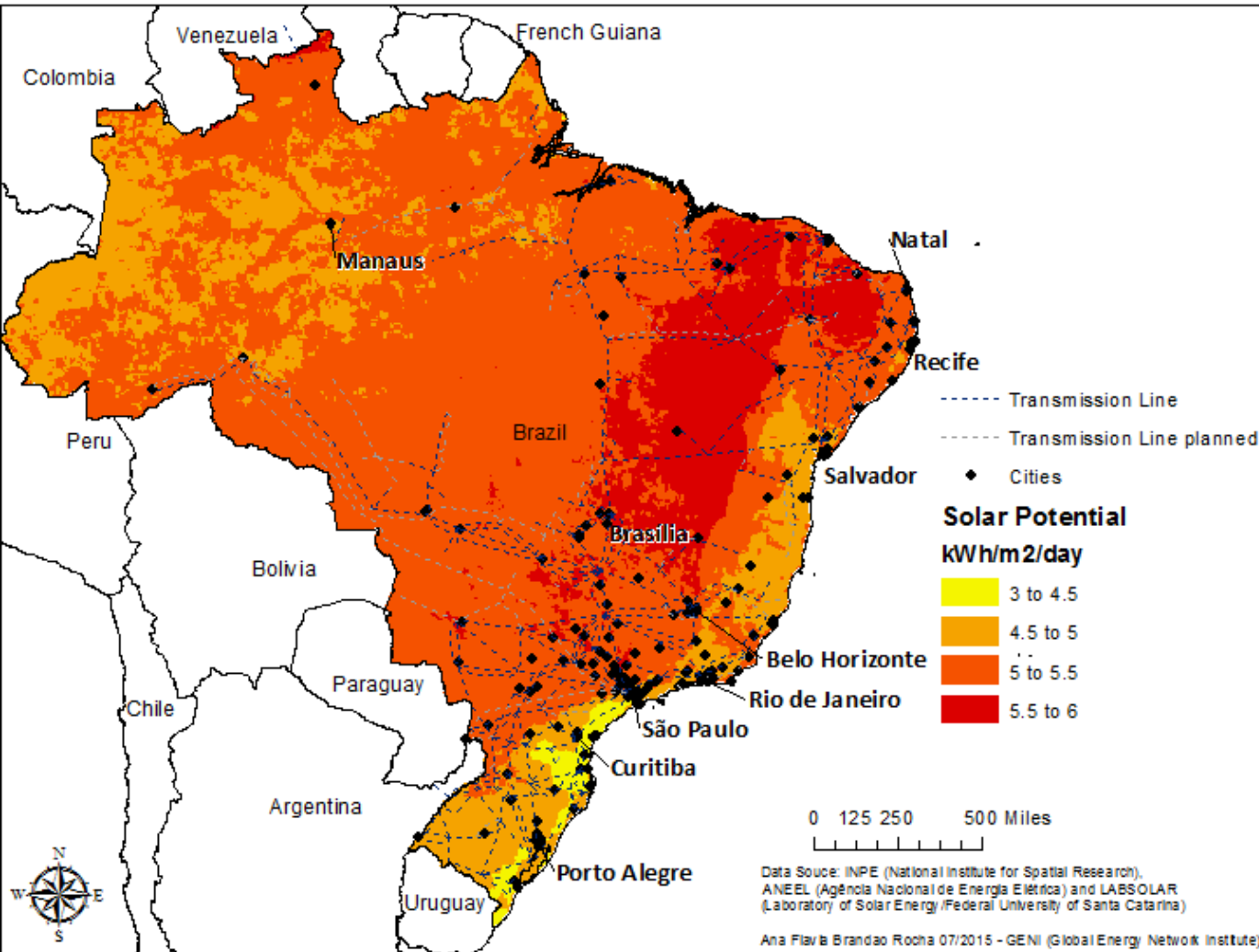
Source: WWF

# Hydropower Potential



The most promising area for hydropower production is in northern Brazil.

# Solar Energy Potential



## Steps

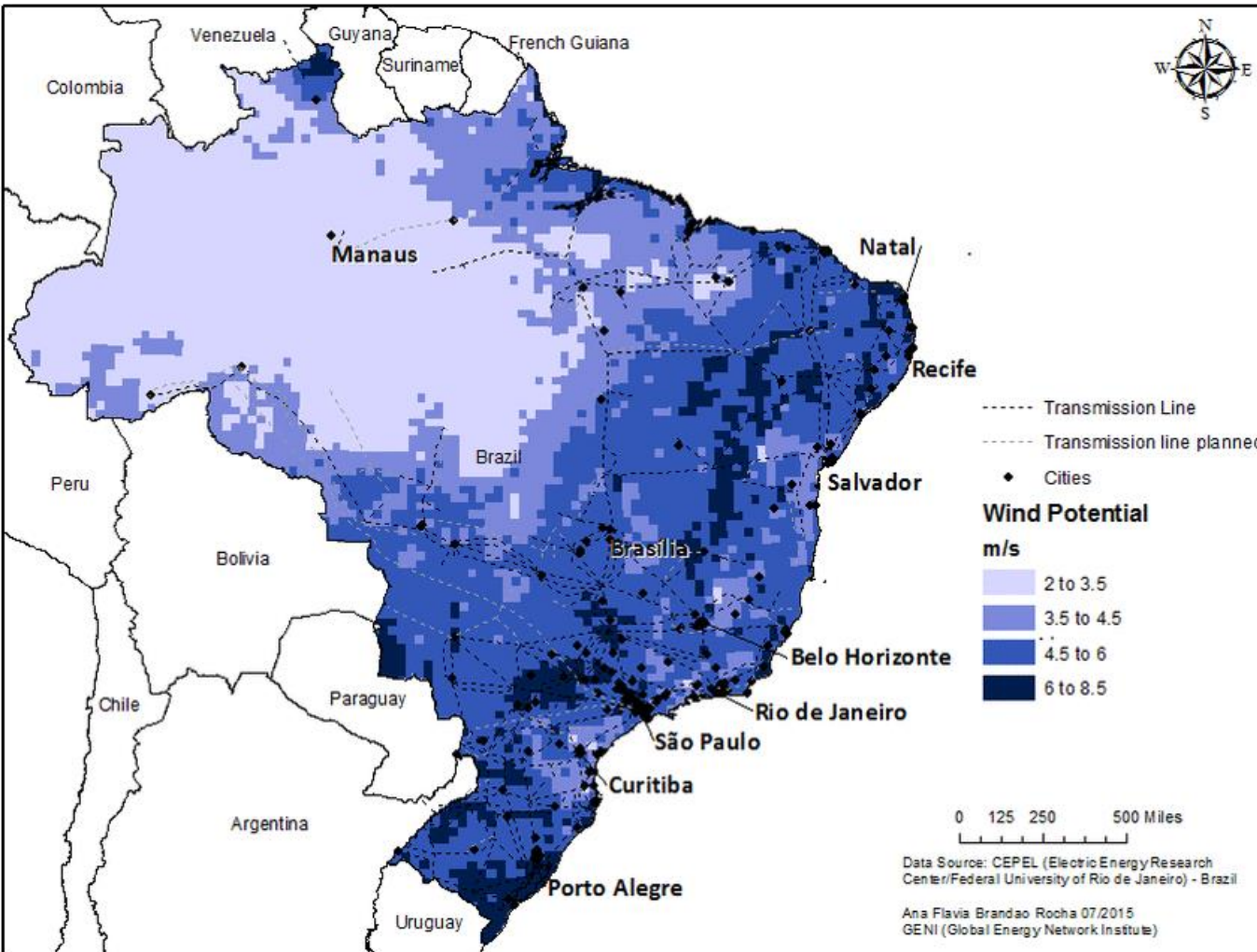
1. Brazil Solar Potential
2. Remove protected land
3. Extract areas within **100 Km** from transmission lines
4. Extract areas within **100 Km** from cities greater than **100,000** inhabitants

**Brazil has a high solar energy potential however, there are only a few solar farms in operation, producing 11.2 MW.**

Source: ANEEL (Agência Nacional de Energia Elétrica)



# Wind Energy Potential



## Steps

1. Brazil Wind Potential
2. Remove protected land
3. Extract areas within **100 Km** from transmission lines
4. Extract areas within **100 Km** from cities greater than **100,000** inhabitants

The wind energy potential in Brazil is around 140 GW. However, the total production of wind energy is 6.45GW.

Source: Ministério de Minas e Energia

# Costs of Electricity Production

Source	Cost for Installation (R\$/kW)	* Cost/MWH (R\$)	
		Minimum	Maximum
Hydro Power Plants	3450	60.63	101.35
Small Hydroelectric Center	5000	112.47	161.96
Wind	3350	89	118
Biomass	3000	91	131
Nuclear	3000	155	192.68
Natural Gas	3000	173.58	
Coal	2750	133.55	
* Costs related to the amount of electricity produced per year, the initial investment, operating and maintenance, fuel prices, among other factors			

Wind and biomass are comparable in cost to hydro.

Source: WWF



# PROINFA Incentives

(Incentive program for renewable electric energy )

- ✓ **Promote the diversification of the Brazilian energy matrix**
- ✓ **Increase security in the electric power supply**
  - **50% Transmission discount for renewables**
  - **80% Transmission discount for solar farms.**



Source: WWF and Ministério de Minas e Energia

# Others Incentives



## BNDES (National Bank for Economic and Social Development)

### ✓ Climate Fund Program

- Incentives for solar energy
- Companies, Government, residential and rural areas

### ✓ Credit Line for Alternative Energy

- Credit line for projects of power generation by alternative renewable sources. Maximum financeable: 80%.
- Legal entities and Brazilian companies

Source: WWF

# Individual power generation Incentives

## Residential Bank Construction Loans

- Low interest rates.
- Small generation tied to the grid.
- Biomass, wind, solar or hydro sources
- The maximum 1MW



## Rural Areas and in Amazon communities

- Individual power generation and small distribution networks
- Use renewable sources or fossil fuels.
- The Program “Lights for All” finances 85% of the costs of these systems.

Source: WWF and ABDI (Agência Brasileira de Desenvolvimento Industrial)



# Recommendations

**Diversify the Energy Matrix with renewable sources!!**

- ✓ **Larger Power Plants of wind and solar sources → Less production costs**
- ✓ **Increase the solar farms in all regions of Brazil**
- ✓ **Increase the wind farms in the northeast and southeast region**
- ✓ **Less reliance on Hydro Plants**
- ✓ **Make more incentives for small scale Renewables Power Plants**
- ✓ **Increase the Incentives for large scale wind, and solar power plants**
- ✓ **Provide Incentives for industrial self-generation using renewable sources**



# THE ROAD MAP FOR A SUSTAINABLE TRANSPORTATION SYSTEM

## KEYPOINTS FROM THE CURRENT PROBLEM IN THE TRANSPORTATION SECTOR IN BRAZIL...

- **LOW INTERCONNECTION AND DIVERSIFICATION AMONG TRANSPORTATION MODES FOR THE TRANSPORTATION OF GOODS THROUGHOUT THE COUNTRY**

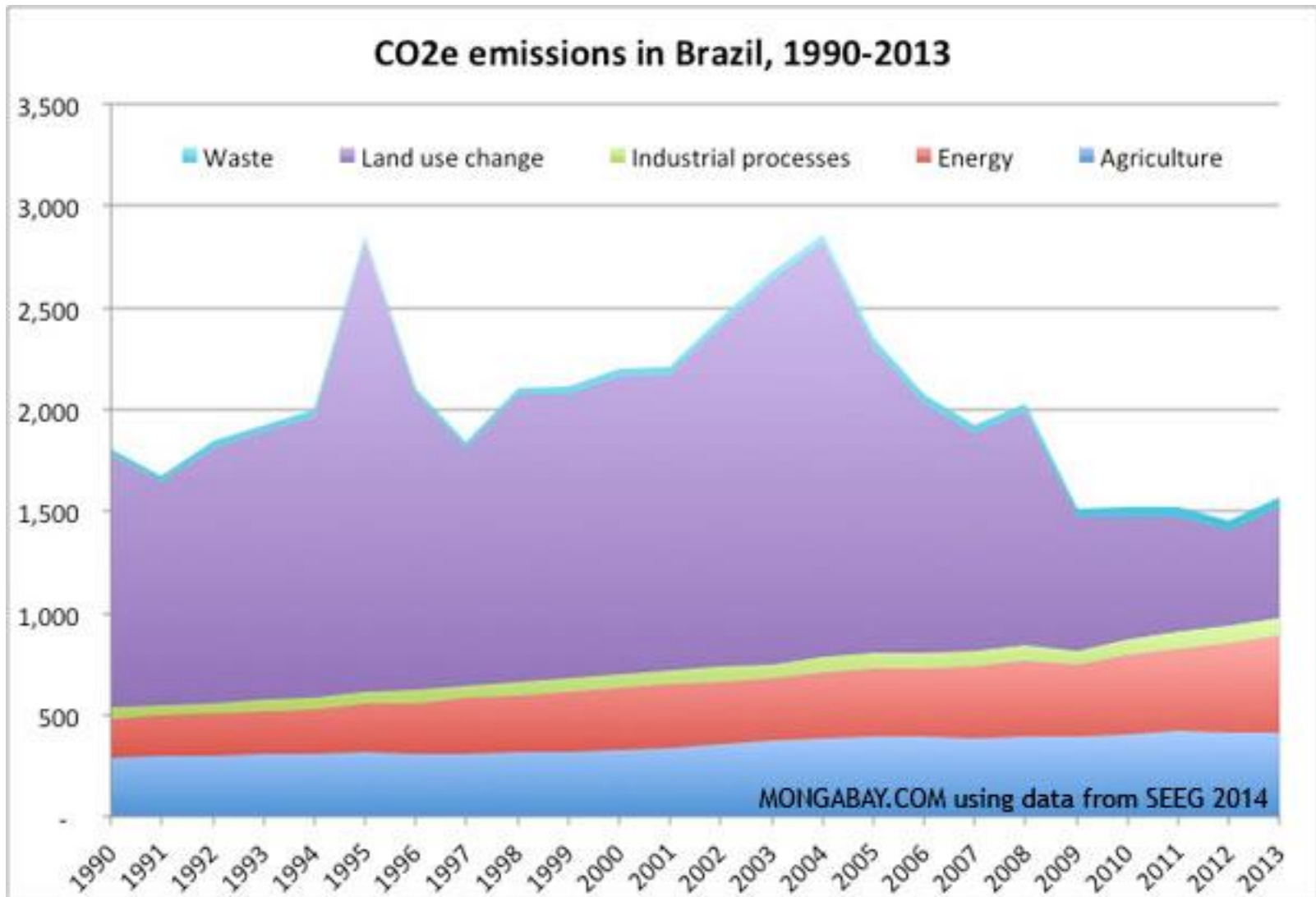
RELATED TO THE DIVERSIFIED SYSTEM...

- LOWER EFFICIENCY
- HIGHER USE OF FOSSIL FUELS
- HIGHER CO<sub>2</sub> EMISSIONS

THE SOLUTION: DIVERSIFY AND INTEGRATE THE *TRANSPORTATION FREIGHT SYSTEM*



## Major causes of CO<sub>2</sub> emissions: Deforestation and Energy Use



44% of the energy emissions comes from road transportation

Emissions are much higher in road freight than ocean or rail

**57%** Heavy-duty trucks account for the dominant share of all logistics-related greenhouse gas (GHG) emissions.



Source: World Economic Forum

Source: world economic forum

RAILROADS AND WATERWAYS ARE WAY MORE EFFICIENT FOR ENERGY USE

## Comparison of distances transported for one tonne of freight given the same energy input



Source: Federal Waterways and Shipping Administration



# KEYPOINTS FROM THE CURRENT PROBLEM IN THE TRANSPORTATION SECTOR IN BRAZIL...

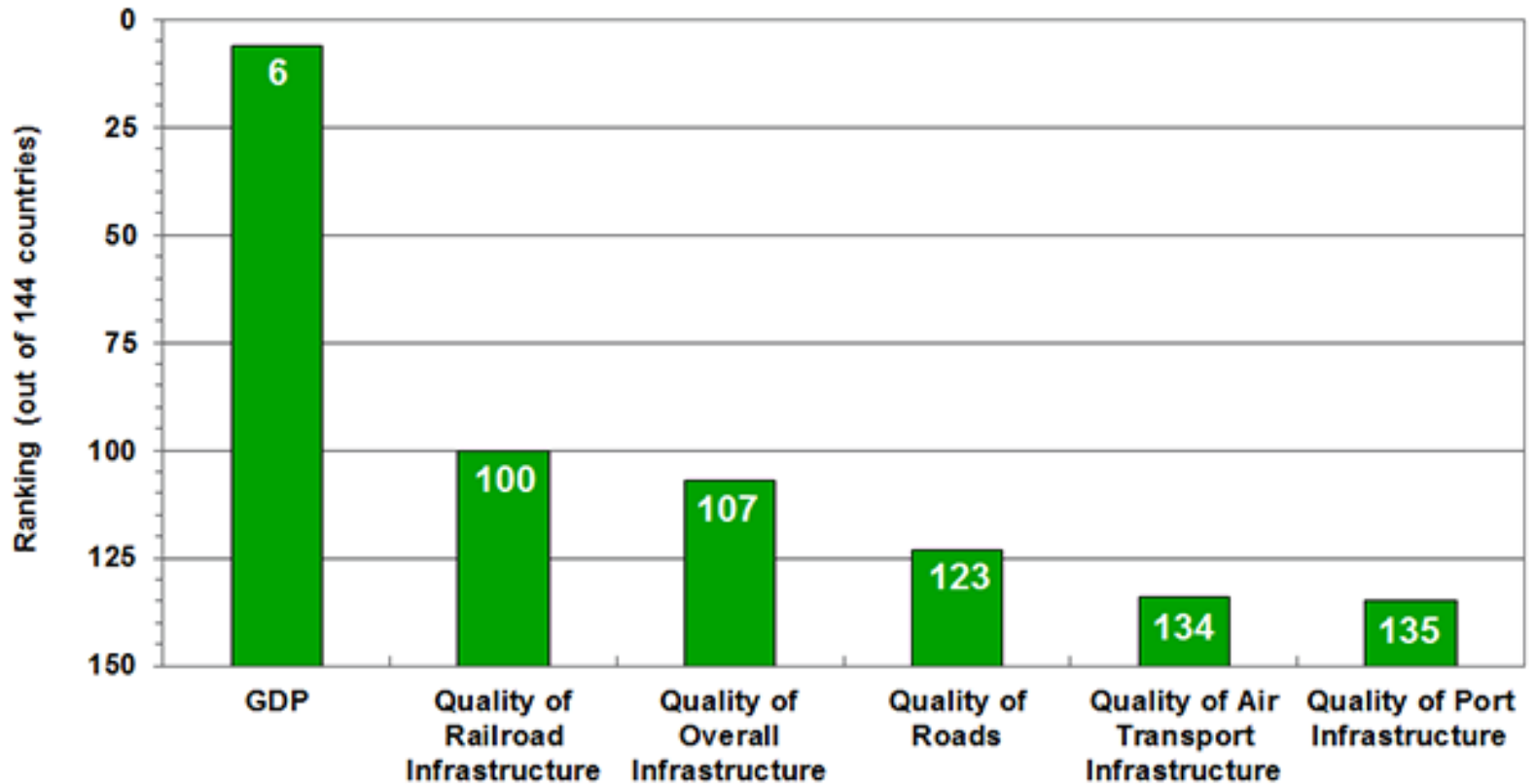
## - LACK OF INVESTMENTS ON INFRASTRUCTURE

- DRIVE HIGHER DISTANCES
- HARM VEHICLES COMPONENTS AND ECONOMY
- MORE CO<sub>2</sub> EMISSIONS

Recommendation: **INVEST A HIGHER FRACTION OF GDP IN INFRASTRUCTURE**



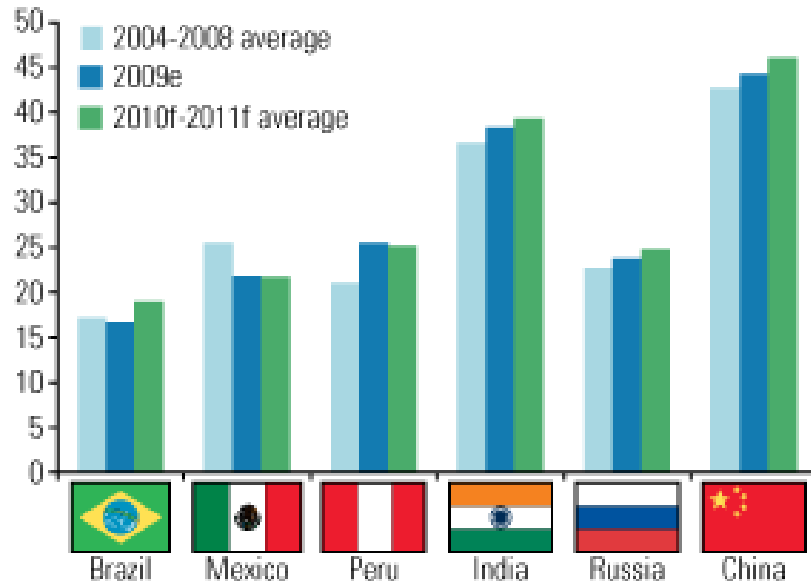
**Figure 1 – Brazil’s GDP and Infrastructure Quality Rankings (inverted scale, 2012)**



Source(s): World Economic Forum and MAPI

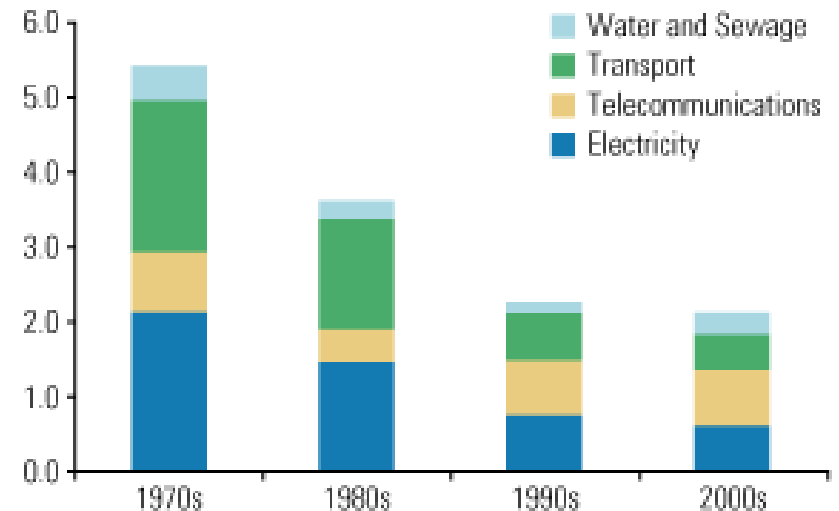
## Brazil Needs to Ramp Up Its Infrastructure Spending

Investment-to-GDP ratio as a % of GDP



Source: Standard and Poor's, Morgan Stanley LatAm Economics \*e = Estimate, f = Forecast

Brazil's Infrastructure investment as a % of GDP



Source: World Bank, IPEA, BNDES (see Bielchowsky 2002, Blyde, Castelar Pinheiro, Daude and Fernandez-Arias 2007, and Frischtak 2007)

Brazil used to spend 2% of its GDP in Transport's infrastructure in 70s. Today, this number is smaller than 0.5%.

## KEYPOINTS FROM THE CURRENT PROBLEM IN THE TRANSPORTATION SECTOR IN BRAZIL

### - **BIG TRAFFIC JAMS IN MAJOR CITIES**

- TARDINESS/ABSENCE OF EMPLOYEES
- BAD QUALITY OF LIFE (STRESS/LONG TIME DRIVING)
- POLLUTION (HEALTH PROBLEMS/ CLIMATE CHANGE)

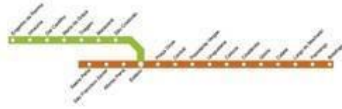
**SOLUTION: BUILD MORE COMPLEX SUBWAY'S NETWORK, EXPAND BUS RAPID TRANSIT AND LIGHT RAIL, INCENTIVE WALKING AND THE USE OF BIKES CREATING NEW BIKEWAYS.**





## Public transportation in big cities

Rio de Janeiro, 1993



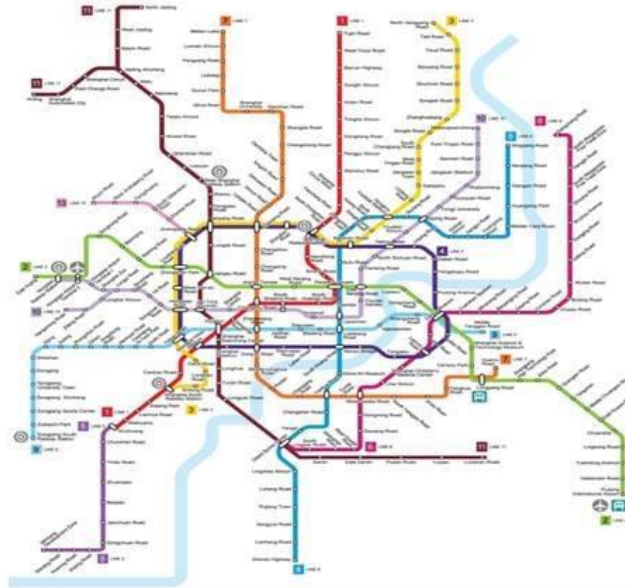
Xangai, 1993

(sem metrô)

Rio de Janeiro, 2013



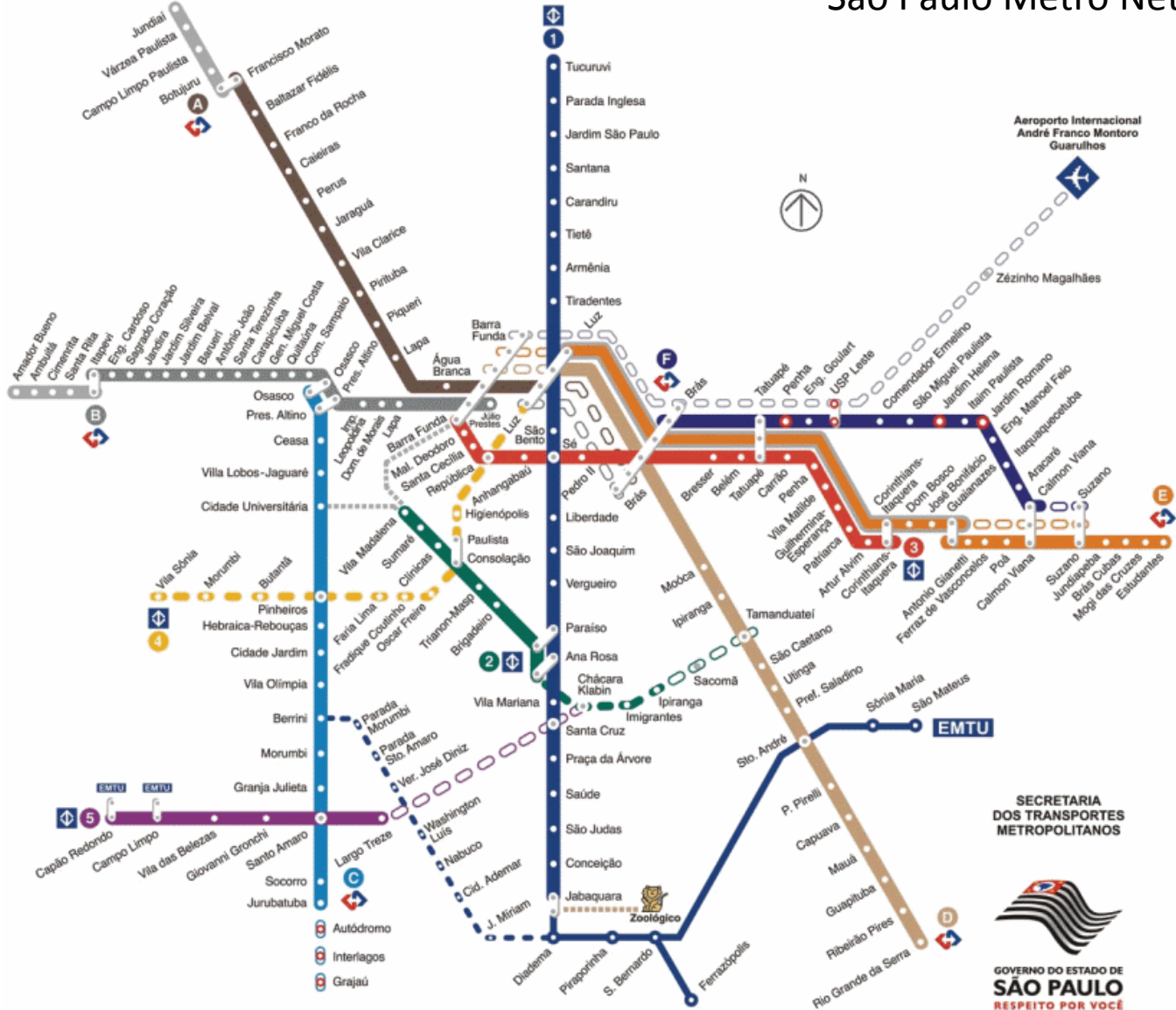
Xangai, 2013



FOR BIG CITIES LIKE RIO DE JANEIRO (>1MI PEOPLE/DAY\*) AND SÃO PAULO (>6MI PEOPLE/DAY\*), IT IS IMPERATIVE TO DEVELOP AN EFFECTIVE SUBWAY NETWORK.

\*(BRT, SUBURBAN RAIL, METRO, BUS)

# São Paulo Metro Network



## CO2 EMISSIONS BY TRANSPORTATION MODES

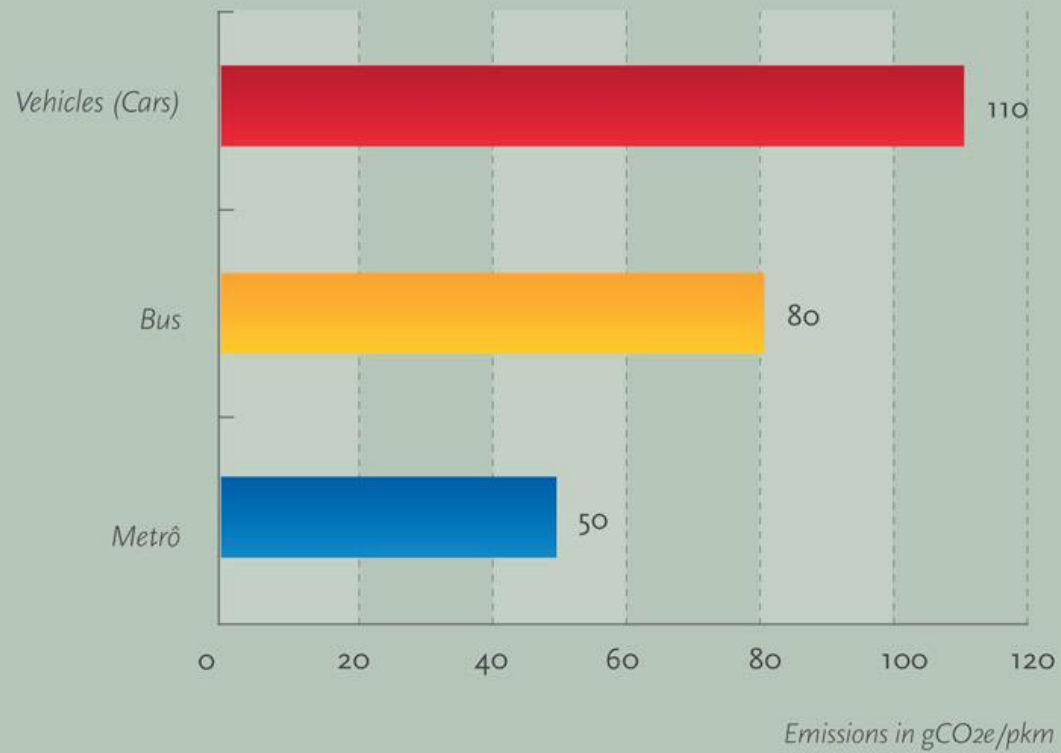


Figure 2 GHG emissions per pkm – Worldwide reference values  
Source: Energy Costs, Renewable and Emissions of CO<sub>2</sub>e. NOVA, 2008.



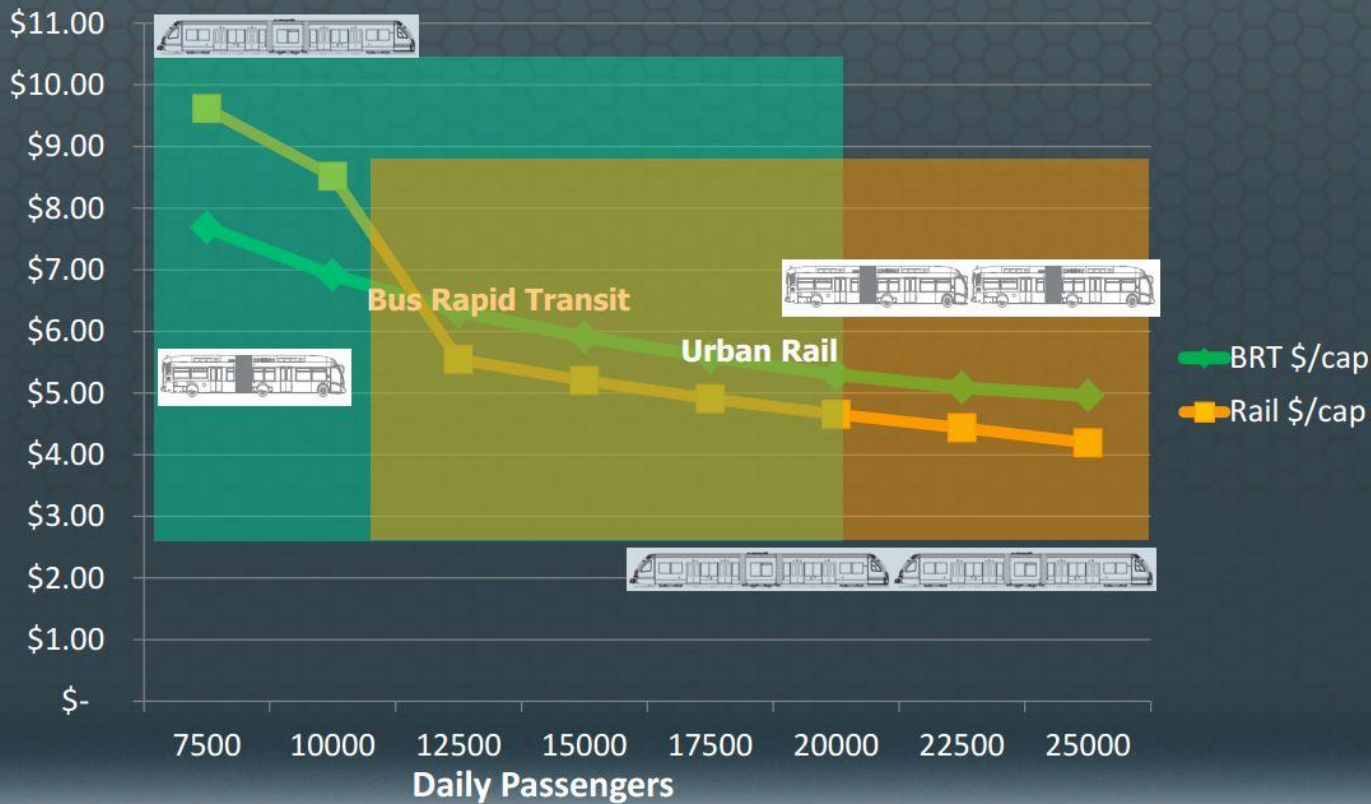
# Light Rail and Bus Comparison

	Agency	System Rev Miles / Rev Hrs	Op Cost per Passenger Mile	Operating Cost / Passenger	Fare Recovery
Light Rail	Puget Sound (planned)	26.5 mph	\$0.15	\$1.60	40.0%
	San Diego	17.4 mph	\$0.26	\$1.63	50.8%
	Denver	17.4 mph	\$0.59	\$3.09	26.6%
	St. Louis	25.9 mph	\$0.34	\$2.46	31.0%
	Portland	15.6 mph	\$0.39	\$2.02	37.4%
	Dallas	21.4 mph	\$0.59	\$4.32	35.1%
	<b>Average</b>	<b>20.7 mph</b>	<b>\$0.39</b>	<b>\$2.52</b>	<b>36.8%</b>
Bus	Puget Sound (avg)	13.8 mph	\$1.12	\$5.34	23.4%
	San Diego	11.8 mph	\$0.78	\$2.94	30.4%
	Denver	15.2 mph	\$0.67	\$3.46	26.4%
	St. Louis	13.4 mph	\$0.93	\$3.52	21.7%
	Portland	12.8 mph	\$0.82	\$3.08	20.0%
	Dallas	13.9 mph	\$0.83	\$3.66	4.5%
	<b>Average</b>	<b>13.5 mph</b>	<b>\$0.86</b>	<b>\$3.67</b>	<b>21.1%</b>
Conclusion		LRT is 54% faster	LRT is 55% cheaper/mile	LRT is 31% cheaper/passenger	LRT is 74% better at the farebox

National Transit Database



# PRICE PER "POUND" OF CAPACITY



**PROJECT CONNECT**  
REGIONAL HIGH-CAPACITY TRANSIT IMPLEMENTATION



[Austinrailnow.com](http://Austinrailnow.com)

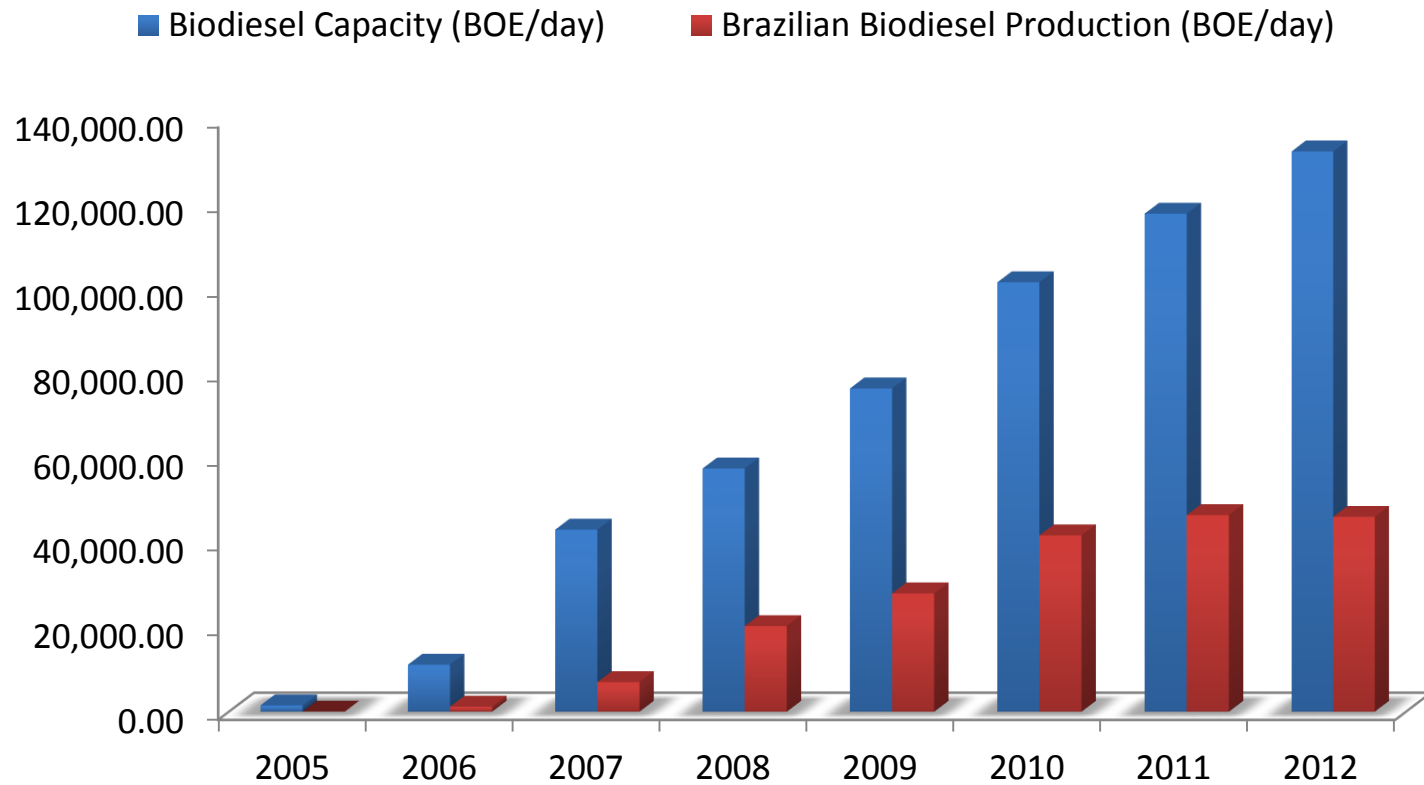
“Metro and urban light-rail systems are costly to construct and to maintain but can provide significant long-term economic, social and environmental benefits. Various studies analyzing investment in urban public transport infrastructure and services have shown that in the long term the sum of public benefits by far exceed the investment costs.”

“Urban public transport systems are more attractive for commuters and more economically viable for operators if they offer the option to travel from any point in the city to any other point. This can be achieved through the expansion of network as well as through intermodal connections.”

-UNITED NATIONS

## USE ALTERNATIVE FUELS OR TYPE OF CARS

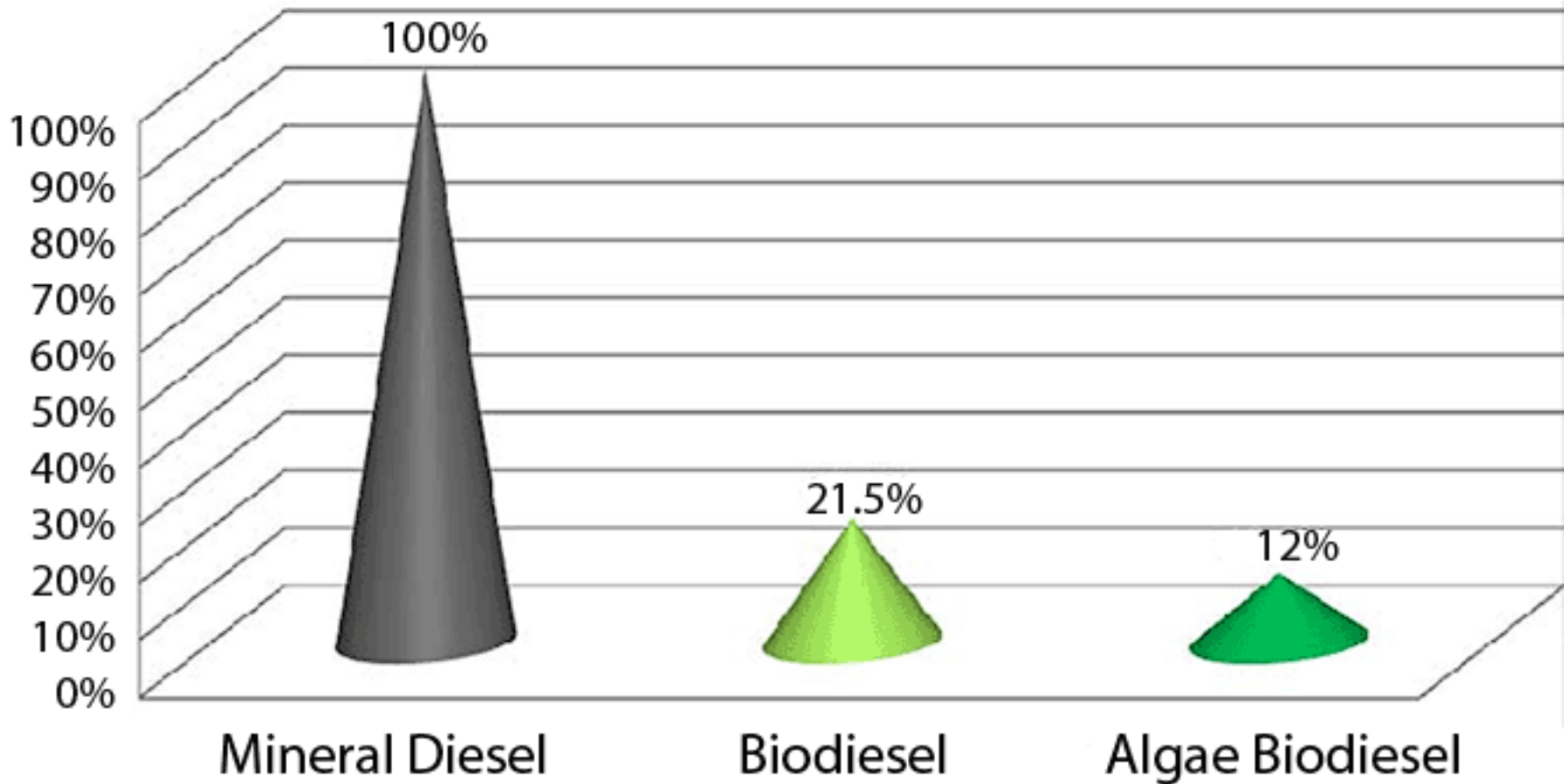
### NATIONAL CAPACITY AND PRODUCTION



E27.5 (max) and B7 – blend mixes

WE CAN INCREASE THE PRODUCTION WITHOUT CLEANING NEW LANDS. ABOUT 60% OF OUR BIODIESEL CAPACITY IS NOT BEING USED. NEW CAPACITY SHOULD COME FROM NEW GENERATION BIOFUELS

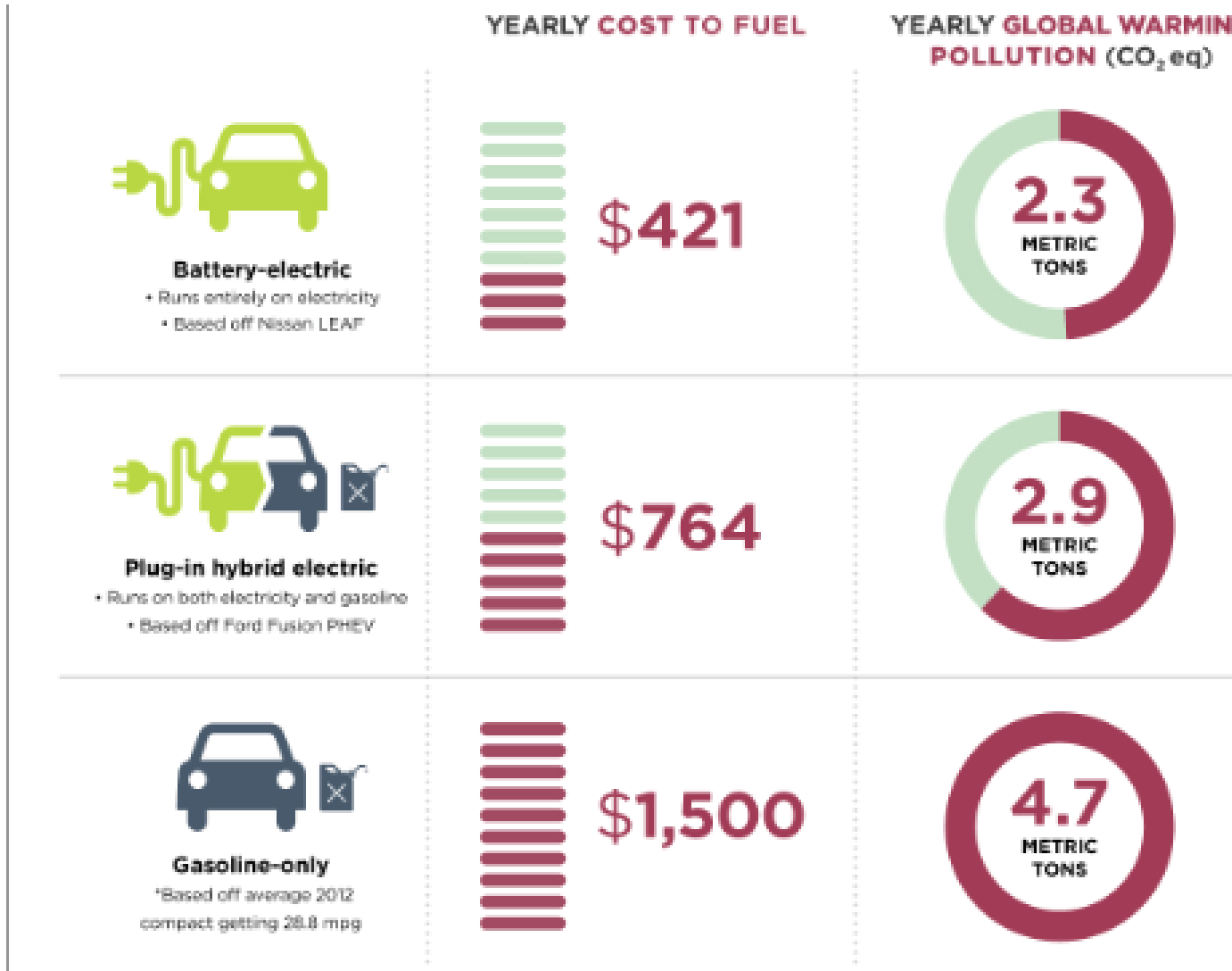
## CO2 emissions output on 100% biofuel burnt



Source: National Research Energy Laboratory (US) and Massachusetts Institute of Technology



# SOLAR CARS: COST EFFECTIVE ON THE LONG TERM. BUT NOT IN COUNTRIES WITH HUGE COSTS FOR ELECTRIC CARS AS BRAZIL (R\$200,000 OR U\$58,000)



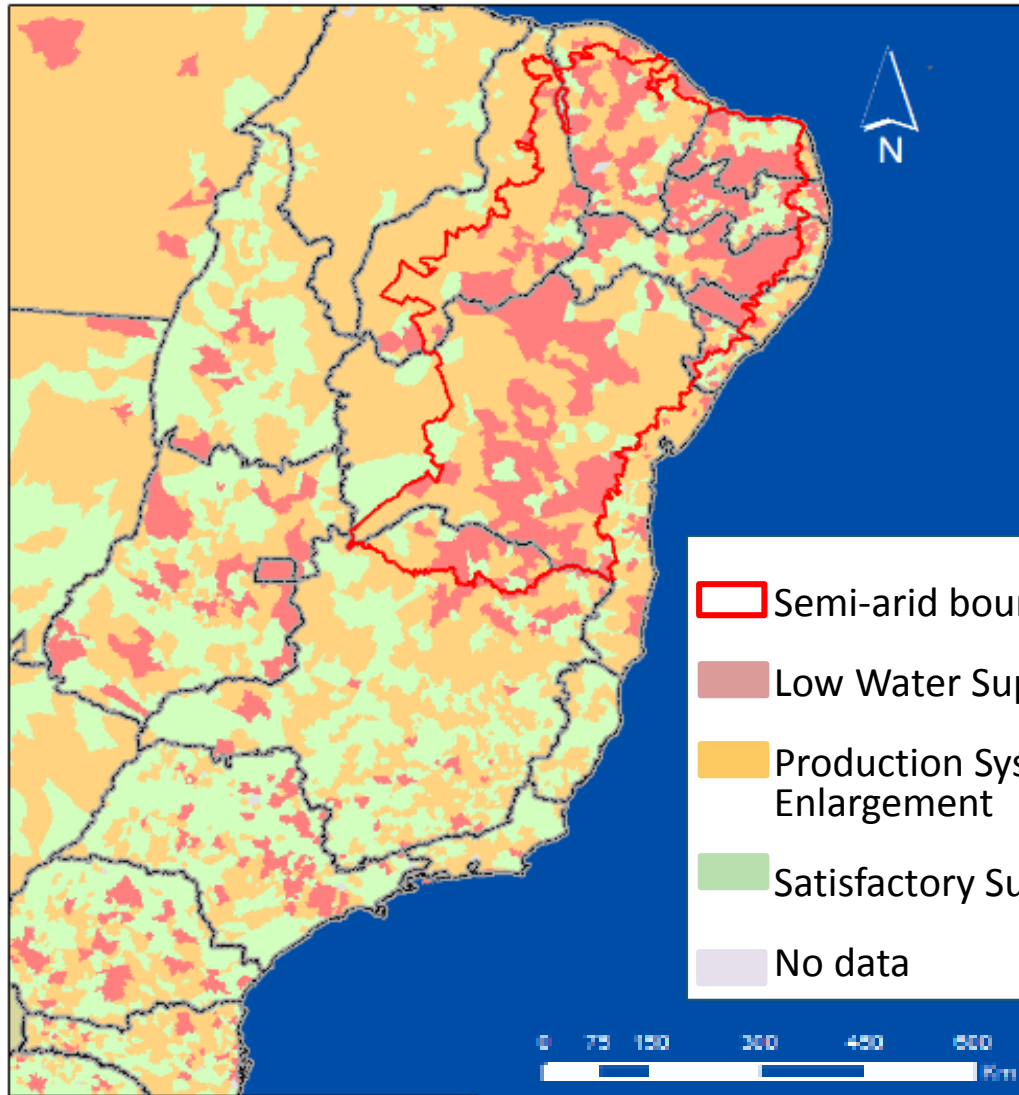
# Road Map: Clean Water for All

## Brazil

# Recap

## Water Volume by Basin

### Situation of the Urban Water Supply of Brazilian Cities



Sources: Brazilian National Water Agency (ANA), Instituto Brasileiro de Geografia e Estatística, United Nations FAO Aquastat

# Northeast Persistent Drought: São Francisco River Transposition

ANA (Water National Agency) Resolution #411 granted in 2005 authorization to the Ministry of National Integration the right to divert water resources of the São Francisco river to the “São Francisco River Integration Project”.



Source: ANA – Portal Brasil



# Northeast Persistent Drought: São Francisco River Transposition

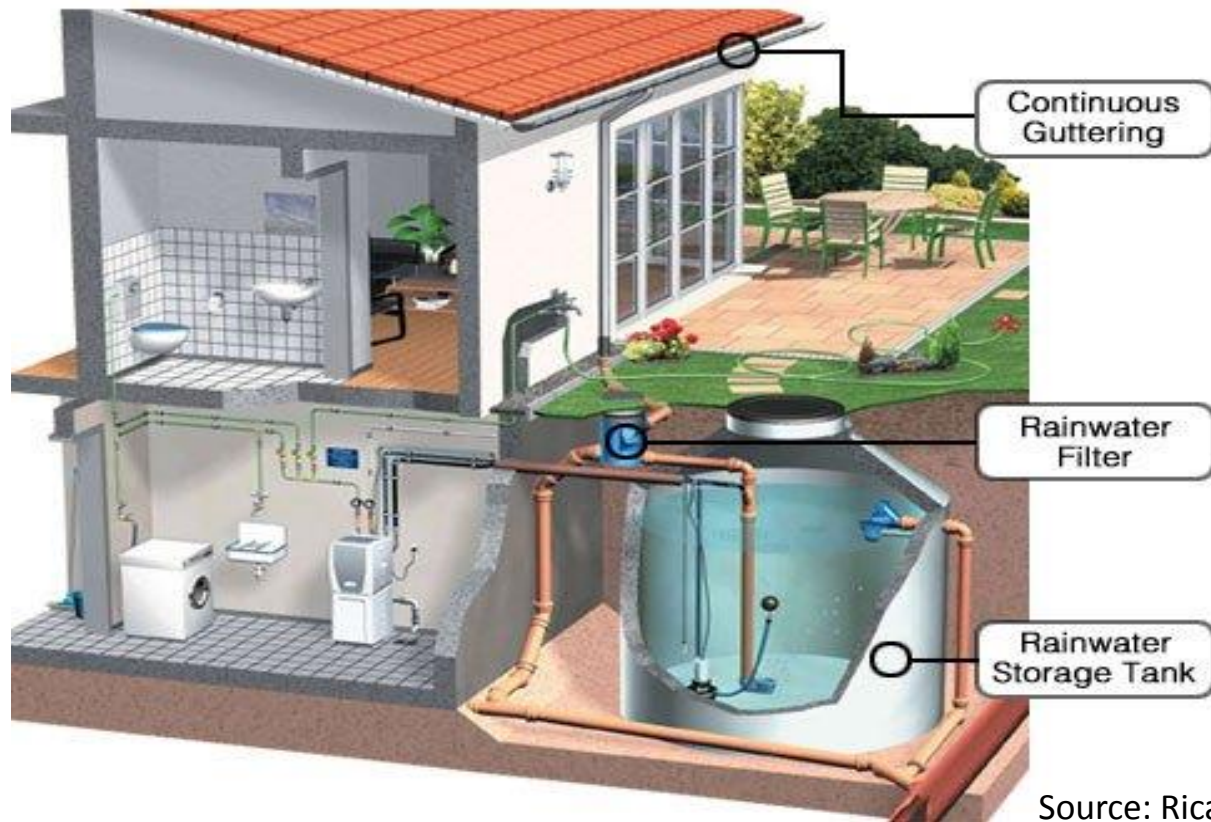
- ✓ Increase water availability through the reservoirs.
- ✓ Rise incomes and trading of the affected regions.
- ✓ Supply up to 12.4 million people in the cities.
- ✓ Reduce illness and deaths caused by contaminated water or lack of water.
- ✓ Supply rural areas with good water quality.
- ✓ The supply of water will help 400,000 people in rural area.



Source: The Economist, 2015

# Residential Rainwater Capture

- ✓ Water from the roofs of houses is stored in a cistern.
- ✓ A model for public housing can meet almost 100% of the domestic water use during rainy seasons.



Source: Ricardo Motta Pinto-Coelho

# University Rainwater Storage

The Federal University of Lavras (UFLA) ranks the 26<sup>th</sup> position in the UI Green Metric World University Ranking

Reservoir →



- ✓ Consumption is 200,000 gallons of water per day.
- ✓ The Water Treatment Plant (WTP) in operation processes 160,000 gallons daily.
- ✓ A new structure will be able to store more than 300,000 gallons/day.
- ✓ This has a positive impact on teaching and researching, and ensuring savings of US\$ 1 million yearly.

Source: Portal UFLA, 2015



# Water Waste vs. Savings

Brazil is one of the countries with higher clean water waste in the world.

## Why Saving?

In 2013, the Brazilian government invested more than \$6.5 billion on water and sewage treatment in Brazil. **If this waste was reduced there will be proportional savings.**

ANA, 2010 (Atlas Brasil de Abastecimento Urbano de Água); 2012-2013



# Replace and Fix Old Pipes

- ✗ In the big São Paulo, 19.4% of all treated water is lost between the treatment plant and the water tank of consumers.

## ✓ Cast Iron to PVC or HDPE

The cast iron pipes allow a loss of **20%** of the volume of water passing through the canal. The PVC pipes implementation avoids the waste, besides increasing the diameter of the pipeline.



## ✓ Pipeline Rehabilitation

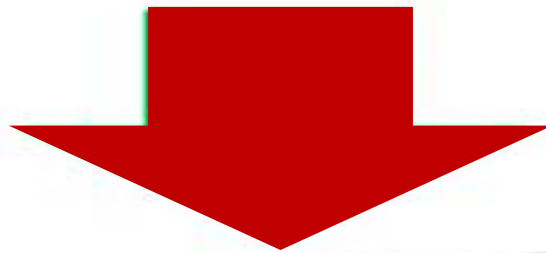
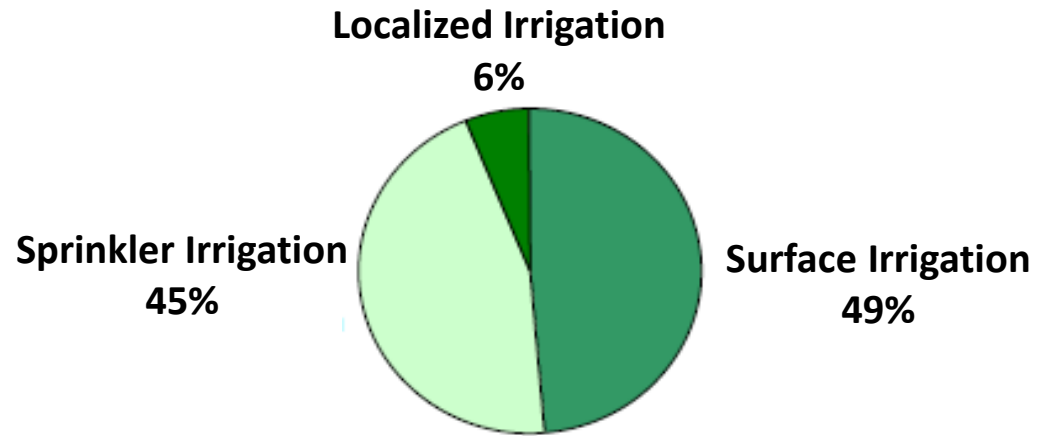
Old and deteriorated mains and laterals are lined with a hard plastic, reinforcing the old pipes, improve the system, and ultimately extending the service life of the old pipes.



Source: Sistema Nacional de Informações sobre Saneamento (SNIS) & Capital Improvements Program (CIP)

# Changing the Irrigation Techniques in Brazil: Drip Irrigation

- Brazil uses around 70% of its water to agriculture sector.
- In 2013, 45% of that was lost due to wasteful practices.



## Flood Irrigation:

- ✗ Uses more electricity as compared to drip
- ✗ Requires more labor as compared to drip;  
24 hours vs 1-2 hours

## Drip Irrigation:

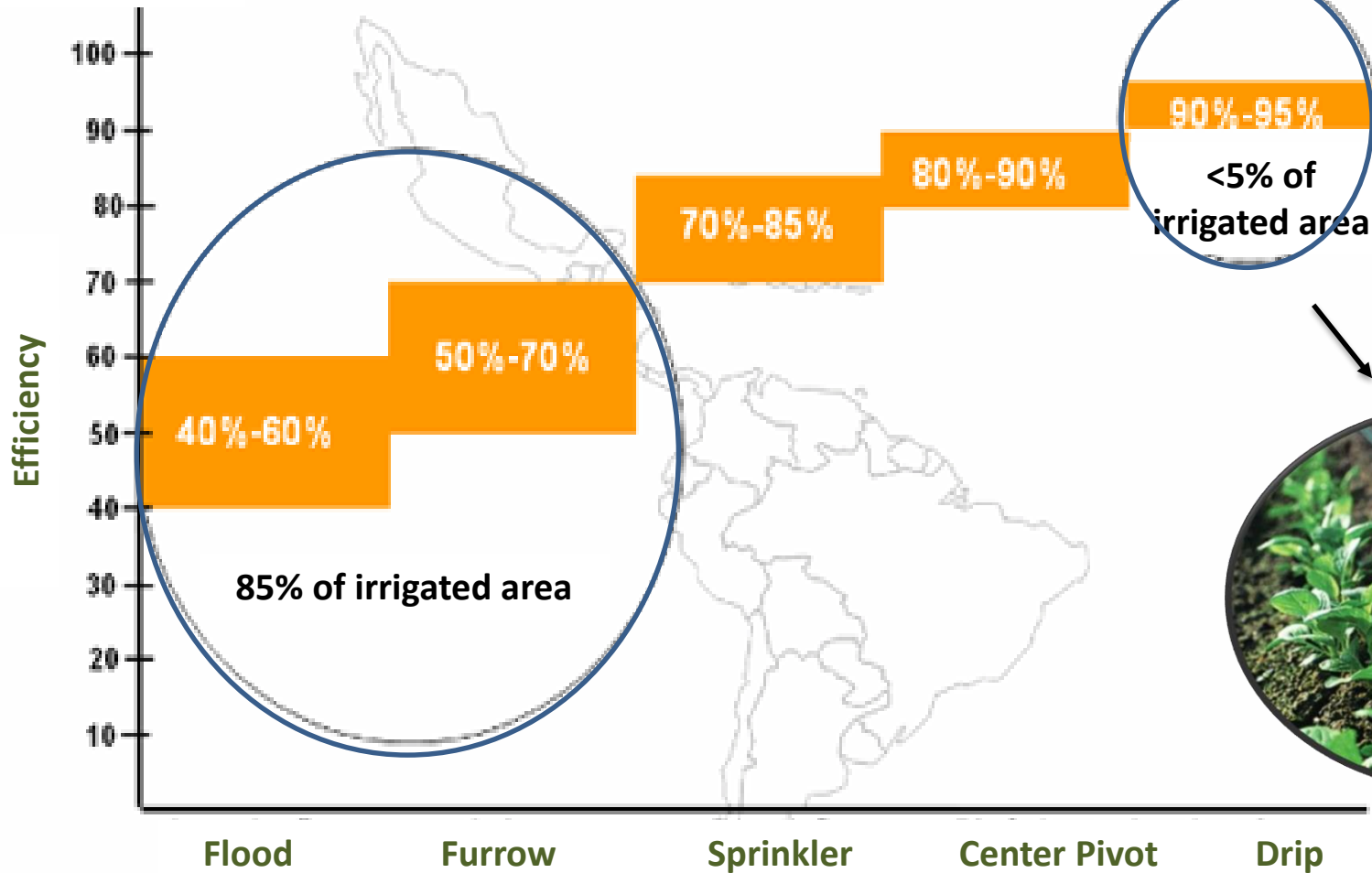
- ✓ Higher Production ✓
- ✓ 20-25% Less Water Used ✓



Source: AQUASTAT – FAO's data

# Drip Irrigation Efficiency

Irrigation (%)



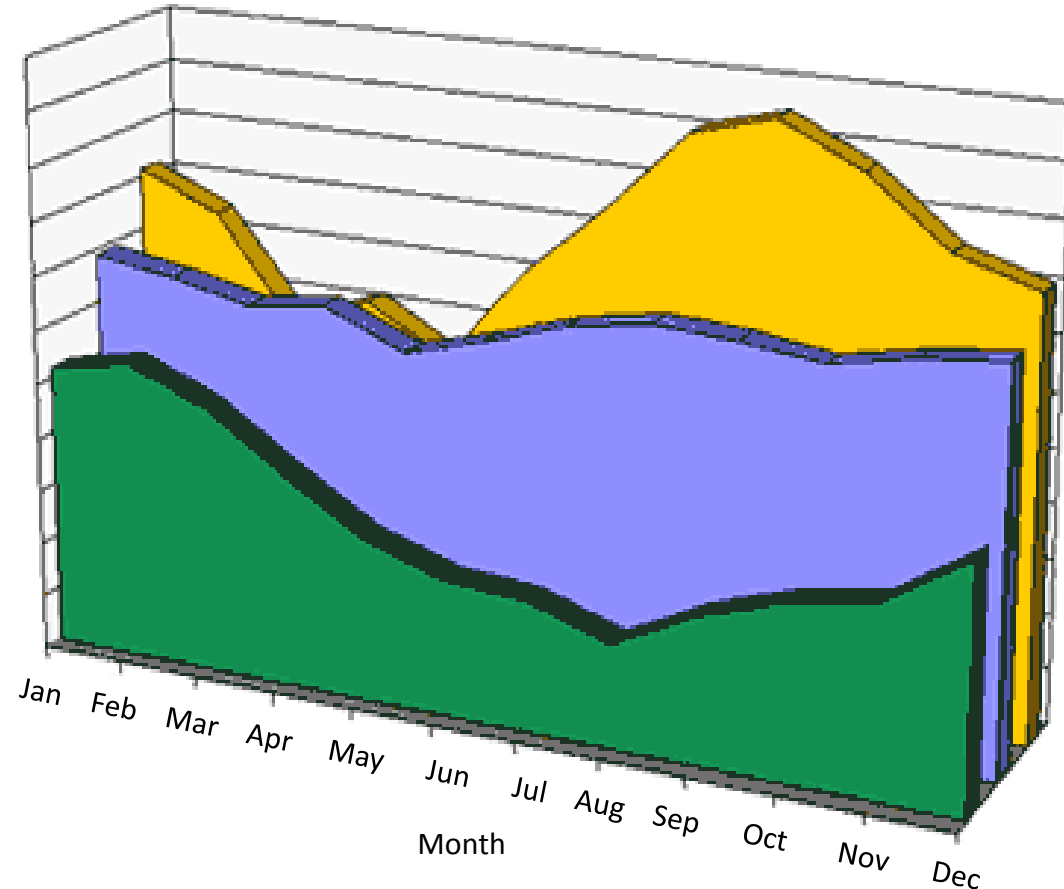
Efficiency of methods of irrigation and the amount of land that it is applied to.

Source: Portal Dia de Campo, [www.diadecampo.com.br](http://www.diadecampo.com.br)

# The Northeast: Brazil's Semi-arid Region

Comparison between the Rio Sao Francisco water flow and the wind occurrence in the Northeast

■ Sao Francisco River flow    ■ Typical wind on land    ■ Typical wind on coast

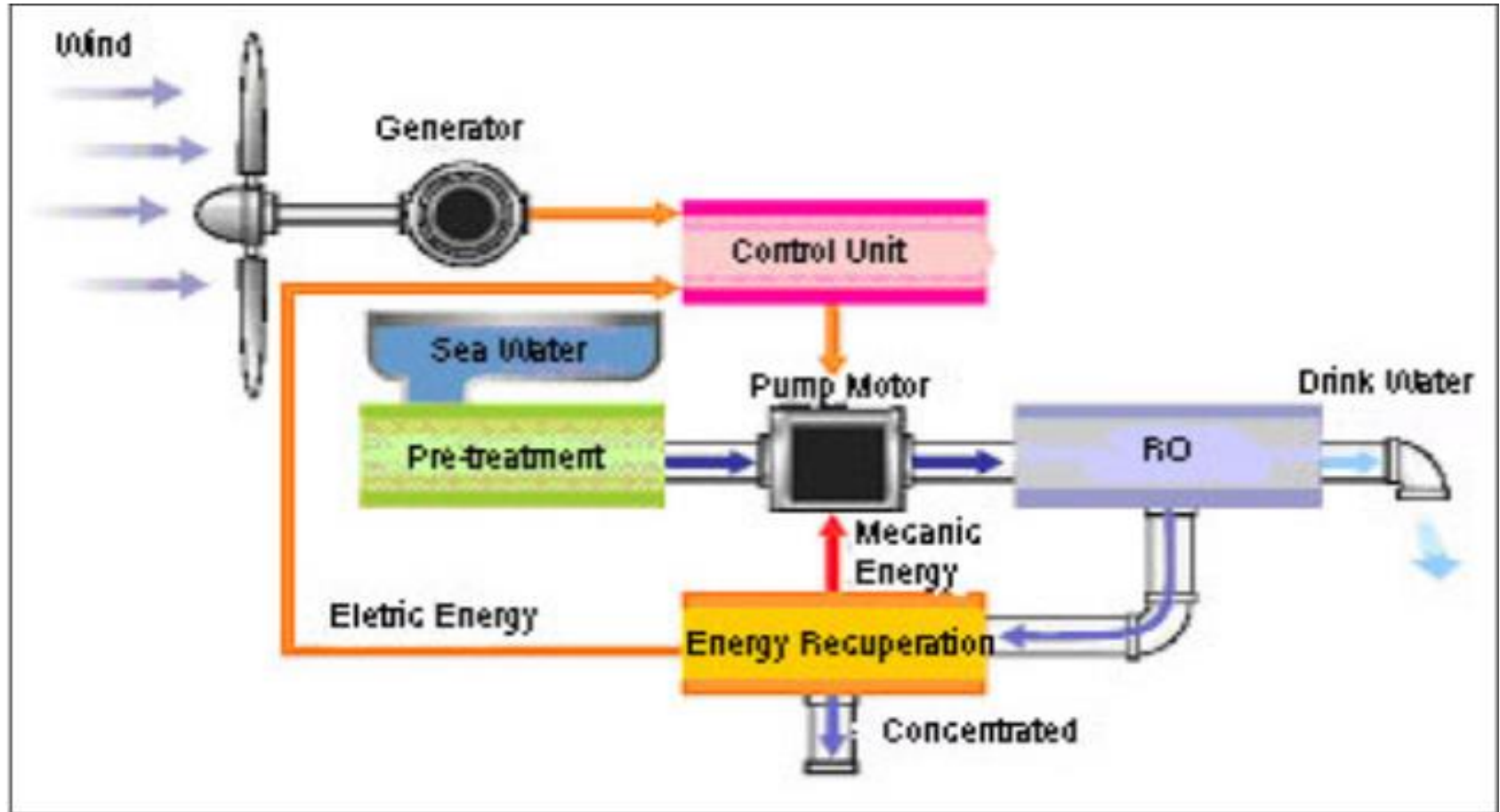


Source: Centro Brasileiro de Energia Eolica



# Desalination

Wind Energy Converter Powered Reverse Osmosis (WEC-RO) plants are a technically promising option in water-scarce regions with plenty of wind.



Source: P. C. M. Carvalho, D. B. Riffel & L. G. Coelho Junior, DEE – Universidade Federal do Ceará

# Questions



Thanks, Peter, Ron and GENI, for the unique experiences!

Thanks, the Audience, for coming!

Hope you all have had a great night...

# Presenters

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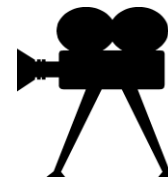
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*GIS Mapping  
Software*



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