



IEE USP

INSTITUTE OF ENERGY AND ENVIRONMENT  
UNIVERSITY OF SAO PAULO

# The Brazilian Network for Shale Gas The View of Cenpetro (IEE-USP)

Colombo C. G. Tassinari and Ildo Sauer

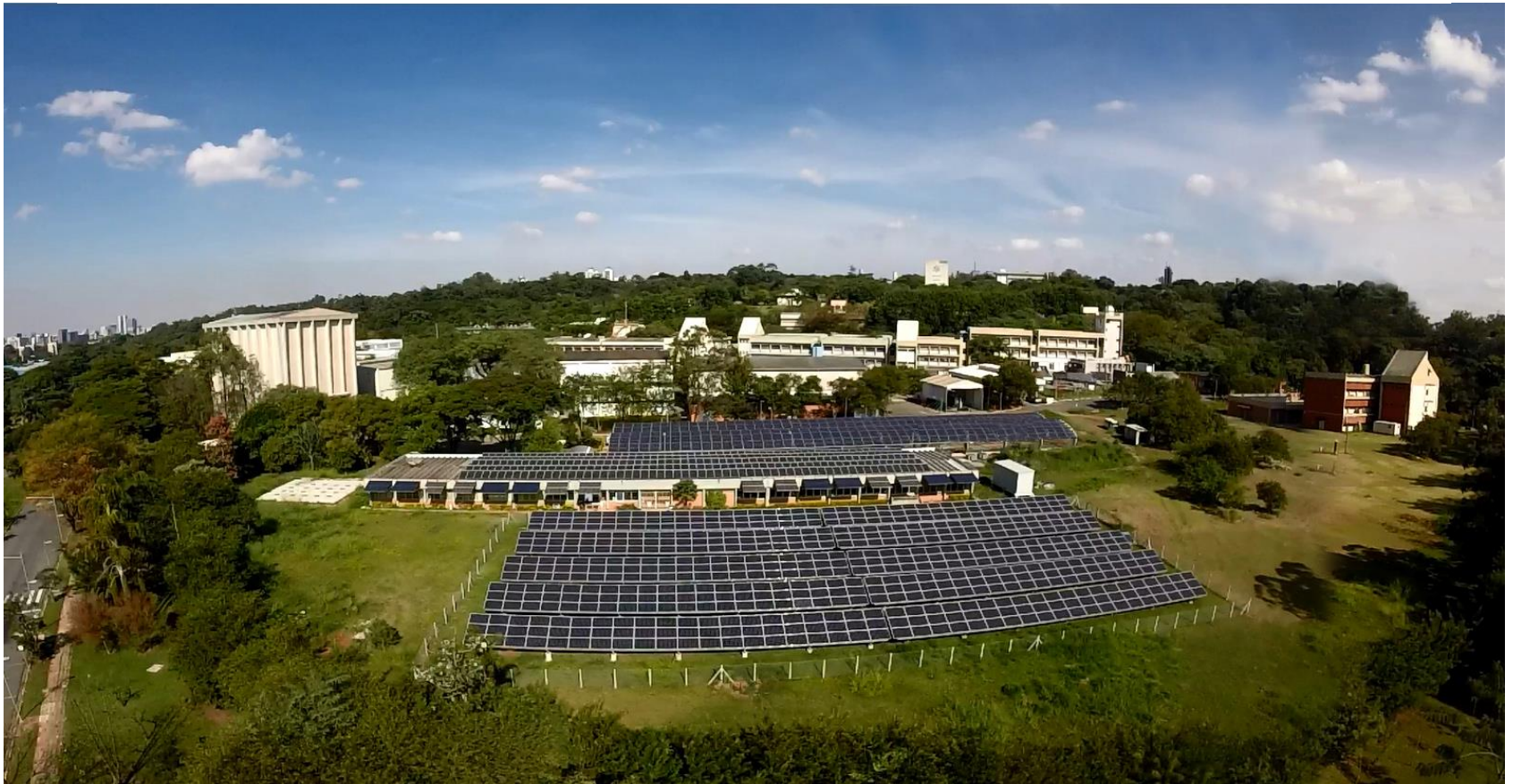
FAPESP-NERC WORKSHOP ON  
SUSTAINABLE GAS FUTURE

Energy System Deployment (opportunities/barriers) of Unconventional Hydrocarbons  
(eg Shale Gas/Oil)



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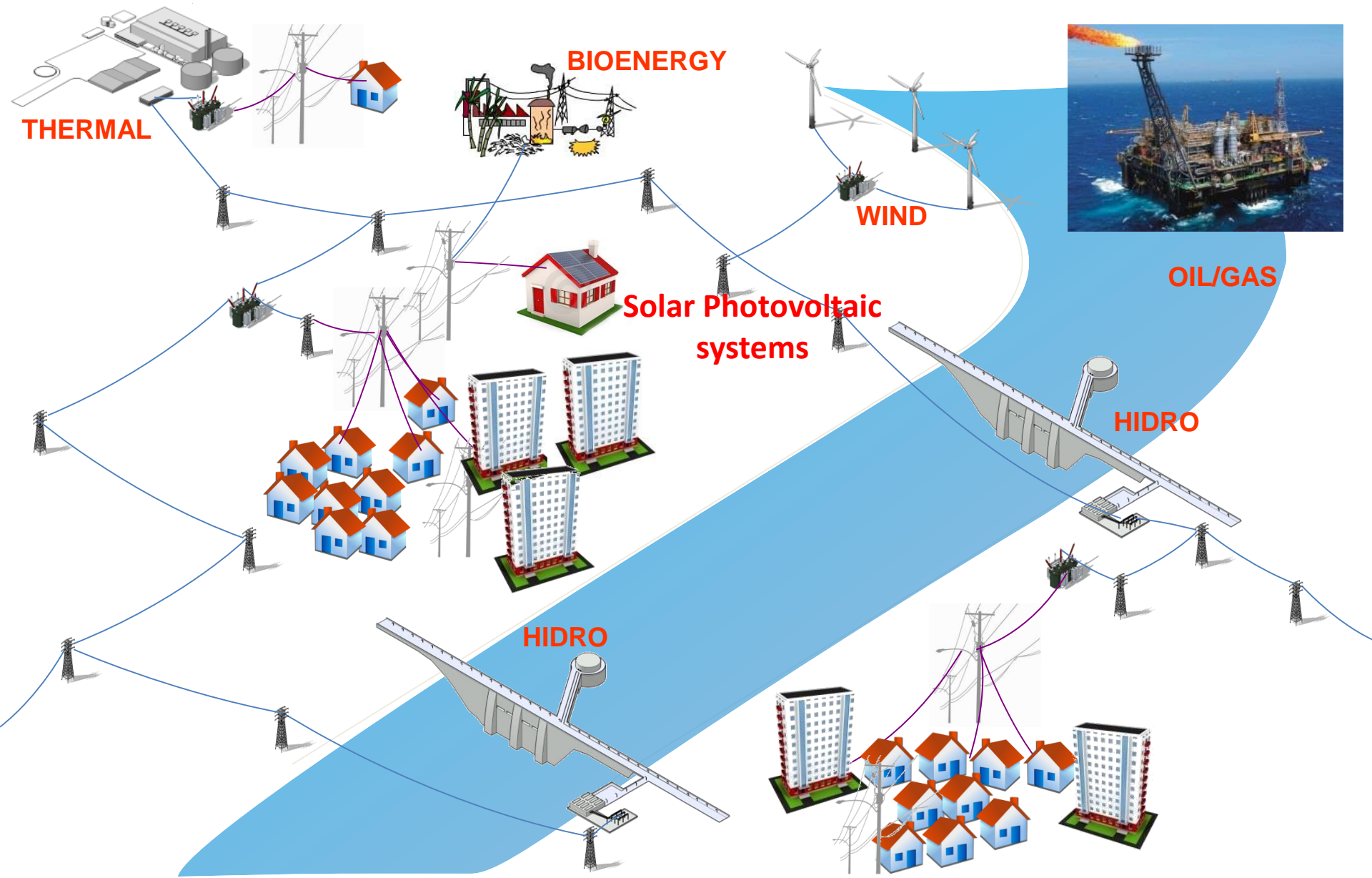
Electrical Power  
Systems Technology

Planning, Analysis and  
Energy Development

Oil Technology,  
Natural Gas and  
Bioenergy

Management, Science  
and  
Environmental Technology

# Interdisciplinary studies and projects in Energy





## Petroleum Rock Sources



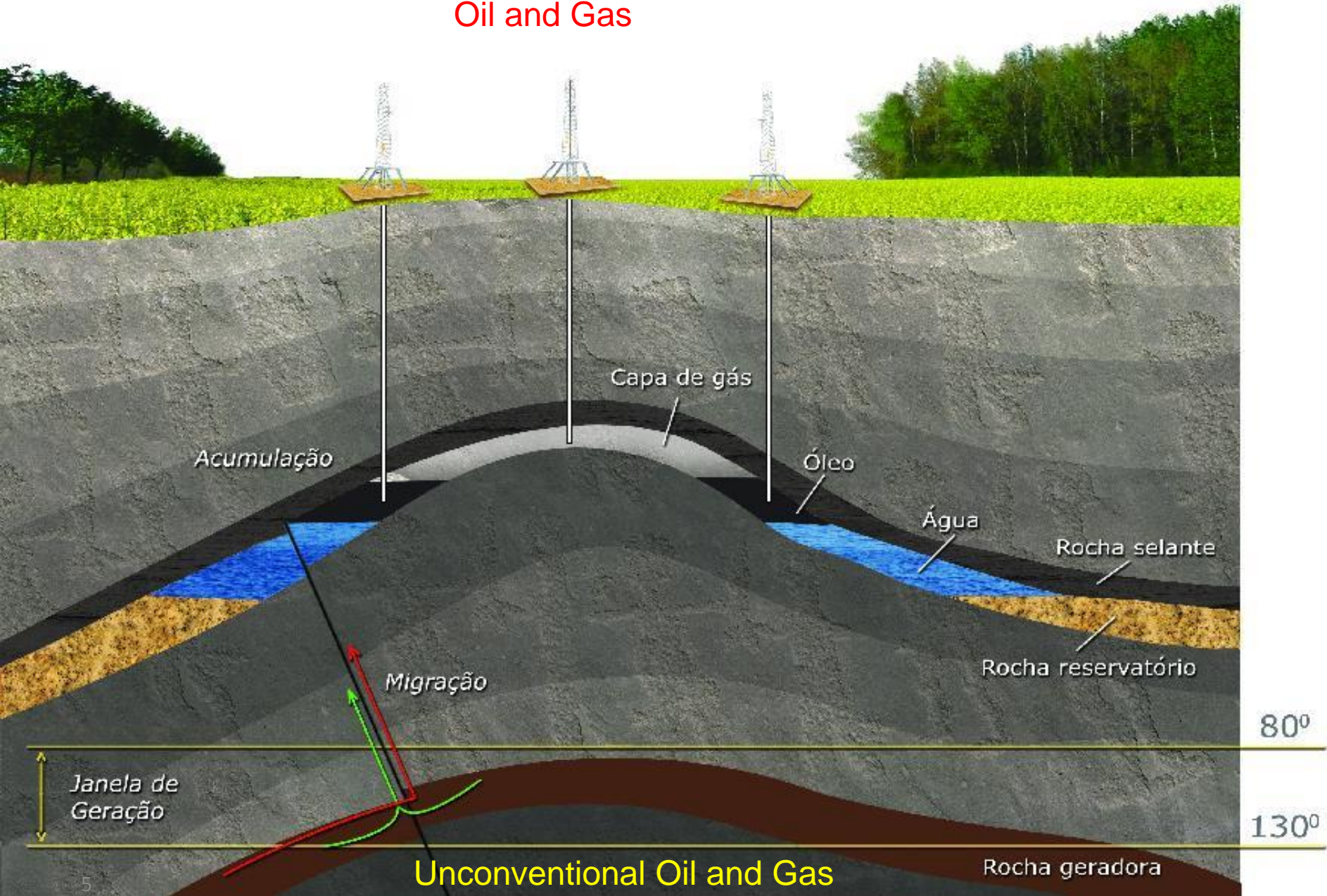
**BLACK SHALES**  
Organic-rich rocks  
with very low permeability

**Shale gas** is natural gas  
contained within  
shale sequences.





# Conventional Oil and Gas

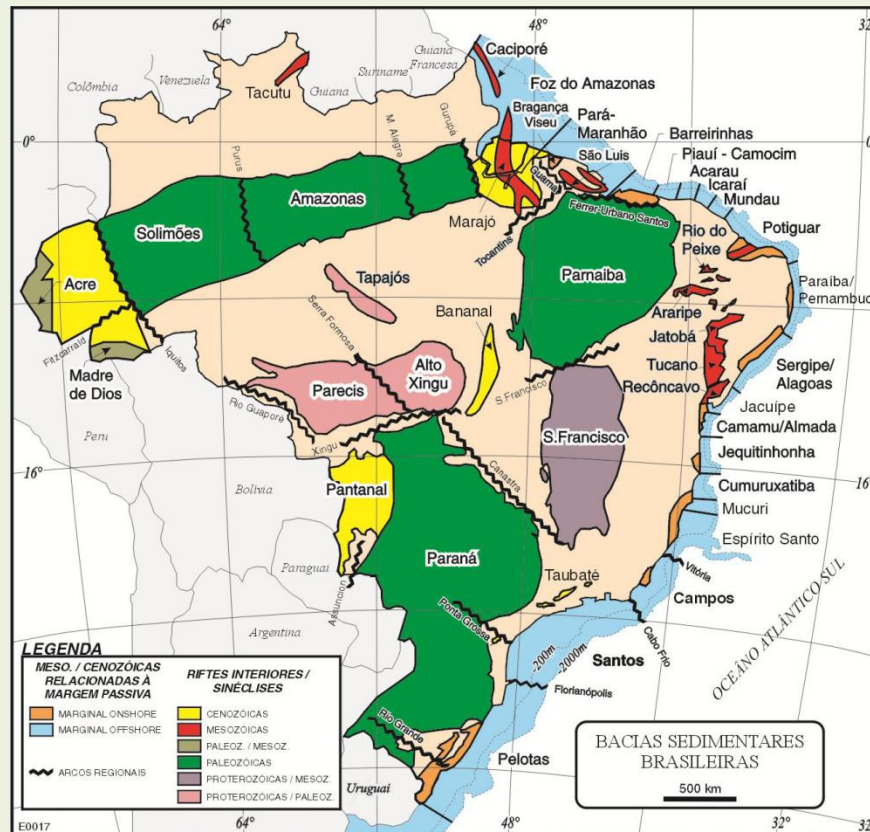


# HOW MUCH UNCONVENTIONAL GAS DOES BRAZIL HAVE ?

- Resources refers to an estimate of the amounts of oil and gas that are believed to be physically contained in the source rock
- Reserves refer to an estimate of the amount of oil or gas that can technically and economically be expected to be produced from a geological formation.

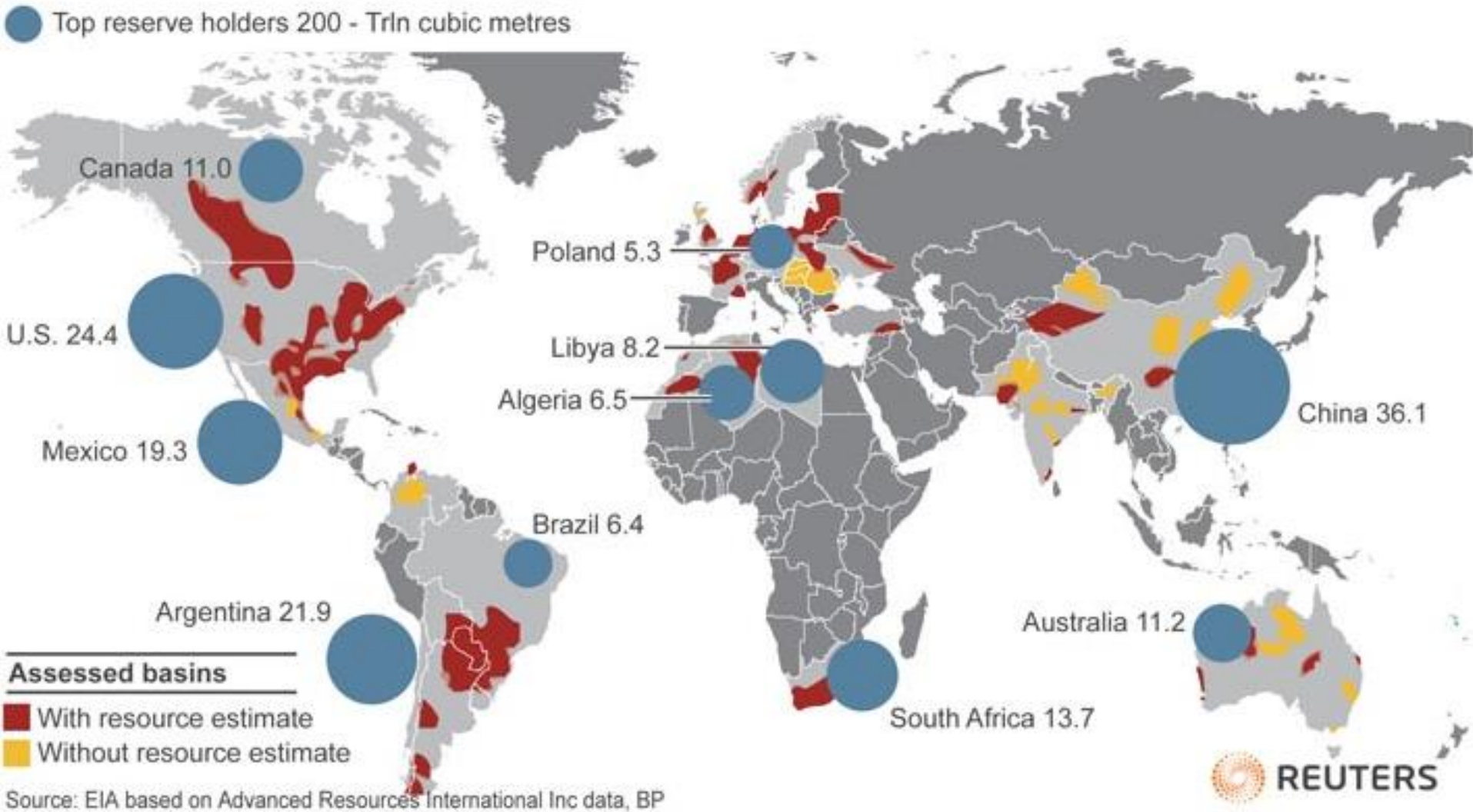
# HOW MUCH UNCONVENTIONAL GAS DOES BRAZIL HAVE?

We have an estimation of gas content in Brazilian black shales





# Global shale gas basins, top reserve holders





# POTENTIAL FOR SHALE GAS IN BRAZIL

ACCORDING ANP  
Petroleum, Natural Gas and Biofuels National Agency (2013)

*USING BARNETT SHALE ANALOGY*

Parnaiba Basin = 64 TCF

Reconcavo Basin = 20 TCF

São Francisco Basin = 80 TCF

Paraná Basin = 226 TCF

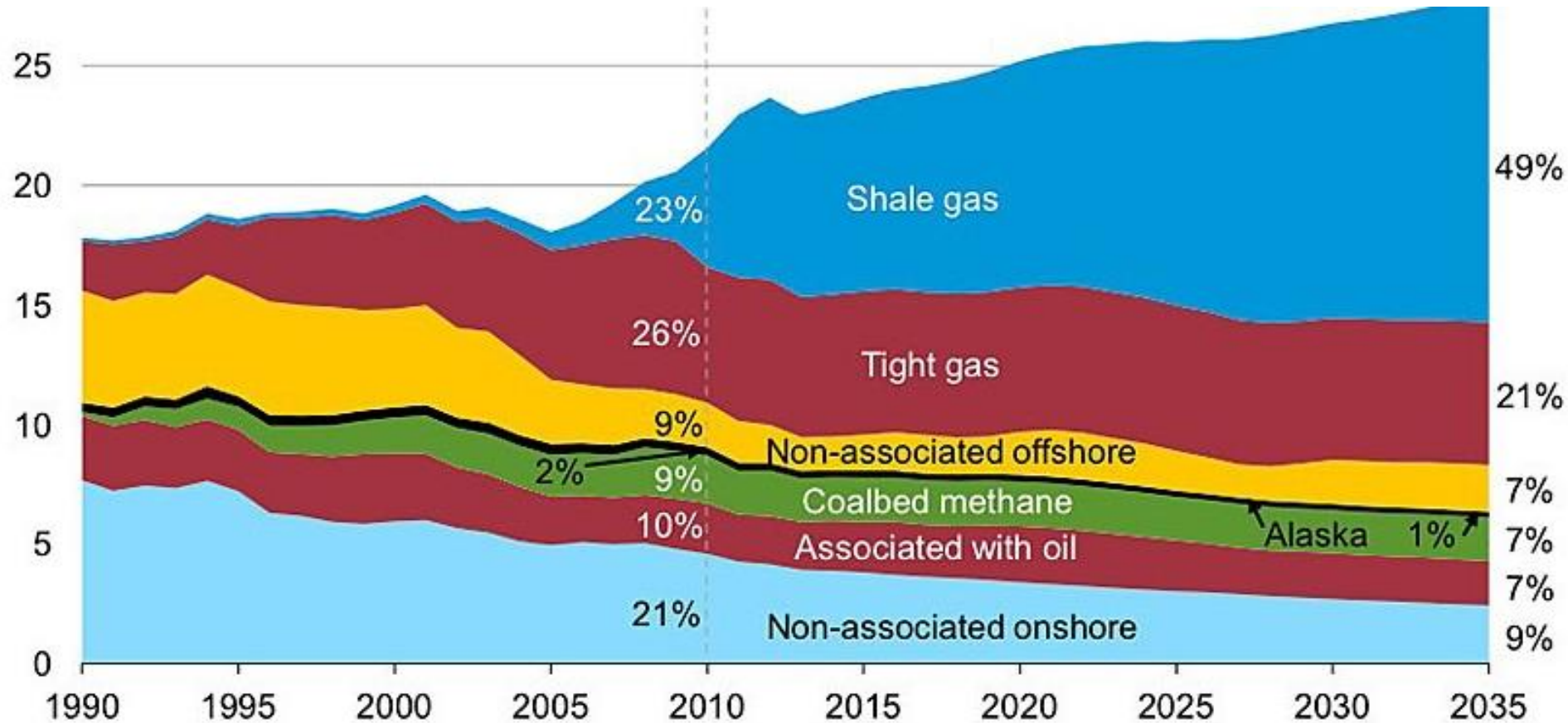
Parecis Basin = 124 TCF

ESTIMATION OF TOTAL  
RECOVERABLE SHALE GAS = 414 TCF

USA = 665; CHINA = 1115; ARGENTINA = 802 TCF



# Shale gas in US gas production, tcf per year

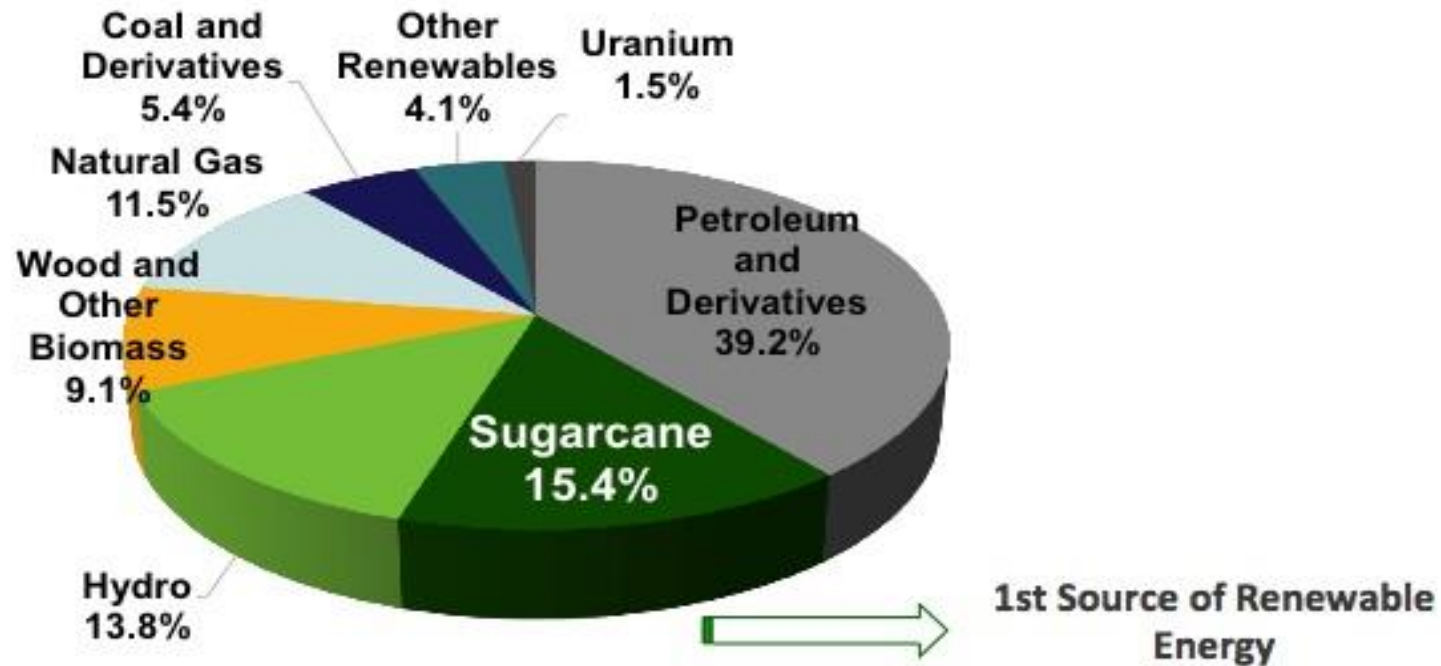


Source: EIA, Annual Energy Outlook 2012 Early Release



# SHALE GAS COULD BE A VERY IMPORTANT ENERGY MATRIX FOR BRAZIL IN THE FUTURE

**BRAZILIAN ENERGY MATRIX IN 2012**



Sources: Balanço Energético Nacional BEN (2013) and International Energy Agency: World Energy Outlook 2012 and Key World Energy Statistics 2012 and Eurostat (2013). Compiled by UNICA

Unconventional gas could be a cleaner *“bridge fuel”* for the transition from coal / oil to renewable energy sources

# To produce Shale Gas

- Acquire rights to drillsite
- Acquire subsurface seismic data
- Formulate development drilling plan
- Permit wells and facilities
- *Drill wells \*\*\*\* and Fracking*
- Complete wells
- Install facilities
- Produce natural gas!

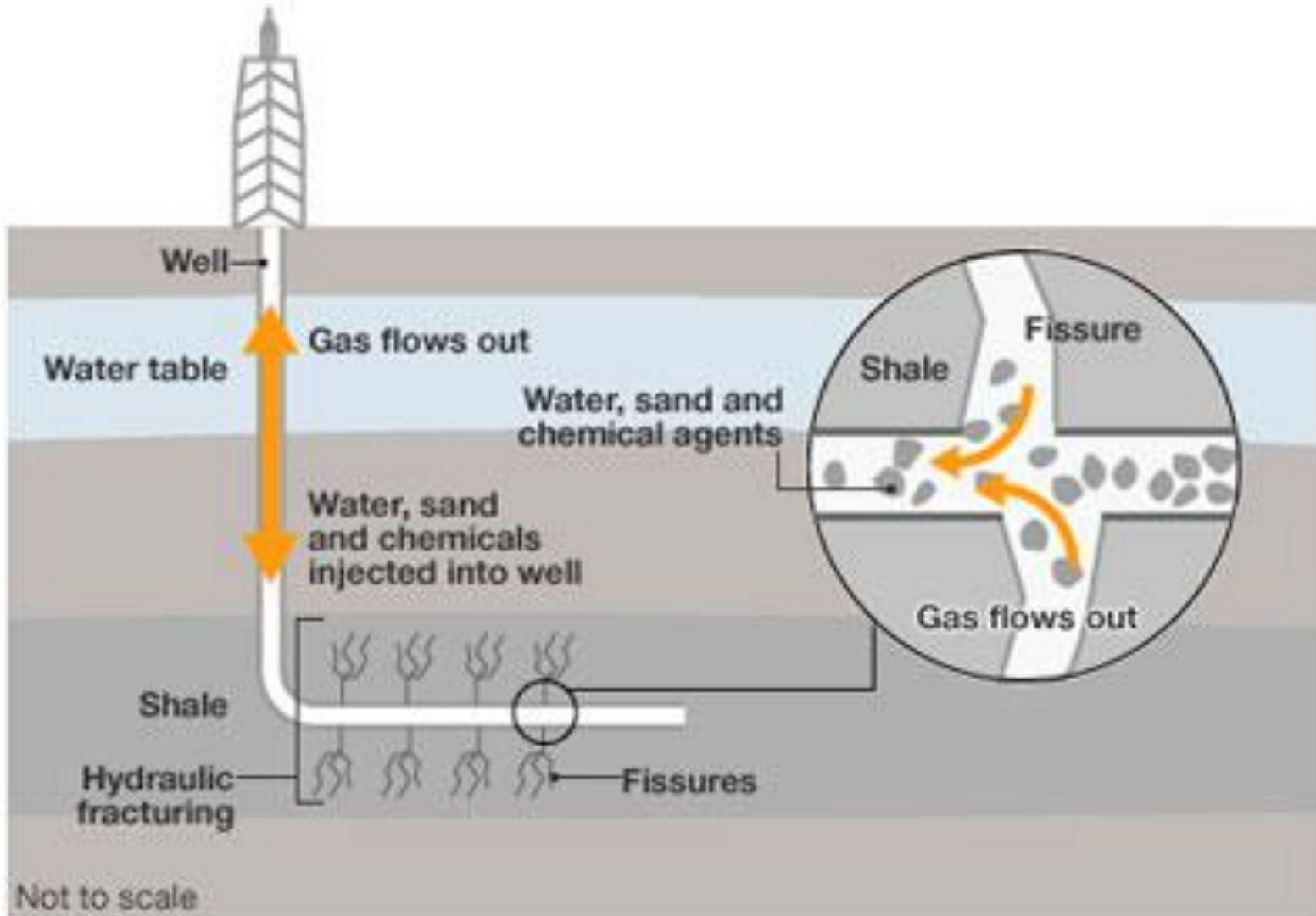


# To produce shale gas

- It is necessary “create a permeable reservoir” and high rates of gas production by using intensively stimulated horizontal wells
- It is necessary a fracking operations:
  - Trucks deliver water, sand and fracking chemicals to drilling site
  - Shale is fractured and the water+sand/chemical mix is pumped

# FRACKING PROCESSES

## Shale gas extraction







# OPPONENTS WARN methane scape during the fracking

- *Fracking is an environmental disaster*
- *Produce air and water pollution*
- *Accelere of global climate change*



# Environmental impacts – real or not?

**1 – air 2 – land 3 – water 4 - community**

- Potential contamination of groundwater by drilling and hydraulic fracturing
- Methane leakage
- Induced seismicity triggered by injection of wastewater following flowback of hydraulic fracturing fluids

Detailed studies have shown that fracking itself is not the source of the contamination.

The contamination appears to result from poor well construction or poor drilling practice (Zoback & Arent, 2014)

It is not very well understood how is the behaviour of natural fractures and faults when submitted to successive fracking process



The Brazilian government was charged to establish measures that can be taken to reduce the environmental impact and to assure the safety of shale gas production

The responsibility for monitoring falls to government and to industry itself

*Sometimes leading the public perception that lobbyists could influence policies*

# The Brazilian universities have expertise in many areas relevant to shale gas exploration

- Geological and Geophysical Assessment
- Hydrogeologic Studies
- Environmental Impacts and Monitoring
- Human Health
- Economic Impacts and Regulations
- Technological Innovation

- *The universities have a reputation for rigor and objectivity in research*
- *Universities can bring a reputation for independence to these investigations*

# Center of Unconventional Oil and Gas Resources (Cenpetro)

## ***GASBRAS* : R&D Network in Unconventional Gas in Brasil)**

***MCTI / FINEP***

**COORDINATION:** USP-IEE – UNIVERSITY OF SÃO PAULO - INSTITUT OF ENERGY AND ENVIRONMENT

### **TEAM:**

- USP - UNIVERSITY OF SÃO PAULO
- UFBA - FEDERAL UNIVERSITY OF BAHIA / UFRN – UNICAMP - UFPa
- UERJ – UNIVERSITY OF RIO DE JANEIRO STATE
- UFMG - FEDERAL UNIVERSITY OF MINAS GERAIS
- UFRGS – FEDERAL UNIVERSITY OF RIO GRANDE DO SUL
- PUCRS - *PONTIFÍCIA UNIVERSIDADE CATÓLICA* OF RIO GRANDE DO SUL
  - Joint-projects with others universities (USA, UK and Australia)



# MAIN OBJECTIVES

## **The Development of the Research Related to the Exploration and Sustainable Production of Shale Gas in Brasil**

1. Geological Evaluation of the Sedimentary Basins (shale layers)
2. Environmental Studies, Prior, During and Posterior Production
3. Development of New Techniques to Exploration and Sustainable Production of the Shale Gas
4. Study of Management, Marketing and Policy Related to the Shale Gas

# 1 – Geological Evaluation of the *shale gas* in Brasil

- Creation of a geological data base using Geographic Information Systems (GIS) for gas-bearing rocks.
- Sampling of shales in outcrops and drill cores
- Geological Characterization of the gas-bearing rocks (shales), following the performance-based geological assessment methodology, of the U.S. Geological Survey (2011)

# ASSESSING PRODUCTION POTENTIAL

## ➤ Shale Reservoir Characteristics

- Type of shale- composition variability
- Clay volume,type
- Microporosity
- Permeability
- Fracture density, orientation, connectivity
- Diagenetic effects (fracture fillings)
- Geomechanical properties
- Stress elements
- Reservoir pressures and Temperature
- Shales type: - contents of organic carbon(COT); Kerogen type I, II ou IIS; vitrinite reflectancy (Ro);
- Sismic interpretations, sismology studies combined with geological studies to use in the hydrocarbon system modeling.



## 2 – Environmental Studies Prior, during and Posterior exploration

- Assessment of the environmental conditions prior to the development of shale gas resources
  - Characterization of the possible contamination plumes by organic and inorganic products.
- Establishment of monitoring system for underground water in real time during shale gas exploration and production
- Development of new techniques and new propants to avoid environmental impacts or to define actions minimizing environmental impacts

***DRILLING A WELL FOR GAS PRODUCTION AND STUDIES***





**Barnett Urban Project Lifecycle UTA  
Carrizo Oil and .Gas Inc**

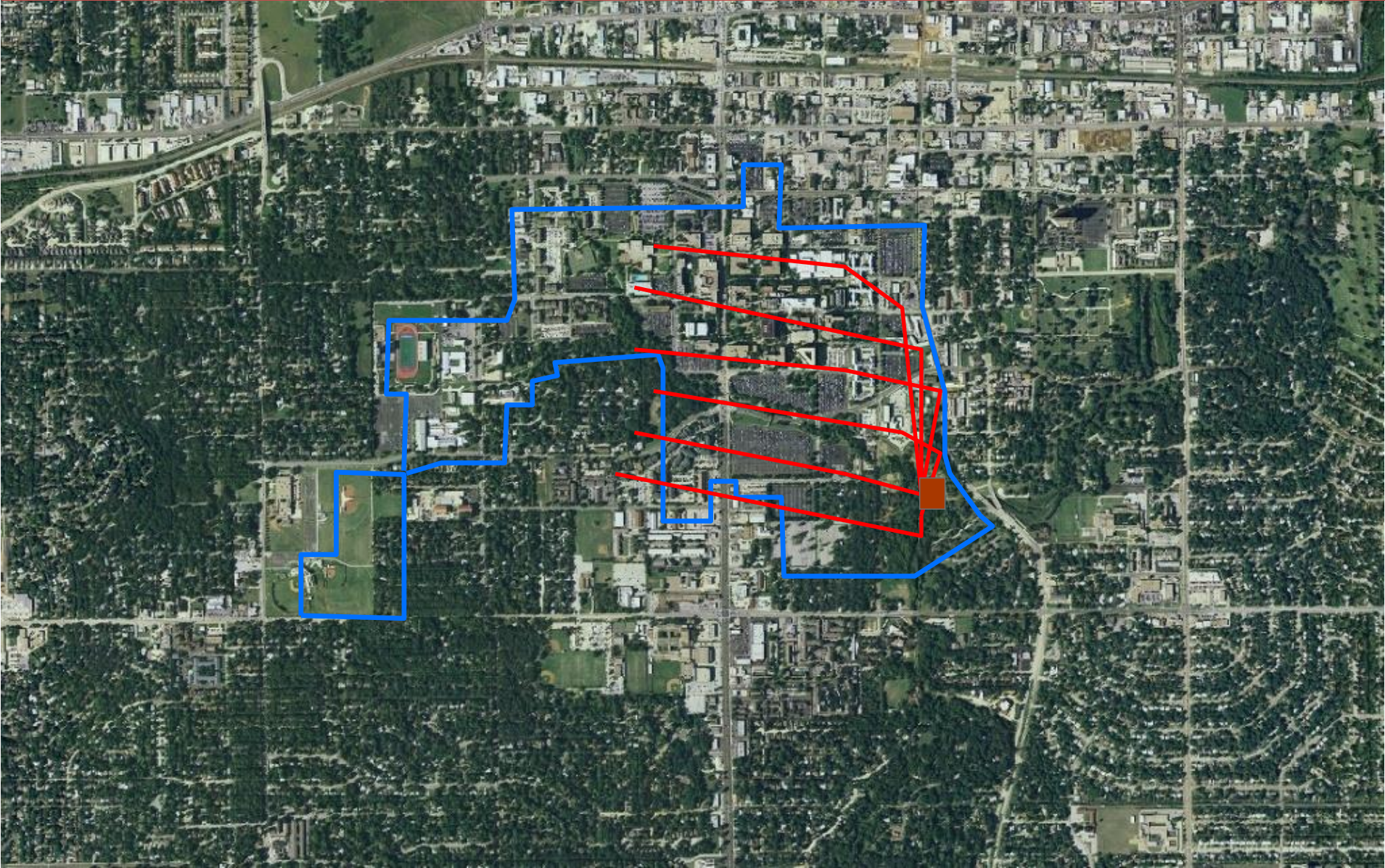


# Barnett Urban Project Lifecycle UTA Carrizo Oil and Gas Inc





# Urban Drilling - UTA





# 3 – Development of new techniques to exploration and sustainable production of the shale gas

## TECHNOLOGICAL & ENGINEERING ISSUES

- DRILLING
  - COMPLETION
  - STIMULATION
  - FRACTURING
  - PROPPANTS
- 
- Assessment of the *fracking process* in the economic and environmental point of view for brazilian shales.
  - Assessment of the pumping and use of large volumes of water during *fracking process* , and water recycling

## 4 – Study of Management, Marketing and policy related to the shale and oil gas in Brasil

- Policy for sustainable production of *Shale Gas as Green Energy in Brasil*
- Potencial Market and production strategy
- Risks, prices and investiments in shale gas busines
- Impacts in the gas global market.
- Establishment of the better regulation and laws for government agencies for shale gas
- Relationship with local society for Urban Drilling



The society had needed of oil for more thirty or forty years







When natural gas is used in place of gasoline, diesel oil or coal

Natural gas has the potential to reduce postcombustion CO<sub>2</sub> emissions by about 50%

TIME

ENVIRONMENT SPECIAL

**THIS ROCK  
COULD  
POWER  
THE  
WORLD**

WHY SHALE CAN SOLVE  
THE ENERGY CRISIS

BY BRYAN WALSH

A century's  
worth is  
buried in our  
backyards ...

... but drilling  
for it threatens  
our land