



Institut of Energy and Environment
University of São Paulo

Unconventional Hydrocarbon Resource Potential in Brazil and 12th Bid Round Overview –

“The Role of the Brazilian Universities”
Prof. Dr. Colombo C. G. Tassinari

*US – Brazil Unconventional Gas Policy and Regulatory Workshop
December 2013 – Rio de Janeiro*

BLACK SHALES

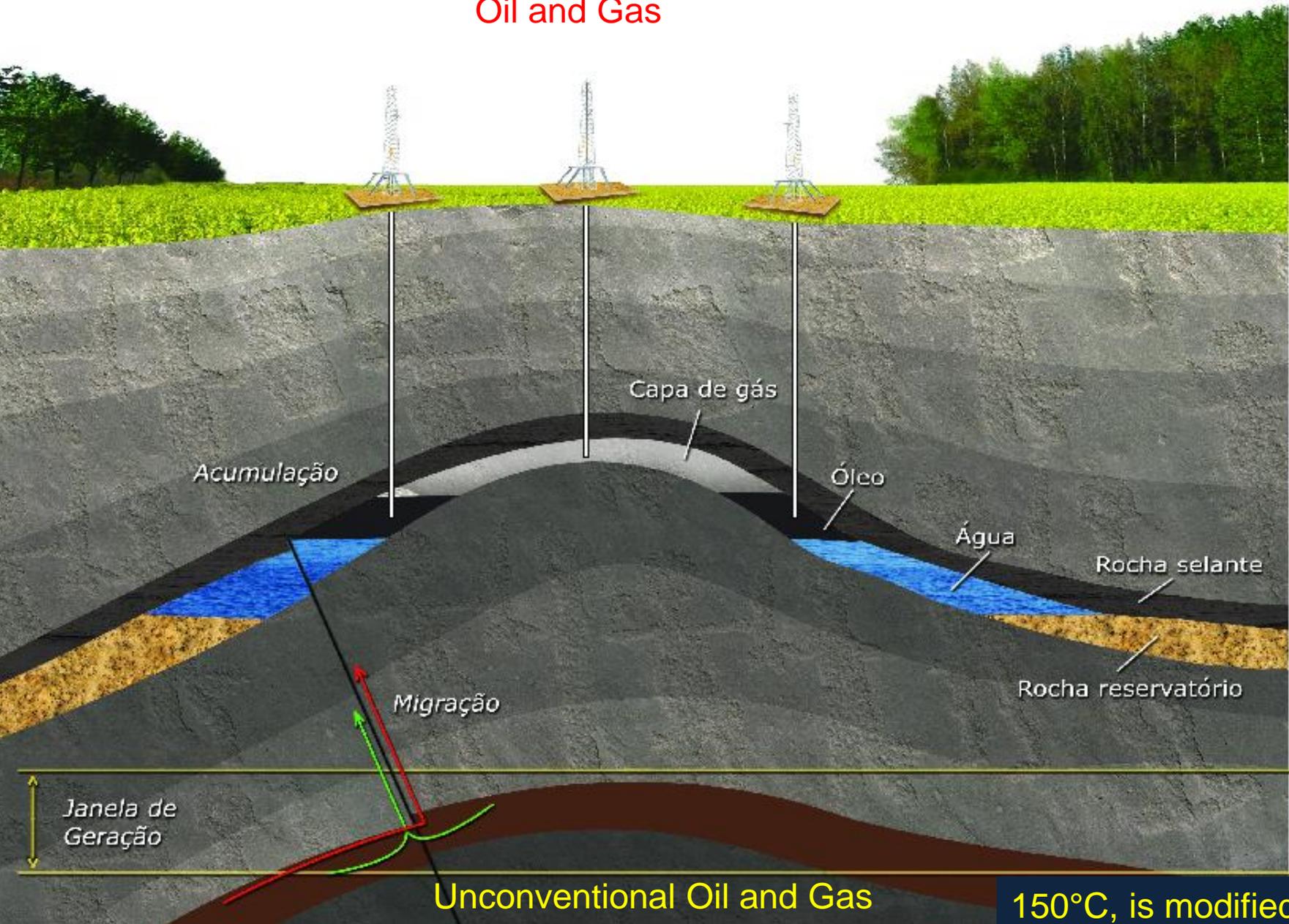
Organic matter-rich rocks
with very low permeability

Shale gas is natural gas
contained within
shale sequences.



Petroleum
Rock Sources

Conventional Oil and Gas

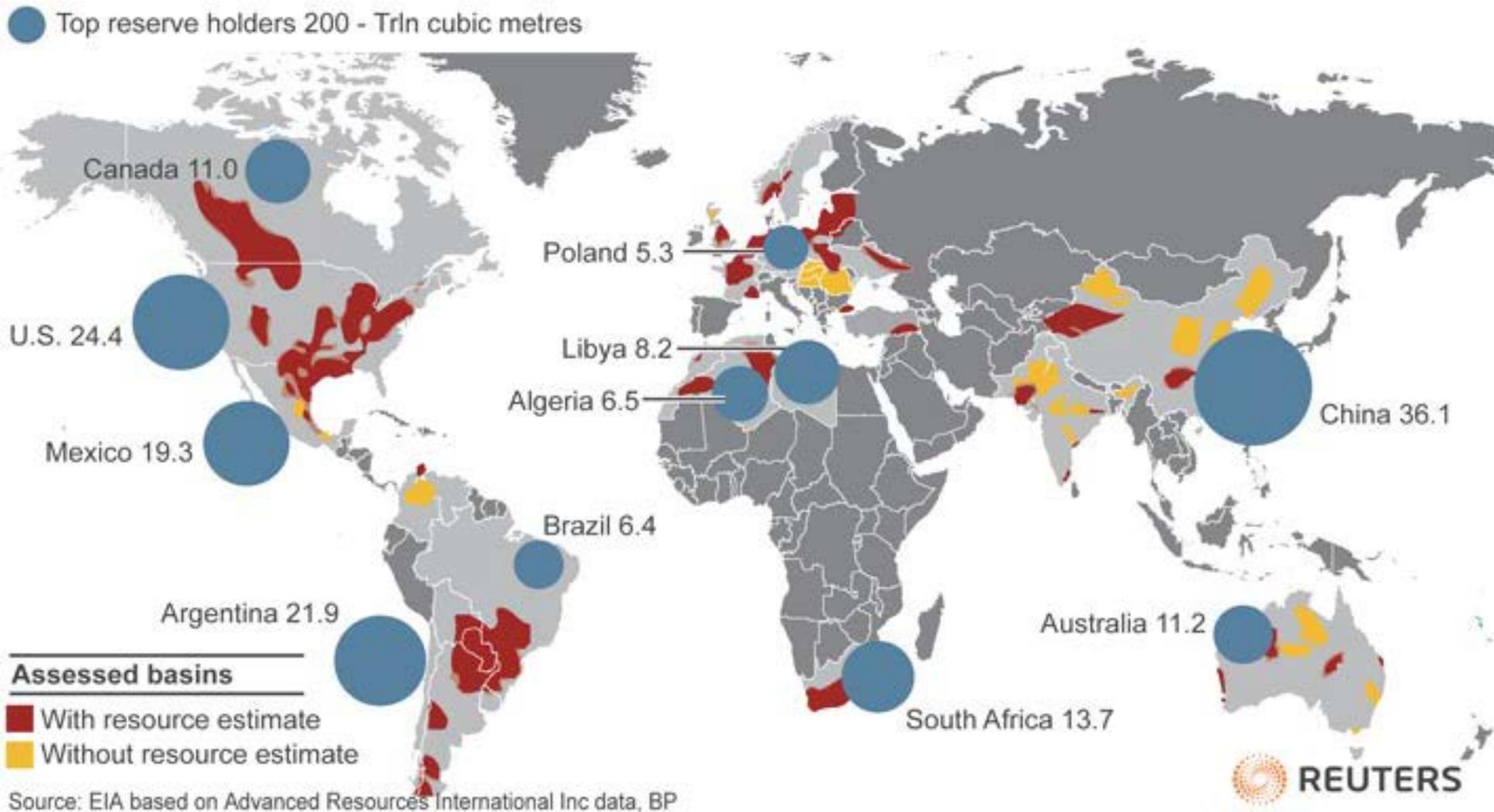


150°C, is modified for gas

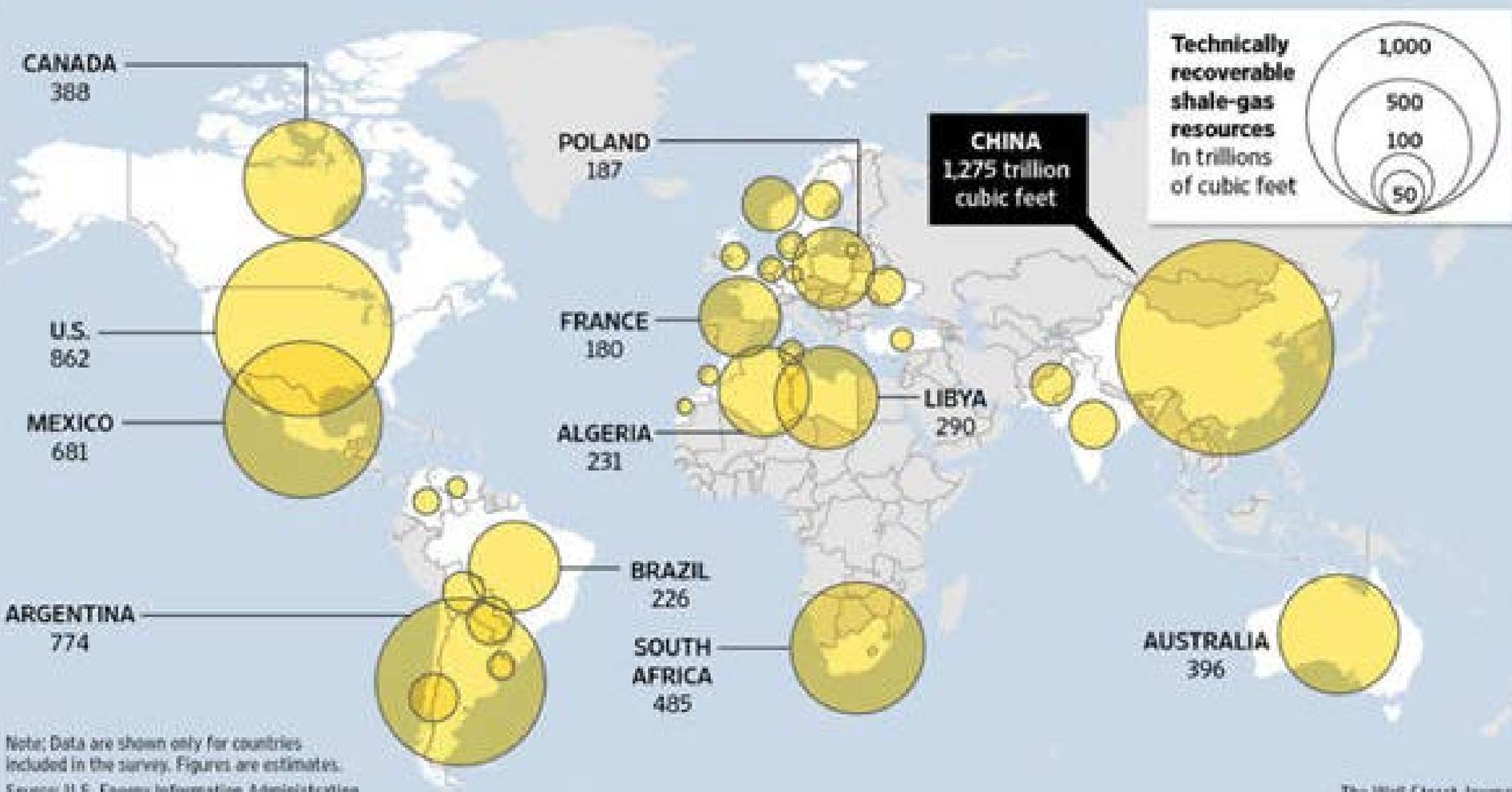
HOW MUCH UNCONVENTIONAL GAS IS IN BRAZIL ?

- ***RESOURCES:*** amount of gas in the shale
- ***RESERVES:*** amount of gas that you might be able extract, technically and commercially recoverable.
- ✓ We have a estimation of gas content in brazilian black shales

Global shale gas basins, top reserve holders



World Shale Deposits



Sedimentary Basins with Potential for *Shale Gas*



ACCORDING ANP

Petroleum, Natural Gas and Biofuels National Agency

➤ Parnaíba Basin



Shale layers are located at depths of 1.600 - 2.500 m

$$V = 64.000 \text{ (area)} \times 0,04 \text{ (average thickness)} = 2.560 \text{ km}^3$$

Barnett shale analogy

$$1.196 \text{ km}^3 \text{ _____ } 30 \text{ TCF}$$

$$2.560 \text{ km}^3 \text{ _____ } x \text{ TCF}$$

$$x = 64 \text{ TCF}$$

ACCORDING ANP

Petroleum, Natural Gas and Biofuels National Agency

➤ Parecis Basin



$$V = 99.000 \text{ (area)} \times 0,05 \text{ (average thickness)} = 4.950 \text{ km}^3$$

Barnett shale analogy

$$1.196 \text{ km}^3 \text{ _____ } 30 \text{ TCF}$$

$$4.950 \text{ km}^3 \text{ _____ } x \text{ TCF}$$

$$X = 124 \text{ TCF}$$

ACCORDING ANP

Petroleum, Natural Gas and Biofuels National Agency

➤ Reconcavo Basin



$$V = 2.000 \text{ (area)} \times 0,4 \text{ (average thickness)} = 800 \text{ km}^3$$

Barnett shale analogy

$$1.196 \text{ km}^3 \text{ _____ } 30 \text{ TCF}$$

$$800 \text{ km}^3 \text{ _____ } x \text{ TCF}$$

$$X = 20 \text{ TCF}$$

SUMMARY

For Reference:

USA: Barnett Shale 30 TCF

USA: 665 TCF

China 1115 TCF

Argentina 802 TCF

Brasil

Bacia do Parnaíba– 64 TCF

Bacia dos Parecis – 124 TCF

Bacia do Recôncavo – 20 TCF

Bacia do Parana – 226 TCF

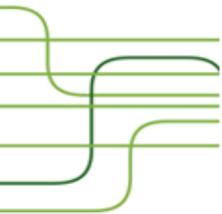
Total Estimation For Resources = 434 TCF

Top 10 countries with technically recoverable shale oil resources

Top 10 countries with technically recoverable shale gas resources

Rank	Country	Shale oil (bbl)	Rank	Country	Shale gas (tcf)
1	Russia	75	1	China	1,115
2	US*	58 (48)*	2	Argentina	802
3	China	32	3	Algeria	707
4	Argentina	27	4	US*	665 (1,161)
5	Libya	26	5	Canada	573
6	Venezuela	13	6	Mexico	545
7	Mexico	13	7	Australia	437
8	Pakistan	9	8	South Africa	390
9	Canada	9	9	Russia	285
10	Indonesia	8	10	Brazil	245
World Total		345 (335)	World Total		7 299 (7795)

***EIA estimates used for ranking order.
API estimates in parenthesis**



Brasil12ª Rodada
Licitações de Petróleo e Gás



12th Bid Round

AGÊNCIA NACIONAL DO PETRÓLEO, GÁS NATURAL E BIOCOMBUSTÍVEIS – ANP

The 12th Bidding Round of blocks for exploration and production of natural gas in Brazil

LICITAÇÕES PARA A OUTORGA DOS CONTRATOS DE CONCESSÃO PARA ATIVIDADES DE EXPLORAÇÃO E PRODUÇÃO DE PETRÓLEO E GÁS NATURAL

Datas: 28 e 29 de novembro de 2013

Local: Windsor Barra Hotel, Rio de Janeiro-RJ

EDITAL CONSOLIDADO: 26/09/2013

17 Companies qualified as operator

Empresa	Habilitação
Petroleo Brasileiro S.A.	A
RWE Dea AG	A
Shell Brasil Petróleo Ltda.	A
Total E&P do Brasil Ltda.	A
EP Energy Pescada Ltda.	B
GDF Suez Energy Latin América Participações Ltda.	B
Geopark Brasil Exploração e Produção de petróleo e Gás Ltda.	B
Gran Tierra Energy Brasil Ltda.	B
Ouro Preto Oléo e Gás	B
Petra Energia S.A.	B
Petrogal Brasil S.A.	B
Alvopetro S.A. Extração de Petróleo e Gás Natural	C
Bayar Empreendimentos e Participações Ltda.	C
Companhia Paranaense de Energia	C
Cowan Petróleo e Gás S.A.	C
Nova Petróleo S.A. - Exploração e Produção	C
Trayectoria Oil & Gas S.A	C

**26 INTERESTED
COMPANIES**

RESULTS – WINNER COMPANIES 12

COMPANIES	Number of Blocks	
	Operator	No Operator
Alvopetro S.A. Extração de Petróleo e Gás Natural	4	0
Bayar Empreendimentos e Participações Ltda.	0	7
Companhia Paranaense de Energia	0	4
Cowan Petróleo e Gás S.A.	2	8
GDF Suez Energy Latin América Participações Ltda.	0	6
Geopark Brasil Exploração e Produção de Petróleo e Gás Ltda.	2	0
Nova Petróleo S.A. - Exploração e Produção	4	3
Ouro Preto Óleo e Gás S.A.	0	7
Petra Energia S.A.	7	0
Petróleo Brasileiro S.A.	43	6
Trayectoria Oil & Gas	10	0
Tucumann Engenharia e Empreendimentos Ltda.	0	4

Total de Empresas Vencedoras: 12

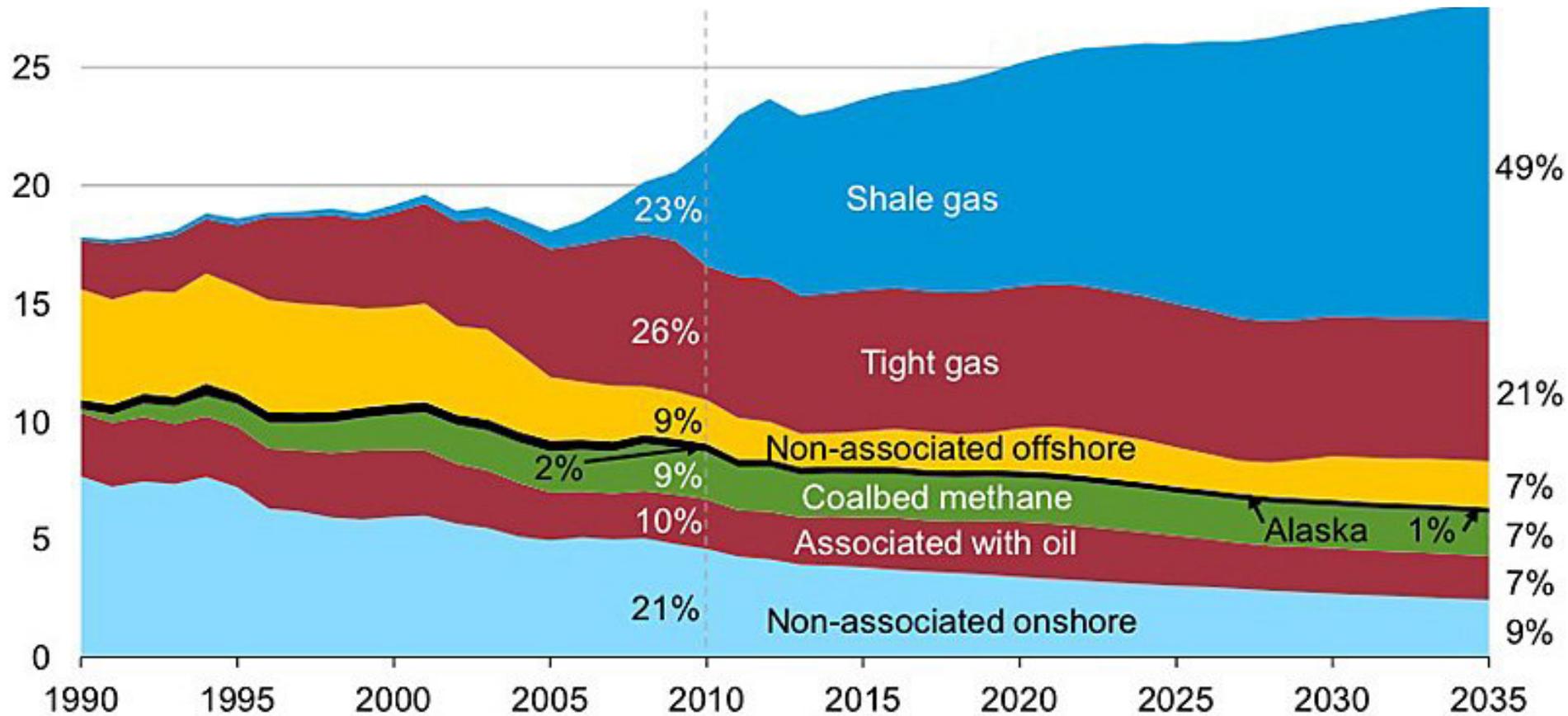
RESULTS – Origin of the Companies

Country Origin	Nº of Companies			
	Qualified	Participants	Winners	Operators
BRASIL	10	8	8	4
FRANÇA	2	1	1	0
BERMUDAS	1	1	1	1
PORTUGAL	1	0	0	0
REINO UNIDO	1	0	0	0
ALEMANHA	1	0	0	0
CANADA	1	0	0	0
ESTADOS UNIDOS	1	0	0	0
COLOMBIA	1	1	1	1
ESPAÑA	1	0	0	0
PANAMA	1	1	1	1
SUMMARY	21	12	12	07

RESULTS – NUMBER OF BLOCKS SEDIMENTARY BASINS

Basin	Blocks	
	Available	Arrematados
Recôncavo	50	30
Alagoas	39	12
Paraná	19	16
Sergipe	41	12
Parnaíba	32	1
Acre	9	1
São Francisco	36	0
Parecis - Alto Xingu	14	0
Total	240	72

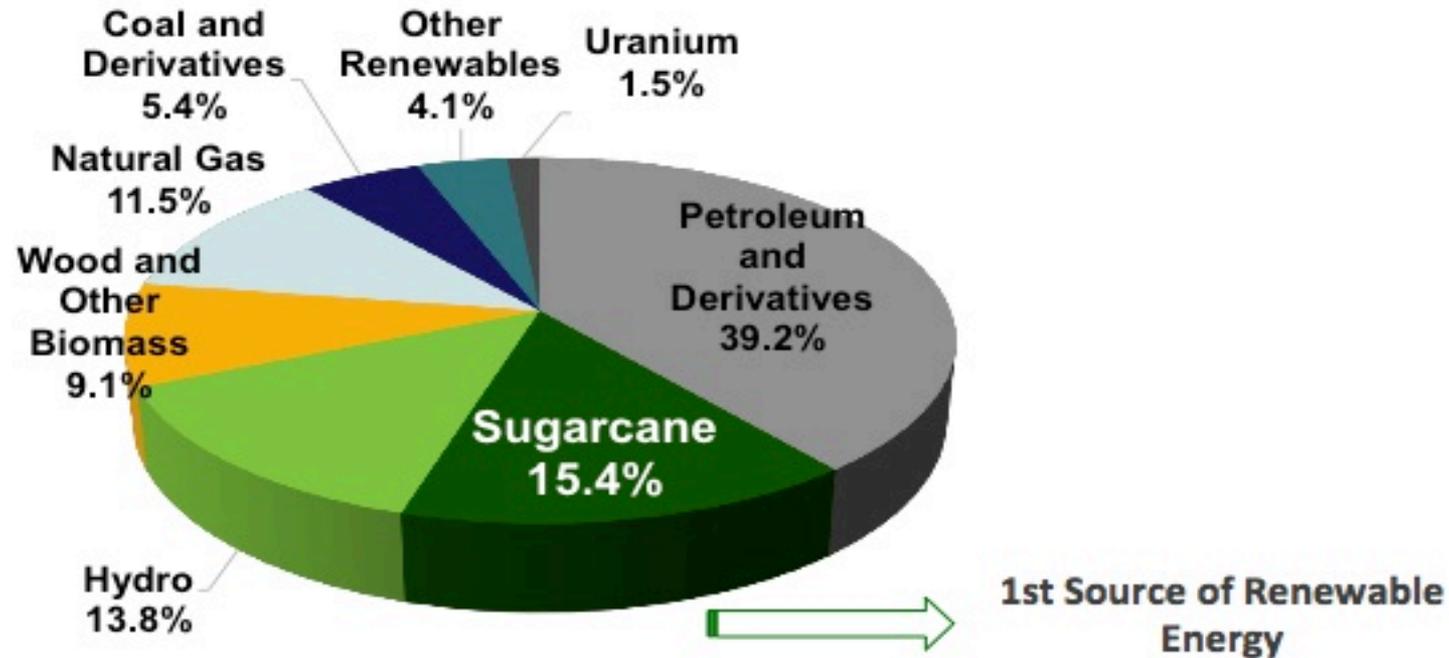
Shale gas in US gas production, tcf per year



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

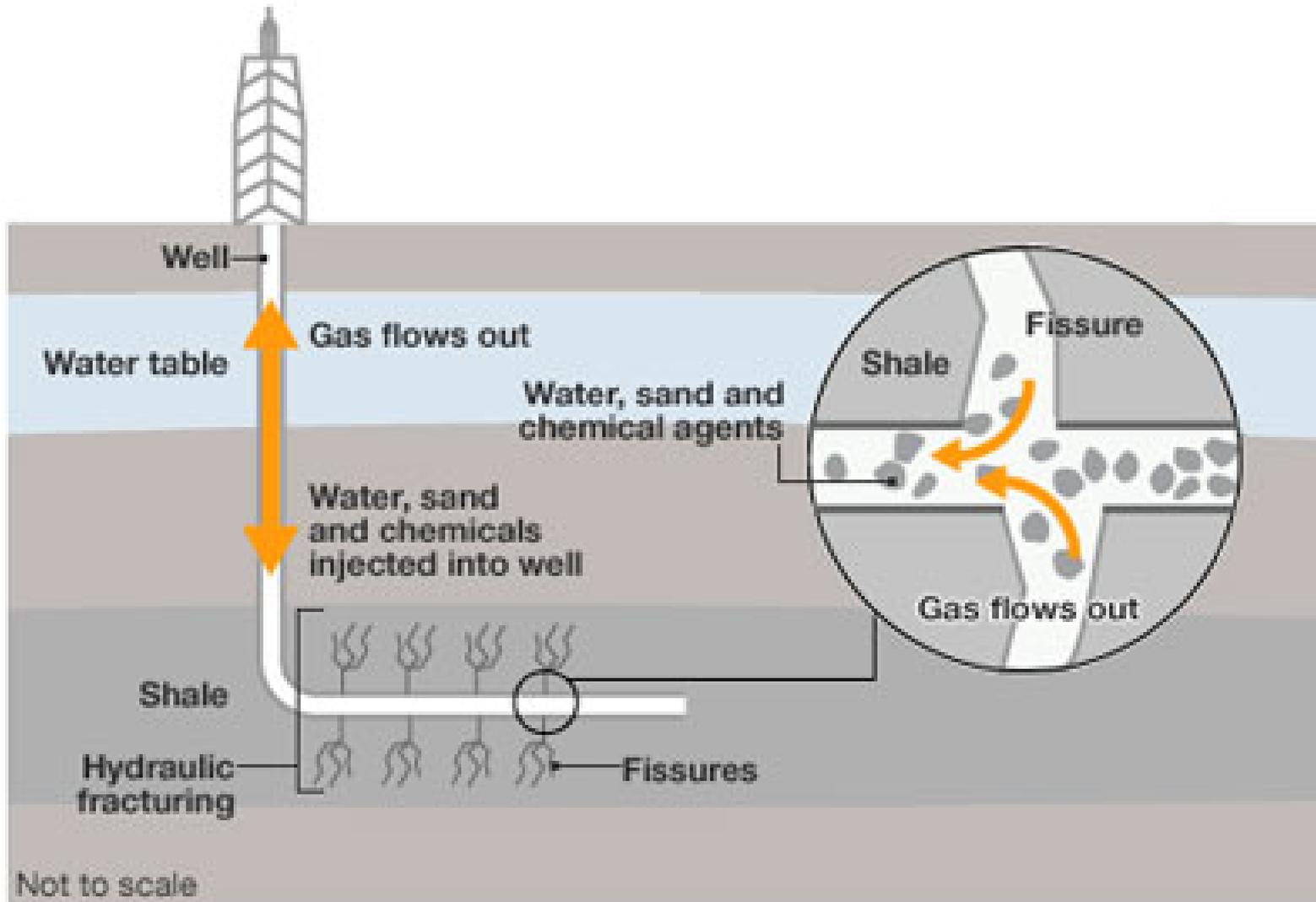
- Acquire rights to drillsite
- Acquire subsurface seismic data
- Formulate development drilling plan
- Permit wells and facilities
- *Drill wells **** and Fracking*
- Complete wells
- Install facilities
- Produce natural gas!

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 and fracking chemicals to drilling site
 - Shale is fractured and the water/chemical mix is pumped in

FRACKING PROCESSES

Shale gas extraction





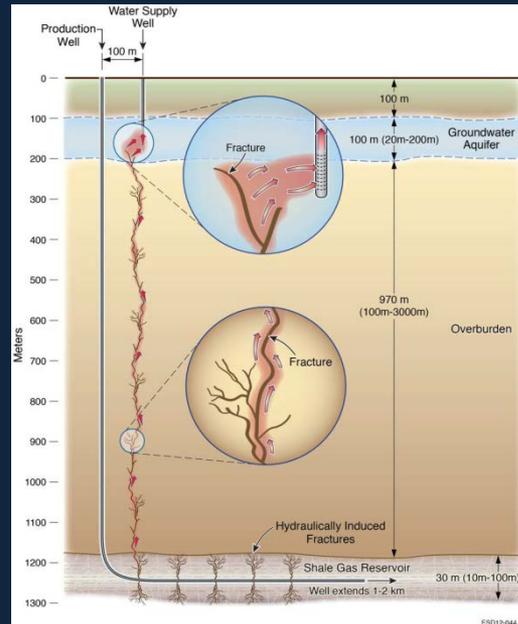
OPPONENTS WARN methane scape during the fracking

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



Environmental impacts – real or not?

- Ground water contamination
- Water use and disposal
- Chemical handling and reporting
- Air quality
- Induced seismicity
- 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*

GASBRAS : R&D Network in Unconventional Gas in Brasil (GASBRAS)

MCTI / FINEP

***Fundo Nacional de Desenvolvimento
Científico e Tecnológico · FNDCT***

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, Canada 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 in Brasil

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

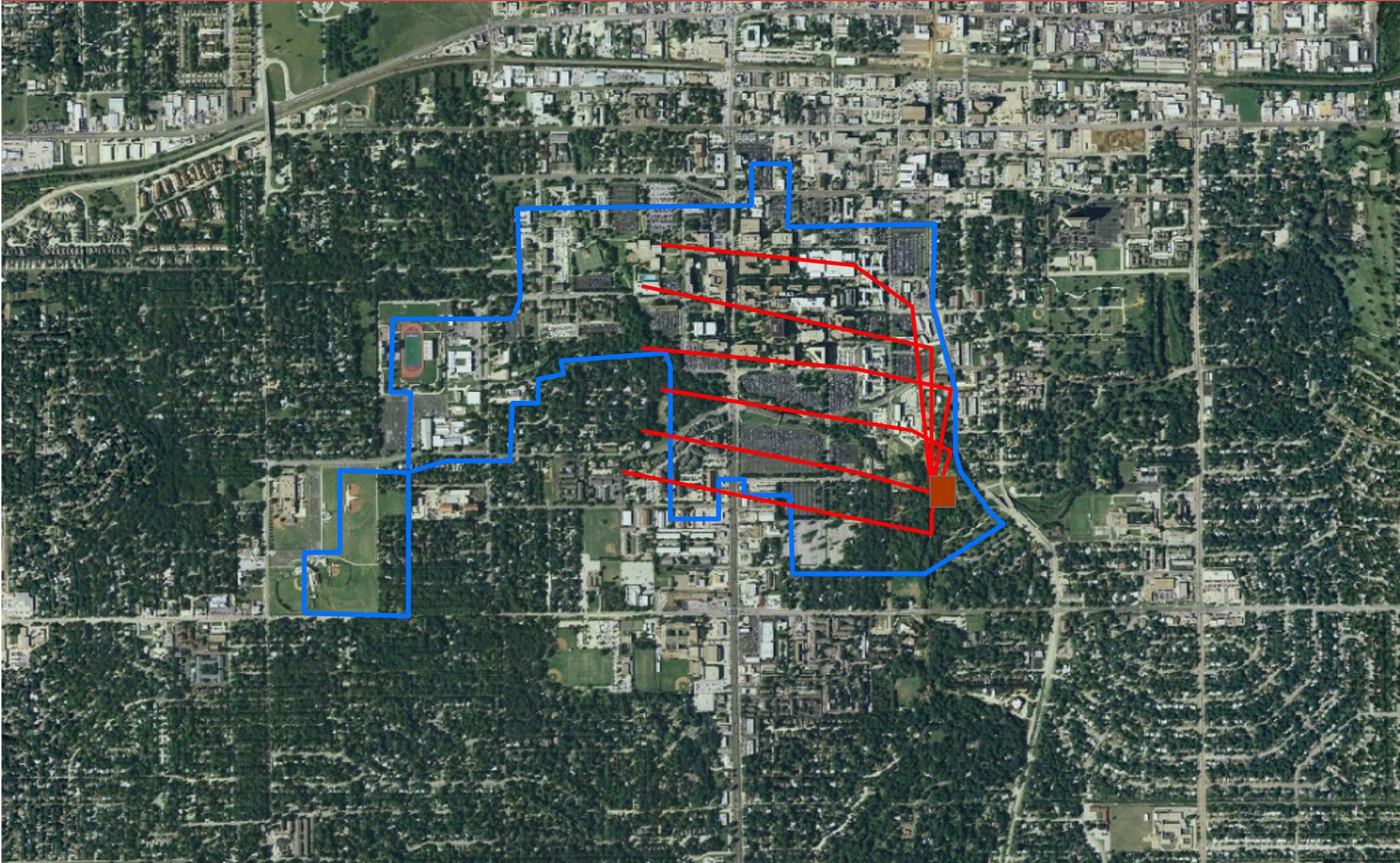


**Barnett Urban Project Lifecycle UTA
Carrizo Oil and Gas Inc**

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 (The use of new natural 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 regulation and laws for government agencies for shale gas
- Relationship with local society for Urban Drilling

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