Sistema FIRJAN

INFORMA, FORMA, TRANSFORMA.

A Importância da Inovação na Indústria do Petróleo

Núcleo de Tecnologia

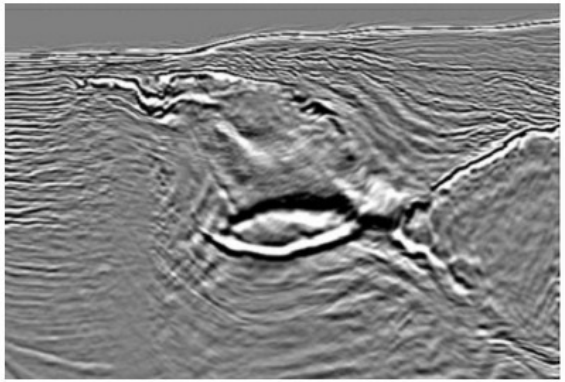
Conselho Empresarial de Petróleo e Gás

Rio de Janeiro (RJ), 14 de junho de 2018

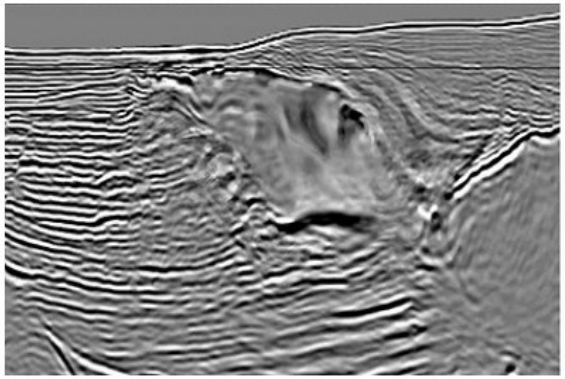
- 1848 – Primeiro poço – Baku, Azerbaijão – sonda a cabo
- 1854 – Patente do querosene - salvou as baleias
- 1855 – Relatório Silliman – destilação
- 1859 – Titusville – sonda para sal, separação óleo/água
- 1870 – Padronização do querosene – Standard Oil
- 1878 – Primeiro navio tanque
- 1891 – Primeiro motor a gasolina – evitou a Great Manure Crisis
- 1912 – Adoção do óleo pela marinha britânica

- 1927 – Primeira perfilagem elétrica
- 1927 – Uso comercial da sísmica de reflexão
- 1929 – Perfuração direcional
- 1935 – Craqueamento catalítico
- 1945 – Primeiro poço horizontal - Azerbaijão
- 1949 – Fraturamento hidráulico – Oklahoma
- 1949 – Primeira perfuração offshore
- 1961 – Primeiro poço submarino – Shell
- 1965 – Testemunhos de águas profundas

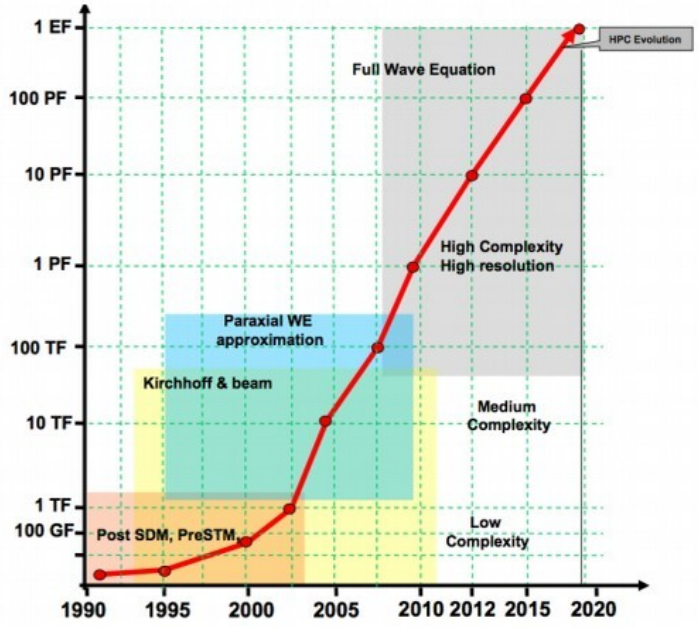
- 1967 – Produção de areias betuminosas
- 1967 – Completação submarina
- 1971 – Sistemas de perfilagem de poço – Schlumberger
- 1977 – Primeiro FPSO – Shell
- 1977 – Início do programa do DoE para folhelhos
- 1978 – MWD
- 1980 – Bomba elétrica submersível
- 1982 – Sísmica 3D
- 1983 – Perfuração subsal
- 1984 – Perfuração direcional
- 1991 – Modelagem sísmica 3D
- 1994 – Completação multilateral – Sísmica 4D
- 1996 – Imageamento sônico
- 1996 – Primeira instalação LNG – Quatar
- 1997- Primeiro poço inteligente – Noruega
- 1997 – Desenvolvimento subsal – Phillips
- 1998 – Extração comercial do gás de folhelho - Mitchell
- 2000 – Sísmica marinha – WesternGeco
- 2001 – Árvore de Natal molhada – Cameron
- 2006 – Shale boom – redução de emissões nos EUA



Migração Kirchoff isotrópica



Migração Reversa em Tempo (RTM) isotrópica
(Custo comp. 10x Migração Kirchoff isotrópica)



Estimativa de capacidade computacional necessária para a adoção das técnicas de processamento avançadas de forma usual (Fonte: Total, BP e Hess)

Fonte: Petrobras

Shale Gas Development in the United States: A Timeline

1821: Natural gas is first extracted from shale in Fredonia, NY.

1947: Hydraulic fracturing first used to extract natural gas from limestone.

1970s: Domestic gas production on the decline; Morgantown Energy Research Center (MERC) initiates the Eastern Gas Shales Project.

1976: Two MERC engineers patent early technique for directional drilling in shale.

1977: DOE successfully demonstrates massive hydraulic fracturing in shale (MHF).

1980: Congress creates Section 29 production tax credit for unconventional gas (lasts until 2002).

1986: First successful multi-fracture horizontal well drilled by joint DOE-private venture in Wayne County, West Virginia.

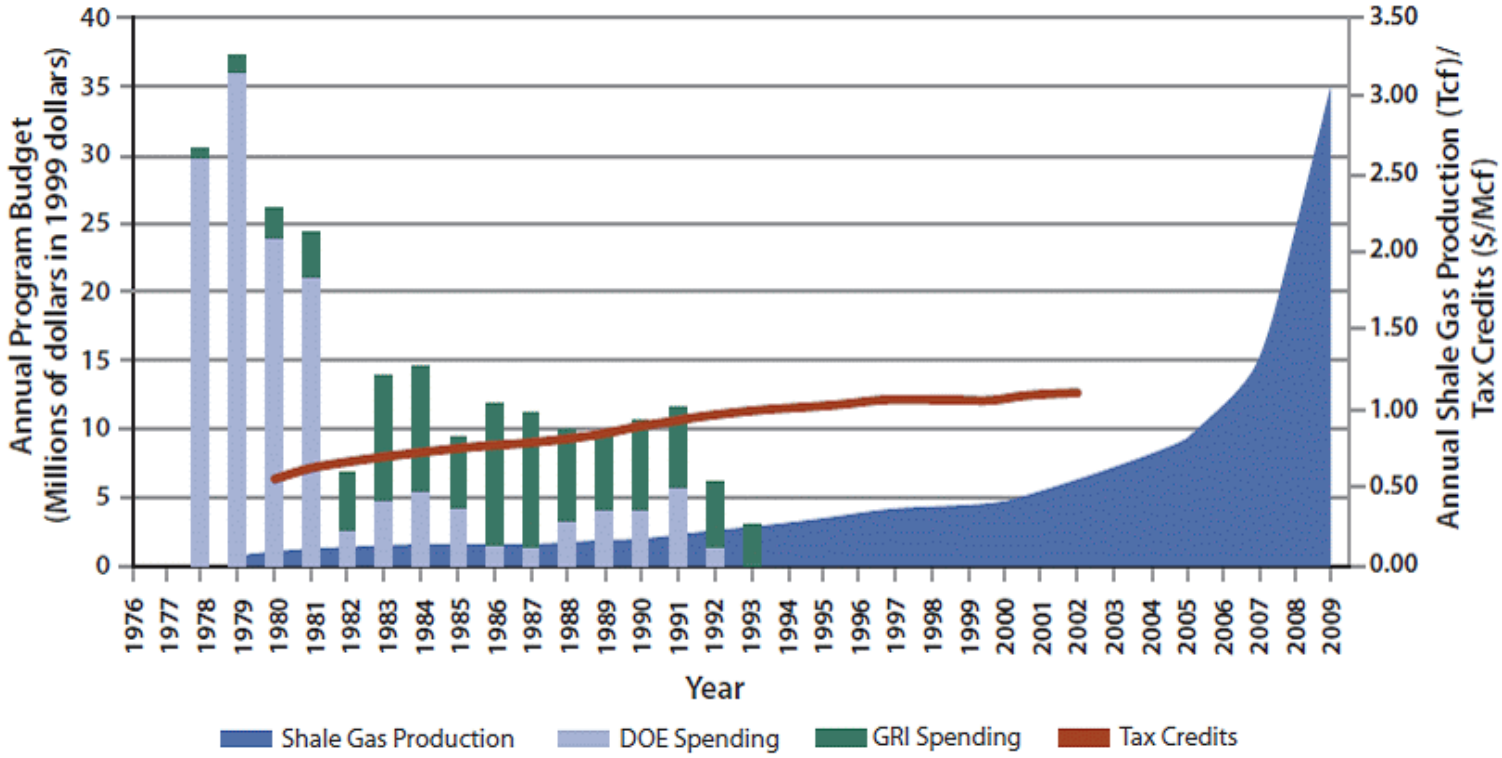
1991: GRI subsidizes Mitchell Energy's first successful horizontal well in the Texas Barnett shale.

1998: Mitchell Energy engineers achieve commercial shale gas extraction.

2000s: Natural gas generation grows faster than any other energy source; shale gas boom pushes prices to record lows.

Fonte: Breakthrough Institute

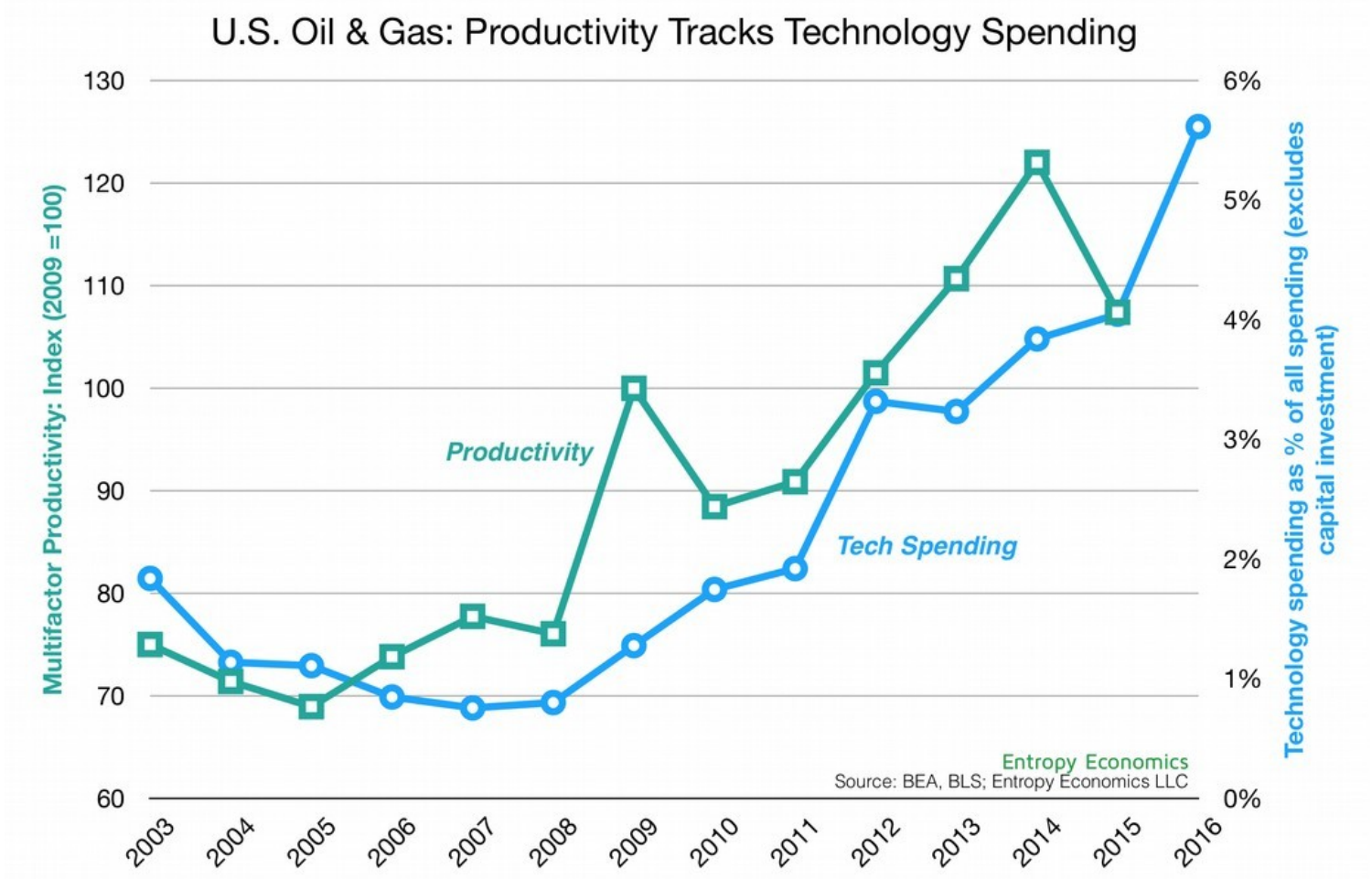
Figure 8.2 Shale Gas RD&D Spending and Supporting Policy Mechanisms



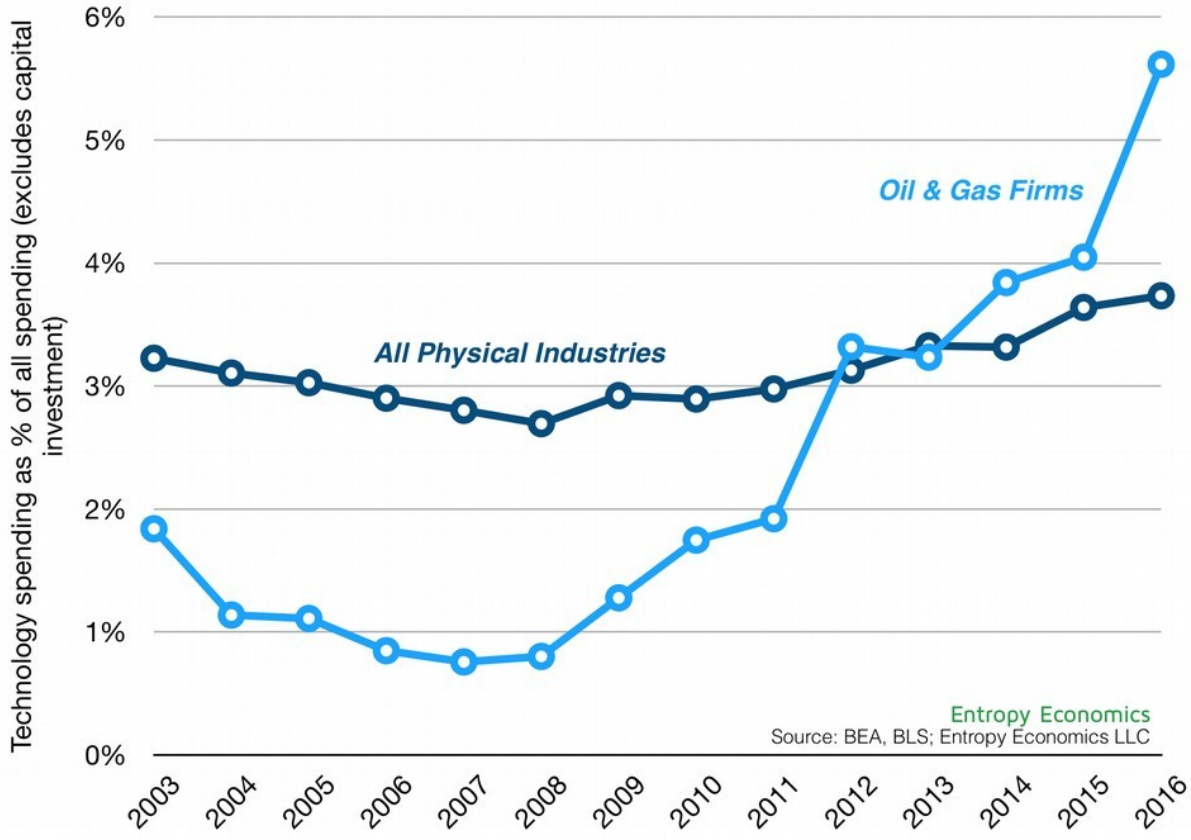
- Subsea to Beach
- Underwater Vehicle
- New generation of Process Equipment
- Riserless Drilling
- Nanoparticles
- Laser Drilling
- Nanomaterials
- Subsea Processing
- Subsea Power Distribution
- Autonomous Underwater Vehicle

- Big Data
- Nanotecnologia/novos materiais
- Blockchain:
- Subsea
- Internet of Things
- Machine Learning
- Inteligência virtual/artificial

- Armazenamento de energia
- Smart Grid
- Transição para economia de baixo carbono
- Indústria 4.0 - prototipagem rápida e automação
- Garantia de escoamento


U.S. Oil & Gas: Productivity Tracks Technology Spending
Multifactor Productivity: Index (2009 =100)
Technology spending as % of all spending (excludes capital investment)
130
120
110
100
90
80
70
60
6%
5%
4%
3%
2%
1%
0%
Productivity
Tech Spending
Entropy Economics
Source: BEA, BLS; Entropy Economics LLC
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016

Technology Spending by Oil & Gas Firms vs. All Physical Industries



Rigzone Ideal Employer Top 10 Innovation Companies

2018 Rank ▼	2017 Rank	Company
1	1	Shell
2	3	ExxonMobil
3	6	Halliburton
4	2	Chevron
5	5	BP
6	4	Schlumberger
7	8	Saudi Aramco
8	7	Total
9	12	Transocean
10	9	BHGE

- Optimizing brownfields could drive upstream innovation. Rigzone, 11.6.2018
- Oil groups stand by bets on out-of-favour plastics. FT 10.6.2018
- American tech giants are making life tough for startups. The Economist 2.6.2018
- Renewables, energy efficiency and increasingly storage are continuing to put a squeeze on demand for gas-fired power plants, the GE CEO has warned. FT 24.5.2018
- Looking for Innovation: Oilfield Services Remain a Challenge. JPT, 22.2.2018
- Innovators go all in one digital. BCG 17.1.2018

- Energias alternativas (eólica, solar)
- Veículos elétricos (automóveis, ônibus, caminhões, scooters, *sharing*)
- Descarbonização das operadoras

OBRIGADO

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