The low-hanging fruit:

FOSSIL FUEL EXPLORATION AND CLIMATE CHANGE

November 2016

LINGO
Leave it in the Ground Initiative

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The Leave it in the Ground Initiative (LINGO) is an international initiative that aims to facilitate the transition from the fossil to the solar age by keeping fossil fuels in the ground. Our work reaches from analysis for the UNFCCC to community resistance against fossil fuel extraction and game changing solutions.

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Cover Image: The Energy Collective,

http://www.theenergycollective.com/kgrandia/216601/are-fossil-fuel-companies-pouring-money-down-drain-carbon-bubble-grows

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Acronyms and technical terms

API : American Petroleum Institute
bboe : billion barrels of oil equivalent
IOC : international oil company
G20 : group of the twenty major economies in the world
IPCC : Intergovernmental Panel for Climate Change
jackup drilling rig : floating barge with drilling equipment on its deck and long support legs used in waters up to 100 meters
LNG : liquefied natural gas
MDB : multilateral development bank
OCI : Oil Change International
ODI : Overseas Development Institute
OGM rights : oil, gas and mineral rights
play : Area in which hydrocarbon accumulations of a given type occur
semi-submersible : The most common type of offshore drilling rig, used for drilling in waters more than 100 meters deep
short selling : short selling happens when traders borrow shares of a stock, sell them to a third party and repurchase later in hopes of pocketing the difference when the shares drop in value
SOE : state-owned enterprise
tpy : tons per year
unburnable carbon : Fossil fuel energy sources that cannot be burnt in a climate-safe world. According to the Intergovernmental Panel on Climate Change (IPCC) and the International Energy Agency (IEA), at least two-thirds of existing proven fossil fuel reserves must be left in the ground to meet the internationally agreed goal of holding a global average temperature rise to no more than 2ºC.
UNCLOS : United Nations Convention on the Law of the Sea
upstream : Sector of the oil and gas industry which includes all the steps involved prior to oil production, such as exploration and research

Executive Summary

In 2016, exploration for additional fossil fuel reserves is no longer necessary. Since the Paris Agreement, the days of what is today still a multibillion dollar industry are counted. In this report we take a look at the global fossil fuel exploration industry and its future in a world where addressing climate change is becoming a priority. And we look at ways to start winding down fossil fuel exploration.

Key findings:

- **Further fossil fuel exploration is incompatible with the Paris Agreement.**
- **Fossil fuel exploration is a sector with diminishing returns on investments. Long payback times expose these investments to additional and increasing risks.**
- **Stopping exploration is a smart option, as it provides significant financial, climate and other co-benefits and high leverage and there are ways to get started immediately.**

1. After Paris, there is no carbon space left for more fossil fuels.

The carbon budget for burning fossil fuels that results from the Paris Agreement and its specific temperature target allows for 16% of current proven fossil fuel reserves (equivalent to 473 Gigatons of CO2 emissions) to be burnt. 84% (equivalent to 2427 Gigatons of CO2) must stay in the ground.[1] Exploration increases the amount of unburnable carbon as additional discoveries do not make a difference to the carbon budget and existing oil and gas fields and coal mines hold enough carbon to break the Paris target.[2] Today's exploration would only make sense in a scenario that sees temperatures rise by much more, triggering run-away climate change.

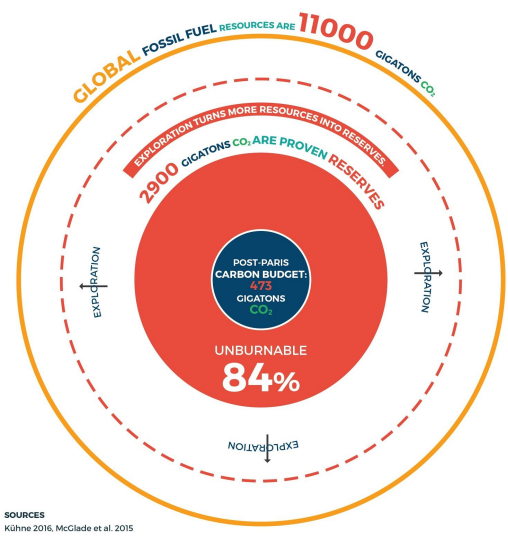

Figure 1. How exploration increases the carbon bubble.[3]

[1] Kühne, Kjell (2016), The global Carbon Budget after the Paris Agreement. Leave it in the Ground Initiative (LINGO), 18.2.2016.
[2] Oil Change International (2016) The Sky's Limit: Why The Paris Climate Goals Require A Managed Decline Of Fossil Fuel Production. Oil Change International, September 2016.
[3] Source: LINGO

2. Exploration is an increasingly bad investment.

While exploration used to be a very attractive investment with internal rates of return (IRR) as high as 20%, this situation has shifted dramatically over the past years. It is more and more difficult to find new deposits in ever harsher environments, and exploration costs are climbing higher and higher. This is a natural dynamic for a non-renewable resource and was already evident (Figure 2) before the recent downturn in fossil fuel prices which add an even bigger question mark to the economics of fossil fuel exploration.

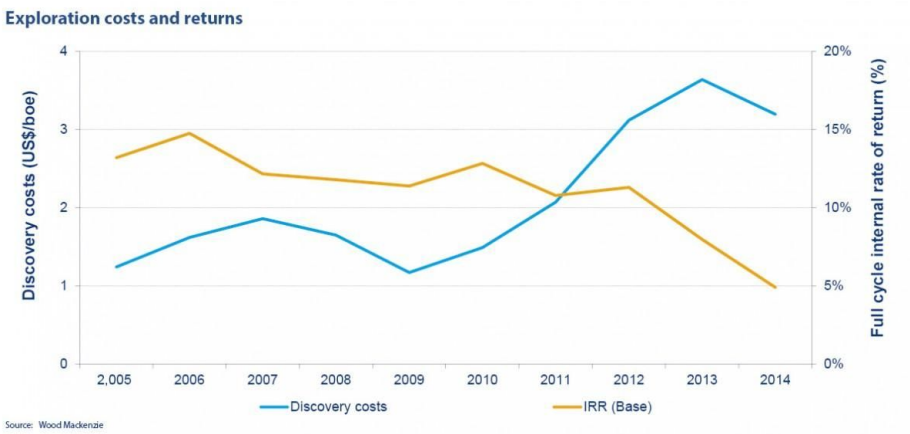

Figure 2. Costs versus IRR for the oil&gas exploration industry 2005-2014.[4]

For exploration activities to make economic sense, the discovered fuels must be extracted and profitably sold. It typically takes between 15 to 20 years for deepwater oil projects from discovery to payback, all delays included,[5] while shale gas projects may have shorter time frames and tar-sands projects even longer ones. For current and future exploration activities, the earliest expected date of turning profitable are therefore usually beyond 2030. This places many of these exploration activities today outside a reasonable time frame for sensible investments. As a "side note", the Paris targets require a complete global decarbonization by about 2035.[6] But even in the absence of effective climate action, the markets for fossil fuels may get much tighter soon due to renewable energy competition as the price trends for renewable electricity and energy storage and plans for phasing out gasoline car sales by 2030 in the EU[7] and elsewhere indicate.
Apart from the time-critical aspect of exploration, the Deepwater Horizon oil spill has shown that offshore oil exploration is a highly risky bet in and of itself: the cost of the disaster exceeded the possible profits from the undertaking by a factor thirty.

Even if the exploration industry still spends billions of dollars, public money outnumbers private investments in exploration, indicating a reliance of the industry on government support.[8] During the

[4] Wilson, Julie (2016) Deepwater Exploration Cutbacks May Come Back To Haunt Oil Drillers. Forbes, 11.2.2016.
[5] Carbon Tracker Initiative (2014) Responding to Shell: An Analytical perspective. July 2014.
[6] NewClimate Institute (2016) Was bedeutet das Pariser Abkommen für den Klimaschutz in Deutschland? Kurzstudie, Februar 2016.
[7] Böll, Sven (2016) Ab 2030 - Bundesländer wollen Benzin- und Dieselautos verbieten. Spiegel online, 8.10.2016.
[8] Oil Change International and Overseas Development Institute (2014) The fossil fuel bailout: G20 subsidies for oil, gas

fossil age, a steady flow of cheap fossil fuels was a priority and to be guaranteed by government intervention (and spending). But today, the same governments have commited to climate targets which will turn these investments into stranded assets. The money would be better spent on ramping up renewable energy infrastructure. The money needed for a single deep-sea well - more than 50 million USD - can install solar panels on all homes in a small town. (See also Figure 4)

3. Stopping exploration provides multiple benefits and high leverage

Offshore oil and gas exploration is implemented with methods that harm marine wildlife. Stopping it would avoid further damages to ecosystems which are already exposed to the combined impacts of a warming climate and other human pressures and contribute to its preservation. But not only is the act of exploring harmful - once oil is found, the possibility of an oil spill becomes an imminent and permanent threat to the local ecosystem, local industries and - through liability in the case of an accident - even to the companies involved in these operations. Offshore exploration is a candidate for an immediate moratorium.

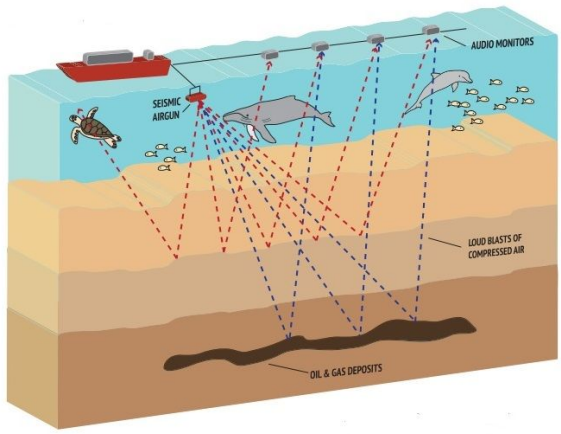

Figure 3. Seismic testing impacts marine wildlife.[9]

Onshore exploration is also pushing deeper into difficult environments with both ecological and social risks associated with fossil fuel development. The increasing number of cases where such projects get contested and halted on ecological and social grounds remind us that these frontiers have not yet been explored for a reason. Exploring for fossil fuels in protected areas and on indigenous lands often contradicts the commitment to prohibit mineral extraction in protected areas made by governments in 2000[10] and the UN Declaration on the Rights of Indigenous People which gives indigenous communities the right to say No to projects on their lands.

Besides the economic, ecologic and social, there are even security concerns that can be addressed by cancelling exploration. A number of areas with fossil fuel reserves are under dispute between states. Cancelling exploration plans for these areas would be a contribution to deescalation and ultimately to peace.[11]

Another argument in favour of addressing exploration first, is leverage: Three dollars spent on exploration may discover a barrel of oil which will swallow 7 to 40 times more money - between 20 and 120 dollars of production costs - before being sold, burned and emitting 0.3 tons of CO2. Very substantial

and coal exploration. Report, November 2014.

[9] Image: Oceana

[10] World Conservation Congress (2000) Resolution 2.82 Protection and conservation of biological diversity of protected areas from the negative impacts of mining and exploration. Amman, 4–11 October 2000.

[11] Benedikter, Roland, et al. (2016) "Keep It in the Ground." The Paris Agreement and the Renewal of the Energy Economy: Toward an Alternative Future for Globalized Resource Policy? Challenge (2016): 1-18.

flows of finance into the fossil industry could thus be diverted by stopping exploration.
The mitigation "cost" of 10 USD per ton of CO2 in this case is actually negative cost, i.e. money saved.

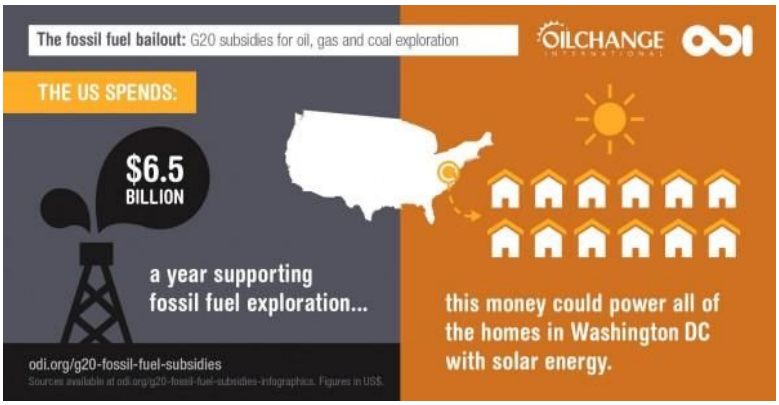

Figure 4. Annual US exploration subsidies in comparison.[12]

Recommendations

Companies:

- Cancel scheduled exploration expenditures and pay dividends or invest in renewables.
- Create and implement transition plans.
- Do not apply for new exploration licenses.

Governments:

- Stop issuing and renewing exploration licenses.
- Review existing exploration licenses in indigenous territories, protected areas, zones in dispute and offshore and cancel where possible.
- Remove exploration subsidies and spend the money on renewable energy security.
- Do not create mechanisms under free trade agreements where cancelling or delaying exploration licenses could result in fines or lawsuits.

Investors:

- Divest exploration companies or demand transition plans out of the industry.
- Urge companies with exploration activities to cancel exploration projects and pay dividends or invest in renewables instead.

Civil society:

- Use all means, such as lawsuits and where necessary civil disobedience to halt or delay exploration projects.

[12] Overseas Development Institute (2014) G20 spends $88 billion a year supporting fossil fuel exploration. November 2014.

1. Introduction

The fossil age - which many of us have known for all of our lives - is coming to en end. The Paris Agreement signals it. We must say goodbye to fossil fuels this century, and the sooner the better, because only staying well below 2 degrees Celsius temperature rise may give us a chance to avoid run-away climate change.

The science, including on carbon budgets is already clear. Numbers are on the table for the adopted targets and the IPCC has confirmed that most fossil fuels must stay in the ground.

What is not so clear is which policies will take us there. Most governments still promote continued or even increasing fossil fuel extraction in spite of its incompatibility with climate targets. Since the words coal, oil and gas have been awkwardly excluded from the UN climate agenda, some may even believe we could reduce emissions and increase fossil fuel production at the same time. To start addressing the issue from the "top" end, this report looks at exploration for more oil, gas and coal. When looking at ways to limit fossil fuel supply, exploration is the low-hanging fruit, because it has no locked-in capital.

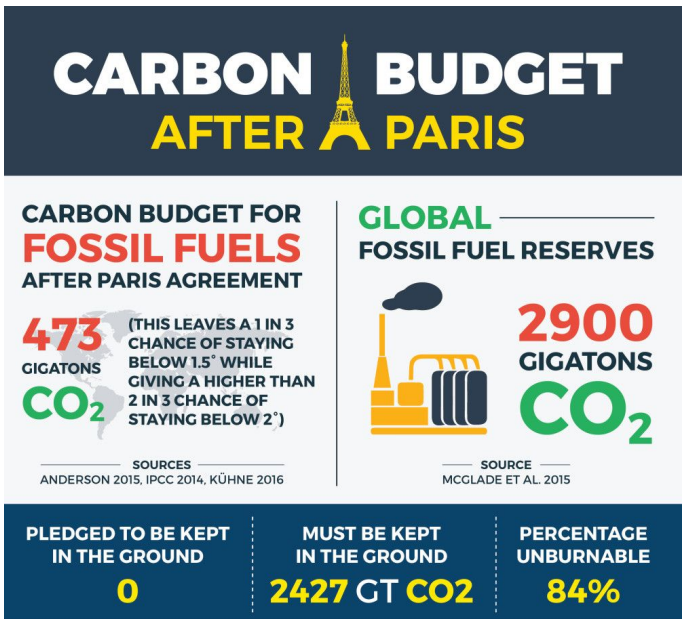

Figure 5. The Paris target translated into a carbon budget for fossil fuels.[13]

[13] Own elaboration, based on Anderson, Kevin (2015) Duality in climate science. Nature Geoscience 8, 898–900.; IPCC (2014) Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to

In a chapter each we look at how exploration for oil&gas and coal works, who does it and where, how it is financed and which way things will go as the end of the fossil age approaches.
The biggest part of oil&gas exploration spending is happening offshore and - according to our perspective on its environmental costs - should be forbidden. Onshore oil&gas exploration has low prospects of big discoveries and high risks due to complex environments, socially, ecologically and often also technically.
Oil and gas are already in their end game, conventional oil has peaked in 2005 and on the second half of the Hubbert curve, new rules apply: it gets harder and harder all the time and risks for investors and for the environment grow. Pulling out altogether or having a portfolio which allows a gradual shift to renewable energy options is the wise thing to do now.
Coal exploration already seems economically unviable today unless financially supported by governments.

In the fossil end game, exploration will be one of the first losers.

From a climate perspective, exploration is one of the worst offenders, because it assumes that curent reserves are not enough.. It should be addressed immediately as it stands in stark contrast to the Paris Agreement.
From an ecologic perspective offshore exploration is a priority, because it is deadly for marine wildlife and only the first step on the way to more offshore drilling with more impacts. But also onshore, increasingly vulnerable ecosystems are targeted by explorers.
From an investor's perspective, exploration is a hot potato. Returns are getting worse and are not looking to get better in the future, due to structural issues that will come to play out in the lifetime of these investments which are naturally long-term.
From a government perspective, exploration is a low-hanging fruit for addressing both economic, ecological and climate issues.

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the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.; Kühne, Kjell (2016) The global Carbon Budget after the Paris Agreement. Leave it in the Ground Initiative (LINGO), 18.2.2016.; McGlade, Christophe & Ekins, Paul (2015) The geographical distribution of fossil fuels unused when limiting global warming to 2 °C. Nature 517, 187–190.

2. Oil and gas exploration

2.1. The oil and gas exploration process

Generally, oil and gas resources are likely to be found in sedimentary basins, which can be both on land or below the sea. Exploration companies employ geophysicists and geologists to find areas where conditions are favorable for encountering oil and gas deposits. To achieve their goal, they use geophysical surveys such as seismic surveys, sending sound waves under the land surface or under the seabed (Figure 6). The waves travel through the rocks and bounce back like echoes and are then analysed by the scientists who use computers to create a precise picture of what is under the ground or the seabed.

Exploration requires to drill wells through thousands of meters of rock and costs millions of dollars. Therefore, companies have to use scientific techniques to identify where fossil resources can be found before drilling.

If the seismic surveys show the potential presence of oil or gas, the company can decide to drill a well. Then, if the company judges that the area is worth to be explored further, more detailed seismic surveys are conducted and exploration wells are drilled. Thanks to these exploration wells, the geoscientists and engineers can try to answer questions relative to the presence, location, quantity, pressure and geological context of oil or gas.[14]

[14] BP (2008) Oil and gas exploration and production. Module 3, BP energy education programme. Accessed 18.8.2016

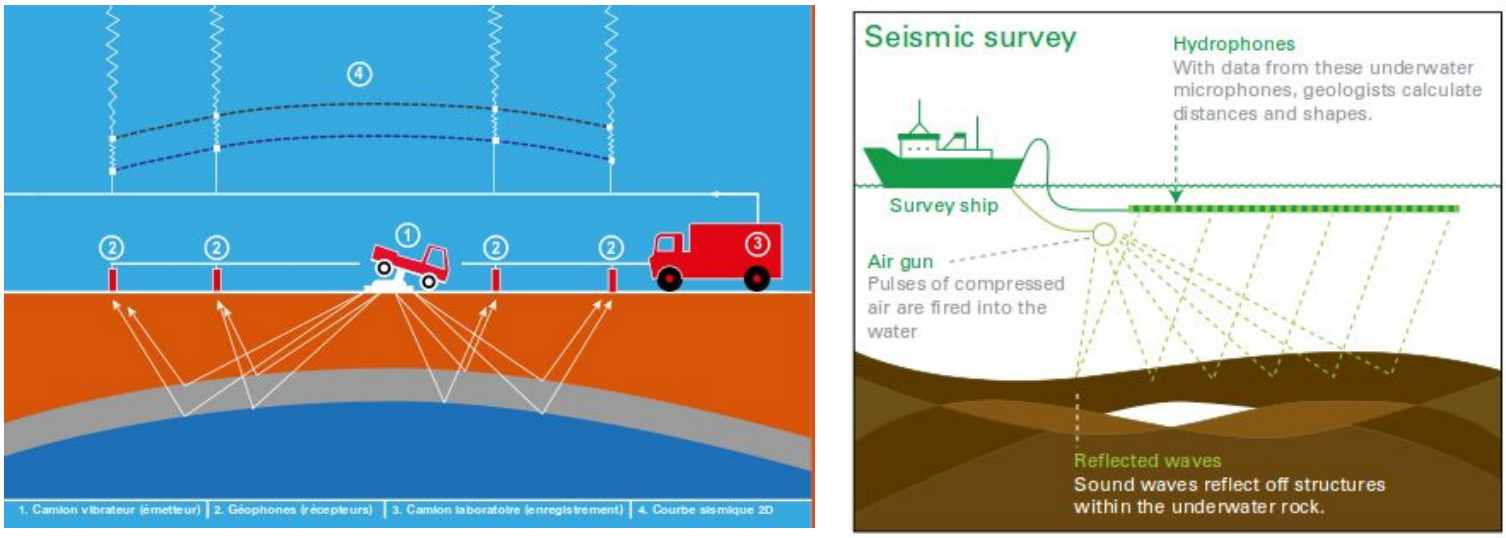

Figure 6. Seismic surveys on land and in the sea.[15]

Once a relevant amount of oil or gas has been discovered, the company drills more wells, called appraisal wells, in order to collect further data on the field. Eventually, if the company decides to produce oil or gas from the field, production wells are drilled.

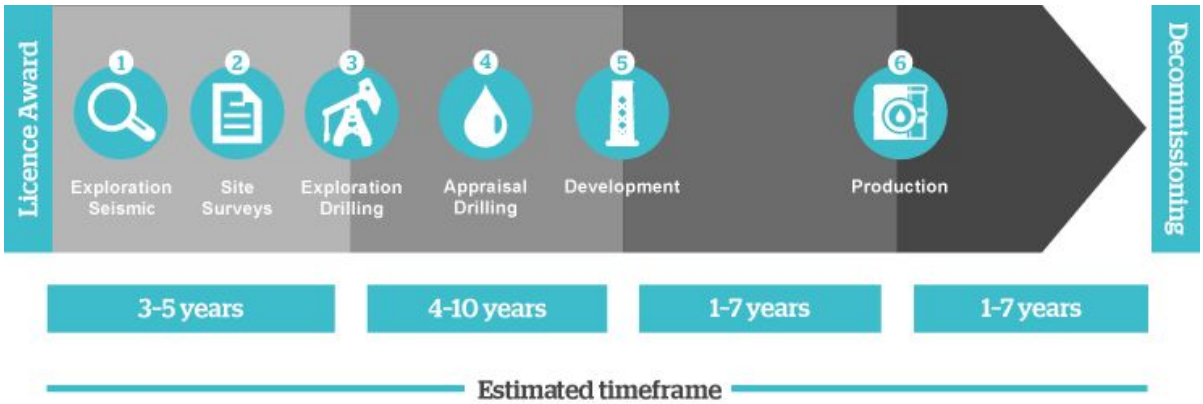

Figure 7. Stages in oil and gas exploration and extraction.[16]

Exploration is an expensive business because an onshore exploration well costs between 3 and 15 million USD and an offshore exploration well can cost from 20 to 200 million

[15] UFIP (undated) PÉTROLE ET GAZ NATUREL EN FRANCE : L'AVENIR EST AUSSI SOUS NOS PIEDS. Union Française des Industries Pétrolières, Accessed 18.08.2016.
[16] Cairn Energy (undated) Oil and gas project lifecycle. Accessed 18.8.2016. Time frames are indicative and may vary substantially depending on oil or gas type, size of the deposit and market conditions.

USD. On average only one exploration well out of seven results in a discovery.[17] It may therefore require companies to drill multiple wells in one area before making a worthwhile discovery, which can take several years.

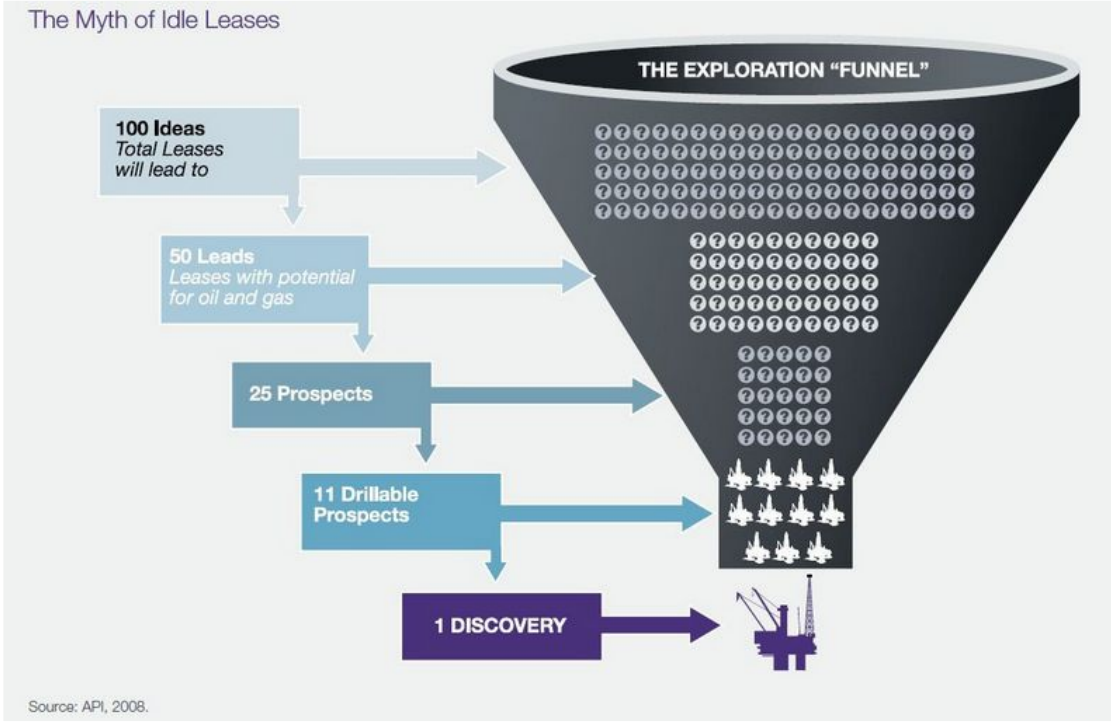

Figure 8. From exploration to discovery - a numbers game.[18]

Exploration is also a high-risk business. Millions of dollars can be spent by companies for lease purchases, exploration and development, just to find out that the field cannot be exploited.[19] The lack of knowledge about the area before buying the lease and at the beginning of the exploration can result in companies spending more than 100 million USD to drill a dry hole. And even discoveries may later turn out to be uneconomic to extract.

In the appraisal phase, when exploration drilling has led to an oil or gas discovery, new wells are drilled in order to collect further information and new seismic surveys can be conducted in order to have a better image of the reservoir. These activities take several more years and cost tens to hundreds of millions of dollars.

[17] See footnote 15.
[18] Image: API (undated) The Myth of Idle Leases. American Petroleum Institute, Accessed 18.08.2016.
[19] API (2009) Onshore access to oil and natural gas resources. American Petroleum Institute.

However, even after investing time and money in the appraisal stage, companies might not find a way to develop the field safely, profitably and responsibly. If the appraisal stage is a failure, it is a lost bet for the company and a huge waste of money. If it is successful, which means that the company decides that the oil or gas field can be developed, the development phase begins. This phase costs hundreds of millions, sometimes even billions of dollars and typically takes 5 to 10 years.

An example deepwater project in the Gulf of Mexico is expected to generate costs between 257 and 727 million USD in the exploration and appraisal phases before production starts generating a cashflow. (see Figure 9)

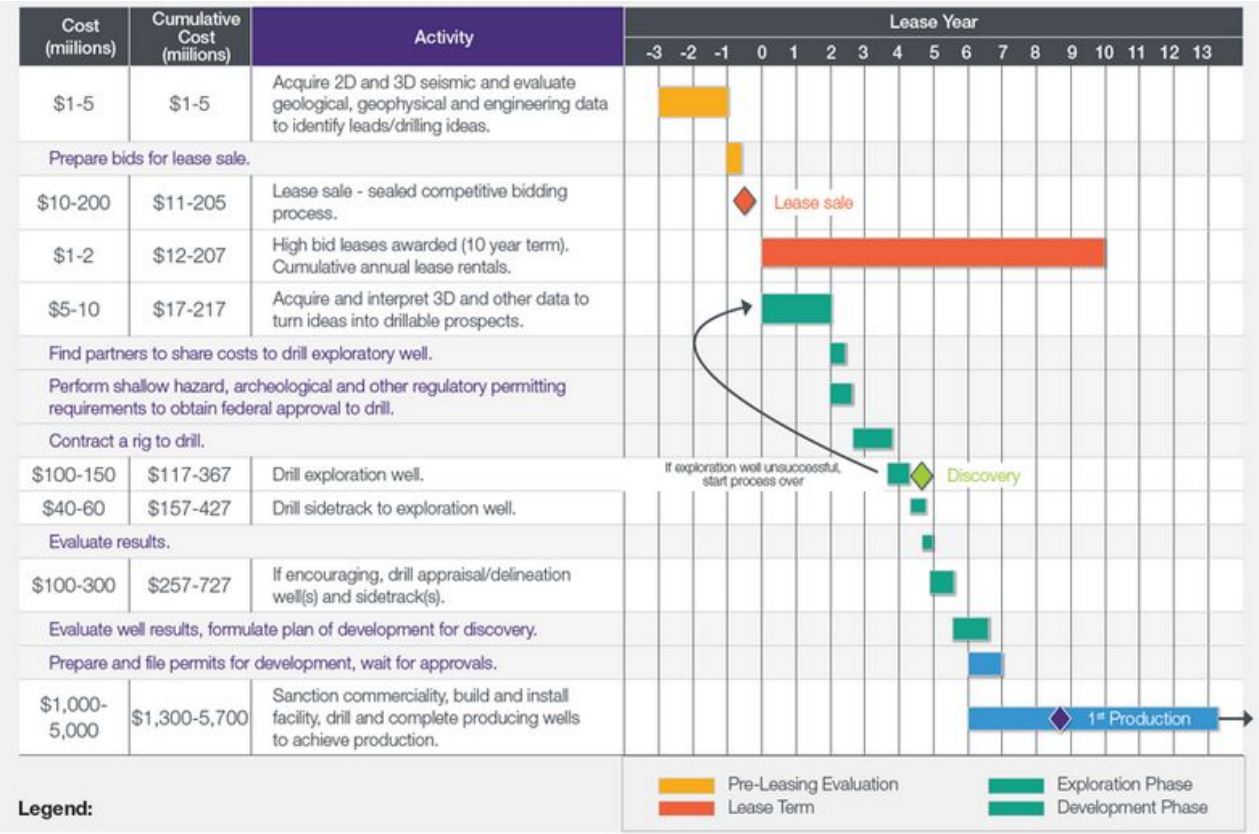

Figure 9. Gulf of Mexico deepwater frontier exploration and production timeline.[20]

[20] Image: API (2012) Gulf of Mexico Deepwater Frontier Exploration and Production Timeline. American Petroleum Institute.

2.2. Impacts of oil and gas exploration

2.2.1. Impacts of seismic surveys

Offshore exploration implies the use of seismic air guns that fire bursts of sound louder than a jet engine every few seconds for weeks.[21] These bursts can be heard 2500 miles away underwater. The use of these powerful and noise polluting techniques have strong impacts on marine life. Animals lose their communication abilities and are forced to move to places different from their natural habitats, abandoning their breeding grounds. Furthermore, the animals are subject to abnormal stress, decreased egg viability and growth, decreased catch rates, hearing impairment, massive injuries, and even death by drowning or strandings.[22] Mass strandings of whales and dolphins have occurred in different places around the world (e.g. Madagascar[23], Peru[24]).

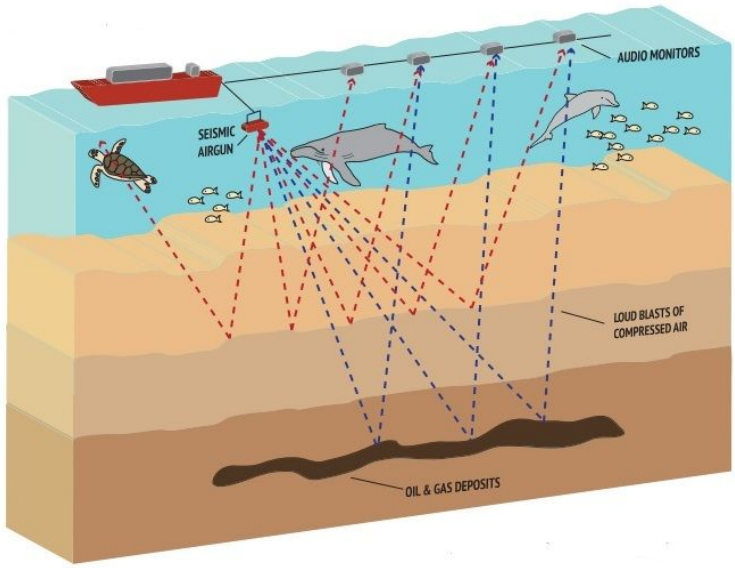

Figure 10. Seismic surveys and marine wildlife.[25]

[21] Oceana (2013) Marine Life and Coastal Economies Threatened by Seismic Airgun Use in Atlantic Ocean. Press release, 15 April 2013.
[22] Weilgart, L. (2013) A review of the impacts of seismic airgun surveys on marine life. Submitted to the UN Convention on Biodiversity Expert Workshop on Underwater Noise and its Impacts on Marine and Coastal Biodiversity, 25-27 February 2014, London, UK. Accessed 17.8.2016
[23] Hogg, J. (2008) Whales stranded off Madagascar. BBC News, Antananrivo. 9 June 2008.
[24] Jolly, D. (2012) Expert Links Dolphin Deaths to Sonar Testing. New York Times Green Blog, 28 May 2012.
[25] Image: Oceana. Accessed 1.11.2016

In response to seismic airgun blasting, marine scientists from all over the world wrote a letter to the president of the United States to register their concern about possible seismic oil and gas exploration along the U.S. mid-Atlantic and south Atlantic coasts.[26] This one exploration programme has been projected to injure or kill over 100,000 whales and dolphins, included some North Atlantic right whales, a species close to extinction.[27]

2.2.2. Impacts of offshore drilling

Offshore exploration activities can cause serious harm to ecosystems.[28] Marine mammals are not only threatened by seismic surveys but also by the inhalation of oil droplets and vapors, entanglement in fishing nets and collisions with ships. Sea birds attracted by the lights of the drilling rigs are in danger, with 200 000 migratory bird killed each year in the Gulf of Mexico near oil platforms. Furthermore, sea turtles are threatened by oil exposure at all life stages, because of contact with skin, ingestion and inhalation of vapors. Lesions have been observed in fish collected near drilling platforms and fish catches can be considerably reduced due to the pollution destroying nursery habitat and breeding areas.[29]

Pollution from offshore drilling operations is not limited to crude oil, but also includes natural gas liquids, diesel and hydraulic fluids.[30]

Beyond the pollution from normal operation, the risk of accidents, resulting in major oil spills is a major disadvantage of offshore exploration. Unfortunately, oil spills are made even more likely by global warming, because a higher ocean surface temperature in turn increases the duration and intensity of major storms, leading to conditions that can cause accidents at offshore facilities.[31] For the economic risks to the operators themselves, please refer to section 2.6.4. on the Deepwater Horizon case below.

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[26] Letter to the US president, March 2015. http://usa.oceana.org/sites/default/files/statement._atlantic_seismic_5mar15.pdf

[27] Environment North Carolina (2015) Drilling Is Tragic For Marine Life.

[28] NRDC (2009) Protecting Our Ocean and Coastal Economies: Avoid Unnecessary Risks from Offshore Drilling. Natural Resources Defense Council.

[29] Defenders of Wildlife (undated) Impacts of Offshore Oil and Gas Drilling on Marine Wildlife. Accessed 7.9.2016

[30] See footnote 25.

[31] National Wildlife Federation (undated) Hurricanes and Global Warming. Accessed 7.9.2016

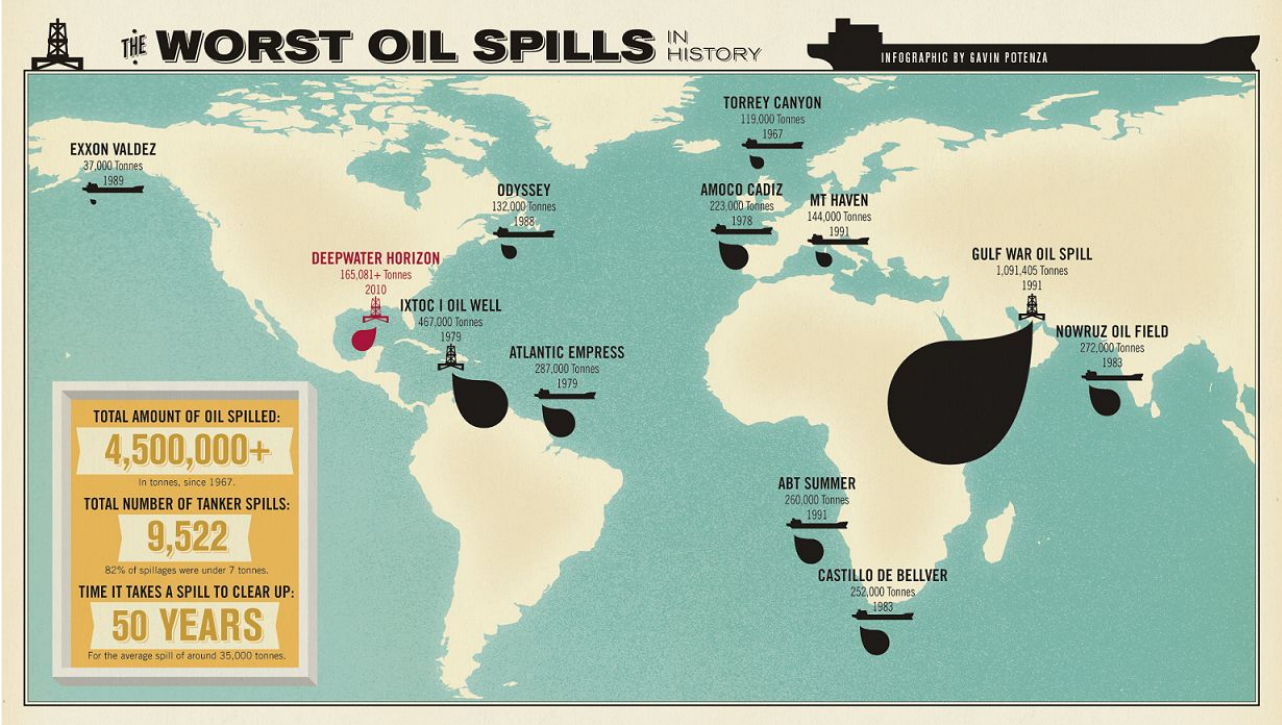

Figure 11. The worst oil spills in history.[32]

2.3. Who explores for oil and gas and where?

Exploring entities can be owned by investors or a government. Investor-owned companies may be publicly traded, with a large number of shareholders and regulated by the stock exchanges if listed, or they can be private firms owned by a small number of shareholders. State-owned enterprises (SOEs) may be completely owned by a state or part of its shares may be traded.

Today, there are five private oil and gas majors who conduct a significant part of global oil and gas exploration activities: Royal Dutch Shell (UK/Netherlands), ExxonMobil (US), BP (UK), Chevron (US) and Total (France).[33]
Most of the main oil producing countries have their own national oil and gas companies, controlled by the state, such as Saudi Aramco in Saudi Arabia, QGPC in Qatar, Sonatrach

[32] Image: Visually (2011), Gavin Potenza: The Worst Oil Spills in History. Accessed 7.9.2016.
[33] Planete energies (2015) Les différents types de compagnies pétrolières et gazières.

in Algeria, NIOC in Iran, NNPC in Nigeria, PEMEX in Mexico and PDVSA in Venezuela, which often have exclusivity for hydrocarbon production. Other partly government-owned companies are Petrobras in Brazil, Gazprom, Lukoil and Rosneft in Russia and Petrochina and Sinopec in China.
Additionally, there are companies which provide services in specific fields (geophysical measurements, drilling, etc.) and rent essential equipment. The biggest multinational groups that provide these services and participate in the exploration of new hydrocarbon sources all over the world are Schlumberger (France/US/Netherlands), Halliburton (US), Saipem (Italy), Transocean (Switzerland), Baker Hughes (US), Fluor (US) and Weatherford International (Switzerland).[34]

In 2014, consultancy Wood MacKenzie produced a forecast of exploration activity until 2030.[35] The highest number of wells was expected in Colombia's Llano Basin, followed by the Western Desert and the Nile Delta in Egypt, the Lower Indus and Middle Upper Indus in Pakistan and the Neuquen basin in Argentina. These basins have only moderate sized yet-to-find volumes, but offer low onshore exploration and development costs.

Substantial investment in exploration was also expected in Yemen and Oman in the Middle East, in the Russian East Barents Sea, a number of African gas basins and onshore basins in East Africa, and in North America, especially in the Gulf of Mexico for deepwater projects. Figure 12 shows the forecast number of exploration wells to be drilled by basin to 2030.

As we will see in section 2.4., these forecasts are very dependent on oil and gas prices, so these numbers have shrunk significantly since 2014.

[34] Baxter-Reffered, Kevin (2009) World's Top 10 largest oilfield services companies.
[35] Wood Mackenzie (2014) Global future exploration basin economic benchmarking.

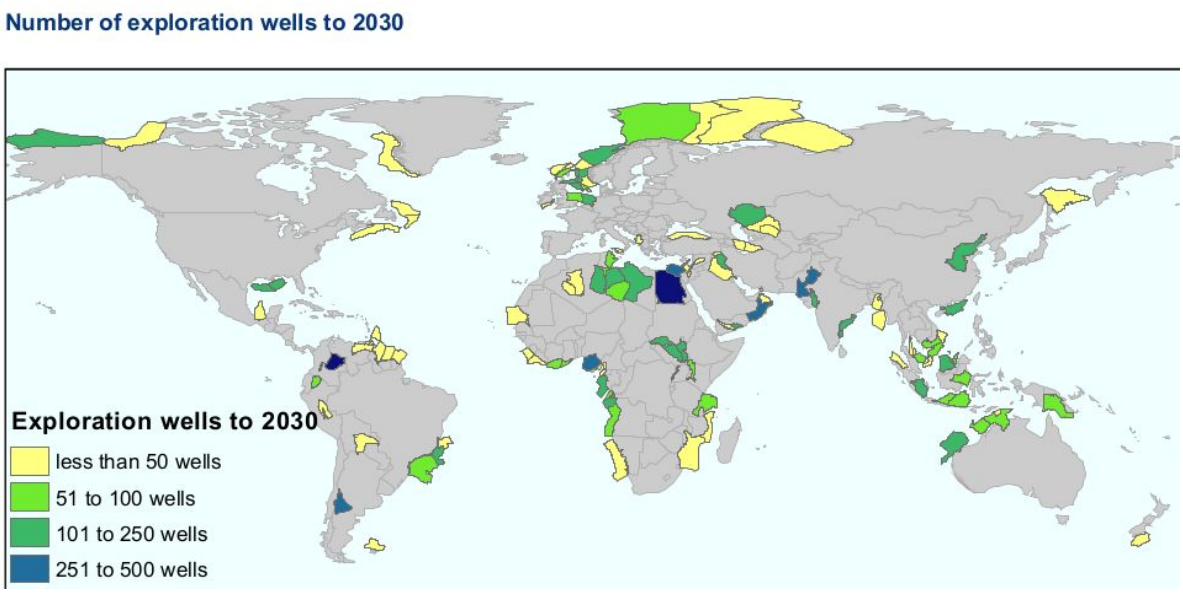

Figure 12. Exploration wells expected to be drilled from 2015 to 2030.[36]

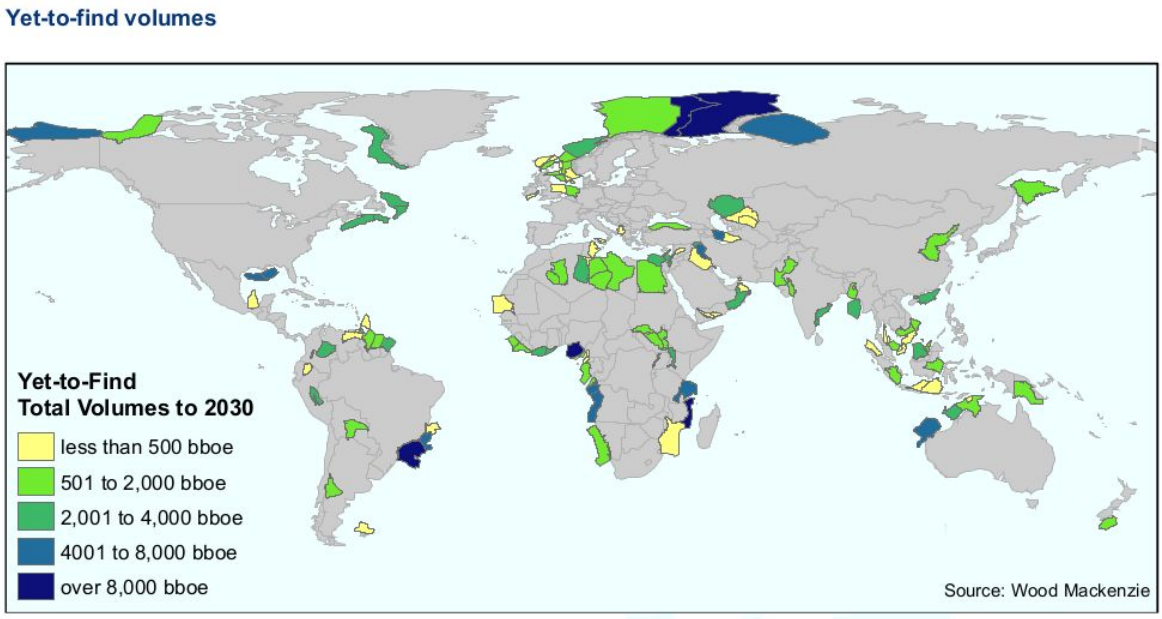

Figure 13. Total yet-to-find volumes in million barrels oil equivalent by basin to 2030.[37]

[36] See previous footnote.
[37] See previous footnote. Million barrels of oil equivalent are erroneously abbreviated as “bboe”.

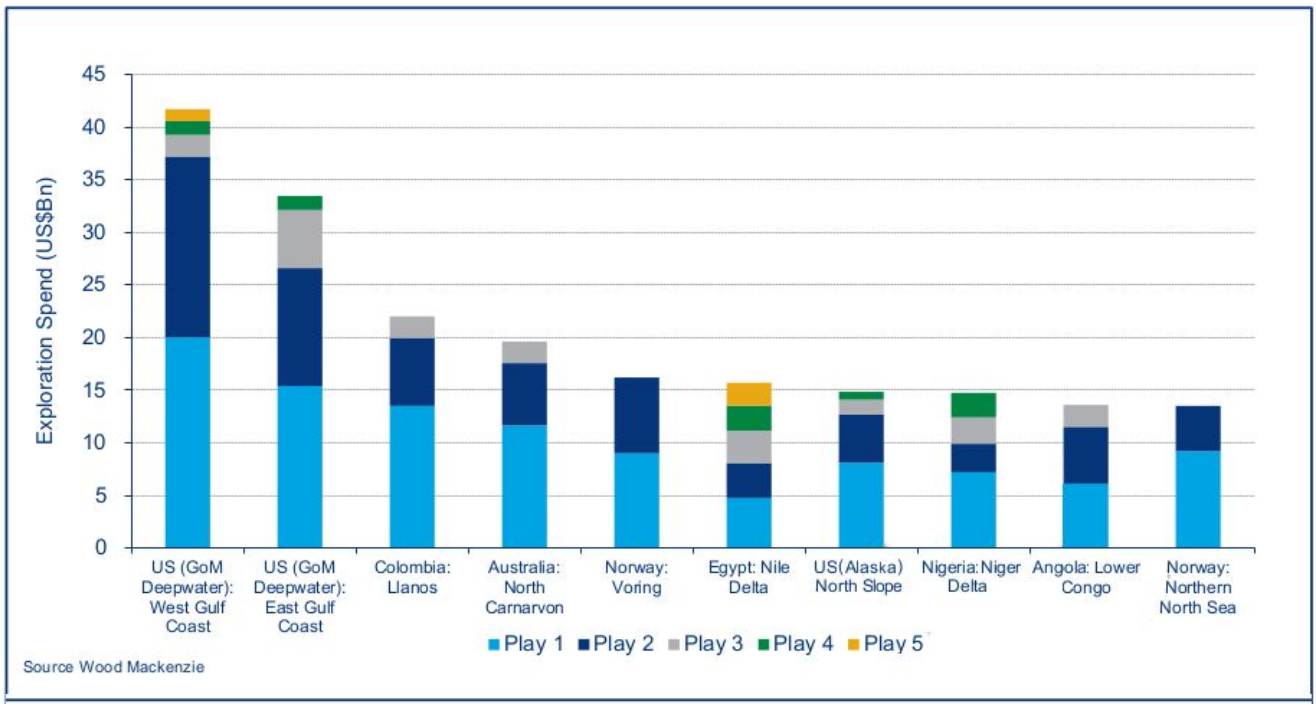

Figure 14. Top 10 oil and gas basins by forecast exploration investment from 2015 to 2030.[38]

Figure 14 shows the 10 exploration basins expected to attract the highest amounts of investments until 2030, with approximately 75 billion USD forecast spendings in the Gulf of Mexico alone.

The focus of exploration activities is shifting more and more towards unconventional fuels such as tar sands, shale gas and oil and deeper into the seas. This also means that exploration is becoming more and more costly.

2.3.1. The offshore market

The biggest players of the global offshore drilling rigs market are shown in Figure 15. Transocean (Switzerland), COSL (China), Nabors (Bermuda), Ensco (UK), Diamond

[38] See footnote 33.

Offshore Drilling (USA), KCA Deutag (UK) and Maersk Drilling (Denmark).[39] In addition to private companies, there are also a number of SOEs active in the field, and China Oilfield Services Limited has the biggest rig fleet among them.

The Largest Publicly Traded Drilling Contractors in 2011

Firm	Enterprise value[a] ($billion)	Fleet value[a] ($billion)	2011 revenue ($billion)	Jackups	Semis	Drillships	Total	Headquarters
Transocean	25.4	32.1	9.1	68	50	23	141	U.S.
Seadrill	27.1	15.6	4.0	21	12	6	39	Norway
Diamond Offshore	8.9	8.7	3.3	13	32	3	48	U.S.
Ensco	16.7	14.5	2.8	42	18	5	65	U.S.
Noble	13.3	11.7	2.7	45	14	13	72	U.S.
Saipem	26c	4.5	1.0b	7	7	2	16	Italy
Rowan	4.5	5.7	0.9	31	0	0	31	U.S.
Songa Offshore	1.7	1.9	0.7	0	5	0	5	Norway
Ocean Rig	3.6	3.0	0.7	0	2	4	6	Norway
Atwood Oceanics	3.2	2.7	0.6	6	6	1	13	U.S.
Aban	2.9	2.4	0.6	15	0	3	18	India
Hercules Offshore	1.3	1.1	0.5b	33	0	0	33	U.S.
Vantage	1.5	1.7	0.3	4	0	4	8	U.S.
Japan Drilling	0.4	1.2	0.3	4	2	0	6	Japan
Total	110.5	106.8	26.4	289	148	64	501	
% of world fleet				54%	66%	60%	58%	

Note: (a) Enterprise and fleet value evaluated on December 21, 2011. (b) Only includes offshore drilling revenues.
(c) Most of Saipem's enterprise value is associated with non-offshore drilling activities and is not included in the total.
Source: Jefferies and Company, Inc., 2012; financial reports; RigLogix, 2011.

Figure 15. The largest publicly traded drilling contractors in 2011.[40]

Latin America, Asia-Pacific, North America and Africa are currently the four largest markets in the offshore drilling industry, all around 20 billion USD per year.[41]

Along with declining oil prices, the offshore drilling market has contracted over the last years. This is indicated by lower utilization rates and day rates for drillships and semi-submersibles.[42] The offshore industry has registered a substantial loss of activity

[39] Kaiser, M.J., B. Snyder, and Pulsipher, A.G. (2013) Offshore drilling industry and rig construction market in the Gulf of Mexico. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2013-0112.
[40] See previous footnote.
[41] Markets and markets (2014) Offshore Drilling Rigs Market. Press release. Accessed 7.9.2016.
[42] IHS (2016) IHS Petrodata Offshore Rig Day Rate Trend. Accessed 7.9.2016.

between 2013 and 2016. Deepwater and ultra deepwater projects tend to require high levels of investment due to high well costs rather than high volumes of resources. As a result of low oil prices, the three last years have known a cut of more than 50 percent in global deepwater spendings. Indeed, 68 projects have been cancelled between October 2014 and January 2016, with 380 billion USD of total project capex deferred from the 68 projects. Among them, 29 were deepwater projects, accounting for 56% of the total capex deferred.[43]

2.4. Who funds oil and gas exploration?

Huge amounts of funds are mobilized by the oil and gas industry each year for its operations, including exploration. Figure 16 details the distribution of funding sources.

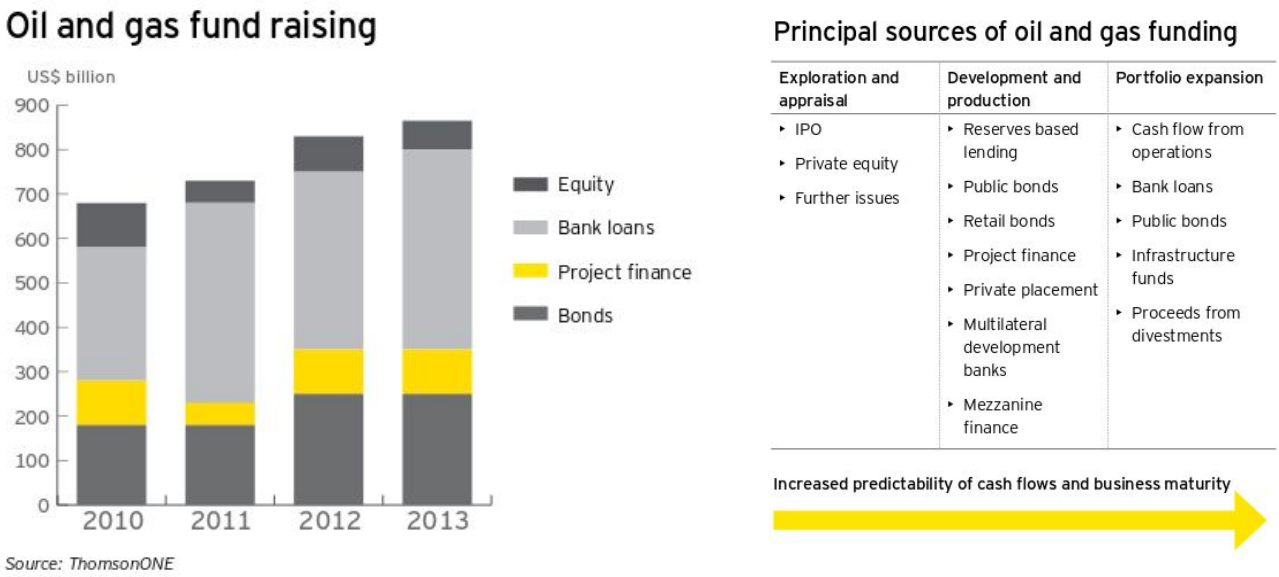

Figure 16. Sources of oil and gas funding, including exploration.[44]

Upstream spending has almost continuously increased over the past decade. Figure 17 combines the upstream expenditures of 42 oil and natural gas companies since 2000. However, two years later, exploration spending was cut due to the drop of the oil price from 100 to 40 USD/bbl, as explained in the previous section.

[43] *World Oil (2016) Toll of oil price slump mounts as 68 major projects delayed. World Oil, 14.1.2016.*
[44] *Image: Brogan, Andy (2014) Funding challenges in the oil and gas sector. EY.*

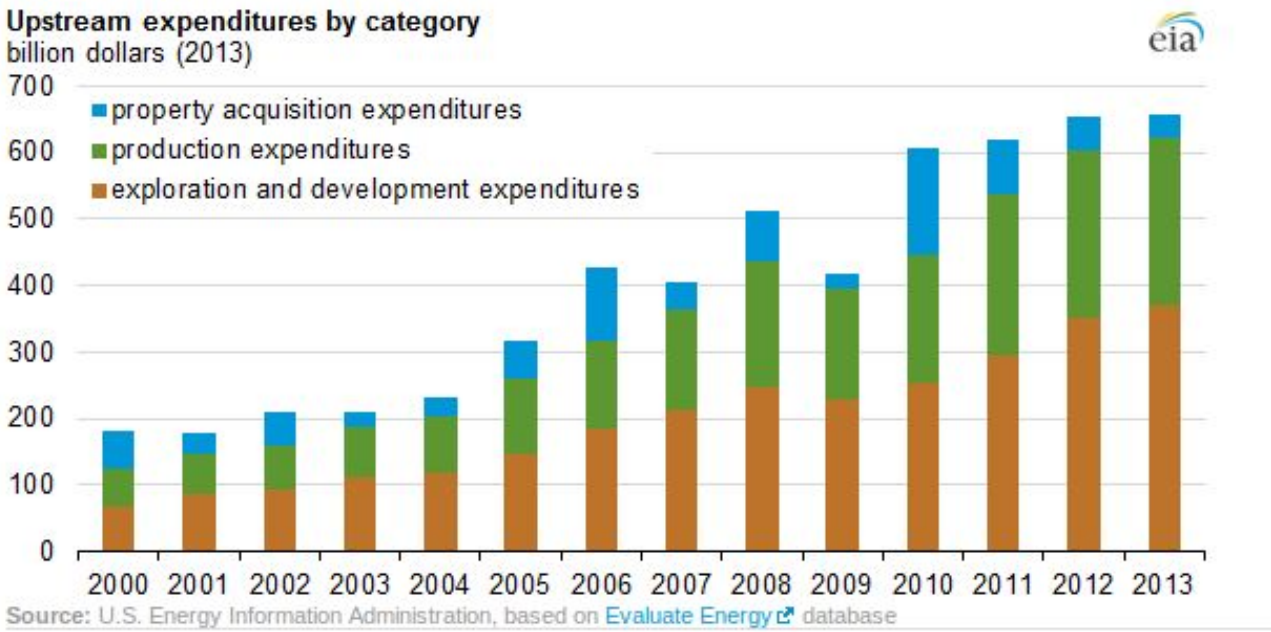

Figure 17. Global upstream oil and gas spending.[45]

In 2011, the 50 biggest US oil and gas firms spent a combined 21 billion USD on exploration (Figure 18) and the figure for the whole G20 stood at 88 billion USD in 2013, before the meltdown of oil prices (Figure 20).

US – capital expenditures (millions) (a)

	2007	2008	2009	2010	2011
Proved properties acquired	$ 23,941.8	$ 19,824.7	$ 3,943.7	$ 42,209.7	$ 12,125.4
Unproved properties acquired	10,977.3	32,608.1	9,643.5	59,080.8	30,769.5
Exploration	13,364.3	16,121.4	14,268.8	15,502.2	21,670.0
Development	53,173.9	66,501.4	45,138.7	61,472.5	84,416.9
Other	465.3	994.9	208.6	82.8	180.7
Total	**$ 101,922.6**	**$ 136,050.5**	**$ 73,203.4**	**$ 178,348.0**	**$ 149,162.4**

(a) Includes the 50 largest companies based on 2011 end-of-year oil and gas reserve estimates. Activity related to XTO Energy has also been reflected as described on page 1.

Figure 18. Capital expenditures of the 50 biggest US oil and gas firms 2007-2011.[46]

In the United States, exploration costs account for about 6% of the overall oil and gas extraction industry.

[45] Image: US Energy Information Administration (2014) Global upstream oil and gas spending continues to favor exploration and development. Accessed 8.9.2016.
[46] Image: EY (2012) US E&P benchmark study.

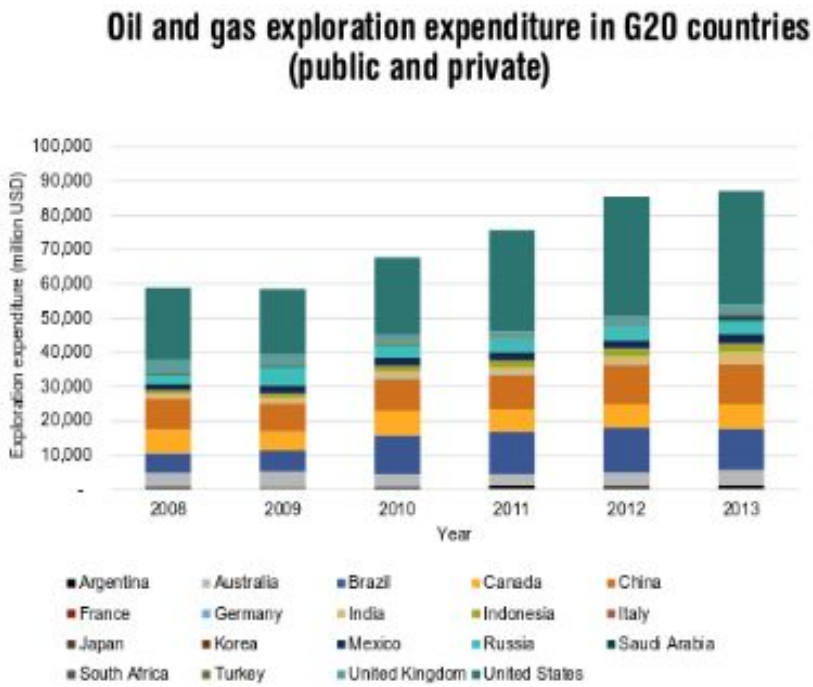

Figure 19. Oil and gas exploration spending wordwide.[47]

[47] See footnote 8. Please note that data quality varies among countries.

Figure 20. Oil price development 2012-2016.[48]

The low oil prices of the last years have been turning many deepwater projects unviable. Indeed, the break-even cost for most deepwater projects are over 60 USD per barrel, where as the actual prices have dropped to less than 40 USD.[49] Thus, usptream spendings are expected to drop by 22% from 2015 to 2020, i.e. 740 billion USD since the decrease of oil prices in 2014.[50] All producing countries have been affected by the oil price drop, the United States occupying the first place with a 48% decline in upstream investment. Figure 21 shows the drop in spending on conventional oil and gas exploration as the low oil prices reduce the amount of cash that is available to companies for investing in exploration. The expectation of higher levels of activity in the future is built on hopes of higher oil prices in the near future.

[48] Image: Gallucci, Maria (2016) Oil Price Crash: US Mining And Exploration Investment Falls 35% As Energy Companies Curb Spending. International Business Times, 2.10.2016.
[49] Blum, Jordan (2016) Deep-water spending down big as wild frontier goes cold. Fuelfix Blog, 4.5.2016.
[50] Wood Mackenzie (2016) Global upstream spend slashed by US$1 trillion since the oil price drop. News Release, 15.6.2016.

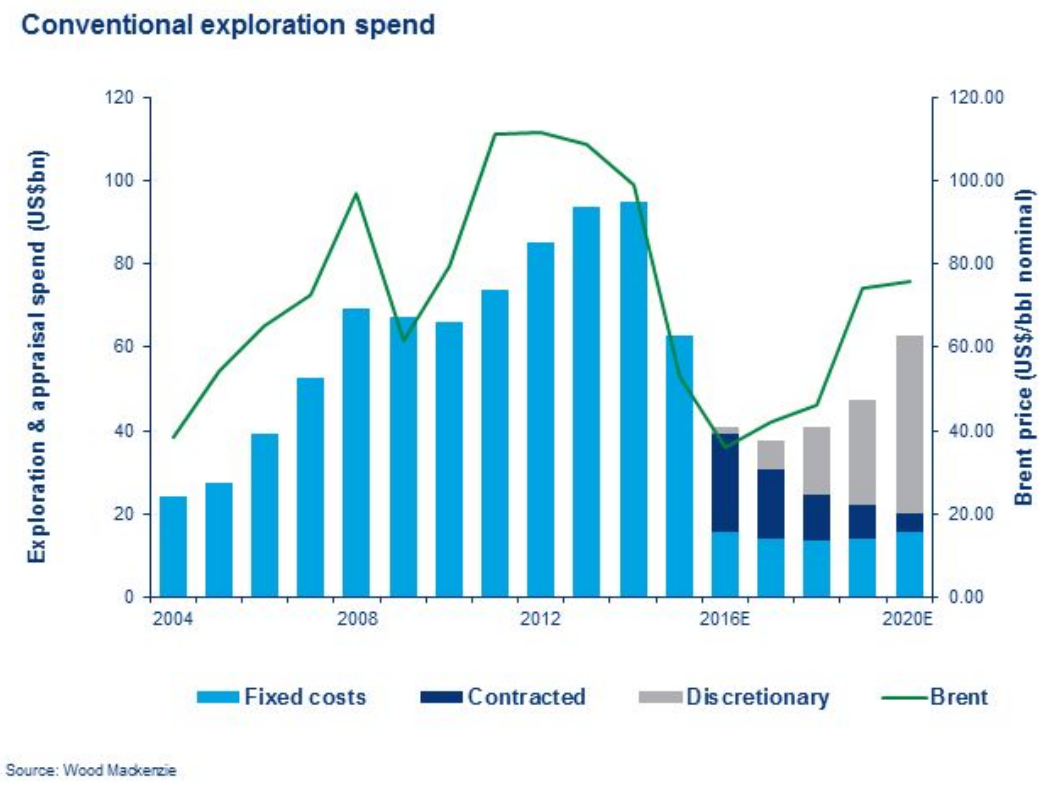

Figure 21. Past and projected spending on conventional oil and gas exploration.[51]

The slump in oil prices also gave traders the opportunity for short selling energy companies, with exploration and production companies seeing short interest rise by 12 percent at the end of 2014.[52]

2.4.1. Capital expenditures by oil and gas companies

A big portion of exploration is financed by oil companies themselves. Reserve restitution is seen as an important figure in the industry - even a relevant one for executive bonuses. In addition, exploration is a high-risk business where attracting external capital at favourable conditions is a challenge. As long as internal rates of return appear as attractive and there is cash on hand that can be allocated to this purpose, oil and gas companies invest some of their own money in exploration.

Figure 22 shows the capital expenditures of the biggest companies operating in the G20

[51] Image: Wood Mackenzie (2016) Exploration: the life blood of global oil supply. Analysis, 27.4.2016.
[52] Cox, Jeff (2015) Short sellers ganging up on oil companies. CNBC, 13.1.2015.

countries for 2013. 19 oil and gas companies spent more than 1 billion USD each on exploration, with Petrobras topping the list with more than 8 billion USD.

	Company (ranked by capital expenditure on exploration in G20)	Headquarter country	Type of company	G20 countries (where company in top 10 for exploration capex.)	2013 capital expenditure on exploration across G20 (million $)
1	Petrobras	Brazil	SOE	Brazil, Argentina	8,211
2	PetroChina	China	SOE	China	6,078
3	Shell	Netherlands	Private	(10) Saudi Arabia, US, Canada, China, Brazil, Australia, UK, Germany, Korea and South Africa	4,361
4	Sinopec	China	SOE	China and Saudi Arabia	3,155
5	BP	United Kingdom	Private	(6) US, Indonesia, Canada, India, Argentina and UK	2,951
6	Pemex	Mexico	SOE	Mexico	2,703
7	CNOOC	China	SOE	China, Indonesia, Canada and Argentina	2,211
8	Chevron	United States	Private	(6) US, China, Indonesia, Canada, Australia and UK	2,022
9	ONGC (India)	India	SOE	India	1,689
10	ConocoPhillips	United States	Private	(6) US, China, Indonesia, Canada, Australia and UK	1,673
11	Statoil	Norway	SOE	US, Canada, Brazil and Germany	1,555
12	Gazprom	Russia	SOE	Russia	1,336
13	Pioneer Natural Resources	United States	Private	US and South Africa	1,282
14	ExxonMobil	United States	Private	Canada, Germany, Turkey and South Africa	1,278
15	Eni	Italy	Private	Italy and South Africa	1,268
16	Repsol	Spain	Private	Brazil	1,245
17	Apache	United States	Private	Australia and UK	1,235
18	Halcon Resources	United States	Private	US	1,081
19	Anadarko	United States	Private	US, South Africa	1,019
20	Newfield Exploration	United States	Private	US	990
Total					**47,344**

Source: Rystad Energy (2014).

Figure 22. Capital expenditure on exploration by companies operating across the G20.[53]

[53] See footnote 8.

2.4.2. Bank funding

The World Bank Group has provided more than 3.1 billion USD in loans, equity financing and guarantees for projects involving fossil fuel exploration between 2008 and 2013. The majority of this financing was provided by the International Finance Corporation (IFC) with 2.3 billion USD, the rest being financed by the International Development Association (IDA) and the Multilateral Investment Guarantee Agency (MIGA).[54] From 2008 to 2013, the Multilateral Development Banks (MDBs) financed projects including fossil fuel exploration to the amount of 4.5 billion USD, and in 2013 alone the total amount reached 1.6 billion USD.[55]

2.4.3. Subsidies

Besides exploration investments by SOEs, there are specific national subsidies given by governments for exploration, such as direct funding by government agencies to conduct seismic tests and drill exploration wells or tax deductions for companies' exploration expenses.

Subsidies given by G20 governments for exploration exceeded 3 billion USD in 2013 (See Figure 23), and these subsidies have been increasing over the past years. As an example, exploration subsidies by the US government almost doubled between 2009 and 2013. (See Figure 24)

[54] Oil Change International (2014) World Bank Group financed $1 billion in fossil fuel exploration projects in 2013. April 2014.
[55] See footnote 8.

Country	National subsidies to exploration	National subsidies to exploration and extraction (including an exploration component)
Argentina	Not available	0-5,000*
Australia	57 to 137	2,897 to 3,543
Brazil	28	530
Canada	498	928
China	Not available	1,500
France	40	42
Germany	Not available	344
India	25	111
Indonesia	115	245
Italy	Not available	407
Japan	724	724
Korea	16	16
Mexico	Not available	Not available
Russia	1,436	2,436
Saudi Arabia	Not available	Not available
South Africa	0 to 316	Not available
Turkey	516 to 524	516 to 524
United Kingdom	8 to 81	543 to 1,174
United States	136	5,123
Total G20 annual national subsidies	**3,599 to 4,076**	**16,362 to 22,647**

Figure 23. Annual national subsidies for fossil fuel exploration in 2013 (million USD)[56]

Subsidy	2009 Value (million $)	2013 Value (million $)	Percentage increase
Percentage depletion allowance	340	900	165%
Amortisation of oil and gas geological and geophysical expenditures	40	110	150%
Deduction for intangible oil and gas drilling costs	1,600	3,500	119%
Domestic manufacturing deduction	605	587	-3%
Expensing of coal exploration and development costs	N/A*	26	-
Total	**2,585**	**5,123**	**98%**

Figure 24. US Federal Government fossil fuel exploration subsidies in 2009 and 2013[57]

There is a stark contradiction between governments signing the Paris Agreement while handing out huge subsidies to the fossil fuel industry. The 10 billion USD pledged to the

[56] See footnote 8. Subsidies for coal are included in this figure.
[57] See footnote 8.

Green Climate Fund as of July 2016[58] pale in comparison to the 88 billion USD governments have been spending on subsidizing exploration in just one year.[59]

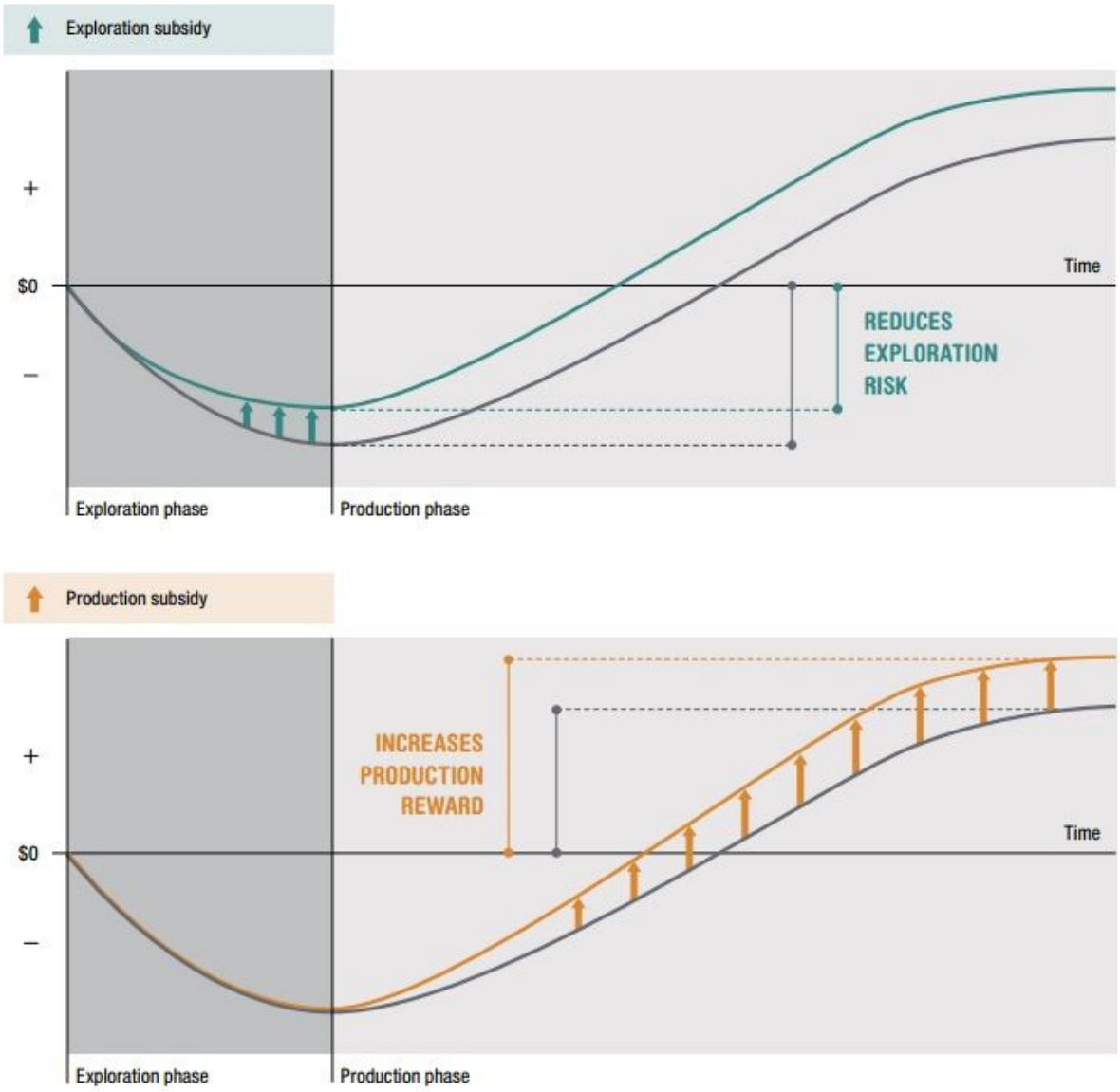

Figure 25. Impact of subsidies on project cash flow during exploration and production phases.[60]

[58] Green Climate Fund (2016) Status of Pledges and Contributions made to the Green Climate Fund. Accessed 16.8.2016.
[59] See footnote 8.
[60] See footnote 8. Another effect visible in the charts: the financial breakeven point of the project is reached sooner with subsidies.

It is a valid question to ask what would happen if all these subsidies were provided for the support of the renewable energy sector. We will look at this sector in more detail in section 4.3.1. (Energy alternatives). Here we just note that public money could be better invested in long term jobs and sustainable industries, encouraging the energy transition and respecting the Paris Agreement at the same time.

A 2013 report by Oil Change International and the Overseas Development Institute identified that overall government spending on exploration exceeded private investments by about a factor of two.[61] This indicates that subsidies are a fundamental factor in the exploration business. If governments would not subsidize fossil fuel exploration and fossil fuels more generally, a considerable percentage of these activities would simply not take place.[62]

2.5. Exploration in the oil end game

Conventional exploration has peaked. New frontier basins are very hard to find, risky to explore in, and expensive to finance. Returns on investment take more and more time to occur, if they do. As the age of cheap conventional exploration is in the past, there is a need for the companies to move on and adapt their strategies.[63]

Maybe the biggest risk, looking at it from a perspective of someone who has a vested interest in the industry, emanates from alternative energies. As will be explored further in section 4.3.1., there is a real and growing danger of oil and gas becoming obsolete as a source of energy in the medium term due to strong competition from renewable energy sources and other technological innovations.

2.5.1. Peak oil

Peak oil is an idea that has stirred a lot of controversy. Independently of which side one takes, few authors question the fact that oil is a non-renewable resource. Discovery of oil has already peaked in the 1960s (see Figure 26). Conventional oil production has peaked in 2005[64] and today, exploration is unlikely to discover big amounts of conventional oil. Of

[61] See footnote 8.
[62] For an instructive case study that explores the economics of Gazprom's Prirazlomnoe project in the Russian Arctic see page 20 of the report referred to in footnote 8.
[63] Sakhalinsk (2014) The Oil End Game? The View from the Mountain Blog, 9 May 2014, Accessed 8.9.2016.
[64] Lewis, Mark C. (2014) Toil for oil spells danger for majors. Kepler Chevreux ESG Sustainability Research, 15

course, if only prices were high enough, there is a huge resource base of unconventional oil waiting to be explored and extracted. Low prices are currently leading companies to cancel expensive projects on a huge scale. See for example the announced write-down of 4.6 billion barrels, mainly in the tar sands by Exxon.[6566] But as we will see in section 4.3.1., energy alternatives are already drawing a limit for higher fossil fuel prices.

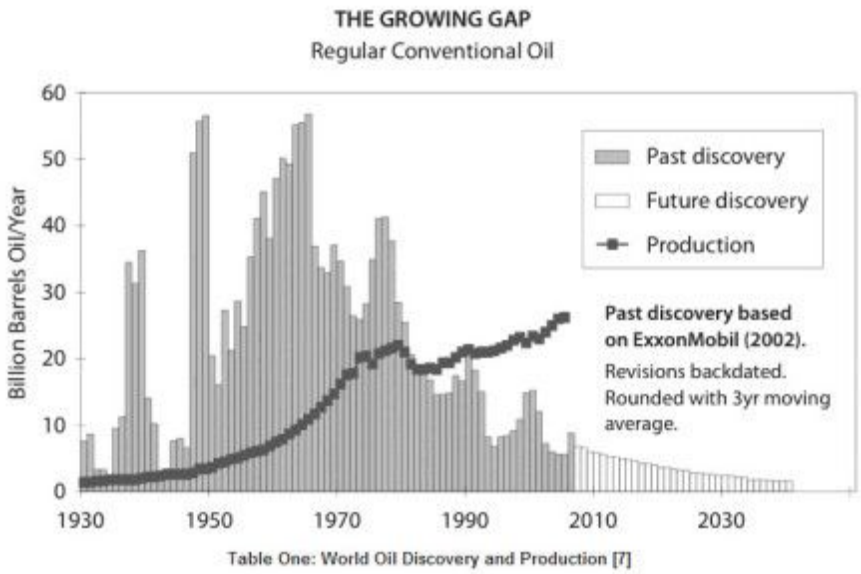

Figure 26. World oil discovery and production[67]

So far, about 30% of oil and gas is being produced offshore and 70% onshore. The tendency is for offshore oil to grow in importance.

September 2014.
[65] ExxonMobil (2016) ExxonMobil Earns $2.7 Billion in Third Quarter of 2016. News Release, 28.10.2016.
[66] Kusnetz, Nicholas (2016) Exxon's Big Bet on Oil Sands a Heavy Weight To Carry. Inside Climate News, 30.9.2016.
[67] See footnote 63.

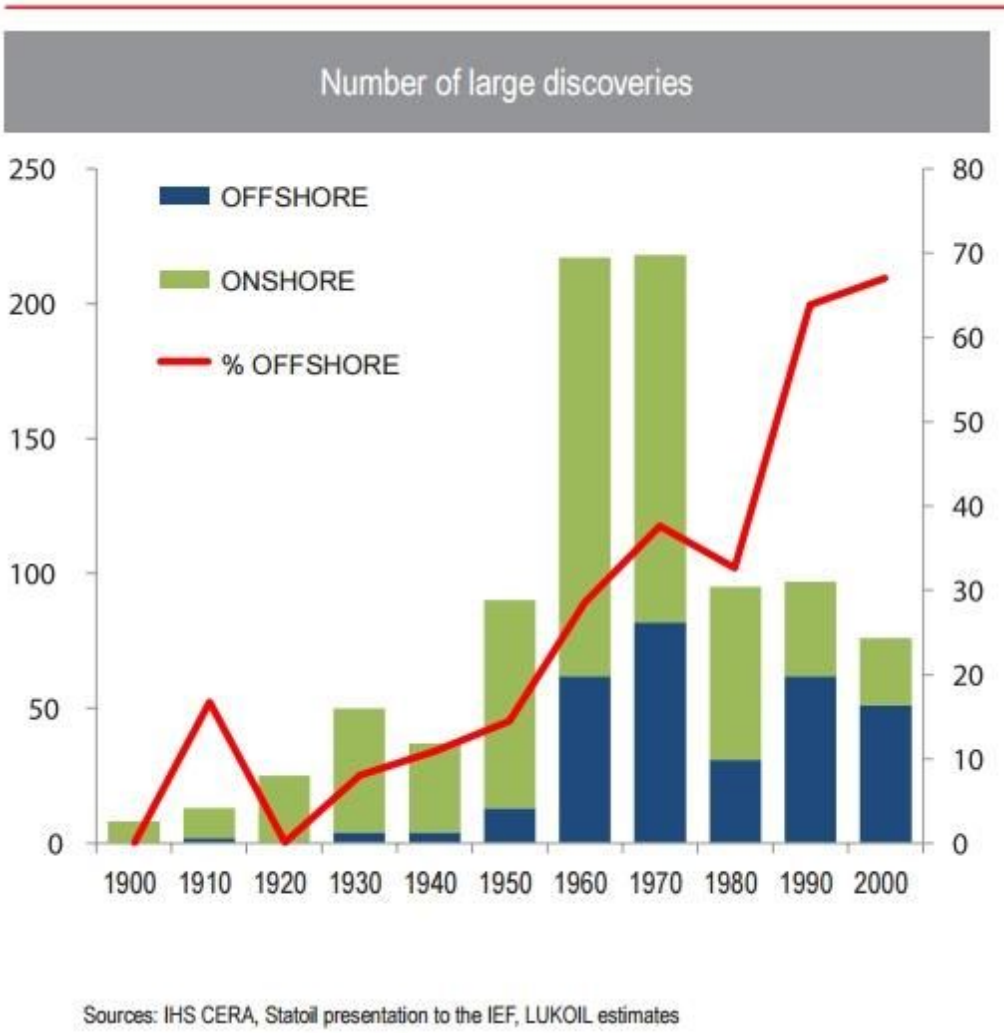

Figure 27. Large onshore and offshore oil discoveries.[68]

2.5.2. Increasing costs, declining returns

Oil and gas exploration costs have increased in the past years. As an example, one offshore exploration well in West Australia cost an average 40 million USD in 2011 and about 90 million USD in 2013.[69]

The low hanging fruit is now mostly gone and the industry is shifting towards the more

[68] Lukoil (2013) Global Trends In Oil & Gas Markets To 2025. Accessed 9.9.2016. Large discoveries include all giant oil fields >0.5 bboe.

[69] Australian Petroleum Production & Exploration Association (2014) Oil and Gas Industry Cost Trends. Accessed 9.9.2016.

challenging areas with break-even prices above 60 USD/bbl or even above 100 USD/bbl. This in itself would not be a problem, but the internal rate of return of exploration projects has also plummeted. (Figure 28)

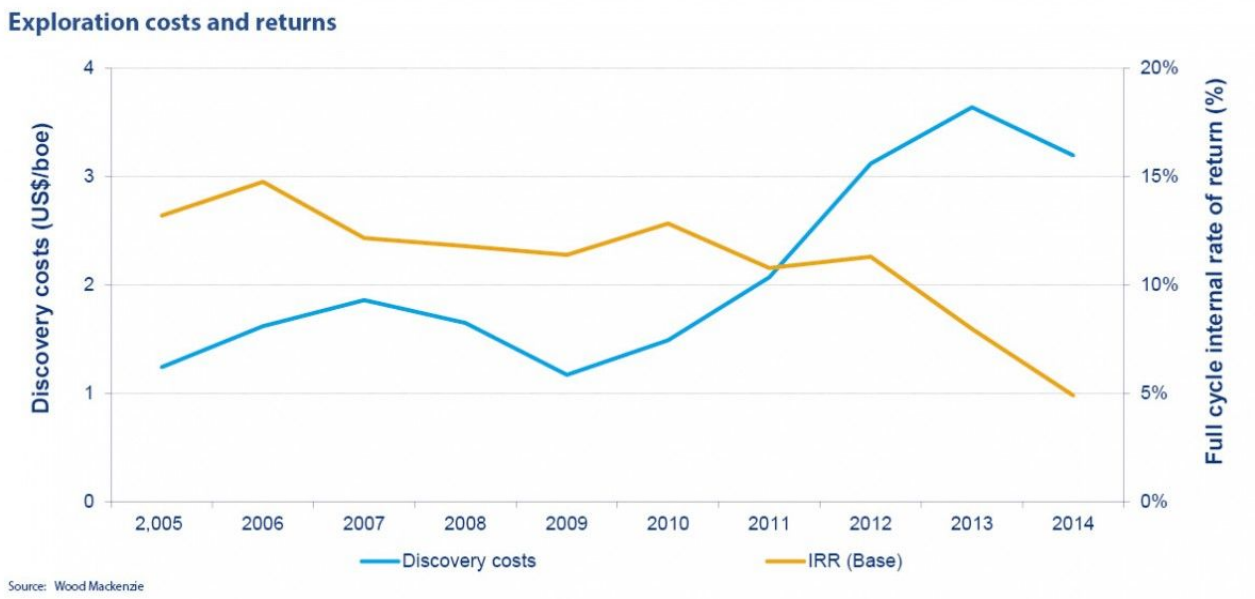

Figure 28. Exploration costs and returns from 2005 to 2014.[70]

Another symptom of the atrophying business model of pure oil and gas companies relates to profitability and return on capital, as illustrated in the graph above. Even before the recent collapse in oil prices, upstream oil profits were losing their appeal over manufacturing. In 2014, at 8 per cent the returns to shareholders of energy companies were at their lowest since 2007, well below those for manufacturing at 15 per cent (US Energy Information Agency, 2015). Furthermore, between 2011 and 2014, energy companies had to sell assets and increase their debt to maintain their dividends and share repurchases (US Energy Information Agency, 2015).

According to one report, the average return on capital of the largest European and US oil companies dropped from 21 per cent in 2000 to 11 per cent in 2013, even though the average price of benchmark Brent crude rose from $29 to $109 in the same period… Even when crude prices were at higher levels the financial performance of large international oil companies was unimpressive (Crooks and Adams, 2015). Overall, there can be little doubt that, from an investor's point of view, the IOCs have been failing to perform.[71]

Exploration projects are less and less attractive for investors and will have a much harder time competing for financial resources. When exploration makes little financial sense, companies can shift to acquisitions of reserves instead of conducting their own risky exploration adventures.

[70] Wilson, Julie (2016) Deepwater Exploration Cutbacks May Come Back To Haunt Oil Drillers. Forbes 11.2.2016.
[71] Stevens, Paul (2016) International Oil Companies. The Death of the Old Business Model. Chatham House. May 2016.

Exploration will first retreat from frontier areas, where likelihood of success is lower to mature fields, where less new oil and gas can be found, but infrastructure costs are lower. [72]

The Carbon Tracker Initiative has identified those projects high on the cost curve that will struggle to return a profit should prices be lower than expected. This could be the case for over a trillion USD worth in investments in high-cost oil projects.[73]

Banks are also becoming more reluctant to lend their money to oil and gas drillers. David Feldman, a restructuring attorney at Gibson, Dunn & Crutcher, says "*Lenders are looking for ways within the four corners of their credit agreements to stop borrowers from borrowing more [...] They don't want to keep throwing good money after bad.*"[74] This attitude by banks indicates that the cost of capital may increase for explorers going forward.

2.5.3. Increasing risks

Today, exploring for oil and gas is getting harder and harder, with technically more challenging fields, at ever greater depths, often with smaller field sizes, in more risky areas, harsher environments and complicated socio-political contexts.[75] (Figure 29) Unless high oil prices justify the enterprise, companies tend to shy away from these areas. But at higher prices they start to look attractive again. Some of the areas are subject to land rights of indigenous peoples which are protected under the UN Declaration on the Rights of Indigenous Peoples and ILO Convention 169 even if national governments are not the first to declare this. Others are in protected areas where any mineral extraction should be banned or in ecologically significant areas where it could be.[76] Still others are contested

[72] See for example this analysis of the situation in Norway: Rystad Energy (2013) Petroleum Production under the two degree scenario (2DS). Final report. July 3rd, 2013.
[73] Carbon Tracker Initiative (2014) Carbon Supply Cost Curves: Evaluating Financial Risk to Oil Capital Expenditures.
[74] Bloomberg (2016) Banks increasing credit squeeze on drillers. Fuelfix, 20.5.2016.
[75] Sustainability Accounting Standards Board (2014) OIL & GAS EXPLORATION & PRODUCTION. Research Brief. June 2014.
[76] Austin, Duncan and Sauer, Amanda (2002) Changing Oil: Emerging environmental risks and shareholder value in the oil and gas industry. World Resources Institute, July 2002.

between countries.[77] Project delays and even cancellations after significant amounts of money have been invested are to be expected in such contexts, adding to the inherent high risk of exploration.

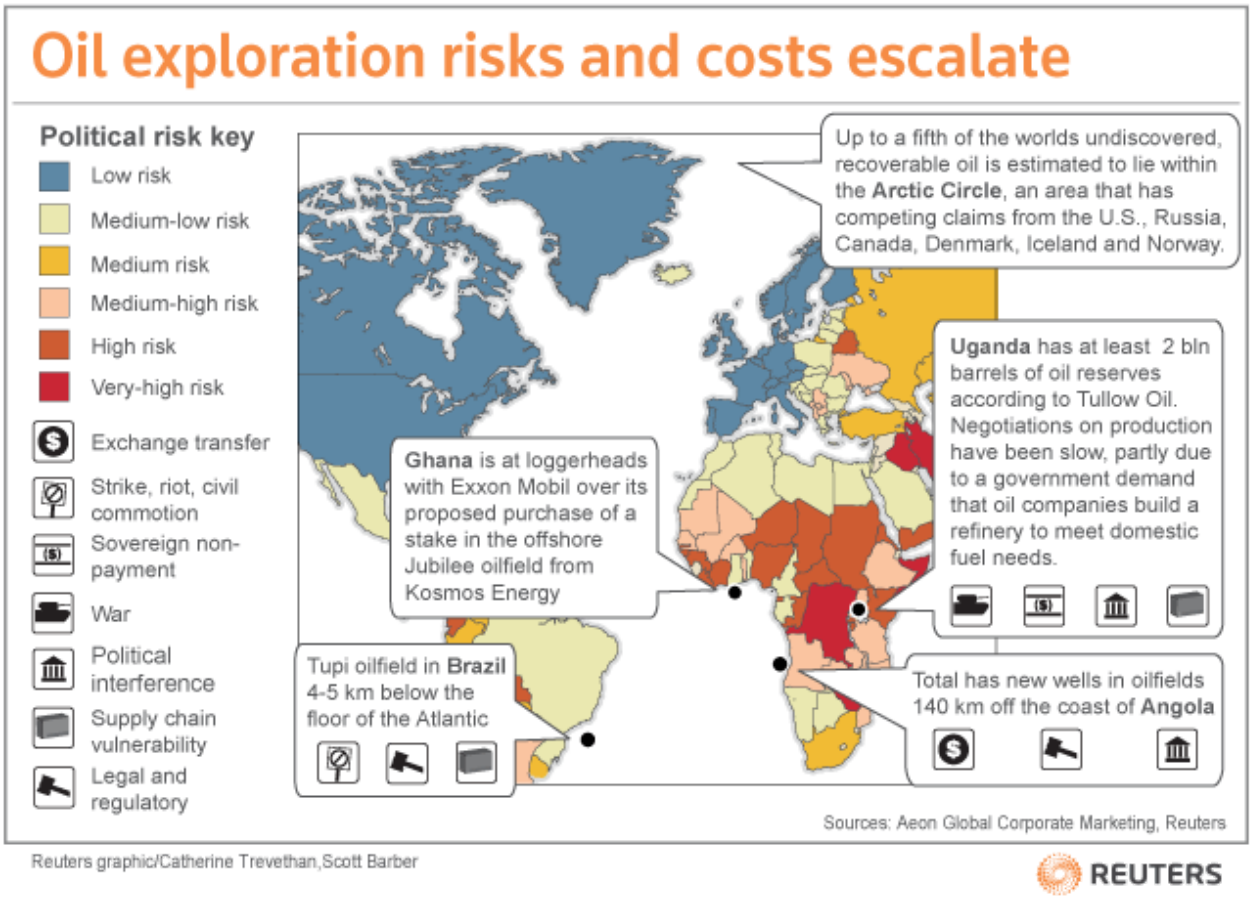

Figure 29. Some illustrative political risks in the oil exploration business.[78]

2.6. Case studies

2.6.1. Wadden Sea, Germany

The Wadden Sea is an intertidal zone on the the North Sea coast of Northwestern Europe,

[77] Benedikter, R. Kühne, K., Benedikter, A. & Atzeni, G. (2016) The Future of Resources: A New Chapter. New Global Studies, Vol 10, 2, 133–161, July 2016.
[78] Image: Johnson, Christopher (2010) Oil exploration costs rocket as risks rise. Reuters, 11.2.2010.

spanning from the Netherlands to Denmark. The Wadden Sea has been a protected by several National Parks in Germany since 1985, and belongs today to UNESCO World Heritage Site. Nevertheless, German authorities gave a license to exploration companies in the same year, resulting in the installation of a drilling platform in the Wadden Sea. According to WWF, the Mittelplate platform is “a deep wound in the Wadden Sea”[79], interfering with the natural habitats of birds and fish.

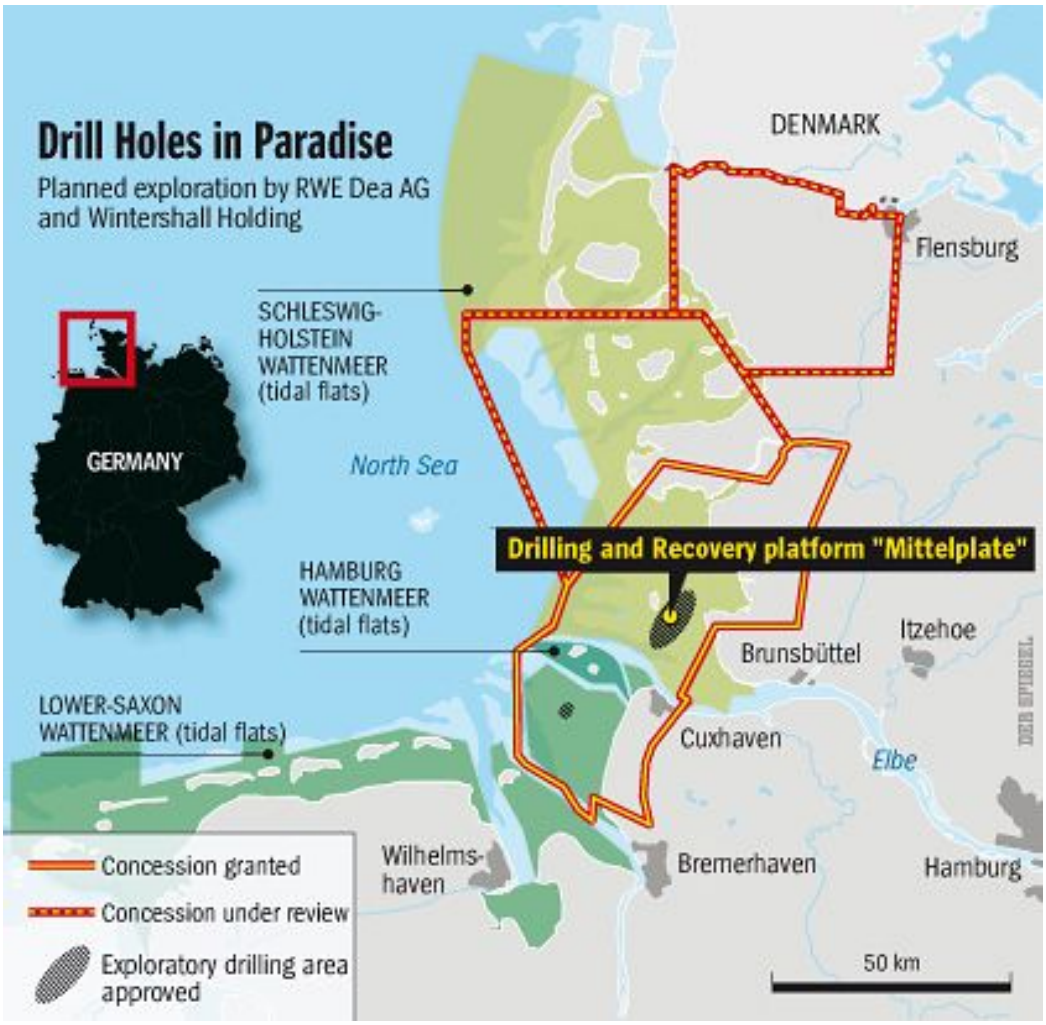

Figure 30. National Parks and drilling concessions in the German Wadden Sea.[80]

The Wadden Sea is a treasure of biodiversity, with up to 4000 species, including 250 endemic species. Only tropical rainforests contain more living biomass than the Wadden

[79] von Bredow, Rafaela (2008) Drilling for Oil in a Coastal Paradise. Spiegel 2008.
[80] See previous footnote.

Sea.[81] Thus, WWF, Greenpeace and other environmental activists have been calling for the end of oil exploration in the Wadden Sea for many years, while the consortium constituted by the companies RWE and Wintershall continue to extract more than 2 million tons of oil each year in the area.

2.6.2. San Juan de Nova, France

The exploration of the territory of San Juan de Nova, located in the Mozambique Channel has been subject to a lot of controversy. Indeed, the exclusive economic zone of this area which is controlled by the French government has been claimed by Madagascar, Mauritius and the Comores.

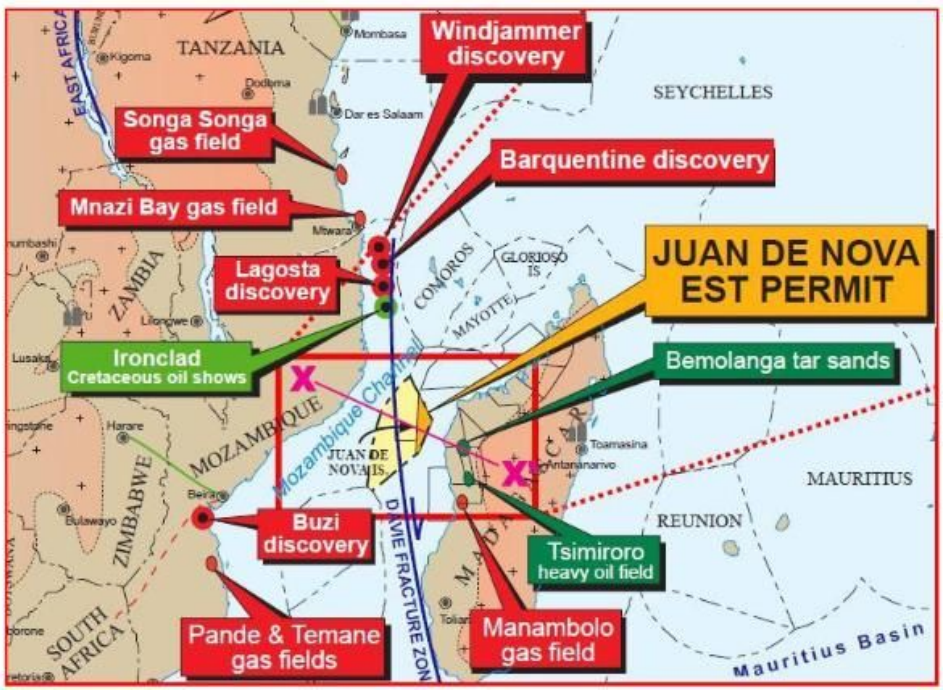

Figure 31.Oil exploration in the Mozambique Channel. [82]

San Juan de Nova is in fact a protected area under French law: it has been classified as a natural reserve since 1975. The scientists use this island as a "point zero" for their studies, as its vegetation has remained nearly original. The Northern area of the Mozambique Channel is inhabited by many species of seabirds, including one of the biggest nesting

[81] See previous footnote.
[82] Rakotomalala, Patrick (2012) San Juan de Nova, du gaz dans l'eau entre Madagascar et la France. Madagascar Tribune, 23.3.2012.

sites in the world and one of the hotspots of marine biodiversity.[83]
However, despite its unique biodiversity and being a protected area, the French government has given out offshore exploration licences to the area in 2008, named "Juan de Nova EST" and "Juan de Nova Maritime Profond".[84]
These exploration titles have been sold by the French State to a Nigerian company called Sapetro and an American company called Marex Petroleum, for a total amount of 75 million euros.[85] Nevertheless, the French Environment Minister Segolène Royale remained silent for the next two years about the delivery of the exploitation permit, which led the two exploring firms to go to court about the issue. The administrative judge condemned the French State to make a decision within the next month, with a 5000 euros daily fine to pay to the two companies in case of delay. Under this pressure, the French minister eventually gave the exploitation title to the companies, which are running until the end of the year 2018. This example shows an inertia which often develops once exploration has started that makes it costly to stop the process, even if for environmental or economic reasons it would be desirable to halt or at least delay it.

2.6.3. Arctic, USA/Canada, Royal Dutch Shell

Even though the Arctic might hold almost 90 billion barrels of undiscovered oil and over 1600 trillion cubic feet of undiscovered gas,[86] Fatih Birol, Executive Director of the International Energy Agency (IEA) said: "I believe that Arctic oil is not for today, and not for tomorrow – maybe for the day after tomorrow. It's geologically difficult, technologically difficult, lots of environmental challenges, and the cost of production is very, very high, especially if you look at the current oil price levels."[87]

Nevertheless, some oil companies showed interest in exploring offshore in the Arctic, but most of them eventually dropped their projects. Total said it would be too risky: *"Oil on Greenland would be a disaster. A leak would do too much damage to the image of the*

[83] Terres Australes et Antarctiques Françaises (undated) District des Iles Eparses. Accessed 9.9.2016.
[84] See previous footnote.
[85] Dupuy, Pierrot (2015) Pétrole autour de Juan de Nova : Le juge administratif de St-Denis a fait plier Ségolène Royal. Zinfos974, 3.10.2015.
[86] Bird, Kenneth J., Charpentier, Ronald R., Gautier, Donald L., Houseknecht, David W., Klett, Timothy R., Pitman, Janet K., Moore, Thomas E., Schenk, Christopher J., Tennyson, Marilyn E. and Wandrey, Craig J. (2008) Circum-Arctic resource appraisal; estimates of undiscovered oil and gas north of the Arctic Circle. U.S. Geological Survey Fact Sheet 2008-3049.
[87] Harvey,Fiona (2015) Drilling for Arctic oil is not viable yet, says IEA chief. The Guardian, 18.5.2015.

company."[88] Shell has announced that it will pull out of exploration in the Arctic after having spent around 7 billion USD.[89]

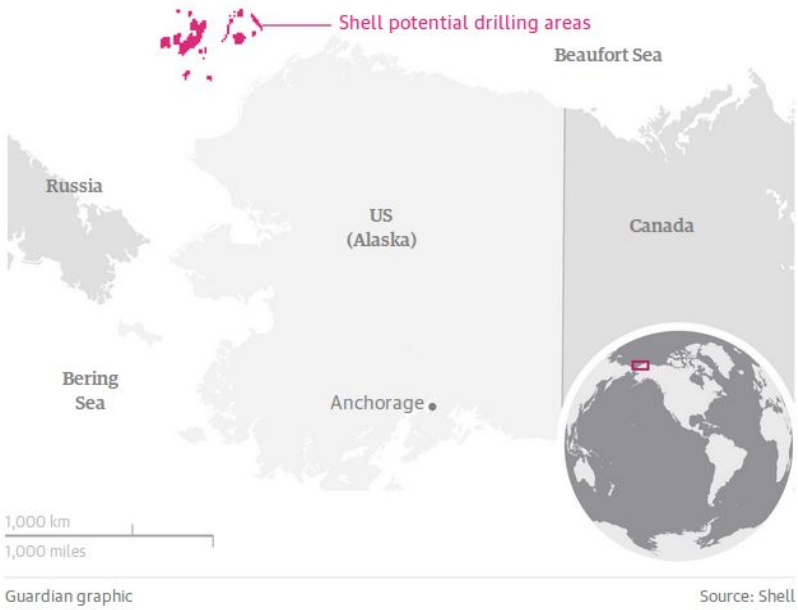

Figure 32 : Shell in the Chukchi Sea in the Arctic[90]

This announcement came after Shell engaged in a battle with "kayaktivists" in Seattle who tried to block and managed to delay the drilling platform and companion ships on its way to the Arctic.[91]

Since then, the Obama administration has declared that it will not offer any new licenses, nor renew existing ones.[92]

In June 2016, Shell announced its retirement from 10 countries within the framework of its plan of cessation of assets in the oil and gas sector. On World Oceans Day, Shell gave up its 30 exploration titles in the Canadian Arctic.[93] The area located in the Strait of Lancaster covers a surface of 8,625 km². Local Inuit groups have tried for a long time to protect this

[88] Ellis, Vicky (2012) Total boss admits Arctic oil drilling could be too risky. Energy Live News, 27.9.2012.
[89] Macalister, Terry (2015) Shell abandons Alaska Arctic drilling. The Guardian, 28.9.2015.
[90] See previous footnote.
[91] Brait, Ellen (2015) Portland's bridge-hangers and 'kayaktivists' claim win in Shell protest. The Guardian, 31 July 2015.
[92] Goldenberg, Suzanne (2015) Obama administration blocks new oil drilling in the Arctic. The Guardian, 16 October 2015.
[93] La relève et La Peste (2016) Shell cède ses droits de prospection dans l'Arctique canadien à une ONG environnementale. La relève et La Peste, 10.6.2016.

environment which is one of the richest regions of marine mammals in the world, especially threatened ones such as belugas and polar bears. The project of a natural marine park extends over 44,500 km² and covers almost the entire strait which connects the North Atlantic to the Arctic Ocean.

Even though the retreat from Arctic waters is not officially a definite one yet it has been well received.

2.6.4. Deepwater Horizon, USA, BP

One of the biggest oil spills occured in 2010 at the Deepwater Horizon platform in the Gulf of Mexico, where 4.9 million barrels of oil were spilled into the sea.[94]

Oil major BP was responsible for the drilling activities, collaborating with the subcontractor Halliburton, and Transocean which owned the rigs. The oil spill resulted in a conflict of interest between the three groups, described by the President Obama as "*executives of BP and Transocean and Halliburton falling over each other to point the finger of blame at somebody else.*"[95]
Anadarko Petroleum and Mitsui Corporation were also shareholders in the enterprise with 25% and 10% respectively and while they left the responsibility for operations to BP, they are also liable for the risks.

BP today faces the consequences of the disaster and a huge number of claims which could be as high as 50 billion USD total. (see infographic below) Given that the prospect BP was drilling contained only about 50 million barrels of oil[96] which at a market price of 100 USD minus breakeven cost of 70 USD[97] could have generated a profit of 1.5 billion USD. So the cost of the disaster exceeds the potential profit of the enterprise by more than a factor thirty.

[94] US Coast Guard (2011) On Scene Coordinator Report Deepwater Horizon Oil Spill. Accessed 5.10.2016.
[95] Jonsson, Patrick (2011) Halliburton 'destroyed' evidence after Gulf oil spill, BP charges. CS Monitor.
[96] Klump, Edward (2010) Spill May Hit Anadarko Hardest as BP's Silent Partner. Bloomberg, 13.5.2010.
[97] Wood Mackenzie (2016) Pre-FID oil projects: global breakeven analysis. 21 Jan 2016.

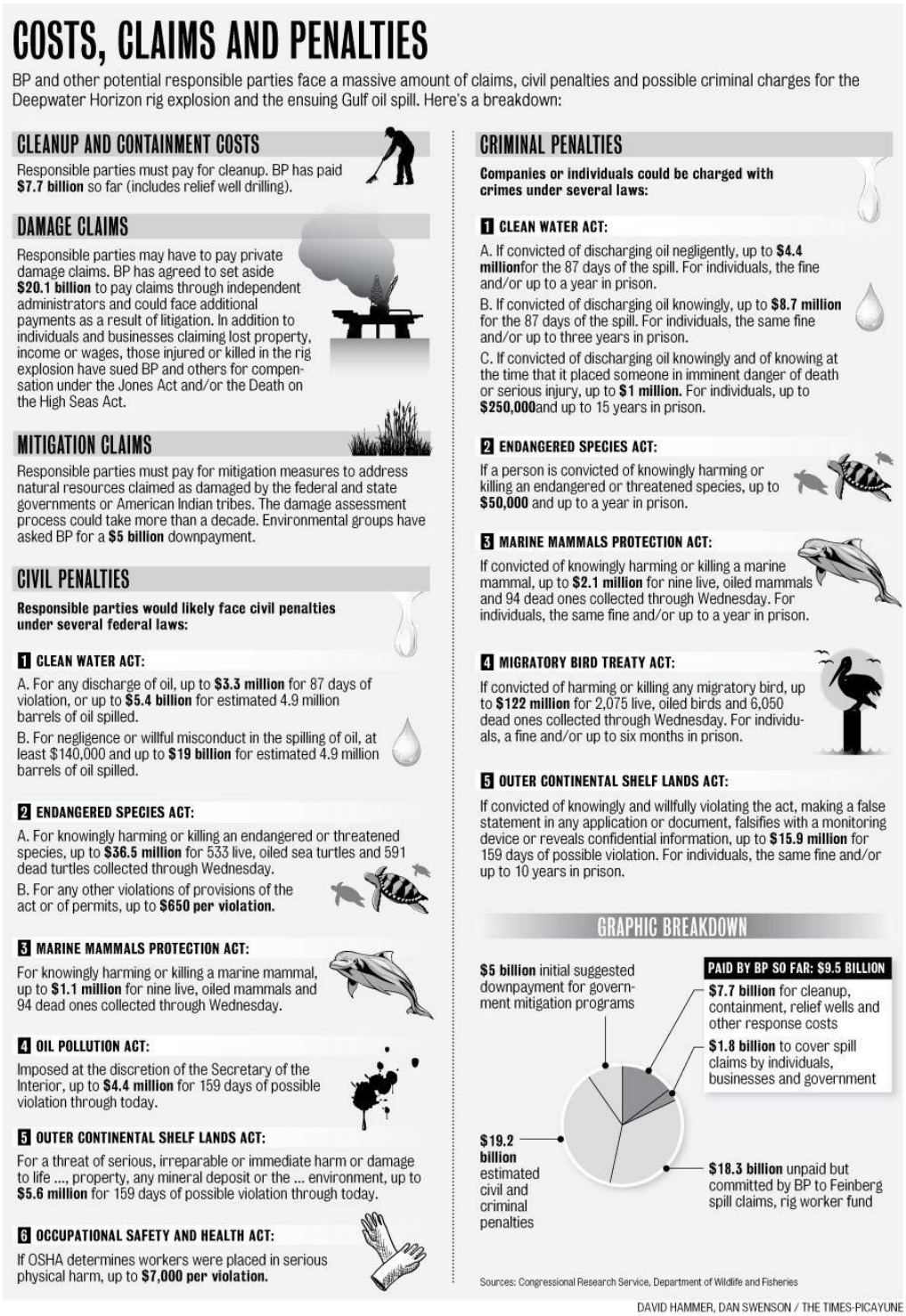

Figure 33. Costs, claims and penalties linked to BP's oil spill[98]

[98] Hammer, David (2010) Feds establish downtown bunker to build criminal, civil cases against BP, others in

The Deepwater Horizon case has put BP in a complicated situation, having to respond in the court for claims of a total amount of 52 billion USD. Four years after the desaster, BP said it had paid 27 billion USD, with cleaning and damage costs of 14 billion USD and civil and criminal claims of 12.9 billion USD.[99]

2.6.5. ConocoPhillips

ConocoPhillips is an example of an oil company that is already updating its strategy. The company is using scenarios compatible with a 50 percent chance of achieving a 2 degree climate target to guide its strategy development.[100] ConocoPhillips has already announced its "strategic decision" to end its deepwater oil and gas exploration efforts by 2017. This exit will free up roughly USD800 million in capital.[101] The following ConocoPhillips projects are also candidates for cancellation, because they present break-even prices much above the current oil price level: Foster Creek, Surmont Oil Sands project, Christina Lake, Narrows Lake and Amauligak in Canada and Ekofisk Wes in Norway.[102]

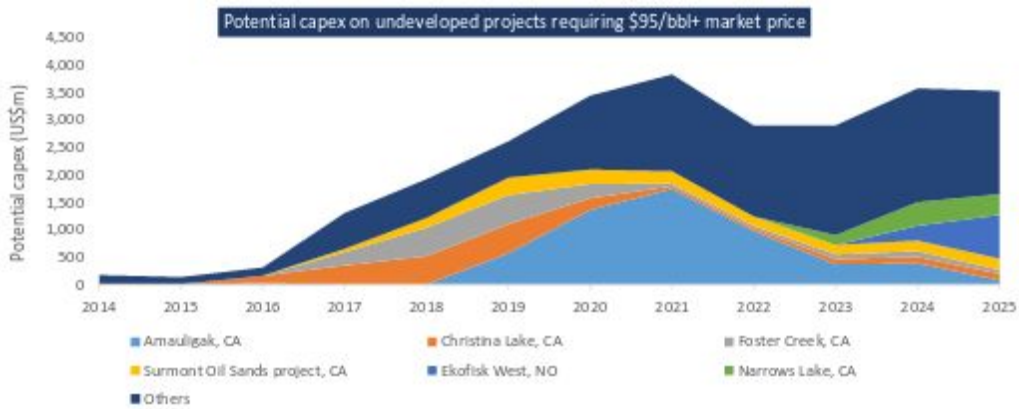

Figure 34. Potential capex on undeveloped projects requiring >95 USD/bbl market price[103]

Gulf oil spill. New Orleans Times - Picayune, Sep 2010.

[99] Pillion, Dennis (2014) Putting a price on Deepwater Horizon: For BP, $27 billion and counting. Alabama Media Group, April 2014.

[100] ConocoPhillips (undated) Carbon Scenarios. ConocoPhillips Website. Accessed 22.10.2016.

[101] Eaton, Collin (2015) ConocoPhillips to exit deep-water exploration by 2017. Fuelfix, 29.10.2015.

[102] Carbon Tracker Inititative (2014) Oil & Gas Majors: Fact Sheets ConocoPhillips.

[103] See previous footnote.

3. Coal exploration

3.1. The coal exploration process

There are two main kinds of coal: black coal and brown coal which is also known as lignite. Black coal can further be divided into thermal coal which is used to produce electricity and coking coal which is used for steel making.[104] Thermal coal represents more than 74% of the global coal production in volume which has been increasing for the last five years. Emerging countries' rapid growth has been a boost for the coal industry. As a result, coal exploration is still an issue in spite of the huge quantities of reserves and the Paris Agreement which renders them unexploitable in theory.[105] To understand the exploration industry better, let us take a closer look to the coal exploration process.

The process is quite similar to oil and gas exploration, beginning with a geological program aiming to determine the areas where coal can be found, in which quantity and quality, and if it would be economically viable to extract it. This geological program includes the following steps:

- *obtain legal title to explore the area*
- *evaluate the geologic information already available*
- *carry out surface exploration*
- *carry out subsurface exploration*
- *collect and analyze samples*
- *estimate the coal resources and the significance of geological factors in their extraction*[106]

[104] Market Research Reports (undated) Coal Industry Market Research Reports, Analysis & Trends. Accessed 9.9.2016.
[105] See footnote 1.
[106] Kang, Lixun (undated) Coal exploration and mining. UNESCO Encyclopedia of Life Support Systems, Accessed 9.9.2016.

Figure 35. What is coal exploration?[107]

After obtaining the license to explore and gathering available information on the area, geological mapping begins in order to locate and identify the coal-bearing strata with

[107] AngloAmerican (2015) Digging Deeper: What is exploration?

precision. The geophysical techniques used for geological mapping are mainly regional gravity surveys, broad-scale seismic studies and airborne magnetometer investigations, followed by more detailed seismic investigations which permit to give an accurate picture of the area.

When this picture is established, an appropriate drilling program can be realized and the first exploratory drill is made. Then, if the company determines that the coal found is worth to be extracted in terms of quality and quantity, mining operations may begin. Figure 36 gives an idea of the time frames involved.

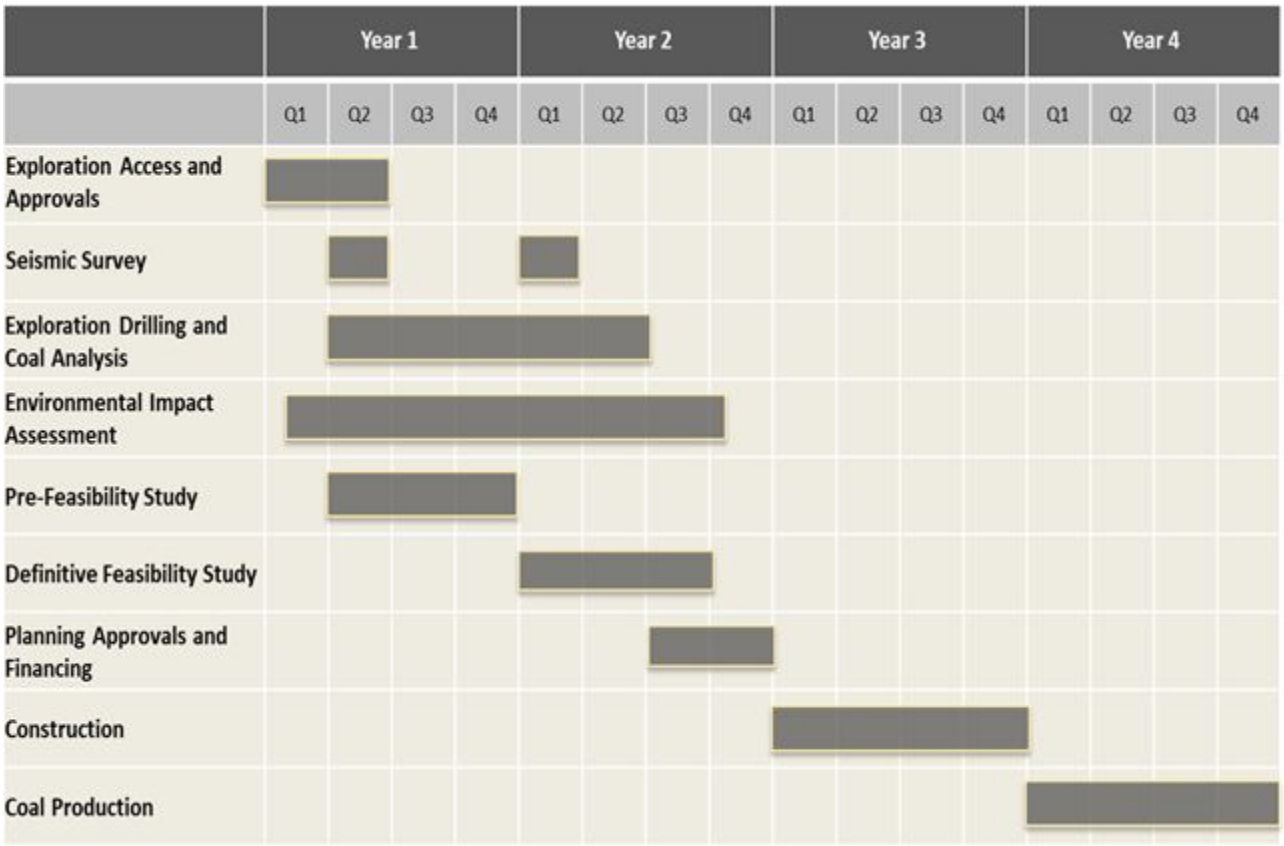

Figure 36. Steps related to coal exploration before the start of coal mining.[108]

[108] New Age Exploration (2016) Lochinvar. Accessed 9.9.2016.

3.2. Who explores for coal and where?

There are an estimated trillion tonnes of coal reserves worldwide.[109] Coal has been found in most countries worldwide, with viable reserves in some 70 countries. The USA, Russia, India and China have the biggest reserves.[110] At current rates of production, this coal would theoretically last around 110 years.

After centuries of mineral exploration, the location, size and characteristics of most countries' coal resources are quite well known. What tends to vary greatly is the assessment about how much of this resource can be extracted economically.

Examples of recent or current coal exploration activities include the following:

In *Indonesia*, the government is planning to supervise 30 to 35 companies active in coal exploration and identifying twelve additional areas for coal prospecting in the years 2015-2019.[111]

In *Australia*, companies have spent over 200 million AUD on coal exploration in 2015, mainly in Queensland, significantly down from the record year 2011.[112]

In *China*, a Central Geological Exploration Fund was set up in 2006 and has been funding coal and other exploration together with provincial governments. Different sources indicate planned or ongoing coal exploration activities in Western China,[113] Inner Mongolia.[114] In 2013, 2014 and 2015 alone, 143 billion new tons of coal were found[115][116] - a potential of 286 Gt of CO2 emissions.[117]

In *India*, the Central Mine Planning and Design Institute (CMDI), a subsidiary of Coal India Ltd. is in charge of regional coal exploration, while detailed exploration is done by private companies. The institution to date has completed over 1000 coal exploration projects and identified over 95 billion tonnes of coal reserves.[118]

Other countries where the search for more coal still continues are *Botswana*, *Canada*, *Colombia*, *Mongolia*, *Mozambique*, *South Africa*.[119]

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[109] McGlade, Christophe & Ekins, Paul (2015) The geographical distribution of fossil fuels unused when limiting global warming to 2 °C. Nature 517, 187–190.

[110] World Coal Association (undated) Where is Coal Found. Accessed 9.9.2016.

[111] Kementerian ESDM (2015) Rencana Strategis Kementerian Energi dan Sumber Daya Mineral Tahun 2015-2019.

[112] Australian Bureau of Statistics (2016) Mineral and Petroleum Exploration, Australia. Accessed 1.11.2016.

[113] MLR (2016) 未来我国西部矿产勘查开发比重将逐步增加. 29.2.2016, Ministry of Land and Resources.

[114] Shenhua (2016) ANNOUNCEMENT REGARDING THE PROGRESS IN OBTAINING EXPLORATION RIGHTS OF COAL RESOURCES AT TAIGEMIAO. 28.5.2015.

[115] MLR (2016) 全国地质勘查基金：体制机制与运作模式创新稳步推进. 9.6.2016, Ministry of Land and Resources.

[116] MLR (2015) China Mineral Resources. September 2015, Ministry of Land and Resources.

[117] For comparison: the carbon budget for fossil fuels for the rest of the century is 473 Gt CO2 - globally.

[118] CMPDI (undated) Exploration. CMPDI Website. Accessed 2.11.2016.

[119] Chadwick, John (2012) Coal still reigns. International Mining, August 2012.

An approximation of (successful) exploration activity are plans to establish new (greenfield) coal mines. For the years 2014 to 2025, Wood Mackenzie's database holds projects worth a total of 268 billion USD, roughly half of which is planned in China alone.[120] Another 220 billion USD were due to be invested in brownfield projects, expanding existing mines. In this case, two thirds of the investments were located in China. Brownfield capital expenditures are often a result of a better understanding of the local geology leading to the identification of additional economically viable reserves.

3.3. Who funds coal exploration?

Coal exploration is funded by some private companies and some government institutions such as geological services. The latter usually do the fundamental work while private investors must have more of an eye on the profits to be earned and usually get involved once some promising indicators have been gathered through spending public money.

3.3.1. Capital expenditures of coal companies

In 2012, the top 20 coal companies globally spent 67 billion USD of their capital on new projects, both greenfield (completely new projects) and brownfield (expansions of existing projects). (See Figure 37) Since then, the outlook for the industry has become much worse, especially for exploration as exemplified by the shrinkage in exploration spending in Australia shown in Figure 38. As we will see in the sections to follow, the swift reduction in exploration expenditures is highly justified for a number of reasons and should be expected to approach zero in the next years.

[120] Carbon Tracker Initiative (2014) Carbon supply cost curves: Evaluating financial risk to coal capital expenditures. September 2014.

Company (ranked by global coal production)	Headquarter country	G20 countries of operation	Annual global capital expenditure (million $)	Revenues (million $)	Total taxes paid to governments (* or income tax where total not available) (million $)
China Shenhua Group	China	China	8,404	46,163	8,254
Coal India	India	India	451	12,560	1,402*
Peabody Energy	United States	US, Australia and China	605	7,014	(448)*
China National Coal Group	China	China	Not available	Not available	Not available
Glencore Xstrata	Switzerland	Australia and South Africa	9,559	232,694	254*
Datong Coal Mine Group (Shanxi)	China	China	4,621	32,291	248*
Arch Coal	United States	US	297	3,014	(336)*
Shanxi Coal and Chemicals Industry Group	China	China	399	13,205	69*
BHP Billiton	Australia	Australia, South Africa, US	23,594	65,953	11,597
Shanxi Coking Coal Group	China	China	Not available	Not available	Not available
RWE	Germany	Germany	6,072	68,266	1,270*
Anglo American	United Kingdom	Australia and South Africa	6,125	29,342	4,527
Alpha Natural Resources	United States	US	216	4,954	(217)*
SUEK	Russia	Russia	Not available	Not available	Not available
Kailuan Group	China	China	771	18,209	30*
Cloud Peak Energy	United States	US	47	1,396	12*
Shanxi Lu'an Mining Group	China	China	1,749	31,952	202*
Yankuang (Mining) Group	China	China	2,370	16,338	(71)*
Bumi Resources	Indonesia	Indonesia	96	3,547	(85)*
Huainan Mining Industry Group	China	China	1,868	11,456	(87)*
Total			**67,243**	**598,354**	**26,795**

Sources: Bloomberg Finance (2014), Schücking (2013).

Figure 37. Capital expenditures, revenues and paid taxes of the top 20 coal companies.[121]

2014 proved to be one of the breaker years for coal project development, with coal prices

[121] See footnote 8.

following a downward trend, leaving little incentive to invest in exploration and projects.[122]

3.3.2. Subsidies

The previous explanations about multilateral development banks and export credit agencies could well also be subsumed under the heading of subsidies, since it is public money being spent on coal. In addition to public institutions borrowing money for coal mining, there are also direct subsidies given:

Governments provide various types of subsidies to coal projects, including government loans or guarantees, tax breaks, free provision of land, water and rail, and subsidised tariffs for electricity and fuel. The Organisation for Economic Cooperation and Development, the group of 34 rich countries, estimates coal subsidies at $11.7 billion annually in the 34 OECD countries. Meanwhile, a recent International Monetary Fund (IMF) assessment put global coal subsidies at $539 billion annually, which includes the costs of managing the environmental and health impacts of coal. In contrast, the International Energy Agency estimates that only $88 billion in government assistance was directed toward renewable energy in 2011.[123]

Figure 38 gives some examples of different subsidy categories and amounts from the US which have increased, not decreased in past years. Figure 39 points to the general importance of subsidies for the industry.

Subsidy	2009 Value (million $)	2013 Value (million $)	Percentage increase
Percentage depletion allowance	340	900	165%
Amortisation of oil and gas geological and geophysical expenditures	40	110	150%
Deduction for intangible oil and gas drilling costs	1,600	3,500	119%
Domestic manufacturing deduction	605	587	-3%
Expensing of coal exploration and development costs	N/A*	26	-
Total	**2,585**	**5,123**	**98%**

Figure 38. US Federal Government fossil fuel exploration subsidies in 2009 and 2013[124]

[122] Rowland, Jonathan (2015) Dark times: exploration and mine development review 2015. World Coal, 9.2.2015.
[123] Endcoal.org (undated) http://endcoal.org/finance-economics/
[124] See footnote 8.

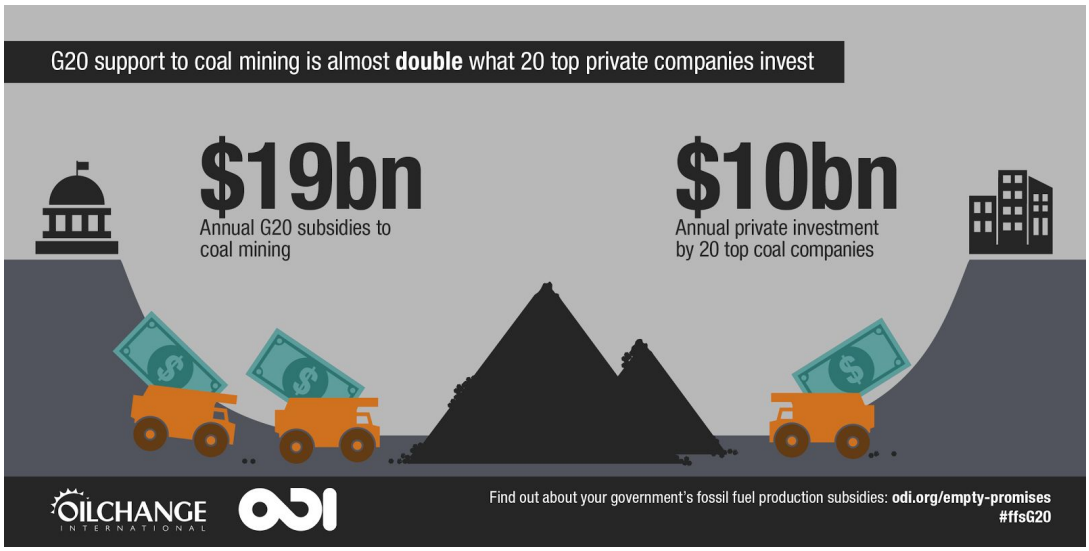

Figure 39. G20 support to coal mining and top 20 private companies' investments.[125]

3.4. Exploration in the coal end game

Coal power generation is the most costly industry in the world in terms of externalities. The external costs of coal mining and power generation include health damages, degradation of buildings, reduction of crop yields, degradation of ecosystems and last but not least the costs to face global warming.[126]

Even without translating this into rules and laws that regulate the industry, a look at the economic "realities" - distorted in favour of coal and other fossil fuels - shows an industry about to decline rapidly: global coal consumption has peaked in 2013[127] and is receding due to emission control measures, climate policies and competition by gas and renewables.

Some of the world's biggest coal companies have been facing economic difficulties in recent years, such as Peabody Energy, the world's top private miner which is now facing

[125] Oil Change International (2015) http://priceofoil.org/content/uploads/2016/06/coal_vs_privateinvestment.png Accessed 5.11.2016.

[126] Epstein, Paul R. et al. (2011) Full cost accounting for the life cycle of coal. In: Ecological Economics Reviews. Robert Costanza et al., Eds. Ann. N.Y. Acad. Sci. 1219: 73–98. See also the interactive graphic of the Harvard School of Public Health here: http://www.chgeharvard.org/resource/explore-true-costs-coal

[127] Buckley, Tim and Sanzillo, Tom (2015) Past Peak Coal in China. Institute for Energy Economics and Financial Analysis. November 2015.

bankruptcy[128] and Alpha Natural Resources which faced bankruptcy in 2015. The fall of coal prices and the bankruptcy of several of its main actors is due to three main factors: the progressively slowing growth of emerging countries, the environmental policies of regulation in developed countries, and the low prices of natural gas which replaces coal. Most Chinese coal companies are writing red numbers, a number of US companies have gone bankrupt over the last years and increasingly strict rules on air pollution are further reducing competitiveness of coal. In the case of some Chinese cities they even mean an end to coal-fired electricity altogether.

For the next few years, a further drop in prices is expected[129] and overall, the price development of renewable energies is going towards a level that makes them competitive with coal in its key markets. This does not bode well for future financial performance in the sector, which has already been performing poorly over the last few years (see Figure 40), making it more and more unattractive for investors.

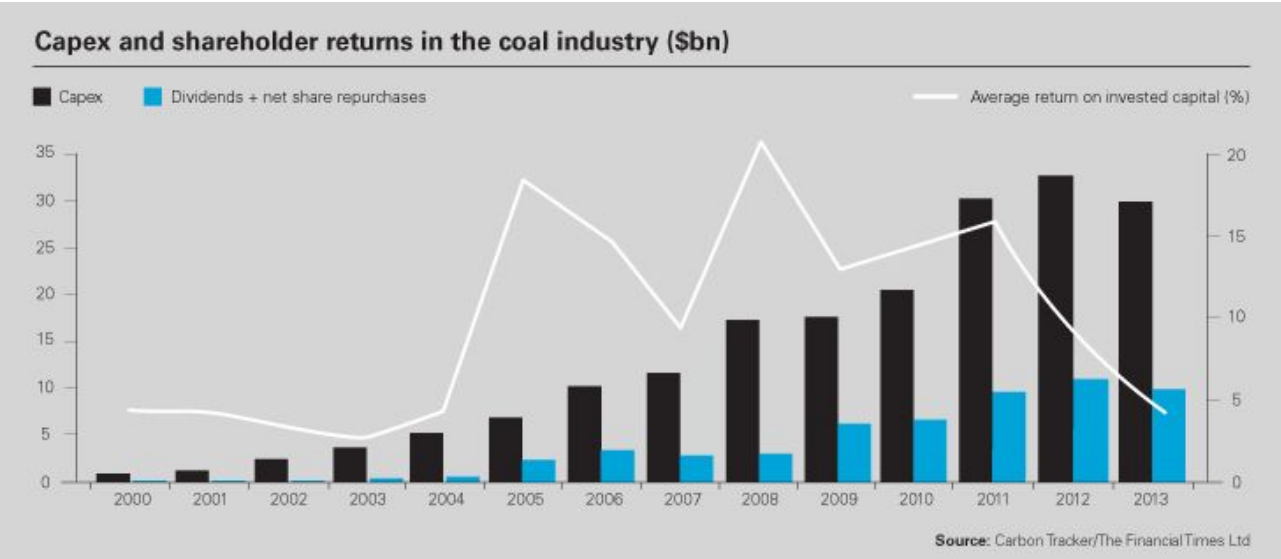

Figure 40. Shareholder returns in the coal industry.[130]

Besides the economic challenges, a fast-growing divestment movement is encouraging institutional investors, governments and private banks to divest from all fossil fuels, starting with coal. In the past two years, dozens of public and private institutions have announced

[128] Riley, Charles and Isidore, Chris (2016) The largest U.S. coal company just filed for bankruptcy. CNN, 13.4.2016.
[129] Platts (2015) Coal Trader International Volume 15.
[130] White & Case (undated) Mining and metals investment changes. Mining & Metals: Opportunity & Risk - Weathering the bottom of the cycle.

plans to divest their fossil fuel holdings because of environmental concerns, ethical investment strategies, or worries that assets might become stranded because of emission regulations. This is also part of the context of the coal end game.

Opposition to coal is growing and increasingly well organized. The global climate movement is tracking each new proposed coal fired power plant[131] and another campaign is in the process of building support for a global moratorium on new coal mines and mine extensions.[132] While these efforts might take a few years to bear fruit, the overall outlook for the industry is not improved by such dedicated opposition.

In India, the chief explorer, the chairman of CMPDI has already identified that time for coal exploration is running out, because there are only expensive coal deposits left to explore. [133] India is the only big market with a strong growth projection for coal.

3.5. Case studies

3.5.1. Australia

Australia, one of the major coal suppliers, has seen its exploration expenditure decrease rapidly for the past years. Coal exploration spending in Australia reached its highest level in 2011 and has dropped since then. (See Figure 41). Despite this drop in exploration expenditure, new coal mining projects are still being developed, mainly in two States: New South Wales and Queensland.

[131] End Coal (undated) Global Coal Plant Tracker. Accessed 11.9.2016.
[132] No New Coal Mines (undated) http://www.nonewcoalmines.org.au/, Accessed 11.9.2016.
[133] Coal Insights (2016) Ten years on, India will not need much of coal exploration. Coal Insights, January 2016.

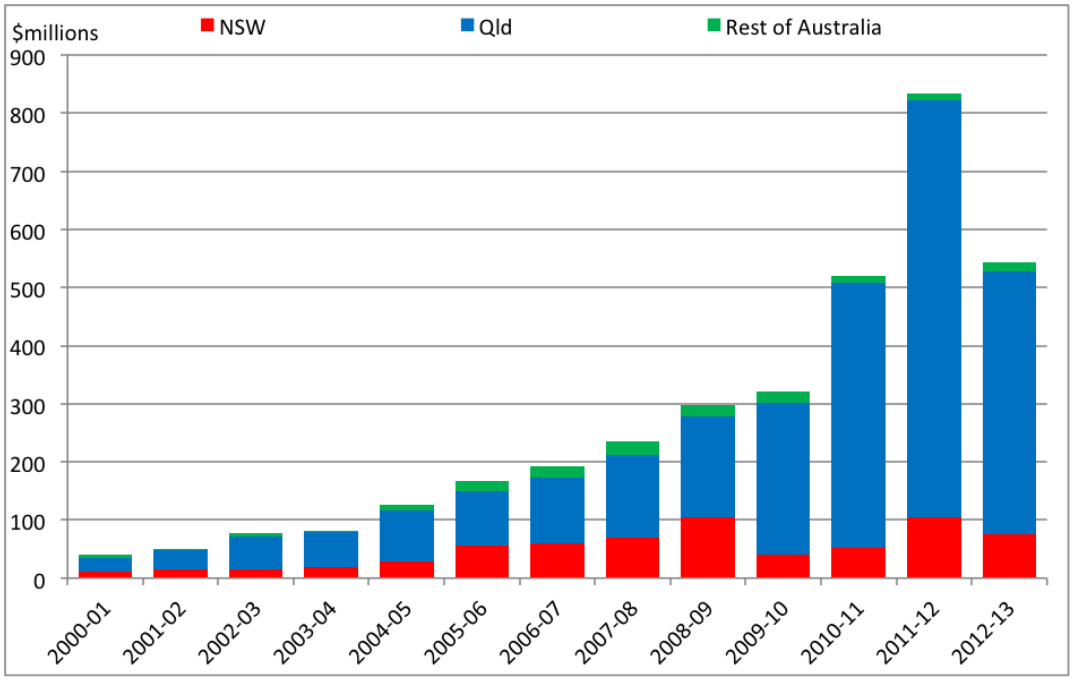

Figure 41. Australian coal exploration expenditure by State.[134]

In New South Wales, the Hunter Valley has been subject to several new projects, in particular with the joint venture of Glencore and Peabody Energy planning to produce 6 million tpy of thermal coal by 2017, and with the development of activities in the Gunnedah coalfield since 2014, aiming for a future production capacity of over 10 million tpy of thermal and lower quality metallurgical coal.

In Queensland, the Bowen Basin has seen the opening of BHP Billiton's Daunia and Caval Ridge mines of hard metallurgical coal since 2014.[135] Furthermore, the mega mines in the Galilee Basin such as Adani's Carmichael project and GVK's Alpha project have received environmental approval by the Australian government.[136] Carmichael is expected to produce 60 million tpy by 2017, for a development cost of 16.5 billion USD, ranking it as one of the biggest thermal coal mines in the world.[137] However, due to the low coal prices, these projects are highly debated on their capacity to recover their financing costs. Besides, these projects have to face opposition from environmental groups which state

[134] See previous footnote.
[135] BHP Billiton (2014) BHP Billiton Opens Caval Ridge Metallurgical Coal Mine in Central Queensland.
[136] Robins, Brian (2014) Adani coal mine approved amid weaker prices. The Sydney Morning Herald, 28 July 2014.
[137] Iminco (undated) Iminco, Adani & GVK mine development gets Queensland govt approval. Iminco Website. Accessed 11.9.2016.

that the development of these mega mines would require to dump 3 million cubic meters of soil into the Coral Sea, 15 miles from the Great Barrier Reef. As a result, the UNESCO has warned that the "in danger" label could be applied to the Great Barrier Reef Marine Park if no progress would be made to protect it in the area.[138]

3.6.2. Mongolia

Coal investment for new projects in Mongolia has been important over the last decade, due to a high level of energy needed for the winter and the difficulty to import coal from the seaborne market at a lower price. Several coal projects are in development, such as the Chandgana project targeting 3.5 million tpy and the Tavan Tolgoi mine holding 7.5 billion tons of coal.[139] Nevertheless, the decline in foreign investment is threatening the support of these projects, which could be abandoned if there is a lack of funds to develop the mining activities.[140]

Besides these financial issues, Mongolia has to face an increase in the number of illegal coal mines, which create huge safety and environmental issues in the country. Indeed, the lack of safety measures provoke the death of many workers each year, and the low prices provided thanks to the absence of taxes is responsible for huge amounts of coal burned in some areas, turning Mongolia in one of the most polluted countries in the world according to a study of the World Health Organization.[141]

3.6.3. Russia

The Russian coal industry sector accounted for only 4.3% of the world's production in 2014 even though the country holds 18% of the world's proven coal reserves.[142] A 132 billion USD programme, mostly financed privately, has been created in order to modernise the industry and increase its production considerably from 2014 to 2030.

[138] News Corp Australia (2015) UNESCO: Great Barrier Reef not 'in danger'. News, 30.5.2015.
[139] See footnote 122.
[140] Brletich, Samantha (2015) Mongolia struggles to develop Tavan Tolgoi coal mine. Mining, 21.9.2015.
[141] Dodson, Sam (2015) Mongolia's illegal coal mines. World Coal, 2.4.2014.
[142] Oil Change International (2015) G20 subsidies to oil, gas and coal production: Russia. Country Study. November 2015.

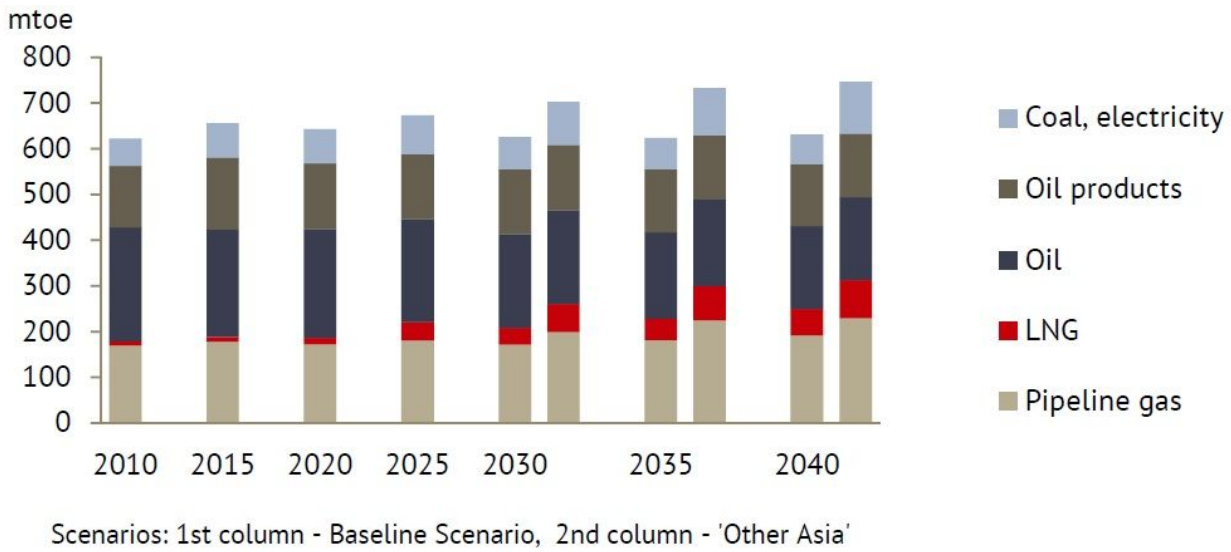

Figure 42. Russian fossil energy outlook to 2040 according to the Energy Research Institute of the Russian Academy of Sciences.[143]

The Russian coal industry benefits from federal tax exemptions and important amounts of subsidies, both on a federal and regional level. New projects are being conducted, such as the Elga project which has begun in 2014 with a capacity of production of 2.7 million tpy and the Amaam project, targeting a production capacity of 1.5 million tpy.[144]

[143] Galkina, Anna et al. (2014) Russian energy sector will cease to be engine of growth. Energy Post 3.7.2014.
[144] See footnote 122.

4. Fossil fuel exploration in the age of climate change

4.1. The climate perspective

From the climate perspective, maintaining a planet with livable conditions for humans and other species is the first priority. The global climate is getting disrupted by the burning of fossil fuels and the more we burn, the worse the situation gets. This is common sense. And exploration is obviously the first step in the chain of events that leads to climate change. It can be seen as a process where exploration happens first, upstream and leads to climate change and its problems downstream. Once exploration has been completed, the explorers have sent further extraction, burning, warming and climate impacts "into the pipeline". Figure 43 shows the relations. Exploration that is happening today looks for new fossil fuel reserves that come on top of what is already available (proven reserves). From the climate perspective this can only be characterized as extreme, because current reserves are already so vast that they could lead to more than 7°C warming.[145] Adding more on top of that is completely out of the question.

Places that are being explored today may in some cases proceed to extraction first, before others which have been known but are more challenging to extract. In fact, some in the oil industry argument that because of their higher pace of production they would be entitled to a higher share of the carbon budget and could thus continue exploring for more oil and gas.[146] The cited document however assumes a global carbon budget about three times as big as the one available after the Paris Agreement. The proposal is also questionable from a justice perspective which asks the question who will be allowed to extract and who will not. In theory, by renouncing the extraction of current reserves, "carbon space" could be created for newly explored reserves. However, so far none of the 196 governments participating in the UN climate negotiations has put forward any reserves as non-extractable.[147] It must be assumed that all reserves are currently planned to be

[145] Edenhofer O., et al. (2014) Technical Summary. (Table TS. 1, page 54) In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. This statement takes the upper end of IPCC projections into account, following the precautionary principle.

[146] Watkins, Sabrina (2015) Addressing Carbon Asset Risk. Presentation by ConocoPhillips, Head of Sustainable Development. October 2015.

[147] Under the Yasuni-ITT Initiative, Ecuador had proposed to leave the oil in the ITT block in its Yasuni National Park in the ground in exchange for a sort of "indemnization" from the international community. Ecuadorian parastatal Petroamazonas has now started drilling in the block in spite of their own constitution and widespread popular opposition.

extracted, resulting in a breach of the targets of the Paris Agreement. Recent analysis has also shown that currently operating oil and gas fields and coal mines are sufficient to emit es much as is allowed under the Paris Agreement.[148]

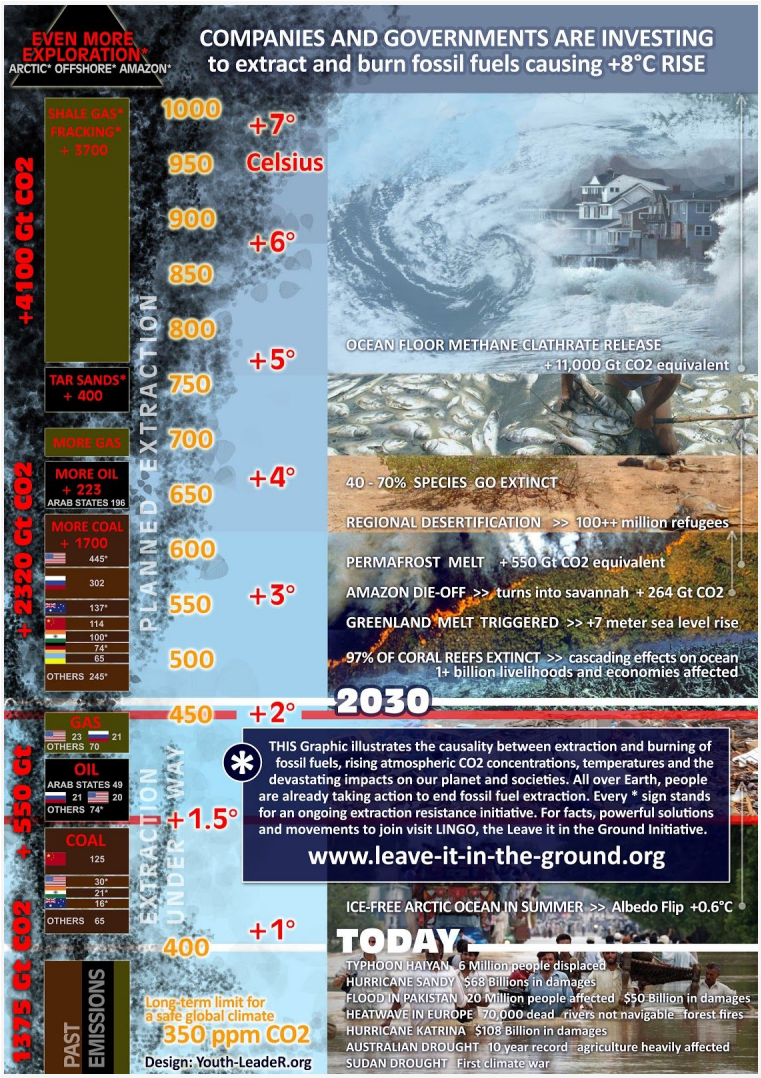

Figure 43. Understanding the climate crisis: fossil fuel reserves to impacts.

Given that only 16% of current proven reserves are extractable under the Paris Agreement and 84% must be kept in the ground, it is highly questionable whether the situation of "overachievement" in keeping fossil fuel reserves in the ground that would free up carbon

[148] See footnote 2.

space for additional reserves identified through exploration activities will ever arise.

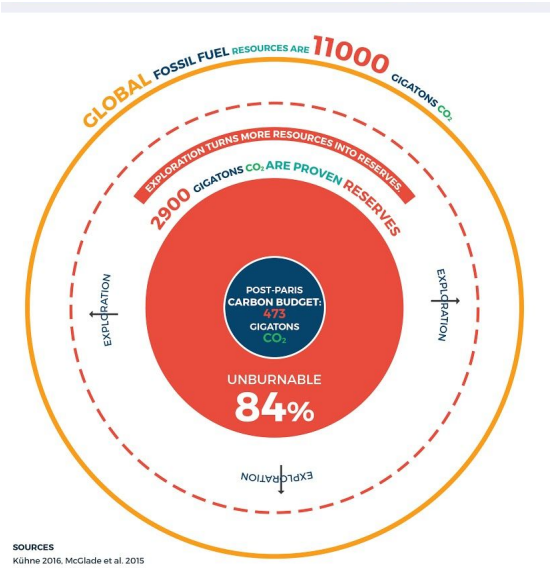

Figure 44. Conceptual map of the post-Paris carbon budget, proven reserves and exploration.

High leverage

Preventing exploration is a high-leverage undertaking from the climate perspective. By preventing a relatively small investment (and small impacts), we can avoid a much bigger investment being made - and bigger harm being caused - in the future. This should be taken into consideration when deciding which issues to campaign on. We can avoid expensive and harmful errors. By looking for the weak spots of projects or even the exploration industry as a whole, it is possible to push on one small issue and create a big change for the environment and the climate. From a climate perspective, an immediate moratorium on all exploration is completely justified by the carbon bubble - the availability of proven fossil fuel reserves that exceed the available carbon budget under the Paris Agreement by a factor six. This is the reasonable thing to do.

Real world politics often turn the most reasonable thing to do into the most tricky thing to do. In order to get closer to ending fossil fuel exploration, we can focus on some parts of it or individual projects. In our current context of increasing action to counter climate change and decreasing renewable energy prices, time is on our side. Delaying projects for some time can often result in a definite cancellation in this context where it becomes harder and harder to continue fossil fuel exploration against reason. This means that time is on our

side when fighting fossil fuels. We will eventually win the struggle to stop them. But at the same time, time is our enemy, because the longer CO2 emissions flow into the atmosphere, the more likely we are to destabilize tipping elements in the global climate system, to extinguish species and destroy cultures forever and to pass the point of no return of global system level run-away climate change. (See the arrows on the right hand side of Figure 43 that indicate the potential for runaway climate change.)

4.1.1. The Paris Agreement

The climate agreement that was adopted in Paris in December 2015 has underlined the wish of governments to not let the planet drift into runaway climate change. The temperature target that had been set at a maximum 2°C temperature rise compared to pre-industrial levels in earlier negotiations, was strengthened to "well below 2°" with a view to limiting it at 1.5°C warming. Unfortunately, this level of ambition has not yet carried over to fossil fuel extraction policies. A concerted effort will be needed to make sure that extraction is limited in line with the temperature targets.

The Global Greens network has announced in April 2016 that they will seek to impulse laws in different countries that maintain specific fossil fuel reserves in the ground in connection with the ratification of the Paris Agreement.[149] The success - and speed of success - of such initiatives will ultimately determine the success of the Paris Agreement in achieving its declared goals.

4.1.2. Beyond 2°C warming

Burning all fossil fuel reserves, including the ones we are still developing right now by exploring, could raise global mean temperature by 6°C or more.[150]

An average increase of 4.5°C would mean annual temperature extremes in the Mediterranean increasing by 8°C and annual temperature extremes increasing by up to 15°C in the Arctic.[151]

Although global warming is expected to have a linear relationship with global CO2

[149] Global Greens (2016) Statement by the Global Greens on the occasion of the Signing of the Paris Agreement. Global Greens Website, 21 April 2016.

[150] Greenstone, Michael (2015) If We Dig Out All Our Fossil Fuels, Here's How Hot We Can Expect It to Get. The New Yoirk Times, 8 April 2015.

[151] Seneviratne, Sonia I. et al. (2016) Allowable CO2 emissions based on regional and impact-related climate targets. Nature 529, 477–483.

emissions, there are tipping elements in the global climate system which must not be ignored. The higher the temperature rises, the higher the risks are to face a domino effect where we pass a point of no return of positive (i.e. self-reinforcing) feedback processes that lead to catastrophic levels of warming.

Given these impacts, continuing exploration for more oil, gas and coal today can be considered a "climate crime". Under the Rome Statute, even the failure to avoid foreseeable harm is punishable. The harm to vulnerable populations is clearly foreseeable with fossil fuel exploration and the resulting emissions. If a case of this kind is taken up by the ICC is another question, but a recent announcement[152] suggests that this is at least a possibility. In the Philippines, a human rights commission is investigating whether fossil fuel producers are to be held responsible for human rights violations inflicted via climate change impacts.[153] The findings will be applicable to current and future fossil fuel exploration.

4.2. The ecological perspective

4.2.1. Exploration in protected areas

The World Conservation Congress in Amman in 2000 resolved that exploration and all mineral extraction should be prohibited by law in all protected areas of IUCN categories I, II, III and IV (see Figure 45 for definitions), and in categories V and VI restricted to those compatible with the objectives of the protected area and subject to prior public consultations and an environmental impact assessment.[154]

[152] Vidal, John & Bowcott, Owen (2016) ICC widens remit to include environmental destruction cases. The Guardian, 15 September 2016.
[153] Vidal, John (2016) World's largest carbon producers face landmark human rights case. The Guardian, 27 July 2016.
[154] World Conservation Congress (2000) Resolution 2.82 Protection and conservation of biological diversity of protected areas from the negative impacts of mining and exploration. Amman, 4–11 October 2000.

Category	Description
Ia	***Strict Nature Reserve***: Protected area managed mainly for science.
Ib	***Wilderness Area***: Protected area managed mainly for wilderness protection.
II	***National Park***: Protected area managed mainly for ecosystem protection and recreation.
III	***Natural Monument***: Protected area managed mainly for conservation of specific natural features.
IV	***Habitat/Species Management Area***: Protected area managed mainly for conservation through management intervention.
V	***Protected Landscape/Seascape***: Protected area managed mainly for landscape/ seascape conservation and recreation.
VI	***Managed Resource Protected Area***: Protected area managed mainly for the sustainable use of natural ecosystems.

Figure 45. The six IUCN Management Categories of Protected Areas.[155]

This resolution seems to have been violated by many governments in the pursuit of further fossil fuels and other mineral resources. In times of climate change and a very small carbon budget, this provision makes more sense than ever and should be strictly adhered to. It could be added that global warming in itself poses a formidable threat to many protected areas and going beyond 2°C of warming, or even beyond 6°C of warming as currently projected exploration implies, is completely incompatible with the objectives of most protected areas.

Given the mentioned declaration, ending fossil fuel exploration in protected areas seems like a very reasonable first step towards implementing the Paris Agreement on its extraction side.

4.2.2. Offshore exploration

There are three main arguments that make offshore exploration a candidate for an immediate moratorium:

Firstly, seismic blasting is detrimental to marine wildlife, as described in section 2.2.1.

Secondly, the Deepwater Horizon disaster has shown that offshore drilling carries a high ecological, social and economic risk. When looking for ways to reduce the carbon “pie” this

[155] IUCN (undated) PADDDtracker – explore legal changes to the world’s protected areas. 2.9.2015.

risky piece is one that should go first.

Thirdly, much of the offshore oil is not competitive on a market with cheaper options. We have enough cheaper options to cover the carbon budget so that additional expensive oil and gas is not needed.[156] It will end up as stranded assets - unless we destroy the climatic equilibrium of our planet.

Freezing new offshore exploration licenses should be considered by the relevant authorities in each country to give time for a reevaluation in light of the Paris Agreement. Besides, marine protected areas cover 9.7% of the territorial seas (0–12 nautical miles), 4.6% of Exclusive Economic Zones (EEZ) (12-200 nautical miles) and 0.14% of the High Seas beyond 200 nautical miles.[157] These areas should be excluded from exploration activities. A drilling moratiorium in "the area" outside of EEZs would also be a useful contribution to limiting the further increase of the carbon bubble.

4.3. The investment perspective

The International Energy Agency estimates that 23 trillion USD would have to be invested between 2014 and 2035 to maintain fossil fuel output at a near constant level.[158] The question is whether this sector will be able to attract this amount of capital. Besides the declining rates of return of fossil fuel investments, there are a number of issues that investors need to carefully consider, in order to avoid unnecessary risks.
The general trend in investments in exploration is to require more and more time to be recovered because of the complexity of drilling in the remaining exploration sites. Time is the key to losing money with exploration adventures. Both the competition by renewable energies and climate action is increasing every year. These trends need to be extrapolated into the future to arrive at a realistic assessment of the possibility of each project returning a profit.

In previous sections, typical time frames for projects have been mentioned. Typical times to break even for an offshore oil field is 20 years, for natural gas from fracked wells it is 10 years and for oil sands it is 25 years. This compares unfavourably to the advancing renewable energy technology that might displace oil and coal from its main markets

[156] McGlade, Christophe & Ekins, Paul (2015) The geographical distribution of fossil fuels unused when limiting global warming to 2 °C. Nature 517, 187–190.
[157] Protect Planet Ocean. Accessed 11.9.2016.
[158] International Energy Agency (2014) World Energy Investment Outlook. Special Report.

electricity generation and vehicle transport before 2030 as will be discussed below.[159]

More and more fossil fuel projects are met with popular resistance and local and even global opposition. This might not happen each time and difficult to quantify. However this risk tends to trump others when it occurs.

In general, fossil energies cannot be expected to be economically competitive much longer. Nevertheless, governments still provide huge amounts of subsidies to fossil fuel companies, which keeps them in the race. But most governments have repeatedly pledged to phase out fossil fuel subsidies. The failure of many countries to do so effectively so far does not necessarily mean that they will never address the issue. Time for fossil fuel subsidies may be up soon. Switching subsidies from fossil to clean energy - demanded by the public opinion and some politicians - is a lever for the energy transition that will increasingly be pulled.
As of today, many new projects are still being conducted with government support. In Brazil, Petrobras has planned to invest 23 billion USD from 2014 to 2018 for offshore exploration in the south east of the country. In Argentina, YPF plans to drill 200 unconventional wells a year until 2023, for a total cost of 15 billion USD. Once these exploration phases will be over, the production phase will last for 10 years more. As in the United Kingdom, where exploration and extraction operations in the North Sea are planned for the next 20 years, with expectations to extract 3 to 4 bboe.

In addition to the mentioned challenges, here are two more risks to take into consideration:

Health, safety and emergency management. Bulgaria has banned high pressure in drilling operations for safety reasons. This was the end of fracking and exploring for more shale gas and oil in Bulgaria. With the Deepwater Horizon disaster, some regulations were reviewed. In general the trend is towards more safety and each disaster means more regulations could be coming that mean delays or higher costs for projects.

Regulatory environment. The proposed Keep it in the Ground Act in the United States[160] is one example of legislation that can collapse whole market segments. The Global Greens have announced that they will generate more of such legislation. Especially in the long term there is a regulatory risk because of climate action gaining traction.

[159] See footnote 7.
[160] US Congress (2015) S.2238 - Keep It in the Ground Act of 2015. 114th Congress (2015-2016).

4.3.1. Energy alternatives

Fossil-based fuels currently provide about 85% of all the energy use worldwide and reserve-to-production ratios for oil, gas and coal are 46 years, 58 years and 118 years respectively.[161] The share of renewable energy sources in net energy production is currently about 10% worldwide.

Before looking at how fossil energy sources are being replaced by renewable energy, we must note that under certain conditions such as high prices energy demand can "evaporate". When applying concepts such as material input per service unit (MIPS) it quickly becomes evident that today, most services are very resource intensive, requiring large amounts of energy. When energy efficiency is considered an important criterion in the design phase, improvements of 90% are not uncommon. This has been shown by the work of the Wuppertal Institute and others for decades now. What has hardly been achieved so far are policies that translate this insight into action to reduce environmental impacts and greenhouse gas emissions while maintaining well-being. This is a potential that might contribute to collapsing fossil fuel markets even faster than is currently already happening.

Neither energy efficiency nor renewable energy do automatically translate into a reduction in fossil fuel extraction and burning. In today's world, "saving" energy frees up fossil fuels for growing markets (Asia, aviation etc.). There can even be a "fertilizing" effect of temporarily depressed energy prices on energy demand, with infrastructure that is dependent on cheap energy "locking in" a high energy demand.

Unfortunately, renewable energy that comes in addition to fossil fuels does basically nothing to reduce emissions.

Besides open subsidies, "hidden subsidies", such as the health and environmental cost of fossil fuels are so far borne by everyone. It must be expected that over time, more of these costs will be included in the fossil fuel price tag, reducing their competitiveness further.

When looking at the levelized cost of electricity, renewable sources are already cheaper today in most markets.[162] This trend can be expected to continue over the next years. Because of sunk costs in fossil infrastructure, the cost advantage mainly plays out when

[161] Rozenblat, Lazar (2016) Why Alternatives Are Important. Renewable Energy Sources.
[162] Lazard (2015) Lazard's levelized cost of energy analysis - Version 9.0.

new generation capacity is built. Open and hidden fossil fuel subsidies distort the picture further. But what is clear is where the market is heading: towards 100% renewable energy. The main question is not if but when the different fossil market segments will collapse.

Tony Seba predicts that by 2030 the markets for fossil-fuelled electricity and internal combustion engine cars will have expired via “clean disruption”.[163]

4.3.2. From fossil fuel to energy companies

There are strong indicators that the old business model of international oil companies is expiring.[164] Fossil fuel companies need to adapt their strategy to the new environment. Some companies are already doing so, for example German energy company Eon which has spun off its fossil fuel business from the rest of the company, or ConocoPhillips which preferred shrinking to taking on unnecessary risks. An answer short of winding down the company, exiting the business and doing so as profitably as possible is to turn into an energy company. When repositioning a company as an energy rather than a fossil fuel company, exploration is one of the first things that need to be reconsidered, because it is linked to the longest time horizons. An initial step any fossil fuel company should do now is to delink executive compensation from reserve replacement targets.[165]

An additional danger for fossil fuel investments is climate litigation. Not only practical concerns, such as the legal challenge of the community of Clyde River to an exploration programme off their coast which has been delayed due to a challenge in Canadian courts, [166] or the Norwegian case where youth contend that the government is violating their constitution and the Paris Agreement by issuing exploration licenses in the Arctic.[167] There are also a whole new category of lawsuits on the horizon that build on a liability of fossil fuel companies for climate change impacts.[168]

Investors can also play a role in pushing fossil fuel companies to create transition

[163] Seba, Tony (2014) Clean Disruption of Energy and Transportation: How Silicon Valley will Make Oil, Nuclear, Natural Gas, Coal, Electric Utilities and Conventional Cars Obsolete by 2030. Clean Planet Ventures, California.
[164] See footnote 67.
[165] Market Forces (2016) Digging deeper. Report. September 2016.
[166] Murray, Nick (2016) Date set for Clyde River's appeal to Supreme Court over seismic testing. CBC News, 2.4.2016.
[167] Reuters (2016) Two Norwegian Environmental Groups Sue Norway Over Arctic Oil Exploration. E&P, October 18, 2016.
[168] French, Kristen C. (2015) A Peruvian farmer is suing an energy giant over climate change. The Verge, December 2, 2015.

strategies to become energy companies, liquidate assets as soon as possible, stop new investments in exploration, or, if unsuccessful divest these companies.
There is even money to be made from short-selling exploration companies, because the fossil end game will eventually finish with fossil assets becoming worthless.

4.4. The government perspective

Governments need to balance different interests, such as energy security, jobs, climate stability and protection of the environment and their own revenue. An updated understanding of energy security allows to see beyond the short-sightedness of self-destructive fossil fuel dependency and the irrelevance of securing energy for non-essential uses.[169]

We would like to point at three measures that require reevaluating policies around exploration which could potentially generate some important synergies between these goals: shifting subsidies, respecting communities' right to say no and administrative moratoria on new exploration permits.

In addition, governments could choose to capture co-benefits of non-extraction. Two cases where this is possible are:

1. Protected natural areas. Please refer to section 4.2. on the ecological perspective above for a more detailed discussion.
2. Areas under dispute with neighbouring countries. The "Keep it in the Ground for Peace" campaign has identified a number of areas with fossil fuel reserves that are contested between neighbours and propose to keep these in the ground to de-escalate conflicts while protecting the climate.[170]

4.4.1. Shifting subsidies

Reinvesting subsidies that are spent on exploration and fossil fuels more generally into priority energy security and/or post-carbon well-being programmes can be a great way to protect the climate and improve general well-being at the same time.[171] It has been shown that substantial emissions reductions up to 58% can be reaped over a short time-frame

[169] Kühne, Kjell (2015) Redefining Energy Security in the 21st Century. Leave it in the Ground Initiative (LINGO), October 2015.
[170] Climate Strike (undated) Keep it in the Ground for Peace. Accessed 24.10.2016.
[171] Jakob, M. et al. (2015) Development incentives for fossil fuel subsidy reform. Nature Climate Change 5, 709.

through such a strategy.[172]

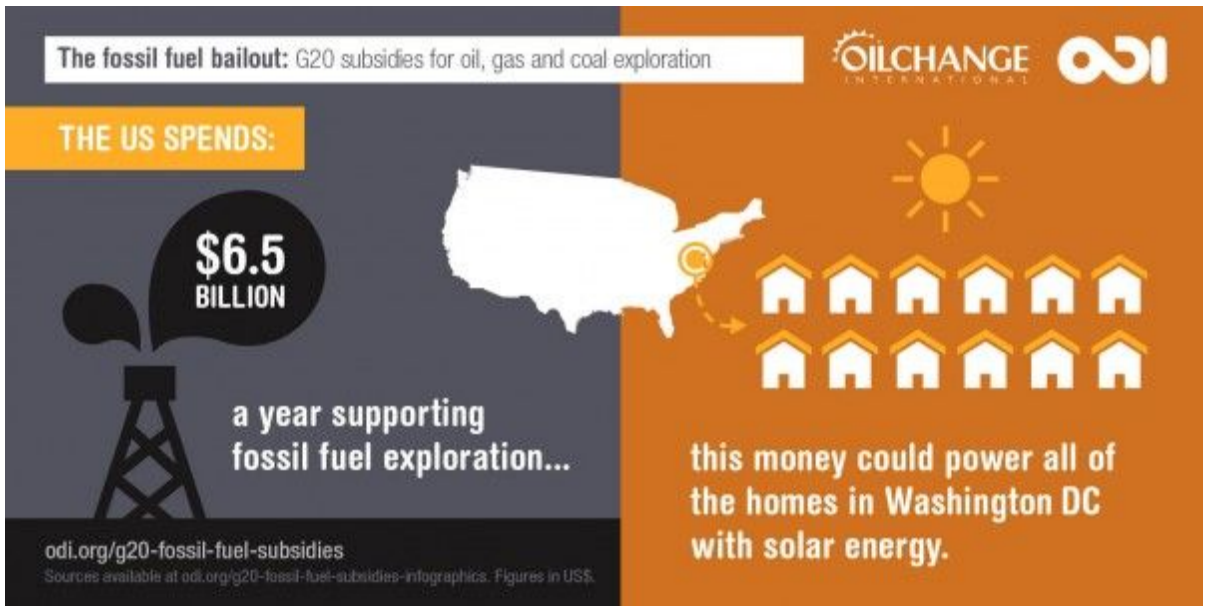

Figure 46. Exemplary option for reinvesting exploration subsidies in the US.[173]

4.4.2. Respecting communities' right to say no

ILO Convention 169 and the UN Declaration on the Rights of Indigenous Peoples foresee indigenous peoples to be consulted before a project on their land under a modality called "Free Prior and Informed Consent" (FPIC). Many countries protect the rights of local populations to their land at least on paper. Were this implemented, many exploration and extraction projects would not go forward. Indigenous peoples are coincidentally also among the first to suffer the impacts of a changing climate. Upholding the right to say no to fossil fuel projects is especially important in the context of the carbon constraints mentioned in the section on the climate perspective. After all, it is desirable to identify places where fossil reserves can stay safely in the ground. Local people are the right address to take that decision in an informed way themselves.

Oilwatch and EJOLT have put forward a proposal to halt fossil fuel activities in protected

[172] Merrill, Laura et al. (2015) Tackling Fossil Fuel Subsidies and Climate Change: Levelling the energy playing field. Nordic Council of Minister.
[173] See footnote 12.

areas and indigenous territories.[174]

In Canada, the failure to consider these legally granted rights has led to many delays and poor performance of a number of fossil fuel infrastructure projects which is targeted among others by the Idle No More movement.[175]

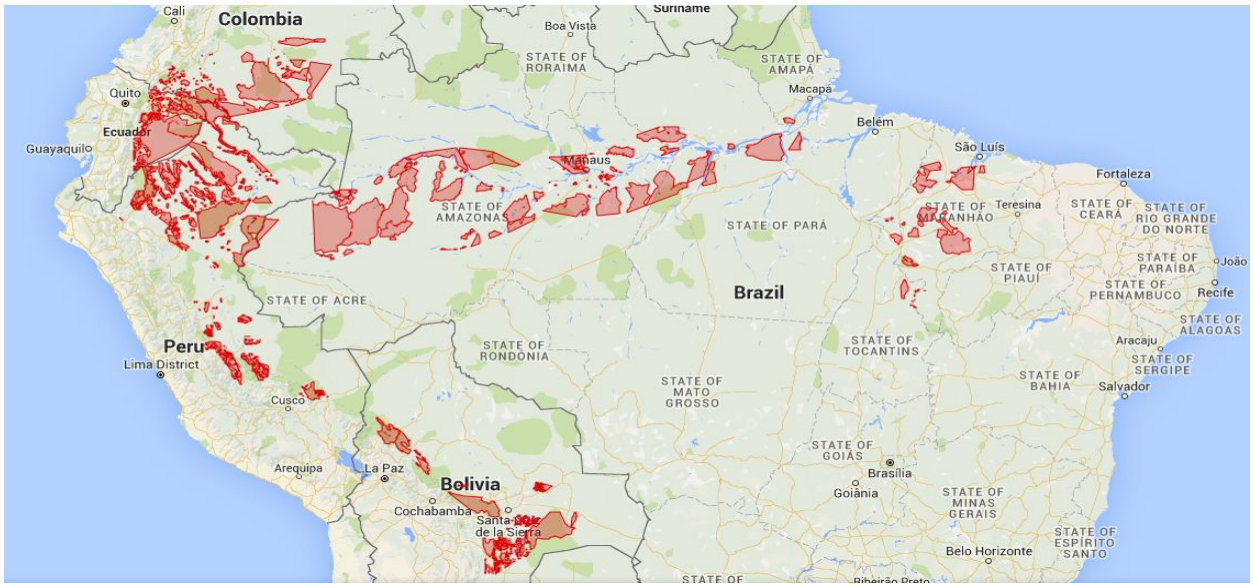

Figure 47. Map of hydrocarbon concessions overlapping with protected areas and indigenous territories in the Amazon.[176]

Figure 47 provides a map of overlap between hydrocarbon concessions, mostly for exploration and protected areas and indgenous territories in the Amazon basin. In times of globalization and internet the previous situation that rights on paper were more or less useless in practice and local opposition to projects could be overcome by making limited concessions or even by bullying local populations, is no longer a given. More and more people and organizations back indigenous peoples demands to self-determination.[177] This changes the game for exploration on land. From a government perspective, upholding the rights of their indigenous and other local populations, and in particular the right to say no, should be a priority.

[174] Temper, L. et al. (2013) Towards a Post-Oil Civilization: Yasunization and other initiatives to leave fossil fuels in the soil. EJOLT Report No. 6.
[175] First Peoples Worldwide (2013) INDIGENOUS RIGHTS RISK REPORT for the Extractive Industry (U.S.) - PRELIMINARY FINDINGS. October 28, 2013.
[176] Image: Climate Alliance Mapping Project (undated) Interactive Map. Accessed 11.9.2016.
[177] See for example the declaration "Keep Fossil Fuels in the Ground: A Declaration for the Health of Mother Earth." December 2015.

4.4.3 Moratoria on exploration permits

Costa Rica has an oil exploration moratorium in place until 2021. British Columbia in Canada also has a moratorium on offshore drilling that has been in place since 1972 and the US and Canada have decided to not drill on Georges Bank, an area off the East coast that is important for fisheries after settling a dispute over ownership of the area at court.

The Chinese government has announced in early 2016 that it will not issue any permits for new coal mines for the next three years. Previously, the Ministry of Land and Resources (MLR) had stopped granting coal exploration licenses in 2007/2008[178] and again from 2009 [179] to 2014[180] - except for certain projects, such as the ones supported by the Central Geological Exploration Fund.

In the United States, the Obama administration has decided to not issue any new offshore exploration licenses in the Arctic and Atlantic - and has drawn opposition from environmental groups for continuing to offer them for the Gulf of Mexico. It has also posed a moratorium on coal mining permits on public lands. These are all examples for government action that can swiftly address the situation and halt further exploration. On the contrary, failing to stop it before issuing permits may result in legal action and fines as in the French case of San Juan Nova mentioned before.

[178] Caijing (2011) 国土资源部：继续暂停受理新煤炭探矿权申请. Caijing, 10.2.2011.
[179] MLR (2011) 国土资源部关于继续暂停受理煤炭探矿权申请的通知. Ministry of Land and Resources, 10.2.2011.
[180] MLR (2015) China Mineral Resources. September 2015.