THE GAME OF ENERGY: A CLASSROOM GAME OF COOPERATION AND COMPETITION SIMULATING THE GLOBAL ENERGY MARKET

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ABSTRACT

This article introduces a game for classroom use based on a simplified model of the global energy market. It was designed for a four-hour session, in a classroom, with up to thirty participants, but preferably with around sixteen participants.
The model simulates the future effects of rising costs of production, political instability, renewable energies to substitute demand, and new technologies such as deepwater oil, and shale layer production.
The model is very simple to give the students a better view of the possibilities, and yet the possible combinations are so many, that no two games will be the same.

INTRODUCTION

This article introduces a game for classroom use based on a simplified model of the global energy market.

The game is a new version of the Petroleum game published in Alves (2001). The original game was published only in portuguese language at a time that companies presented themselves mostly as "oil companies" rather than "energy companies". Also there were three major new issues that appeared since it was published: alternative energy sources, Brazilian sub-salt formation, and Shale oil production. The original model already incorporated these factors indirectly, but not all participants can see that clearly, so a new model to make these factors more explicit is desirable.

The game rules section was written as an appendix so that it can be printed separately for the participants.

DESIGN GOALS

The main goal of the game is to be applicable in a classroom with minimal infrastructure, and therefore it retains the traditional pen and paper logic, however today we have a more easy access to spreadsheets and projectors, so that, not necessarily, the main game data has to be drawn in a blackboard.

The secondary goal is that it will be a competitive and cooperative game at the same time. This market has created cartels several times, but they are short-lived in general due to competition, so the model will retain the original model logic of price fluctuating with supply that is determined by the players in secret, while the demand is fixed and explicit. This creates an incentive towards cooperation, but also to competition and not following the agreements, and thus simulating the dynamics of cartel formation and dissolution.

The tertiary goal is that it can be used in a four hour session with a thirty minutes explanation and a thirty minutes debriefing and three hours of gaming itself. This allows it to be applicable to executive education, MBA, EMBA, graduate, and under-graduation courses.

The quaternary goal is that it has to be fun and engaging, while retaining a reasonable connection with the real world, so the areas of operation are real, the initial reserves are real. Cards and dice are used to represent life-like events of reality giving a sensation of limited control of events to the participants.

USAGE METHODOLOGY

This game was designed for use in a four-hour session, in a classroom, with up to thirty participants, but preferably with around sixteen participants.

The only materials needed are printed copies of the rules, a blackboard, a printed set of the cards, and at least one six-sided die. This makes it a low cost application for any situation. However if a projector and a spreadsheet are available it will be much easier to use.

The participants should preferably have received the rules beforehand, but that is not entirely necessary, since the rules are simple and can be learned while playing.

The facilitator must divide the participants into four to six groups, ideally four groups. Each group can have from two to five participants, ideally four participants. So the number of participants can range from eight to thirty, but with an ideal number of sixteen.

Time usage should be:

a. Thirty-minutes for groups' setup and game explanation.
b. Forty to fifty-minutes for the first turn.
c. Twenty to forty-minutes for subsequent turns.

d. Thirty to forty-minutes for debriefing.

The number of turns will depend on the speed of the groups for decision-making, but at least four turns should be taken, preferable five turns or more.

The facilitator should answer all questions pertaining to the rules of the game to the best of his or her ability, but never directly answer question about which strategy to pursue, or what decision to make. If a group is stuck with decision paralysis, that is unable to make a decision, it should do nothing that turn as a penalty for indecision.

Some questions and issues selected for discussion in the debriefing can be advanced with each group as they realize some of the points. However the game rules purposely miss the issue as which is the objective of the game, and who wins, so that this discussion may rise in the debriefing as how to evaluate a company, its assets, sustainability of the profit and future cash flow. So the facilitator must avoid a direct answer to these issues always pointing to the participants that this issue is missing on purpose, and asking them how they think the companies should be compared to each other. Usually only a few groups rise the question and only in the later half of the session.

DEBRIEFING

The game is a mean to an end, which is learning through experience, so to consolidate this learning a debriefing is necessary at the end of the session. The participants will probably keep talking about the game afterwards but it's important to give them a closure at the end of the session.

The facilitator may discuss whatever he or she finds necessary and important given the purpose of the course but some suggestions are made here.

The first question to address is which company won the game, since it's not explained anywhere on the rules on purpose. The facilitator should induce them to think how much each company is worth, or by how much money they would buy each company, or how much money each company will get in the future. The concepts behind those questions are valuation, future cash flow and assets evaluation. They must understand that cash is not the only asset here, and the reserves will have some value in the future, but this value is not fixed and different evaluations may exist.

Other possible line of discussion is about the game dynamics that represents the cartel game from the game theory (Ordeshook, 1986), that is a variant of the chicken game. They may strike deals during the game but these will be temporary since the Nash equilibrium is not a deal. The facilitator may compare the situation with other typical chicken games, and either discuss in class, assign text readings, or use videos that represent such kind of situation.

A third line of discussion is group dynamics in terms of decision, or how they made their decisions during the game and how they felt time pressure, incomplete information, decision trees, group synergy or conflict, how they dealt with the competition, the deals and betrayals.

A fourth line of discussion is the oil and energy industry itself. The game is of course a simplification of reality but it has enough elements to make a good experience even though it doesn't simulate all aspects, and some equations are imperfect from the economic point of view. Risk analysis is a critical issue here both from the political point of view and technological breakthroughs than are literally "game changers". The game wasn't designed to forecast but some participants will point that it can give some insights about the future of the industry and make them think about it.

A fifth line of discussion is the sustainability, ethics and global responsibility. The model doesn't include those topics directly but these can be debated from the model of the game.

COMMENTS

This model tries to simulate the future effects of both the rising costs of production, as well as the political instability of most producing regions, and the trend to renewable energies to substitute demand in the long run, and new technologies such as deepwater oil, and shale layer production.

The political and technological model is very simple to give the students a better view of the possibilities, and yet the possible combinations are so many, that no two games will be the same. This will reduce their trend to paranoia and allow them to focus on managing the resources.

Notice that the oil depletion occurs by merely economical reasons. The game does not disallow you to find ever more expensive reserves, and in fact it shows that the oil industry will continue to exist only at a smaller size. As renewable energies substitute the demand the offer will have to be smaller in order for it to be profitable.

Other important aspect is the Persian Gulf where most of the reserves are concentrated and yet it's the most vulnerable region of the map. All other areas have one card that once used turns the area into a safe one. North sea and USA/Canada have no cards and are always safe but expensive. This makes for a good risk and return trade-off during the game.

This will lead for most participants to try to extract the oil from the Persian Gulf as soon as possible, probably driving the prices too low. This is a mistake and the facilitator may show that to the participants during the debriefing.

Also there is the problem of asymmetric information. The cards make for an asymmetry automatically so the apparent symmetry in the reserves is broken when you distribute the cards. Allow them to negotiate and discuss as they wish and time limit permits. The game is also a good

negotiation training, as well as strategic.

The game model doesn't incorporate many factors like the economical crisis of 2008, and the model could be complicated much more, however more complexity does not necessarily means a better learning experience for the participants. The complexity was kept low on purpose to maximize learning for participants.

The facilitator can create more complex variations, or he/she can deal with the other factors using other non-game tools as discussions and readings.

The oil reserves were estimated for the year of 2005. The USA reserves was divided into two parts, half was incorporated into Mexico/Venezuela and half into USA/ Canada. Thus the Mexico/Venezuela region represents in fact the whole Gulf of Mexico basin. Brazilian reserves are previous to the announcement of the sub-salt layer.

CONCLUSIONS

This article introduces a game for classroom use based on a simplified model of the global energy market. The game is design to last four hours and train up to thirty participants.

The game is a new version of the Petroleum game published in Alves (2001). There were three major new issues that appeared since it was published: alternative energy sources, Brazilian sub-salt formation and Shale oil production.

The purpose is to create a relatively cheap training tool for Strategy, Business strategy, negotiation, international relations and game theory.

The game rules section was in an appendix so that it can be printed separately for the participants.

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APPENDIX A

GAME RULES

GAME SCENARIO

Your group is the board of an energy company managing the resources at a global level. Your goal is to manage the company and the resources, both expandable and renewable, for the next 20 to 40 years.

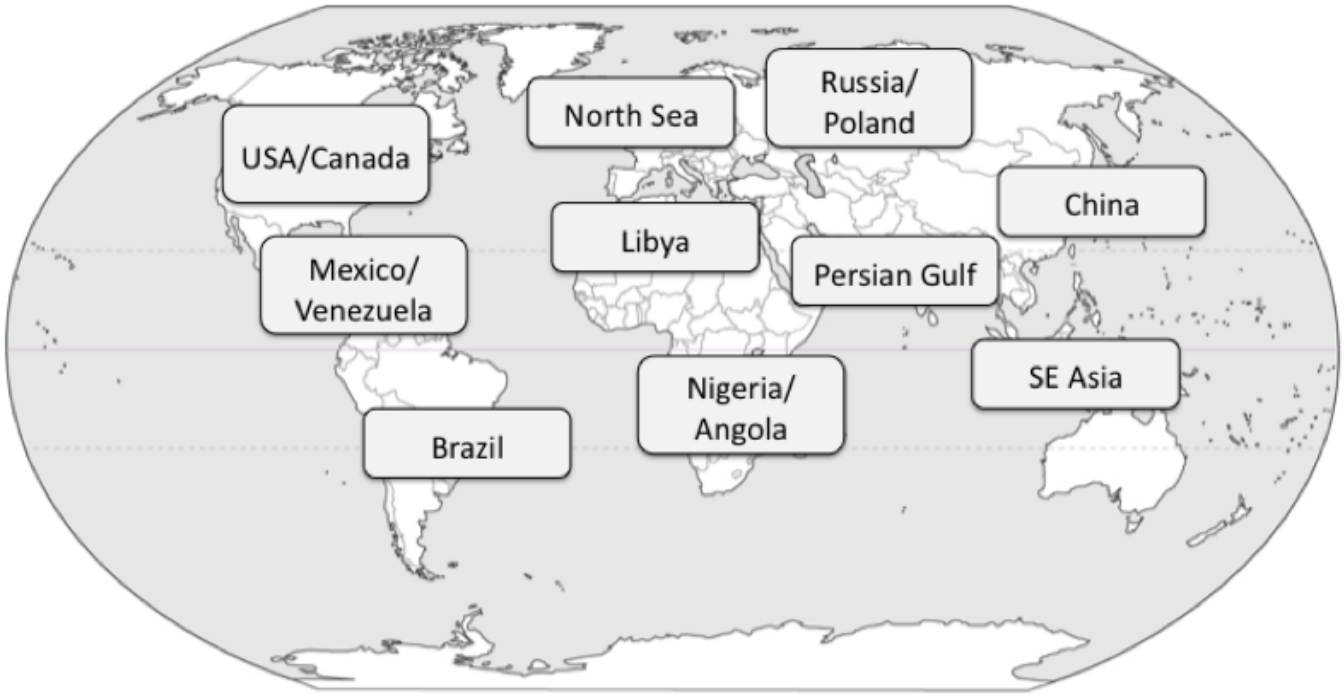
The year is 2004 and the global reserves are high but many fear we are closing to the peak of oil production, and in the long run new alternative energies will be key for survival. Energy demand is still growing but the forecasts indicate that the reserves will not grow fast enough to meet demand. Renewable energies may reduce the demand in the future.

The main reserves are located in the Persian gulf, that has been recently stabilized by a strong US military presence, but there are growing concerns of political stability in the long run, as the war on terror continues and WMD (weapons of mass destruction) are developed in many places. China, South America, Russia and Africa are also worrisome as political stability.

GAME SCALE

- Each turn is the equivalent four fiscal years.
- Each monetary unit ($ 1G) is the equivalent to one billion dollars (1 US$ Billion).
- Each production unit (1 Gb) is the equivalent to one billion barrels of oil.
- Each group starts with one hundred billion dollars ($ 100G).
- Each group starts with one fifth (1/5) of the oil reserves worldwide.
- The remaining reserves starts with the independent group controlled by the rules.
- There are ten regions on the game each representing one or more countries, these are: Brazil, China, Libya, Mexico/Venezuela, Nigeria/Angola, North Sea, Persian Gulf, Russia/Poland, SE Asia and USA/ Canada. Figure 1 shows the relative position of the regions but this plays no role in the game, being just for illustration.

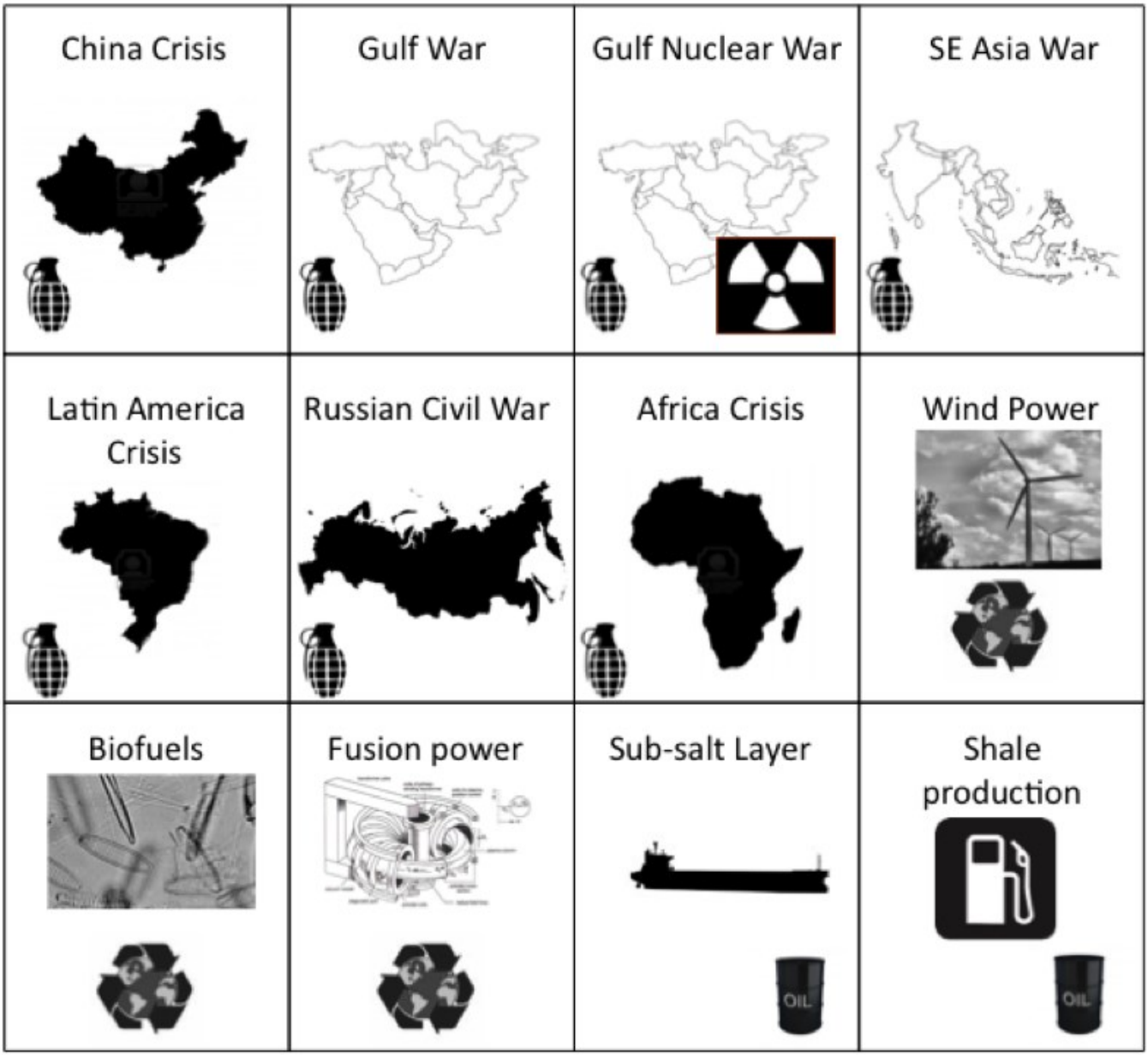
FIGURE 1
GAME MAP WITH TEN REGIONS



There are twelve event cards representing political, military and technological events that may occur during the game. Figure 2 shows one possible configuration for the cards. The facilitator may create his or her own cards for play.

The names of the companies are fictional and can be changed by the facilitator as desired.

FIGURE 2
EVENT CARDS



GAME SETUP

The facilitator will distribute the rules among the participants and separate them into four groups or more groups. Each group can have from two to five participants. Distribute two event cards for each group. Remaining events cards will be in possession of the independents groups managed by the rules. The facilitator must draw, or project, the main data table in a blackboard, or wall. Table 1 shows the main data table with all regions with the initial reserves, location modifier (L), exploration costs for turn one (Exp), and initial cash of the companies (cash). This table will have to be modified along the game as the actions are taken.

GAME SEQUENCE

The game is divided into turns representing four fiscal years. Each turn will be divided into several phases in the following sequence.

Phase 1 – Planning Phase
Phase 2 – Revelation Phase
Phase 3 – Calculation phase
Phase 4 – End of turn phase

Repeat these phases until the specified number of turns, or to the end of class time. A two-hour class will probably last two to three turns, while a four-hour class will last for five to seven turns.

Each phase is now detailed.

Phase 1 – Planning Phase

During this phase the students will make their decisions. They will analyze the situation, discuss among themselves looking at the market size, current cash, and location of resources and the event cards, as well as the competition.

They can:

a. Decide how many production units (Gb) they will extract from each region.
b. Decide many new oil production units (Gb) they will explore in each region.
c. Which event card they will submit this turn

The cost of extracting (action (a)) is one monetary unit per production unit ($1G/Gb). They may extract from several regions each turn, even the just explored new reserves.

The cost of exploring new reserves (action (b)) is given by the equation 1. Where T is the number of the turn, and L is a location factor, different for each region.

$$(3+2T+L)\$G/Gb \quad \textbf{(1)}$$

The event cards (action (c)) are not used on turn 1. From the second turn on every group must present one card for use as well as one of held by the professor. Only two of the cards presented will go into effect each turn, they will be select at random, and the others will return to their original owners. The selected ones will go into effect during the revelation phase

TABLE 1
MAIN DATA TABLE

			Companies				
	L	**Exp T=1**	**Desert Sun**	**Nord Petroleum**	**Pacific Oil**	**Kevron**	**Independents**
Region							
Brazil	+2	7	3	3	3	3	3
China	+1	6	4	4	4	4	4
Libya	0	5	8	8	8	8	8
Nigeria/Angola	0	5	12	12	12	12	12
North Sea	+2	7	2	2	2	2	2
Mexico/Venezuela	+1	6	22	22	22	22	22
Persian Gulf	-1	4	146	146	146	146	146
Russia/Poland	+1	6	14	14	14	14	14
SE Asia	0	5	3	3	3	3	3
USA/Canada	+2	7	39	39	39	39	39
Cash			$100	$100	$100	$100	

Phase 2 – Revelation phase

In this phase all the decisions taken during the previous phase are revealed, so that the decisions taken privately are now public. The facilitator will mark the decisions on the board, or spreadsheet.

The facilitator will now select at random two of the event cards presented. These two will go into immediate effect and the others will be returned to the original owners.

Phase 3 – Calculation phase

In this phase the facilitator will make all calculations in front of the participants in the following order, taking into account the effects of the political event in effect.

a) Debit the costs of extraction.
b) Debit the number of extracted reserves.
c) Debit the cost of exploration of new reserves
d) Credit the new reserves found by exploration in each region.
e) Calculate the total demand for oil
f) Calculate the price of sale for the oil.
g) Credit the income of selling the units.

As said before the cost of extraction is one monetary unit per production unit ($1G/Gb). The cost of exploring a new reserve is calculated by equation 1. Where T is the number of the turn and L is a local factor.

The base demand for oil is given by equation 2. Where T is the number of the turn. Some event cards (wind power, biofuels and Fusion power) can reduce this demand. Each of these cards reduces the demand by twenty production units (20 Gb) for all turns once played, not just for the turn they are played. In the long run all three will probably be in play so that the demand will be reduced by a total of sixty production units (60 Gb).

$$(60+5T)Gb \qquad (2)$$

The selling price of oil is given by equation 3. Where T is the number of the turn, D is the demand; S is the combined supply of all companies, including the independent companies. The Brackets ([ ])represent the function 'integer part of'. If the price is less than 1G$/Gb it should be considered 1G$/Gb to avoid negative or zero prices.

$$(15+T+[(D-S)/5])\$G/Gb \qquad (3)$$

The production of the independent companies is produced randomly by the addition of the results of four six -sided dice, thus varying probabilistically from four to twenty-four (4 to 24) with an average of fourteen (14). However it can be increased by the use of some cards to the result of six six-sided dice.

Example:

Let's suppose that we are in the turn two (T=2) and that the groups produced respectively twenty, eighteen, twelve and ten units (20, 18, 12 and 10 Gb). The independents produced fourteen units (14 Gb).

The demand is seventy units (60+2 x5 = 70Gb). The supply is seventy-four units (20+18+12+10+14 =74 Gb). The selling price is seventeen monetary units per production unit (15+2+[(74-70)/5]= $17G/Gb).

Therefore each company will receive respectively three hundred and forty, three hundred and six, two hundred and four and one hundred and seventy monetary units ($340G, $306G, $204G and $170G).

Phase 4 – End of Turn phase

Once done the calculations the companies must have positive cash. If that is not the case they must sell some reserves at a price of ten monetary units per production unit ($10G/Gb) to the independents until they show positive cash.

The facilitator may at his discretion grant additional money for the group to keep itself in the game without going bankrupt.

EVENT CARDS

There are twelve event cards in the game that allow the players to introduce the unexpected factor in the game that can only be partially planned by the other players.

In the first turn of play no card is played, but from the second turn on there's will always be two cards in play. The renewable energy cards, Shale production, Sub salt Layer, and the Gulf nuclear war card affect the rest of the game once played, not only the turn they have been played.

- **China Crisis** – Revolts in the Xinjiang and Tibet provinces start leading to more revolts in the provinces of Guangdong, Hunan and Manchuria. A widespread crisis in China causes all operations to cease for one turn (four years). No company can extract or explore in China this turn. Planned actions are stopped but the money is not lost.
- **Gulf War** – A war occurs in the Gulf Region, but no WMD is used, allowing the USA to maintain Saudi Arabia outside the main conflict zone. The Gulf region is affected for one turn (four years). Only half of the planned extraction and exploration can be executed. Round fractions down.
- **Gulf Nuclear war** – A war using WMD occurs in the Gulf Region. The war extends for four years and the region ends up nearly destroyed. No extraction or exploration can occur for this turn in the region. All money planned to be used in the region this turn is spent but does not generate any effect. Half of the existing reserves are destroyed, round fractions up. The Location modifier (L) becomes plus one (+1) for

the rest of the game in this region due to the residual effects of radiation, and chemical and biological weapons.

- **SE Asia war** – The discovery of oil reserves in he Spratly islands starts a general war between Vietnam, Philippines, Malaysia and Thailand. Indonesia, China, India and the USA send expeditionary forces to influence the war. This widespread crisis causes all operations to cease for one turn (four years) in the SE Asia region. No company can extract or explore in SE Asia this turn. Planned actions are stopped but the money is not lost.
- **Africa Crisis** – Fundamentalism takes power in Egypt and a war with its neighbor Libya starts. At the same time Nigeria and Angola enter civil wars. The oil operations in Africa are stopped for this turn (four years). No company can extract or explore in Libya and Nigeria/Angola regions this turn. Planned actions are stopped but the money is not lost.
- **Latin America Crisis** – A series of military coups put populist regimes on power in Latin America affecting Brazil, Mexico and Venezuela. These nations have to deals with internal problems as well with their neighbors for a prolonged period. The oil operations in Latin America are stopped for this turn (four years). No company can extract or explore in Brazil and Mexico/Venezuela regions this turn. Planned actions are stopped but the money is not lost.
- **Russian Civil War** – Military coup and a civil war in Russia occur. Intervention comes from all sides like Ukraine, China, India, USA and Germany as the Russians revive the 1918-1921 period once again. The oil operations in Russia are stopped for this turn (four years). No company can extract or explore in Russia/ Poland region this turn. Planned actions are stopped but the money is not lost.
- **Wind Power** – Wind power technology finally reduces its cost enough to become viable against oil energy. It took many decades so that the learning curve reached this point. Many nations begin to massively install wind turbines. Reduce the demand of oil permanently by twenty production units (20Gb) from this turn on.
- **Biofuels** – Third generation biofuels produced from saltwater algae technology finally reduces its cost enough to become viable against oil energy. It took many decades so that the learning curve reached this point. Many nations begin to massively install biofuel plants. Reduce the demand of oil permanently by twenty production units (20Gb) from this turn on.
- **Fusion Power** – Fusion power produced by deuterium technology finally reduces its cost enough to become viable against oil energy. It took many decades so that the learning curve reached this point. Many nations begin to massively install fusion plants. Reduce the demand of oil permanently by twenty production units (20Gb) from this turn on.
- **Shale production** – Horizontal drilling and fracturing have finally reached a point were they are economically viable. Major reserves of shale oil and gas are discovered. Reduce permanently by one the location modifier (L) of Brazil, Russia/Poland, Mexico/Venezuela, USA/Canada, China and Africa.
- **Sub salt layer** – A large reserve of oil under a sub-salt layer is discovered offshore Brazil. The cost of production is still very high but the local State-Owned company (Petrobrás) decided to produce it. Increase permanently the independents production by two six-sided dice (2D6) each turn.