Application of a deterministic- and stochastic approach

on exploration projects

in

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Chapter 1 Introduction

This first chapter provides an introduction into the business of the Oil and Gas industry. By the use of basic geological- and economic principles the main topic of this research will be explained: how should be dealt with uncertainties in exploration well decisions?

1.1 Introduction Research

The worldwide demand for primary energy is expected to increase at an average annual growth rate of 1.2% to 17.376 Million tons of oil equivalent (Mtoe) in 2035. In these projections[1] the fossil fuel share decreases from 82% in 2012, to 76% in 2035, and the renewables share (containing nuclear, hydro, bioenergy and others) increases from 18% to 24% (IEA, 2014). Despite the decreasing share of fossil fuels in future energy consumption, the annual growth rates for gas demand are increasing. A plausible argument is that gas is the cleanest fossil fuel and fits in the transition towards a sustainable energy provision. Renewables should be stimulated, however they cannot satisfy the world's growing demand for energy. Moreover energy supply provided by renewables is intermitting, meaning that gas as cleanest fossil fuel will, given the current options, always be needed to fill the gap.

Natural gas has the largest share in the energy supply of the Netherlands since the discovery of the Groningen Field in the 1960's. Total consumption of the domestic natural gas lied around 50 Billion Cubic Meters (BCM) in 2012. This amount will not be met again in the future, since it has been generally recognized that the production of Groningen gas causes local earthquakes (Focus on Dutch Oil and Gas, 2015). This led to a negative view of Dutch citizens on gas production and forced the government to intervene. The maximum level of gas production was set to 42,5 BCM in 2014. In 2015 the total production from The Groningen Field will not exceed 33 BCM, as the government recently decided. Staatstoezicht op de Mijnen (SodM), a monitoring instance of the Government, advised to reduce gas production as much as possible, as the safety of the Groningen citizens comes first. The minimum level to assure security of supply of 7 million households using Groningen gas for cooking and stoves is 33 BCM. From 2016 it will be seen how to determine a safe and constant production level of gas (www.rijksoverheid.nl).

So far a total of 3345 BCM of gas has been produced in the Netherlands (territory and offshore together). More than 1500 BCM has come from the small fields and approximately 550 BCM is still available (Natural Resources and Geothermal Energy in the Netherlands, July 2015, and Focus on Dutch Oil and Gas, 2015). A uniform classification system, the Petroleum Resource Management System (PRMS) has been adopted in 2013 that helps to determine the future domestic gas production. It distinguishes *reserves*, *contingent resources* and *prospective resources*, all still present in the subsurface (Guidelines for Application of the PRMS, 2011). *Reserves* are defined as discovered gas volumes that are commercially producible. *Contingent resources* are potentially producible, however not yet commercial. The difference between contingent and prospective resources is that the latter needs to be discovered first.

[1] According to the New Policies Scenario defined in the World Energy Investment Outlook 2014

Due to past extensive exploration and production of *hydrocarbons*, the majority of large- and relative easy fields in the Netherlands (but also worldwide) has been explored and produced already. From a geological- and technical perspective a field is labelled as "easy" when hydrocarbons have been found without the need of technical innovations that are required today, to find and produce the challenging fields. Shallow gas production by means of shallow horizontal wells is an example in which sophisticated technology needs to be applied. From a world-perspective it is likely that remaining promising fields will be found at distant locations as deep-water offshore and the Arctic (IEA, 2014). For such operations extensive knowledge and technologies are required and automatically associated with higher costs. Coping with increasing risks and challenges results in rising finding- and development costs per barrel, as was published in the World Energy Investment Outlook 2014 (IEA, 2014). Proper financial predictions are therefore of high relevance, taking these increasing difficulties and uncertainties in the (near) future into account.

This research will focus on the phase of the oil and gas industry where many uncertainties occur: the *exploration* phase. Exploration is the phase prior to *production* and in which decisions are based on assumptions as the field has not been discovered yet. Therefore many factors are uncertain and estimation errors can have a high effect on the economics (Demirmen 2007).

Energie Beheer Nederland (EBN) approaches its current economic analysis for standard exploration decisions *deterministically*. This is a scenario-based approach, where several expectations are being evaluated towards the decision if an exploration well should be drilled or not. It is questioned if this is the ideal way to approach such decisions that are associated with large uncertainties. Perhaps a *stochastic* approach would be of more value to EBN's decision makers, where a Monte Carlo simulation is able to take all uncertainties into account. Given the fact that this industry deals with many uncertainties (geologically, but also economically), a stochastic approach possibly enriches the economic evaluations. This research is of importance to EBN, as it will try to explore whether a stochastic approach would be beneficial to the decision makers at EBN. Exploration decisions between 2010 and 2014 have been analysed to investigate the benefit(s) of the stochastic approach.

The research question of this study is defined as:
Does a more advanced exploration decision process lead to a better quality result?

An *advanced exploration decision process* is defined here as a stochastic- instead of a deterministic approach of the economic analysis for exploration well decisions. A result is of better quality when insights in uncertainties are improved, guiding the decision process.

The research question will be answered with a set of sub-questions:

a) *Is EBN willing to change from a deterministic- to a stochastic approach?*
b) *How much do the results of a deterministic- and stochastic approach differ?*
c) *What is the added value of a stochastic approach for the decision making process at EBN?*

The remainder of this report contains information that is (temporarily) confidential.