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A realistic and integrated model for evaluating oil sands development with Steam Assisted Gravity Drainage technology in Canada

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HIGHLIGHTS

- Developed an oil sands with Steam Assisted Gravity Drainage evaluation model.
- Conduct a feasibility study of a typical oil sands development with new model.
- Quantify the effects of critical parameters on the economics of a development.

ARTICLE INFO

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ABSTRACT

Oil sands resource is the third largest oil reserve, and 70% of the oil sands are in Canada. The emerging of Steam Assisted Gravity Drainage technology has made the commercial development of oil sands economically feasible. However, with the recent oil price crash, the development of oil sands has faced an uphill battle. A realistic and integrated evaluation model is highly needed to overcome difficulties from the low oil price and provide meaningful and valuable information for operators as well as investors to make the right decision. The existing evaluation models have considerable limitations (i.e., the incapability of evaluating integrated oil sands development with Steam Assisted Gravity Drainage technology, the lack of investigation into the input parameters with historical data, and ignoring the effect of the subsurface reservoir, etc.). This study developed an integrated evaluation model through the analyses of a significant amount of actual historical data. This integrated model includes six subcomponent models, ranging from the subsurface reservoir to infield flowline. Data from 35 Canadian oil sands development with 15 internal and external parameters were collected and investigated. The oil price effect was analyzed and quantified through simulations. The breakeven Western Canada Select oil price of $39/bbl. (equal to the West Texas Intermediate oil price of $55/bbl.) and other key price points and distributions were identified. Also, the top seven geological and technical parameters that contribute 86% of the net present value variations were identified and investigated. These quantified effects of external and internal parameters are useful findings for decision making. Considering various price scenarios and uncertainties of the input parameters, this study has concluded that developing oil sands resources with the Steam Assisted Gravity Drainage technology is economically feasible and socially beneficial after we take all stakeholder interests into consideration, which is true even with the sustainable and realistic oil price in the foreseeable future.

1. Introduction

Oil sands, a type of unconventional petroleum resource, are confirmed as the third largest oil reserve. The total estimated oil sands reserve is 170 billion barrels in Alberta, Canada [1]. Oil sands, a mixture of bitumen, sands, water, and clay, have characteristics of high viscosity greater than 10,000 cp. and a low API gravity [2]. Such unfavorable characteristics had prevented oil sands from becoming a

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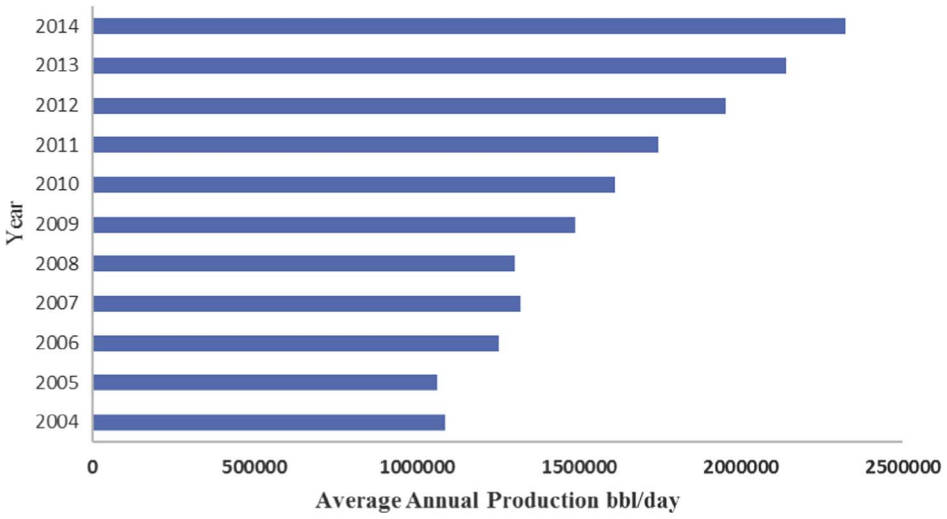

Fig. 1. Annual production from oil sands projects in Alberta [3].

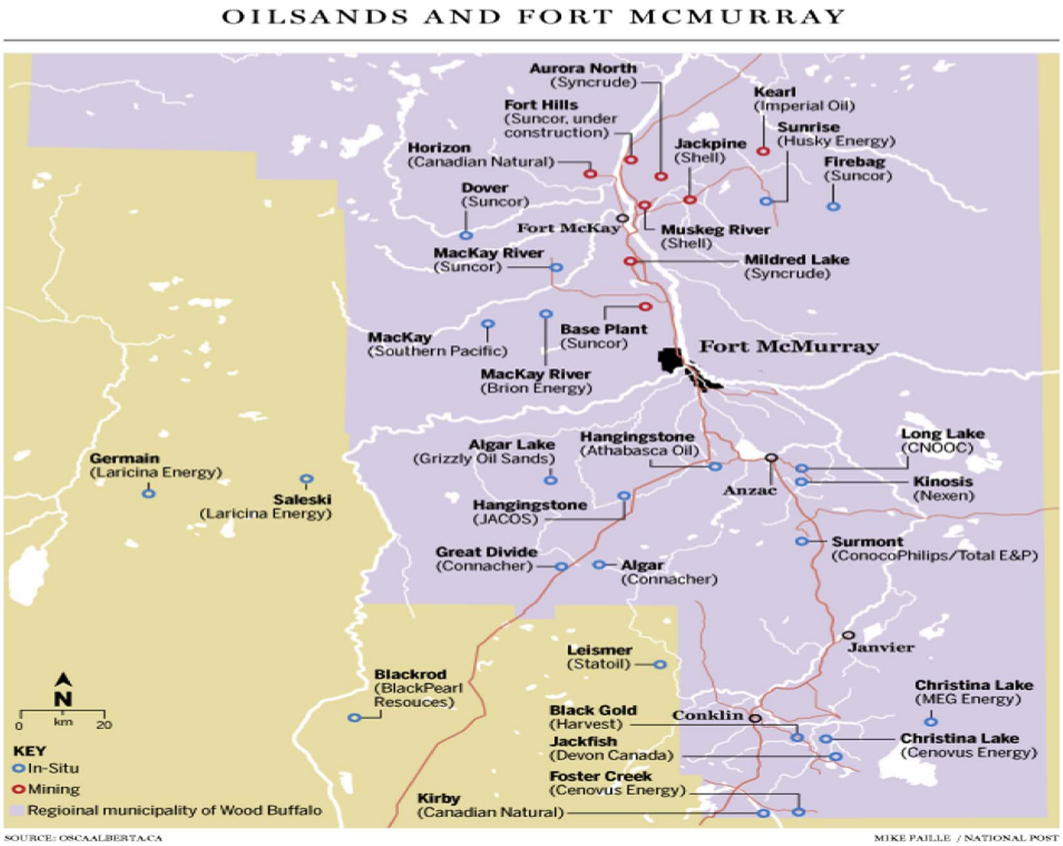

Fig. 2. Oil sand project map in Alberta [3].

commercial energy source for a long time. With the advancement of technology, the business development of oil sands has become feasible. The oil sands production in Alberta has been significantly increased from about 1 million bbl. /d to 2.4 million bbl. /d between 2004 and 2014. This is equivalent to an annual growth rate of 8% (Fig. 1). By 2014, about 30 oil sands development with an average investment of more than 1 billion dollars have been developed in Fort McMurray, Alberta (Fig. 2). However, the recent plunge in the crude oil price from more than $100/bbl. to the lowest level of just above $30 /bbl. has drastically changed the oil sands development situation. Capital spending was reduced to $23 billion in 2015 from $34 billion in 2014 [3]. Also, about $60 billion of new or expansions of existing oil sands projects were delayed or even canceled. Furthermore, many oil companies cut production and laid off employees to overcome capital constraints. With the low oil price scenario, understanding the economic and technical drivers of oil sand developments as and developing a suitable and effective method to evaluate the feasibility of oil sands projects are critical for the sustainable development of Canadian oil sands in the future.

The oil sands are mainly extracted with two approaches: mining and in-situ methods. The selection of method mostly depends on the depth of the deposit. As shown in Fig. 3, shallow oil sand deposits can be accessed through mining, which accounts for about 20% bitumen production in Canada; the rest of the oil sands are extracted with in-situ methods. To date, two major types of in-situ methods have been developed: cyclic steam stimulation (CSS) and Steam Assisted Gravity