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Economic appraisal of shale gas plays in Continental Europe

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HIGHLIGHTS

- Economic feasibility of five European shale gas plays is assessed.
- Polish and Austrian shale plays appear profitable for P90 assessment criterion.
- Posidonia (Germany), Alum (Sweden) and a Turkish shale play below the hurdle rate.
- A 10% improvement of the IRR by sweet spot targeting makes all plays profitable.

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ABSTRACT

This study evaluates the economic feasibility of five emergent shale gas plays on the European Continent. Each play is assessed using a uniform field development plan with 100 wells drilled at a rate of 10 wells/year in the first decade. The gas production from the realized wells is monitored over a 25 year life cycle. Discounted cash flow models are used to establish for each shale field the estimated ultimate recovery (EUR) that must be realized, using current technology cost, to achieve a profit. Our analyses of internal rates of return (IRR) and net present values (NPVs) indicate that the Polish and Austrian shale plays are the more robust, and appear profitable when the strict P90 assessment criterion is applied. In contrast, the Posidonia (Germany), Alum (Sweden) and a Turkish shale play assessed all have negative discounted cumulative cash flows for P90 wells, which puts these plays below the hurdle rate. The IRR for P90 wells is about 5% for all three plays, which suggests that a 10% improvement of the IRR by sweet spot targeting may lift these shale plays above the hurdle rate. Well productivity estimates will become better constrained over time as geological uncertainty is reduced and as technology improves during the progressive development of the shale gas fields.

1. Introduction

There is a growing interest in the assessment of the world's shale gas resource potential, which has intensified regional exploration efforts that must establish the presence and volume of prospective natural gas resources. US shale gas fields provide important guidance for the economic development of shale gas wells in emergent shale plays elsewhere in the world. A principal reason why the development of shale plays remains economically risky is that the estimated ultimate recovery (EUR) is poorly constrained during the early stages of field development.

We model the economic potential of five potential European shale gas fields. Not all shale gas plays are equal, and reservoir quality varies within the plays and between the plays as has become apparent from US shale plays. Fig. 1a provides a concise overview of the major US shale gas growth areas [1]. By 2009, the production of US domestic gas from unconventional resources (tight sands, coal beds and shale) surpassed the domestic output of conventional gas [2]. By 2012, shale gas accounted for over half of all the US gas produced from unconventional (or continuous) resources. Fig. 1b shows that the marginal breakeven costs for US shale gas basins differ [3], which is a consequence of variations in well productivity (due to intrinsic petro-physics of the reservoir and the variation in well effectiveness) and differences in field development cost.

This study makes a first attempt to evaluate the economics of five potential shale gas plays in Europe (Austria, Germany, Poland, Sweden and Turkey). Well productivity type curves are established for each play based on an earlier review of estimated ultimate recovery (EUR) for the plays [4]. Decline curve analysis provides the well productivity model that fits the prior published EUR data. Subsequently, the net present value (NPV) and internal rate of return (IRR) of each shale play are calculated by applying discounted cash flow analysis, using representative inputs for gas price, pro-

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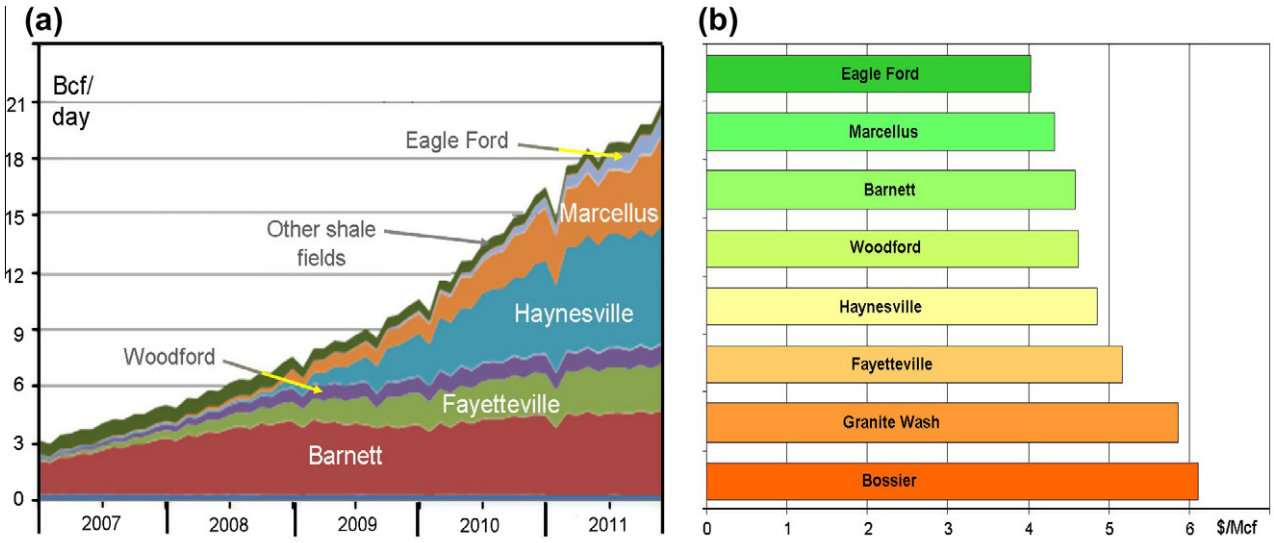

Fig. 1. (a) Major US shale gas plays and production since 2000 [1]. (b) Breakeven marginal prices for major US shale gas play, duly accounted for or limited to "best" well performance. (*Data source*: Bloomberg & Credit Suisse [3]).

duction cost, taxes, depreciation and discount rate. The sensitivity of IRR and NPV to variations in EUR is modeled for each play, which thus provides the minimum EUR for which wells are economic – a directive for 'sweet spot targets'. A stochastic approach that accounts for the spatial spread of well productivities is included, using production volume probabilities P10–P50–P90. The spread in NPV and IRR related to the well productivity uncertainty range provides an indication for the risk taken when only few wells are drilled and provides a screening criterion for selecting the best field development opportunities.

2. European shale plays

Europe's unconventional gas resources in place were first ranked in a global perspective by Rogner [5], who estimated some 1255 trillion cubic feet (Tcf) gas in place from the following unconventional resources: shale gas: 549 Tcf; tight sands: 431 Tcf; and coal-bed methane: 275 Tcf. Europe ranks at the lower end of global unconventional resource potential, with only 4% of the worldwide total (Asia and North America lead, with respectively 30% and 25% of GIP). This is partly due to the exclusion of Poland, Hungary and Romania in Rogner's assessment of 1997 [5]; appraisals for these countries were not available at that time.

The technically recoverable shale gas volumes for Europe were estimated to range between 150 and 200 Tcf by WoodMacKenzie [6]. CERA [7] considered technically recoverable shale gas to range between 106 to 423 Tcf (3–12 Tcm), and the US Department of Energy raised this to 18 Tcm [8]. This number also has been confirmed in resource appraisals by BGR [9], Medlock et al. [10] and in the review by McGlade et al. [11]. Fig. 2a places the shale gas resource estimates in perspective by comparison to Europe's three major producing conventional gas fields (Groningen in Netherlands; Troll and Ormen Lange on Norway's Continental Shelf). Fig. 2b confirms that the TRR estimates differ greatly per country:

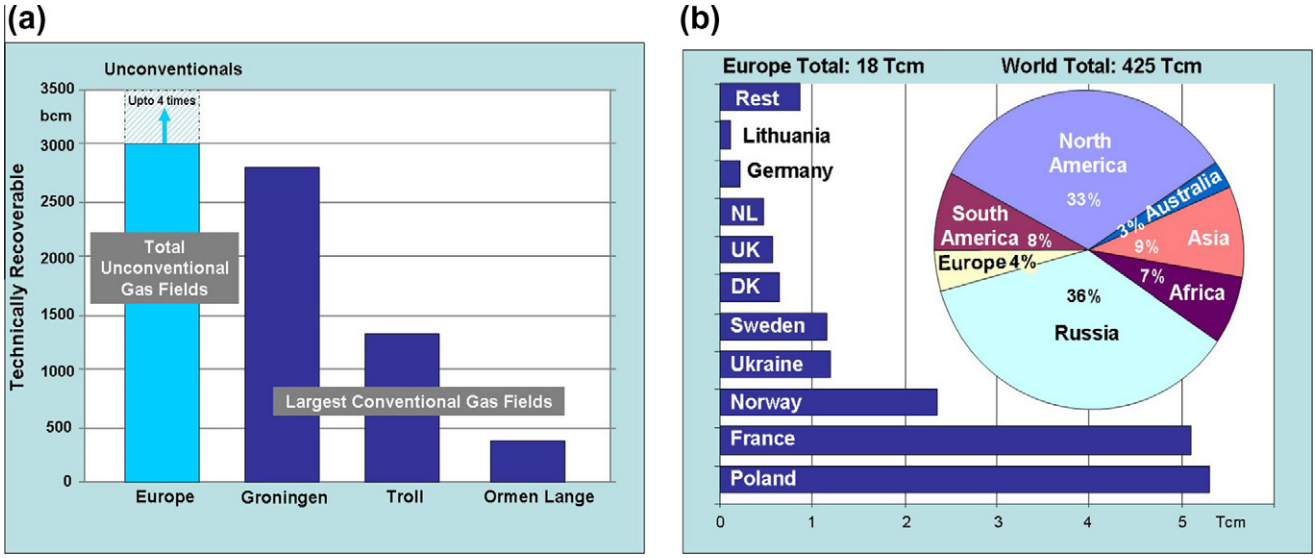

Fig. 2. (a) Relative sizes of Europe's largest conventional gas fields (Groningen, Troll and Ormen Lange Gas Fields), and an early estimate of 12 Tcm for Europe's total recoverable unconventional gas. (b) World shale gas inventory of 2011 estimates 425 Tcm recoverable resources, of which only 18 Tcm (4%) occurs in Europe. The country spread of the 18 Tcm is indicated by the horizontal bars (*Source*: DOE/EIA [8]; Weijermars and McCredie [12]).