



NORWEGIAN PETROLEUM
DIRECTORATE

Evaluation of reserve growth for oil - 2005-2014

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1. SUMMARY

A review by the Norwegian Petroleum Directorate reveals the good work carried out to increase the resource base on the Norwegian Continental Shelf over the past ten years. There is more oil left to produce from fields and discoveries now than there was in 2005, and it is also assumed that there is more oil left to discover than was the case ten years ago.

In 2005, the Norwegian Petroleum Directorate launched the goal for oil reserves to grow by 800 million Sm³, or 5 billion barrels, over the course of ten years. A review of achieved results shows that reserve growth fell somewhat short of this objective. If the Plan for Development and Operation (PDO) for Johan Sverdrup had been submitted by 2014, the goal would have been achieved with a solid margin.

Over the course of this decade, the fields that formed the basis for the goal in 2005 have seen reserve growth more or less in line with expectations. The Norwegian Petroleum Directorate had hoped for even more robust growth, but this did not materialise, despite the high activity level. However, additional opportunities have been identified on the fields and, at the turn of the year, there was just as much oil left to produce as what has been delivered over the past ten years. The potential for reserve growth is greater now than it was ten years ago.

The discoveries that formed the basis for the goal in 2005 have achieved greater reserve growth than expected, despite the fact that less than half have been approved for development so far. In the discoveries that were approved for development after the goal was set, the resource estimate for recoverable oil has nearly doubled.

There has been a considerable increase in exploration activity since 2005, and vast oil volumes have been proven. The contribution to reserve growth is modest in relation to the resources discovered, as it takes time from when a discovery is made until a development decision is in place. Only a small share of the resources discovered have been matured up to reserves with a development decision.

2. INTRODUCTION

In 2004, the Norwegian Petroleum Directorate had long been impatient with the lack of follow-through of projects on the Shelf, both to improve recovery from existing fields and for developing discoveries. As a result of this, a goal to increase oil reserves by 800 million Sm³ over the next ten years was launched in the report “Petroleum resources on the Norwegian Continental Shelf 2005”.

This report also summarises the background for the reserve growth goal, and provides definitions for key terms. It also shows how the resource situation for oil in fields and in discoveries has changed in the past ten years.

The discussion relating to growth in the total oil reserves is divided into three main sources; the fields that were operational or had a development decision in place when the goal was presented (hereinafter called basis fields), the discoveries that had been made (basis discoveries), but with no development decision yet, and contributions from discoveries made after 2004.

3. TERMS

Reserves

Resources are classified as reserves, for example when a discovery has been approved for development by the licensees. We have chosen to set this time for when the Plan for Development and Operation (PDO) is submitted. In addition, the remaining sellable volumes that are slated for production from a field are classified as reserves. The reserve estimate is revised on an annual basis, and will normally decline as the fields produce. Beyond deductions for produced volumes, the reserve estimates will vary depending on development in reservoir understanding, new measures adopted and assumptions regarding future activity level on the fields.

The terms *total* reserves or *original* reserves are also used in many contexts. This is the sum of what has been sold and the reserves, and reflects total recoverable approved volumes from the fields. In order to follow the development on fields over time, the total reserves are used to analyse resource utilisation from the fields.

The estimate for the scope of the total reserves in the various fields is uncertain. The Norwegian Petroleum Directorate publishes expectation values. This means that it is equally probable that the reserves will increase as decrease without the decision to implement new measures.

Contingent resources

Resources in fields and discoveries are classified as contingent when a production decision has not yet been made. In order to be classified as reserves, a production decision is required.

Resource accounts

The Norwegian Petroleum Directorate’s resource accounts provide an annual overview of reserves, contingent and undiscovered resources on the Norwegian continental shelf. The accounts are a distribution of the petroleum resources on the Shelf according to resource categories (project maturity) and sea areas. It also provides an overview of historic production and reserves per field, as well as the resource estimate per discovery.

Prognosis

The term prognosis in the report is used for the resources that were identified in the 2004 resource accounts and estimate for when a decision would be made regarding these resources, thus making them reserves.

Reserve growth

Gross total reserve change, i.e. change in the total reserves over time. This report describes the change between the 2004 and 2014 resource accounts. The goal period runs from 2005 to 2014.

Basis field and basis discovery

When discussing the changes in the ten-year period, the basis fields are those that had a development decision or were in production at the beginning of 2005. The basis discoveries are discoveries made before 2005.

Oil

Crude oil is primarily produced from oil fields and sold as oil. Part of the oil that is sold comes from condensate production, associated with gas. This is often mixed into the crude oil stream in the processing and transport systems and is defined as oil. Normally, this will be clear at the time of development, but there are also examples of the product definition changing during the production period.

4. BACKGROUND FOR THE GOAL

In 2004, the Norwegian Petroleum Directorate had long been impatient with the lack of follow-through of projects on the Shelf, both to improve recovery from existing fields and for developing discoveries. As a result of this, a goal to increase oil reserves on the Norwegian Shelf was presented in the report “Petroleum resources on the Norwegian Continental Shelf 2005”.

The goal for reserve growth of five billion barrels – 800 million Sm³ oil – was set on the basis of historic reserve growth, knowledge about fields and discoveries and the potential on the shelf.

The basis for the goal was the contingent resources in the 2004 resource accounts. There was a total of 582 million Sm³ oil, distributed between 403 million Sm³ in fields and 179 million Sm³ in discoveries. The objective was to be achieved through project decisions for all of the contingent resources, and new projects totalling 218 million Sm³ would be identified and approved during the period. This supplement would come as a result of new, improved and cost-effective production methods, as well as resource increases in the discoveries and development of new discoveries.

5. GOAL ACHIEVEMENT

The Norwegian Petroleum Directorate has followed the reserve development and compared the annual growth with the goal. The results are shown as contributions from the basis fields, contributions from the basis discoveries and contributions from discoveries made later. It emerges from Figure 1 that the goal set in 2005 was not achieved. The result was a reserve growth of 676 million Sm³ oil, or 85 percent of the 800 million Sm³ goal. (Johan Sverdrup is not included in the reserve growth because the development plan was submitted in 2015 – i.e. after the goal period).

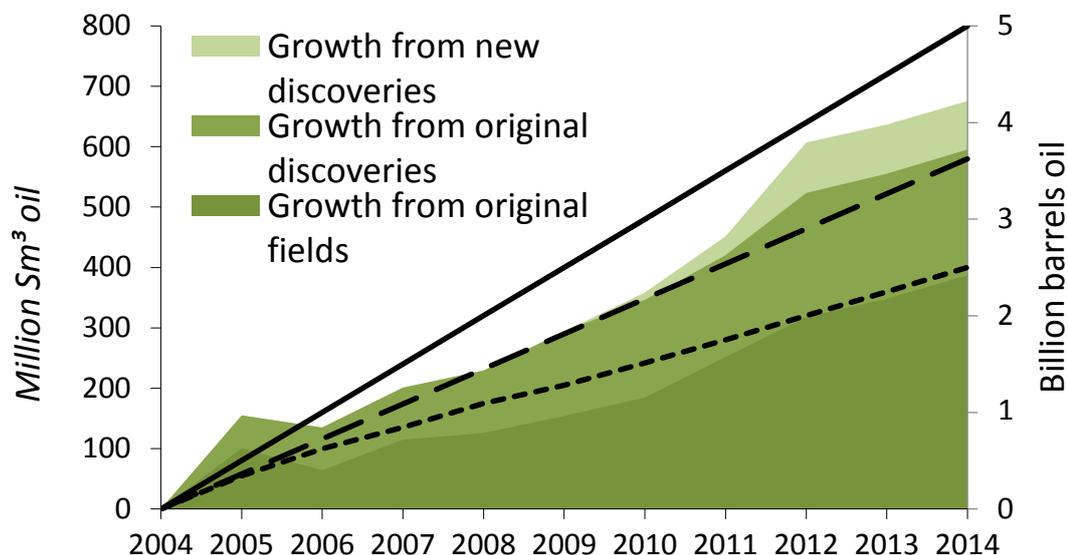


Figure 1 Reserve growth during the goal period

403 million Sm³ oil had been identified as contingent resources in fields in 2004. These resources were distributed over small and large measures; from an additional well to new facilities. After ten years, the reserve growth was 388 million Sm³ oil, see Figure 2. 179 million Sm³ oil was proven in the 62 basis discoveries. Twenty-eight of these discoveries have been approved for development during the period, and contributed 208 million Sm³ oil reserves, i.e. more than predicted. Development of subsequent discoveries has also contributed a reserve growth of 80 million Sm³ oil.

The following section presents the reserve growth in the three discussed main groups.

5.1 Basis fields

There was good development on the fields from 2005 to 2014. Several new facilities have been added to already producing fields; five platforms and 19 larger subsea templates. About 1000 new wellbores have also been drilled for production and injection.

As previously mentioned, a total of 403 million Sm³ oil was indicated as contingent resources in fields at the end of 2004. Of this, 272 million Sm³ oil was in firm projects, 125 million Sm³ in potential – not firm – measures for improved recovery and immature additional resources totalling 6 million Sm³ oil.

The reserve growth from basis fields was 388 million Sm³ oil during the 2004-2014 period. This is 96 per cent of the contingent resources that were identified on the fields in the 2004 resource accounts. Figure 2 shows the reserve growth in the fields and the development in the contingent resources since 2005.

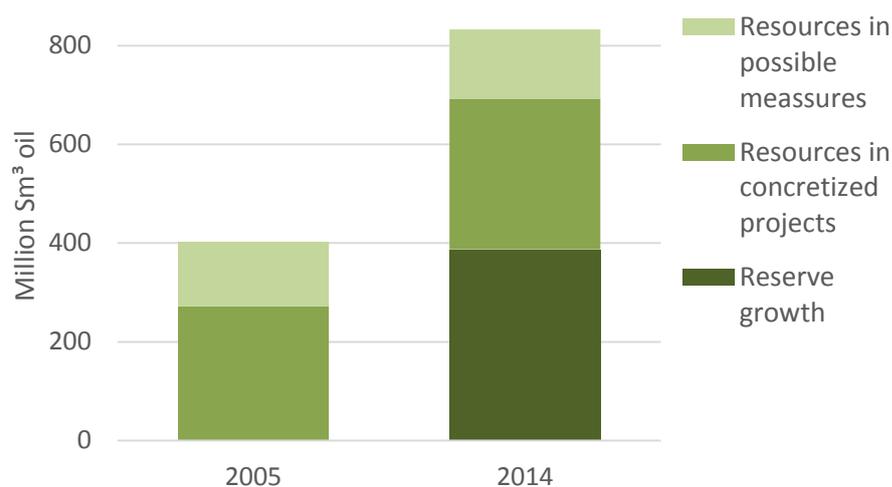


Figure 2 Reserve growth and change in contingent resources for the basis fields

The figure also shows that even greater contingent resources have now been identified in the basis fields compared with ten years ago. The 2014 resource accounts have 445 million Sm³ of contingent oil resources in the basis fields, or 42 million Sm³ more than in 2004. This comes in addition to the resources matured into reserves during the 10-year period.

Of the 67 basis fields, 40 had reserve growth totalling 433 million Sm³, while 12 fields had a reduction totalling 45 million Sm³. Figure 3 shows fields where the change is greater than 5 million Sm³.

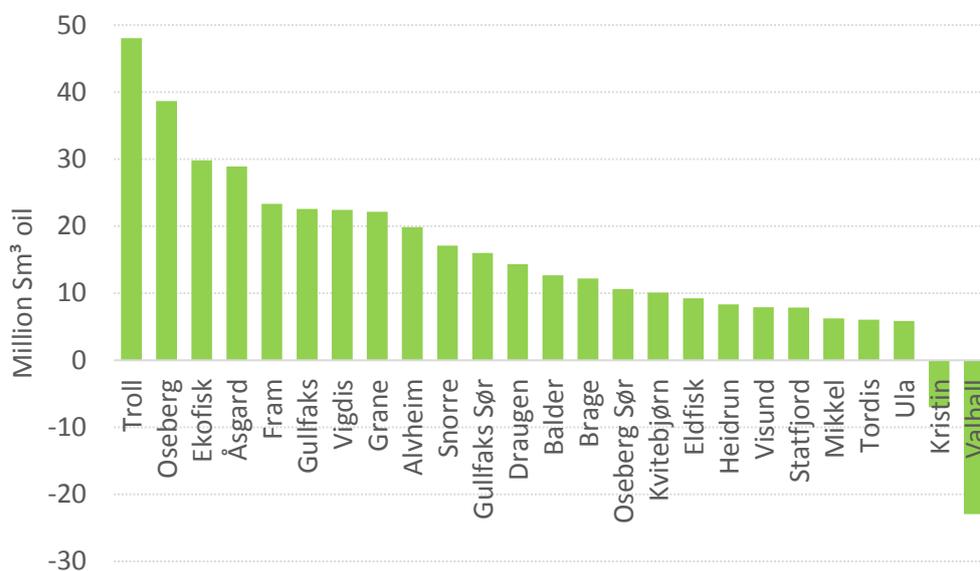


Figure 3 Fields with the largest change in reserves since 2004

There are many reasons for the considerable reserve growth on multiple fields, but the drilling of wells, increased lifetimes and improved knowledge regarding the fields are common denominators. The resource base increased during the period on some fields as the result of a decision to develop new deposits in the fields.

For Valhall, which had the largest reserve reduction during the period, a new reservoir model in 2006 revealed that the reservoir was more complex and smaller than previously assumed. Following this, the field has seen minor, but positive growth in oil reserves.

It is important that work continues to progress on identifying new possibilities on the fields, clarifying these possibilities and making decisions. Figure 4 shows the estimates for expected future oil production from the fields in 2005 and the status in 2014, including the oil produced and sold since 2004.

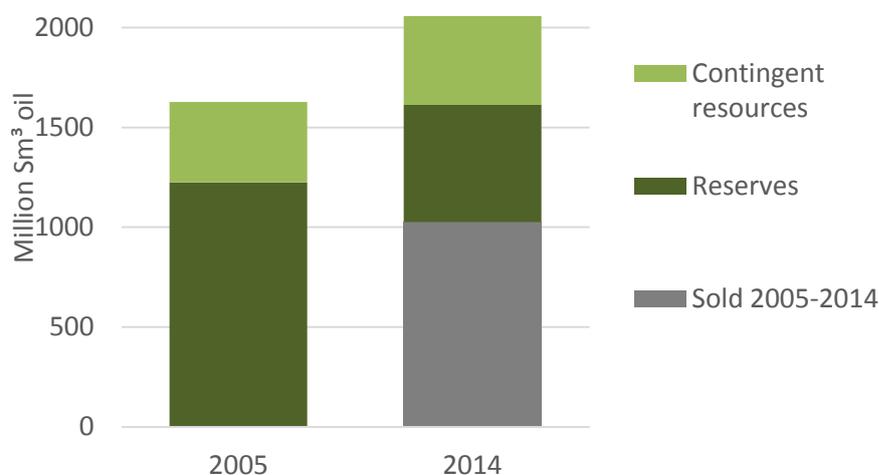


Figure 4 Change in remaining and sold oil in basis fields since 2004

The current estimate shows that there is just as much oil left to produce from the basis fields as has been produced over the past ten years.

5.2 Basis discoveries

In 2005, there were 62 discoveries without a development decision, 40 of these discoveries had oil resources. The total estimate for contingent resources in discoveries was 179 million Sm³ oil. Up to 2014, development decisions have been made for 28 of these. In 2005, the oil resources in these 28 discoveries were estimated at 112 million Sm³. The growth of nearly 100 million Sm³ is equally distributed between discoveries registered with oil resources and discoveries that for various reasons did not have an estimate for oil resources in the 2004 resource accounts. Development of the basis discoveries has resulted in 27 new fields with total reserves amounting to 208 million Sm³ oil, see Figure 5.

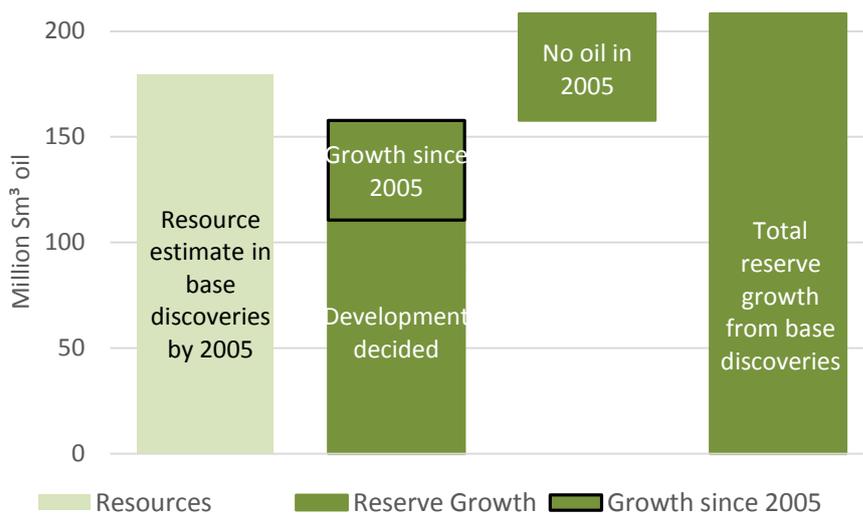


Figure 5 The reserve growth from the 62 basis discoveries came from 28 basis discoveries that have been approved for development and from discoveries that did not have oil resources at 2005.

The growth in oil resources in basis discoveries with oil is primarily the result of more knowledge up to the development decision. Data acquisition, optimisation of development solutions and drainage strategy have been key. The reserves in many of these also increased after the PDO was approved, through improved reservoir understanding, projects and additional resources.

The most common reasons for why there is now oil in discoveries that did not have oil resources in 2005, is that oil was subsequently found when delineating the discoveries, and that the concept decision in connection with development resulted in condensate resources being sold as oil. There are also discoveries that were not shown in the resource accounts, either because they were registered as additions to fields, or as discoveries where development was not considered probable.

When discoveries are approved for development, they receive a field status and field name. Figure 6 shows the total oil reserves in the largest fields based on development of the basis discoveries. About half of these fields have more than 5 million Sm³ of recoverable oil and constitute 90 per cent of the reserve growth from the basis discoveries.

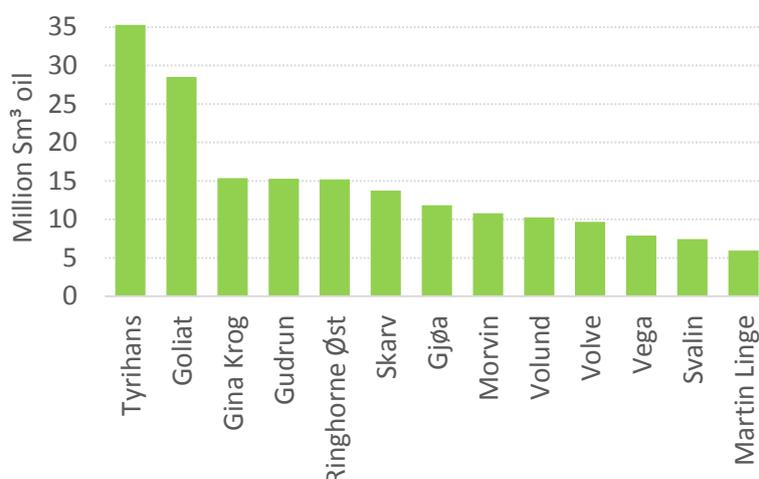


Figure 6 Total reserves in the largest oil fields based on the basis discoveries

Thirty-four of the basis discoveries were not approved for development¹ in the ten-year period. In the 2004 resource accounts, the oil resources in these 34 discoveries constituted 68 million Sm³ oil. The current estimate for oil resources in discoveries from before 2005 that were not approved for development is 75 million Sm³ oil.

5.3 The new discoveries

Discoveries made after 2004 have so far led to development decisions for 13 new fields, and have contributed total reserve growth of 80 million Sm³ oil. The majority of the oil reserves are in a few fields with stand-alone development solutions. Figure 7 shows the reserve growth for these new fields. Edvard Grieg, Ivar Aasen and Knarr represent more than 75 per cent of the reserves from new discoveries with development decisions.

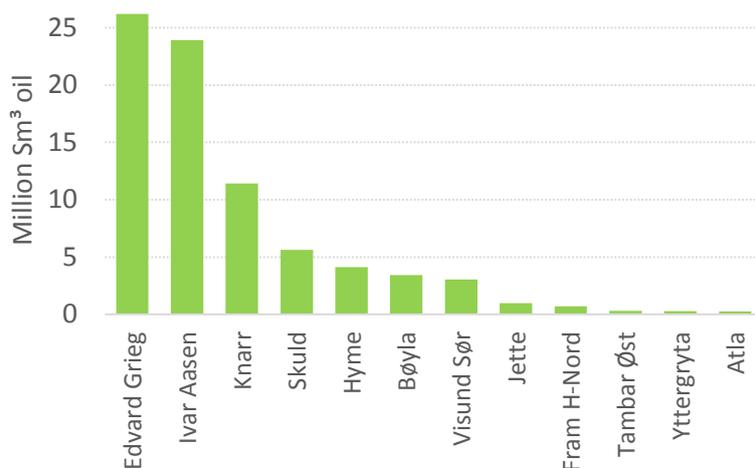


Figure 7 Fields discovered after the reserve growth goal was formulated

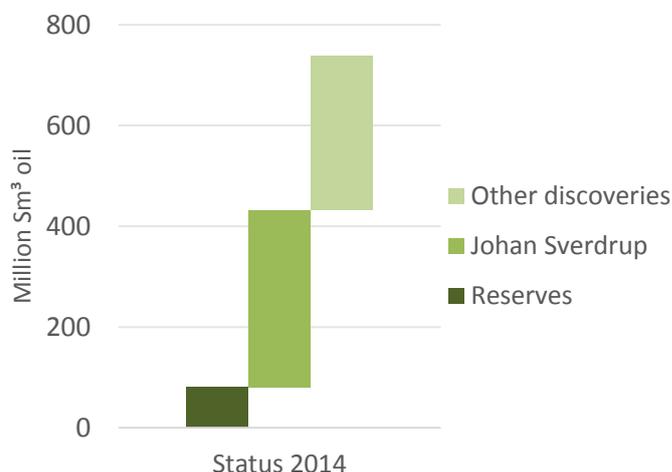


Figure 8 provides an overview of reserves and resource estimates in oil discoveries made after 2004. In addition to the 13 fields with development decisions, 64 discoveries without development decisions at the turn of the year are recorded with 658 million Sm³ of contingent oil resources. As emerges from the figure, more than half of these resources relate to Johan Sverdrup.

¹ 33/9-6 Delta had test production during the 2009-2014 period. The production has generated reserves that are included in the growth. The conclusion from the test production was that development beyond the single well from the test production was not relevant.

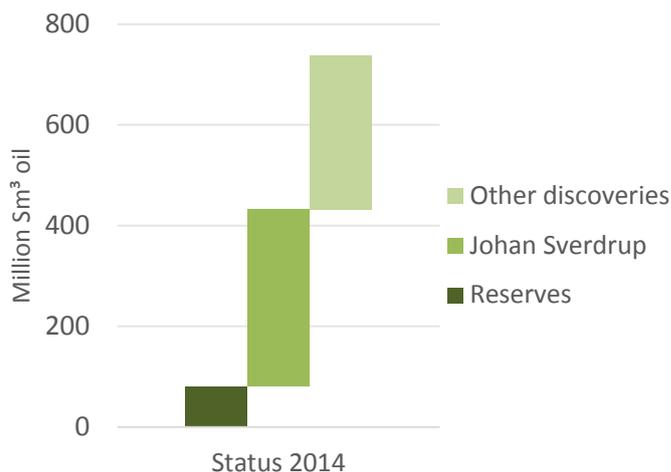


Figure 8 Distribution of oil resources discovered after 2004

The Plan for Development and Operation of Phase I for Johan Sverdrup was submitted to the authorities in the winter of 2015. If the plan had been delivered 44 days earlier, i.e. in 2014, the goal for reserve growth during the ten-year period would have been far exceeded.

6. RESOURCE ACCOUNTS

There has been an increase in the estimated oil resources over the past ten years. Figure 9 shows that the estimate for remaining production has increased by 200 million Sm³ oil. More than 1100 million Sm³ of oil have been produced and sold during the period, i.e. 7 billion barrels. Compared with the 2004 resource accounts, proven oil resources have increased by 73 per cent.



Figure 9 Comparison of resource accounts for proven oil at 31 Dec. 2004 and 31 Dec. 2014.

In 2005, the estimate for proven remaining oil production was 1807 million Sm³. Now, in 2015, the corresponding estimate is 1012 million Sm³ oil. This entails a growth of 205 million Sm³ oil, despite the fact that 1115 million Sm³ oil was sold during the period.

Though many discoveries have been made since 2004, the estimate for undiscovered oil on the Norwegian Continental Shelf has only increased to a small extent during the period.

7. NEW GOAL FOR RESERVE GROWTH

The NPD launched a new reserve growth goal in the “Petroleum resources on the Norwegian Continental Shelf 2014 – Fields and discoveries” report.

The goal is reserve growth of 1200 million Sm³ oil or 7.5 billion barrels during the ten-year period from 2014-2023. The goal and prognoses for reserve growth in fields and discoveries, respectively, are shown in Figure 10.

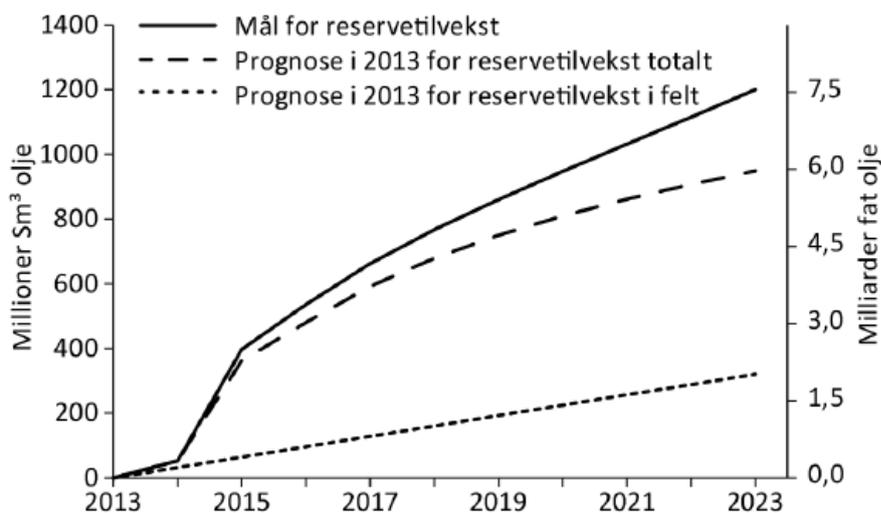


Figure 10 The NPD's reserve growth goal, Resource Report 2014.

Oil reserves increased by 40 million Sm³ in 2014. So far in 2015, plans for development and operation of Johan Sverdrup Phase 1 and Maria have been submitted.