



NORTH SEA STUDY OCCASIONAL PAPER
No. 120

**The Effects of Budget 2011 on Activity
in the UK Continental Shelf**

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and
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April, 2011

DEPARTMENT OF ECONOMICS

NORTH SEA ECONOMICS

Research in North Sea Economics has been conducted in the Economics Department since 1973. The present and likely future effects of oil and gas developments on the Scottish economy formed the subject of a long term study undertaken for the Scottish Office. The final report of this study, The Economic Impact of North Sea Oil on Scotland, was published by HMSO in 1978. In more recent years further work has been done on the impact of oil on local economies and on the barriers to entry and characteristics of the supply companies in the offshore oil industry.

The second and longer lasting theme of research has been an analysis of licensing and fiscal regimes applied to petroleum exploitation. Work in this field was initially financed by a major firm of accountants, by British Petroleum, and subsequently by the Shell Grants Committee. Much of this work has involved analysis of fiscal systems in other oil producing countries including Australia, Canada, the United States, Indonesia, Egypt, Nigeria and Malaysia. Because of the continuing interest in the UK fiscal system many papers have been produced on the effects of this regime.

From 1985 to 1987 the Economic and Social Science Research Council financed research on the relationship between oil companies and Governments in the UK, Norway, Denmark and The Netherlands. A main part of this work involved the construction of Monte Carlo simulation models which have been employed to measure the extents to which fiscal systems share in exploration and development risks.

Over the last few years the research has examined the many evolving economic issues generally relating to petroleum investment and related fiscal and regulatory matters. Subjects researched include the economics of incremental investments in mature oil fields, economic aspects of the CRINE initiative, economics of gas developments and contracts in the new market situation, economic and tax aspects of tariffing, economics of infrastructure cost sharing, the effects of comparative petroleum fiscal systems on incentives to develop fields and undertake new exploration, the oil price responsiveness of the UK petroleum tax system, and the economics of decommissioning, mothballing and re-use of facilities. This work has been financed by a group of oil companies and Scottish Enterprise, Energy. The work on CO₂ Capture, EOR and storage was financed by a grant from the Natural Environmental Research Council (NERC) in the period 2005 – 2008.

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1. Introduction

The investment environment in the UK Continental Shelf (UKCS) is constantly changing. This reflects the effects of several factors including major changes in (1) oil and gas prices (and expectations regarding their future behaviour), (2) exploration success rates, (3) investment and operating costs, (4) costs and availability of finance, and (5) the tax system. In recent years tax reliefs were introduced for investments in fields characterised by heavy oil, HP/HT or gas in remote locations. Budget 2011 increased the Supplementary Charge (SC) from 20% to 32%. The result is that the total tax rate on PRT-paying fields is increased from 75% to 81% and on non-PRT paying fields from 50% to 62%. Relief for decommissioning is not allowed against the increased element of the SC resulting in total relief being at 69% on PRT-paying fields and 50% on non-PRT-paying ones. The notion of a fair fuel stabiliser is introduced whereby the surcharge on the SC rate could be reduced when the oil price falls below \$75. No details of the schedule of tax rate reduction is given and no mention is made of gas prices.

There are several possible effects of the tax increase. The most obvious is to render some new investments non-viable. These could be new fields or incremental projects. The tax system is essentially a proportional or flat-rate one (except in cases where the field allowances apply), and

projects which are modestly or marginally profitable under the pre-budget system can in principle be rendered non-viable as the result of Budget 2011. The investment hurdle issue is discussed in Section 2. There are over 350 undeveloped discoveries in the UKCS covering a very wide range of expected returns, varying from highly profitable to quite uneconomic. In these circumstances the potential exists for projects being rendered non-viable as a result of a substantial increase in the flat-rate or proportional tax rate. Returns to exploration are also reduced as a consequence of Budget 2011 and in principle the effort could be reduced.

As a result of the reduction in industry net cash flows the ability of investors to finance exploration and development projects is reduced. The UKCS is increasingly reliant on medium and small companies to undertake exploration and development and they rely much more on external finance (both debt and equity) to finance their investments than the majors. Providers of finance will see that the returns to prospective investments are reduced by the tax increase and will react accordingly with respect to their willingness to provide finance. Banks are generally very cautious in their assessment of proposals for funding projects. Currently one leading bank employs an oil price of \$52 when assessing the returns to a prospective project.

The tax increase applies to tariff income as well as production income. Third party tariffing is increasingly common in the UKCS and is generally to be encouraged to keep down the total costs of developing new fields and projects. A significant increase in tax could introduce upward pressure on tariffs.

The tax increase can in principle increase the perceived political risk of doing business in the UKCS. A conventional response to this is to increase the threshold return from new investments to reflect this increased risk. It will be recalled that there have been three significant tax increases over the last decade.

While these possible effects exist the extent of them can only be discovered by empirical investigation. In this paper extensive economic modelling is undertaken to ascertain the size of the effects on new field developments and incremental projects. The modelling was undertaken under pre- and post-Budget 2011 terms. It was assumed for simplicity that the exploration effort was not reduced as a result of the tax increase, though some negative effect is very likely.

The outputs highlighted are changes in production of oil and gas, field investment, operating costs, decommissioning costs, and tax revenues/net cash flows over a long term period.

2. Methodology and Data

The projections of changes in production and expenditures have been made through the use of financial simulation modelling, including the use of the Monte Carlo technique, informed by a large field database validated by the relevant operators. The field database incorporates key, best estimate information on production, and investment, operating and decommissioning expenditures. These refer to nearly 340 sanctioned fields, 177 incremental projects relating to these fields, 34 probable fields, and 46 possible fields. These unsanctioned fields are currently being examined for development. An additional database contains 252

fields defined as being in the category of technical reserves. Summary data on reserves (oil/gas) and block locations are available for these. They are not currently being examined for development by licensees.

Monte Carlo modelling was employed to estimate the possible numbers of new discoveries in the period to 2036. The modelling incorporated assumptions based on recent trends relating to exploration effort, success rates, sizes, and types (oil, gas, condensate) of discovery. A moving average of the behaviour of these variables over the past 5 years was calculated separately for 6 areas of the UKCS (Southern North Sea, (SNS), Central North Sea (CNS), Moray Firth (MF), Northern North Sea (NNS), West of Scotland (WOS), and Irish Sea (IS)), and the results employed for use in the Monte Carlo analysis. Because of the very limited data for WOS and IS over the period judgemental assumptions on success rates and average sizes of discoveries were made for the modelling.

It is postulated that the exploration effort depends substantially on a combination of (a) the expected success rate, (b) the likely size of discovery, and (c) oil/gas prices. In the present study 3 future oil/gas price scenarios were employed as follows:

Table 1		
Future Oil and Gas Price Scenarios		
	Oil Price (real) \$/bbl	Gas Price (real) pence/therm
High	90	70
Medium	70	50
Low	50	30

The postulated numbers of annual exploration wells drilled for the whole of the UKCS are as follows for 2011, 2030, and 2035:

Table 2			
Exploration Wells Drilled			
	2011	2030	2035
High	38	32	25
Medium	32	22	20
Low	25	18	15

The annual numbers are modelled to decline in a broadly linear fashion over the period.

It is postulated that higher exploration effort is associated with more discoveries but with lower success rates compared to reduced levels of effort. This reflects the view that low levels of effort will be concentrated on the lowest risk prospects, and thus higher effort involves the acceptance of higher risk. For the UKCS as a whole 3 success rates were postulated as follows with the medium one reflecting the average over the past 5 years.

Table 3	
Success Rates for UKCS	
Medium effort/Medium success rate	= 27%
High effort/Low success rate	= 25%
Low effort/High success rate	= 29%

It should be noted that success rates have varied considerably across sectors of the UKCS. Thus in the CNS and SNS the averages have exceeded 30% while in the other sectors they have been well below the average for the whole province. It is assumed that technological progress will maintain these success rates over the time period.

The mean sizes of discoveries made in the historic period for each of the 6 regions were calculated. They are shown in Table 4. It was then assumed that the mean size of discovery would decrease in line with recent historic experience. Such decline rates are quite modest.

Table 4	
Mean Discovery Size (Mmboe)	
SNS	8.2
CNS	31.84
NNS	67.61
MF	14.94
WoS	74.7
IS	7.14

For purposes of the Monte Carlo modelling of new discoveries the SD was set at 50% of the mean value. In line with historic experience the size distribution of discoveries was taken to be lognormal.

Using the above information the Monte Carlo technique was employed to project discoveries in the 6 regions to 2036. For the whole period the total numbers of discoveries for the whole of the UKCS were as follows:

Table 5	
Total Number of Discoveries to 2036	
High effort/Low success rate	216
Medium Effort/Medium Success Rate	165
Low effort/High success rate	161

For each region the average development costs (per boe) of fields in the probable and possible categories were calculated. These reflect substantial cost inflation over the last few years. Broadly, investment and operating costs doubled in the period 2003 – 2008. Investment costs per boe depend on several factors including not only the absolute costs in different operating conditions (such as water depth) but on the size of the fields. Thus in the SNS development costs for new fields were found to average nearly \$12.05 per boe because of the small size of fields. In the CNS they averaged \$17.27/boe and in the NNS they averaged \$13.65/boe. Operating costs over the lifetime of new fields were also calculated. The averages were found to be \$11.47/boe in the SNS, \$12.36/boe in the CNS and \$11.82/boe in the NNS. Total lifetime field costs (including decommissioning but excluding E and A costs) were found to average \$24.62 per boe in the SNS, \$31.95 per boe in the CNS, and \$26.71 per boe in the NNS.

Using these as the mean values the Monte Carlo technique was employed to calculate the development costs of new discoveries. A normal distribution with a SD = 20% of the mean value was employed. For new discoveries annual operating costs were modeled as a percentage of accumulated development costs. This percentage varied according to field size. It was taken to increase as the size of the field reduced reflecting the presence of economies of scale. Thus the field lifetime costs in small fields could become very high on a per boe basis.

With respect to fields in the category of technical reserves it was recognised that many have remained undeveloped for a long time, and so the mean development costs in each of the basins was set at \$5/boe higher than the mean for the new discoveries in that basin. Thus for the CNS the mean development costs are over \$22/boe and in NNS over \$18/boe. For purposes of Monte Carlo modelling a normal distribution of the recoverable reserves for each field with a SD = 50% of the mean was assumed. With respect to development costs the distribution was assumed to be normal with a SD = 20% of the mean value.

The annual numbers of new field developments were assumed to be constrained by the physical and financial capacity of the industry. The ceilings were assumed to be linked to the oil/gas price scenarios with maxima of 20, 17, and 13 respectively under the High, Medium, and Low Price Cases. These constraints do not apply to incremental projects which are additional to new field developments.

A noteworthy feature of the 177 current incremental projects in the database validated by operators is the expectation that the great majority

will be executed over the next 3 or 4 years. It is virtually certain that in the medium and longer-term many further incremental projects will be designed. They are just not yet at the serious planning stage. Such projects can be expected to be linked not only to currently sanctioned fields, but also to those presently classified as in the categories of probable, possible, technical reserves, and future discoveries.

Accordingly, estimates were made of the potential extra incremental projects from all these sources. Examination of the numbers of such projects and their key characteristics (reserves and costs) being examined by operators over the past 5 years indicated a decline rate in the volumes. On the basis of this, and from a base of the information of the key characteristics of the projects in the database, it was felt that, with a decline rate reflecting historic experience, further portfolios of incremental projects could reasonably be expected. As noted above such future projects would be spread over all categories of host fields. Their sizes and costs reflect recent trends.

With respect to investment decision making and project screening criteria oil companies (even medium-sized and smaller ones) currently assess their opportunities in the UKCS in comparison to those available in other parts of the world. Capital is allocated on this basis with the UKCS having to compete for funds against the opportunities in other provinces. A problem with the growing maturity of the UKCS is the relatively small average field size and the high unit costs. Recent mean discovery sizes are shown in Table 4 but, given the lognormal distribution, the most likely sizes are below these averages. It follows that the materiality of returns, expressed in terms of net present values (NPVs), is quite low in relation to those in prospect in other provinces (such as offshore Angola,

for example). Oil companies frequently rank investment projects according to the NPV/I ratio. Accordingly, this screening method has been adopted in the present study. Specifically, the numerator is the post-tax NPV at 10% discount rate in real terms and the denominator is pre-tax field investment at 10% discount rate in real terms. This differs from the textbook version which states that I should be in post-tax terms because the expenditures are tax deductible through allowances. Oil companies maintain that they allocate capital funds on a pre-tax basis, and this is employed here as the purpose is to reflect realistically the decision-making process. The development project goes ahead when the NPV/I ratio as defined above in real terms ≥ 0.3 in the first case and ≥ 0.5 in the second case examined. The 10% real discount rate reflects the weighted average cost of capital to the investor. The modelling has been undertaken under the current tax system. This includes the field allowances introduced in 2009 and 2010.

In the light of experience over the past few years some rephrasing of the timing of the commencement dates of new field developments and incremental projects from those projected by operators was undertaken related to the probability that the project would go ahead. Where the operator indicated that a new field development had a probability $\geq 80\%$ of going ahead the date was left unchanged. Where the probability $\geq 60\% < 80\%$ the commencement date was slipped by 1 year. Where the probability $\geq 40\% < 60\%$ the date was slipped by 2 years. Where the probability was $\geq 20\% < 40\%$ the date was slipped by 3 years, and where the probability was $< 20\%$ it was slipped by 4 years. If an incremental project had a probability of proceeding $\geq 50\%$ the date was retained but where it was $< 50\%$ it was slipped by 1 year.

3. Results

A. Economic Hurdle NPV@10%/I@10%≥ 0.3

(i) Changes in Number of Fields/Projects Passing Economic Hurdle

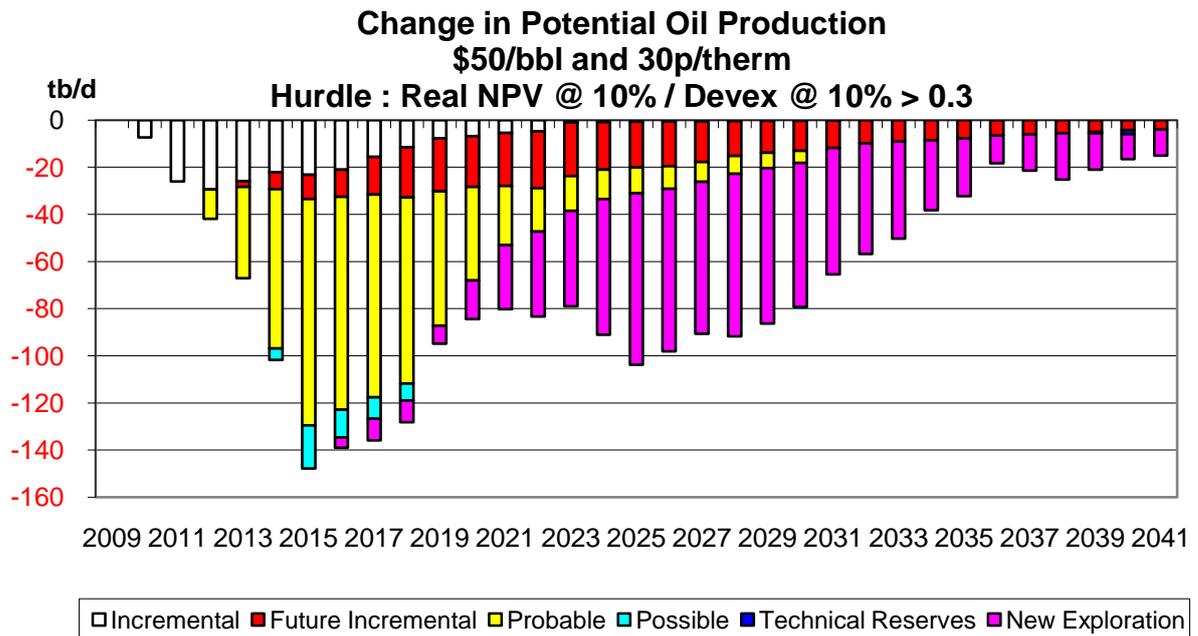
The changes in the number of fields/projects passing the economic hurdle under the 3 oil/gas price scenarios in the period to 2041 are shown in Table 6. There are reductions in all categories of investments. The reductions in the numbers of incremental projects passing the hurdle is particularly noticeable, suggesting that the tax increases are not compatible with the maximisation of economic recovery.

Table 6						
No of fields/projects passing hurdle rate						
NPV@10%/I@10% > 0.3						
	2010 Tax system			2011 Tax system		
	\$50, 30p	\$70, 50p	\$90, 70p	\$50, 30p	\$70, 50p	\$90, 70p
Probable Fields	9	23	32	7	21	29
Possible Fields	9	27	38	8	25	37
Technical Reserve Fields	61	167	238	62	159	232
New Exploration Finds	58	148	215	50	143	213
Incremental Projects	117	149	162	85	139	155
Future Incremental	202	314	414	187	296	408
TOTAL	456	828	1099	399	783	1074

(ii) Changes in Oil Production

The changes in oil production emanating from the non-development of fields/projects which were viable under the pre-budget terms are shown in Chart 1 under the \$50, 30 pence price case. The annual reduction grows rapidly to nearly 150,000 b/d over the next few years. Thereafter it calls considerably but will average around 50,000 b/d until the early 2030's. The cumulative loss of production in the period to 2041 is 810 million barrels (mm bbls). This may be compared to a total production of 9,152 mm bbls under pre-budget terms. The reduction is thus 8.85%.

Chart 1



Over the next decade the reduction in production is principally among current and future incremental projects and probable fields. It is an obvious case for concern that a large volume of production from fields in the probable category is at risk.

In Chart 2 the loss of oil production over the period under the \$70, 50 pence case is shown. It is in the 20,000-40,000 b/d range over the next few years but then increases to over 100,000 b/d in the early 2020's and nearly 140,000 b/d in the late 2020's. The cumulative loss of production to 2041 is 862 mmbbls which can be related to the total of 13,727 mmbbls which would have been produced on pre-budget terms. The loss is thus 6.28%. Over the next few years the loss is from current and future incremental projects, but in the later years of the study period the loss emanates principally from fields in the category of technical reserves.

Chart 2

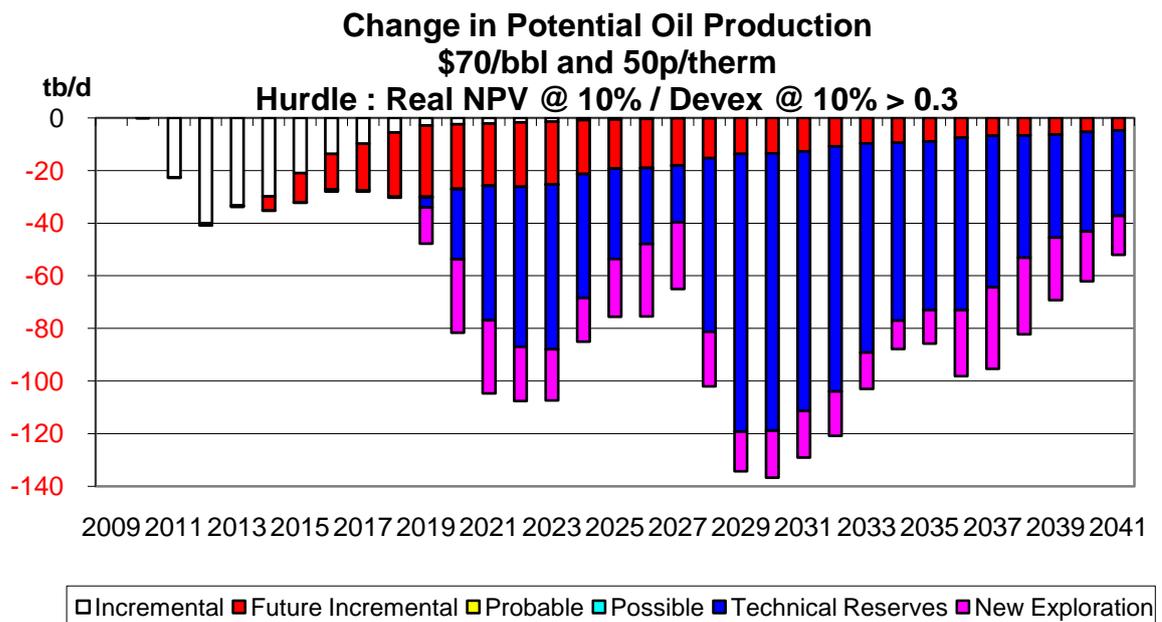
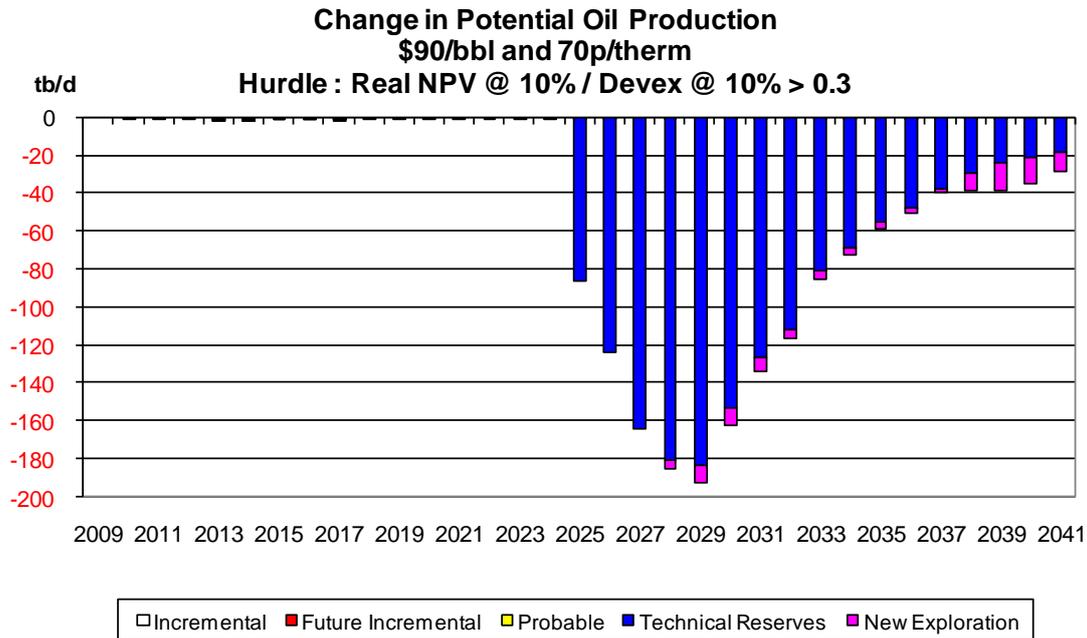


Chart 3



In Chart 3 the loss of oil production under the \$90, 70 pence case is shown. The cumulative loss is 597 mmbbls which can be compared to a total of 17,065 mmbbls which could have been produced under the pre-budget terms. The loss is thus 3.49%. It is overwhelmingly concentrated in the fields in the category of technical reserves.

(iii) Changes in Gas Production

In Chart 4 the changes in gas production over the period are shown under the \$50, 30 pence case. The loss increases rapidly from nearly 60 mmcf/d to 130 mmcf/d in 2015 and remains at over 100,000 mmcf/d until 2026. The cumulative loss to 2041 is 764 bcf. This can be compared to a total of 19,844 bcf which would have been produced under the pre-budget terms. The loss is thus 3.85%. It is noticeable that for much of the period the loss is concentrated in incremental projects highlighting the concern that maximum economic recovery is endangered.

Chart 4

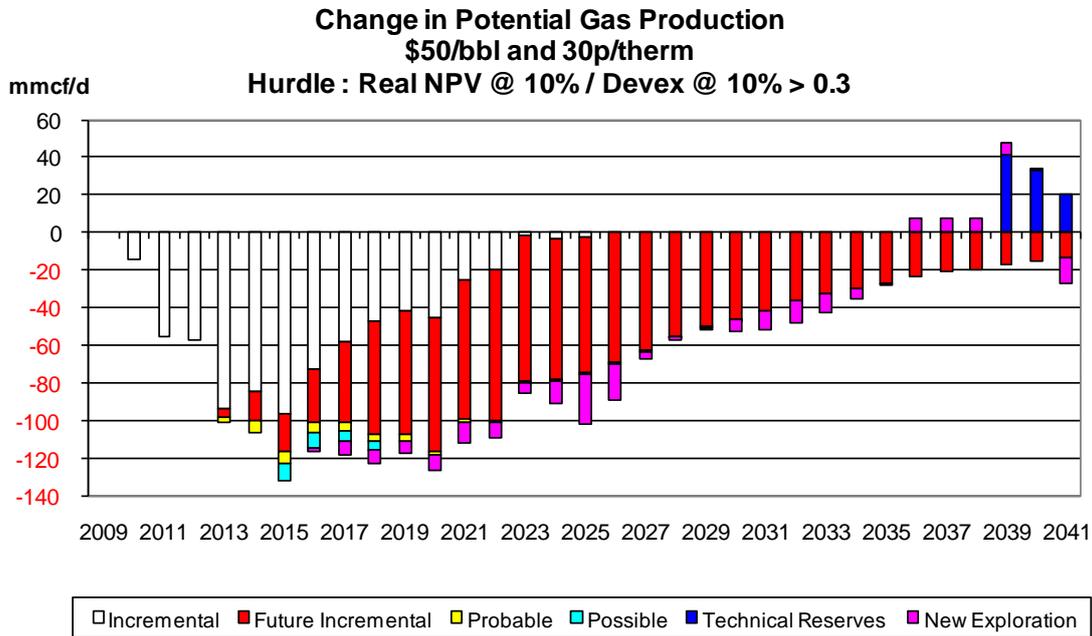
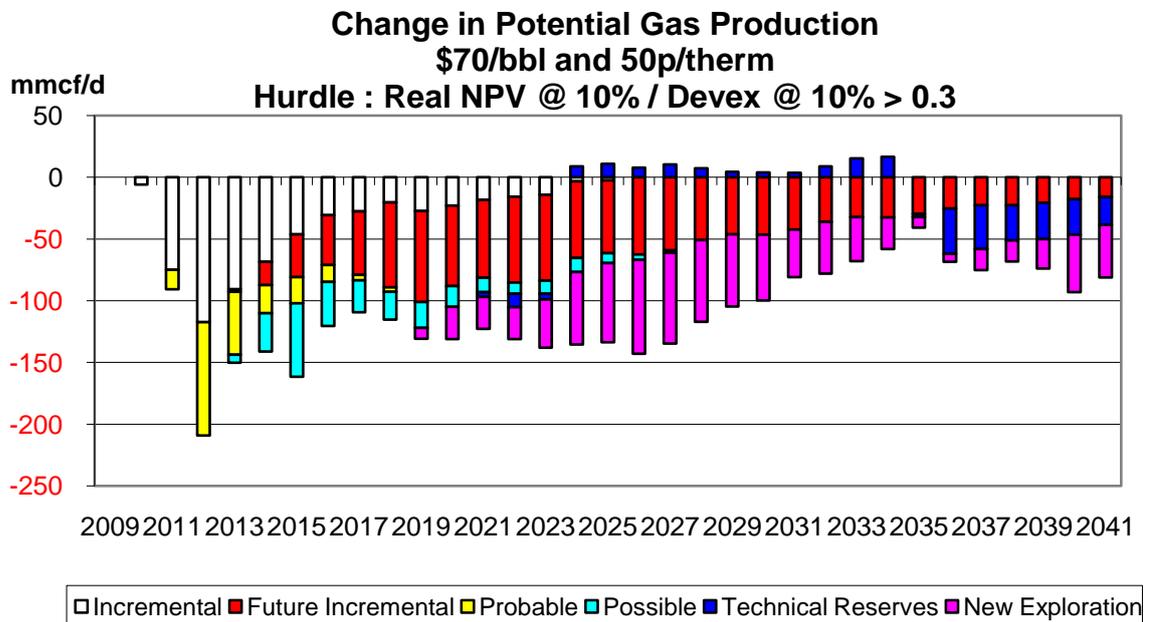


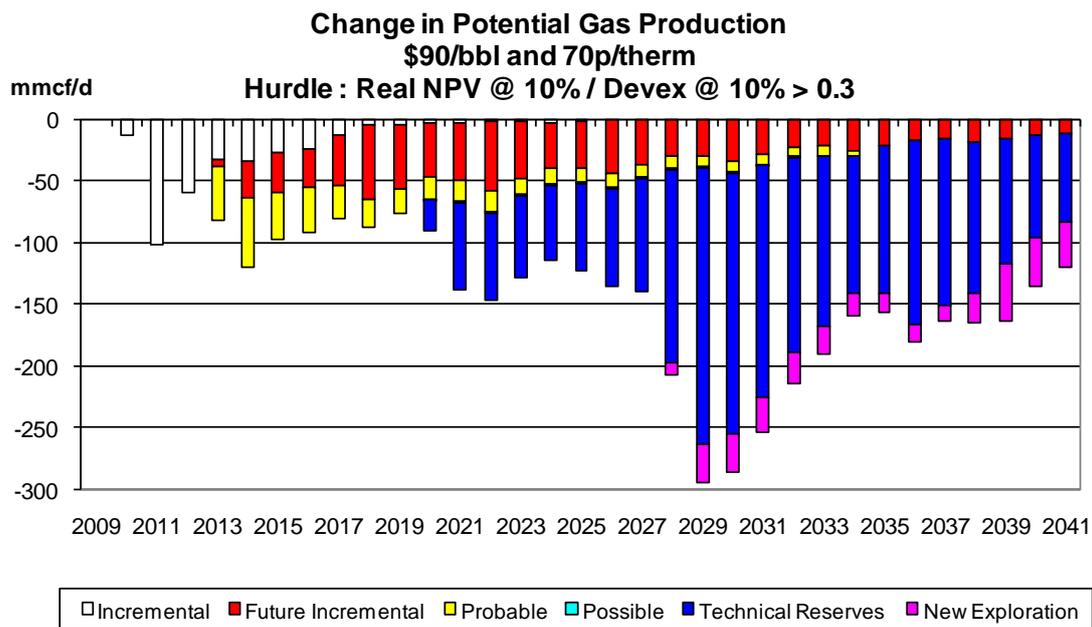
Chart 5



In Chart 5 the loss of gas production under the \$70, 50 pence case is shown. It exceeds 100,000 mmcf/d in the period to 2030. The total loss

in the period is 1,209 bcf which can be compared to a total production of 33,011 bcf in the period under pre-budget terms. The loss is thus 6.28%. Over the next few years the loss is concentrated in incremental projects and probable fields. This is clearly a cause for concern. In the period to 2015 the annual loss sometimes exceeds 150 mmcf/d. In the longer term the loss is spread across all categories of fields. There is also a small increase in production in a few years. This comes about from the combination of the increased rate of tax relief (from 50% to 62%) in small fields where the SC is largely sheltered by the field allowance. The result is that post-tax returns are increased!

Chart 6



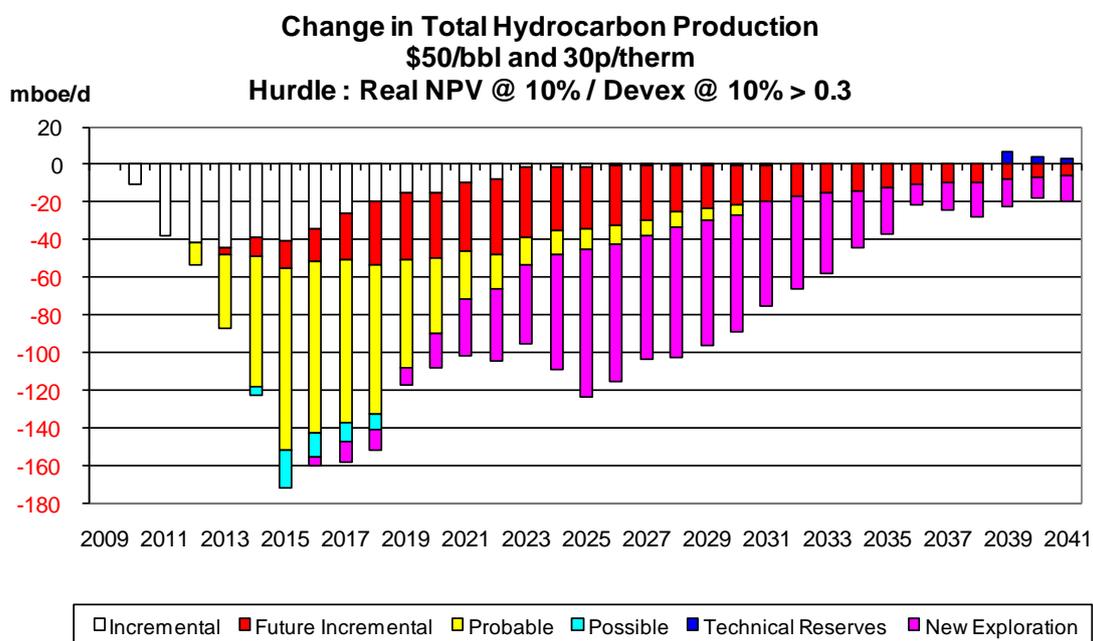
In Chart 6 the loss of gas production under the \$90, 70 pence case is shown. The loss soon reaches 100 mmcf/d and in the later part of the period grows to nearly 300 mmcf/d. The cumulative loss is 1,654 bcf which can be compared to a total production of 45,974 bcf over the

period. The loss is thus 3.6%. In the long term much of the loss is in the high cost fields in the technical reserves category.

In Chart 7 the loss of total hydrocarbon production (including NGLs) is shown under the \$50, 30 pence case. It is seen that the loss increases rapidly to 170,000 boe/d in 2015 and remains over 100,000 boe/d until 2029. The total loss over the period is 947 mmbœ which can be compared to a total production of 12,885 mmbœ under the pre-budget terms. The loss is thus 7.35%. Over the next decade much of the loss is from probable fields. In the longer term much of the loss is from fields in the category of new discoveries.

(iv) Changes in Total Hydrocarbon Production

Chart 7



In Chart 8 the changes in total hydrocarbon production under the \$70, 50 pence case is shown. The loss rapidly reaches 60,000 boe/d and in the

2020's exceeds 130,000 boe/d. At its peak the loss is over 150,000 boe/d. The total loss in the period is 1,050 mboe which can be compared to a total production of 19,863 under pre-budget terms. The loss is thus 5.3%.

Chart 8

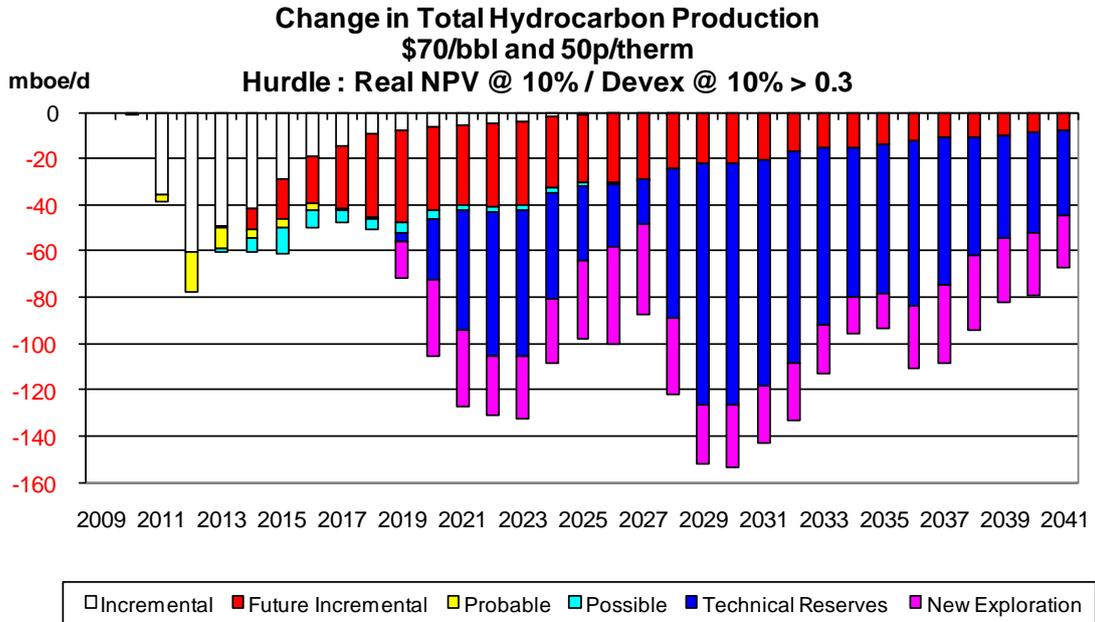
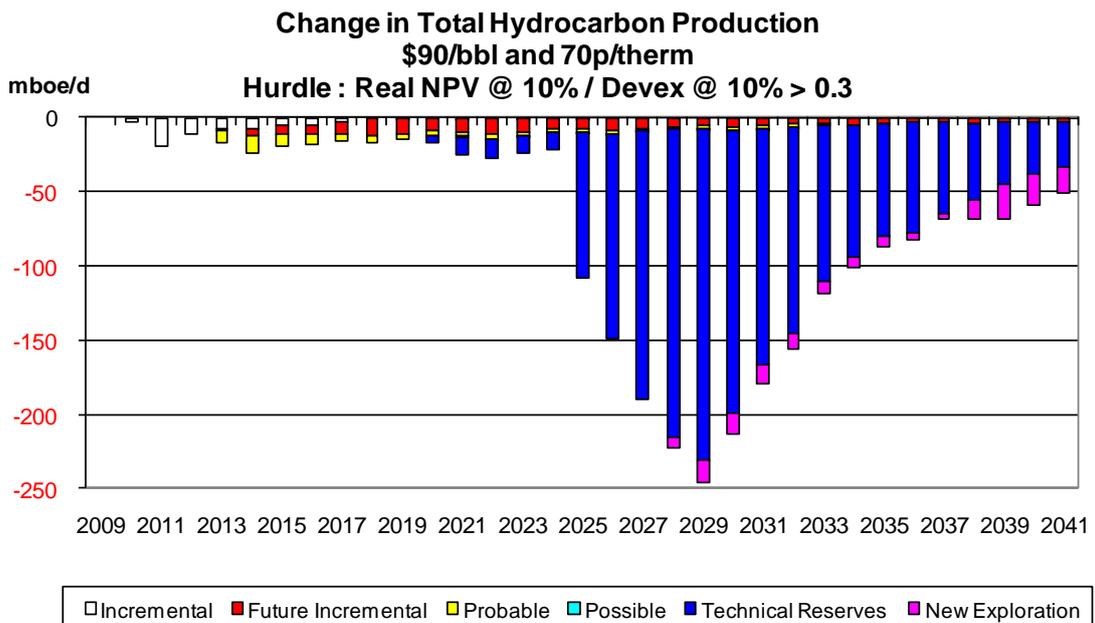


Chart 9



In Chart 9 the change in total hydrocarbon output under the \$90, 70 pence case is shown. It is seen that large losses do not occur until 2025. The peak loss is nearly 250,000 boe/d in 2029 and the cumulative loss is 890 mmboe which can be compared to a total of 25,533 mmboe under the pre-budget terms. The loss is thus 3.48%. The overwhelming share of the loss comes from fields in the category of technical reserves.

(v) Changes in Development Expenditures

In Chart 10 the changes in development expenditures over the period are shown under the \$50, 30 pence case. The reduction increases rapidly to over £1 billion in 2013. Much of the loss is concentrated in probable fields. In later years the loss of investment is much less. This reflects the small number of projects which are viable under the pre-budget terms. The cumulative loss of investment is £9.8 billion (at 2010 prices). Of this £2.5 billion is in fields in the probable category and £3.7 billion in incremental projects (current and future).

Chart 10

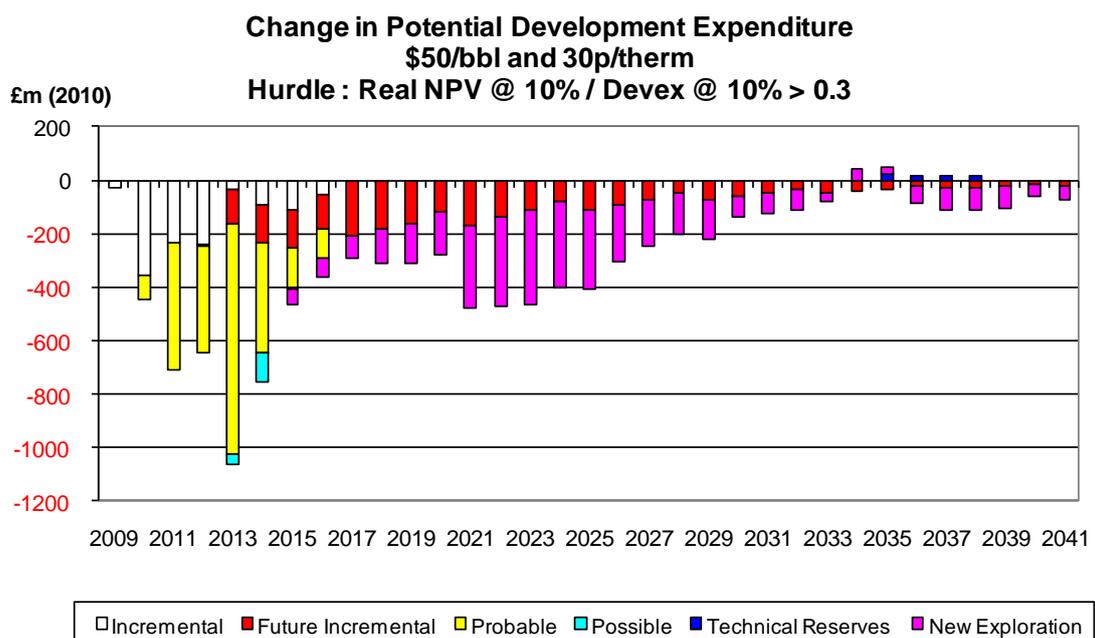
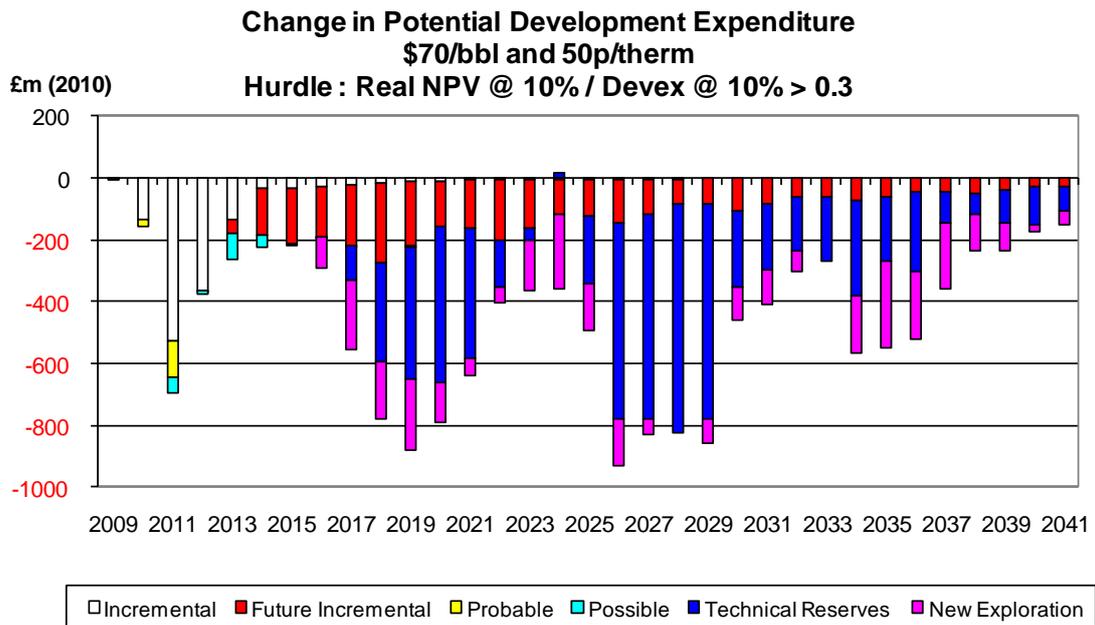


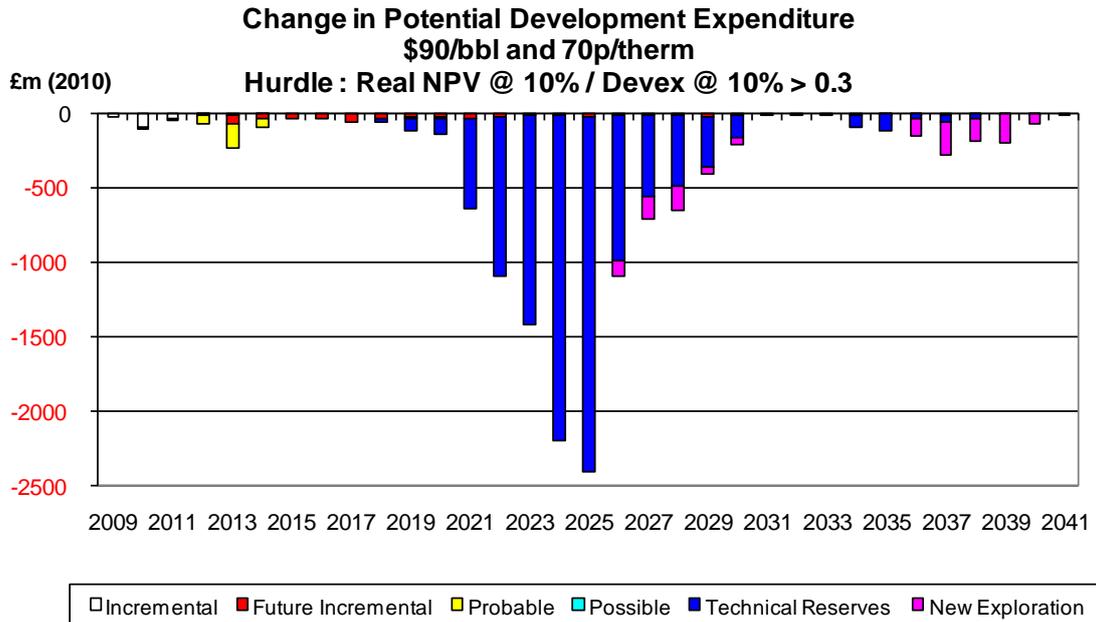
Chart 11



In Chart 11 the reduction in development expenditures under the \$70, 50 pence case is shown. It quickly reaches £700 million and in later years the annual figure sometimes exceeds £800 million. The cumulative total over the period is £15.1 billion (at 2010 prices). In the longer term the reduction is concentrated in fields in the category of technical reserves.

In Chart 12 the reduction in development expenditures under the \$90, 70 pence case is shown. The largest reduction occurs in the period 2023 – 2025 when the annual reduction is nearly £2.5 billion. The total reduction is £13.1 billion (at 2010 prices).

Chart 12



(vi) Changes in Operating Expenditures

In Chart 13 the annual reductions in operating expenditures under the \$50, 30 pence case are shown. They rise to £370 million in 2017 with large reductions being attributed to probable fields. In the longer term the greater part of the reduction occurs with fields in the category of new discoveries. The total reduction is £6.4 billion over the period.

Chart 13

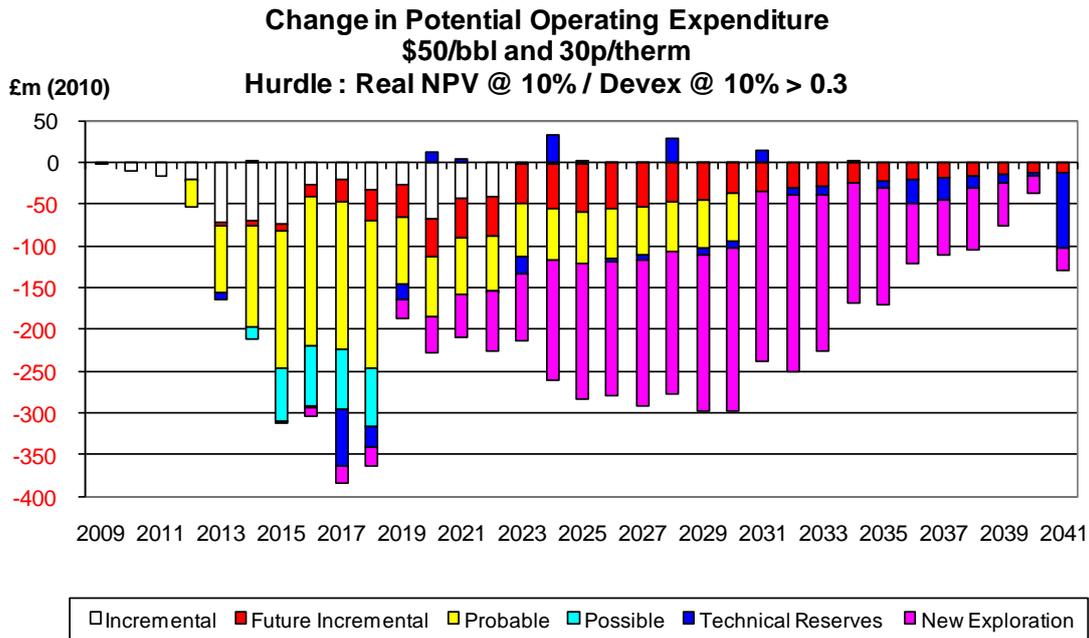
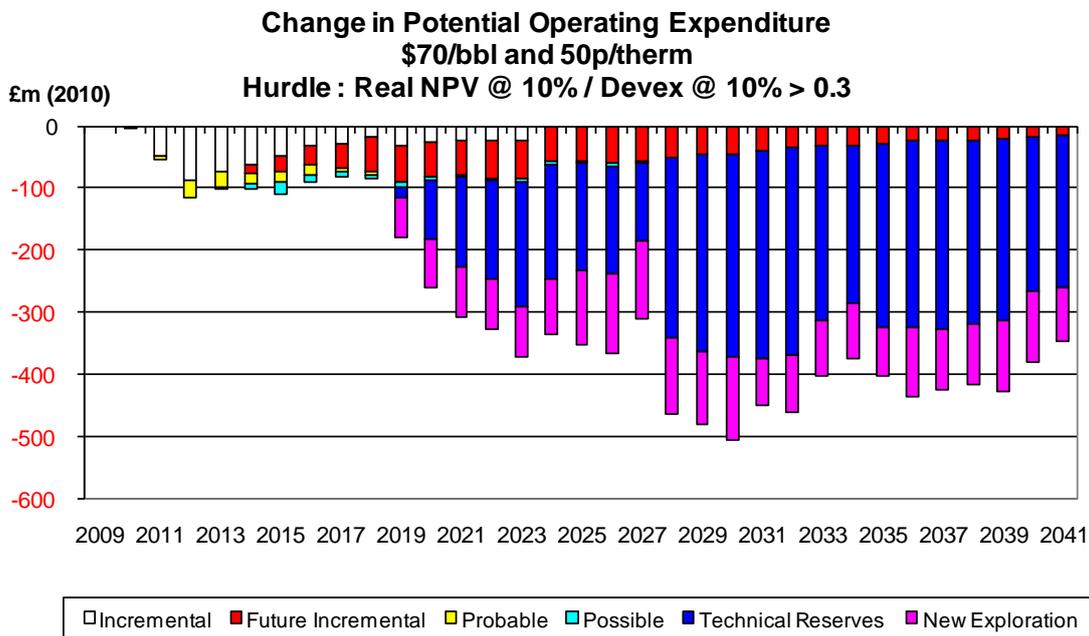


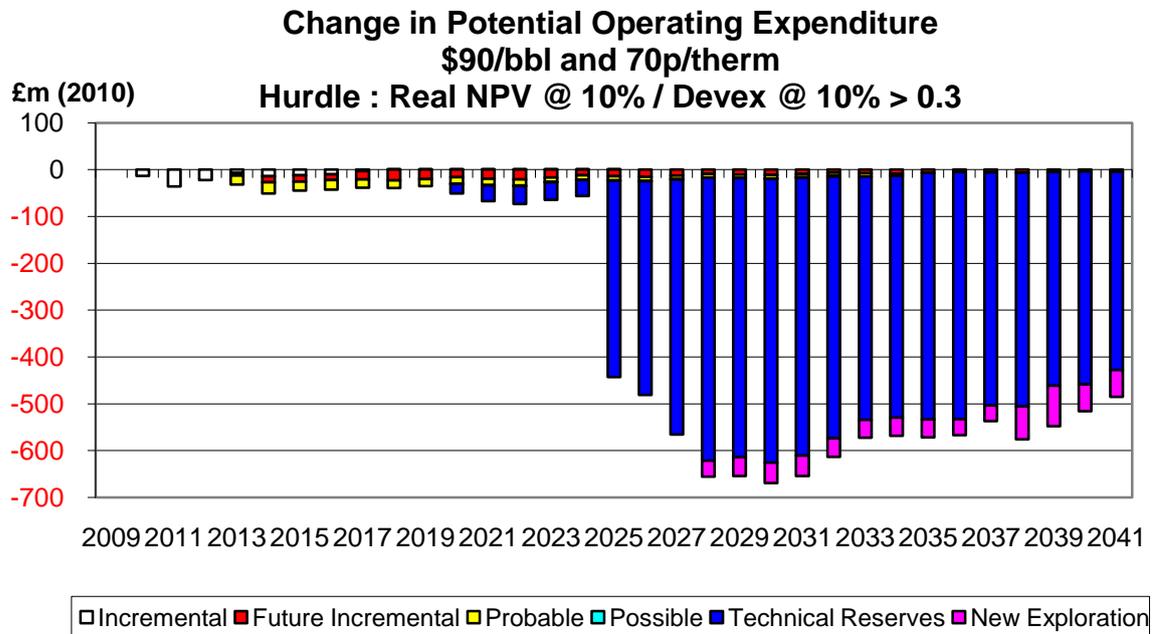
Chart 14



In Chart 14 the reductions in operating expenditures under the \$70, 50 pence scenario are shown. They exceed £100 million per year in the short term but then exceed £300 million by 2020. The largest annual

reduction is over £500 million in 2030. The cumulative reduction is £9.5 billion.

Chart 15

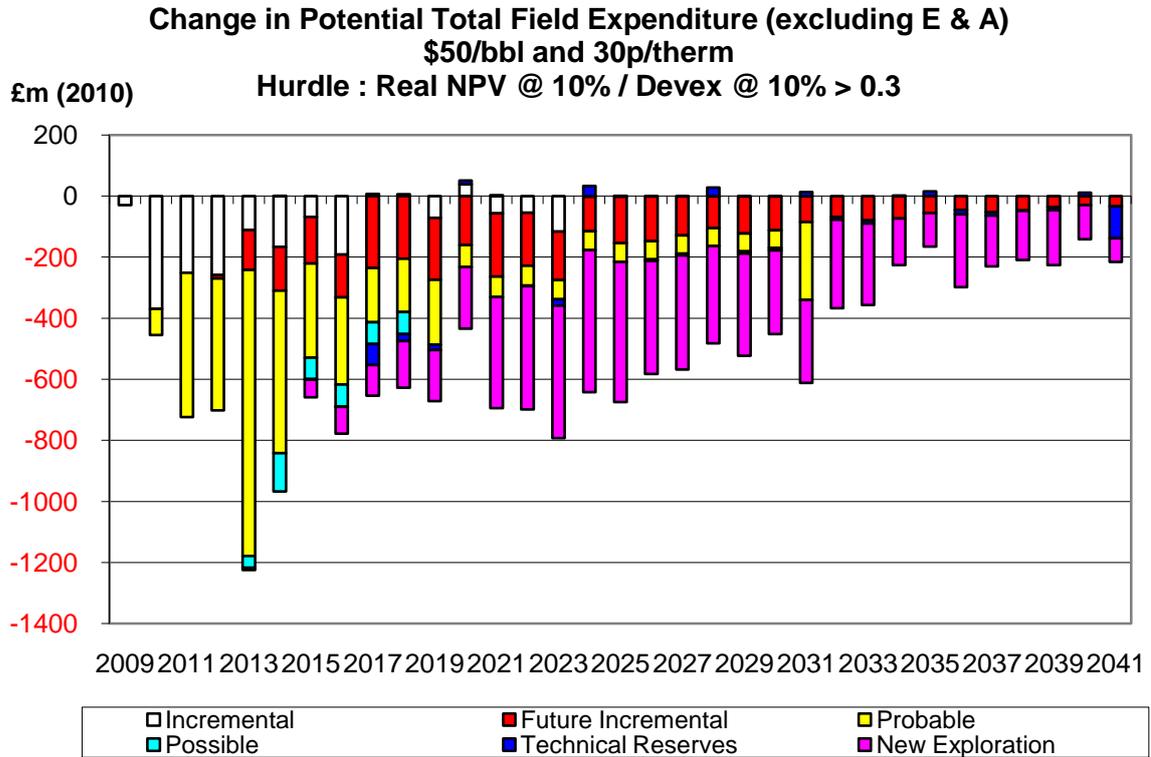


In Chart 15 the reductions in operating expenditures under the \$90, 70 pence case are shown. Annually they are in the range £50 - £75 million until the early 2020's when they increase dramatically to reach a peak of £650 million. The cumulative total is £10.3 billion.

(vii) Changes in Total Field Expenditures

The changes in decommissioning expenditures were found to be relatively modest in relation to investment and operating costs. Often a change in timing took place. The changes in total field expenditures (excluding E and A costs) affect employment in the industry. They are shown under the \$50, 30 pence case in Chart 16.

Chart 16



The size of the decrease increases rapidly to over £1.2 billion in 2013 and for many years thereafter the annual decrease exceeds £600 million. The total decrease over the whole period is £16.9 billion (at 2010 prices). In the early years there is a major reduction in expenditure in probable fields, while in the longer run much of the lost expenditure is on fields in the category of new discoveries. (It should be noted that under this price very few fields in the category of technical reserves were viable on pre-budget terms).

In Chart 17 the reductions in total field expenditures under the \$70, 50 pence case are shown. The reduction soon exceeds £800 million but is then under £400 million per year to 2016. Subsequently it grows considerably and often exceeds £1 billion per year. Over the whole

period the reduction is £25.2 billion. The majority of the lost expenditure is in fields in the categories of technical reserves and new discoveries.

Chart 17

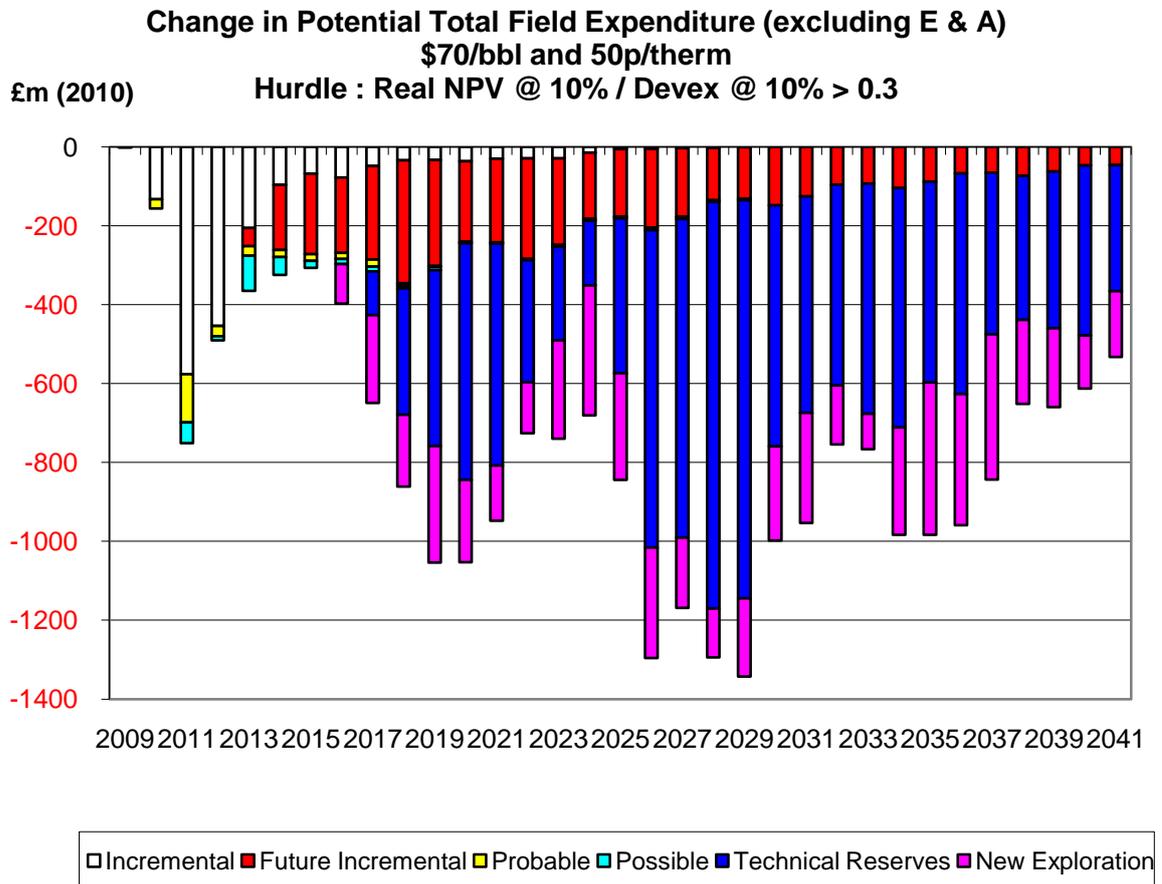
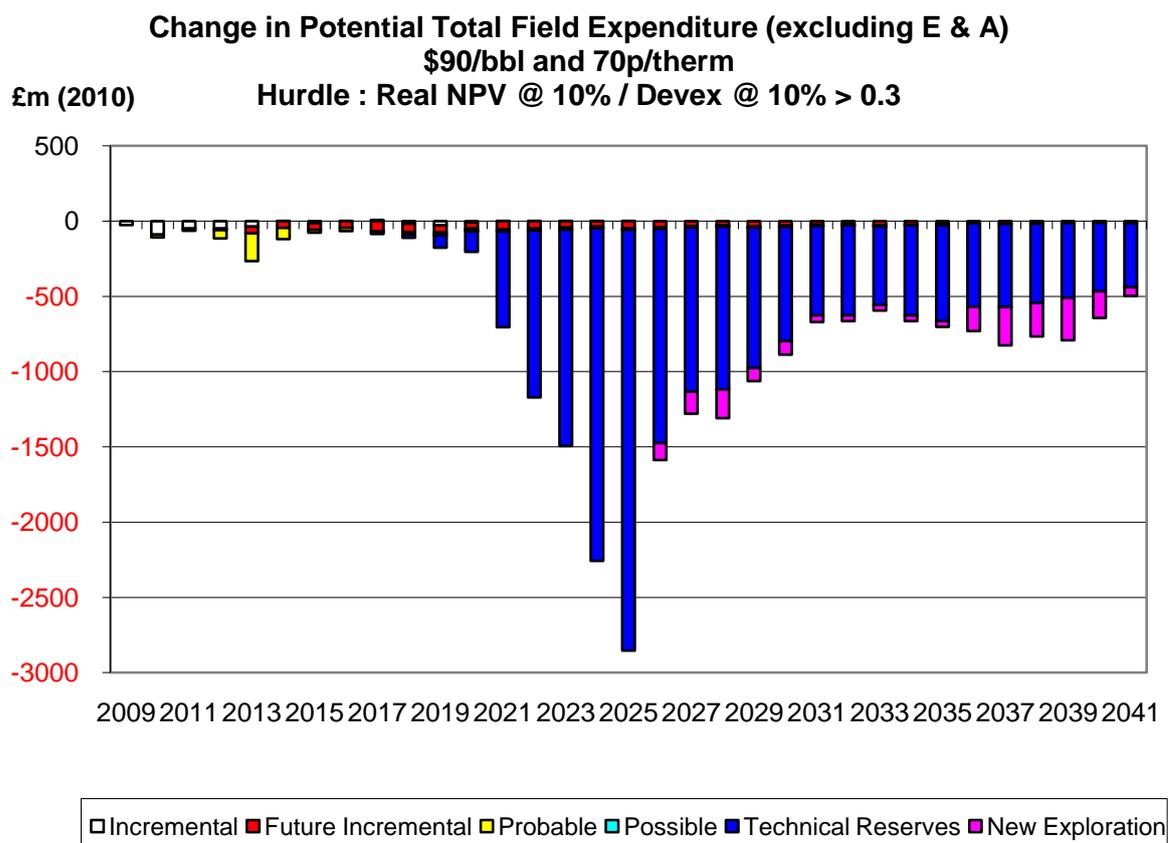


Chart 18



In Chart 18 the reductions in total field expenditures under the \$90, 70 pence case are shown. The reductions are substantial in every year but in the 2020's they grow enormously to £2.75 billion in the year 2025. The aggregate reduction is £23.5 billion. The majority of the lost expenditures relate to fields in the category of technical reserves.

(viii) Changes in Tax Revenues

In Chart 19 the changes in tax revenues are shown under \$50 price case. In the next few years there is an increase averaging over £1.0 billion annually (at 2010 prices). Thereafter there are substantial tax losses emanating from the reduced investment in new fields in the probable category. In the long term the average annual net increase in revenues is

around £400 million per year. The total increase in tax revenues over the whole period is £13.8 billion. The low figures for much of the later period reflect the low level of activity in the UKCS.

Chart 19

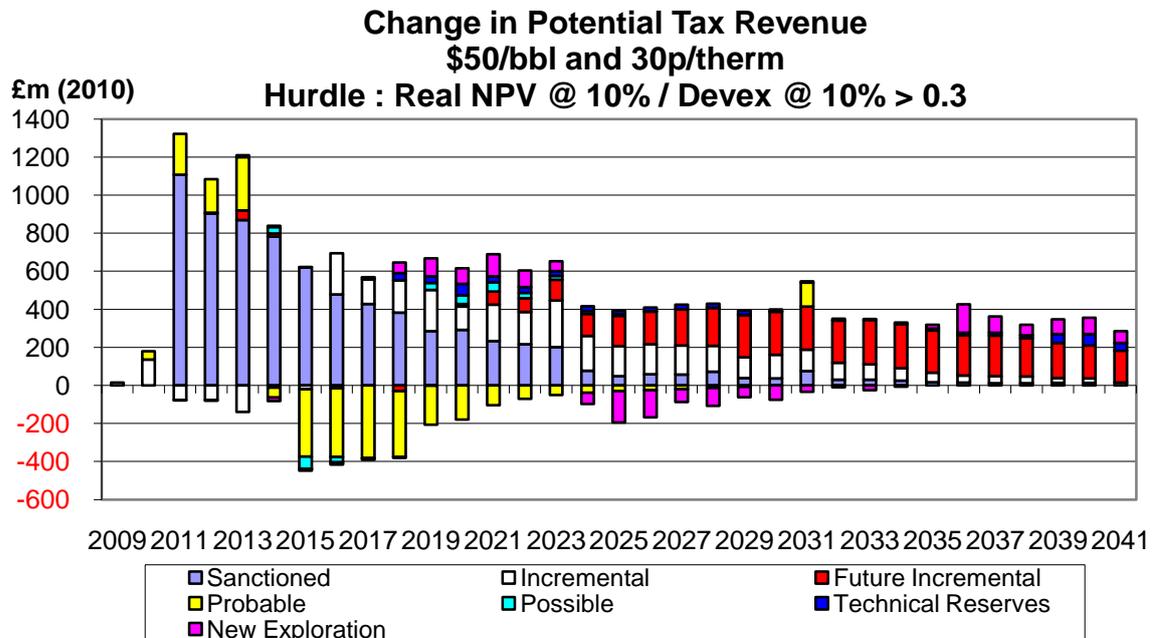
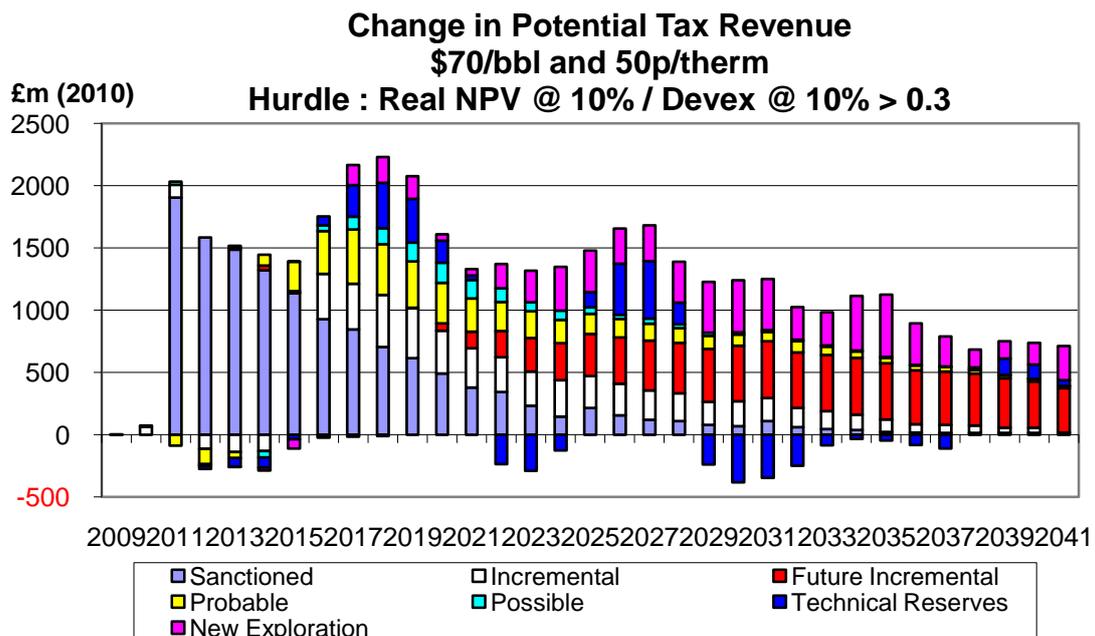
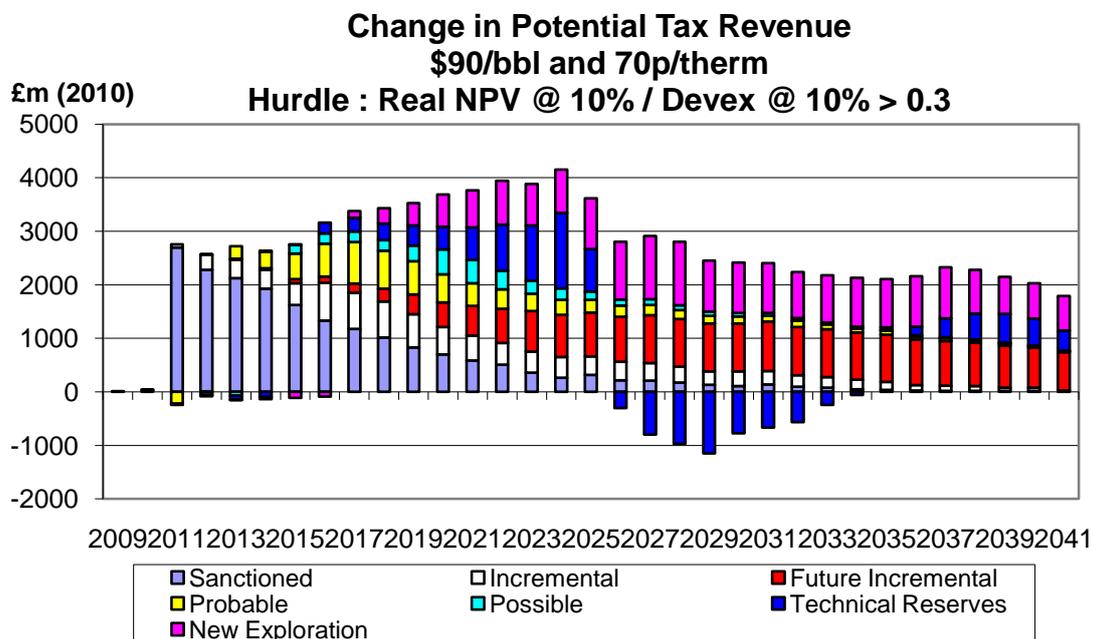


Chart 20



In Chart 20 the increase in tax revenues under the \$70 price case is shown. In 2011 this amounts to £2 billion. The net increase is less in subsequent years because some projects are not undertaken. Over the medium term the net increase averages around £1.5 billion per year, but in later years it is very much less. The total increase over the period is £35.5 billion.

Chart 21



In Chart 21 the increase in total revenues under the \$90 price case is shown. In the early years the net increase averages around £2.5 billion. In the medium term it grows to over £4 billion in 2024 after which it falls substantially. The total increase over the period is £80.8 billion.

B. Economic hurdle NPV@10%/I@10%>0.5

(i) Changes in numbers of Fields/Projects Passing Hurdle Rate

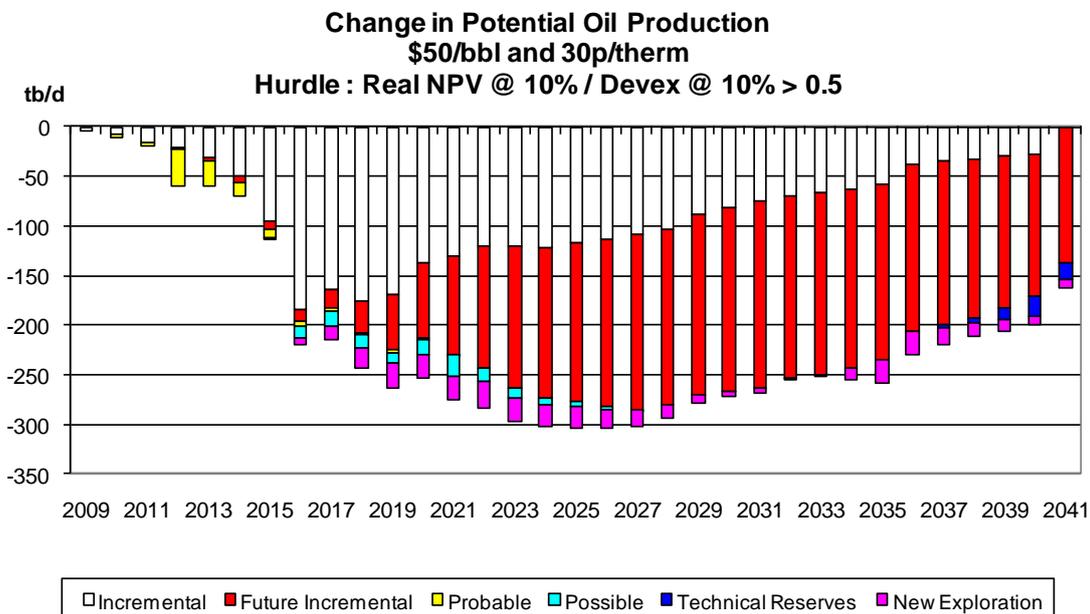
In Table 7 the numbers of fields/projects passing the economic hurdle of NPV@10%/I@10%>0.5 are shown under pre- and post-budget terms under the 3 prices scenarios. Compared to the hurdle of NPV@10%/I@10%>0.3 there are substantially less investments undertaken under all prices scenarios and under both pre-budget and post-budget terms. Further, the decrease in the numbers of new developments resulting from Budget 2011 is greater when the NPV/I hurdle is >0.5 rather than >0.3. With the higher hurdle the aggregate number of viable new fields and projects falls from 340 to 217 (36%) under the \$50 price case, from 698 to 636 (9%) under the \$70 case, and from 1022 to 943 (7.7%) under the 490 case.

Table 7						
No of fields/projects passing hurdle rate						
NPV@10%/I@10% > 0.5						
	2010 Tax system			2011 Tax system		
	\$50, 30p	\$70, 50p	\$90, 70p	\$50, 30p	\$70, 50p	\$90, 70p
Probable Fields	6	18	28	4	16	23
Possible Fields	6	20	35	3	16	30
Technical Reserve Fields	45	124	209	43	115	193
New Exploration Finds	30	128	211	25	115	196
Incremental Projects	93	132	152	84	116	141
Future Incremental	160	276	387	58	258	360
TOTAL	340	698	1022	217	636	943

(ii) Changes in Oil Production

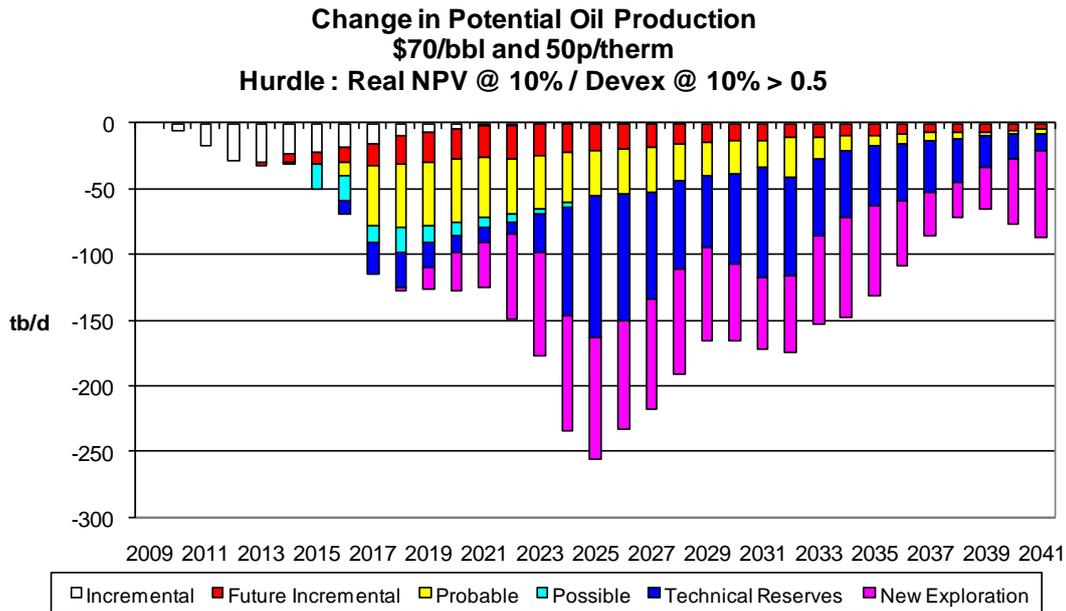
In Chart 22 changes in oil production are shown under the \$50 case. The reduction grows rapidly in the 2020's. Incremental projects in both categories dominate the reduction. Over the whole period production is reduced by 2,540 million barrels. This can be compared with the total production of 7.7 billion bbls produced under pre-budget terms. The reduction is thus 32.9%.

Chart 22



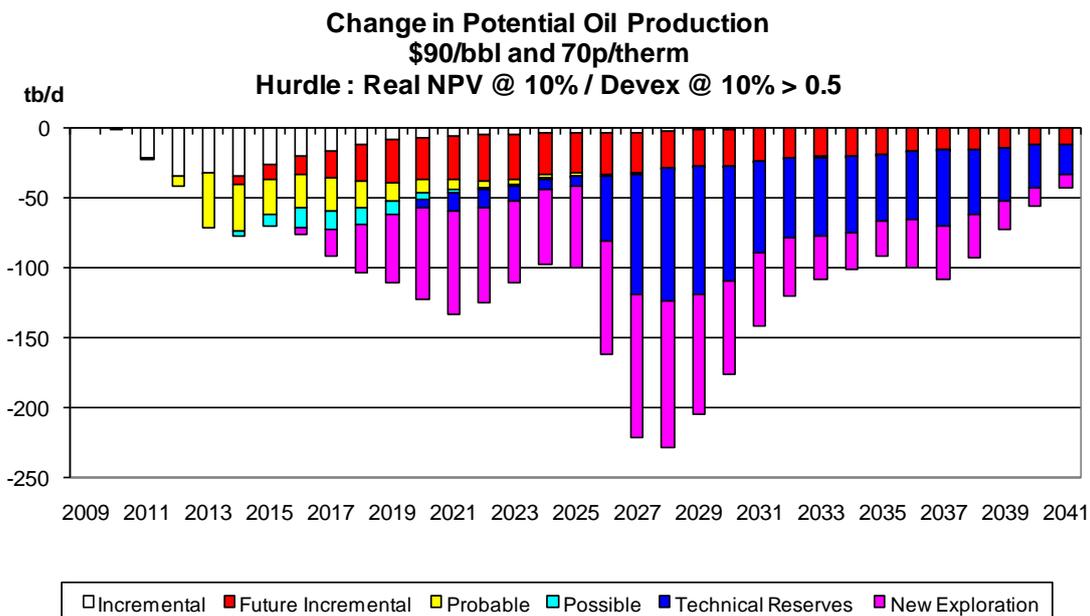
In Chart 23 changes in oil production are shown under the \$70 price case. The reduction grows over the years to exceed 100,000 b/d in 2015. By 2025 the reduction exceeds 250,000 b/d. In the long term the reduction is concentrated in fields in the categories of new discoveries and technical reserves. Over the whole period the total reduction in production is 1,429 million barrels. This can be compared with a pre-budget aggregate production of 11.8 billion barrels. The reduction is thus 12.1%.

Chart 23



In Chart 24 the reduction in oil production is shown under the \$90 case. It increases to 70,000 b/d in 2013 and grows to 130,000 b/d in 2021. By 2028 the reduction is 230,000 b/d. Over the whole period the total reduction in production is 1,242 million barrels. This can be compared with a total production of 15.8 billion barrels under the pre-budget conditions. The reduction is thus 7.8%.

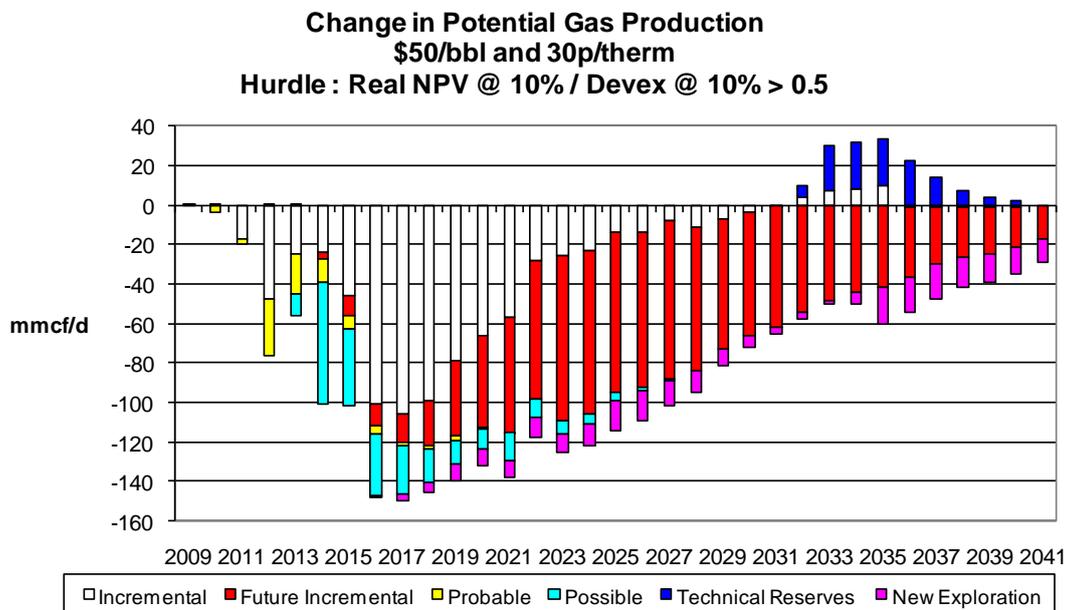
Chart 24



(iii) Changes in Gas Production

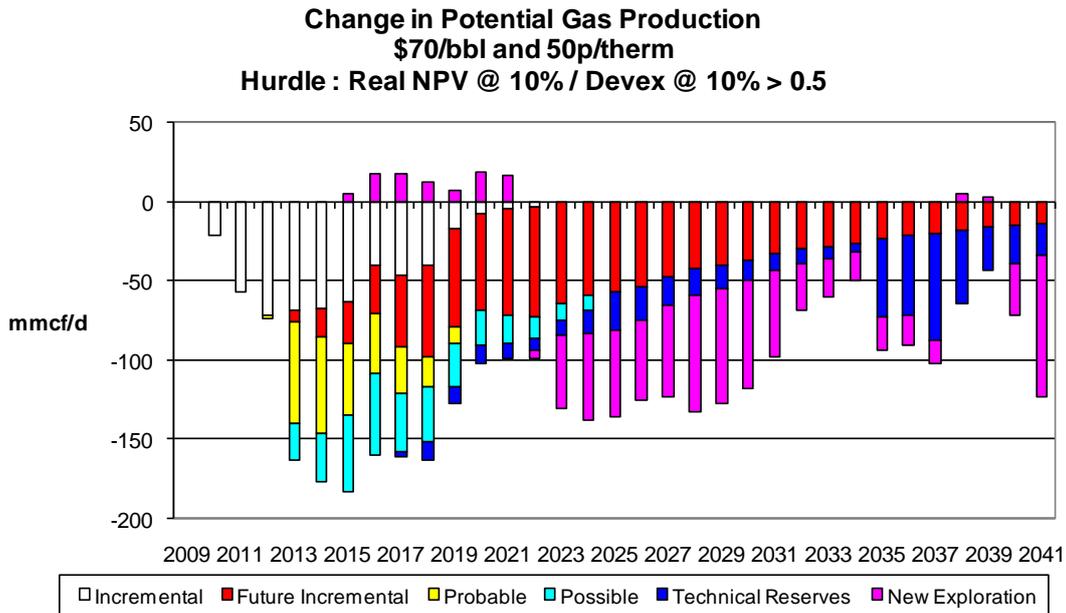
In Chart 25 the reduction in gas production under the \$50, 30 pence case is shown. It increases rapidly to 100 mmcf/d in 2014 and peaks at 150 mmcf/d in 2016. Much of the decrease occurs from incremental projects. Over the whole period the total reduction in production is 920 bcf. This can be compared with a total production of 18,363 bcf under pre-budget terms. The total reduction is thus 5%.

Chart 25



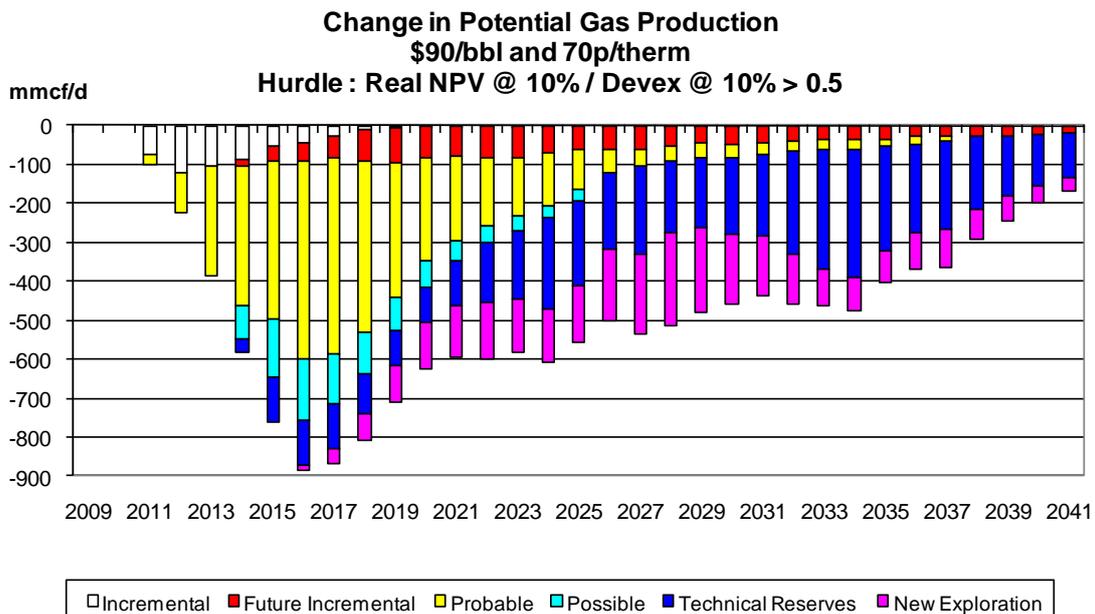
In Chart 26 the reduction in gas production under the \$70, 50 pence case is shown. It increases rapidly to exceed 160 mmcf/d in 2013. The reduction over the long term is principally with new discoveries and incremental projects. Over the whole period the aggregate reduction in production is 1,233 bcf. This can be compared with total production of 29,372 bcf under pre-budget terms. The reduction is thus 4.2%.

Chart 26



In Chart 27 the reduction in gas production are shown under the \$90, 70 pence case. The reduction increases rapidly to nearly 900 mmcf/d in 2015. Over the period the reduction is principally among probable fields. Over the whole period the aggregate reduction in production is 5,568 bcf. This can be compared with total production of 42,150 bcf under pre-budget terms. The reduction is thus 13.2%.

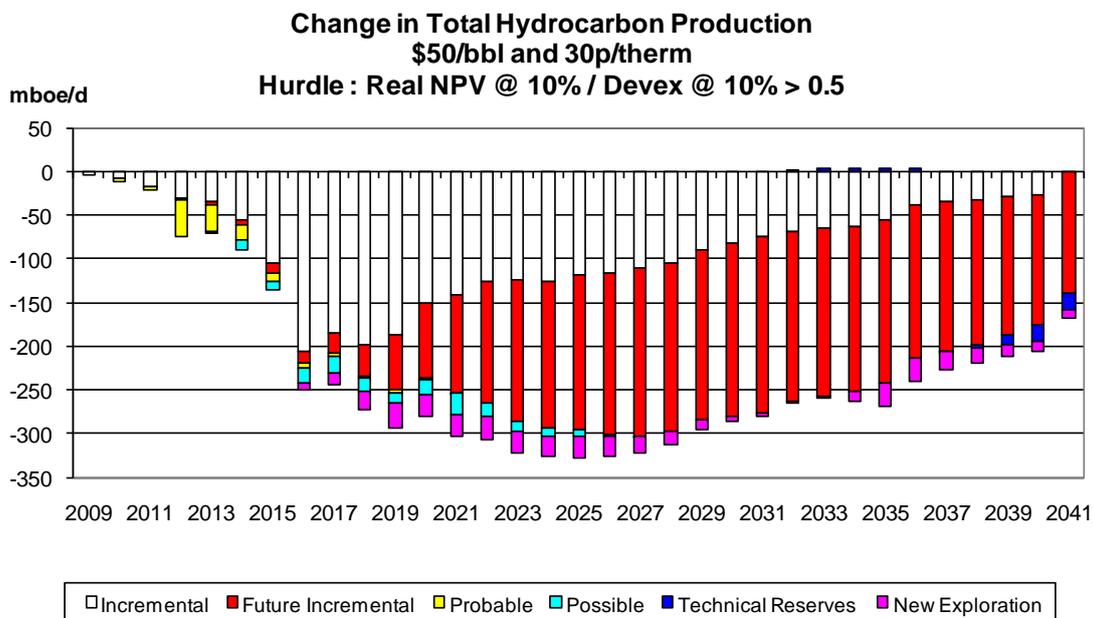
Chart 27



(iv) Changes in Total Hydrocarbon Production

In Chart 28 the reduction in total hydrocarbon production (including NGLs) is shown under the \$50, 30 pence case. The reduction increases to 250,000 boe/d in 2016 and reaches a peak of 325,000 boe/d in 2024. The reduction is principally among incremental projects and new discoveries. Over the whole period the aggregate reduction in total hydrocarbon production is 2,728 million boe. This can be compared with total production of 11,156 million boe under pre-budget terms. The reduction is thus 24.4%.

Chart 28



In Chart 29 the reduction in total hydrocarbon production under the \$70, 50 pence case is shown. It increases to 100,000 boe/d in 2016 and reaches a peak of 275,000 boe/d in 2015. The reduction is principally among new fields and technical reserves. Over the whole period the aggregate reduction in production is 1,678 million boe. This can be compared to total production of 17,294 million boe under pre-budget terms. The reduction is thus 9.7%.

Chart 29

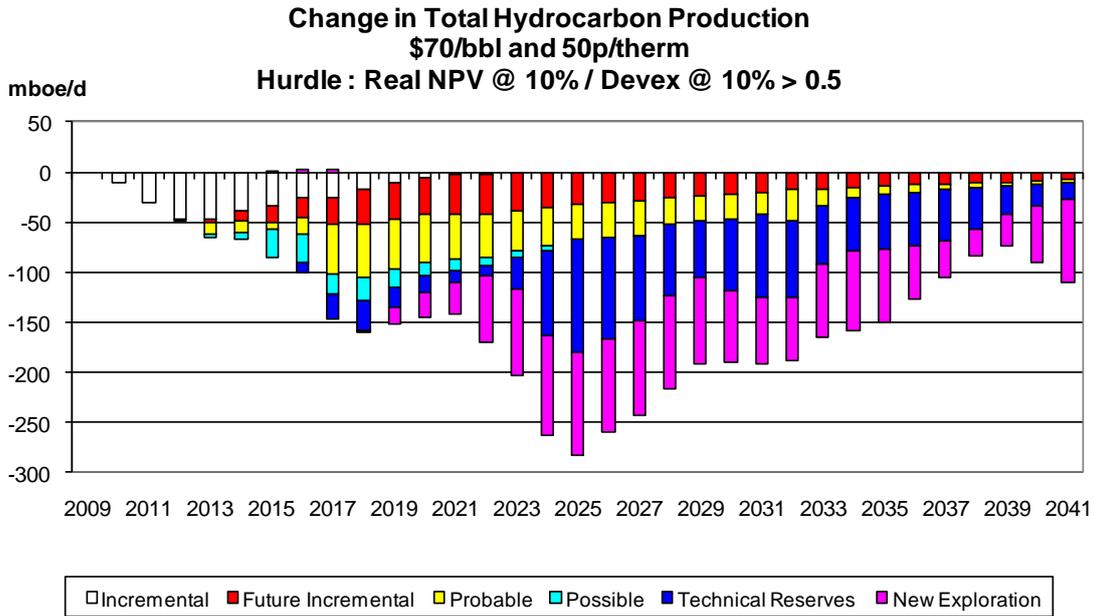
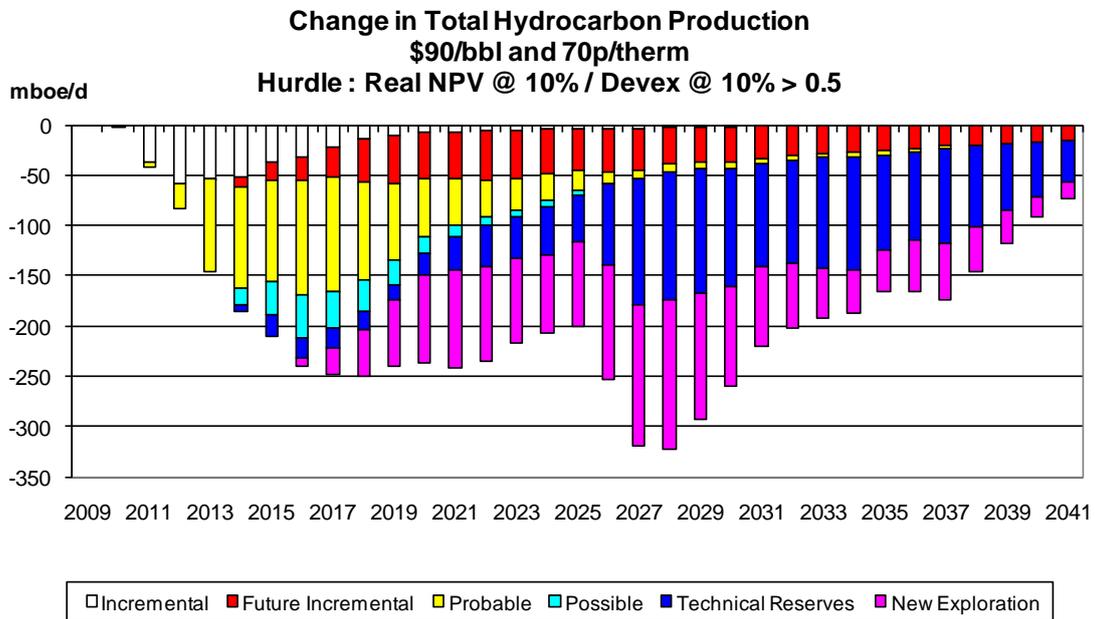


Chart 30

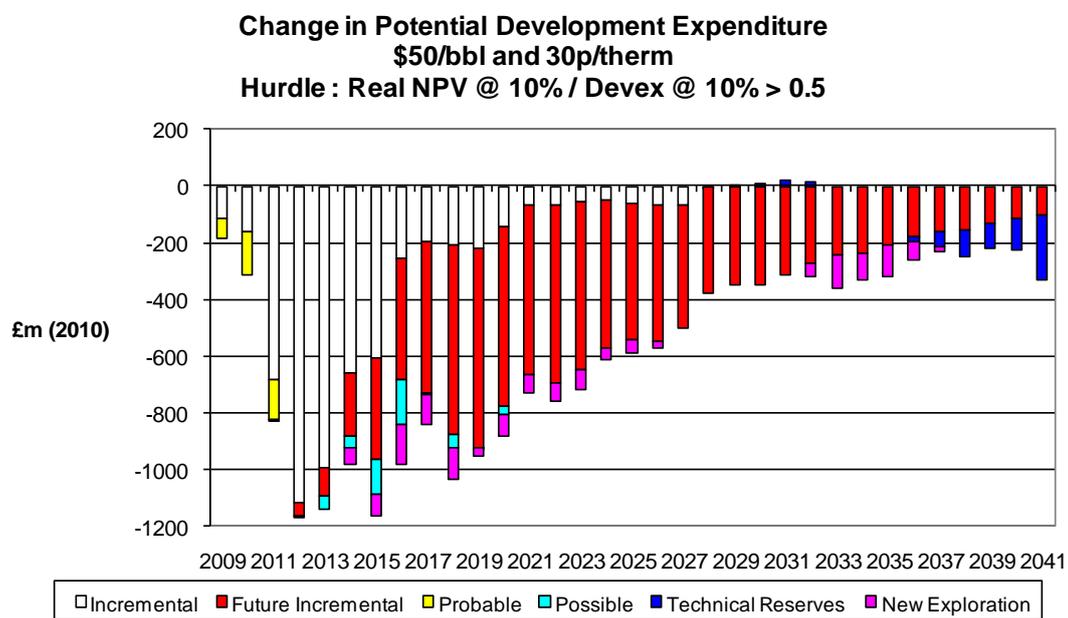


In Chart 30 the reduction in total hydrocarbon production is shown under the \$90, 70 pence case. The reduction grows to 250,000 boe/d in 2017. Over the whole period the sources of the reduction are principally

probable fields, technical reserves and new discoveries. Over the whole period the aggregate reduction in production is 2,254 million boe. This compares with total production of 23,614 million boe under pre-budget terms. The reduction is thus 9.5%.

(v) Changes in Development Expenditures

Chart 31

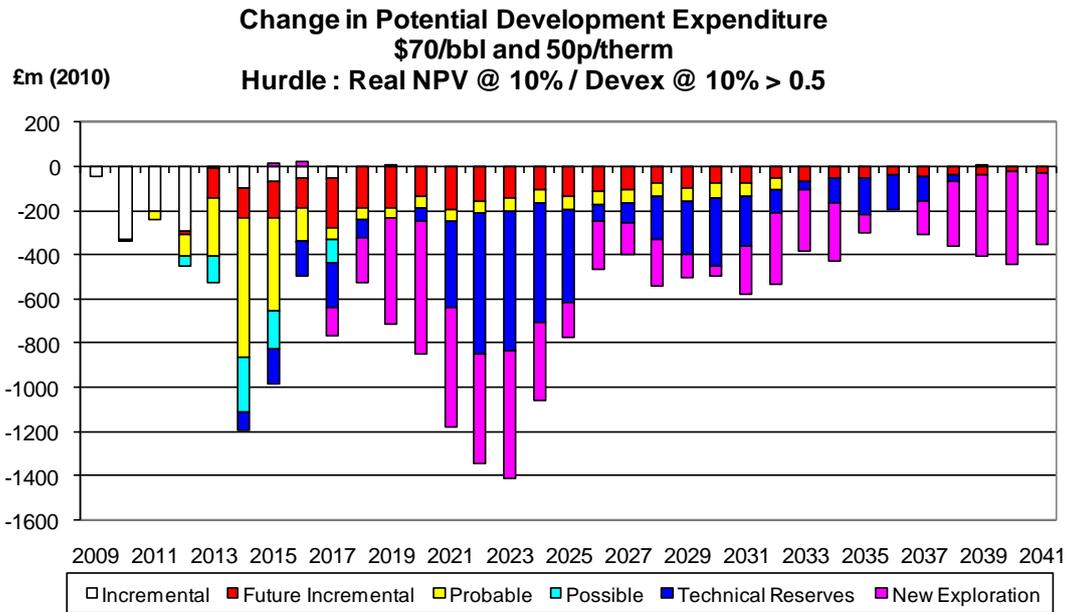


In Chart 31 the reduction in development expenditures under the \$50, 30 pence case is shown. The reduction grows rapidly to £1.2 billion in 2012 and is generally in excess of total amount until 2018. Over the period the reduction is mostly in incremental projects and new discoveries. Over the whole period the aggregate reduction in field investment is £19.2 billion (at 2010 prices).

In Chart 32 the reduction in development expenditures under the \$70, 50 pence case is shown. It increases to £1.2 billion in 2014 and peaks at

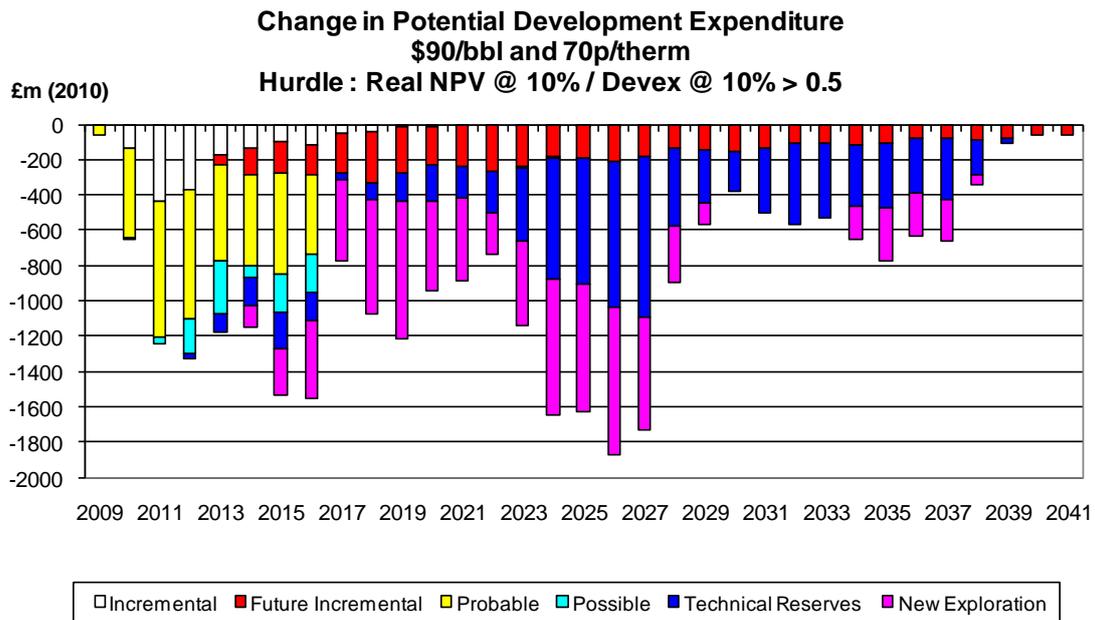
£1.4 billion in 2023. Over the period the reduction is principally among probable fields, new discoveries and technical reserves. Over the whole period the aggregate reduction in investment expenditures is £19.5 billion.

Chart 32



In Chart 33 the reduction in development expenditures under the \$90, 70 pence case is shown. It increases rapidly to £1.35 billion in 2012 and nearly £1.6 billion in 2015. Over the whole period the aggregate reduction in investment expenditures is £29.1 billion (at 2010 prices).

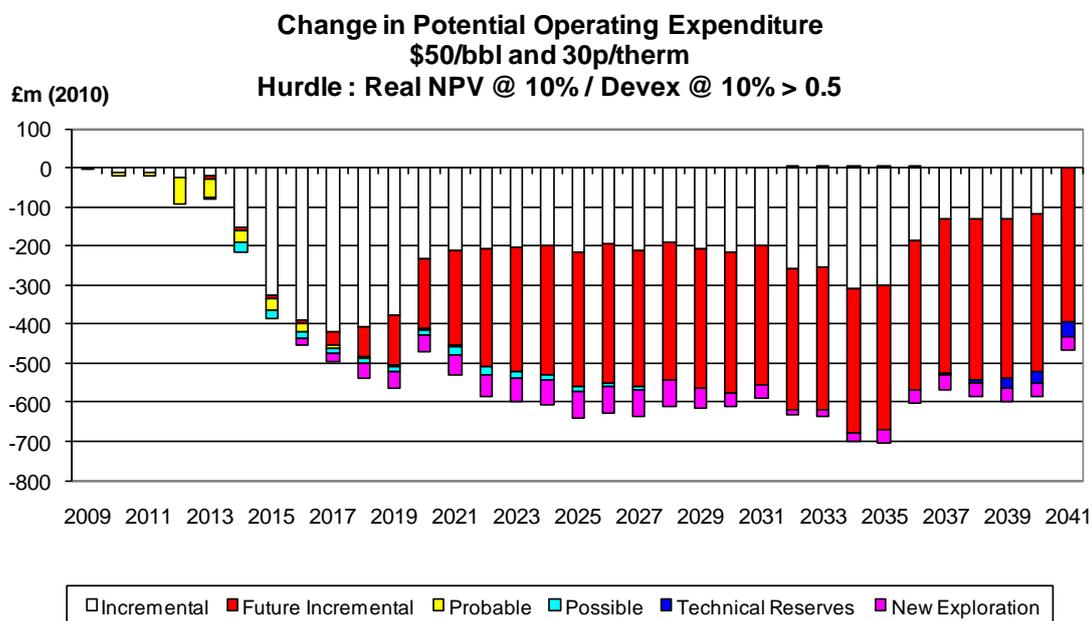
Chart 33



(vi) Changes in Operating Expenditures

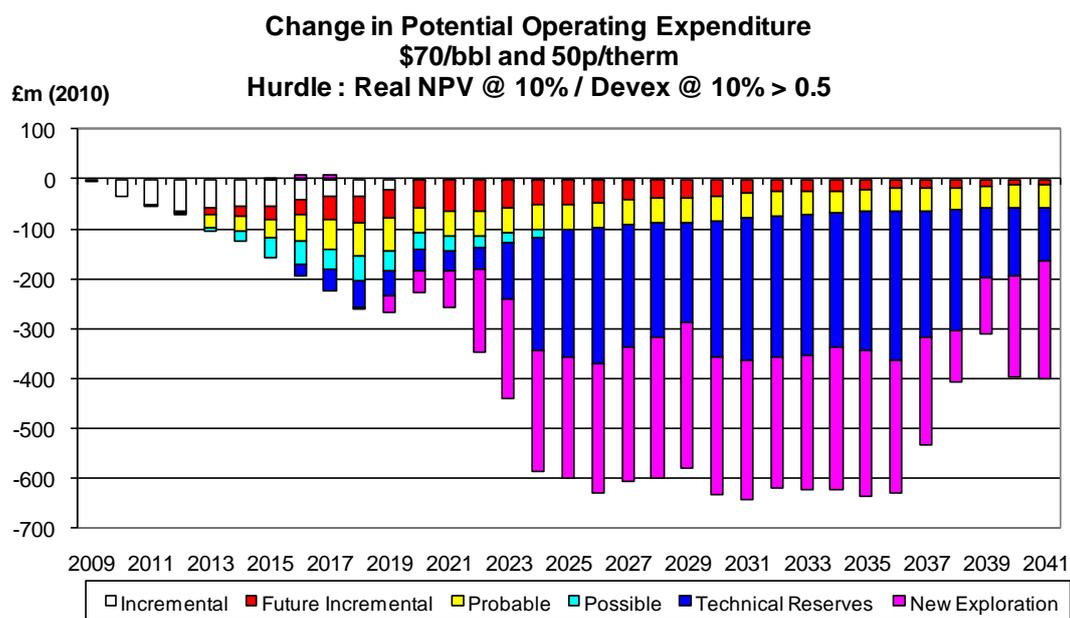
In Chart 34 the reduction in field operating expenditures is shown under the \$50, 30 pence case. These grow to £500-£600 million per year for much of the study period. The reductions are concentrated in new discoveries and incremental projects. Over the whole period the aggregate reduction in field operating expenditures is £16 billion (at 2010 prices).

Chart 34



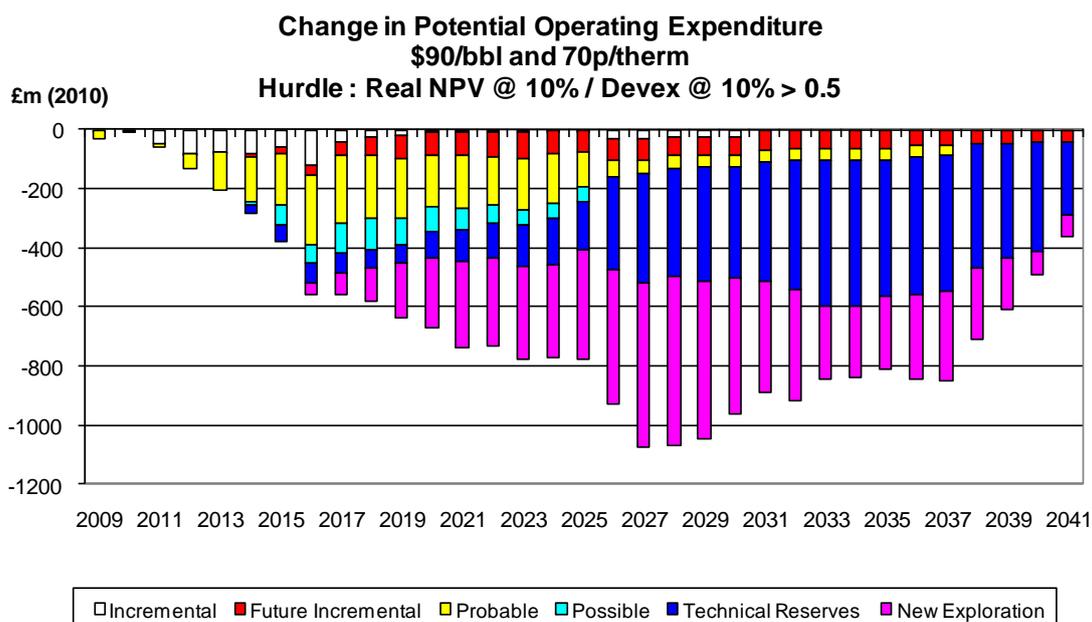
In Chart 35 the reduction in field operating expenditures is shown under the \$70, 50 pence case. They increase over the years to exceed £600 million in 2024 and remain above that level for many years. The reduction is most noticeable on new discoveries and technical reserves. Over the whole period the aggregate reduction in operating expenditures is £12.8 billion (at 2010 prices).

Chart 35



In Chart 36 the reduction in field operating expenditures under the \$90, 70 pence case is shown. The reduction grows steadily over the years to reach a maximum of over £1 billion in 2027. The decrease is principally among new discoveries and technical reserves. Over the whole period the aggregate reduction in operating expenditures is £21.1 billion.

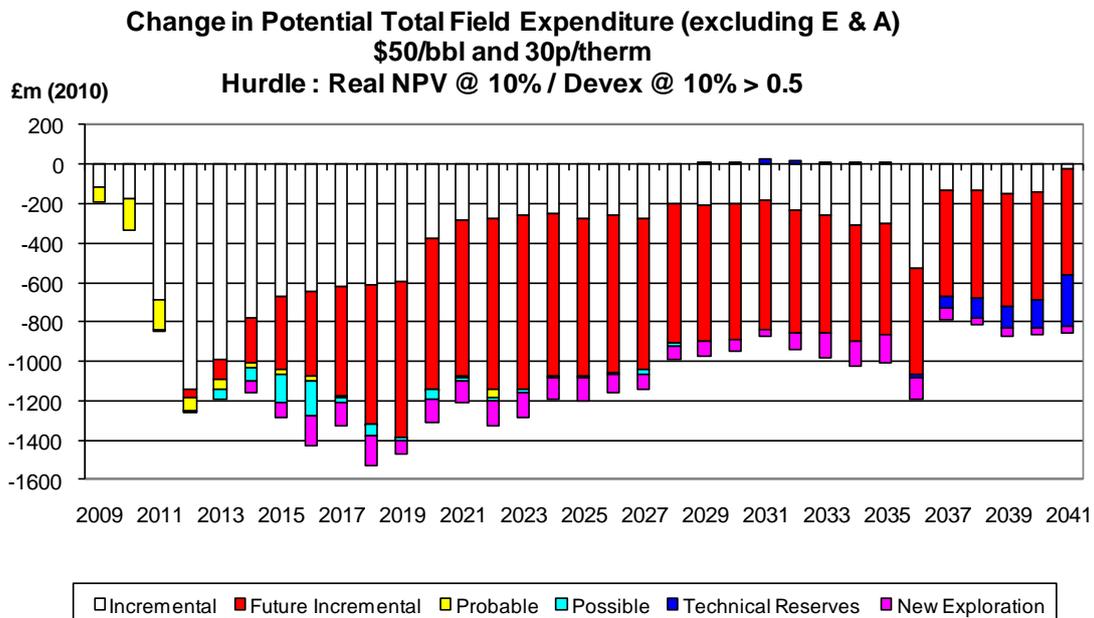
Chart 36



(vii) Changes in Total Field Expenditures

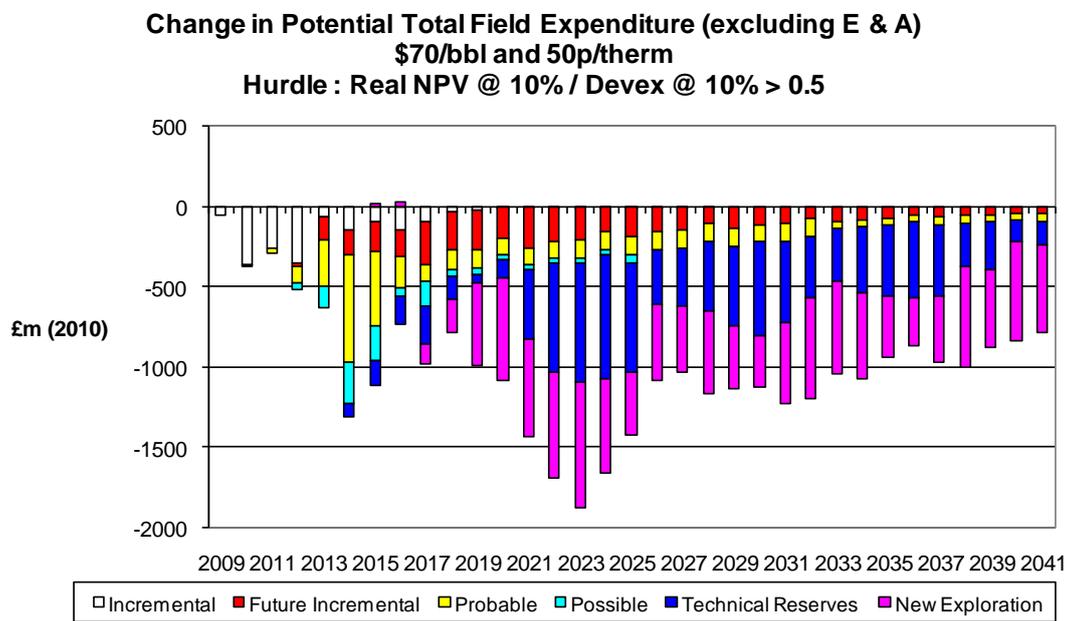
In Chart 37 the reduction in total field expenditures (including decommissioning) are shown under the \$50, 30 pence case. These increase rapidly to exceed £1.2 billion and attain a peak of £1.5 billion in 2018. The reduction is concentrated on incremental projects and new discoveries. Over the whole period aggregate field expenditures are reduced by £34.9 billion (at 2010 prices). Much of the reduction occurs in the categories of incremental projects and new discoveries.

Chart 37



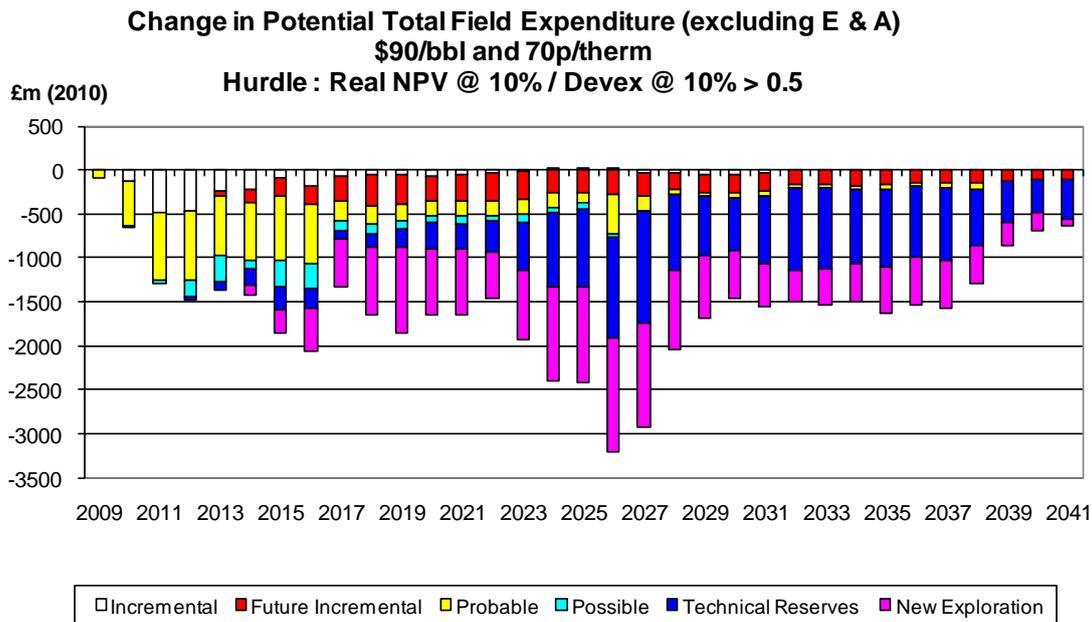
In Chart 38 the reduction in total field expenditures under the \$70, 50 pence case is shown. The reduction increases to £1.4 billion in 2014 and reaches a peak of £1.8 billion in 2023. Much of the reduction occurs in fields in the categories of technical reserves and new discoveries. Over the whole period the aggregate reduction in field expenditures was £33.2 billion (at 2010 prices).

Chart 38



In Chart 39 the reduction in total field expenditures under the \$90, 70 pence case is shown. The reduction reaches £1.5 billion in 2012 and reaches a peak of £3.2 billion in 2026. Over the whole period the aggregate reduction in field expenditures is £52.2 billion.

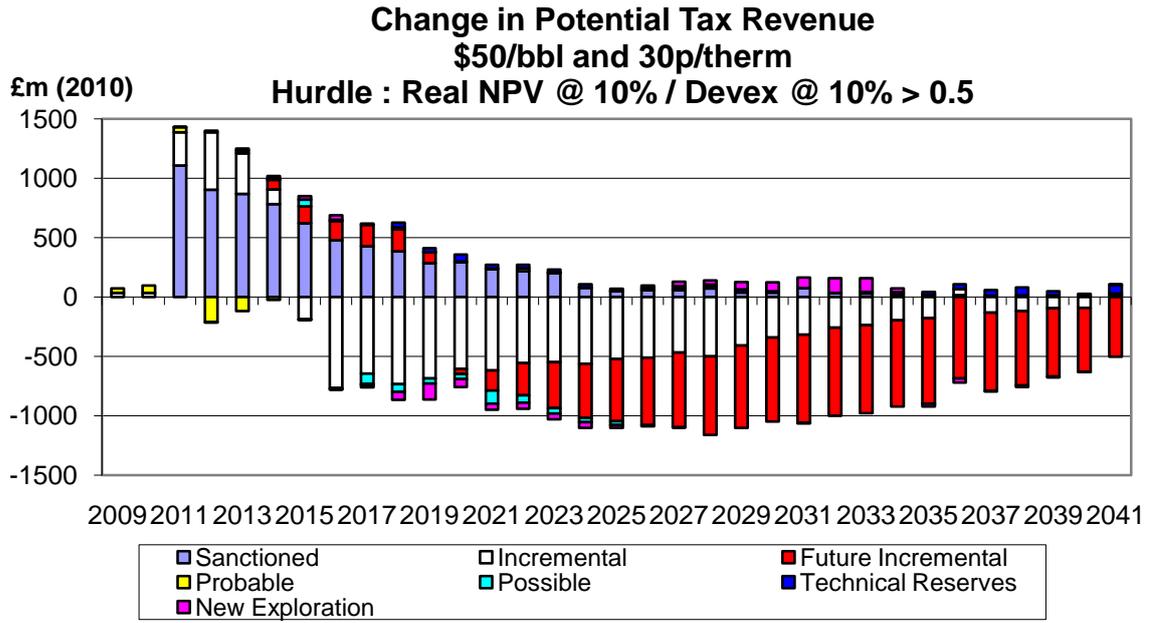
Chart 39



(viii) Changes in Tax Revenues

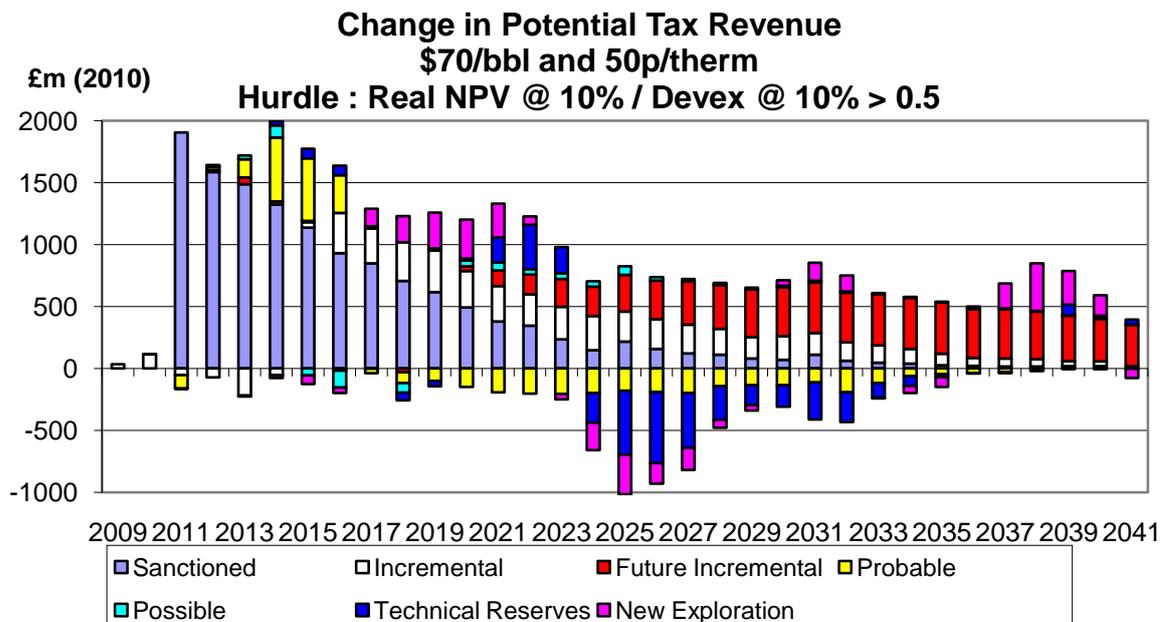
In Chart 40 the changes in the tax revenues are shown under the \$50, 30 pence case. While substantial increased net revenues occur over the next few years these are followed by large net revenue reductions. Over the whole period the aggregate reduction in tax revenues is £12.7 billion (at 2010 prices).

Chart 40



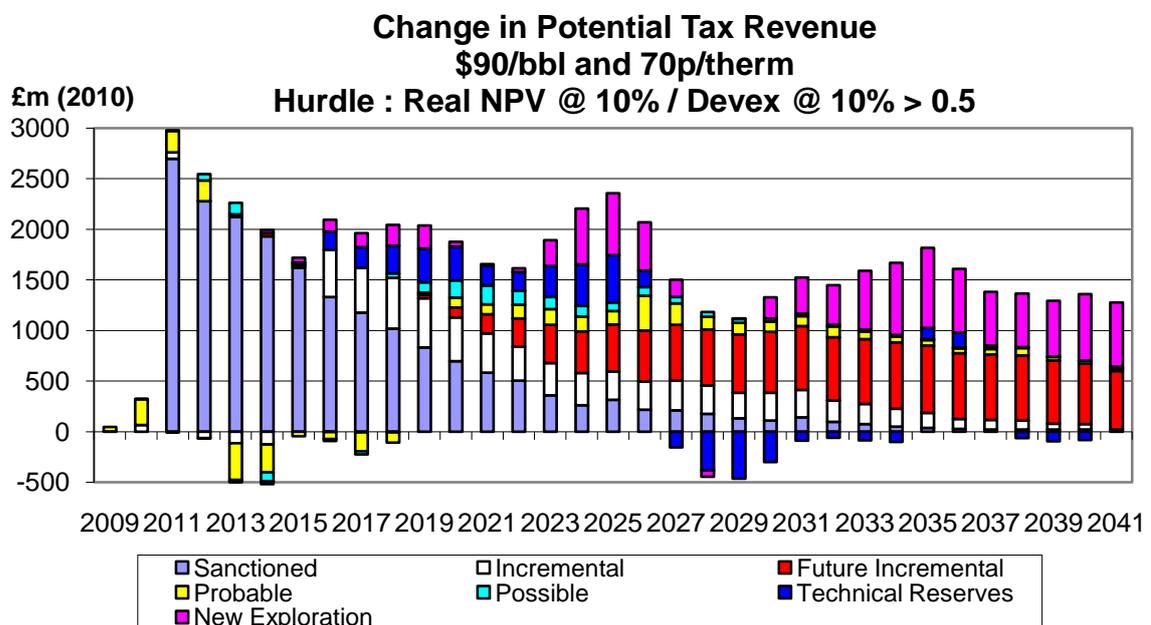
In Chart 41 the changes in tax revenues are shown under \$70, 50 pence case. Over the next few years the increases are in the £1.5-£2 billion range. After that they fall off sharply. Over the whole period the aggregate increase in tax revenue is £23.2 billion (at 2010 prices).

Chart 41



In Chart 42 the changes in tax revenues are shown under the \$90, 70 pence case. In the near term the increases are in the £2.5 billion-£3 billion range and for many years they exceed £2 billion per year. Over the whole period the aggregate increase in tax revenues is £51.6 billion (at 2010 prices). These are net increases and conceal major tax reductions from probable and possible fields of £4.2 billion.

Chart 42



4. Other Effects

In the economic modelling the emphasis has been on the effects of the tax increase on investment in new fields and incremental projects. As noted in Section 1 there are several other effects. Thus the increased tax rates reduce the returns from exploration and some marginally or modestly attractive prospects may not be drilled. There will be a reduced exploration effort on this count. Further, the reduced net cash flows reduce the ability of investors to finance exploration which can also result in a reduced exploration effort.

The UKCS is becoming increasingly dependent on medium and small companies not only for exploration but for field developments. The financing problem is increased by the tax increases. External providers of capital (debt and equity) will note the reduction in expected cash flows from the tax increase. Banks generally take a cautious view of the financing of projects in the petroleum industry and the net result may be greater difficulty in raising external finance for new developments.

The tax increase applies to tariff incomes as well as production incomes. One possible consequence is that asset owners may attempt to increase tariff rates to compensate for the increase in tax. In turn this could cause further difficulties in concluding tariff agreements.

5. Conclusions

In this study the effects of the tax increases announced in Budget 2011 on investment in new fields and incremental projects have been examined in detail under a range of oil and gas prices used for screening long term projects, and under two investment hurdles. When the investment hurdle was set at $NPV@10\%/I@10\% \geq 0.5$ the results under the \$50, 30 pence price were that over the 30-year period to 2041 there could be a reduction of 23 new field developments and substantial incremental projects undertaken. The result would be a cumulative reduction of oil and gas production of 920 million boe. A reduction in field investment of £19.2 billion (at 2010 prices) would occur. Total field expenditures would be reduced by £34.9 billion. Tax revenues would be reduced by £12.8 billion.

Under the \$70, 50 pence case there would be 62 less new field developments and major incremental projects undertaken over the period. The resulting loss of production would be 1.7 billion boe. The reduction in field investment would be £19.5 billion and the reduction in total field expenditures £33.2 billion. Tax revenues would increase by £23.3 billion.

Under the \$90, 70 pence case there would be 79 less new field developments and major incremental projects undertaken over the period. The resulting loss of production would be 2,254 million boe. The reduction in field investment would be £29.1 billion and the reduction in total field expenditures £52.2 billion. Tax revenues would increase by £51.6 billion.

There will be further reduction in activity relating to the reduced prospective returns on new exploration and the increased financing problems for medium and small companies resulting from the tax increases.

The analysis indicates that the policy of maximising economic recovery from the UKCS has been impeded by the tax increases. This is noteworthy with respect to incremental projects in mature fields subject to PRT, but also in many new fields where the investment and operating costs are very high. A noteworthy finding is that even under the \$90, 70 pence price case a substantial number of fields/projects are rendered uneconomic by the tax increases.

The root of the problem emanates from the coexistence of a flat-rate (or proportional) tax system (except where field allowances apply) with a

large number of undeveloped discoveries and incremental projects which cover a very wide range of expected profitability. Some fields/projects will offer substantial returns. Some will be moderately profitable, some will be marginally attractive and many will be uneconomic. The consequence of raising the flat tax by a significant amount will be to render some fields/projects uneconomic when they were acceptable on pre-budget terms. This study has quantified these effects.

A progressive tax system whereby the (percentage) take increases as the returns to investments increase and decrease when the returns are lower can more efficiently collect the highly differentiated economic rents which personify the situation in the UKCS. The above suggests that allowances relating to the investment costs are needed to facilitate the development of fields/projects which are uneconomic under the Budget 2011 proposals. For new fields there are already field allowances for the SC relating to physical characteristics namely small size, HP/HT, heavy oil, and remote, deep water gas fields. These are really proxies for investment costs and a cleaner system would be to have an allowance relating to the investment costs. This would be superior to allowances based on physical characteristics because there will inevitably be cases where a field is uneconomic for reasons other than those covered by the precise physical characteristics embedded in the field allowances.

The study has also highlighted the disincentives to pursue incremental projects in PRT-paying fields. These have become greater as a result of Budget 2011. To remedy this allowances against PRT relating to the investment costs of the incremental projects are appropriate.

A wider review of the system is necessary if maximum economic recovery is to be attained. This would include further examination of appropriate tax rates as well as allowances.