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The Prospects for Activity in the UKCS to 2035: the 2007 Perspective

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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 is also financed by a grant from the Natural Environmental Research Council (NERC).

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b) Prospective Activity Levels in the UKCS to 2035
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d) Economic and Taxation Aspects of CO2 Capture, Transportation, Injection in fields in UKCS, EOR and Sequestration
   (i) Estimation of (Integrated) Cost Curves for CO_2 Capture, EOR and Sequestration in the UKCS6
   (ii) Taxation and other Incentives for CO_2 Capture, EOR and Sequestration
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The Prospects for Activity in the UKCS to 2035: the 2007 Perspective

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The Prospects for Activity in the UKCS to 2035: the 2007 Perspective

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1. <u>Introduction</u>

The prospects for activity levels in the UK Continental Shelf (UKCS) are a function of several factors including prospectivity, (size of field and expected success rate), costs of exploration, appraisal and development, oil and gas prices, the availability and cost of access to infrastructure, technological progress, and the tax régime applied to the various activities. This study incorporates all these factors in the modelling of prospective activity to 2035.

2. <u>Methodology and Assumptions</u>

The projections of 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, recently-updated, 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 over 300 sanctioned fields, 90 incremental projects (61 probable and 29 possible) relating to these fields, 29 probable fields, and 25 possible fields. All these are as yet unsanctioned but are currently being examined for development. An additional database contains 227 fields defined as being in the category of technical reserves. Summary data on reserves (oil/gas) and block location 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 2030. 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 10 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 4 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	50	40
Medium	45	36
Low	35	28
Very Low	30	18

These values are below current market levels but are used to reflect values generally used by investors when assessing long-term investments.

The postulated numbers of annual exploration wells for the whole of the UKCS are as follows:

Table 2 Exploration Wells		
	2007	2030
High	45	35
Medium	40	32
Low	30	22
Very Low	25	18

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

It is postulated that success rates depend substantially on a combination of (a) recent experience, and (b) size of the effort. It is further suggested that higher 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 that higher effort involves the acceptance of higher risk. For the UKCS as a whole 4 success rates were postulated as follows:

Table 3 Success Rates	
Medium effort/Medium success rate	= 23%
Very High effort/Very Low success rate	= 18%
High effort/Low success rate	= 19%
Low effort/High success rate	= 24%

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	13
CNS	27
NNS	21
MF	40
WoS	80
IS	5

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 2030. For the whole period the total numbers of discoveries for the whole of the UKCS were are follows:

Table 5 Total Number of Discoveries to 2030	
Very High Effort/Very Low Success Rate	177
High Effort/Low Success Rate	165
Medium Effort/Medium Success Rate	144
Low Effort/High Success Rate	126

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. 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 the whole of the UKCS the average development costs on this basis were $11.72/boe with quite a wide variation. Operating costs over the lifetime of the fields were also calculated, as were the decommissioning costs. Total lifetime field costs were found to average well over $21 per boe, and were over $20 per boe in the SNS, nearly $24 per boe in the CNS and $27 per boe in the NNS.

For new discoveries annual operating costs were modelled 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 was reduced reflecting the presence of economies of scale in the exploitation costs of fields.

With respect to fields in the category of technical reserves it was recognised that many have remained undeveloped for a long time, so the mean development costs in each of the basins was set at $1/bbl higher than for the new exploration finds. 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. This subject is currently very pertinent in the UKCS. The ceilings were assumed to be linked to the oil/gas scenarios with maxima of 20, 20, 17 and 13 respectively under the High, Medium, Low and Very Low Price Cases. These constraints do not apply to incremental projects which are additional to new field developments. To put these assumptions in perspective 13 new fields received development approval in 2005 and less in 2006, but in the 1990's significantly higher numbers (around 20 per year) were achieved.

A noteworthy feature of the 112 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 and executed. They are just not yet at the serious planning stage. Such projects can be expected not only on currently sanctioned fields but also on 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 90 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.

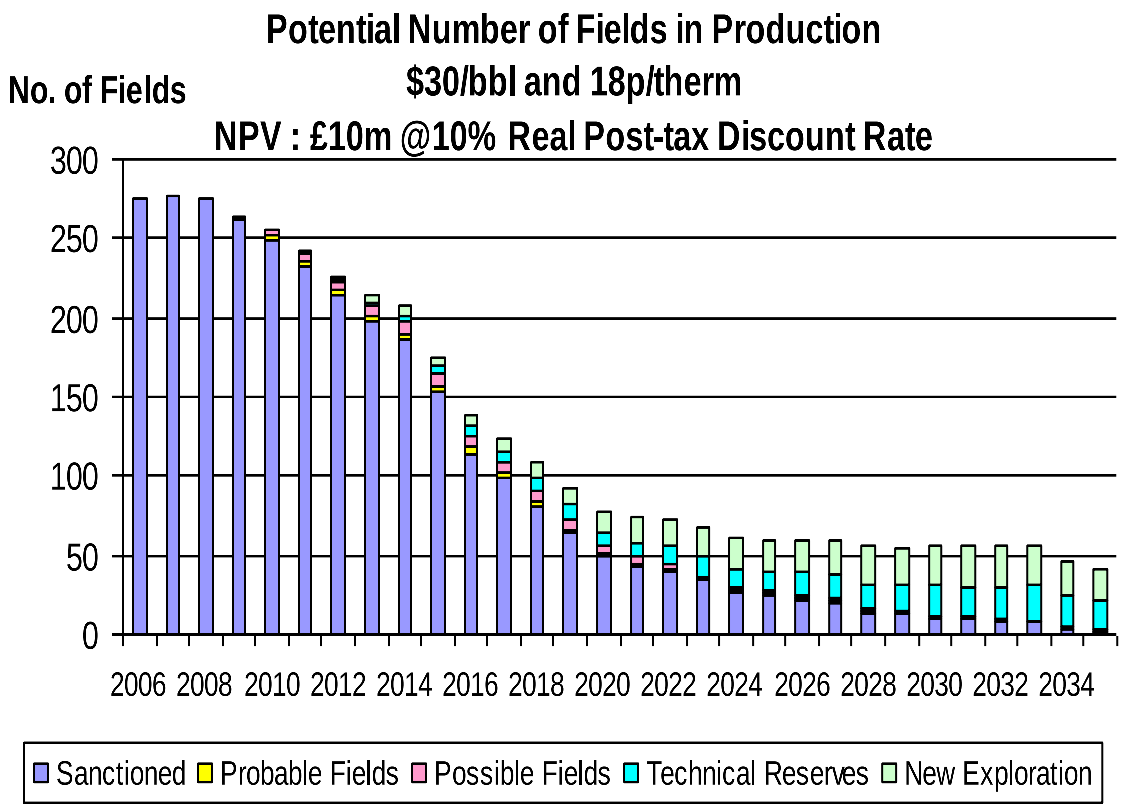
The financial modelling incorporated a discount rate, field economic cut-off, and the full details of the current petroleum tax system. The base case emphasised has a post-tax discount rate of 10% in real terms. An important assumption is that adequate infrastructure will be available to facilitate the development of the future projects. It is also assumed that investment decisions are made on the basis of the oil/gas prices indicated. When the prospective investments in probable and possible fields and incremental projects were subjected to economic analysis it was found that most were quite small and the returns in terms of NPVs were correspondingly often small Investors have expressed concern abut the materiality of projects in the UKCS compared to opportunities elsewhere in the world, and, to reflect these, two alternative investment criteria were used to reflect the relationship between the risks and rewards and capital allocations. The first was a minimum NPV of £10 million at the 10% real discount rate. The second was a minimum NPV/I ratio of 0.3 (NPV/I) +1=1.3. I was expressed in pre-tax terms to reflect the manner in which capital is allocated by investors (rather than the textbook approach which has both NPV and I on a post-tad basis).

3. Results of Modelling

a) Very Low Price Case

Under the Very Low Price Case the activity levels under the £10 million minimum NPV investment criterion are shown in Charts 1 – 8 and in Charts 9 – 16 under the NPV/I criterion. It is seen that the number of producing fields drops sharply and the decline rate in production is very fast, especially with gas. Total hydrocarbon production falls to around 2.5 mmboe/d in 2010 and 0.7 mmboe/d in 2020 under the £10 million NPV criterion and to less than 0.5 mmboe/d in 2020 under the NPV/I criterion. Very many of the potential new field developments are uneconomic with both criteria. Consequently field development expenditures collapse to extremely low levels by 2011. In effect under this scenario the UKCS becomes nearly non-viable as far as new investments are concerned. Decommissioning expenditures are seen to reach major levels from 2014 onwards, with many large fields being decommissioned in the period 2014 – 2021.

Chart 1



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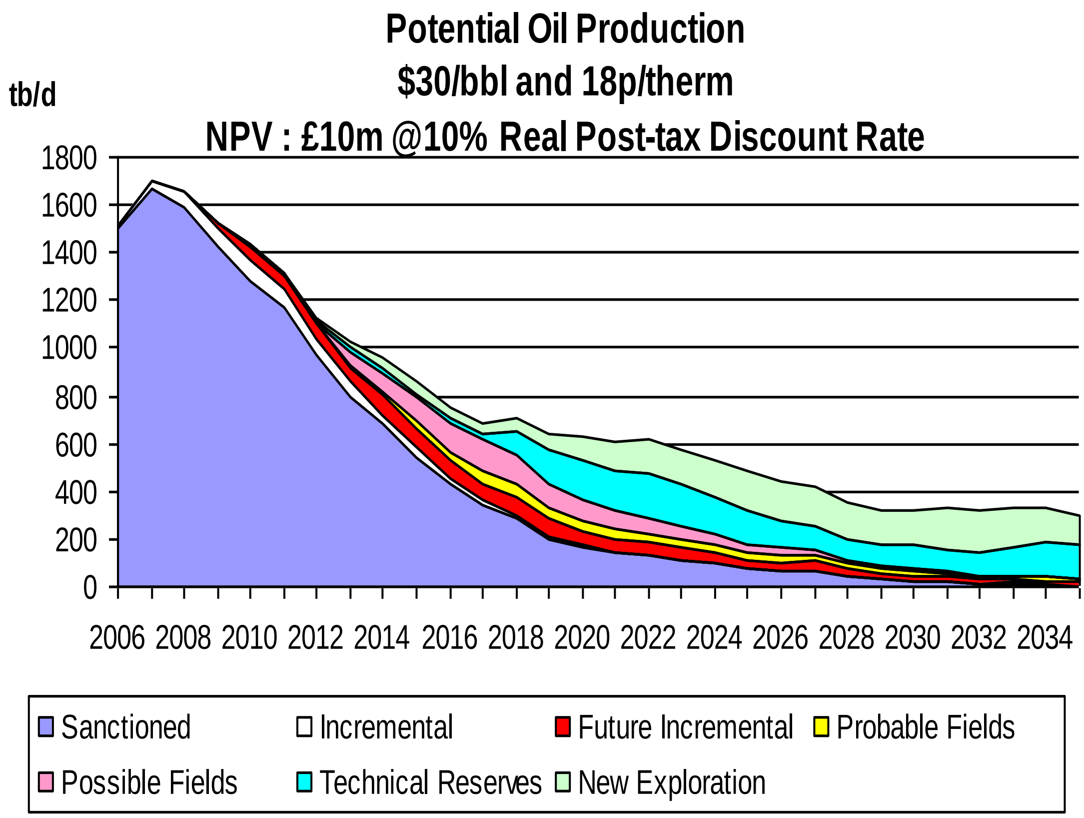

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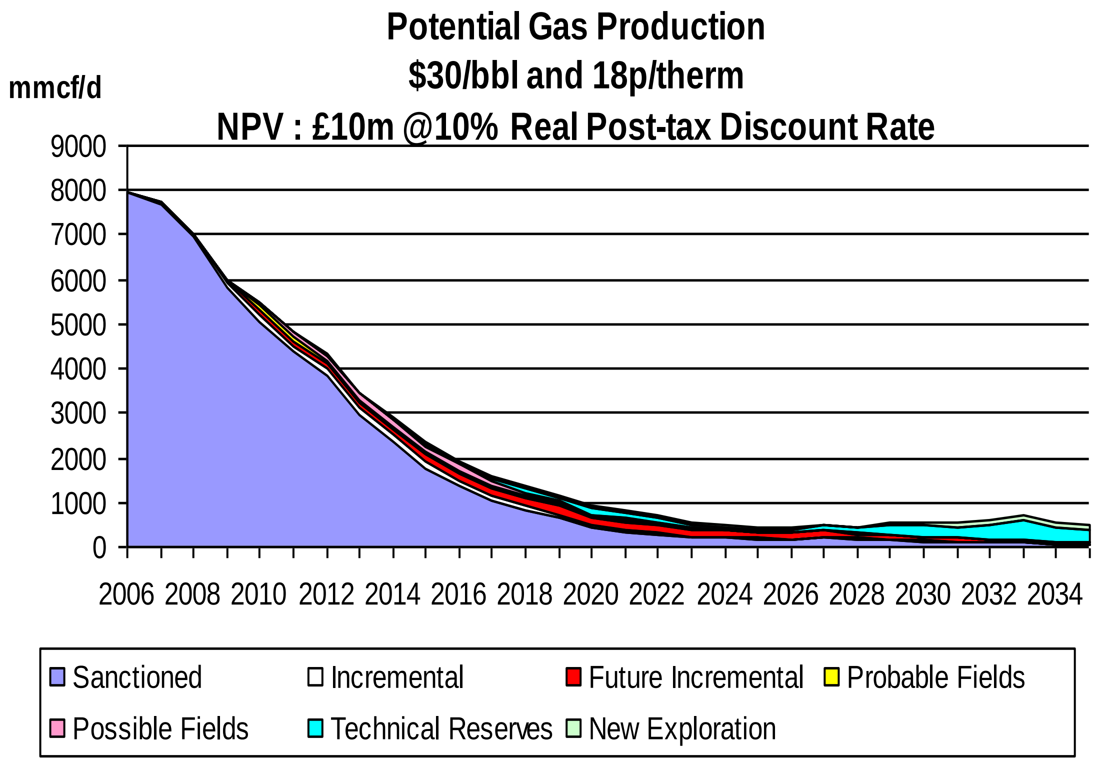

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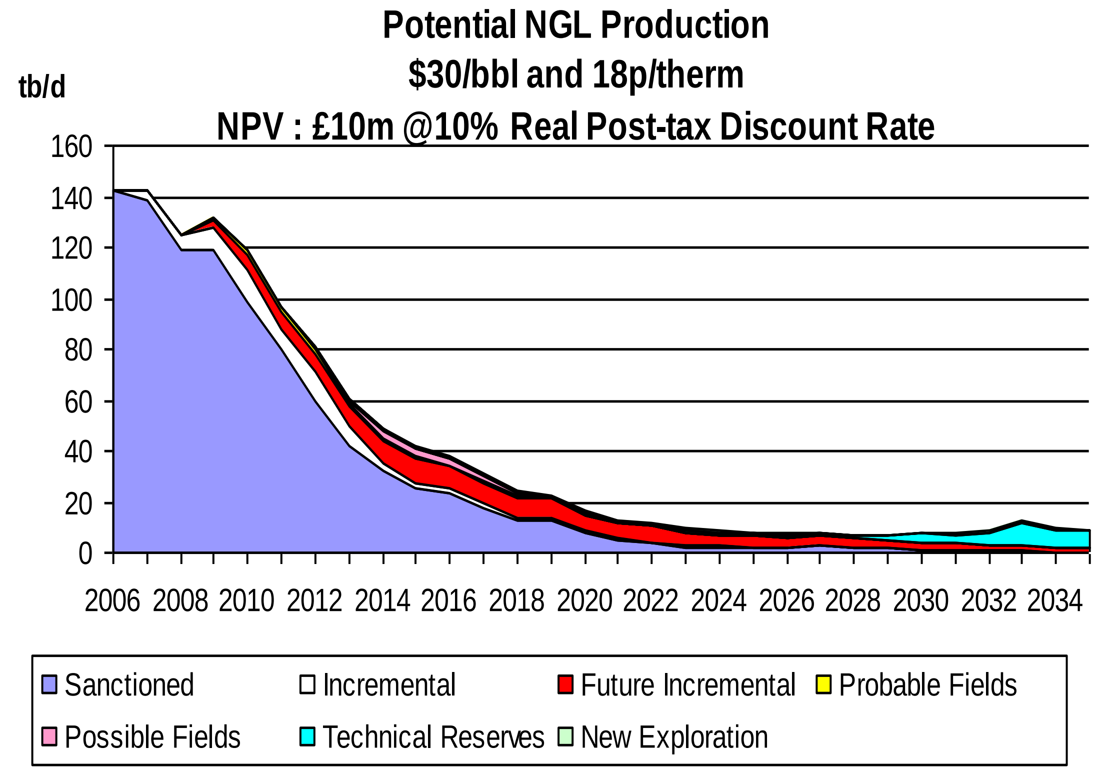

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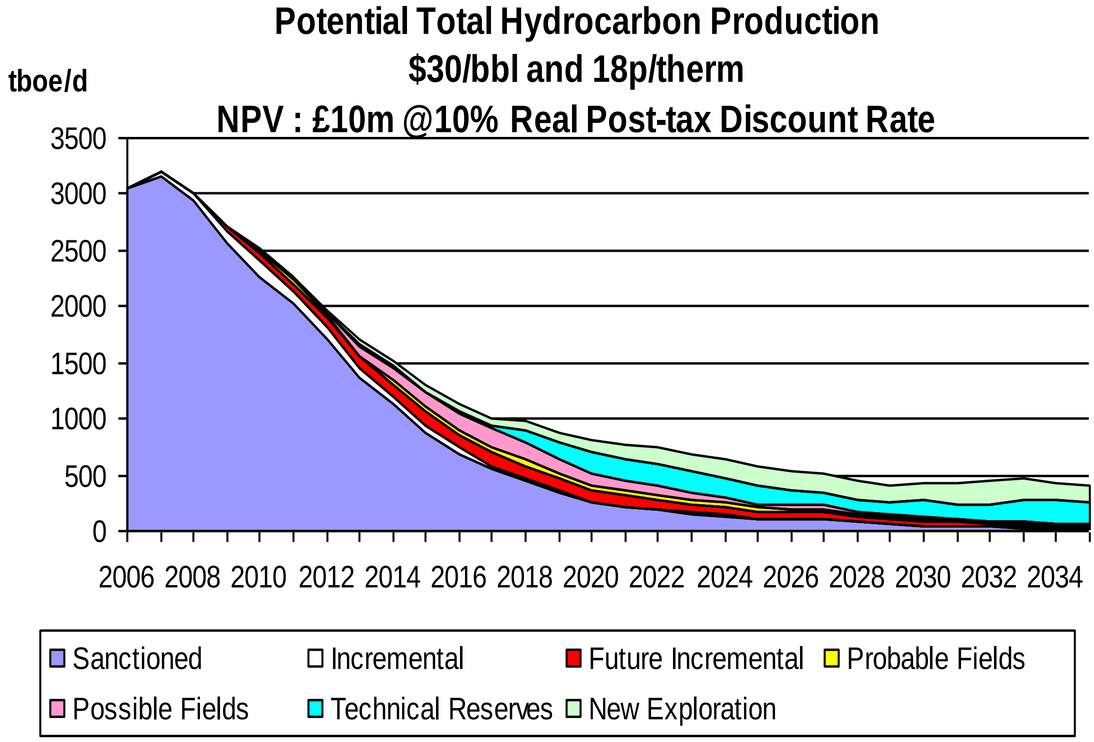

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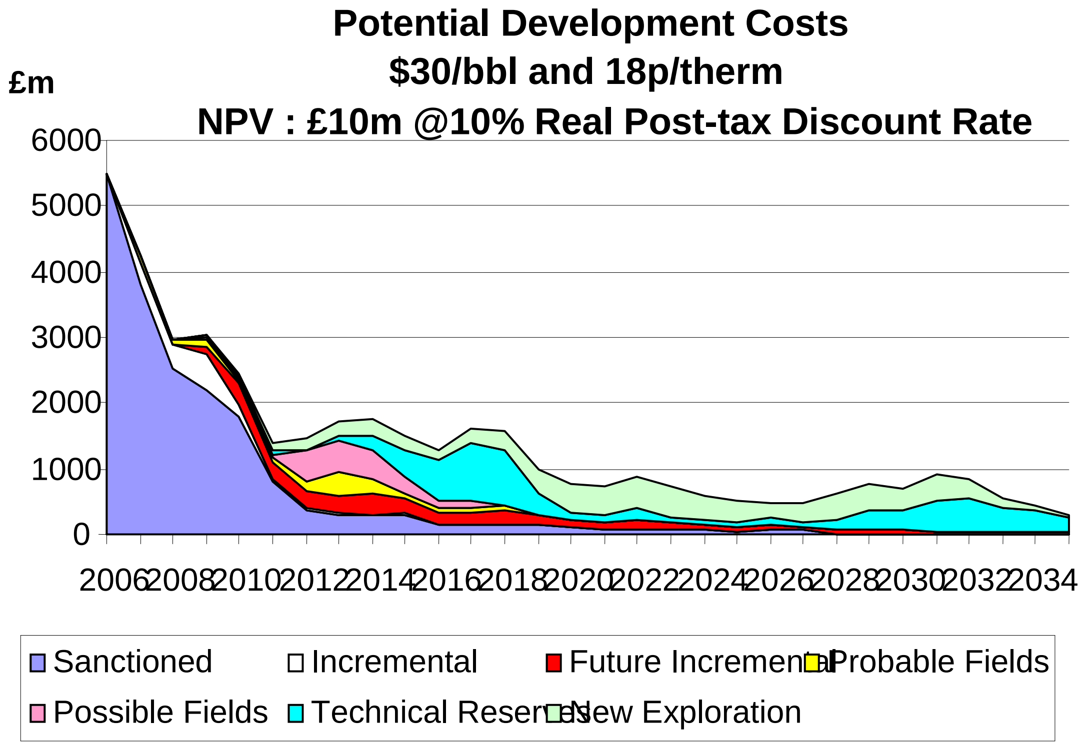

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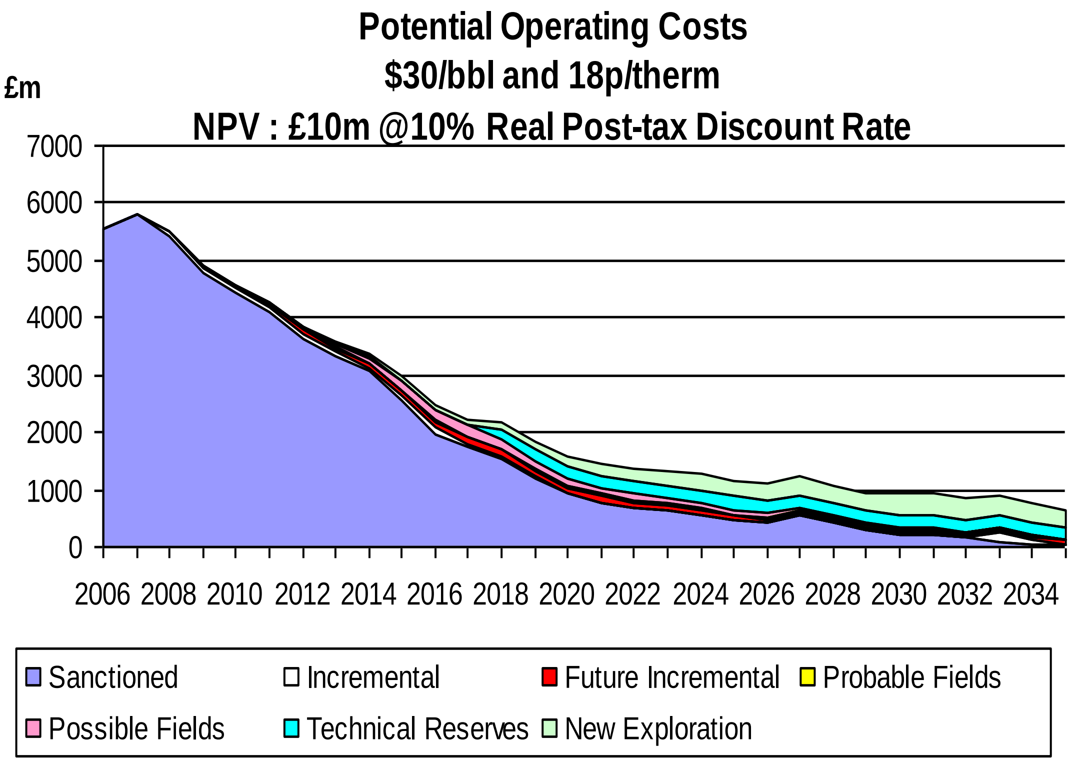

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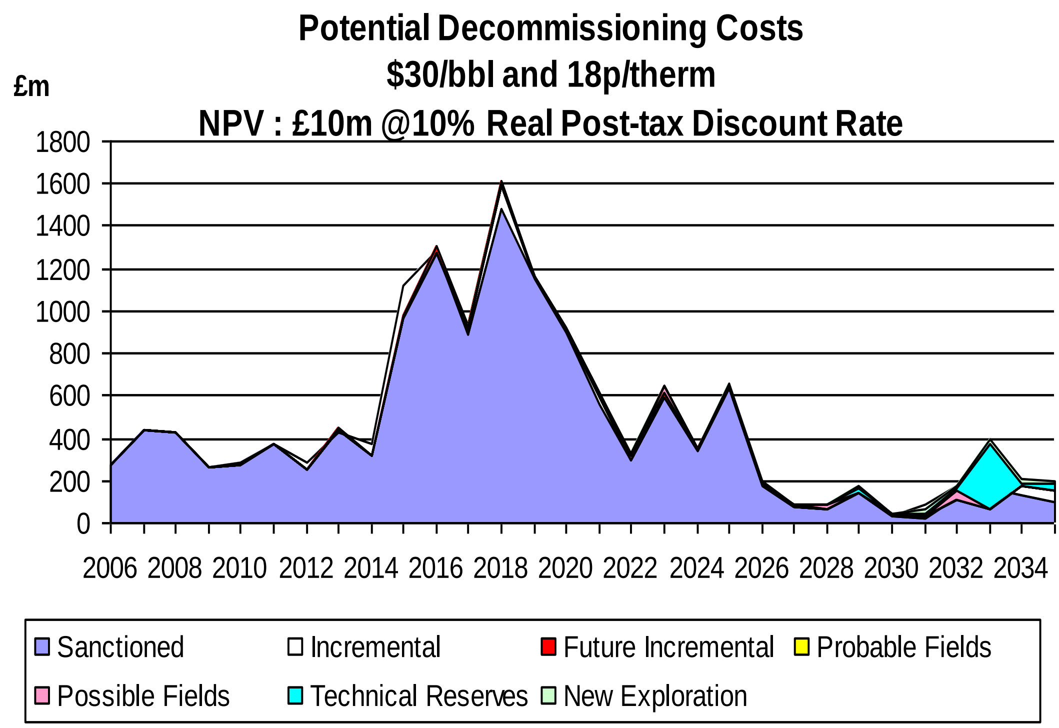

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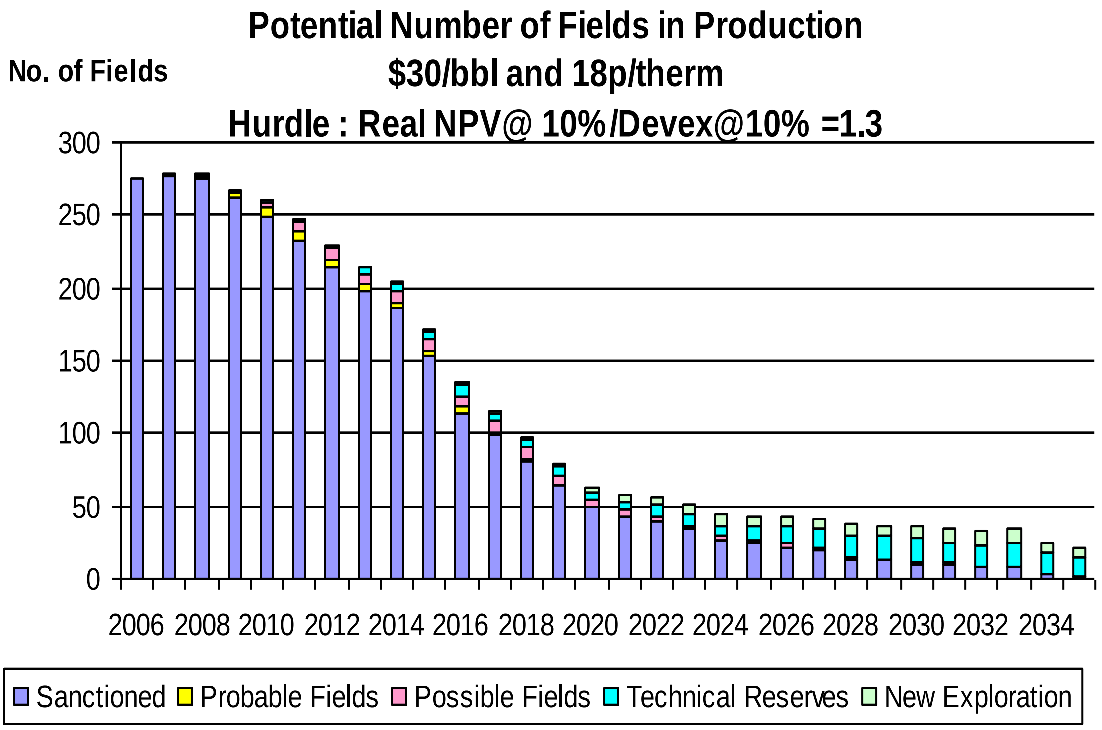

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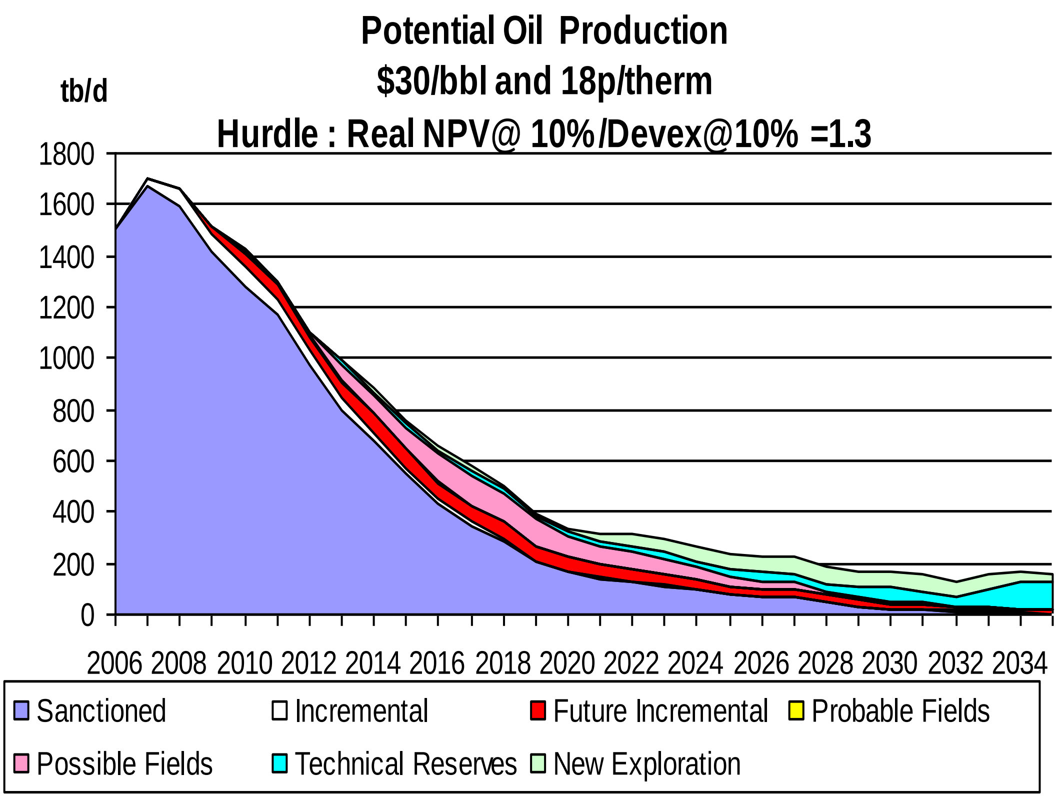

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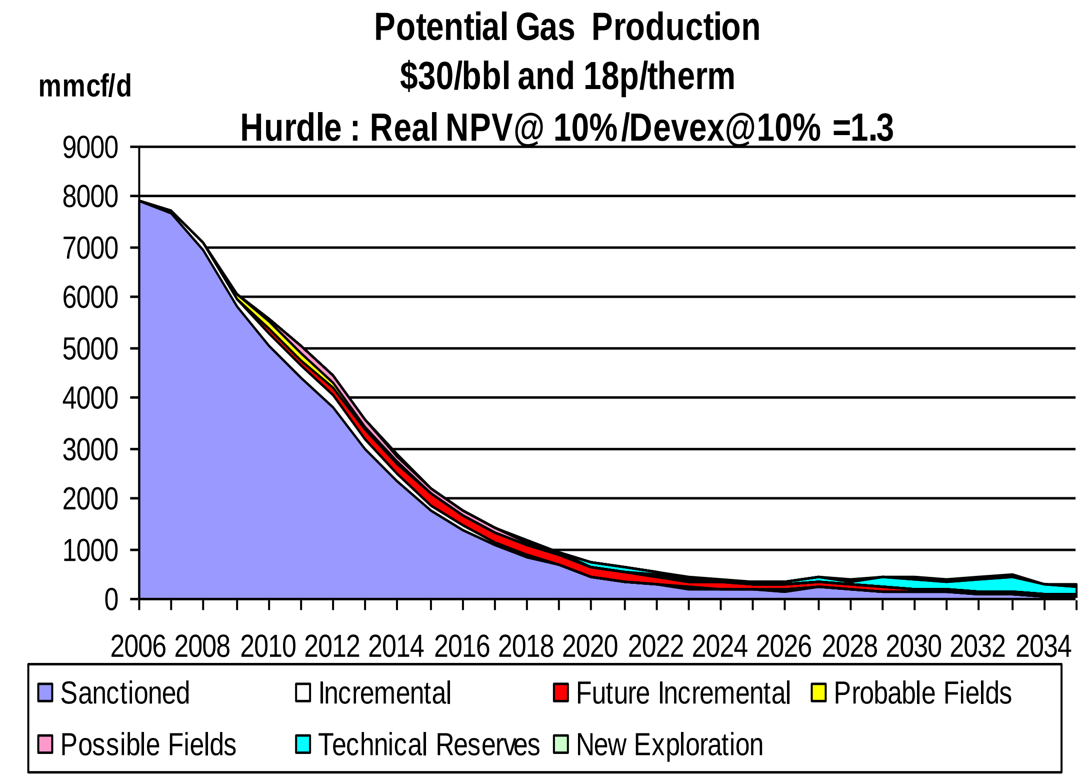

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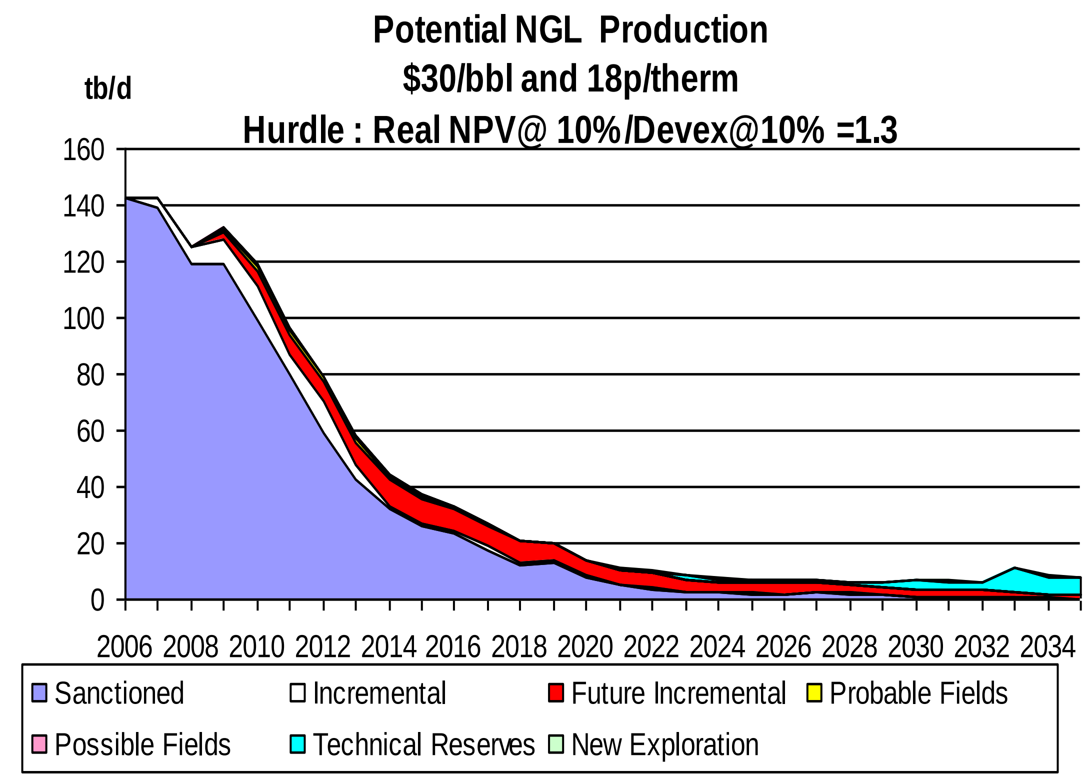

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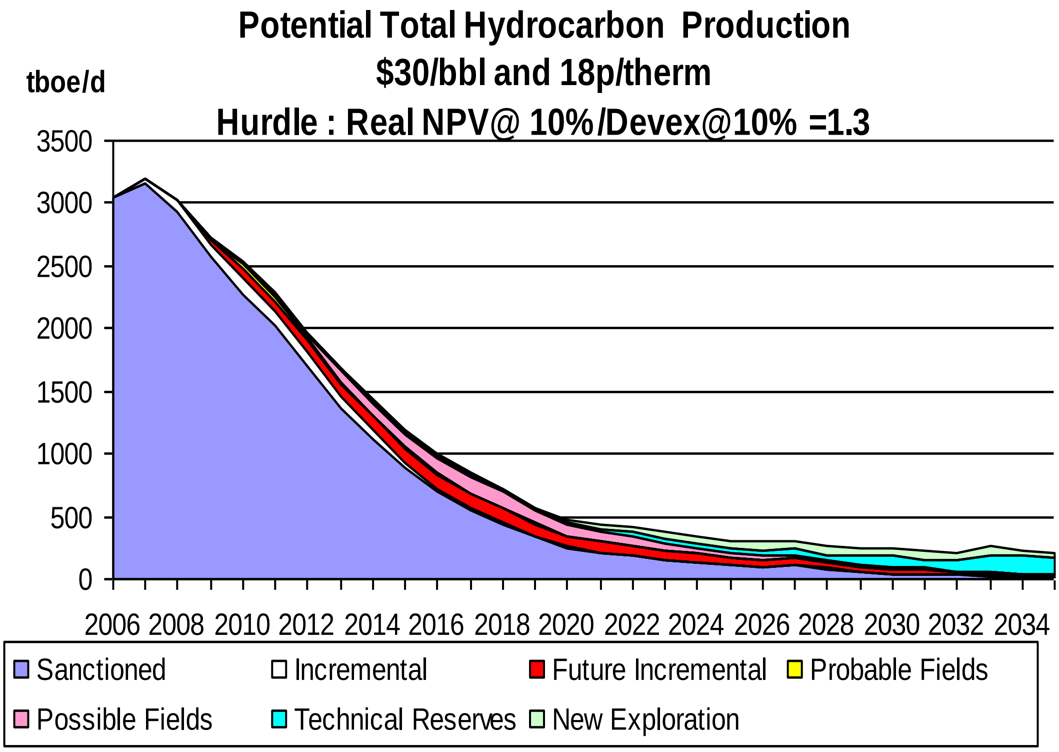

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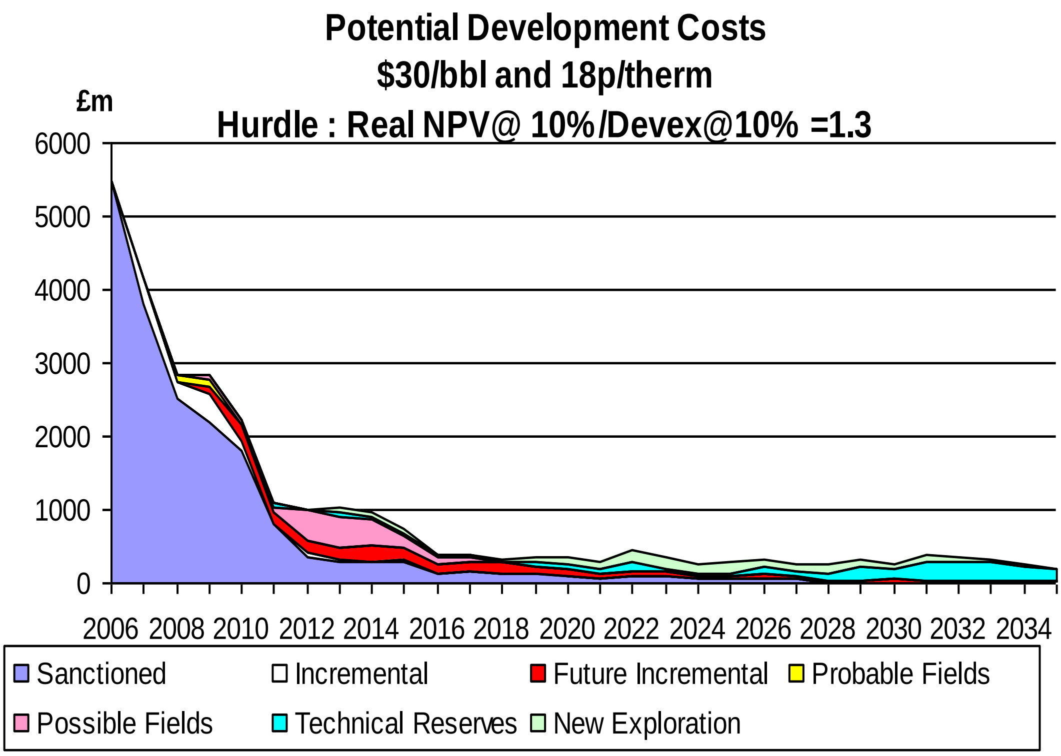

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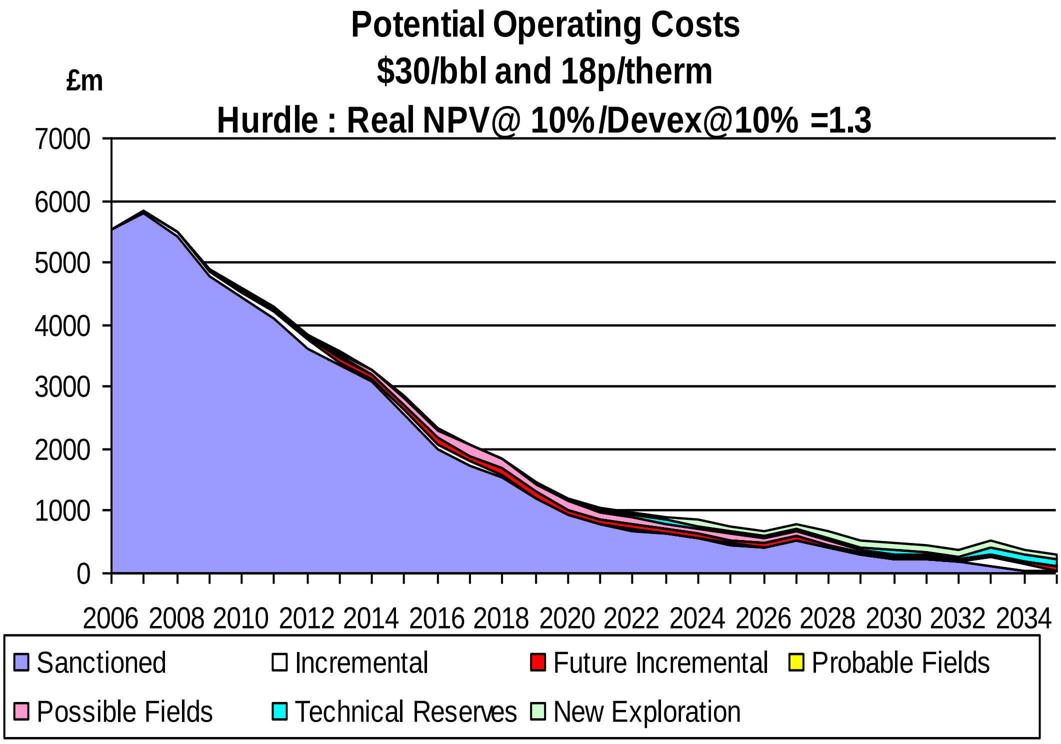

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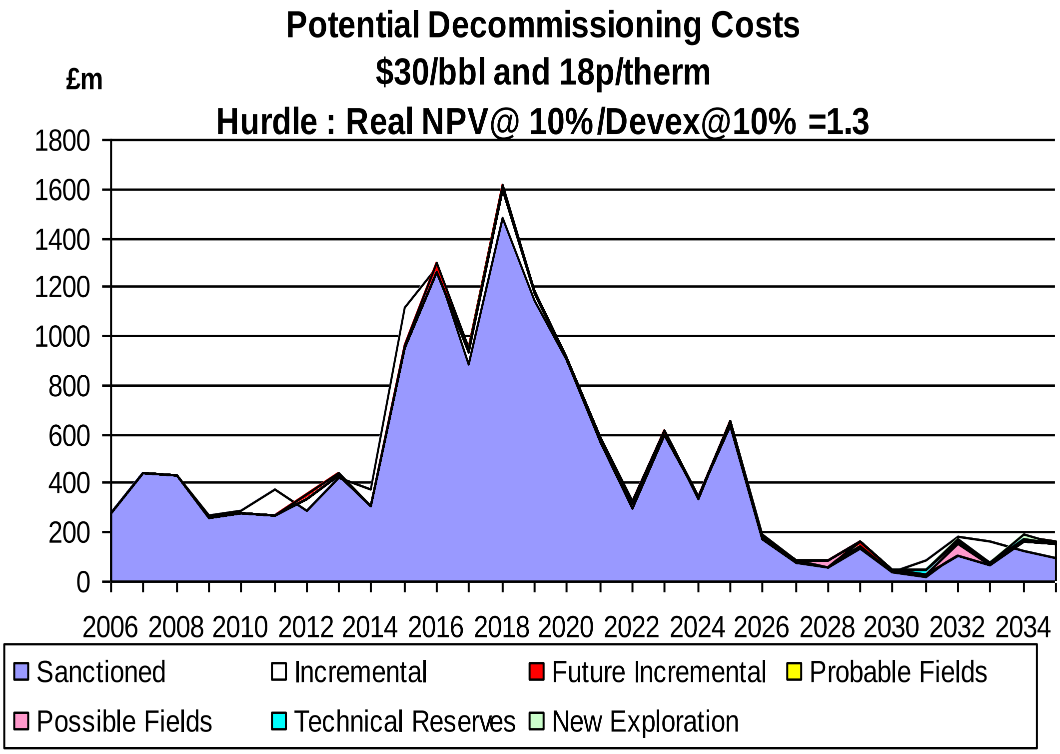
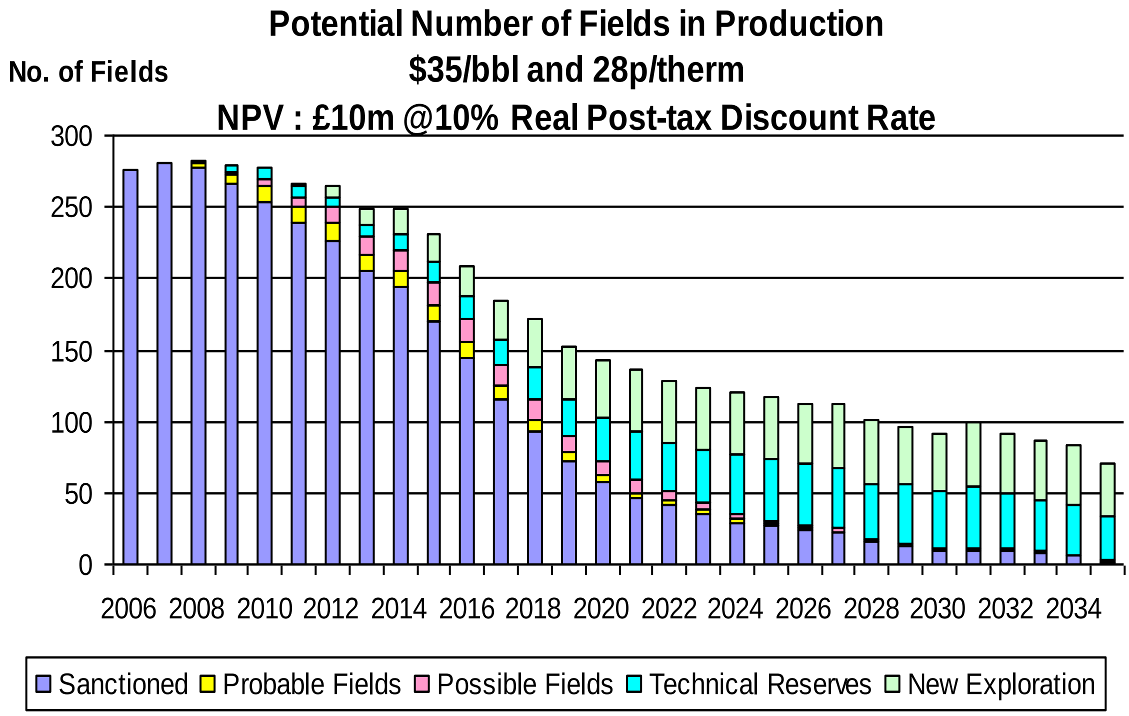


b) Low Price Case

The results under the Low Price Case are shown in Charts 17 – 24 with the £10 million NPV criterion and in Charts 25 – 32 under the NPV/I criterion. It is seen that activity levels are significantly higher compared to the Very Low Price Case, but nevertheless the production decline rates are still quite fast, especially for gas. Total hydrocarbon production is around 2.65 mmboe/d in 2010 and 1.4 mmboe/d in 2020. Field development investment also declines substantially from current levels, but on average remains in excess of £3 billion per year to 2018. With the NPV/I criterion future activity levels are generally substantially lower in the longer term. Thus total hydrocarbon production is around 0.75 mmboe/d in 2020 and field development expenditures in the longer-term markedly lower than with the minimum NPV criterion.

The regional distribution of activity is indicated in the Appendix in Charts A.1 – A.6 for the minimum NPV criterion and in Charts A.7 – A.12 for the NPV/I criterion. A noteworthy feature is the substantial longer term contribution to oil productions from West of Scotland. The gas contribution is very modest, however, it should be stressed that new discoveries projected for the West of Scotland region reflect-recent trends, and, given the large amount of unexplored acreage, a breach in the trend is still possible.

Chart 17



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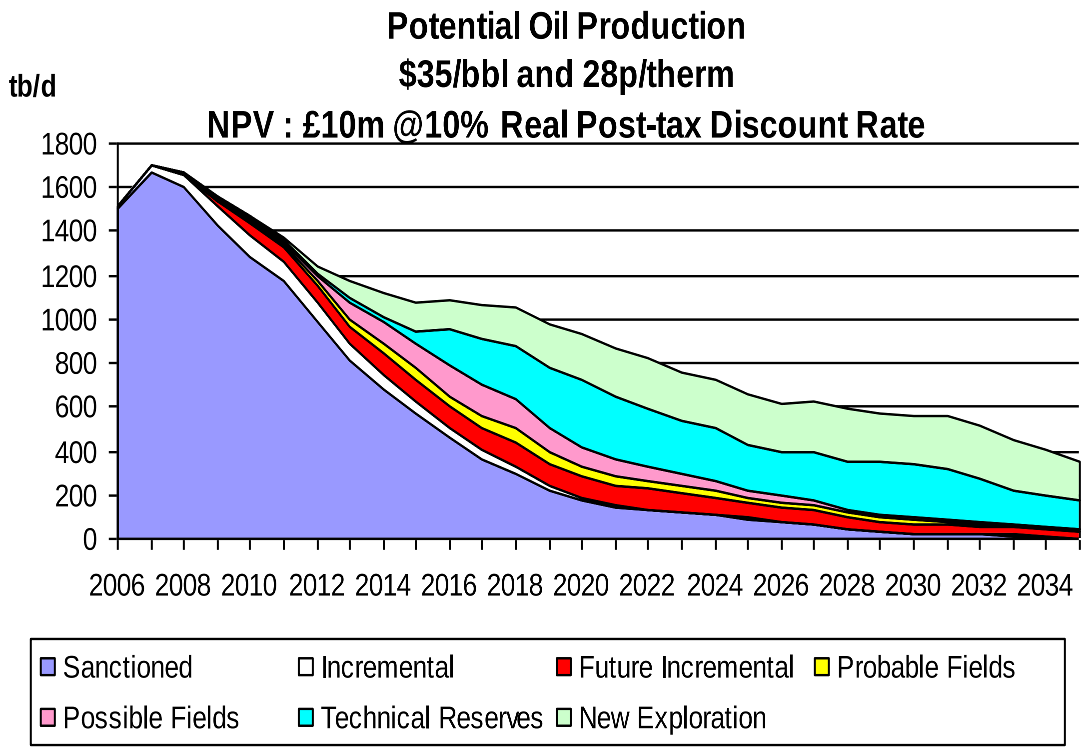

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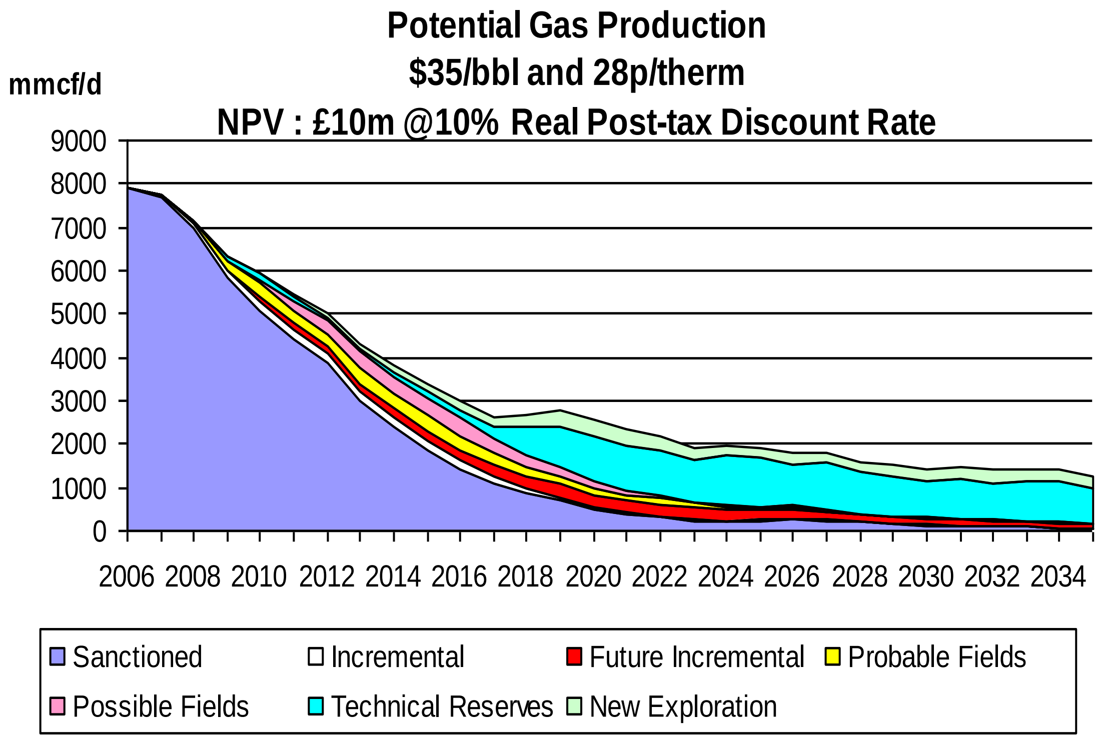

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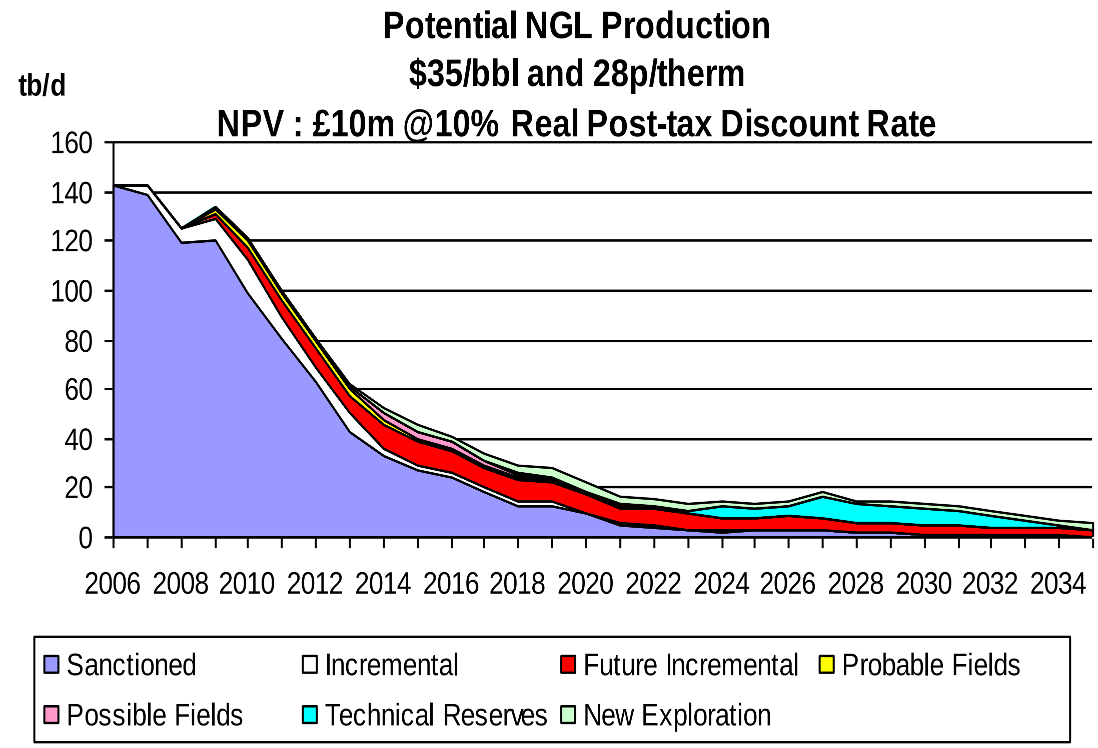

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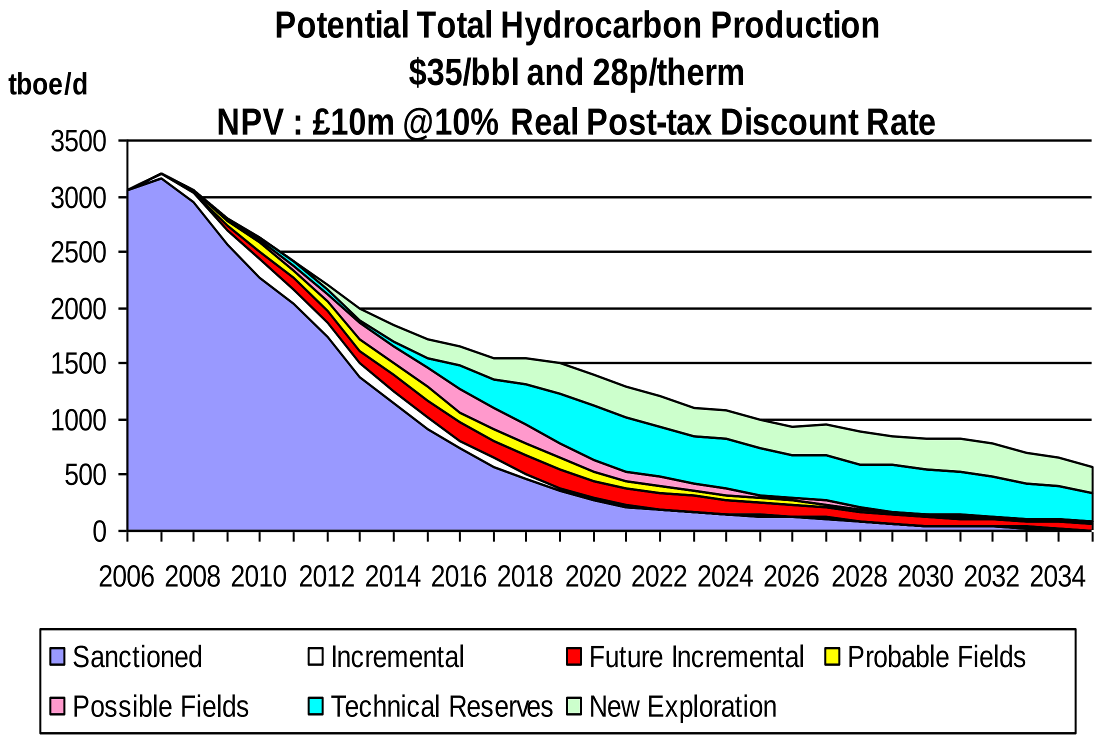

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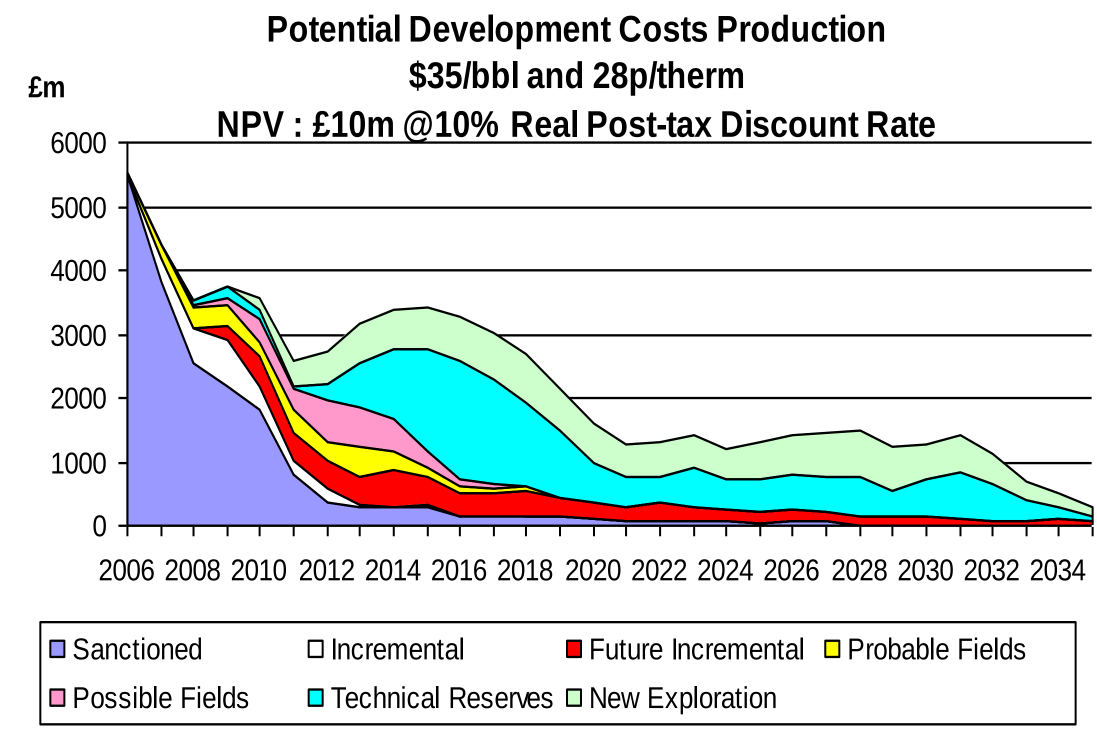

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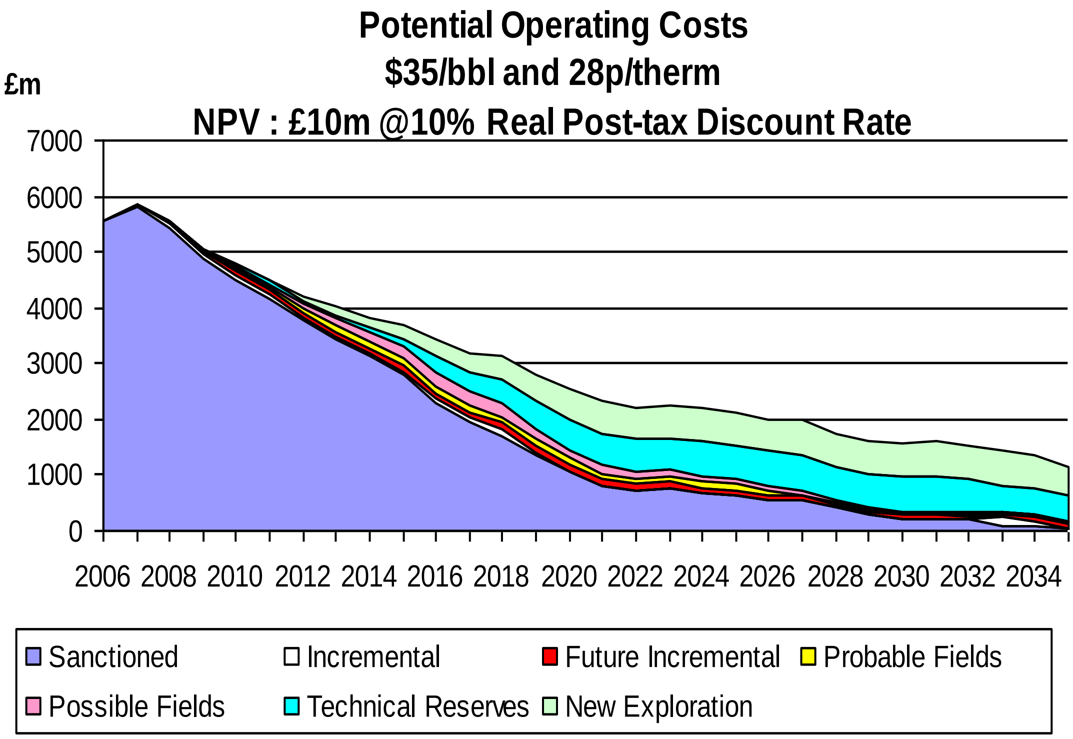

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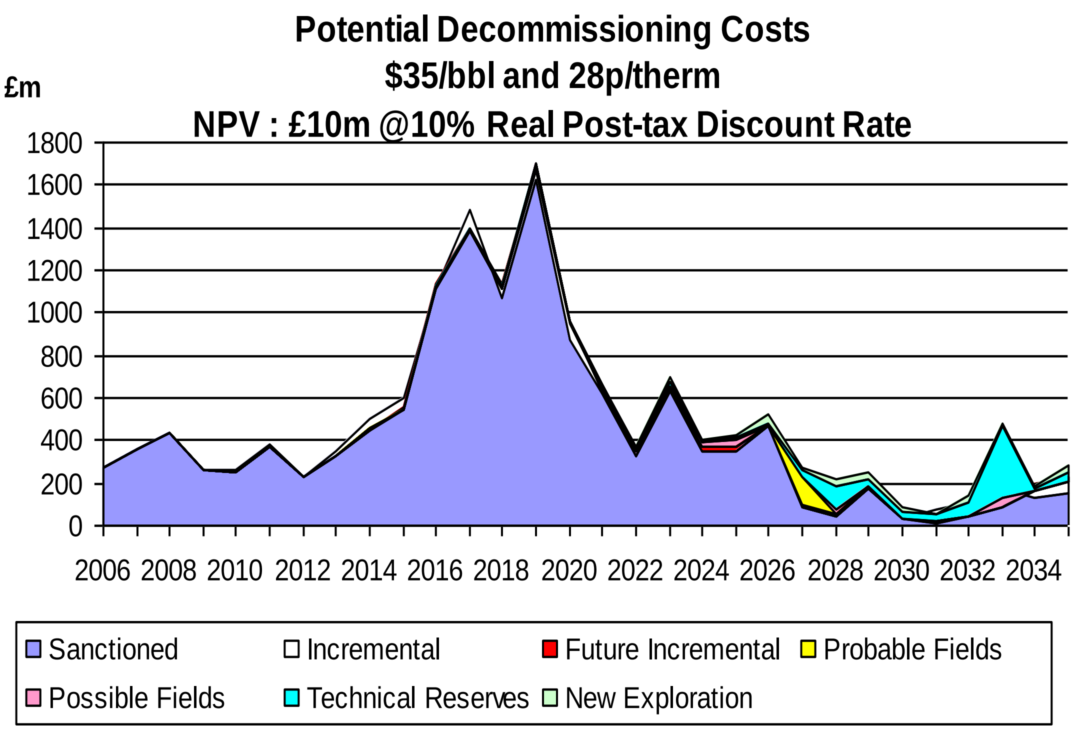

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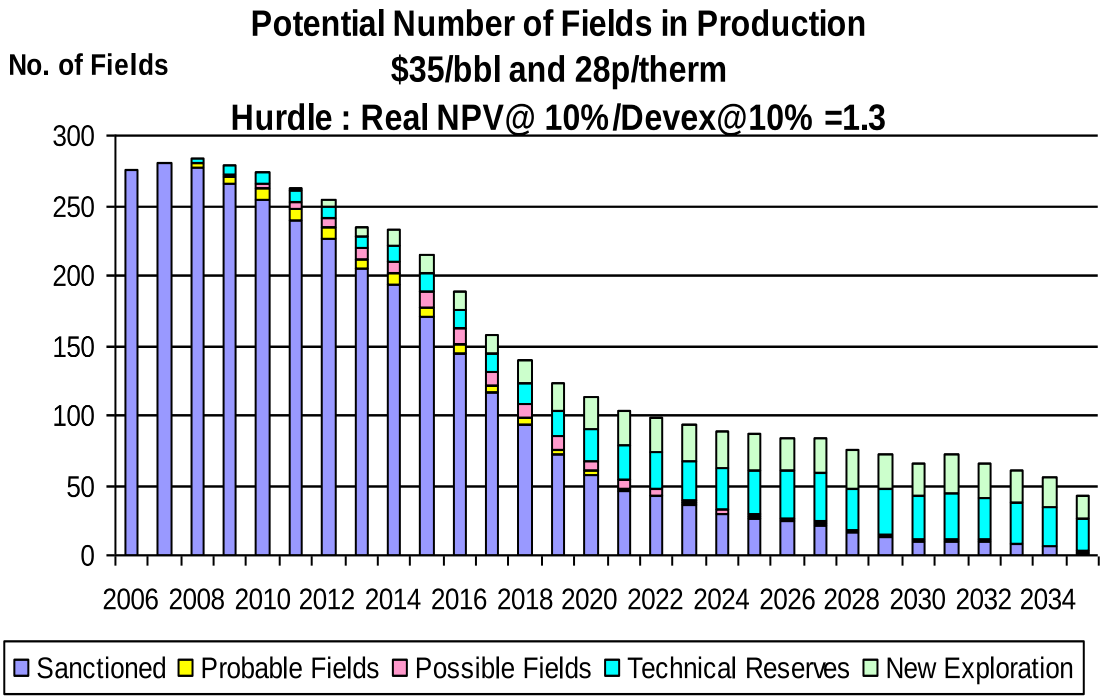

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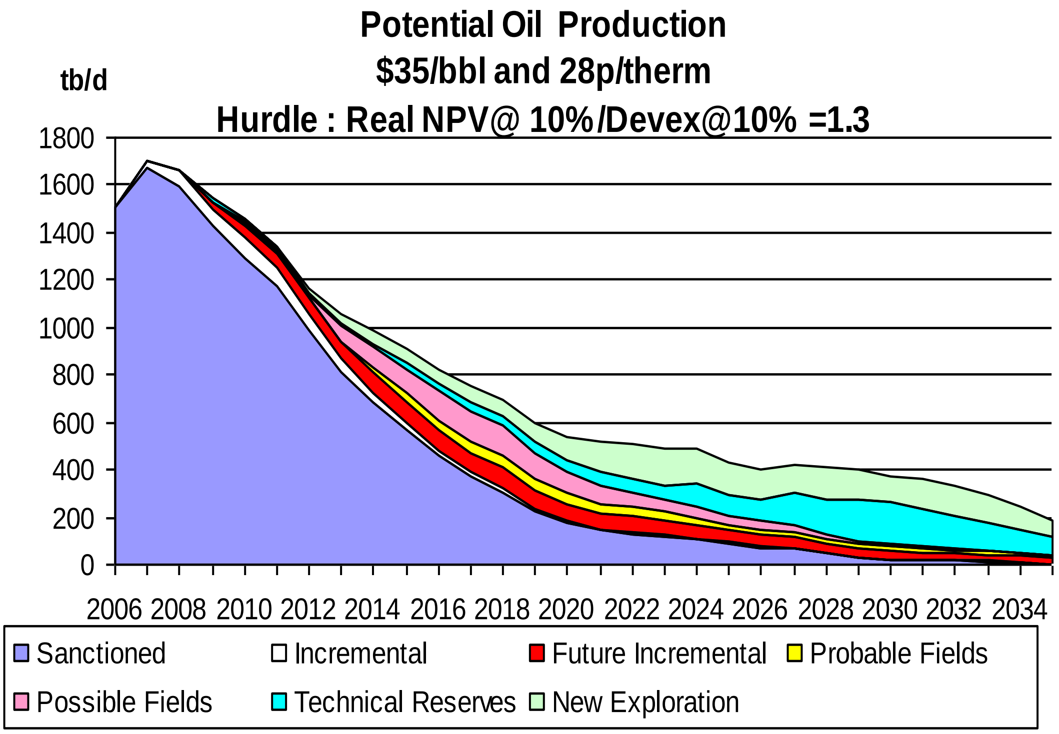

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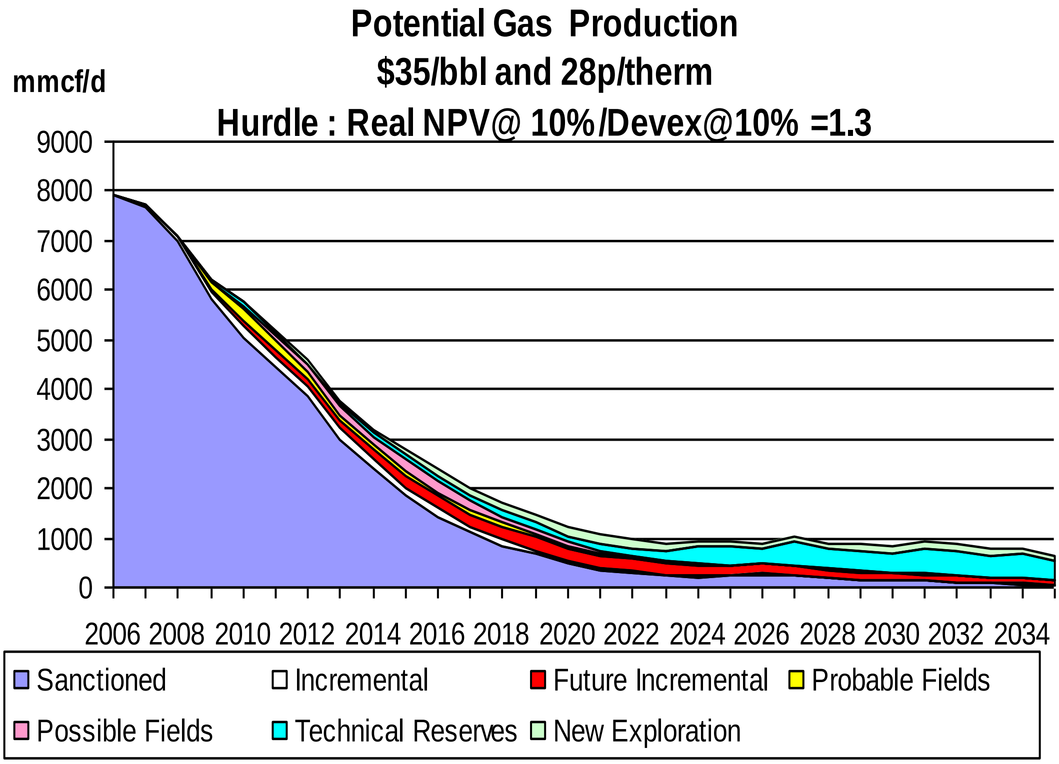

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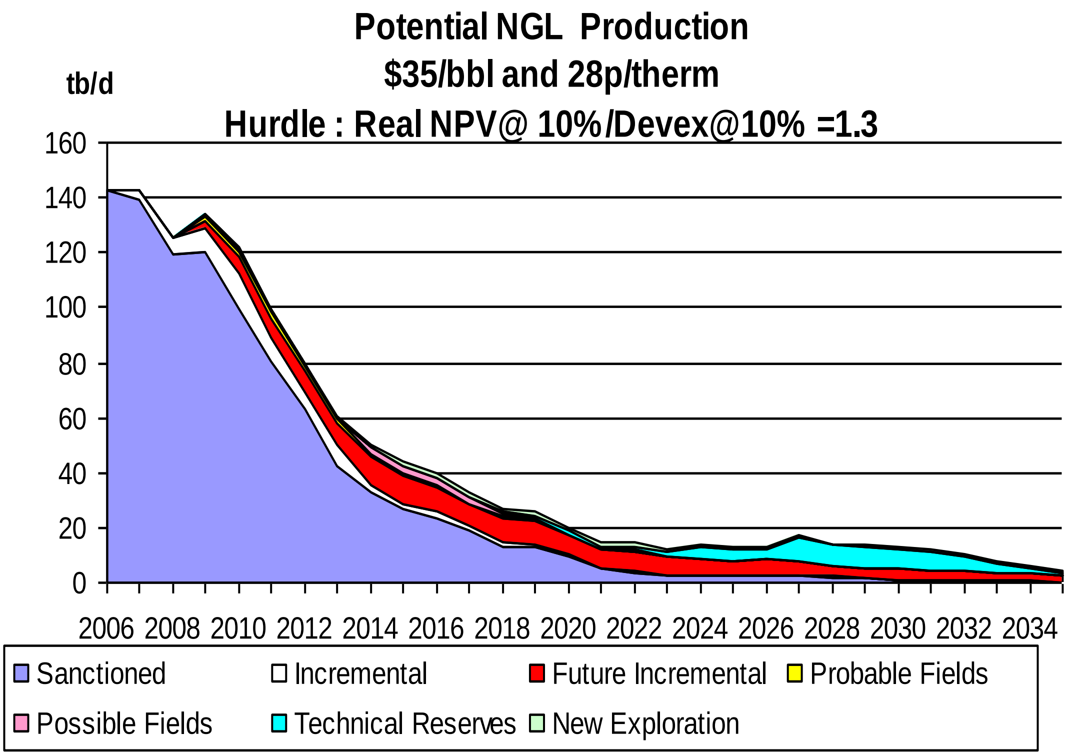

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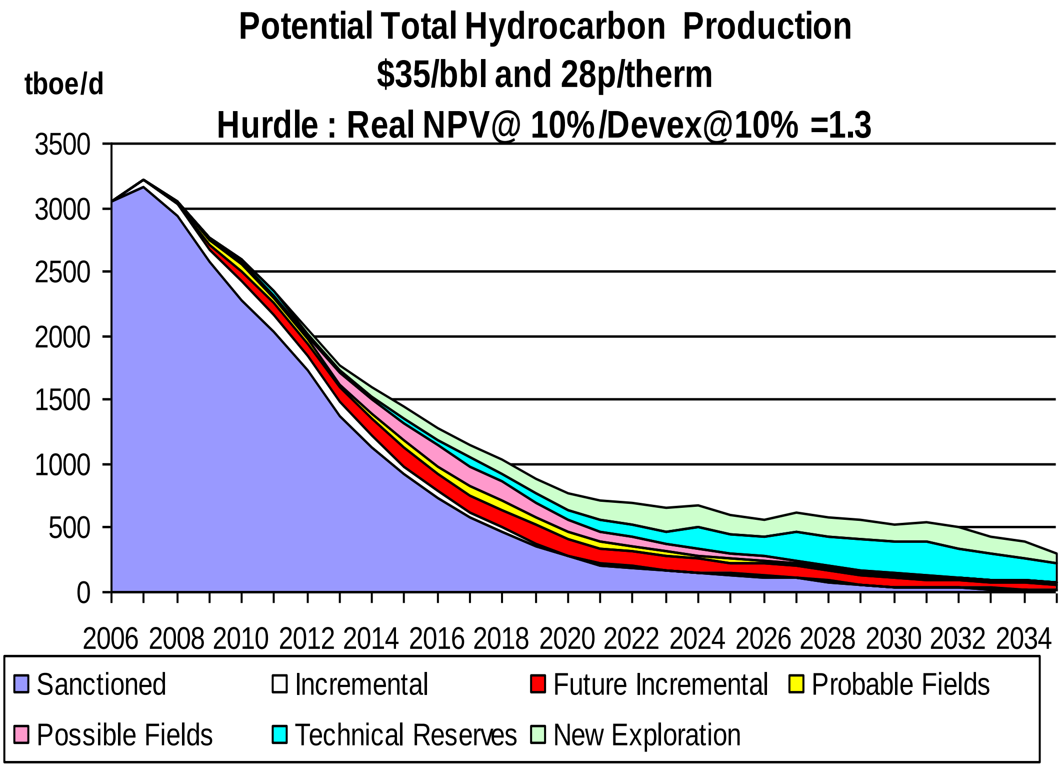

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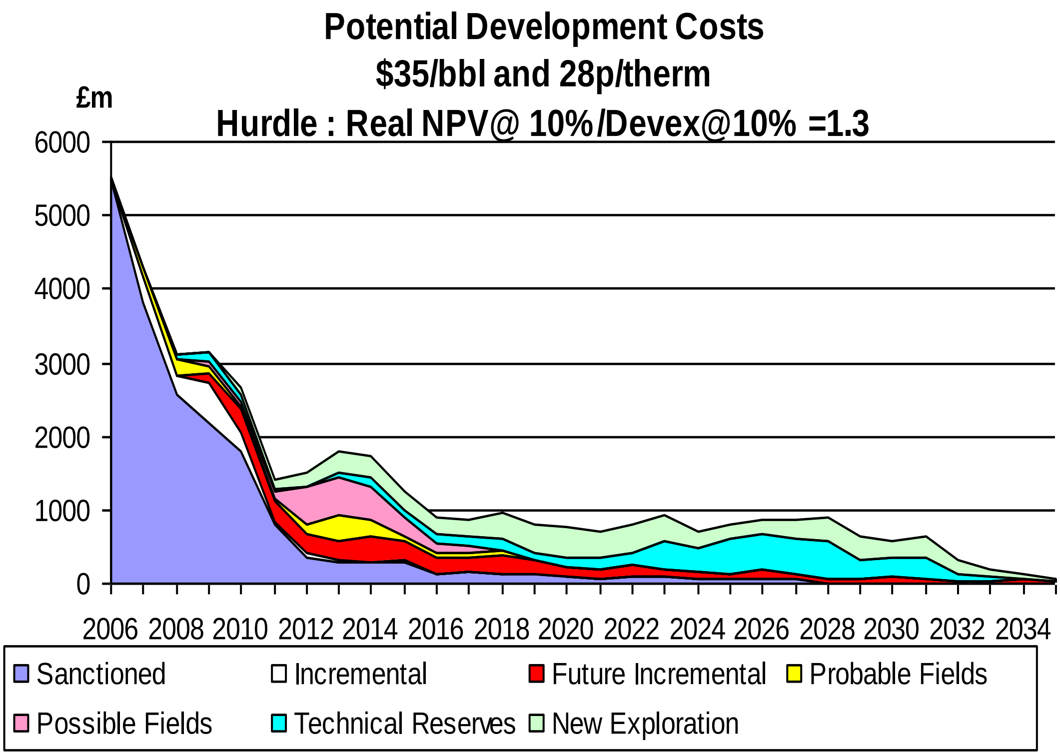

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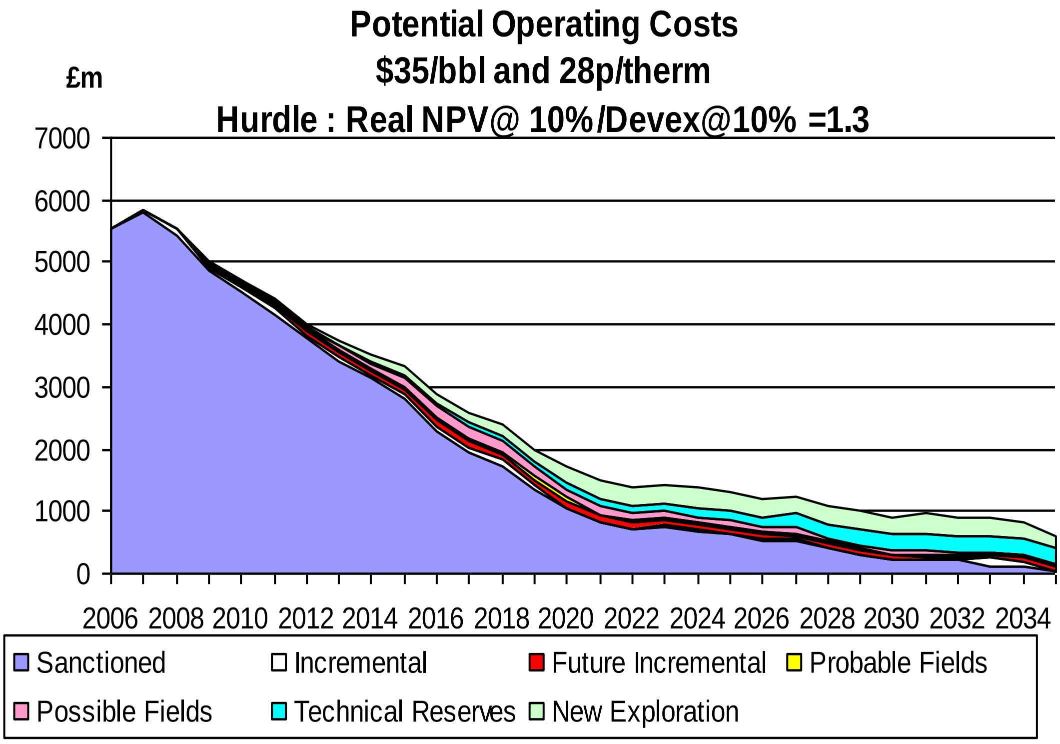

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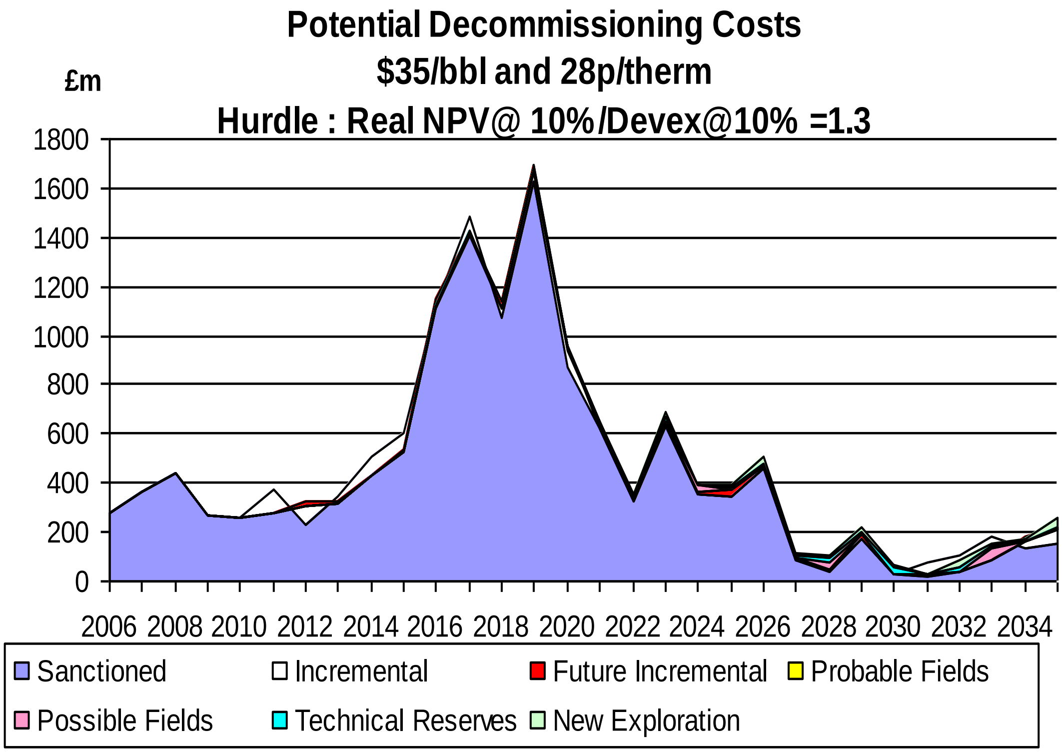
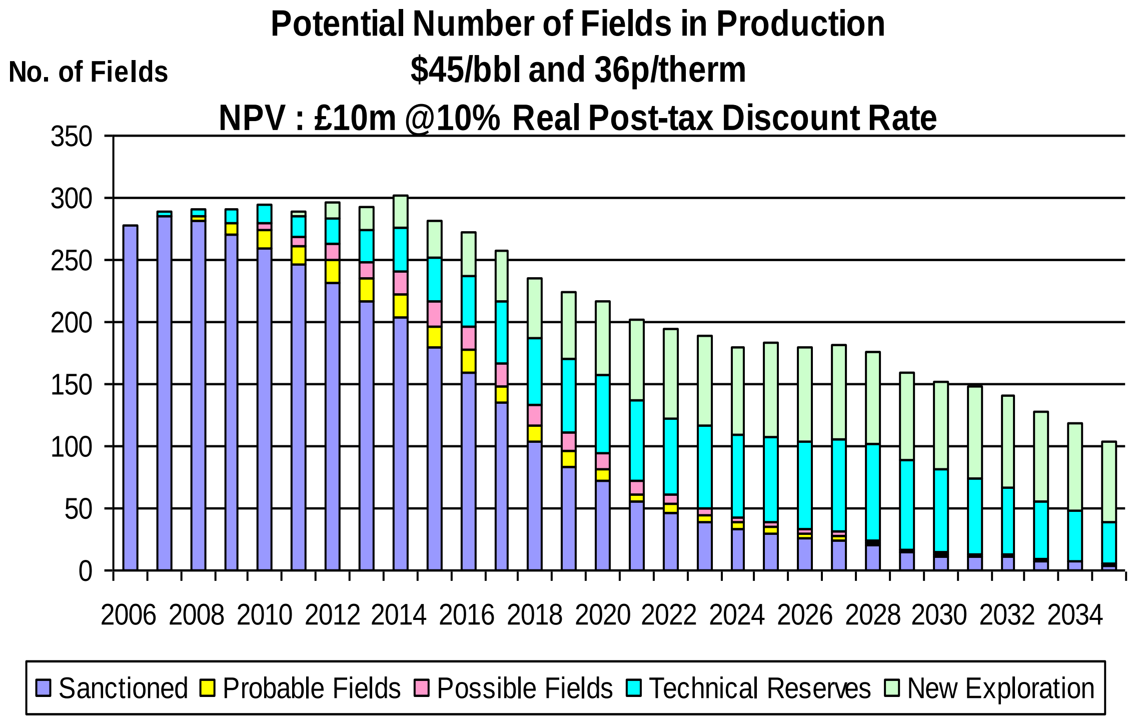


c) Medium Price Case

In Charts 33 – 40 the prospective activity levels under the Medium Price Case are shown with the minimum NPV criterion, and in Charts 41 – 48 under the NPV/I criterion. Longer-term activity levels are seen to be substantially higher under this price scenario. With the minimum NPV criterion total hydrocarbon production is 2.75 mmboe/d in 2010 and 1.6 mmboe/d in 2020. Field development expenditures average over £4 billion per year in the period to 2015. Under the NPV/I criterion total hydrocarbon production is nearly 1.4 mmboe/d in 2020. It is again noticeable that oil production declines less steeply than gas in the longer-term. There are far more new oil developments than for gas. Field development expenditures exceed £3 billion per year up to 2014.

Chart 33



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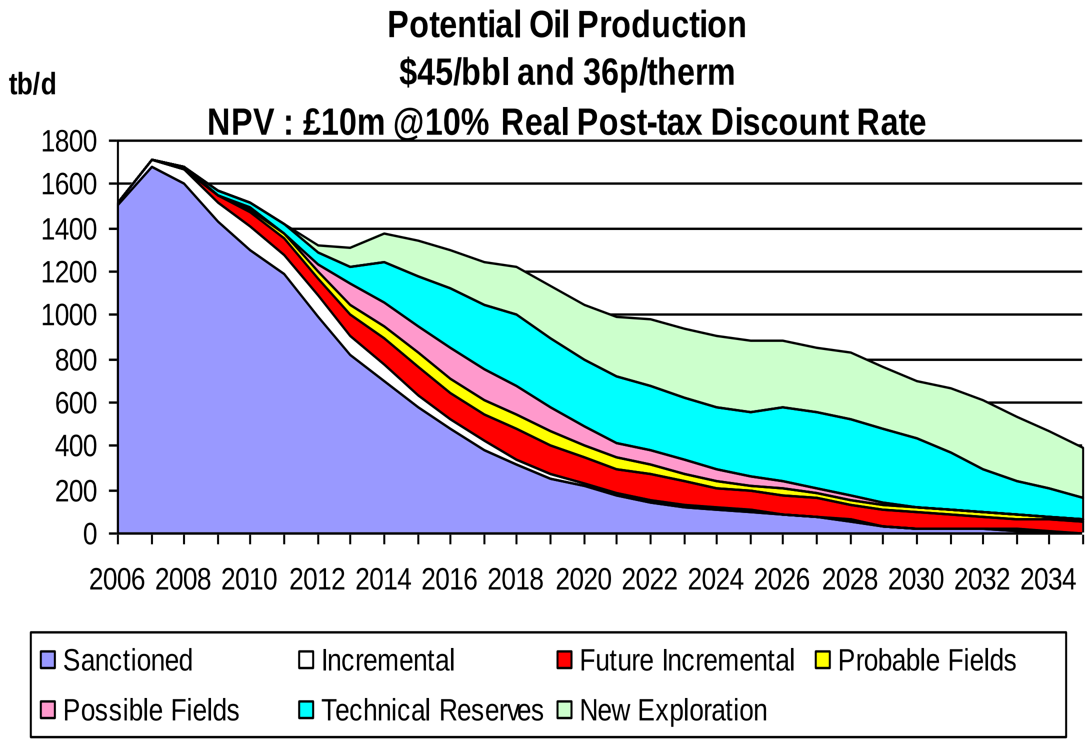

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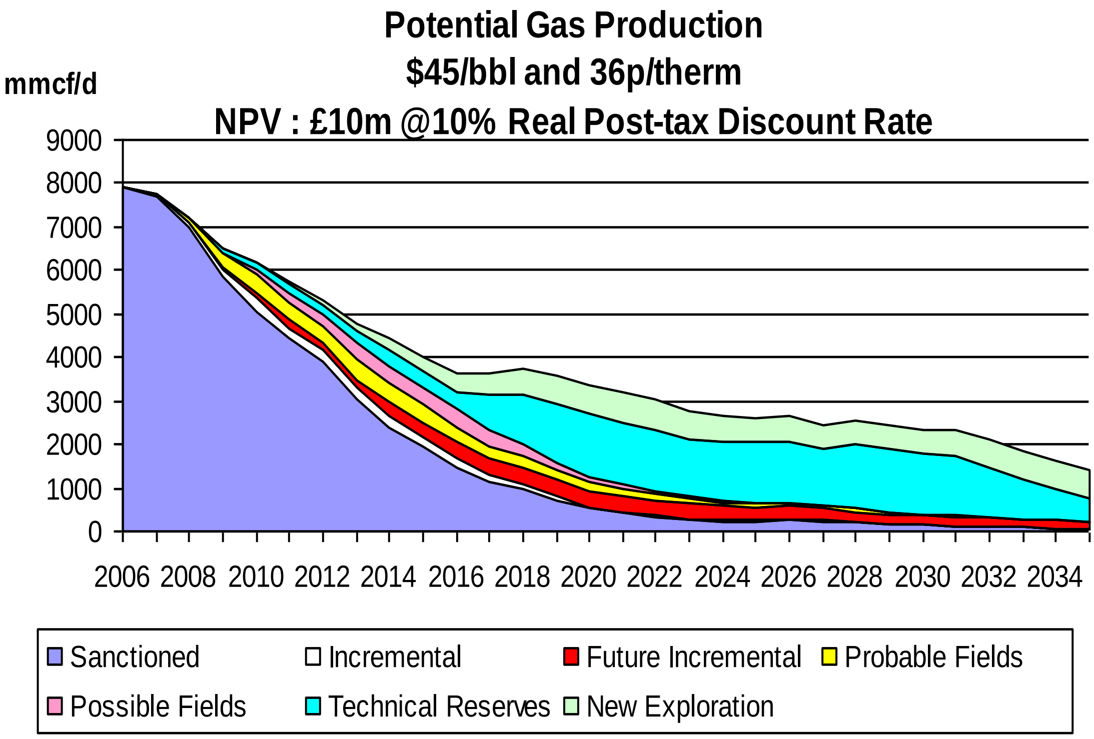

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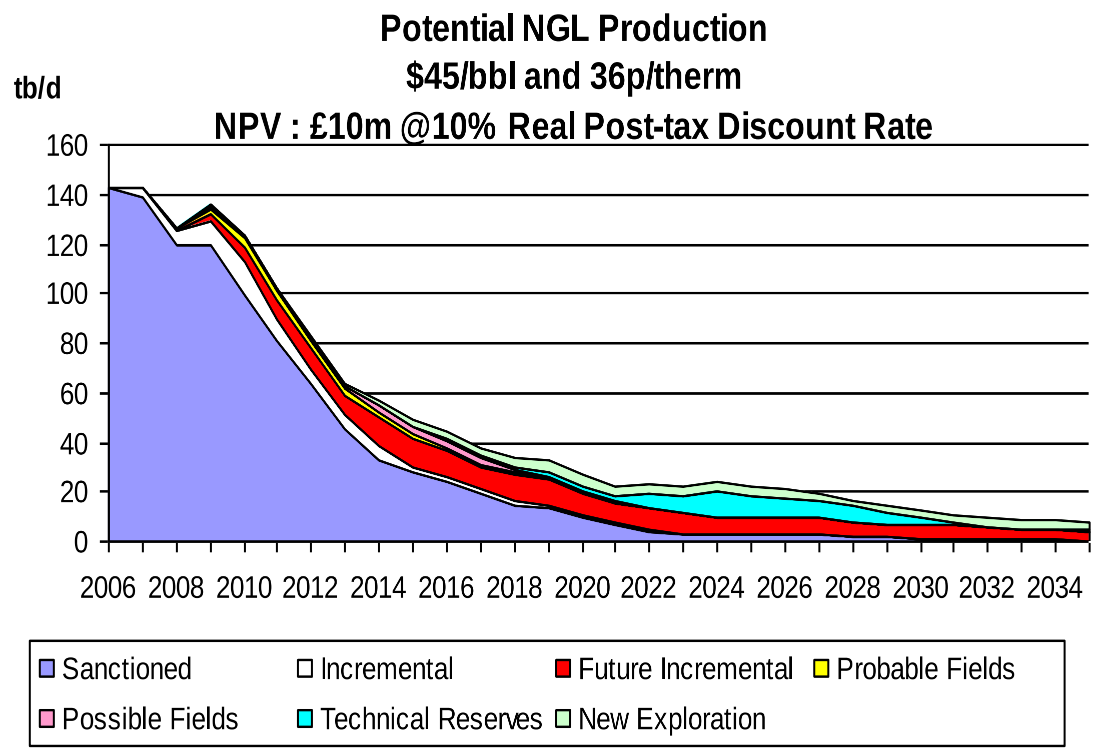

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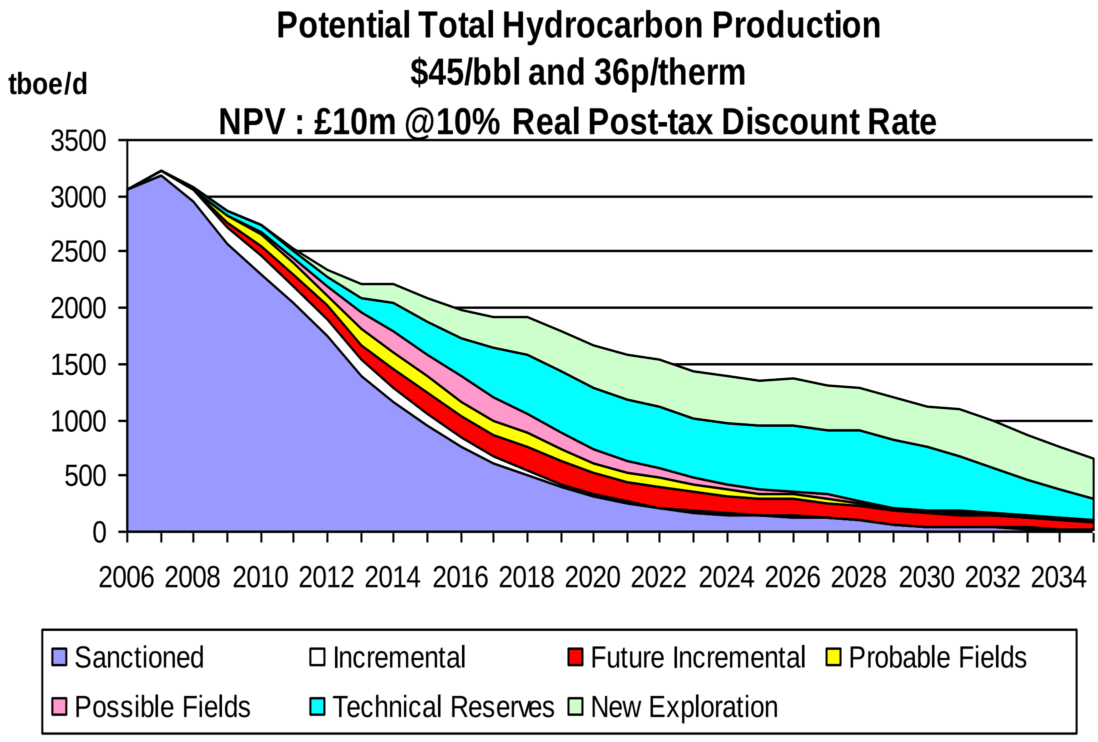

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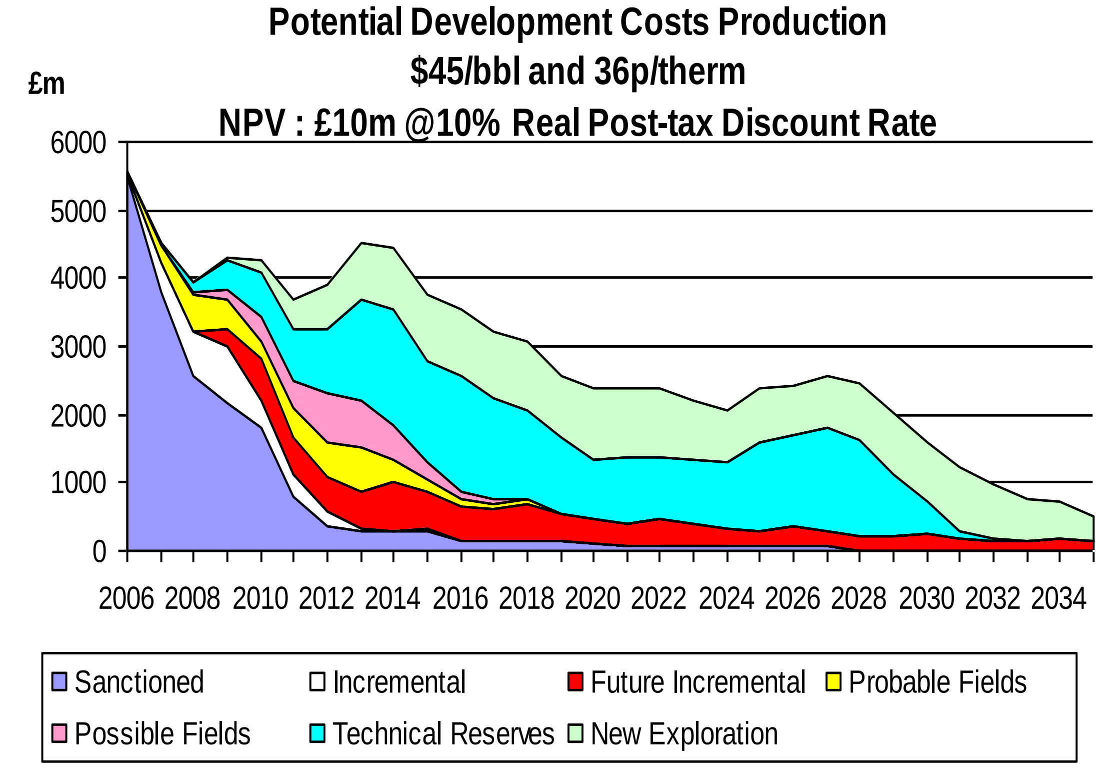
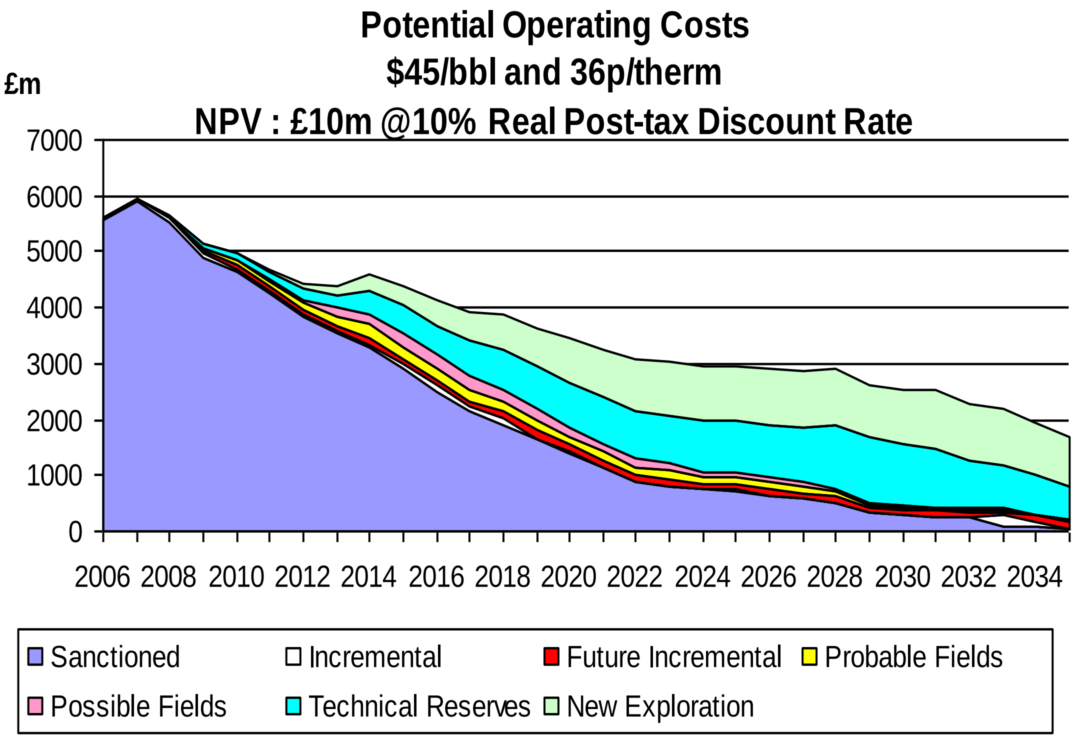


Chart 39



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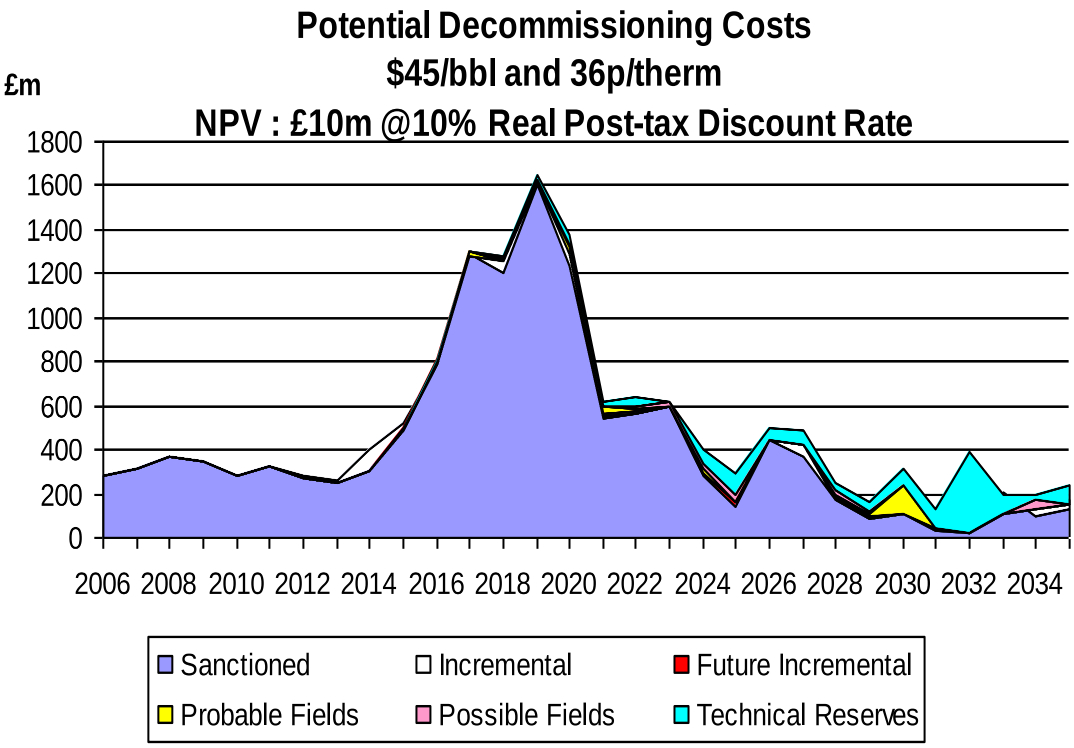

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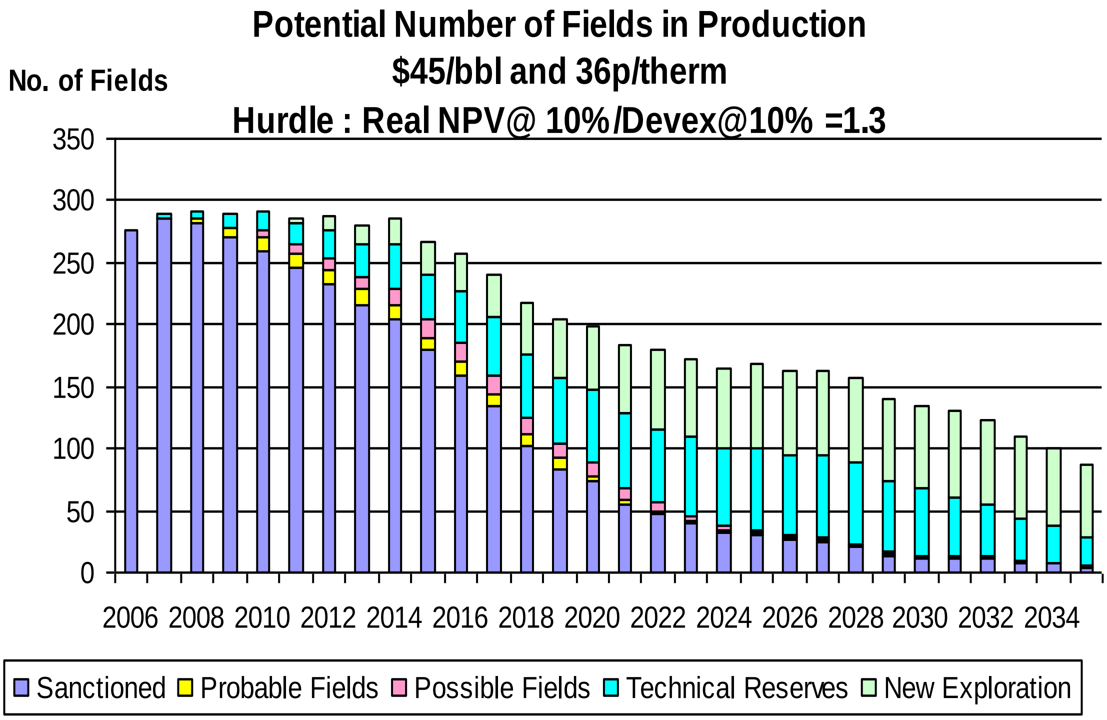

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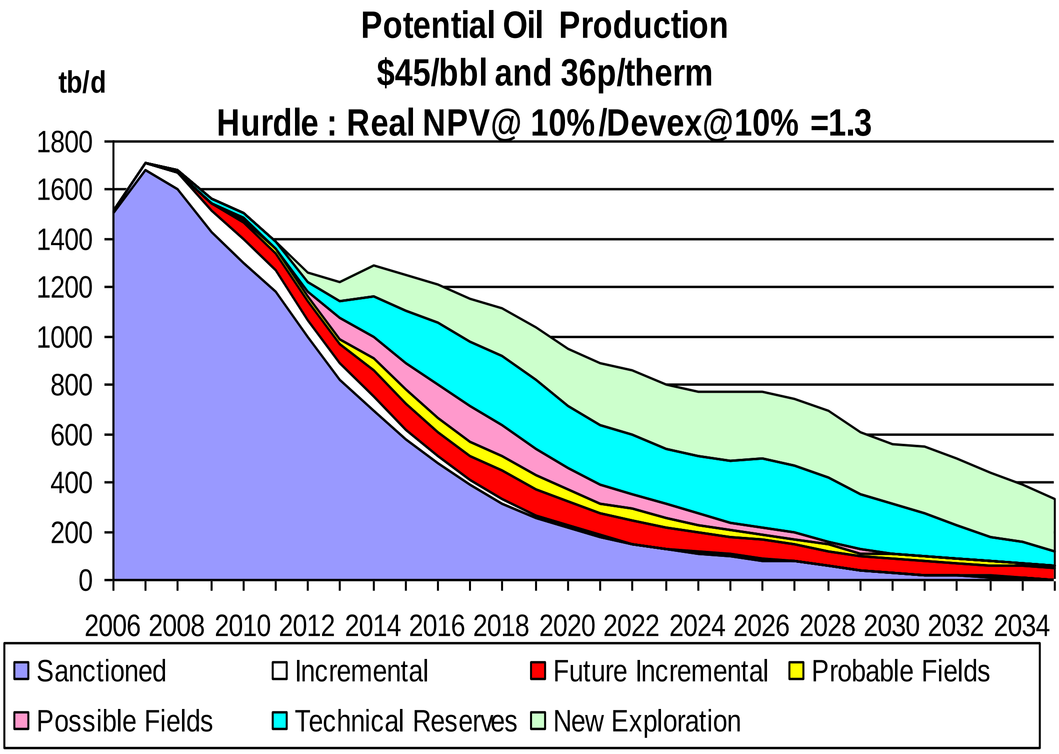

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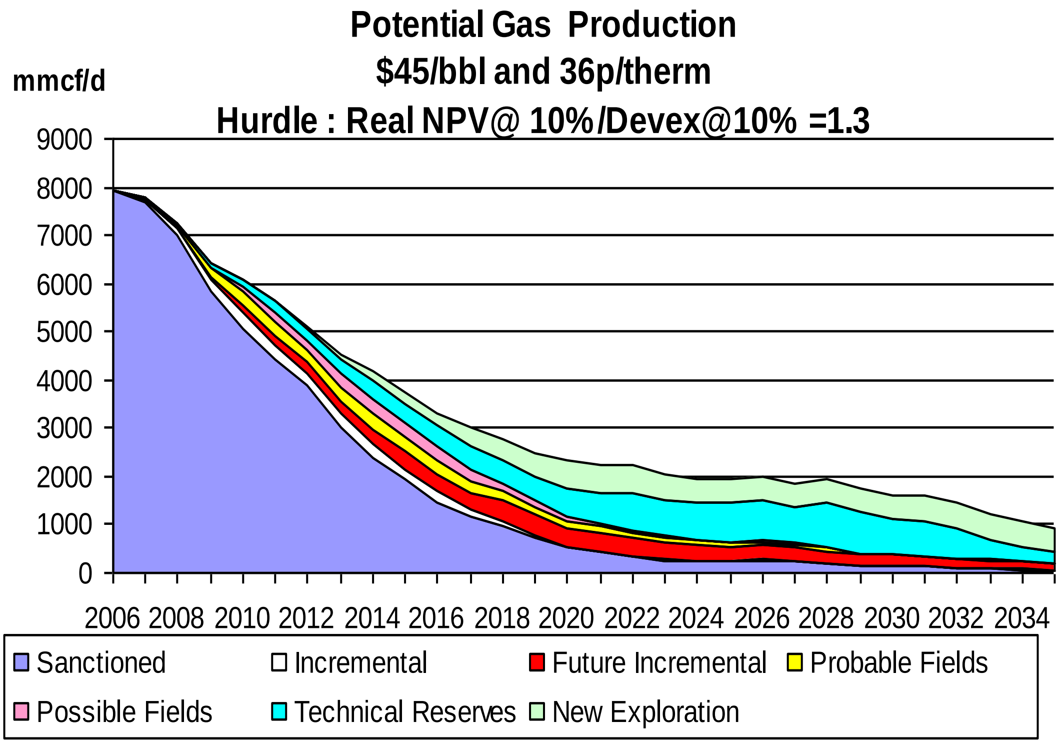

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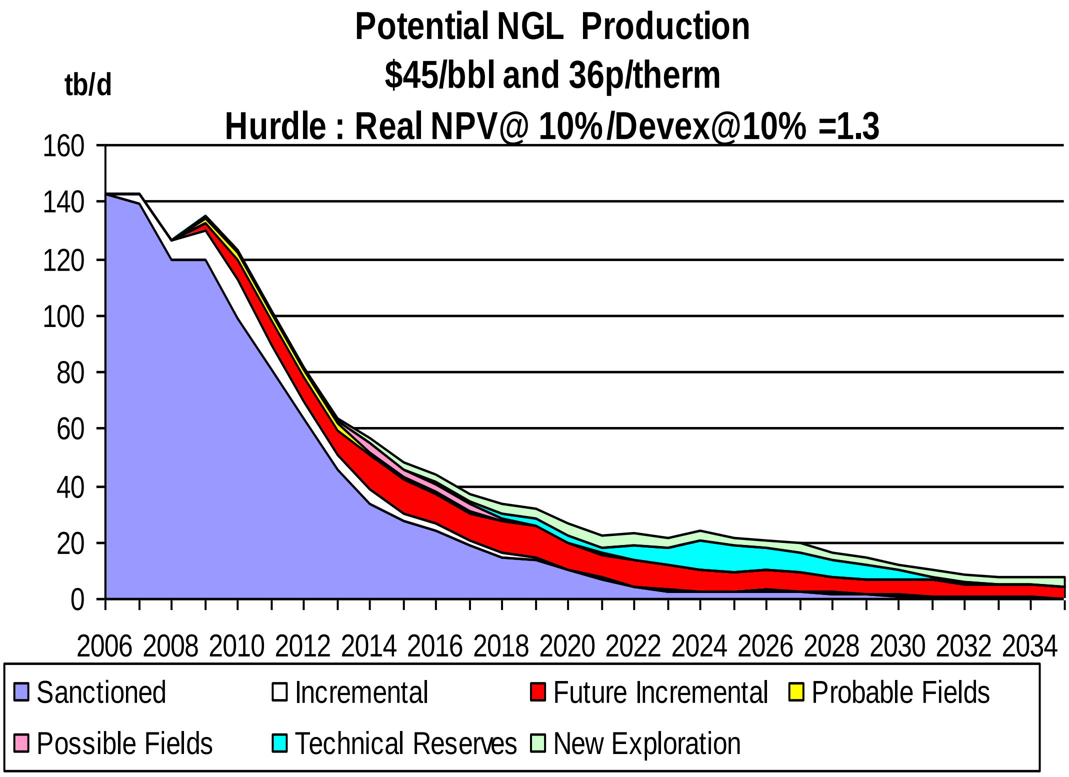

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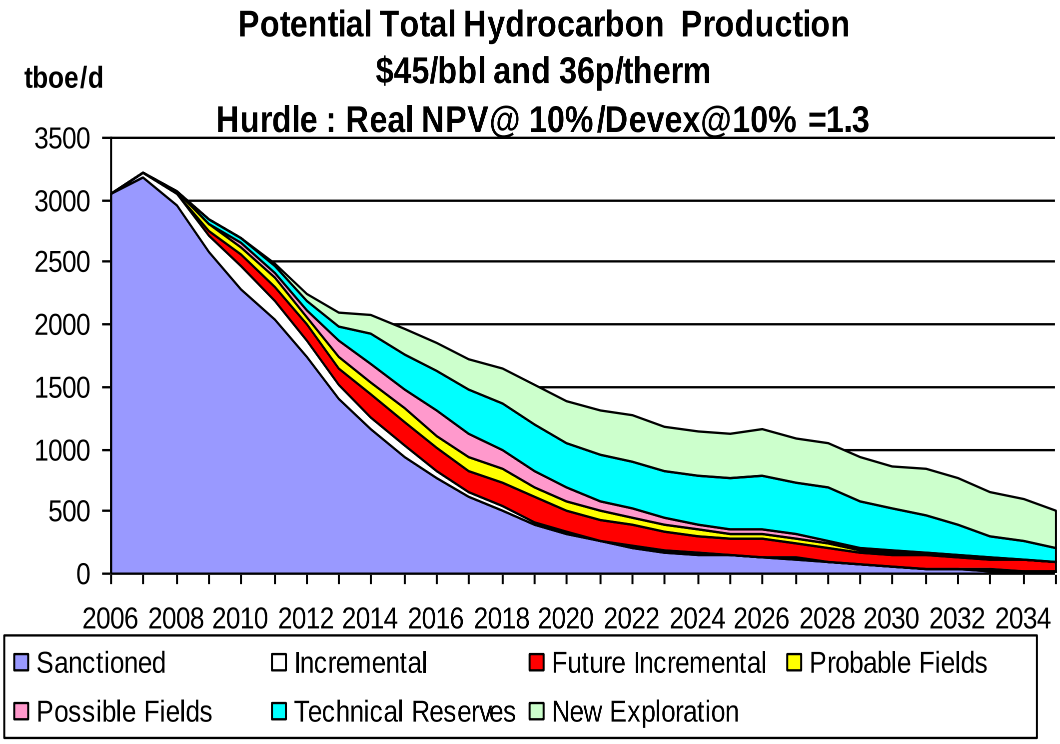

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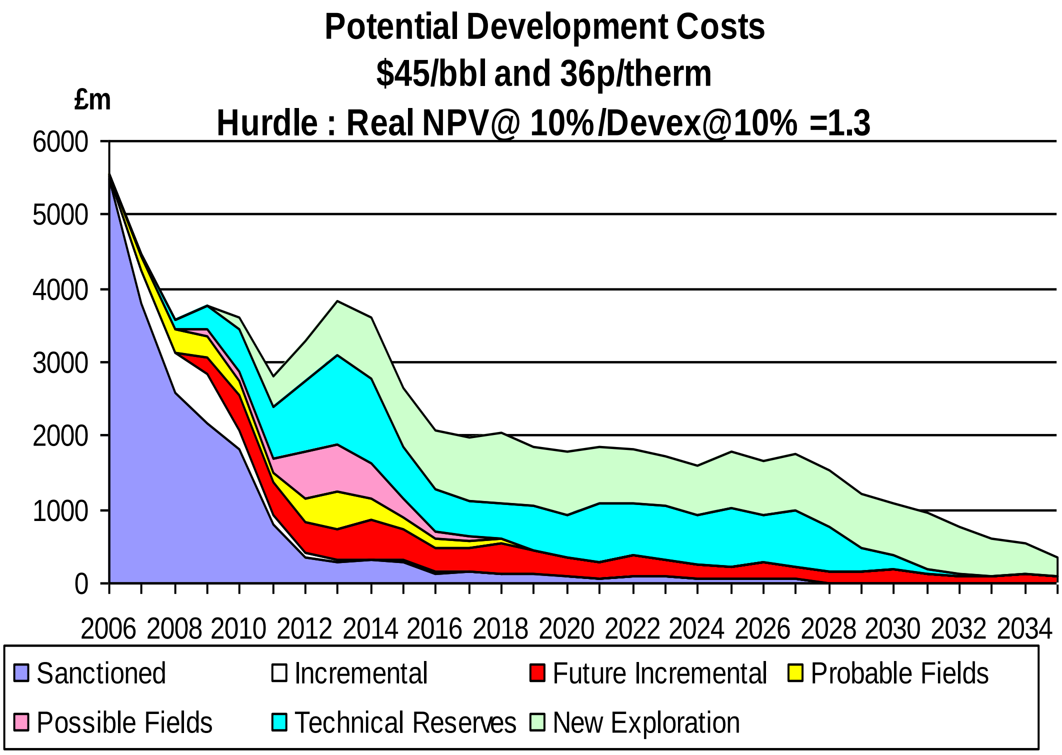

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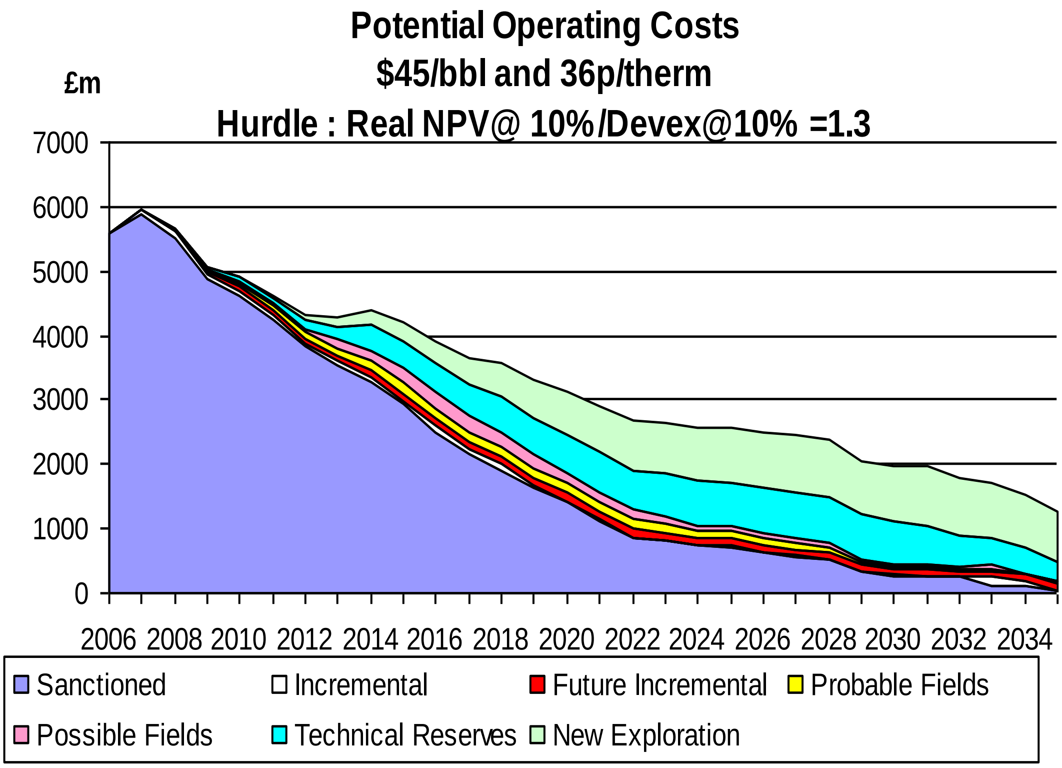

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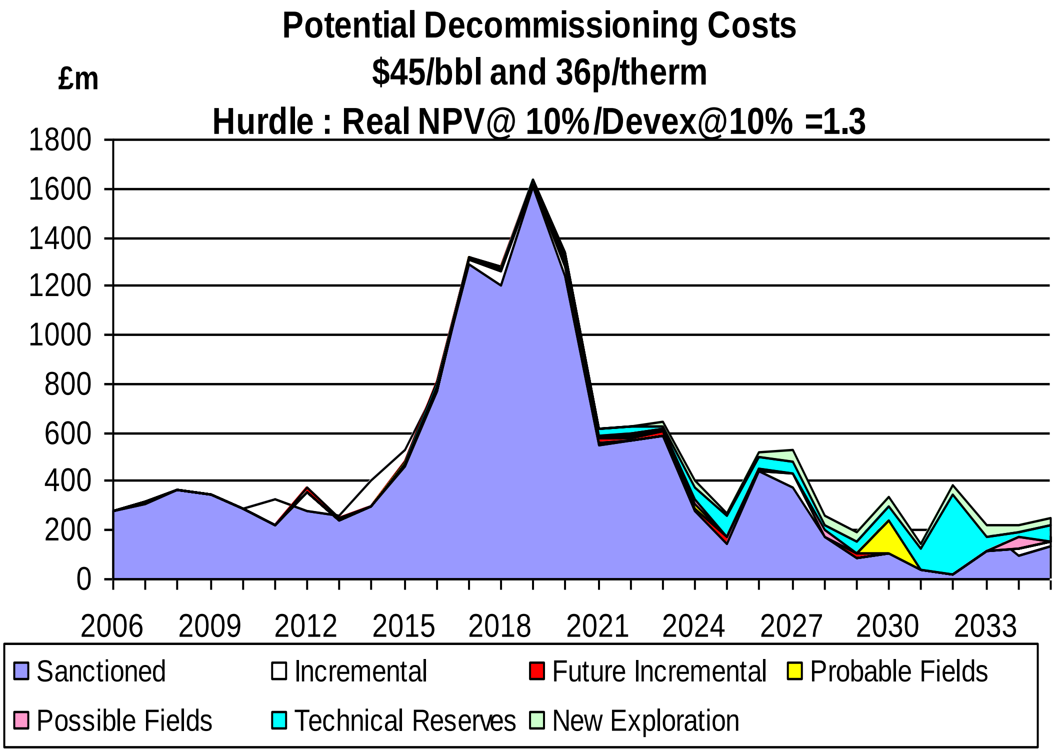
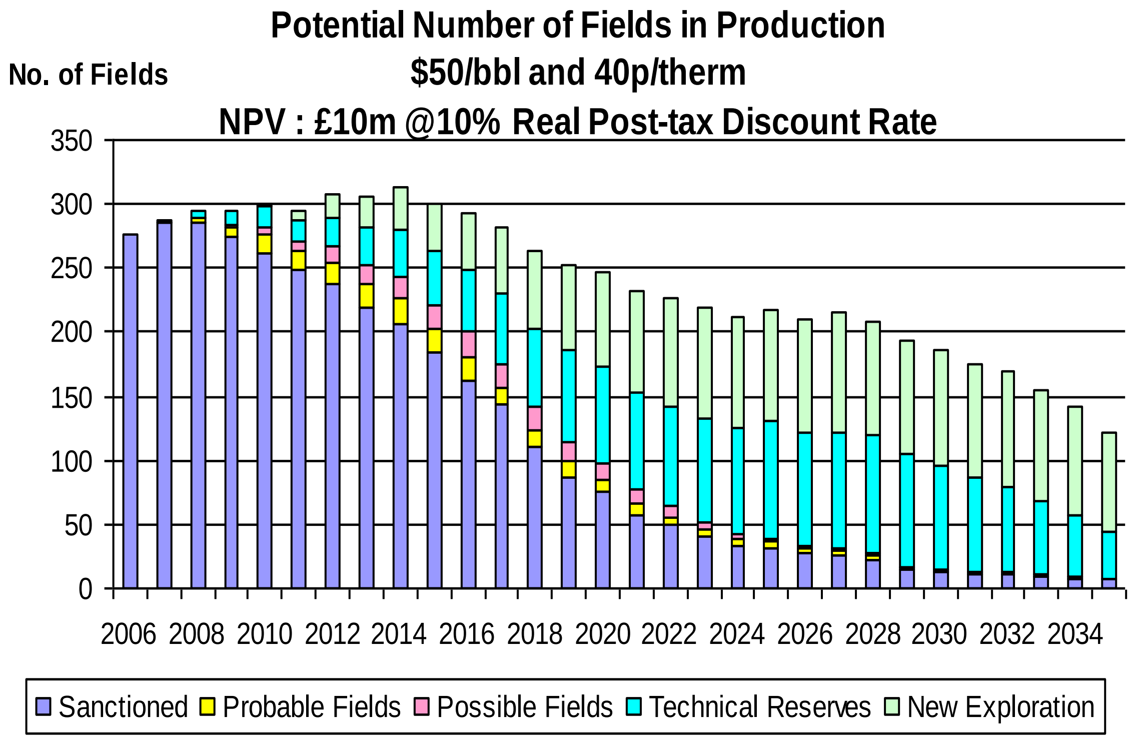


d) High Price Case

The prospective activity levels under the High Price Case are shown under the minimum NPV criterion in Charts 49 – 56. There is a marked increase compared to the Medium Price Case. Thus total hydrocarbon production becomes 2.75 mmboe/d in 2010 and 1.75 mmboe/d in 2020. Field development expenditures are relatively healthy until 2018 with the yearly average well over £4 billion. Under the NPV/I criterion total hydrocarbon production is 1.6 mmboe/d in 2020. Field development expenditures average over £4 billion until 2015.

The production projections on a regional basis are shown in charts A.13, A.14, and A.15 for oil, gas, and total hydrocarbon production respectively, under the NPV/I criterion.

Chart 49



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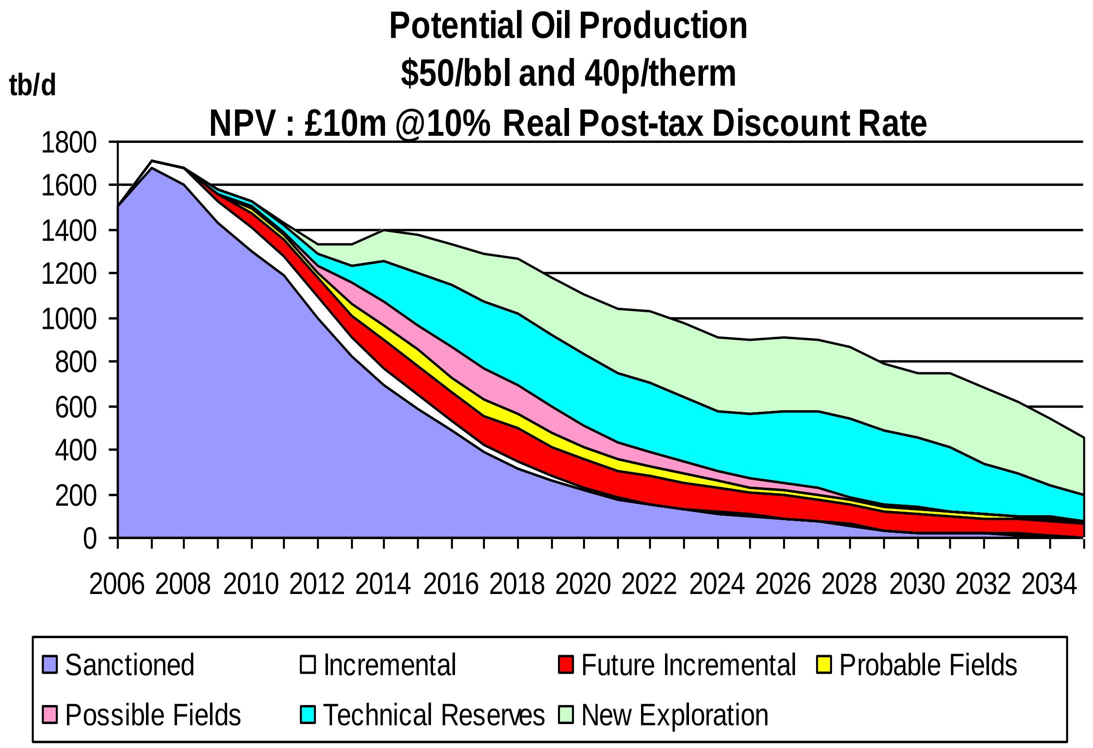

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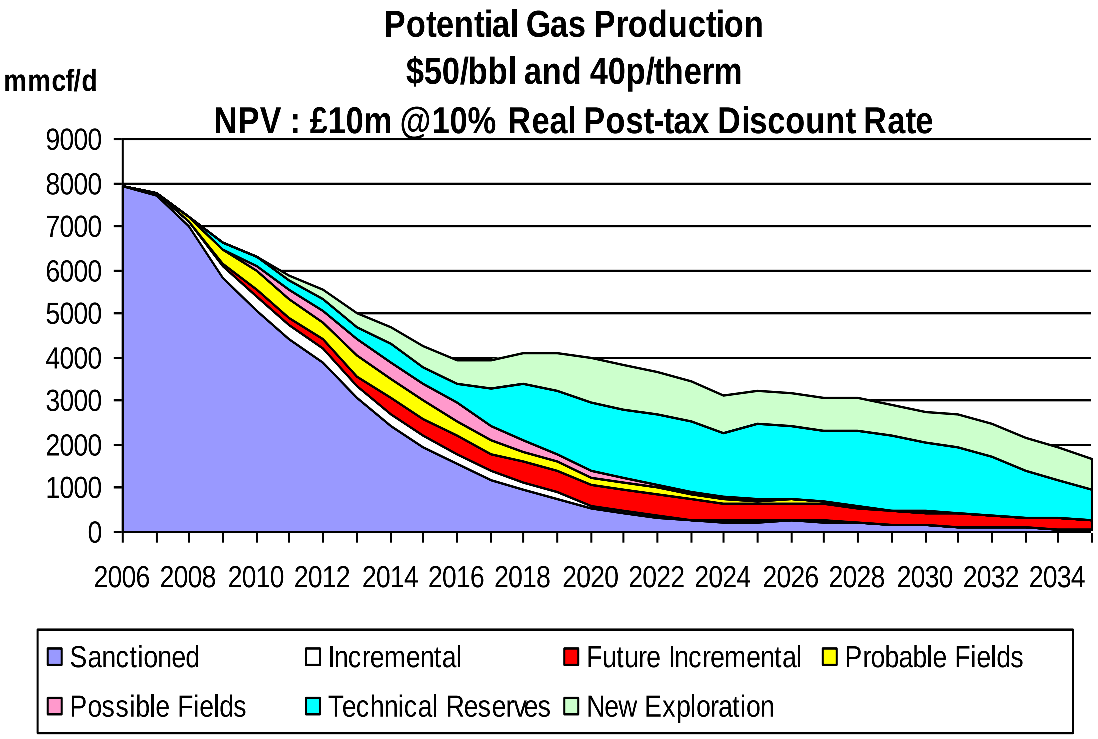

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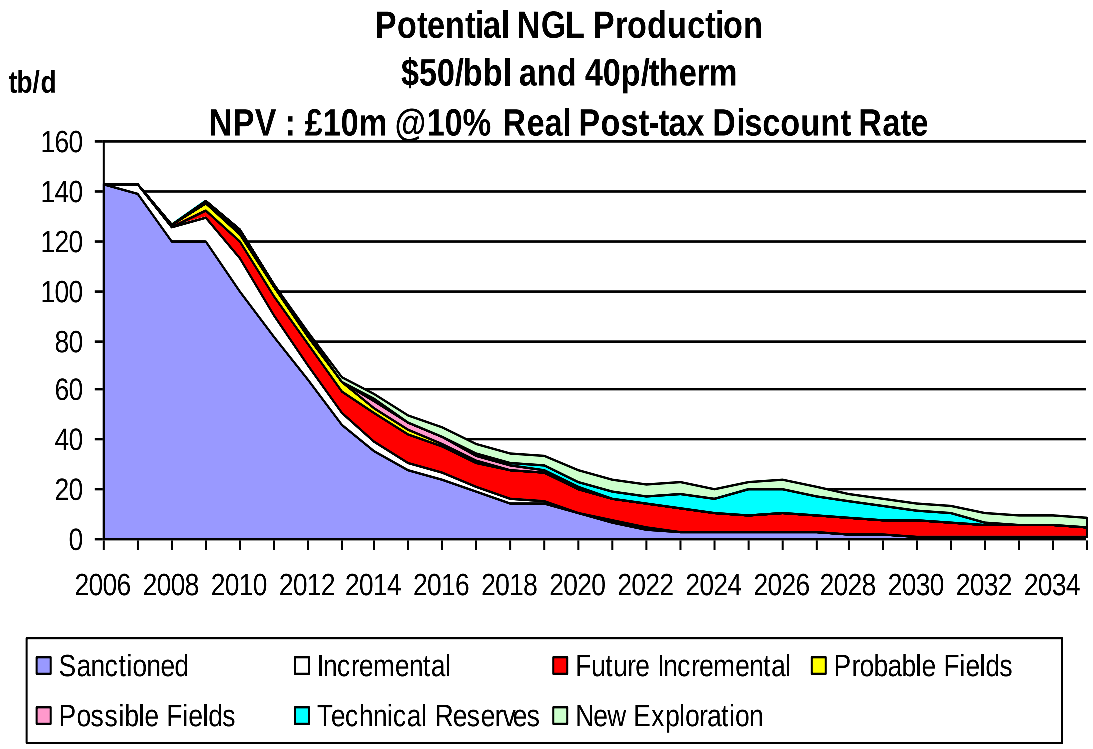

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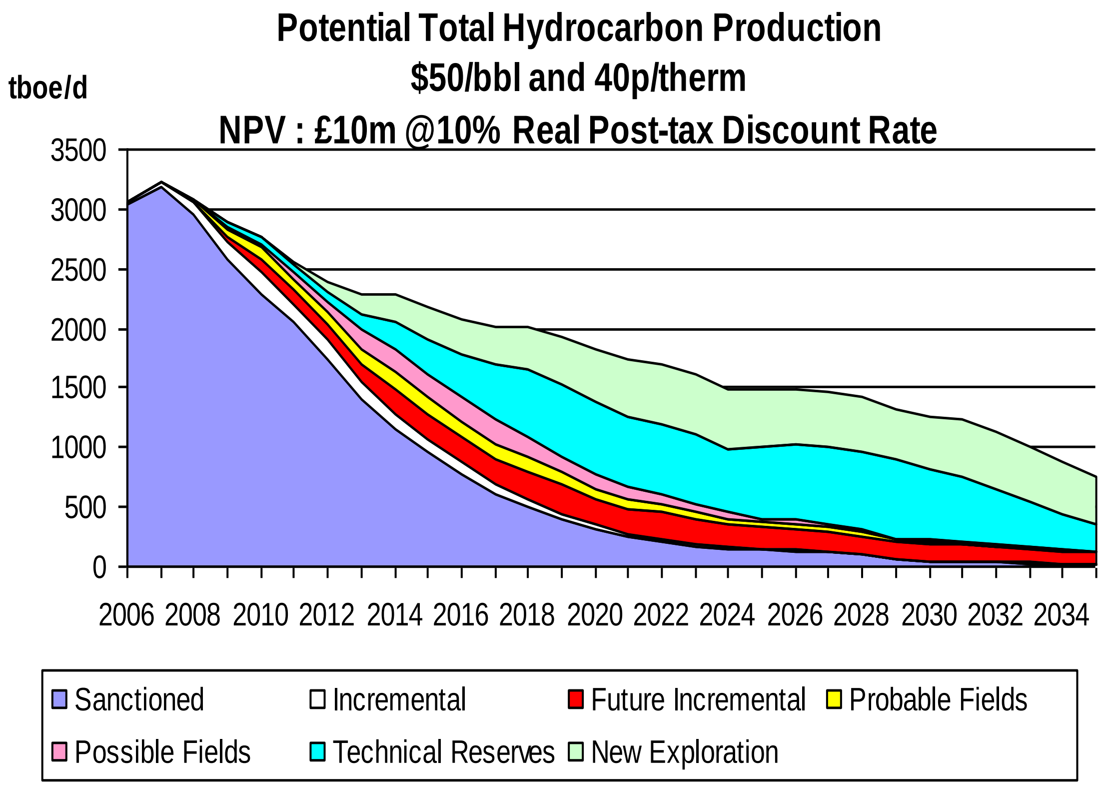

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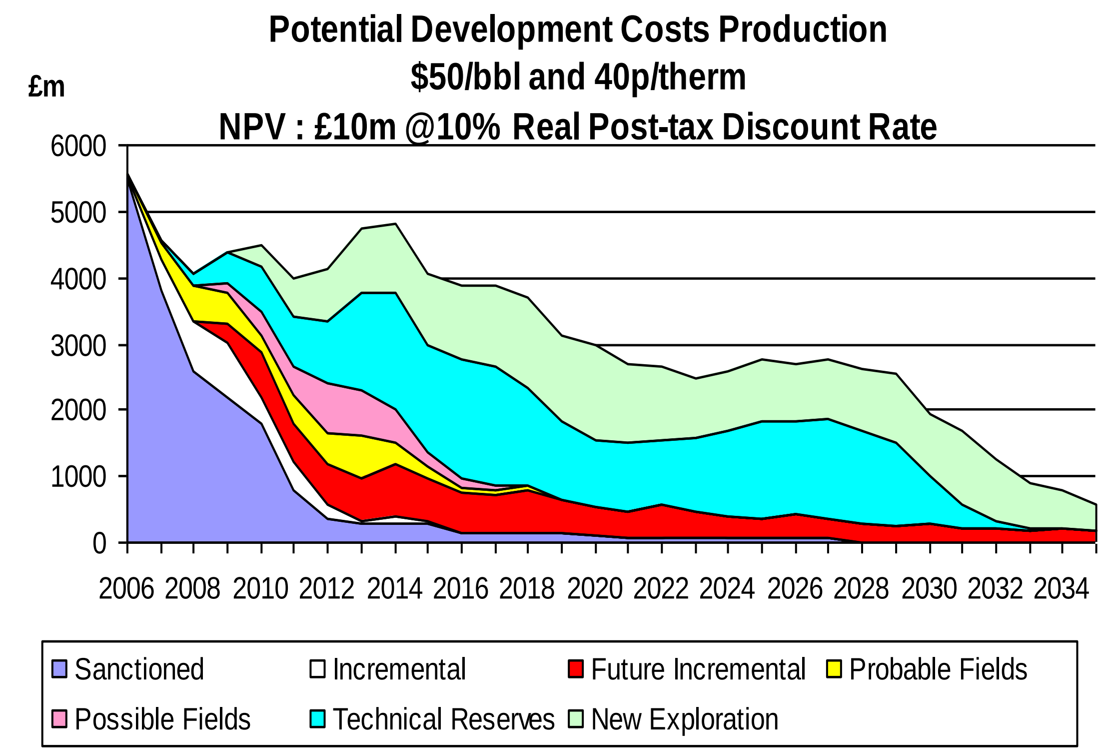

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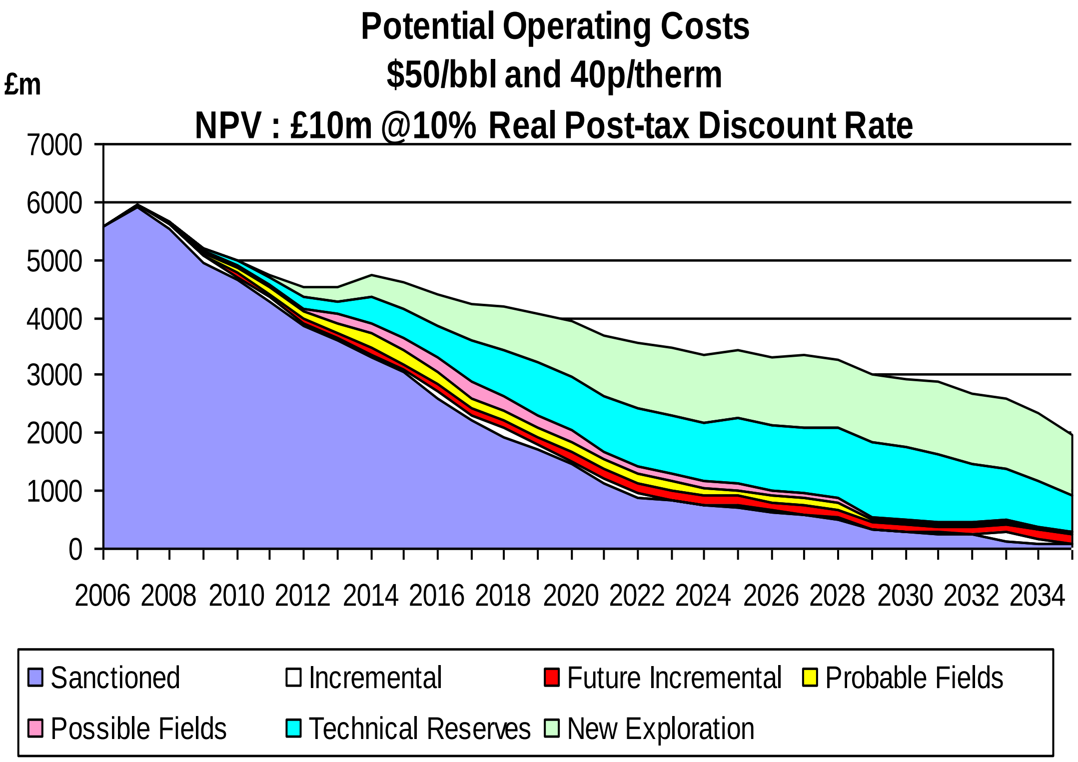

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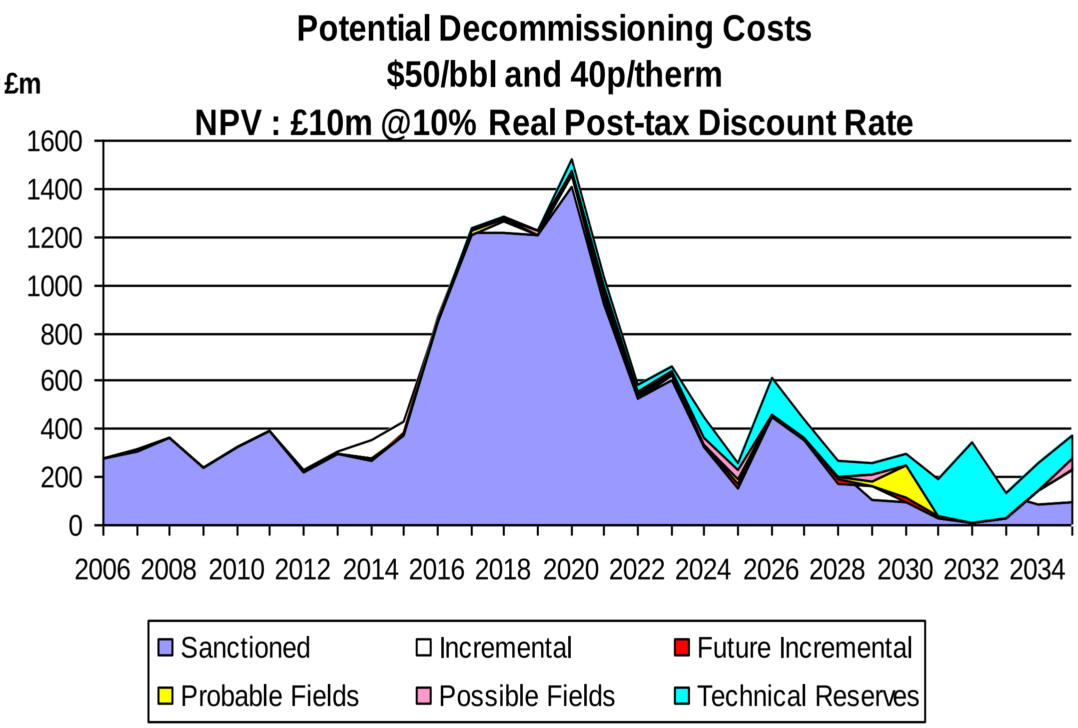

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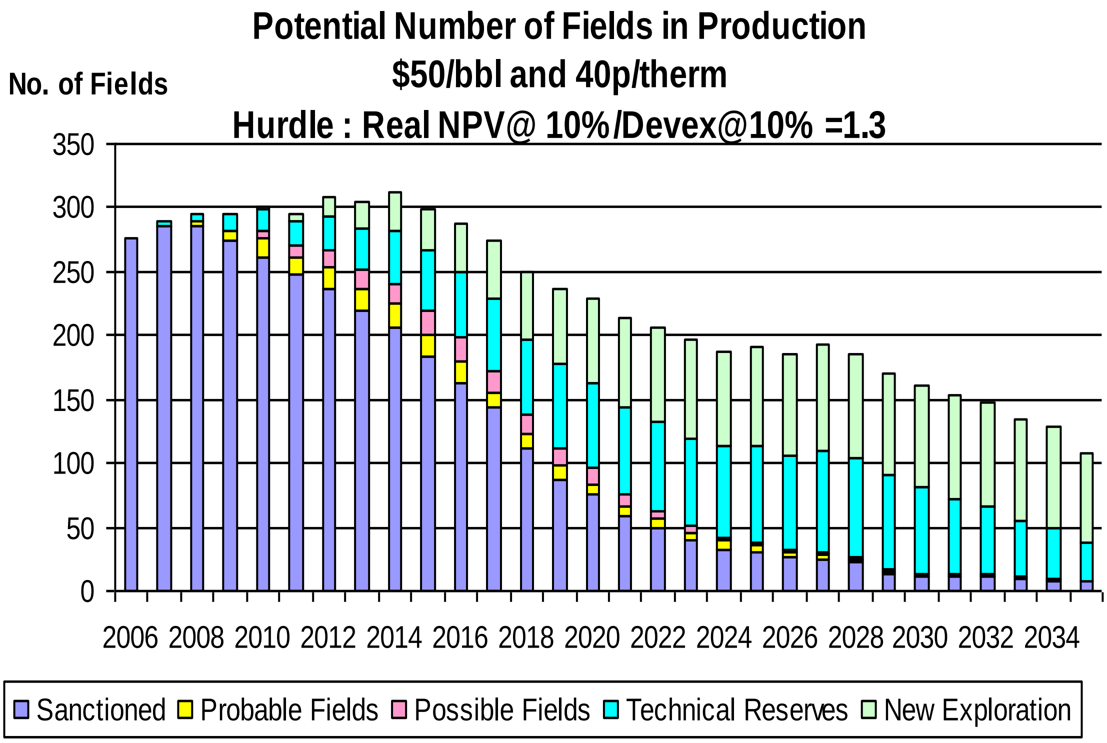

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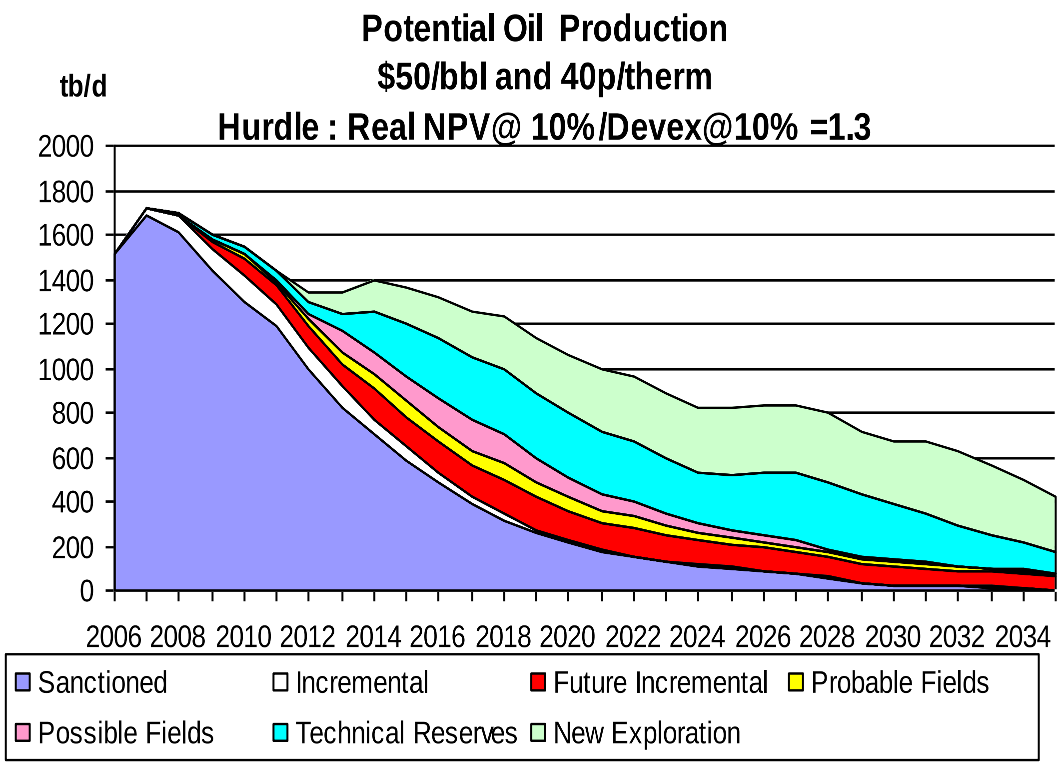

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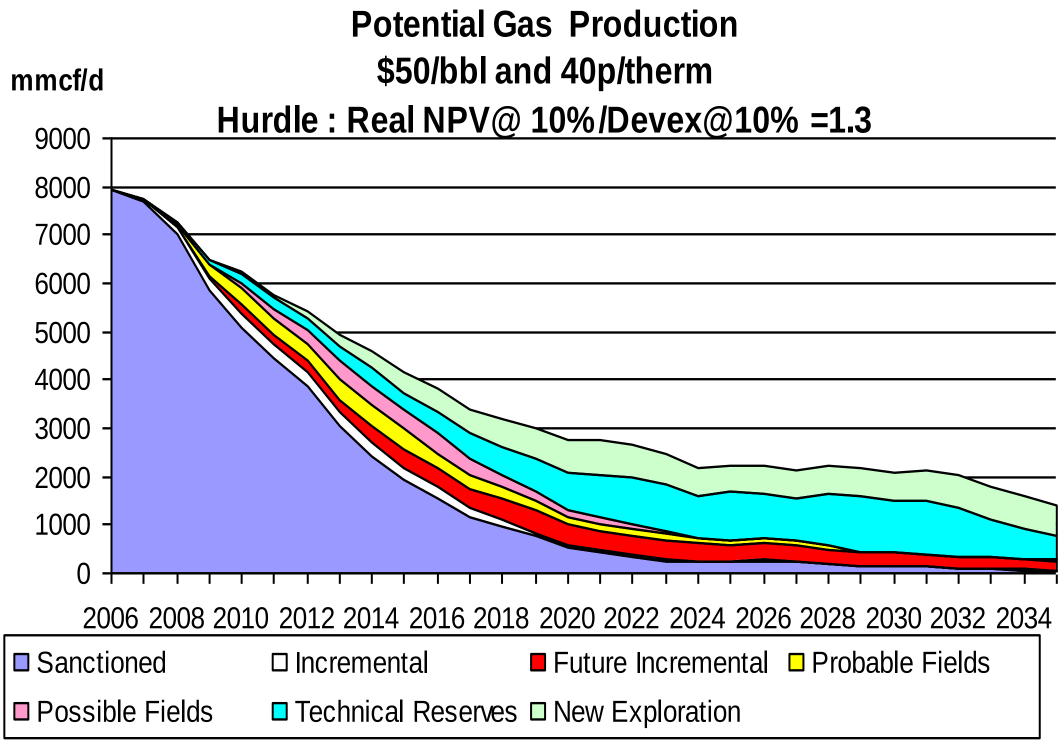

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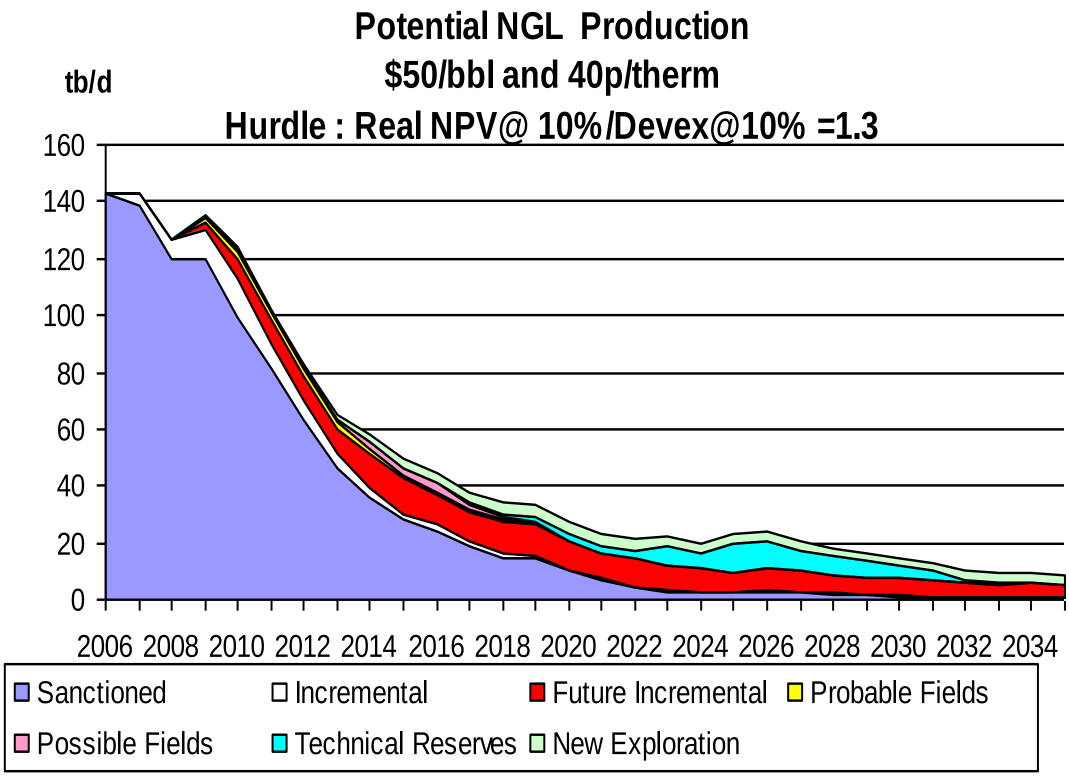

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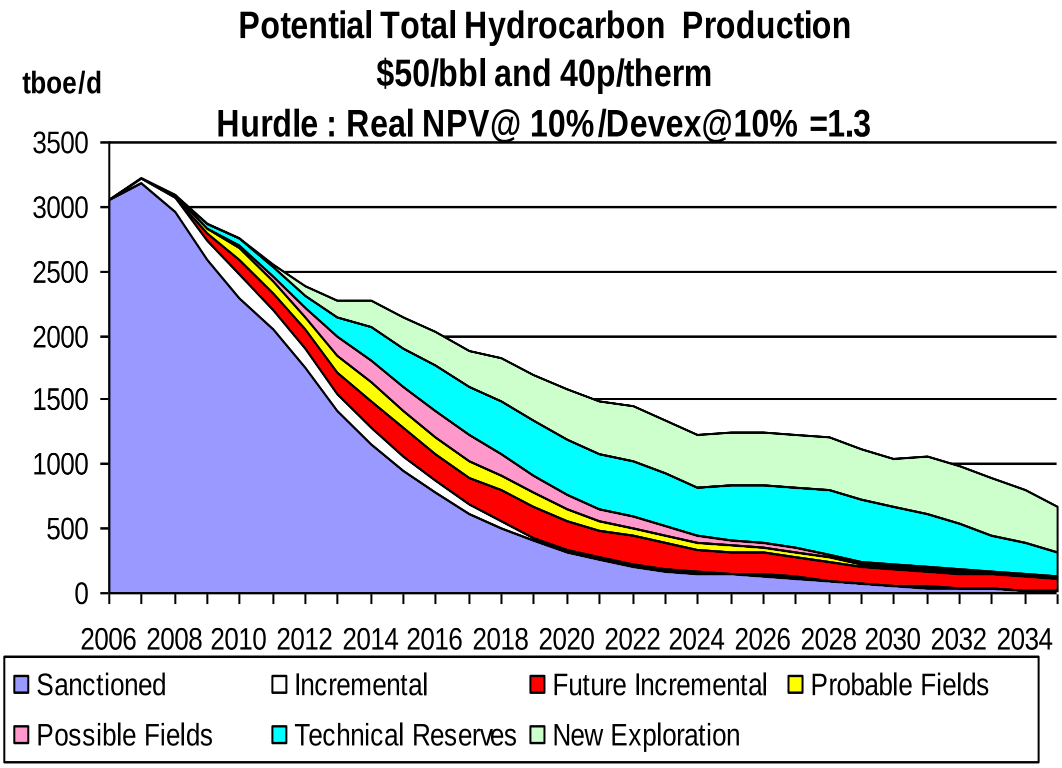


Chart 62

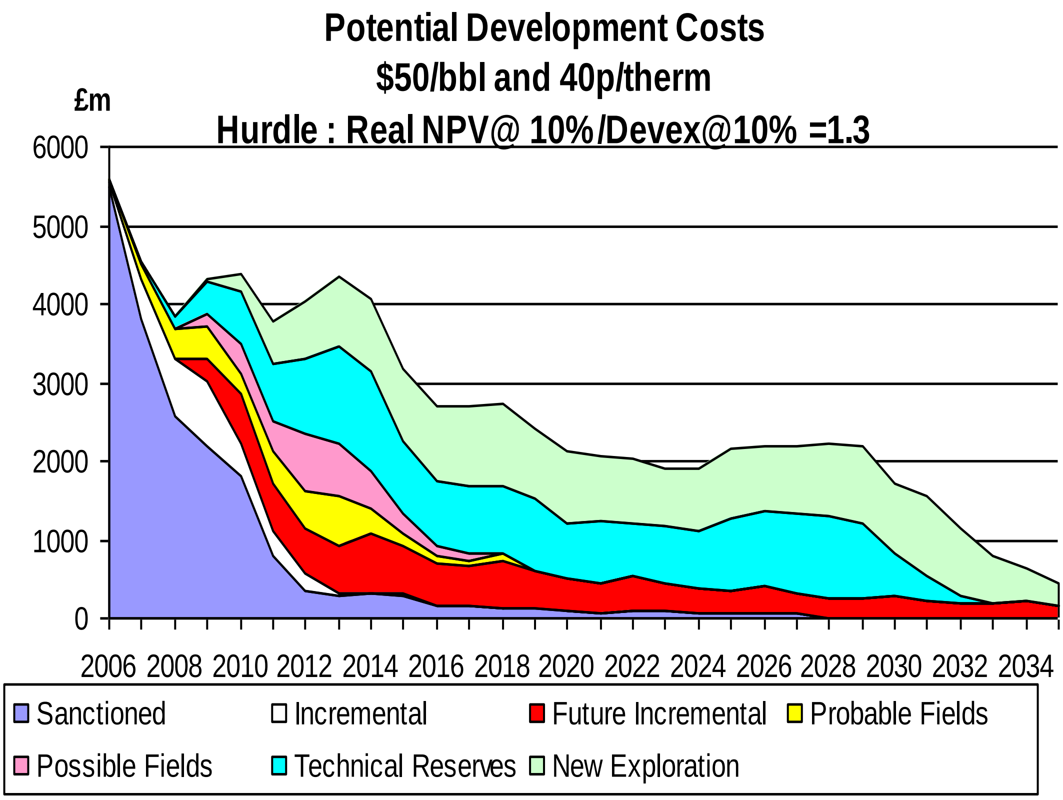


Chart 63

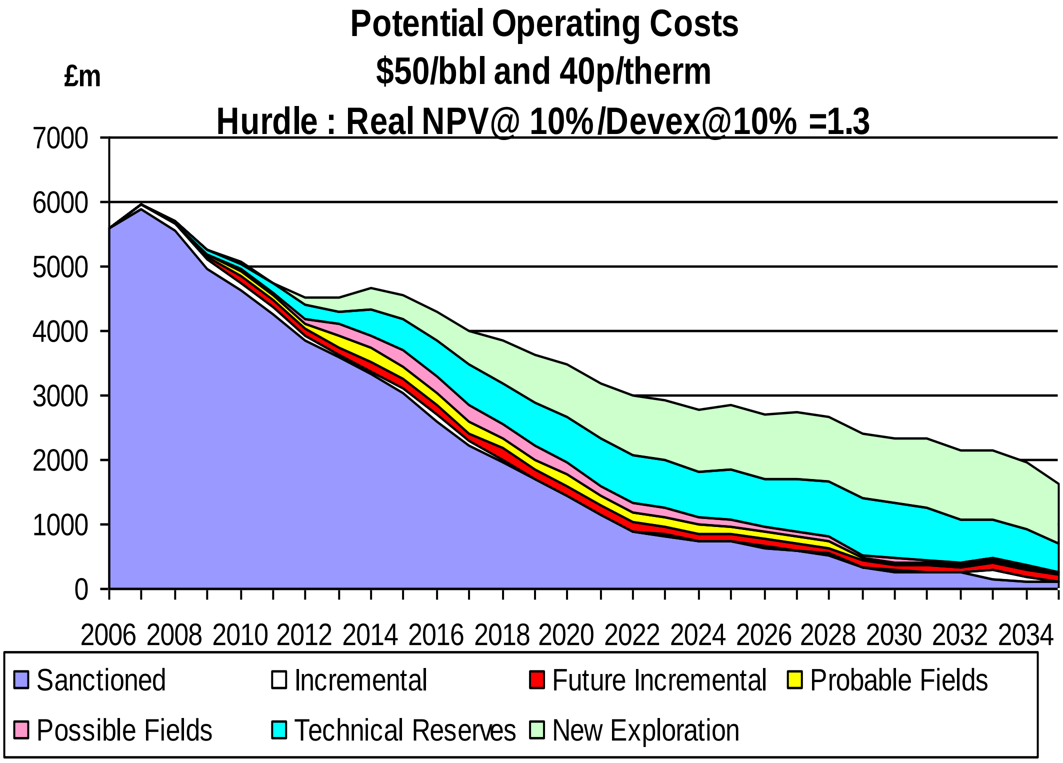
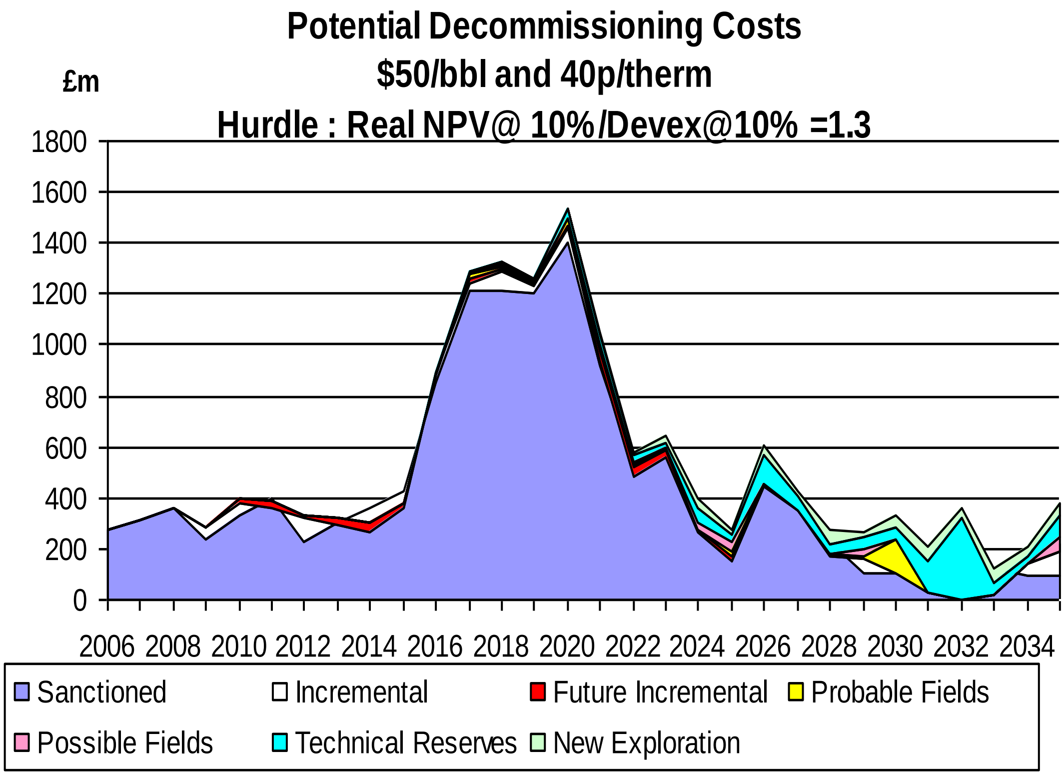


Chart 64



4. Consistency with Official Estimates of Remaining Potential

It was felt useful to examine the modelled aggregate production in relation to the official DTI (now BERR) estimates of the remaining potential. The latter indicate a central estimate of just over 21 billion boe, with a low estimate of 11.7 billion and a high of 38.7 billion boe. The estimates from the present modelling under the different categories are shown in Table 6. It is seen that, under the NPV/I investment criterion the total depletion in the period 2007 – 2035 inclusive ranges from 10.2 billion boe under the Very Low Price to 18.1 billon boe under the High Price Case. Under the £10 million minimum NPV criterion the corresponding range is from 12 billion boe to 19.5 billion boe. These results are felt to be broadly consistent with the official estimates of the remaining potential. It is noteworthy that the developments of the relatively high cost technical reserves are substantially less under the NPV/I criterion. The development of new discoveries is also less. The investment costs per boe are relatively high in relation to NPV with the technical reserves in particular.

Table 6

Cumulative Potential Production from 2007 to 2035 Hurdle : Real NPV @10% / Real Devex @ 10% = 1.3 mmboe Current Tax System								
	Sanctioned	Incremental	Future Incremental	Probable Fields	Possible Fields	Technical Reserves	New Exploration	
$30/bbl and 18p/therm	7888	344	672	59	482	438	345	10228
$35/bbl and 28p/therm	8030	409	922	345	562	1180	1093	12541
$45/bbl and 36p/therm	8176	478	1291	573	640	2721	2655	16534
$50/bbl and 40p/therm	8217	563	1614	666	719	3240	3080	18099

Cumulative Potential Production from 2007 to 2035 NPV : £10m @ 10% Real Post-tax Discount Rate mmboe Current Tax System								
	Sanctioned	Incremental	Future Incremental	Probable Fields	Possible Fields	Technical Reserves	New Exploration	
$30/bbl and 18p/therm	7888	376	718	301	522	1099	1104	12009
$35/bbl and 28p/therm	8030	482	1071	565	695	2866	2092	15802
$45/bbl and 36p/therm	8176	532	1401	688	729	3928	2985	18439
$50/bbl and 40p/therm	8217	574	1621	690	734	4212	3494	19541

5. Conclusions

In this study projections of future activity levels in the UKCS have been made with the employment of financial simulation modelling including the use of the Monte Carlo technique to project new discoveries. The work has also been informed with a good quality database. The behavioural assumptions of investors have reflected those typically employed as far as oil/gas prices and project acceptance criteria are concerned. The results indicate a very high degree of price sensitivity in activity levels across the range of prices under both investment criteria. At prices of £30/18 pence and $35/28 pence activity levels fall off very sharply in the medium-term. Under the $50/40 pence scenario relatively healthy levels of activity are maintained over many years. On this basis the long-run potential is very substantial for the whole UKCS chain.

It should be stressed that the longer-term levels of activity depend on the infrastructure of main pipelines, terminals and key processing platforms remaining substantially intact. This is not guaranteed and substantial refurbishment is likely to be required to keep some of it in sound condition. The activity levels postulated also depend on the success of the various PILOT initiatives, namely the infrastructure Code of Practice, the fallow block/field initiative, and the stewardship initiative. Success of the last of these is required to ensure that the future incremental projects are developed.

This study indicates prospective activity levels under the current tax system. The sensitivity of activity to tax variations is the subject of a forthcoming paper.

Appendix

Chart A.1

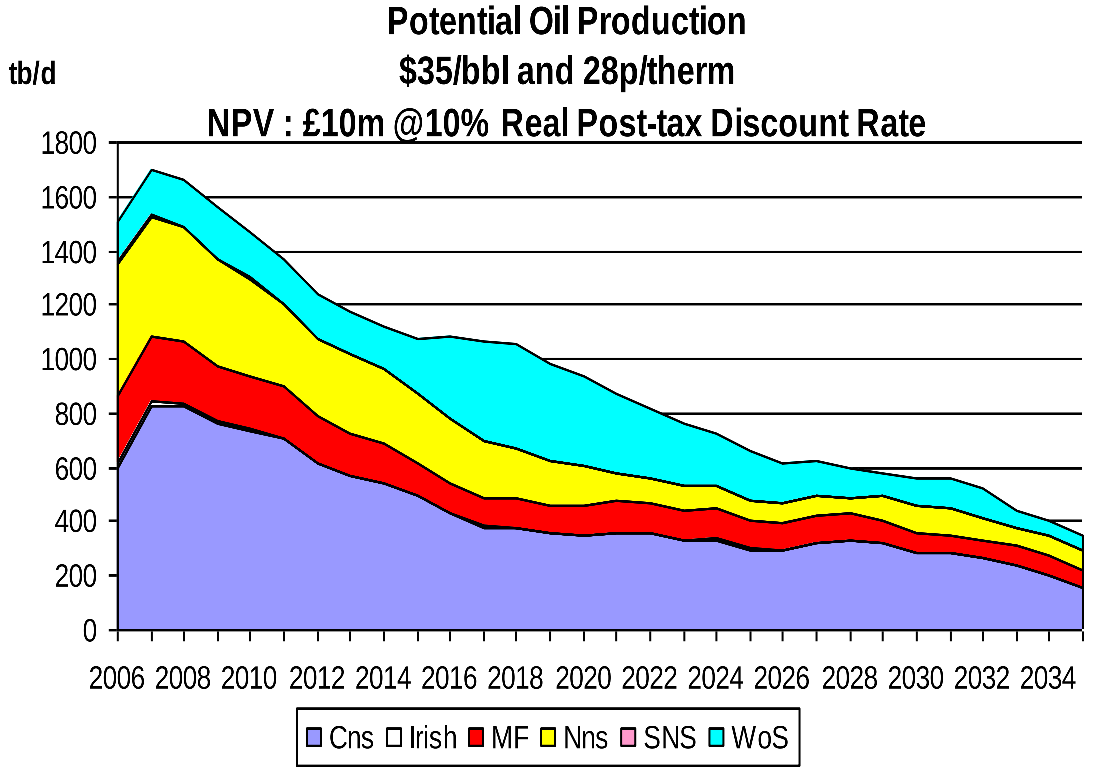


Chart A.2

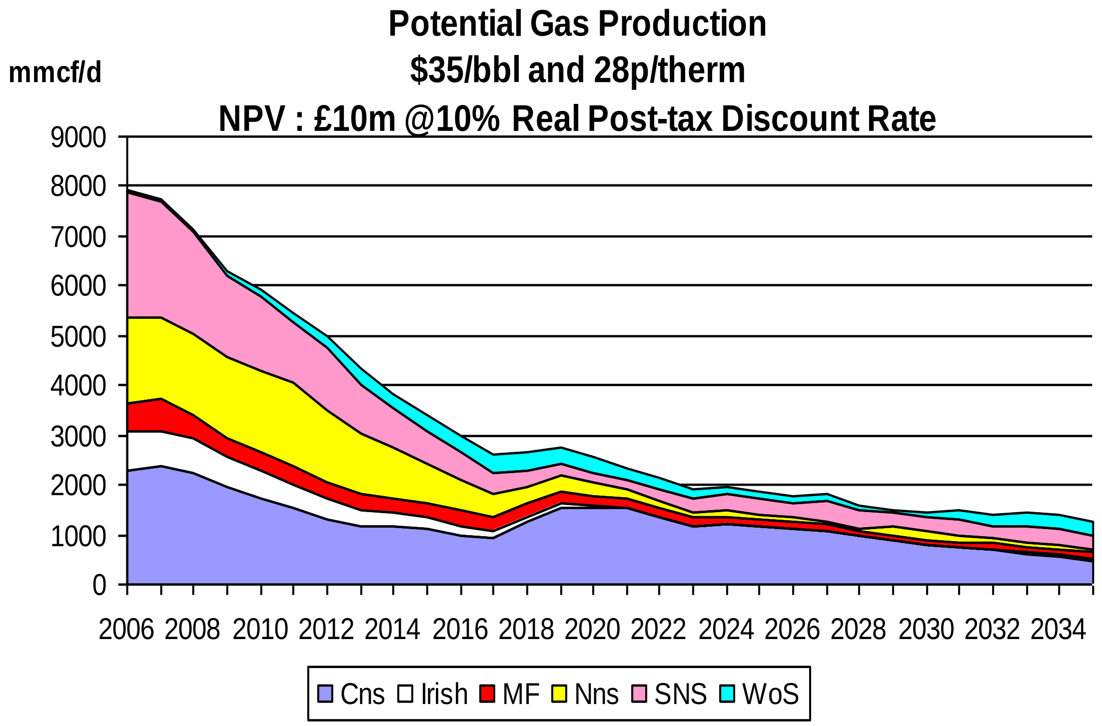


Chart A.3

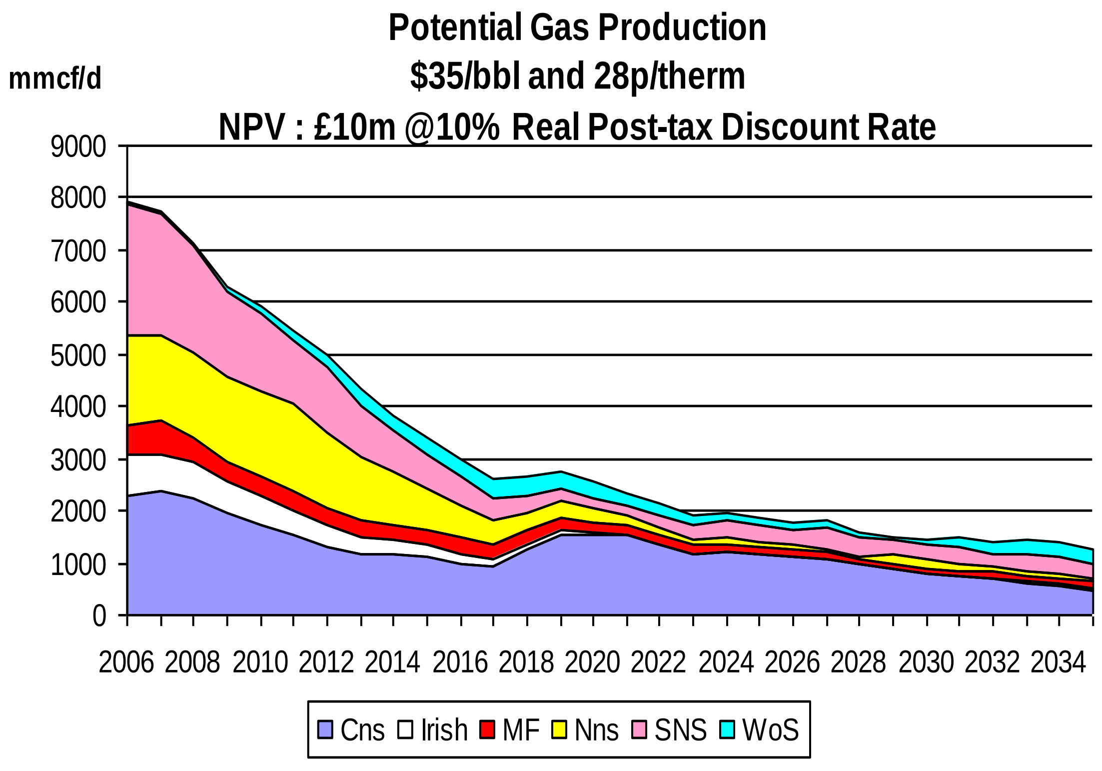


Chart A.4

Potential Development Costs Production
$35/bbl and 28p/therm
NPV : £10m @10% Real Post-tax Discount Rate

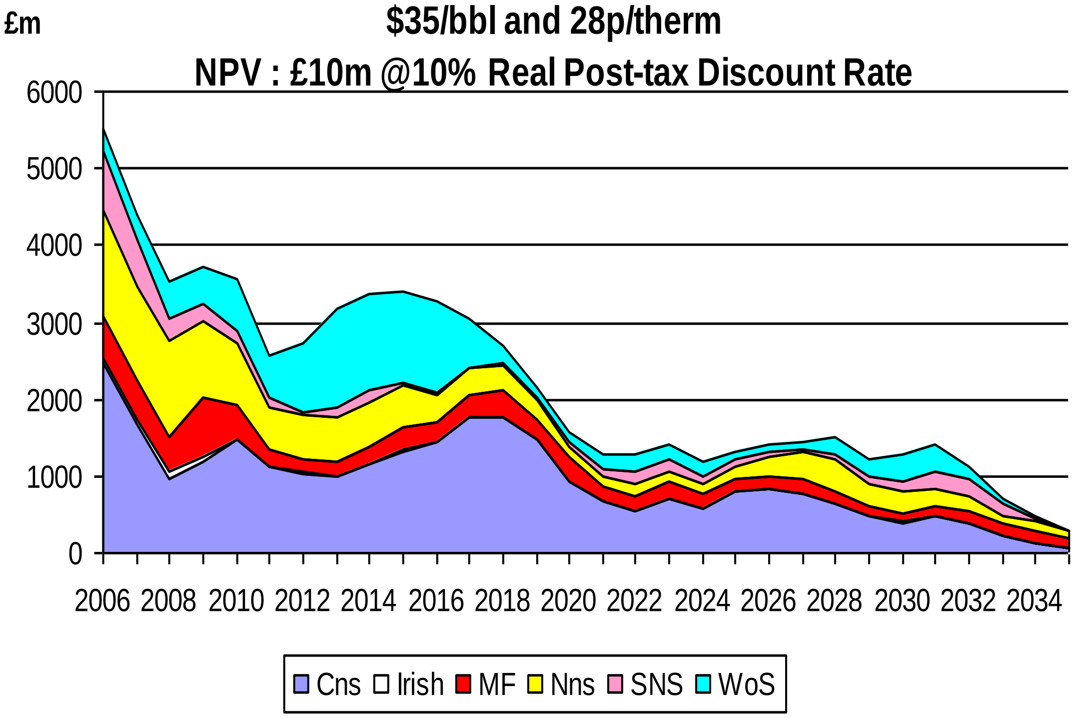


Chart A.5

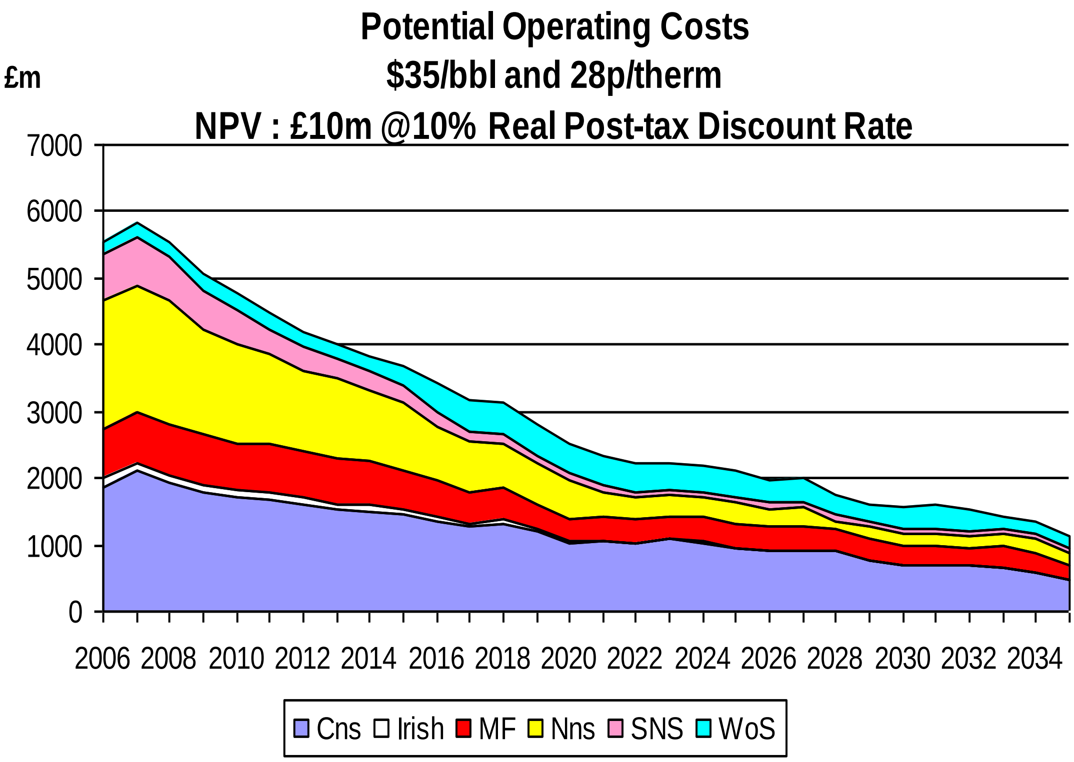


Chart A.6

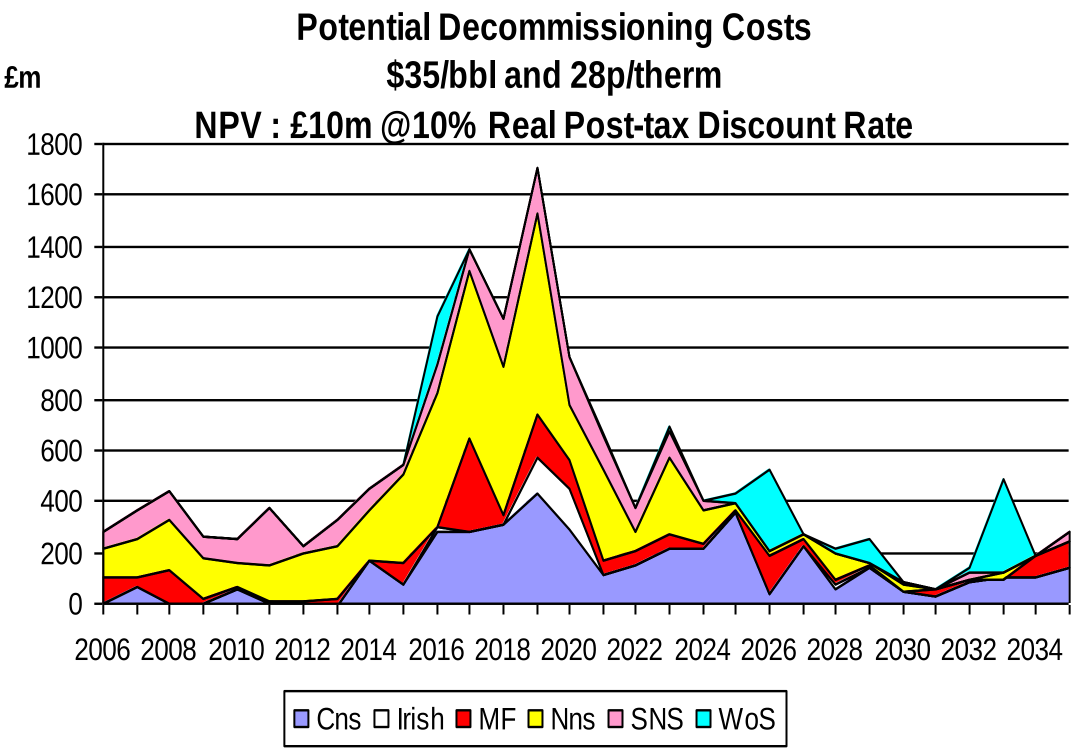


Chart A.7

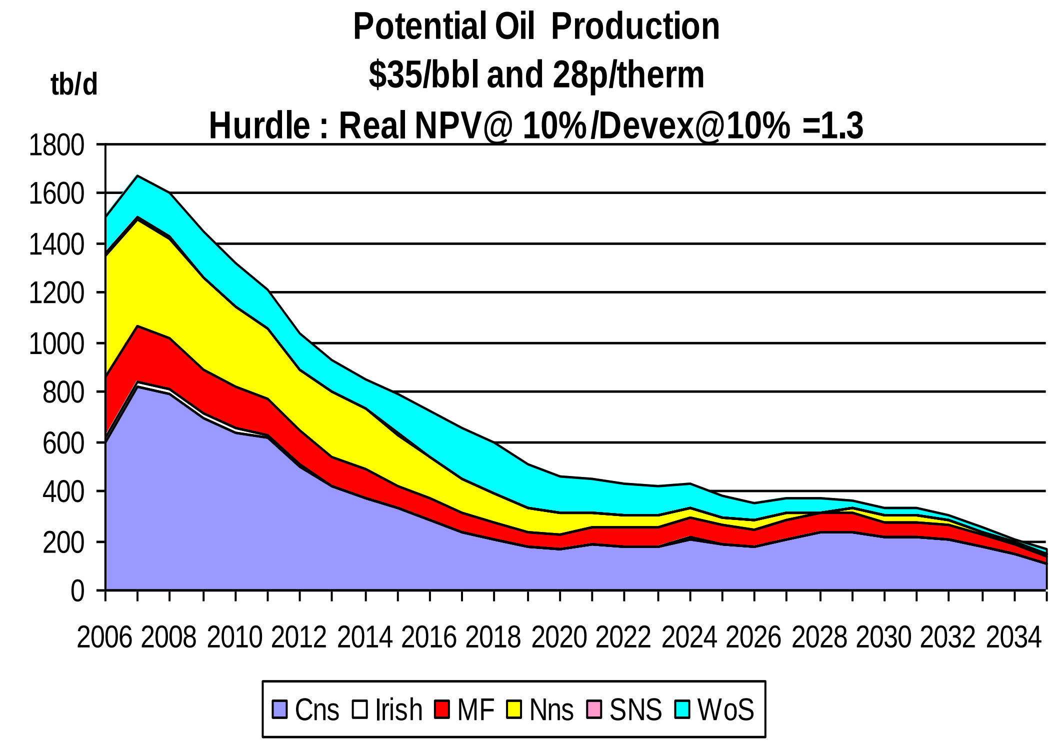


Chart A.8

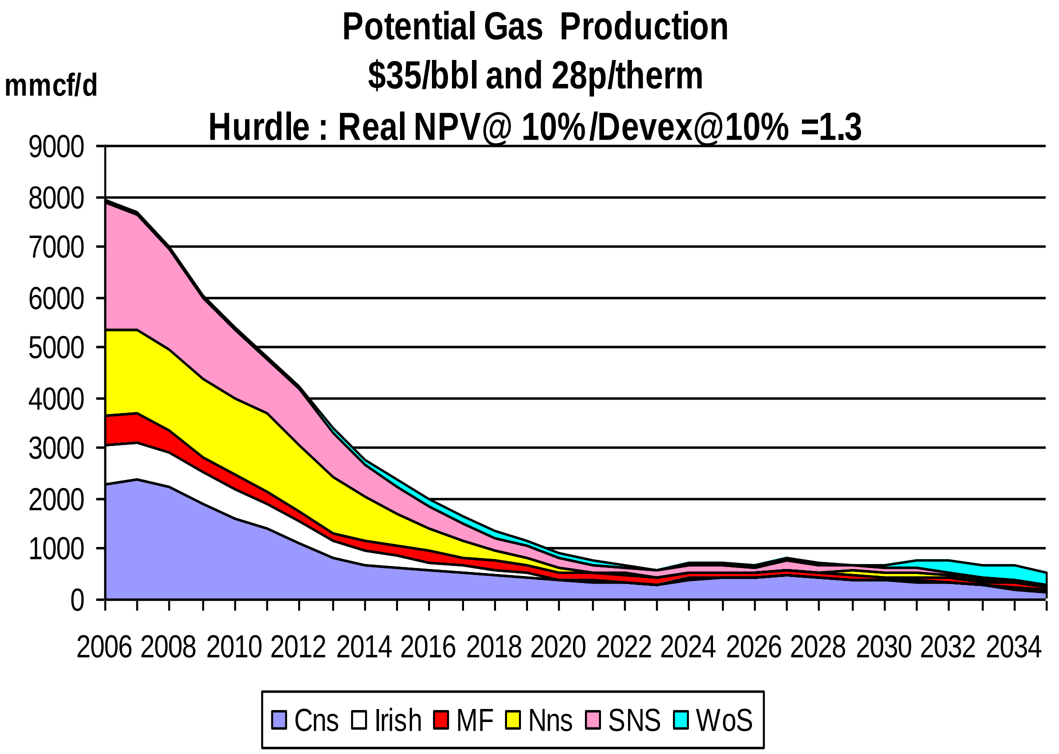


Chart A.9

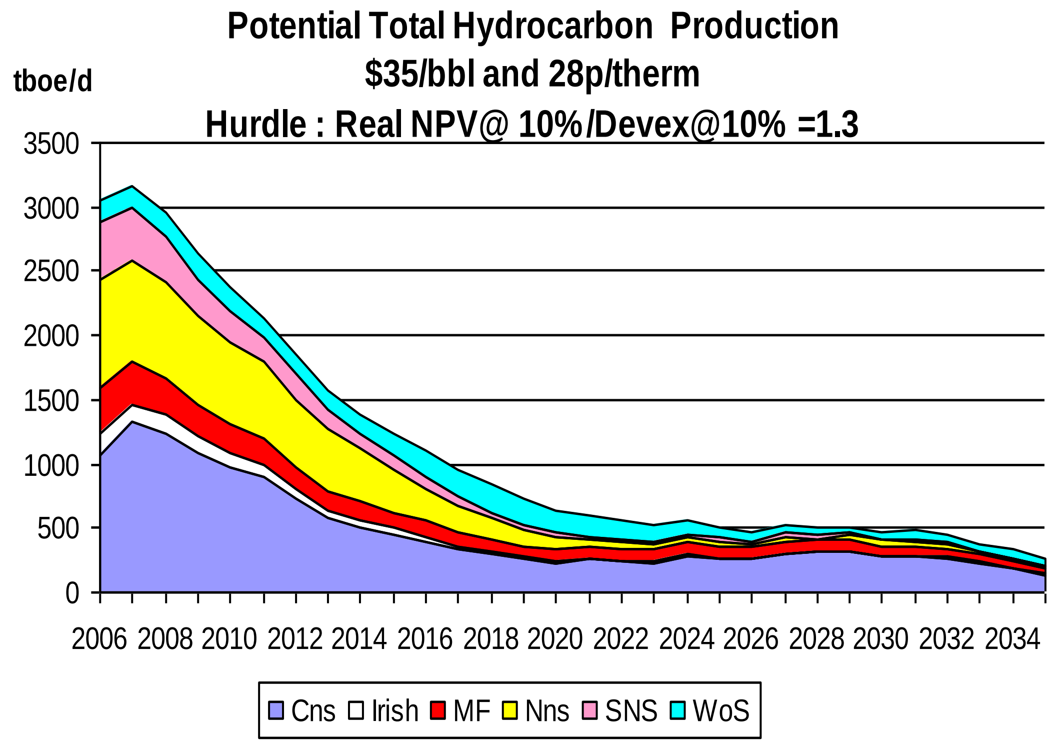


Chart A.10

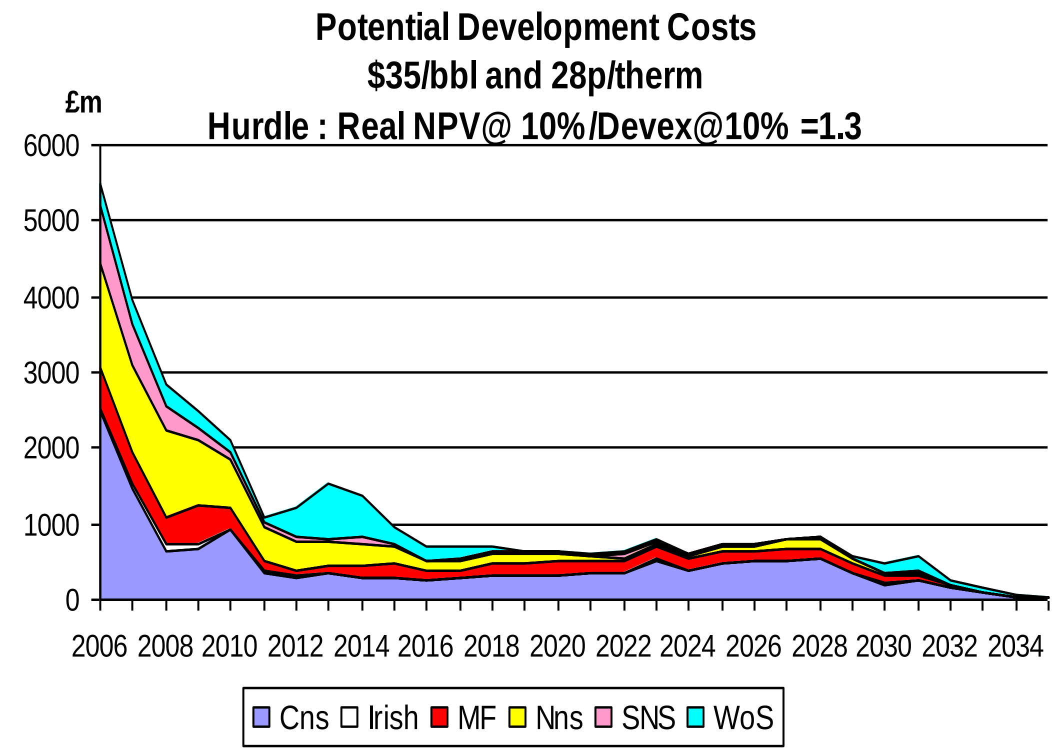


Chart A.11

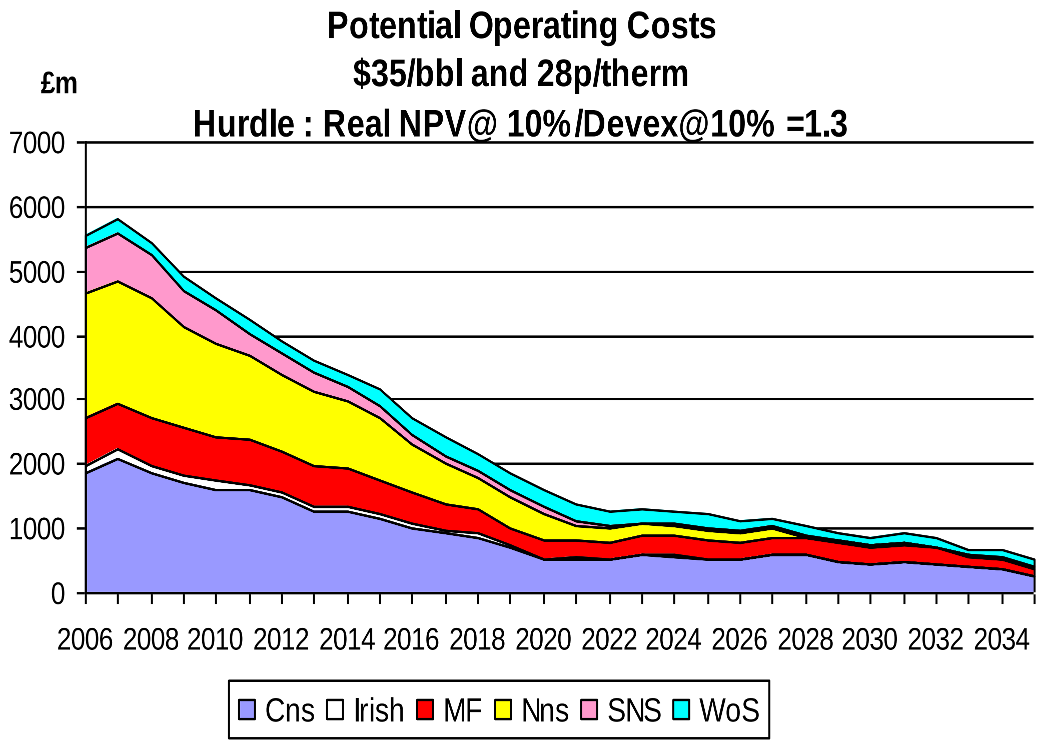


Chart A.12

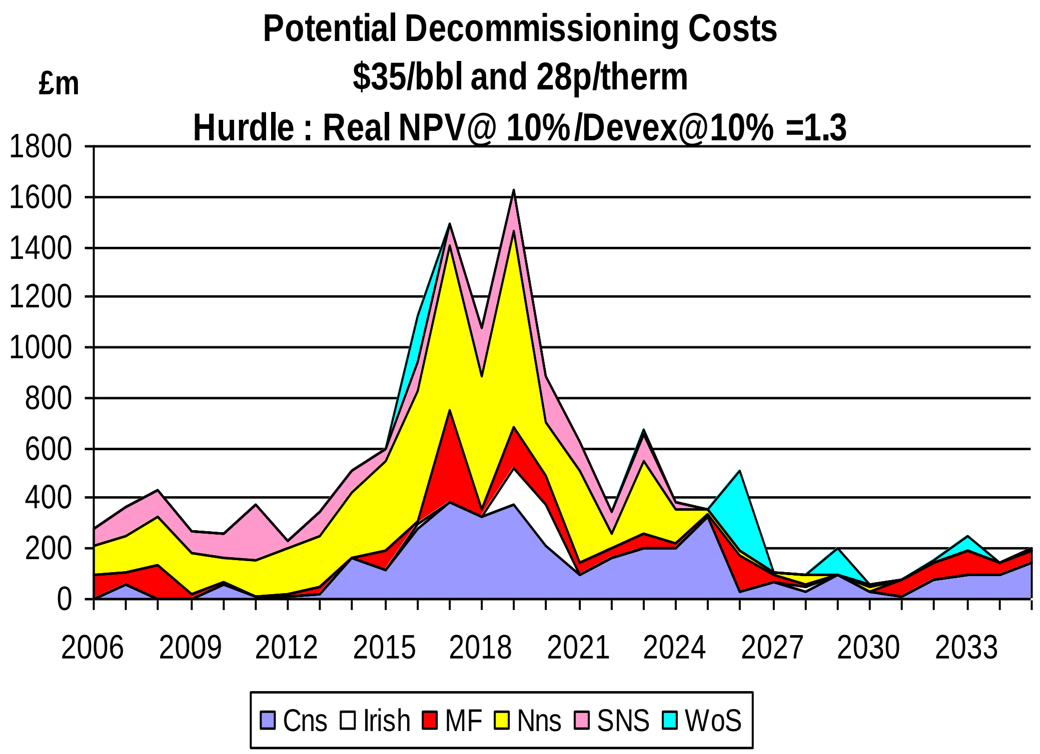


Chart A.13

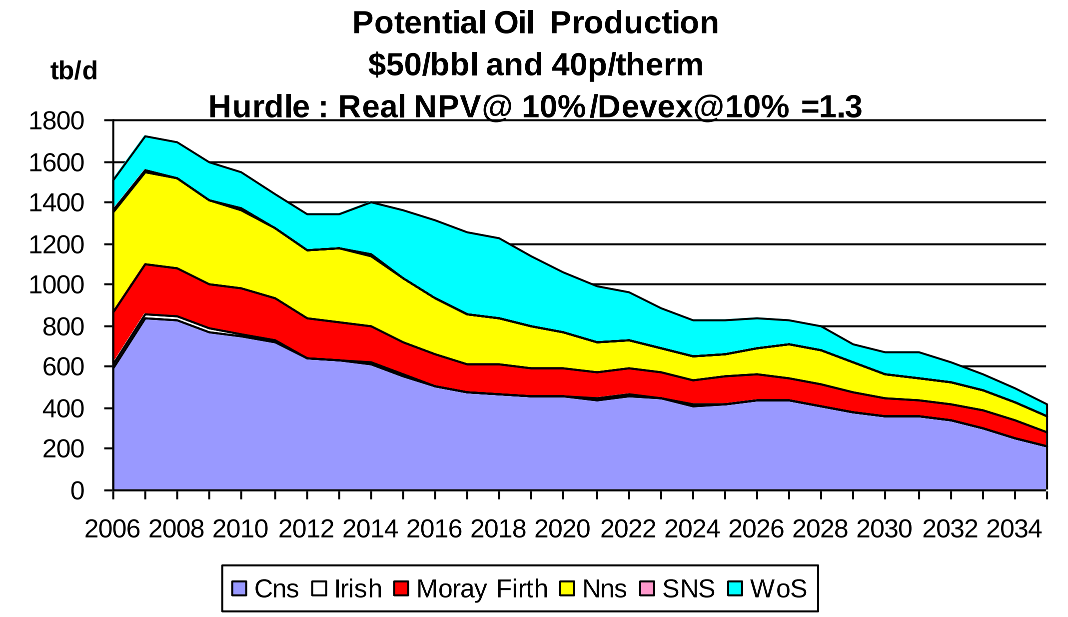


Chart A.14

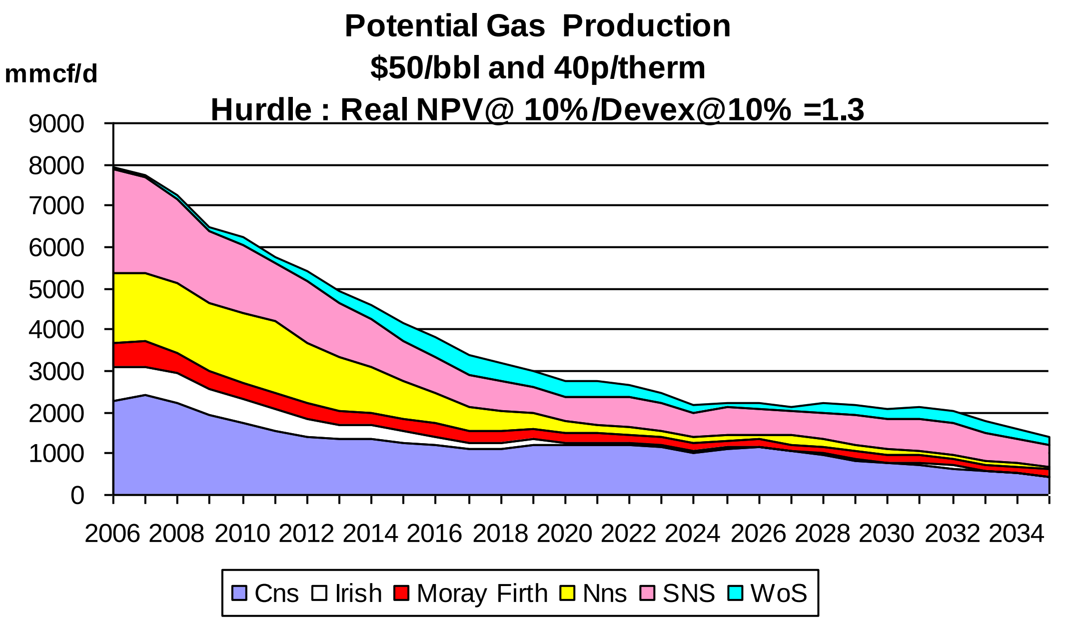
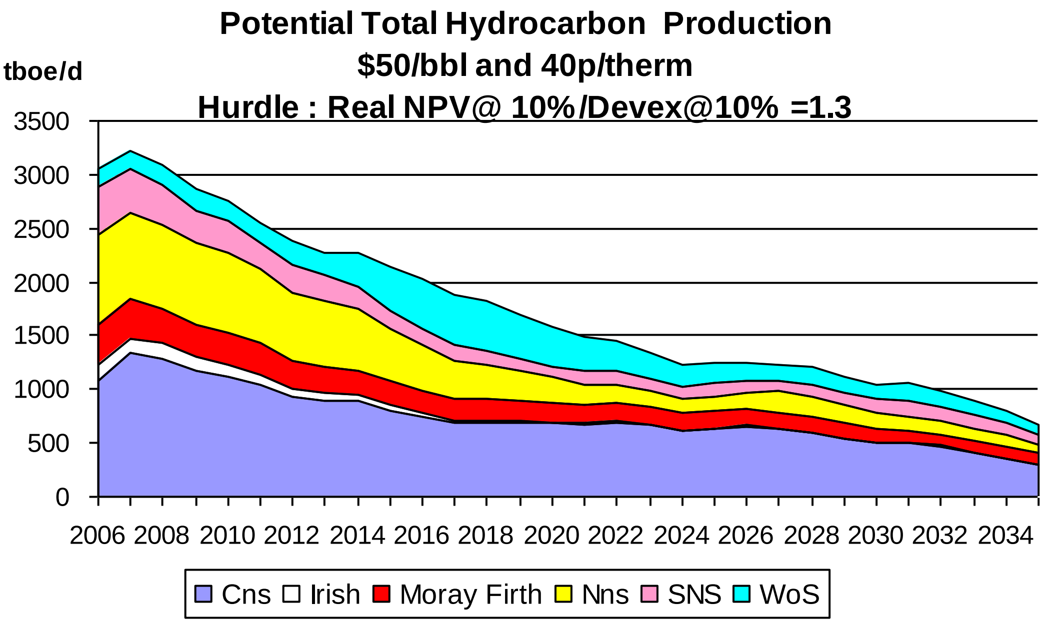


Chart A.15



Potential Total Hydrocarbon Production
$50/bbl and 40p/therm
Hurdle : Real NPV@ 10%/Devex@10% =1.3
tboe/d
3500
3000
2500
2000
1500
1000
500
0
2006 2008 2010 2012 2014 2016 2018 2020 2022 2024 2026 2028 2030 2032 2034
Cns
Irish
Moray Firth
Nns
SNS
WoS