ECONOMIC ANALYSIS OF CO2 FOR EOR AT GULLFAKS USING A PROPOSED VOLUME ALLOWANCE FOR RECOVERED INCREMENTAL OIL

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A recent study[1] conducted by the CENS Partners[2] in collaboration with Statoil New Energy Ventures evaluated the prospects for delivering 5 mtCO2/yr to the Gullfaks field for a 10 year period. The study has subsequently formed the basis for an analysis—reported here—to consider the economic impact of secondary extensive water flood (EWF) and tertiary CO2-miscible WAG (CO2-MWAG) in the Gullfaks field through to year 2030.

The delivery of CO2 to Gullfaks has also been evaluated in combination with an additional CO2 demand from other prospective fields within the Norwegian Tampen region and adjacent fields in the UK sector. This analysis provides an indication regarding the potential for "economy of scale" if delivery capability were increased to respectively 10 and 20 mtCO2/yr.

The results presented in this paper were derived using a modification to the CENS Economic Model (CEM); developed by the CENS partners. The assumptions within the CEM have been extensively 'vetted' in dialogue with industry and government organisations.

The present analysis was conducted with data covering CO2-sources and transportation together with certain field data appropriate to the Gullfaks Project. Results show project economics before and after tax and include an evaluation of the impact of the proposed Volume Allowance (VA). The analysis provides additional insight for stakeholders into the factors that most influence the economics of the proposed project.

Two cases were evaluated for the Gullfaks field; (i) an extensive water flood (EWF) requiring 33 new/reworked wells, and (ii) a miscible CO2 water alternating gas (CO2-MWAG) flood requiring the same 33 new wells and the injection of 5 mtCO2/yr for 10 years. The economics of the cases were built up incrementally so that the EWF (Option 1) was first evaluated on its own, then the incremental project of adding the CO2 to the EWF (incremental Option 2) was

[1] Kaarstad, O. and Hustad, C-W., "Delivering CO2 to Gullfaks and the Tampen Area". Client Report for Elsam A/S, Kinder Morgan CO2 Company and Statoil New Energy Ventures. Rev-0 dated 6th October 2003.

[2] The CO2 for EOR in the North Sea (CENS) Project commenced in August 2001 as a collaboration between the Danish coal-fired power plant operators Elsam A/S, the US-based Kinder Morgan CO2 Company and IN-CO2 ApS.

evaluated and finally both projects were looked at in combination (that is combined CO2-MWAG also termed Options 1+2).

Fig. 1 represents the estimated annual oil production if a) no changes are made until decommissioning in 2018, b) EWF is implemented through 2018, and c) the CO2-MWAG is implemented and the life of the field extended to 2030.

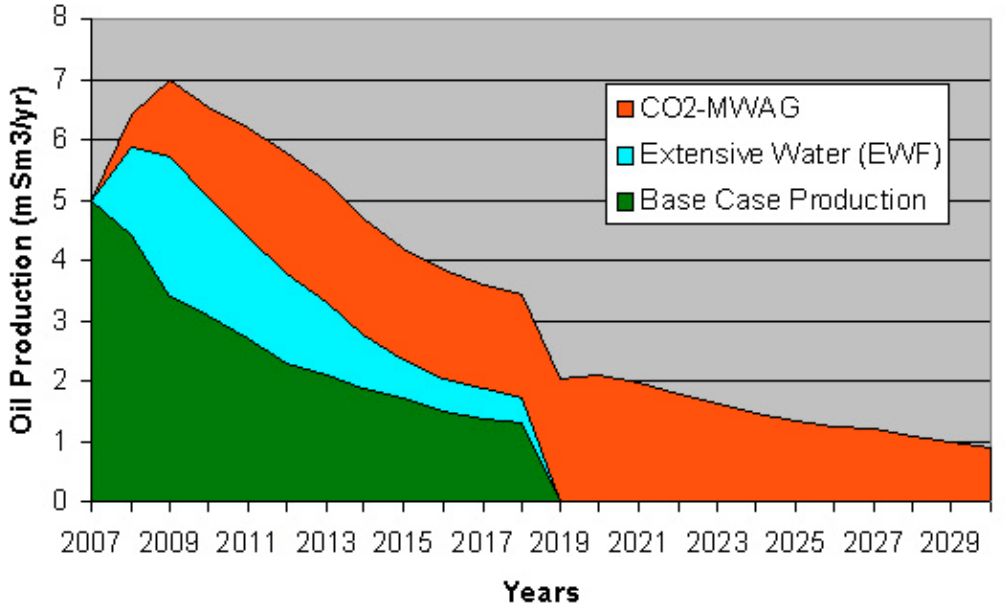

Fig. 1: Estimated Existing and Proposed Production Profiles for Gullfaks.

Fig. 2 depicts only the incremental annual oil production for the EWF and CO2-MWAG projects over the same period from year 2008 through to 2030.

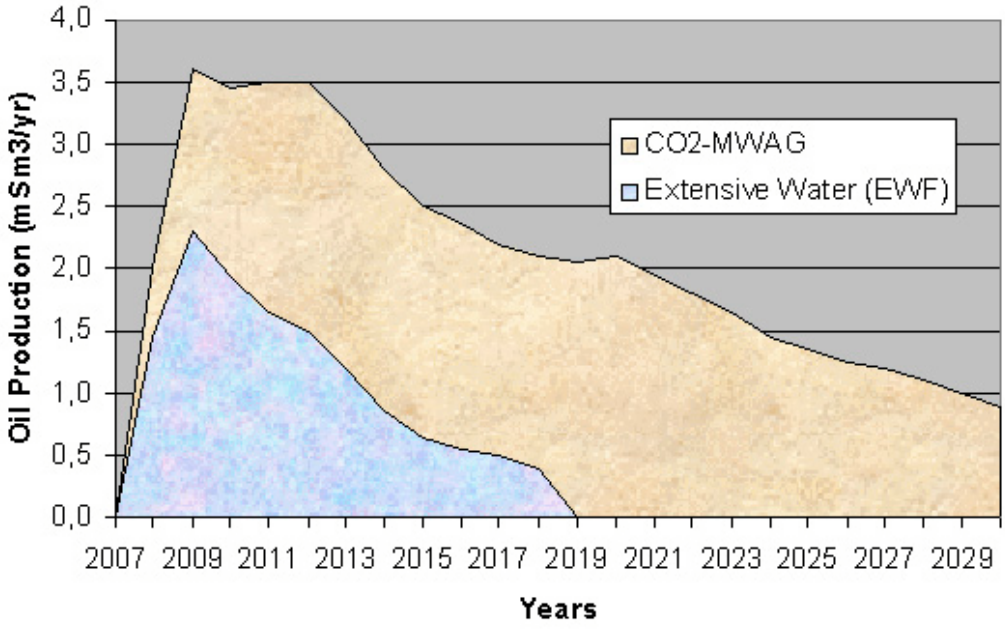

Fig. 2: Estimated Incremental Production Profiles for Gullfaks.

The combined investment at the Gullfaks field for the two projects exceeds $550 million dollars and the EWF portion is approximately 25% of the total. This includes investments for drilling, reworking of other wells, the addition of top side equipment for handling CO2, as well as re-injecting produced gas (and CO2) that comes up with the oil. Statoil has estimated that the total CO2-MWAG could produce 49 million standard metres cubed (mSm3) or 308 million barrels of incremental oil, while the EWF could produce about 26% of the total (that is equivalent to 13 mSm3 or 82 mbbl).

In Table 1 each project was evaluated using a common set of "Base Case" assumptions as defined by:

(i). Averaged oil price throughout duration of project is $17.50/bbl.

(ii). Inflation is set to 0%

(iii). The delivered cost for purchased CO2 is $48 per tonne (/tCO2).

(iv). NPV discount rates are 7% for "Before Tax" calculations and 8% for the "After Tax" estimates.

Results for the three alternative options are shown in Table 1 below.

Oil @ $17.50/bbl CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**312**	**-24**	**15.7**	**6.8**	**526**
EWF	**858**	**159**	**140**	**40.1**	**785**
CO2 addition	**-546**	**-183**	**< 0**	**< 0**	**-259**

Table 1: Comparison of Extensive Water Flood (EWF) and CO2-Miscible WAG for Gullfaks[3]. Using a "Base Case" oil price of $17.50/bbl and a cost for CO2 of $48.00/tCO2.

We observe that the EWF Project required 25% of the capital while producing 27% of the incremental oil—but without the necessity to buy any CO2 as injectant fluid. This is the fundamental economic driver for the project and the reason that EWF creates a substantial economic benefit both before and after tax. Also note that while the combined CO2-MWAG is a 'modestly' attractive project with 15.7% before tax IRR. The incremental benefit of adding the CO2-flood—at these oil and CO2 prices—is actually negative as indicated in the bottom row where the combined project ("CO2 addition") reveals a significant degradation to just doing the EWF with oil at $17.50/bbl.

A government perspective on the project is shown in the last column where the overall discounted incremental taxes from implementing the projects indicates that the government treasury is better off by $259 million—if only the EWF is implemented. However, the combined CO2-MWAG project could also be looked at as a project that provides the

[3] The results represented in this analysis are derived from the CENS Economic Model (CEM) and not those prepared from the Gullfaks operator's model. Therefore, while similar in magnitude, results are not identical.

government with $526 million in incremental tax value while also sequestering 50 million tonnes of CO2 and producing 226 million incremental barrels of oil.

If the project was evaluated at higher oil prices and/or lower delivered CO2 costs, the results would change as can be seen in Table 2, Table 3 and Table 4.

The results for the three options at an oil price of $20.50/bbl are presented in Table 2 below.

Oil @ $20.50/bbl CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**800**	**76**	**25.9**	**11.3**	**937**
EWF	**1 029**	**196**	**163**	**46.4**	**934**
CO2 addition	**-229**	**-120**	**1.5**	**1.2**	**3**

Table 2: "Base Case" with oil price increased to $20.50/bbl.

We now observe that with an oil price of $20.50/bbl the government is actually tax positive under both incremental projects. Also, by comparison with Table 1, the NPV of the CO2-MWAG increased $100 million while the NPV of the government's taxes increased by $411 million (or approximately 80% of the NPV benefit). Furthermore the CO2 addition project has both a positive before and after-tax IRR, but these are below the investment hurdle rates and therefore the NPV's are negative.

The results for the three options with a delivered cost for CO2 at $38.50/tCO2 are shown in Table 3 below.

Oil @ $17.50/bbl CO2 @ $38.50/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**624**	**41**	**23.8**	**10.0**	**782**
EWF	**858**	**159**	**140**	**40.1**	**785**
CO2 addition	**-234**	**-118**	**<0**	**<0**	**-4**

Table 3: "Base Case" with CO2 cost decreased to $38.50/tCO2.

In reducing the cost of CO2 by $9.50/tCO2 the result becomes similar to the case for increasing the oil price by $3.00/bbl shown in Table 2. The government is nearly net positive in both cases and the negative NPV's for the CO2 addition project are approximately equivalent.

In order to obtain positive NPV's for the "CO2 addition" project—both before and after tax—it is necessary to reduce the cost of CO2 (as indicated) and further increase the oil price by $6.00/bbl from the "Base Case" to $23.50/bbl as shown in Table 4. Alternatively one may hold

the CO2 price at $48.00/tCO2 and increase the oil price a further $3.00/bbl to $26.50/bbl as shown in Table 5.

Also, when reducing the CO2 cost by $9.50/tCO2 and evaluating the project with an oil price that is effectively near the low-end of the OPEC desired oil price range, both the EWF and the incremental CO2 project have positive NPV's—and contribute over 80% of the incremental benefit to the government!

Oil @ $23.50/bbl CO2 @ $38.50/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**1 600**	**240**	**43.1**	**17.3**	**1 604**
EWF	**1 201**	**232**	**186**	**52.5**	**1 083**
CO2 addition	**399**	**9**	**14.2**	**8.4**	**521**

Table 4: "Base Case" with oil price increased to $23.50/bbl and with CO2 cost decreased to $38.50/tCO2.

The results in Table 5 essentially reflect what happens when the project analysis is conducted at an oil price closer to the current market price—near the targeted mid-range of the OPEC oil producers—around $26.50/bbl.

Oil @ $26.50/bbl CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**1 776**	**275**	**44.5**	**18.1**	**1 759**
EWF	**1 373**	**268**	**208**	**58.5**	**1 232**
CO2 addition	**403**	**7**	**13.2**	**8.3**	**527**

Table 5: "Base Case" with oil price increased to $26.50/bbl.

At this oil price level both incremental projects have positive before and after-tax NPV's. Furthermore the government has collected significant tax income in maintaining the 78% effective tax rate upon the Norwegian Continental Shelf (NCS).

However, oil companies do not evaluate projects with oil prices at this level because they have as recently as 1998 experienced by oil prices in the mid-teens. Statoil was also reluctant to estimate a delivered CO2 price of $38.50 if the Gullfaks project was to be the only CO2 for EOR project implemented: they are the parties investing the millions to implement these IOR projects whilst only obtaining 22% of the economic benefit. Therefore, they invest in projects where there is less oil price risk included. And with respect to the present analysis, it is likely they would only support the EWF project as evaluated with the oil price at $17.50/bbl. This is in line with their internal criteria for evaluating all prospects around the globe and ensuring

support of projects with the least market price risk and greatest potential for oil production and profit.

Governments on the other hand have a different perspective. They are not the party putting money at risk, but are most interested in seeing their oil resources developed in the most economic manner. These are their countries' reserves and the only reserves that they can tax from a production point of view. They therefore plan budgets and anticipate tax revenues based on oil prices closer to the prevailing market rates, and have a different risk profile than the oil companies.

Governments also have an interest in the impact of CO2 on the environment. The use of CO2 for EOR can reduce overall emissions to the atmosphere while extracting oil that otherwise will be left in the ground. Furthermore governments and oil field operators recognise that there are a limited number of years in which to develop CO2-flooding in a field before its production decline curve is so low that the field is decommissioned and the infrastructure is removed. After this happens, it may be too costly to ever go back to extract the tertiary oil that was available under the CO2 for EOR scenario. **The government risk is that by doing nothing, they may loose the potential 'tail-end' production forever.**

The analysis so far indicates that at higher oil prices and/or lower CO2 delivered costs, the projects are attractive and represent large incremental tax generators. Therefore, there is an opportunity for the government and oil companies to create mechanisms or frameworks to adjust the split of pre-tax income in order to advance these IOR prospects. To evaluate the mechanisms that are available to governments, the CENS Economic Model (CEM) was designed to integrate changes to fiscal and tax structures that apply to the oil fields on the NCS. Two obvious changes that may be considered include reducing the rate for the Special Tax (currently 50% additive to the 28% corporate tax, resulting in an effective tax rate of 78%) and reducing the period over which assets may be written off against profits (currently 6 years). However, in Kon-Kraft's recent study of oil field taxation, a third idea was proposed with respect to projects for increasing tail-end production covering IOR (or EOR projects). This involved a volume allowance (VA) for incremental production.

Oil @ $17.50/bbl VA @ $2.15/bbl CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**312**	**138**	**15.7**	**13.6**	**337**
EWF	**858**	**218**	**140**	**50.3**	**717**
CO2 addition	**-546**	**-80**	**< 0**	**4.1**	**-380**

Table 6: "Base Case" in combination with a $2.15/bbl pre-tax Volume Allowance (VA) per incremental barrel of oil.

The Volume Allowance as proposed in the Kon-Kraft taxation study was a pre-tax mechanism; the income subject to the Special Tax was reduced by 15 NOK per incremental barrel of oil produced above an agreed decline curve. In dollar terms, this equates to a $2.15 allowance for every incremental barrel. For the Gullfaks project this would apply to the incremental oil indicated previously in Fig. 2. The results when incorporating such an

allowance to the "Base Case" assumptions are shown in Table 6 and can be compared directly with analysis in Table 1.

Here it can be seen that the government has redistributed some of its incremental tax income in the combined CO2-MWAG and EWF projects to create a positive after tax NPV with a greater after tax IRR for both these cases. It also has the effect of reducing the negative after tax NPV for the "CO2 addition" and improving the after tax IRR to a modest 4.1%. However, at the level of $2.15/bbl the proposed VA may not be sufficient to encourage an investment decision for the "CO2 addition" option.

But since we are talking about incremental projects and incremental taxation that won't be there if a project is not undertaken by the oil companies, it may also be instructive to look at what a larger Volume Allowance might mean to the set of IOR projects being considered by Gullfaks. If for example the VA was increased to 30 NOK (or approximately $4.30) per incremental barrel, the results would be as shown in Table 7.

Oil @ $17.50/bbl VA @ $4.30/bbl CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**312**	**300**	**15.7**	**18.9**	**148**
EWF	**858**	**277**	**140**	**60.0**	**648**
CO2 addition	**-546**	**23**	**< 0**	**8.9**	**-500**

Table 7: "Base Case" in combination with a $4.30/bbl pre-tax Volume Allowance (VA).

Note that now all three options have a positive after-tax NPV, and the government has an additional increase in tax value of $171 million with the incremental oil produced from the combined CO2-MWAG. However, this means the government has forgone approximately $637 million of incremental tax value to fund the VA based on $17.50 oil price. (Compare EWF in Table 1 to CO2-MWAG here in Table 7).

The Kon-Kraft tax report emphasised a desire to not take negative projects before tax and make them positive projects after tax. However, as demonstrated in the foregoing analysis, whether a project is positive before tax is more dependent on what level of oil price or operating cost (CO2 delivered cost) is being imposed on the project. **As seen here, the Volume Allowance is an efficient mechanism that places the incentives on the operator to recover more incremental oil.**

As also inferred in the above analysis, government effectively has a lower risk exposure than the oil companies, and can consider evaluating projects at oil prices that are closer to the averaged market price. The effect is seen in Table 8 with an oil price of $23.50 and in Table 9 at $26.50 per barrel.

In Table 8 at $23.50/bbl all projects have a positive NPV before and after tax, and the government has $970 million of incremental tax income (which is approximately 80% of the increased benefit from the higher oil price).

Oil @ $23.50/bbl VA @ $4.30/bbl CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**1 288**	**499**	**35.4**	**24.6**	**970**
EWF	**1201**	**349**	**186**	**71.6**	**946**
CO2 addition	**87**	**150**	**8.5**	**13.2**	**24**

Table 8: Volume Allowance at $4.30/bbl and with oil price of $23.50/bbl.

In Table 9 at $26.50/bbl the government has not only $1,382 million in additional tax income from the incremental oil production, but also has $150 million increased tax value as compared to the EWF project without the VA (Note $26.50/bbl in Table 5 above). This additional income may also be augmented further by higher oil prices, higher oil production than estimated for the CO2-EOR project, and any reduction in operating costs especially with respect to delivered cost for CO2.

Oil @ $26.50/bbl VA @ $4.30/bbl CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**1 776**	**598**	**44.5**	**27.3**	**1 382**
EWF	**1 373**	**385**	**208**	**77.3**	**1 096**
CO2 addition	**403**	**213**	**13.2**	**15.1**	**286**

Table 9: Volume Allowance at $4.30/bbl and with oil price of $26.50/bbl.

The previously referenced study (see footnote 1 on page 1) conducted by the CENS Partners confirmed that the $48.00 per tonne CO2 price is sufficient to obtain significant quantities of CO2 from existing sources in Denmark, the Netherlands or the UK. The level of this price was influenced by the short contract period of 10 years used in the Gullfaks analysis and the low volume of CO2 which was to be transported through a 'small' 18-inch pipeline.

If the Volume Allowance were to be instituted, a greater demand of CO2 might be foreseen so that both the scale and efficiency of the transport systems could be improved. Also, with the acceptance of CO2 Capture and Storage (CCS) being recognised as a mechanism within the EU Emissions Trading System (ETS)—subject only to agreeing guidelines for measuring and monitoring the CO2—there is now a strong possibility of further reductions in the cost of delivered CO2.

In the original study (footnote 1) the lowest achievable cost for delivered CO2 was $38.50 per tonne CO2. In the following we therefore compare this cost for CO2 with oil price at $17.50 and $26.50 respectively.

With the price of oil at $17.50/bbl and delivered price of CO2 at $38.50/tCO2 (see Table 10), the project economics can be compared with $48.00/tCO2 previously shown in Table 7. The pre-tax NPV of the CO2-MWAG project has (exactly) doubled from $312 to $624 million. For the operator the after-tax IRR has improved from 18.9 to 21.2%. However the tax income generated by the project increases from $148 to $404 million, so that the government receives approximately 82% of the upside for the reduced cost of delivered CO2.

Oil @ $17.50/bbl VA @ $4.30/bbl CO2 @ $38.50/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**624**	**365**	**23.8**	**21.2**	**404**
EWF	**858**	**277**	**140**	**60.0**	**648**
CO2 addition	**-234**	**88**	**< 0**	**11.5**	**-244**

Table 10: CO2 cost at $38.50/tCO2 together with VA at $4.30 and oil at $17.50/bbl.

In Table 11 at $26.50 for oil, the project now achieves a $1,637 million in incremental tax value: this is also $405 million more than the EWF project without the VA evaluated at $26.50/bbl (as seen previously in Table 5). The project will also have sequestered 50 million tonnes of CO2 and helped open the way for other projects enabling greater economies of scale with larger volumes of CO2 from the continent and also from new additional sources in Norway.

Oil @ $26.50/bbl VA @ $4.30/bbl CO2 @ $38.50/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**2 088**	**663**	**52.2**	**29.4**	**1 637**
EWF	**1 373**	**385**	**208**	**77.3**	**1096**
CO2 addition	**715**	**278**	**18.8**	**17.4**	**542**

Table 11: CO2 cost at $38.50/tCO2 together with VA at $4.30 and oil at $26.50/bbl.

If mechanisms like the Volume Allowance helps initiate future IOR and EOR projects, then there are also additional opportunities to further develop the fields because of the prospect of a longer field life. This includes prospects for more satellite fields being developed off platforms that have been given such life extension. These prospects may potentially surpass the incremental production of between 6 to 15% of a field's original oil in place that is typically assumed to be realised by CO2-flooding.

The level of the VA proposed in the Kon-Kraft taxation report and shown here as part of this analysis, may need to be evaluated in more specific detail. However the analysis suggests that it is important that both government and oil industry focus attention on this—

apparently—very efficient mechanism, and seek to agree on a level for the VA that will maximise the incremental production of oil as well as tax revenue.

Also indicated in this paper is that a higher level may be necessary to produce the right incentives for the oil producers. For example if the VA is set at $5.90 per incremental barrel, the results can be seen in Table 12 to provide a more attractive CO2 project to Gullfaks even at low oil prices in order to ensure investment while netting out nearly zero in incremental tax to the government at $17.50 oil ($140 million reduction from Table 7 above), but retaining 78% of the upside to the government as previously shown.

Oil @ $17.50/bbl VA @ $5.90/bbl CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**312**	**421**	**15.7**	**22.4**	**8**
EWF	**858**	**321**	**140**	**67.1**	**597**
CO2 addition	**-546**	**100**	**< 0**	**11.7**	**-590**

Table 12: "Base Case" in combination with a $5.90/bbl pre-tax Volume Allowance (VA).

Summary: The Kon-Kraft proposed Volume Allowance structure—when implemented at an appropriate level—could encourage extensive development of tail-end production (IOR or EOR projects) including CO2 for EOR. The VA enhances the economics of a project while reducing the market price risk. It is not a subsidy on sequestered CO2, but an incentive for incremental oil production, and is only applied to reduce Special Tax payments after annual incremental oil is produced. It is therefore very efficient and functions as a boost to both production and taxation, is self-funding from incremental taxation even with oil prices below $17.50 per barrel.

The Volume Allowance is not just a mechanism for CO2 for EOR but a mechanism for tail-end production. It creates an economic driver for CO2-EOR immediately. It also encourages oil companies to seek the cheapest CO2 as they receive 22% of the benefit. But using the VA it is the government of Norway that will benefit the most from future developments of reduced capture costs, realisable emission credits and tax income that encourages field life extension through use of CO2 for EOR. However, these improvements will take time to materialise and may be difficult to quantify up front for a long-term project evaluation. The proposed mechanism should create incentives for tertiary project development using CO2 while society collectively works out the issues of carbon sequestration, GHG-emissions and CO2-trading.

For now, the Gullfaks project can most likely be justified on the basis of an appropriate VA—and not through a CO2-credit. Any forthcoming credits, tax incentive and technical developments will reduce the effective cost of delivered CO2 and, as shown above, this benefit is carried at the level of approximately 78% through to the Norwegian Finance Ministry. These, and possibly further benefits, will be extensively realised in the future after the first real CO2 for EOR projects are approved and CO2 is being sequestered in oil reservoirs.

SUPPLEMENTAL ANALYSIS

The Volume Allowance (VA) as proposed by the Kon-Kraft works on the after-tax free cash flow of a proposed EOR project and not on the pre-tax cash flow. This has the effect of minimising the amount of capital necessary to fund such a mechanism, but it is not the only way that such an allowance could be constructed.

If the VA were to be implemented as a pre-tax (PPVA) payment, the amount for comparison purposes would have to be equal to $9.77 per incremental barrel of oil as compared to the results of Table 7 above providing the same after tax benefits. On this basis as seen in Table 13 below, each incremental project has a positive before and after tax NPV, and substantial positive IRR's before and after tax. Also note that the government has a positive discounted net tax for the combined project even though the incremental addition of CO2 has a negative discounted net tax effect. Again in this scenario, the project has sequestered 50 million tonnes of CO2 and produced 308 million barrels of incremental oil.

Oil @ $17.50/bbl PPVA @ $9.77/bbl CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**1 901**	**300**	**46.9**	**18.9**	**148**
EWF	**1 417**	**277**	**214**	**60.0**	**648**
CO2 addition	**485**	**23**	**14.3**	**8.9**	**-500**

Table 13: A Pre-tax Paid Volume Allowance (PPVA) of $9.77 per barrel with oil price at $17.50/bbl and cost of CO2 at $48.00/tCO2.

If the oil price was decreased to $16.43/bbl and the other above conditions applied, the projects would still be attractive (see Table 14) and the government would be at a break even with respect to discounted net taxes for the combined CO2-MWAG.

Oil @ $16.43/bbl PPVA @ $9.77/bbl CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**1 727**	**265**	**43.6**	**17.8**	**1**
EWF	**1 355**	**264**	**206**	**57.9**	**595**
CO2 addition	**371**	**1**	**12.7**	**8.0**	**-594**

Table 14: Oil at $16.43/bbl, a PPVA of $9.77 per barrel and $48.00/tCO2

If on the other hand, the oil price was increased as before to $23.50/bbl, the government would have a substantial increase in discounted net taxes as shown in Table 15, and the CO2

addition would more than breakeven on a discounted net tax base. Note again that the government is also gathering over 78% of the incremental post-tax benefits.

Oil @ $23.50/bbl PPVA @ $9.77/bbl CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**2 877**	**499**	**64.4**	**24.6**	**970**
EWF	**1 760**	**349**	**258**	**71.670.7**	**946**
CO2 addition	**1 117**	**150**	**22.1**	**13.2**	**24**

Table 15: Oil at $23.50/bbl, a PPVA of $9.77 per barrel and $48.00/tCO2.

And at an oil price of $26.50 and a CO2 price that reflects larger volumes and additional projects with cost of CO2 at $38.50 per tonne, the results shown in Table 16 may be achieved. Again, there are substantial incremental gains in discounted net tax flows and again the government collects over 80% of the net benefit of the oil price increase and CO2 price decrease.

Oil @ $26.50/bbl PPVA @ $9.77/bbl CO2 @ $38.50/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**3 677**	**663**	**80.3**	**29.4**	**1 637**
EWF	**1 932**	**385**	**280**	**77.3**	**1 096**
CO2 addition	**1 745**	**278**	**32.0**	**17.4**	**542**

Table 16: Oil at $26.50/bbl, a PPVA of $9.77 per barrel and $48.00/tCO2.

This analysis demonstrates that there are pre-tax payment and allowance mechanisms that could substantially change the way the oil industry looks at life-extension projects and more particularly, CO2 for EOR projects. **The Volume Allowance provides a protection to the downside case on oil prices for the party putting up the major capital investments while retaining for the Norwegian Finance Ministry over 78% of the benefits from any oil price increases, cost savings as in the case of CO2-pricing and better than expected oil production amounts.**

The VA is also an efficient incentive mechanism. It works on the principle of rewarding incremental production independent of the price of oil. At $23.50 per barrel of oil, as seen in Table 8 and Table 15, the pre-tax VA's (or PPVA's) produce economically viable projects. However when compared with a reduction in the Special Tax to the level of 25% as seen in Table 17 below, the addition of CO2 is only modestly attractive while the EWF and combined CO2-MWAG are attractive. However, the government is shown to receive respectively 55%

and 29% less tax from the EWF and CO2MWAG projects when compared to projects with a pre- or post-tax VA and a 50% Special Tax rate.

Oil @ $23.50/bbl Spec. Tax @ 25 % CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**1 288**	**739**	**35.4**	**34.4**	**691**
EWF	**1 201**	**795**	**186**	**163**	**426**
CO2 addition	**87**	**-14**	**8.5**	**7.6**	**216**

Table 17: Oil at $23.50/bbl, No PPVA, $48.00/tCO2 and Special Tax reduced to 25%.

The reduction in Special Tax rate also does not provide as much incentive to an oil field operator to invest in a CO2 project at low oil prices. Table 18 shows negative NPV's and IRR's for the "CO2 addition". In comparison, the project represented in Table 7 shows that the "CO2 addition" had a positive after-tax NPV and nearly a 9% after-tax IRR. Therefore, there is less likelihood that a project would be approved under a Special Tax reduction as compared to a Volume Allowance—and again, with the VA the government retains over 78% of the upside benefits in the project.

Oil @ $17.50/bbl Spec. Tax @ 25 % CO2 @ $48.00/t	Project NPV		Project IRR		Income Tax
Project	Before Tax ($ mill)	After Tax ($ mill)	Before Tax (%)	After Tax (%)	Disc. cumulative ($ mill)
CO2-MWAG	**312**	**145**	**15.7**	**14.7**	**330**
EWF	**858**	**481**	**140**	**110**	**410**
CO2 addition	**-546**	**-296**	**< 0**	**< 0**	**-128**

Table 18: Oil at $17.50/bbl, No PPVA, $48.00/tCO2 and Special Tax reduced to 25%.

Also note that Table 18 shows the government would have more tax under this low oil price scenario if the combined CO2-MWAG was implemented along with a 25% Special Tax. However, this would shift at an oil price just below $20.50 and then the government would be better off in a VA scenario. A comparison to Table 7 shows that the government through a significant VA scenario effectively forgoes some tax revenues at low oil prices to keep the oil field operator whole while retaining more than 78% of the upside when oil prices are at or above an oil price of approximately $20.50/bbl—a level which is 10% below the desired minimum price range proposed by OPEC!

The level of the Volume Allowance used in a large part of this analysis was set at twice the level in the Kon-Kraft report on Oil Field Taxation. This level needs to be discussed among the oil field operators and the appropriate government ministries to achieve the

most efficient level possible that would maximise incremental oil development throughout the NCS while securing sufficient upside revenue to the government for their support of this mechanism and for minimising the downside market price risks to project participants.