



**BP CATS – Mod 498 – CO<sub>2</sub>**  
**7<sup>th</sup> August 2014**

- Current specifications
- Recap of CO<sub>2</sub> forecasting
- Historical relationship – CO<sub>2</sub> and other spec:
  - Gross Calorific Value
  - Wobbe Index (GSMR)
  - Soot Index (GSMR)
  - Incomplete Combustion Factor (GSMR)
- User concerns response
  - Tata Steel
  - GrowHow
  - SSE
- Alternative options – offshore / onshore CO<sub>2</sub> removal
- Summary

# Current specifications



- CATS existing CO<sub>2</sub> spec is 2.9mol%
- NEA has Reasonable Endeavours right for short-term breaches of CO<sub>2</sub> to 4mol%
- Other UK terminals have a 4.0mol% NTS entry spec
- CATS strictly adheres to all NEA specifications which includes:
  - Wobbe >48.14 <51.41; ICF <0.48; SI <0.60
- NEA does not contain a total inerts specification
- CATS have requested a revised CO<sub>2</sub> spec to 4mol%
- Two main benefits:
  - avoid restricting throughput of existing gas fields
  - avoid risk of potential new gas fields not being developed

# Action 0601a - Recap of CO<sub>2</sub> forecasting



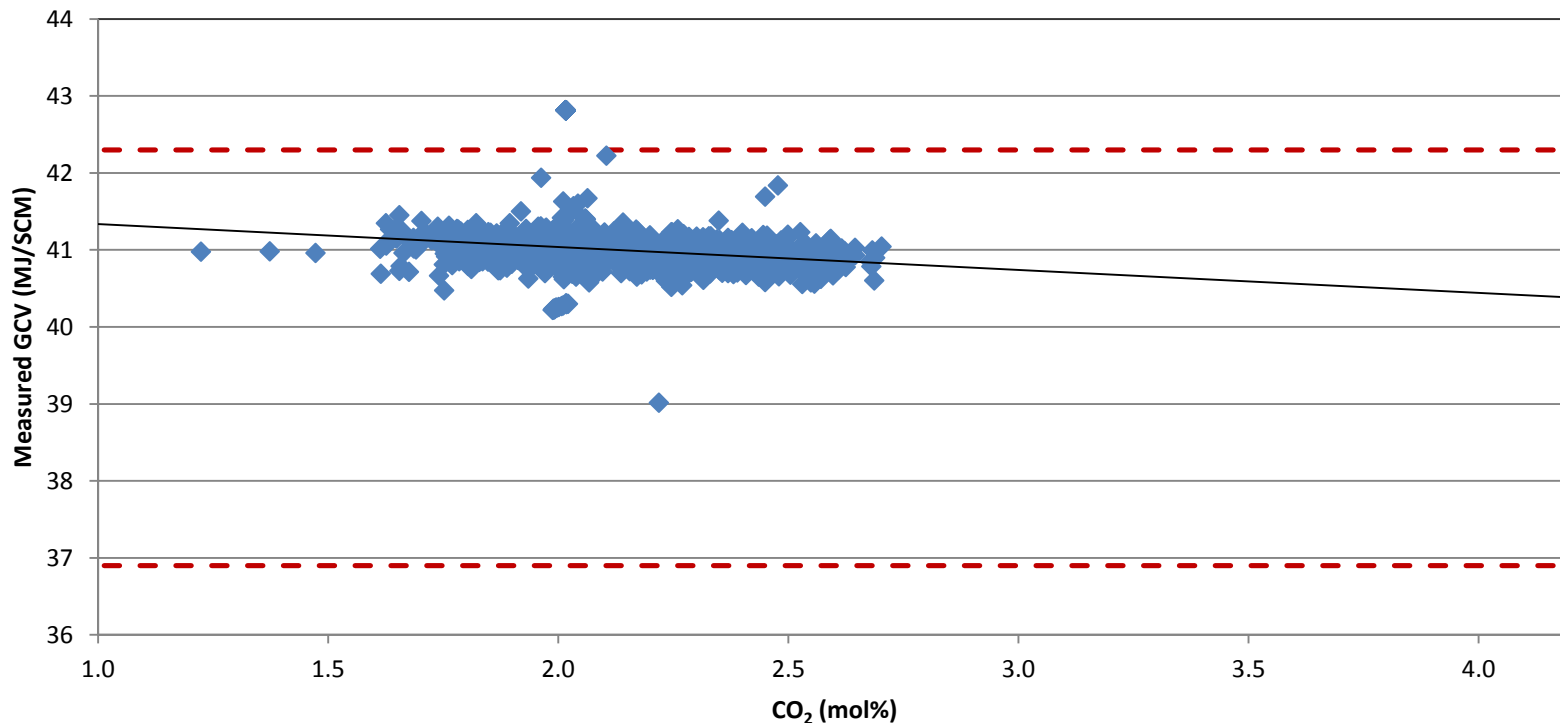
- Analysis based on current gas fields + two material, potential new gas fields c2019
- 2014-2018
  - Expect CO<sub>2</sub> > 2.9mol% for maximum of 5% of time at peak of 4mol%
  - Tend to occur during summer months for short periods (2-3 days)
  - Estimate an overall impact of 0.03mol% on annual average
- 2019+
  - Based on two material, potential new gas fields
  - non-summer months – between 2.66mol% and 3.57mol% (flow dependent)
    - CATS expect CO<sub>2</sub> concentrations >2.9mol% the majority of the time but expect maximum to be approximately 3mol%
  - summer months – between 2.66mol% and 4mol% (flow dependent)
    - CATS expect CO<sub>2</sub> concentrations >2.9mol% the majority of the time but expect maximum to be approximately 3.6mol%
- **Other prospective gas fields with lower CO<sub>2</sub> levels will lessen the impact**

# Action 0601a - Historical relationship – CO<sub>2</sub> & other spec



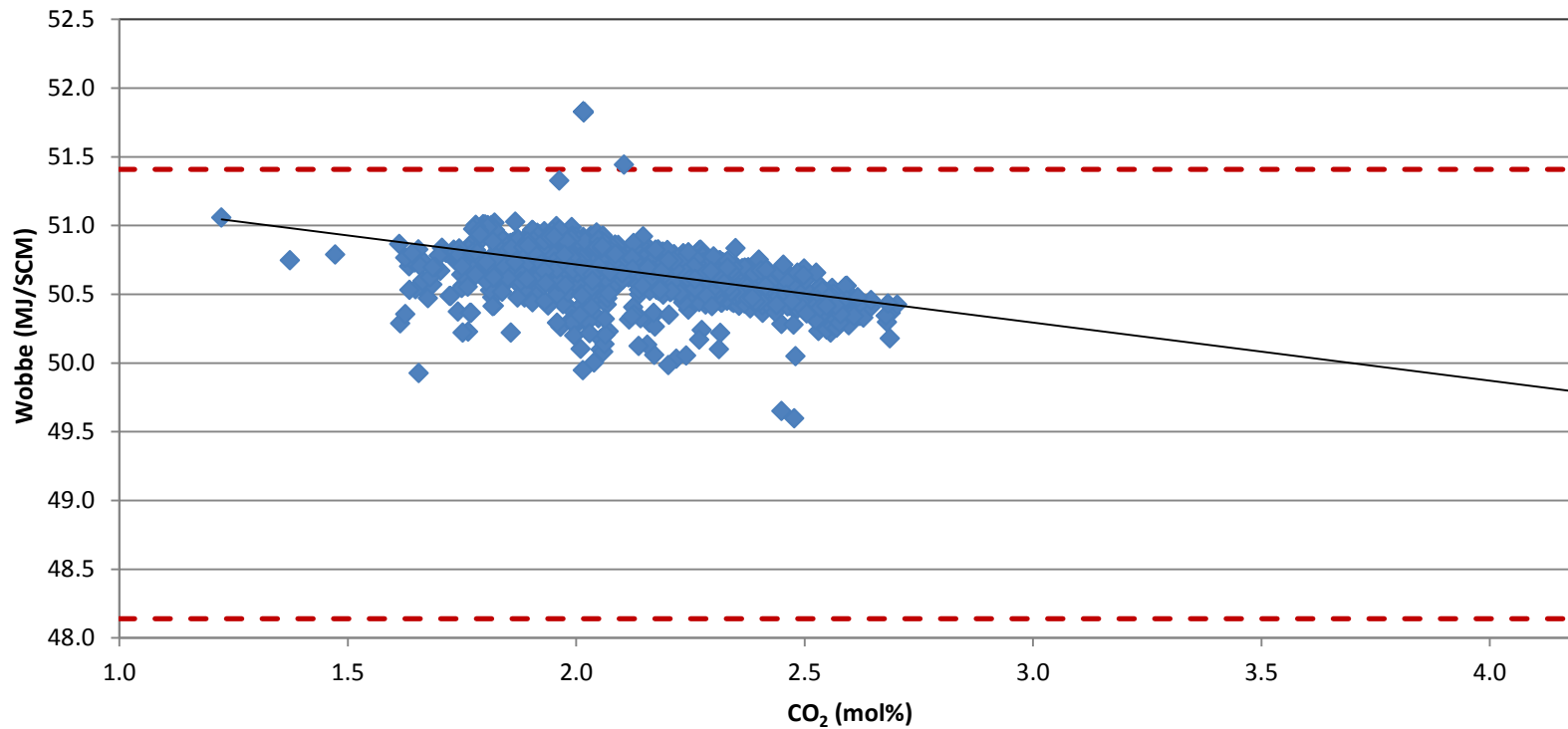
- Various concerns have been raised by Users at Mod 498 Workgroup
- Principal concern relates to the impact on energy content of the gas
- CATS has assessed the relationship between CO<sub>2</sub> and GCV, WI, SI and ICF

# Action 0601 - Gross Calorific Value (GCV)



- Daily averages from 1/1/13 – 7/7/14
- Scatter in normal operating conditions
- Value at 4.0mol% remains above midpoint of GCV spec range
- Impact of 2.9mol% to 4.0mol% = c0.4MJ/SCM decrease

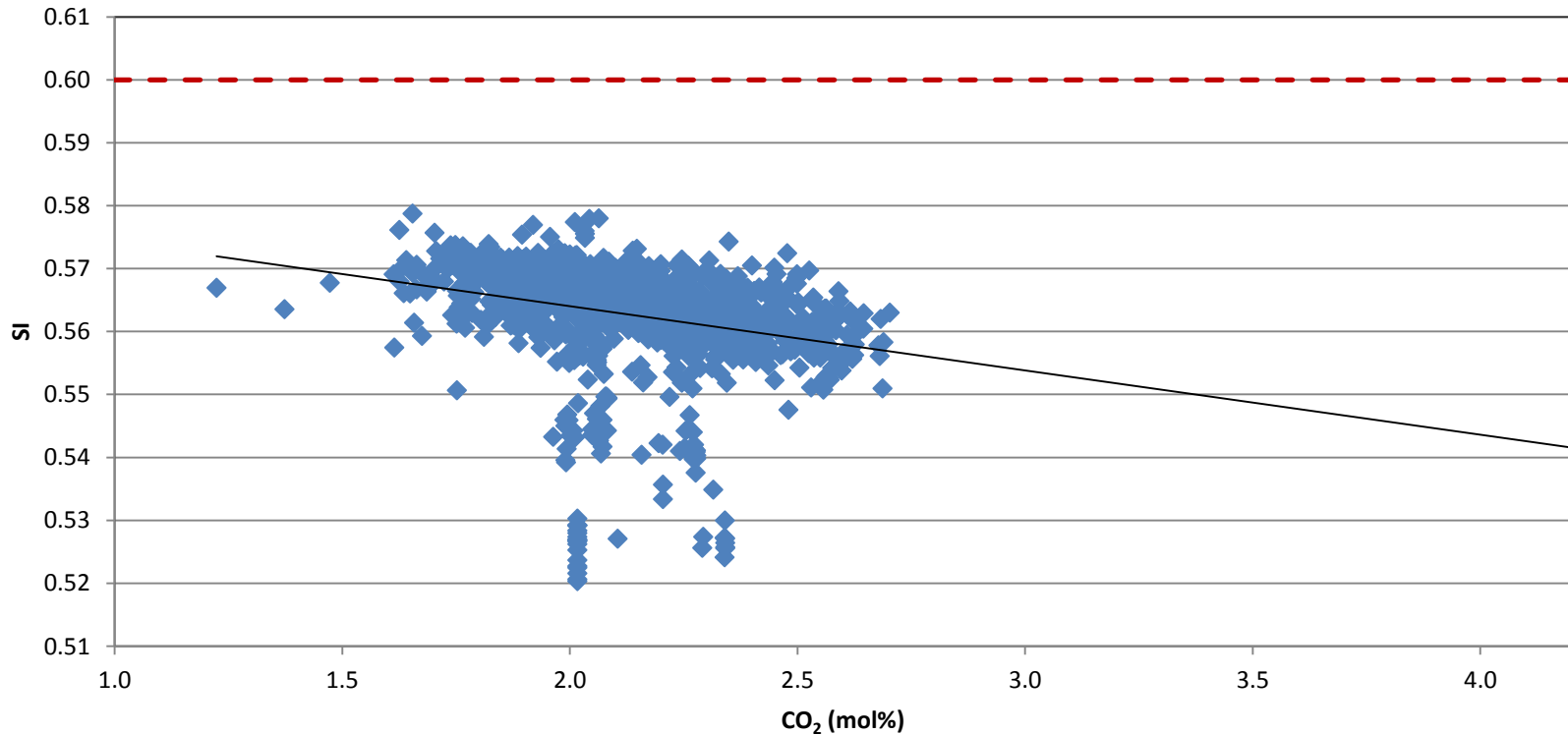
# Action 0601 - Wobbe Index (WI)



- Daily averages from 1/1/13 – 7/7/14
- Scatter present in normal operating conditions
- Value at 4.0mol% remains above midpoint of WI spec range
- Impact of 2.9mol% to 4.0mol% = c0.5MJ/SCM decrease



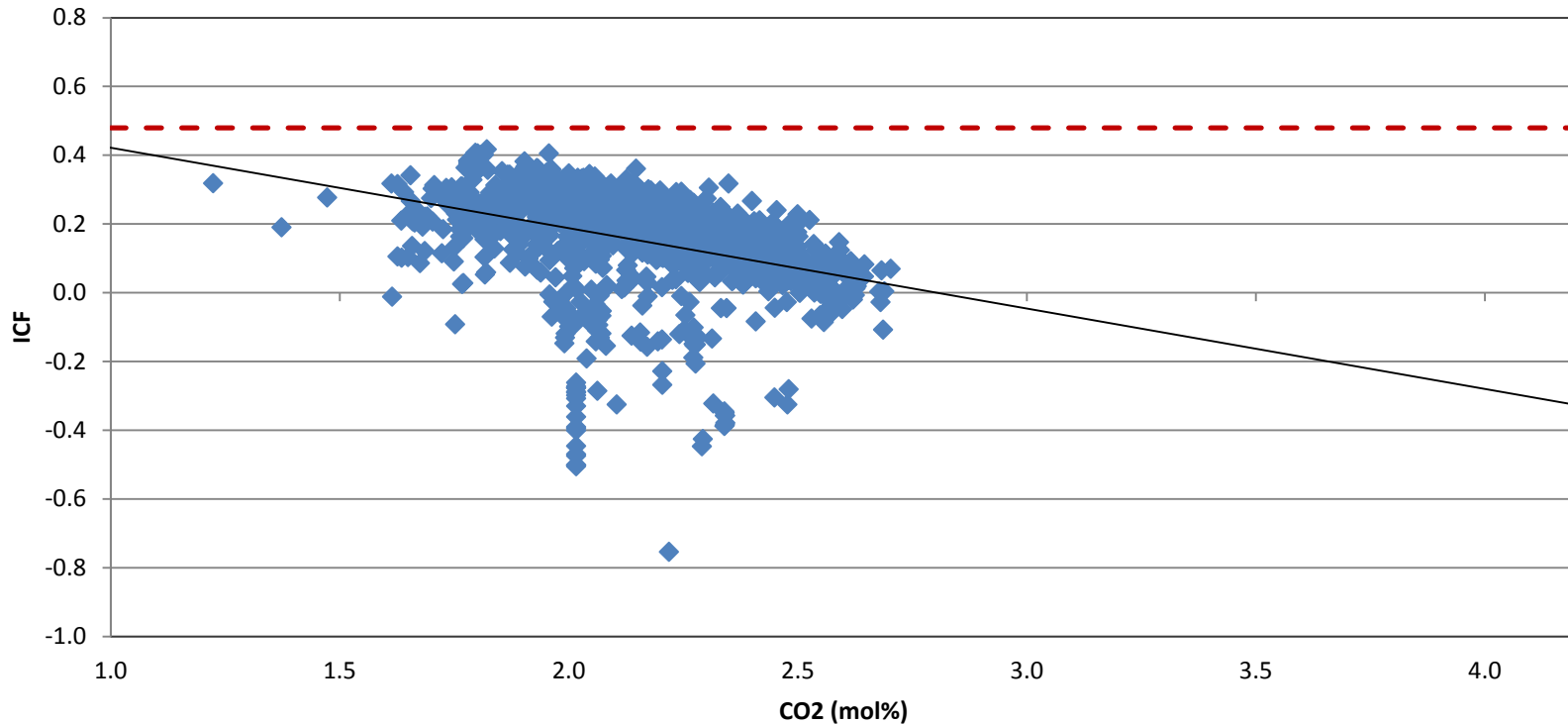
# Action 0601 - Soot Index (SI)



- Daily averages from 1/1/13 – 7/7/14
- Scatter present in normal operating conditions, only an upper constraint, so scatter below trend line is acceptable
- Value at 4.0mol% falls well within specification
- Impact of 2.9mol% to 4.0mol% = c0.01 decrease



# Action 0601 - Incomplete Combustion Factor (ICF)



- Daily averages from 1/1/13 – 7/7/14
- Scatter present in normal operating conditions, only an upper constraint, so scatter below trend line is acceptable
- Value at 4.0mol% falls well within specification

- BP CATS response to the following Users concerns
  - Tata Steel
  - GrowHow
  - SSE

# Action 0601c - Tata Steel

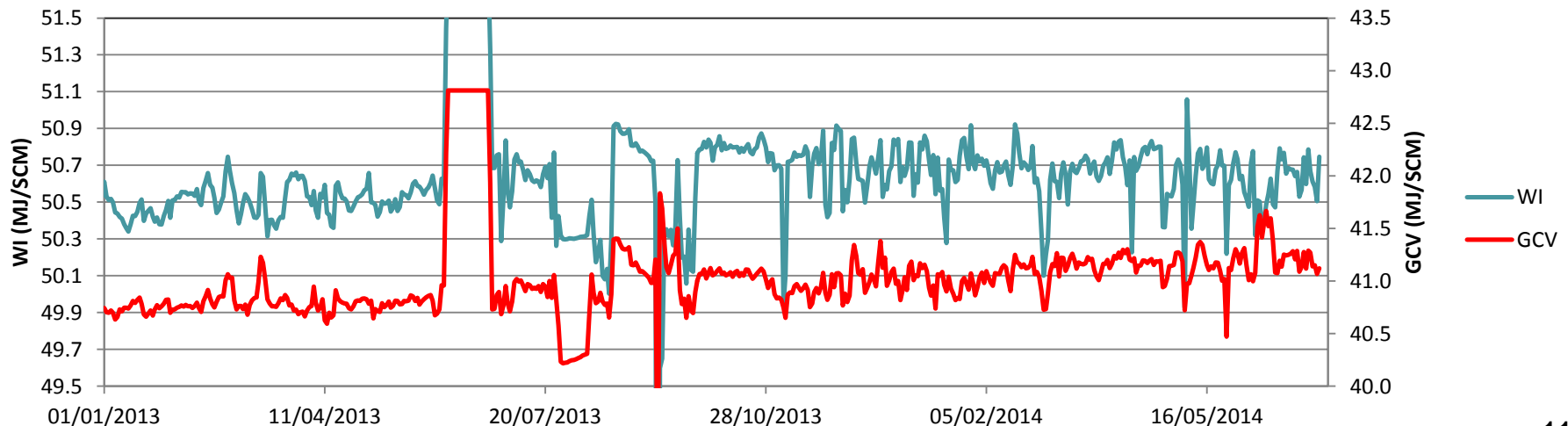


- Tata Steel:

- GCV, WI, SI & ICF will all remain within current specification limits during periods when CO<sub>2</sub> peaks at 4.0mol%. Estimates of new averages shown below:

Specification Parameter	Spec. Range	Data Extrapolation	HYSYS Modelling
<b>GCV (MJ/SCM)</b>	36.9 – 42.3	40.5 – 40.7	40.7
<b>WI (MJ/SCM)</b>	48.14 – 51.41	49.8 – 50.2	49.4
<b>ICF</b>	<0.48	-0.25 – -0.3	-0.57
<b>SI</b>	<0.60	0.54	0.58

- GCV & WI have increased significantly in the last year (see below) – this would still be a net increase with the effect of increased CO<sub>2</sub>



- GrowHow:
  - EU ETS costs – please provide details of the impact and we can work together to gain a better understanding of the impact (Action 0602)
  - Extra CO<sub>2</sub> treatment loading – only required for short periods in summer months
  - GCV is expected to be within specifications, therefore systems should be designed to cope with this

- OEM inerts limit:
  - Total inerts level remains approximately constant with increasing CO<sub>2</sub> as less N<sub>2</sub> is required
  - CATS historically used 7.0mol% as total inert limit
  - There is no limit in the NEA
  - NEA currently includes an obligation to accept short-term breaches of CO<sub>2</sub> up to 4.0mol%
  - BP operating experience is that gas turbines can cope with 10 – 15vol% inerts and that new machines may be tailored to the expected gas specification
- Unpredictable re-tuning:
  - High CO<sub>2</sub> will predominantly occur during summer months
  - Gas field maintenance can generally be predicted, so warning can be given
  - Variation will occur within current specifications and be similar to what has been experienced in the past
  - EU ETS costs – please provide details of the impact and we can work together to gain a better understanding of the impact

# Action 0604: How does Mod 0498/0502 fit with the proposed BS EN 16726?



- BP has given due consideration to the EU Gas Quality Standard/ BS EN 16726 developments, given their relevance with Mod 0498/0502.
- While the impact is uncertain, as provisions could be amended and the binding status is undecided (see next slide), BP has worked assuming the latest draft Standard becomes mandatory.
- On the basis of current wording, Mod 0498/0502 does fulfil all conditions CEN developed
- Context:
  - CEN has drafted a Standard under EU Commission mandate and recommended (developing on previous EASEE-gas work on gas quality) that gas with CO<sub>2</sub> levels below 2.5% cannot be refused entry to the system on grounds of CO<sub>2</sub> content.
  - Co<sub>2</sub> level can be increased to 4% subject to certain conditions being met
    - Condition 1: Gas does not flow to other member states:
    - Condition 2: Network is a dry network
    - Condition 3: The Network is not connected to installations that are sensitive to 4% CO<sub>2</sub>

# Action 0604 - continued



- Condition 1: Gas does not flow to other member states: Modelling provided by NGG during previous Workgroup meetings showed that even under the worst theoretical scenarios, no scenario of gas flow/ composition could achieve a 4mol% Co<sub>2</sub> gas flow to other member states, as:
  - Teesside gas does not flow to Ireland under any reasonable circumstances.
  - In the low demand scenario, Teesside natural gas could be in proximity of Bacton. However, in a peak flow scenario high CO<sub>2</sub> fields represent only a small flow proportion blended out with low Co<sub>2</sub> gas, as well as by Easington, Theddlethorpe, Barrow (and Isle of Grain) gas. Under a scenario with 4mol% gas flow at Teesside, no peak flow is possibly envisageable.
- Condition 2: Gas flows into a dry network: NTS is a dry network
- Condition 3: the network is not connected to installations that are sensitive to 4% CO<sub>2</sub>
  - Affected network users are being extensively consulted in order to share concerns, which are under discussion. In addition, extensive investigation is being conducted to assess risks. Hence by definition, approving the 0498/0502 would reasonably imply that sensitivity is non-existent or negligible.
  - As the concept of “sensitive” is not defined in the Draft Standard, BP expects that DECC and Ofgem will make sure its impact is compatible with the national interest and the specific circumstances of GB market and UKCS.
- Notwithstanding the above, EU gas quality Standard is still a draft:
  - DG Energy could turn the standard binding by amending EU NC on interoperability
  - EU Standard could apply only at IPs, at least on interim basis
  - Significant unresolved incompatibilities suggest that further debate looks likely



# Action 0606 - Alternative options



- If Mod 498 is not approved, there are three potential outcomes:
  - new gas fields will build offshore facilities to remove CO<sub>2</sub>
  - CATS will build onshore removal facilities to remove CO<sub>2</sub> at Shippers expense
  - material costs of CO<sub>2</sub> removal may result in certain gas fields not being developed which could adversely impact CATS remaining life
- CATS is currently exploring these options with a potential new gas field
  - BG operated Jackdaw field



## Jackdaw field

- Jackdaw Field was discovered in 2005
- Contains gas/condensate at very high pressure and temperature
  - c. 1200bar and 200oC – categorised as “ultra” HPHT
- Technically complex project
- Plan to send gas to Teesside via CATS pipeline
- Significant resource but economically challenging due to high costs
- High costs exacerbated by presence of H<sub>2</sub>S and 4% CO<sub>2</sub>



## Jackdaw processing costs

- In Q4 2013 Jackdaw evaluated processing options for 300mmcf/d of gas
  - Offshore removal of H<sub>2</sub>S and CO<sub>2</sub>
  - Onshore removal of H<sub>2</sub>S and CO<sub>2</sub>
  - Onshore removal of H<sub>2</sub>S with relaxed NTS entry spec for CO<sub>2</sub>
- Cost of offshore facilities to remove H<sub>2</sub>S and CO<sub>2</sub> is significant: £126million
- But cost of onshore removal of H<sub>2</sub>S and CO<sub>2</sub> is greater still: £200million
  - Amine sweetening, glycol dehydration, new flare system, electricity substations
  - Contaminants now introduced to much larger volume of gas to be treated
  - Challenges of project being undertaken at operating facility
- Relaxation of NTS entry spec for CO<sub>2</sub> reduces cost of onshore processing significantly to £58million

- Expect minimal impact on CO<sub>2</sub> levels during 2014-2018
- Modelling suggests CO<sub>2</sub> levels will increase 2019+ **but other prospective gas fields will lessen the impact**
- Historic analysis shows that higher CO<sub>2</sub> levels will have minimal impact on the energy content of the gas
- CO<sub>2</sub> removal for one field estimated at offshore - £126m, onshore - £200m, + ongoing opex
  - risk of non-development due to challenging economics
- Request to users to share details on :
  - potential EU ETS cost impact
  - OEMs in operation that stipulate a maximum level of 4% inerts