The impact of Auto/Oil I and II on refinery costs and global CO_2 emissions.

The EU Commission's independent consultants recently published their results on the consequences of Auto/Oil II in terms of refinery costs. In addition CONCAWE has estimated the associated changes in global CO_2 emissions.

AUTO/OIL I

Under the Auto/Oil I (AO I) study work in 1996, the EU commission contracted A.D. Little associated with Touche Ross to provide the basis for the cost effects of changes to gasoline and diesel fuels characteristics. The AO I programme finally resulted in a full set of specifications for application in 2000 with a limited number of properties to be further tightened by 2005. The calculated cost of the 2005 package for the then 12 EU Member States was estimated at US$ 34 billions (G$34) in terms of Net Present Value (NPV) of the combined investment and annual operating costs over a period of 15 years.

With hindsight, it is now apparent that the benzene control up-front investment costs were overestimated and the accelerated progress in gas oil desulphurization technology (an increase in attainable desulphurization rates from about 97 per cent to 99.5 per cent for virgin gas oils) was unforeseen back in 1994 when the studies started. Even so the real costs over 15 years still to come may very well fall within the +/-30 per cent claimed as study accuracy limits. Any under-run is far from assured.

AO I mandated 'environmental quality' changes, year 2000 and 2005 road fuels)

	Unit	*Pre 2000 average*	*01/01/2000 spec.*	*01/01/2000 average**	*01/01/2005 spec.***	*01/01/2005 average****
Gasoline						
RVP (summer)	kPa	68	60	58		
Aromatics	%v/v	40	42**		35	33
Benzene	%v/v	2.3	1.0**			0.8
Olefins	%v/v	11	18	11		11.5
Sulphur	mg/kg	300	150**		50	40
Oxygen	%m/m	0.6	2.7	1.0		0.6
Diesel Fuel						
Cetane Number		51	51	53		53
Density	kg/m^3	843	845	835		835
PAH	%m/m	9	11	6		5.7
Sulphur	mg/kg	450	350	300	50	40
T95	°C	355	360	350		355

* Agreed in technical phase of AO I study. ** Amended by AO I political processes. *** Forecast in AO II Bechtel study

Although some flexibility still exists to avoid or at least defer investment costs beyond implementation of the new specifications, this is not expected to significantly reduce the global costs to the refining industry. Additional measures may further limit the scope of alternatives based on product exchanges and component selection. For example, the octane loss associated with benzene control in gasoline is commonly compensated for by MTBE import rather than refinery investment. Any ban on MTBE (see relevant article page 22) would require a fundamental reassessment of the benzene control options in many refineries. Market imbalances caused by the new limits may trigger large differential costs in the early years after their introduction and therefore have a comparatively large effect on the NPV. This may be the case for gas oils. Demand for heating oil (the traditional sink for lesser quality components) is steadily declining under, amongst other things, the pressure to reduce CO_2 emissions. At the same time demand for diesel is growing.

AUTO/OIL II

The consultant chosen by the Commission for Auto/Oil II (AO II) refinery cost evaluations is Bechtel Ltd. The fuels matrix and the costs are set out in a final report on conventional fuels dated December 1999.

The AO II study is based on the Commission's pre-Kyoto scenario which shows gasoline growth nearly as strong as diesel with modest overall growth in transport fuels offsetting a modest and steady decline in heating fuels. CONCAWE, on the other hand, expects that the growth in road fuels will be predominantly diesel unless the countries that currently weight much more tax onto gasoline than diesel change policies.

AO II fuels packages and cost effects (excludes combined gasoline and diesel cases)

Gasoline		*MS1*	*MQ1*	*MS2*	*MQ2*	*MS3*	*MQ3*	*MS4*	*MQ4*		
E150	%v	77	88	79	90	77	88	79	90		
Oxygen	%m	2.7	0.6	2.7	0.6	2.7	1.1	2.7	0.6		
Olefins	%v	18	11.5	18	11.5	18	11.5	14	10		
Capital cost	G$		2.0		3.7		0.7		4.6		
Annual cost*	G$/a		0.16		0.35		0.40		0.46		
NPV**	G$		3.6		7.2		4.6		9.1		
Global CO_2	Mt/a		1.1***		1.4***		1.9*		1.2*		
Diesel		*DS1*	*DQ1*	*DS2*	*DQ2*	*DS3*	*DQ3*	*DS4*	*DQ4*	*DS5*	*DQ5*
Density	kg/m^3	840	830	840	830	830	825	840	830	840	830
PAH	%m	11	5.1	6	3.0	6	2.8	6	3.0	6	3.0
Cetane		51	53	51	53	51	53	53	55	51	53
T95	°C	360	352	360	355	360	351	360	353	345	335
Capital cost	G$		2.2		4.5		6.7		4.5		5.6
Annual cost*	G$/a		0.2		0.25		0.46		0.22		0.56
NPV**	G$		4.2		6.9		11.1		6.7		11.1
Global CO_2	Mt/a		2.6*		N/A		6.7*		4.4*		7.4*

MS and DS are the gasoline and diesel specification cases respectively. MQ and DQ are the anticipated average qualities in the Bechtel study.
*Arabian Light US$20/barrel FOB price basis. Global CO_2 calculated by CONCAWE. **Calculated as per AO I using: capital cost + 9.75 x annual cost. ***Calculated from Bechtel figures.
N/A: Not Available. CONCAWE cannot accurately model PAH, and global CO_2 is not calculable from Bechtel figures.

The results of the Bechtel study in terms of refinery costs are presented in the table on page 12. The NPV calculation methodology is the same as in AO I. CONCAWE estimates of the associated **global** CO_2 emissions changes (by global is meant integrating all effects from refineries, hydrogen and other components, e.g. MTBE, production and petroleum fuels usage) are also included in the table.

Could this start happening here?

The gasoline cases use additions of various combinations of isomerization, alklyation and TAME processing. The diesel cases require major configuration changes adding hydrocrackers as well as hydrodearomatization processes and additions to the associated hydrogen production and sulphur recovery infrastructures.

For inland heating gas oil and fuel oil, the Commission is now advising a 'Kyoto -6 per cent' scenario that shows significant and early reductions in consumption of these products. Post 2005, when the diesel supply/demand balance is expected to be already under strain following the AO I measures, any diesel density or T95 reductions will seriously widen the structural EU diesel fuel/gas oil supply demand and quality imbalances. In particular, DQ3, DQ4 and DQ5 involve diesel production shortfalls or/and capital expenditure on projects that not all EU refining companies may be prepared to withstand. Supplies of such fuels would be less reliable than the market is accustomed to. The implications of such occurrences will fall into the area of diesel price instability, supply disruption and possibly shortfalls. The consequences would be likely to ripple through various countries with different intensities. The disturbances to economies and lifestyles are not the sorts of things that can be calculated beforehand.

The air quality implications of these potential AO II conventional fuels measures are being quantified, but are expected to be so small that they would not even be discernible in the emissions projections illustrated in the next article. In engineering planning circles, there is a well-regarded offshoot of Murphy's Law, known as the Law of Unintended Consequences, that lurks within complex, difficult to define systems. It is generally considered wise to ensure the benefits of proceeding with a serious change are really well worth having before 'bungee jumping' into the unknown. When the conditions cannot all be calculated, it becomes vital to ensure that a good strong safety net is present in case the elastic snaps.