Airneth

The challenges of high-priced oil for aviation

Airneth Report 2

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Executive summary

Not the resources of oil as such, but much more the insecurity of supply due to geopolitical instability in combination with a tight oil market makes a scenario with much higher oil prices than the world is currently experiencing not unlikely.

Aviation is completely dependent upon oil as its fuel source. Since no practical energy substitute is readily available for commercial aviation, a scarcity of petroleum relative to demand will present a major challenge for the air transport industry and aviation policy.

In addition, efficiency gains due to operational measures and new aircraft technology are limited for the short-and medium term. In particular, it has been demonstrated that the annual reduction rate in fuel consumption per traffic unit is not a constant but is itself also falling, in contrast to past estimates.

A high-priced oil scenario will therefore have severe consequences for demand, airline revenues, the competitive position of airports and eventually airline network strategies and fleet development. In particular, transfer demand, short-haul and leisure traffic can be expected to be heavily affected by high oil prices due to their relative high price sensitivity.

Currently, little research has been done that

investigates the potential impacts of high oil prices on the aviation industry. Hence, Airneth argues that more research in this field is needed. In this respect, the large-scale, international 2006 initiatives of the French Académie Nationale de l'Air et de l'Espace (ANAE) on air transport and the energy challenge have to be appreciated[i].

According to Airneth, important research themes include:

- The extent to which airlines pass on high fuel prices to their clients in both the passenger and cargo market
- The potential impacts of high oil prices on:
    - demand in various market segments airline revenues;
    - the competitive position of hub airports;
    - environmental impacts.
- Potential second order effects of a high-priced oil scenario in terms of network and fleet development.

Furthermore, Airneth recommends policy makers to consider the following issues:

- Assess to what extent current aviation scenarios sufficiently include a future with high-priced oil.
- Assess the risks of a high-priced oil scenario for the various stakeholders in the industry.
- Study the options that governments and other stakeholders in the industry have to anticipate a high-priced oil scenario.

- Ensure ongoing involvement by policy makers in the international debate on the energy challenge for the aviation industry.

1. About Airneth

Airneth is an initiative to support aviation policy in the Netherlands using the most recent insights from academic experts from various disciplines. In addition, Airneth has the objective to address important policy issues in the academic world.

Airneth uses several tools to achieve its goals. In workshops, seminars and via the interactive website, Airneth stimulates the exchange of knowledge between academics and policy makers in the field of air transport.

This report is based on the results of a seminar "The challenges of high-priced oil for aviation" on 13 January 2006 in The Hague, The Netherlands. Participants came from different academic, policy and industry backgrounds.

2. Context and objectives

Recently, attention has been paid in the academic literature to the potentially large impacts such a high-priced oil scenario might have on the global aviation industry.

Aviation is completely dependent upon petroleum as its fuel source. Since no practical energy substitute is readily available for commercial aviation[ii], a scarcity of petroleum relative to future demand will present a major challenge for the air transport industry and aviation policy because of its impact on demand, airline revenues and eventually airline network strategies and fleet development.

Because of the policy relevance of the issue, Airneth thinks it is necessary to communicate these and other related (academic) insights to policy makers and experts in the field. The objective of the seminar "The challenges of high-priced oil for aviation" was three-fold. Firstly, to gain insight into the current state and drivers of the jet fuel market and the oil industry in general. Secondly, to address the way airlines will be able to deal with a high-priced oil scenario. Thirdly, to address the policy implications of a high-priced oil scenario.

During the seminar, these questions where addressed by four speakers: Drs. Lucia van Geuns of the Clingendael International Energy Program, Mr. Paul Cluett of Shell Aviation, Paul Peeters of Paul Peeters Advies and Jaap de Wit/ Guillaume Burghouwt from Airneth[iii].

Presentations and abstracts are available at www.airneth.nl. Publications for further reading are available at http://www.airneth.nl/file.php?page=8.

3. Current state and drivers of the jet fuel market and the oil industry in general[1]

By Lucia van Geuns, CIEP

Demand for oil, gas and coal will continue to grow in the next 25 years, albeit at different growth rates. Demand for energy will be particularly strong in emerging market economies because these economies are still in a more energy intense phase of economic development. This also translates into a strong demand for oil.

The distribution of future demand and supply leads to one conclusion: the import dependency of major consuming countries/regions is not only set to increase, but will also be concentrated on only a few suppliers. Five countries around the Gulf (Iran, Iraq, Kuwait, Saudi-Arabia and UAE) contain 65% of the world proved oil reserves.
This will heighten concerns about security of supply. Security concerns about the supply of oil include decreasing indigenous supplies, increasing imports, choke points in trade routes, competition with other consuming countries, limited ability to diversify and produce indigenous sustainable energies and concerns about the political stability of producing countries (geopolitical risks).

The current oil market is a 'tight' market: the low oil price in the 1990s now results in production and refining capacity constraints, there is a strong demand growth driven by the China, India and the US, low spare capacity and the fact that the timing of some new production is unclear. Tight markets allow every small and short-lived disruptures to have a major impact on prices.

Future outlook for the oil industry in general:

- Fossil fuel will be the dominant source of energy for the coming decades.
- Oil prices are likely to stay relatively high in the coming years due to capacity constraints.
- Investments are necessary to meet growing demand.
- There will be greater competition among companies for reserves/production.
- There will be greater competition among consuming countries to secure flows.
- Geopolitical risks are high.

[1] http://www.airneth.nl/serve_file.php?dType=dDocument&id=88

4. Fuel efficiency of commercial aircraft. An overview of historical and future trends[2]

By Paul Peeters, Paul Peeters Advies

It is a wide-spread believe that civil aviation fuel efficiency historically increased continuously and considerably – an often cited figure is 70% during the last four decades, first published by the IPCC Special Report on Aviation and the Global Atmosphere.

Furthermore a constant annual increase of fuel efficiency is often assumed to calculate efficiency gains in the future.

Paul Peeters shows that, based on bottom-up (micro) and top-down (macro) analyses of aircraft fuel efficiency, that the long term increase has been much less. It can be concluded that the last piston-powered aircraft were as fuel-efficient as the current average jet. This result was obtained by comparing several large piston-engined aircraft with both old and new jet airliners and was confirmed by the macro analysis, which reveals a sharp increase in fuel consumption per seat-kilometre as piston-engined aircraft were replaced by jet engines. The last piston-powered airliners were at least twice as fuel-efficient as the first jet-powered aircraft.

He also shows that the efficiency gain per year is not a constant. This is due to the fact that fuel efficiency is only one of the parameters in aircraft design. The annual efficiency gain is not a constant, but is itself also falling. Cost, overall economy, travel speed, and airport compatibility play a significant role as well. The common practice of defining future cuts in energy consumption per seat-kilometre in terms of a constant annual percentage reduction is therefore not very accurate.

A further reduction of fuel consumption with 50% by 2020, as predicted by many studies, is unlikely to evolve in the real world. A 25% reduction in fuel consumption in 2040 is more likely to be expected than the 40-50% reduction predicted by the industry. This means that many studies on predicted future efficiency gains are rather optimistic.

[2] http://www.airneth.nl/serve_file.php?dType=dDocument&id=144

5. Oil market and impact on aviation markets[3]

By Paul Cluett, Shell Aviation

Shell Aviation is currently the number one supplier of jet fuel in the world, supplying about 87 million litres of fuel to 20.000 aircraft.

After the downturn in the economy and the negative growth of airline revenues in 2001 and 2002, overall airline revenues are again growing since 2003. However, there are large regional differences in airline profitability, ranging from substantially negative in the North America, to substantially positive in Asia.

Oil price volatility is just one among the many factors that influence airline profitability and the state of the airline industry in general. Other factors include airline costs, supply of infrastructure, aviation taxes, development of low-cost carriers, airline bankruptcies, industry consolidation etc.

Oil prices have been soaring in recent years, including for example the Hurricane Katrina, concerns about the adequacy of the US oil stock, production cuts by the OPEC, Iraq instability and growing demand for oil. Prices have increased from 30 dollars/barrel in January 2003 to over 65 dollars/barrel in September 2005 (Brent).

The price of jet fuel closely follows the movements of the crude oil price. Also jet prices have been increasing since 2003. Between 2003 and 2005, rising jet fuel prices have results in additional costs of over 35 billion dollars.

Within the global supply and demand chains of jet fuel, there have been remarkable changes in recent years. The global jet movement before September 11th was characterised by a few traditional suppliers and highly regionalised trading of jet fuel. After September 11th, this pattern has changed. The global jet fuel movement is now characterised by a much more free flowing global movement of jet fuel with new geographical patterns of demand and supply. What has cause this change? Factors include:

- Growth in non-traditional exporters of jet fuel, such as India
- Supply by countries not adhering to OPEC quotas and restriction of supply
- Instability in certain regions (e.g. Nigeria, Venezuela, Iraq)
- Refinery margin between Jet versus Diesel
- Lack of expenditure on refinery capacity/stock-outs

[3] http://www.airneth.nl/serve_file.php?dType=dDocument&id=146

- Military demand spurts
- Growth of low-cost airlines
- Growth of aviation industry in China and India
- Threat of terrorism

Cluett concludes that no alternative jet fuels exits for aviation on the short/medium-term. Taking into account the state of the jet fuel and airline industry, Cluett stresses:

- Continue to buy new fuel efficient aircraft
- The need to recognise that fuel will remain 20-25% of the airlines operating costs
- The need to have risk management expertise to manage jet fuel price volatility
- The need for airlines, airports and governments to understand the supply chain of jet fuel and its vulnerabilities
- Hold more stock in order to avoid short term stock-outs
- The need to buy into the EU emissions trading scheme

6. The challenges of high-priced oil for aviation[4]

By Guillaume Burghouwt and Jaap de Wit, Airneth

Jet fuel prices have escalated in recent years. Without disregarding the uncertainties surrounding future oil supply and demand, De Wit and Burghouwt argue that a high-priced oil scenario is not an unlikely scenario for the aviation industry. In addition, a high-priced oil scenario may pose a significant challenge to the world-wide airline industry for a number of reasons.

First, fuel hedging is in particular a strategy to insure against oil price volatility in the short-run. For the longer run, airlines will eventually have to deal with the challenge in other ways. More efficient fuel use through operational strategies is possible, deliver substantial cost savings to airlines but do not significantly reduce the dependence of aviation on petroleum.
Second, initiatives are undertaken to research and develop hydrogen-aircraft. However, this is essentially a long-term solution since such aircraft can be expected to be operational earliest around 2025.
Third, other energy-types are not suitable for use in aircraft or do not offer the same energy intensity as oil offers. In other words, no practical energy substitute is readily available for commercial aviation.
Finally, the marginal improvements in fuel efficiency of new generation aircraft are likely to only offer part of the solution to a high priced oil scenario: the fuel efficiency gains of new generation aircraft are probably not as large as

[4] http://www.airneth.nl/serve_file.php?dType=dDocument&id=147

the 40-50% gains aviation industry predicts, looking at the study of Peeters et al[iv].

It is therefore likely that rises in fuel prices will first generate innovations in aviation management before technological breakthroughs significantly reduce the energy intensity of aviation[v]. In addition, important second order effects on the global aviation market can be expected.

In case of a high-priced oil scenario (with substantially higher oil prices), airlines will pass on part of the fuel costs to their clients. Further unbundling of ticket prices including weight, distance and speed-based pricing could be part of the pricing strategy in a high-priced oil environment.

Passenger demand will certainly be severely affected. High fuel costs may on the one hand work against hub-and-spoke systems, which are characterised by a large amount of routing. On the other hand, high oil prices could also result in suspension of direct services between thin city-pairs and reinforcement of the position of hubs in these city-pairs. The level to which airlines pass on fuel costs to connecting passengers will be of great influence to the strategic position of airlines in specific connecting markets. Another way of dealing with increasing oil prices may be found in the fleet development, which will be more and more directed towards fuel efficiency. High fuel prices may work against regional jets, which are relatively fuel inefficient.

De Wit and Burghouwt argue that, given the potential impacts of a high-priced oil scenario, more research in this field is needed:

- To what extent and how do airlines pass on increasing fuel costs to passengers and air cargo clients?
- What might then be the impact on the generalised transport costs for various types of connections? How would these changes in generalised costs affect demand and airline revenues?
- What would be the second order effects on airline network and fleet development?

7. Recommendations

Aviation is completely dependent upon oil as its fuel source. Since no practical energy substitute is readily available for commercial aviation, a scarcity of petroleum relative to demand will present a major challenge for the air transport industry and aviation policy. In addition, efficiency gains due to operational measures and new aircraft technology are limited for the short- and medium term.

Currently, little research has been done that investigates the potential impacts of high oil prices on the aviation industry. Hence, Airneth argues that more research in this field is

needed. In this respect, the large-scale, international 2006 initiatives of the French Académie Nationale de l'Air et de l'Espace (ANAE) on air transport and the energy challenge have to be appreciated[vi].

According to Airneth, important research themes include:

- The extent to which airlines pass on high fuel prices to their clients in both the passenger and cargo market
- The potential impacts of high oil prices on:
  - demand in various market segments (business/leisure, short-haul/long-haul, OD/transfer);
  - airline revenues;
  - the competitive position of hub airports;
  - environmental impacts
- Potential second order effects of a high-priced oil scenario in terms of network and fleet development.
- Aircraft design and alternative fuel development

Furthermore, for policy makers it may be important to consider the following issues:

- Investments in infrastructure of restrictions of airport capacity growth are assessed using scenarios on the future of the aviation industry. The question is to what extent current aviation scenarios sufficiently include a future with high-priced oil.
- What are the risks of a high-priced oil scenario for the various stakeholders in the industry?
- How can governments and other stakeholders in the industry anticipate a high-priced oil scenario?
- Airneth recommends ongoing (international) involvement by policy makers in the debate on the energy challenge for the aviation industry.

8. Registrated participants

First name	Last name	*Organisation*
Frits	Bisschop	*Districon*
Paul	Bleumink	*Buck Consultants International*
Peter	Blok	
Johan	Blom	
Dries	Blommers	*Transport Safety Institute B.V.*
Pieter	Cornelissen	*Netherlands Peak Oil Foundation*
Tobias	Dander	*Tobias Dander Creative Impulse*
Anneke	de Wit	*DGTL*
Douglas	Dutting	*Peak Oil Netherlands Foundation*
Linda	Heemskerk	*SEO Economisch Onderzoek*
Heiko	Jessayan	*FD*
Hans	Klein Heerenbrink	*C4P*
Maarten	Koopmans	*KLM*
Rembrandt	Koppelaar	*Peak Oil Netherlands Foundation*
Eric	Kroes	*Rand Europe*
Frank	le Clercq	*Universiteit van Amsterdam*
Andreas	Ligtvoet	*Rand Europe*
H.W.B.	Messelink	*Schiphol Group*
Janic	Milan	*TU Delft*
Peter	Minderhoud	*DGTL*
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Jos	Nollet	*DGTL*
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Eric	Pels	*Vrije Universiteit*
Jan	Petit	
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Michael	Portier	*NIVR*
Toon	van der Hoorn	*Universiteit van Amsterdam*
Lucia	van Geuns	*Clingendael Instituut*
Marko	van Leeuwen	*Verbond van Verzekeraars*
Maarten	van Mourik	
Frank	Wijnen	*Shell*

[i] http://www.anae.fr/challenge/
[ii] http://noorderlicht.vpro.nl/dossiers/11867650/
[iii] Airneth has tried to summarise the contributions of the speakers as accurate as possible. However, the summaries in this publication have not been authorised by the authors. All errors are under responsibility of Airneth.
[iv] P.M. Peeters, J. Middel & A. Hoolhorst (2005). Fuel efficiency of commercial aircraft. An overview of historical and future trends. National Aerospace Laboratory (NLR). http://www.transportenvironment.org/docs/Publications/2005pubs/2005-12_nlr_aviation_fuel_efficiency.pdf
[v] A. Perl and J. Patterson (2004). Will oil depletion determine aviation's response to environmental challenge? Annals of Air

and Space Law, vol. XXIX, pp. 259-273.

[vi] http://www.anae.fr/challenge/