Traffic Forecasts for the Fehmarn Belt Fixed Link

Review of Critical Weaknesses



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Technical note: Although this paper is written in English figures are presented with decimal points and commas following the rules in Denmark and Germany.

1. Preface

On 18th April 2015 the Danish Parliament passed the law of construction for a fixed Fehmarn Belt Link. The political process leading to that decisive milestone was highly dependent of various traffic forecasts; in particular, of a traffic model that was set up in the late 90's and then "re-activated" in 2014.

This author has in two books discussed the methods and trustworthiness of two of the most important traffic forecasts used for a key political decision. The first one was a fore-cast presented in 2008 when a majority of political parties agreed on constructing the fixed link. The second one was the forecasts made in late 2014 used for the final parliamentary approval of the project.

If the political agreement from 2008 consisted of only a decision to make further and more detailed analyses, this would have been a sensible step by step process of decision making. However, this was not the case. The political agreement was in fact formulated as an irreversible final decision to establish the fixed link.

To understand this peculiar political situation, it is necessary to explain the nature of Danish 'political agreements'. Such agreements have formally no legal implications since they are not part of an official parliamentary process. The agreements are in fact of a private nature. However, their implications on the subsequent formal processes in Parliament are decisive. This is because the political parties have agreed - as a self-chosen code of conduct - that the agreements must be treated as unbreakable. Despite the provision of subsequent decision-making material, at the end of the day individual MPs from the agreement parties are in practice forced to vote in favour of the fixed link.

The consequence of this code of conduct was that as early as in 2008, it was agreed that each and every MP belonging to the parties behind the agreement was destined many years later to vote yes to whatever law of construction would be presented to Parliament. Thousands of pages prepared between 2008 and 2015 for decision making might influence - and did influence - what kind of a fixed link should be built. However, the final agreement to any fixed link eventually presented to Parliament was, in reality, given as early as in 2008, and not in 2015, when the law of construction was passed formally in Parliament.

Such an upside-down decision process would naturally not welcome any new evidence during the formal legislation preparing process. Accordingly, this setup has a built-in risk that new evidence might be produced with a clear bias, might be mispresented, or even not published in order to omit any public discussion that might question the original and in practice final decision.

The forecast from 2008 stood publicly undisputed until June 2014 when my first book, "The Fehmarn Belt Fixed Link – made in Denmark", ref. [17], was published. The book came as a clear surprise and Femern A/S was evidently not prepared for such an 'ambush' (this phrase

was used by a prominent MP in the media). Furthermore, Femern A/S was not staffed to react professionally to criticism concerning their own forecasts. The company had been organised to construct the fixed link and there was a binding political agreement to build no matter what, so why staff for further documentation of the rationale behind the reason to build? This seemed to be the thinking at Femern A/S.

However, another bolt of lightning flared down from the clear sky in November 2014 – and this time ignited by Femern A/S. The date and time was presumably not accidental. A few hours before I went to the podium to speak to an interested audience, Femern A/S announced a brand new traffic forecast documented in a report of more than 600 pages. Nobody, outside the Ministry and its subsidiaries, knew anything about the task, since contrary to EU-regulation on public procurement, the task had not been exposed to competition.

At first glance, this new situation looked much like what I had argued and hoped for: A comprehensive forecast made this time not by Femern A/S itself but by independent German consultants. I really doubted whether it would be worthwhile for me to spend more time on the subject. However, having learned by experience, I started reading, and what I saw after a few pages, regrettably, did not support my initial optimism. An almost twenty year old traffic model had been scantily dusted off without taking into account what basically had changed in transport supply and demand during all these years.

In January 2015 I published my second book, *"Analyse af nye trafikprognoser for Femern-forbindelsen, 2014"*. (Analysis of new traffic forecasts for the Fehmarn Belt Fixed Link, 2014), ref. [18]. In the book I pinpointed severe drawbacks and misperceptions concerning the new traffic forecasts.

The Danish State is currently waiting for the final German environmental approval, which presumably will be issued by mid-2018, and it is time for me to close my own 'case' in relation to inadequate documentation of traffic demand for the Fehmarn Belt Fixed Link.

It is my hope that the documentation on the following pages might be used to raise a discussion of how to document, decide upon and organise the establishment of publicly financed or guaranteed mega infrastructures.

It is my clear impression that most of the MPs are fully aware that had they known in 2008 what they know today, the political agreement would not have been signed. The main lessons to be learned from the past, according to my judgement, are the following:

 In case of deciding infrastructures above a certain level of economic obligation, the politicians should restrict themselves to making only conditional agreements in the first place and then wait on the final agreement until the final planning documents have been prepared. Such a change would reduce the risk of having biased documents produced in order to avoid public debate on the appropriateness of the original and in fact final political agreement. A state-owned organisation, such as Femern A/S, with only one single project to construct and to operate, should not be asked to produce decision-material such as estimates of traffic demand, socioeconomic and business economics. An organisation with only one single project should stick to its technical tasks and be supplemented by independent agencies to produce non-technical documentation needed for political decision. By such limitations there would be much less risk that a technical oriented organisation produces biased documentation to safeguard its own future survival.

Decisions in Parliament should, of course, be taken according to the members' own will and visions. However, documentation prepared for decision making should be in line with best professional standards. Any attempt to organise analyses and conclusions to cover inconveniences by previous decisions ought to be completely unacceptable.

> February 2018 Knud Erik Andersen

2. Summary

The traffic forecasts for the Fehmarn Belt Fixed Link published in 2014 acted as the central precondition for passing the law of construction in Folketinget – the Danish Parliament. However, the forecasts were flawed by misperceptions; misunderstandings and maybe even deliberate misrepresentations. The consequence was substantially overestimated traffic forecasts for the fixed link and Parliament was regrettably misled.

800.000 cars not accounted for

A massive contingent of 800.000 cars per year was assumed to be diverted from the Great Belt (Storebælt Bridge) to the Fehmarn Belt tunnel. This figure was not a result of the traffic model run but quite extraordinarily, a manually added traffic demand on top of the calculated output. The client simply instructed the consultants to add an extra 800.000 cars per year through the tunnel. Three years after the introduction of this astonishing and massive diversion of traffic, no documentation whatsoever is publicly available.

Conclusion: Until documentation might otherwise be produced, the 800.000 diverted cars can only be interpreted as a backward calculation of extra traffic demand needed for keeping the payback period of the investment below a politically defined pain threshold of about 36 years.

Violation of the model's limits of usability

Based on traffic model forecasts, the consultants have concluded the demand for ferry traffic would be too limited to make a profitable business case when the tunnel opens. Accordingly, in forecast scenarios, the consultants have deleted the ferry line from the model's transport network and all 'existing' ferry traffic will be transferred to the tunnel.

However, the traffic model was not designed to run calculations on parallel traffic services. The split of traffic between the two different modes of transport is not based on any documentable estimation of the customers' trade-offs between such two modes. The output from the model used to argue for closing down the ferry line has no traceable explanation (causality). The model should have been substantially upgraded with specialised traffic surveys if the output were to be used as it has been used. However, the model was set up back in the 90's when a scenario of parallel services was out of the question, and accordingly, it would have been a waste of money to design the model and the data collection for a scenario which at the time was excluded.

If private capital were to finance the tunnel, comprehensive, expensive and sophisticated traffic surveys would necessarily have been carried out in order to be able to forecast almost all foreseeable competing business strategies between the two modes. Nothing of the sort has been done.

Conclusion: The traffic model was in its 2014-specification not usable for calculating the split of traffic between a parallel ferry line and the tunnel. The most important premise for the economics of the fixed link, i.e. closing down the Rødby – Puttgarden ferry line, relied simply on applying a model totally outside its area of validity.

Disregarding competitive behaviour

A substantial part of the so called generated traffic is traffic diverted from an array of ferry routes from all over Scandinavian waters such as Skagerrak, Kattegat, Fehmarn Belt and the Baltic Sea. These ferry routes are treated in the model's transportation network, more or less, as unresponsive road links but with a wider range of service parameters, such as: sailing time, fares, frequencies, etc. However, once the model was calibrated to be in line with base year transport statistics for the ferry lines, the model worked exactly as if these ferry lines were just as commercially non-responsive as a simple road link.

If a stretch of road 'experiences' a loss of customers, it will of course not be able to 'introduce' countermeasures. A ferry line, however, will naturally react with a variety of countermeasures to try to hold on to its customers and to keep its market share. Such fundamental commercial responses are not at all accounted for in the current forecasts. The model is erroneously used as if the private ferry operators were obliged to stick to original levels of service defined in an earlier competitive setting.

The traffic model is conceptually designed as if it were a state *strategic* model, in which the state controls or can forecast all supply variables: time consumption, km's driven, fares, frequencies, etc. However, the privately-operated ferry lines which are supposed to deliver customers to the Fehmarn Belt call for *strategic* and *competition* modelling, which is completely absent in the forecasts.

Conclusion: Compared to typical applications of traffic models in other contexts, the Fehmarn Belt case is extremely atypical. The generated traffic is to a large extent supposed to be diverted traffic, not from pure road transport corridors, but from corridors dominated by privately operated ferry lines with strategic strategies in contrast to road stretches. Each of these ferry lines will naturally react to even a risk of loss of customers to Fehmarn Belt. Such commercial and competitive reactions from a series of ferry lines have not been properly dealt with in any way, leading to a substantial overestimation of diverted traffic to the tunnel.

Averaging into meaninglessness

The Fehmarn Belt traffic model was basically structured and estimated to reflect the transport market as it looked back in 1996 when a huge data collection was carried out. At

that time the market for passenger car traffic crossing Fehmarn Belt was very simple: cars driving between all over Eastern Denmark / Scandinavia to and from all over the Continent. Accordingly, the model was set up to handle only one segment of passenger car traffic. However, this market segment of traditional 'Europe-traffic' has been slightly decreasing during the last twenty-five years – mainly because of deregulation of air traffic leading to markedly cheaper air tickets. As a consequence, the ferry line Rødby – Puttgraden, even when it was state-owned by Germany and Denmark, began to develop a demand for a completely new low-price market for short time border shopping in Puttgarden.

This special segment currently comprises about one third of the total passenger car market on the ferry line, which offers fare discounts of some 75 pct. or more compared to the fare for ordinary 'Europe-traffic'. Such two completely different market segments can, of course, not be handled accurately in a model capable of handling only one passenger car segment. However, such was the case in the 2014- forecasts. The model was only "reactivated" and not re-estimated. Therefore, a Europe-traffic-market with a fare level of index 100 and a low price and time restricted border-shop market with a fare level of index 25 pct. (or below) is averaged in the model to only one segment, simply because the model back in the late 90's was and still is not structured and estimated to forecast two completely different car traffic segments.

Conclusion: Due to an outdated model specification, the two completely different traffic segments with current indexed fare level 100 and 25 have been merged into one single "average" segment with an indexed price level of about 80. However, if the fare for the border shoppers in real life rises from index 25 to index 80, these, by nature, cost-sensitive customers will simply disappear or stay with a ferry line. Nevertheless, they have all been "forced" down into the tunnel and assumed to pay the average fare and with no influence at all on traffic volumes. On the other hand, non-shoppers have been attracted to the tunnel with a discount of about 20 pct. and thereby being over-attracted to the tunnel compared to the current situation. In real life Femern A/S will be forced to abandon the flat fare strategy and turn to a more differentiated one which should have and might have been evaluated using a traffic model suited for the purpose. Currently estimated revenues will naturally not hold in a real fare scenario – most likely they will be substantially reduced.

Lorry Transport

Unlike the situation with passenger cars, the forecasts for lorry traffic in the Fehmarn Belt corridor seem reasonable compared to the observed traffic – maybe even a bit conservative, judged from a short-term perspective.

The main problem with the forecast for lorry traffic through the tunnel is that the traffic model was neither estimated nor calibrated to forecast a scenario with a possible parallel ferry service. At a very late stage, Femern A/S asked KPMG to make an analysis on the business economics of a potential parallel ferry service. But the key problem with the forecasts from Femern A/S and the report from KPMG is the same: they are not based on traceable customer analyses of trade-offs in the choice of either transport above or beneath Fehmarn Belt. Two of the leading hauliers have made a clear statement that they would make their choice of passage mode crossing the Fehmarn Belt based on tight cost evaluations.

Conclusion: The far most potentially dangerous threat to the business economics of the fixed link has not in any way been substantiated by in depth analyses of the hauliers' own preferences in a realistic competitive setting. The market for transporting lorries is extremely cost sensitive. This has not been reflected in the forecasts.

Closing remarks

The aforementioned problematic preconditions and additional worrisome matters shown on the following pages have contributed to a major overestimation of the traffic forecasts and thereby to an unrealistic economic outlook for the fixed link. It would require access to the traffic model and most importantly additional specially designed traffic surveys if a welldocumented forecast estimate was to be made. This is regrettably not possible.

Based on past and long-time experience with traffic forecasting and modelling, this author believes that Femern A/S should expect less than half of the generated traffic currently foreseen and a slower general growth in person traffic due to the fact that long distance trips have shifted from car to air and short-range traffic will not be able to fill the gap simply due to the sparsely populated nearby catchment areas.

Lorry traffic however will with little doubt continue to increase in the future. However, if a low-price ferry line continues with parallel services, a substantial part of the road-based goods transport will have an economically relevant choice.

Even under the current extremely optimistic presumptions, the fixed link is still a high-risk investment. Such a situation would normally call for analysis of statistical uncertainty of the total outcome of the investment, but such an analysis has not been demanded by Danish authorities.

The decision to build the fixed link is political and cannot as such be discussed. However, what can be discussed is that the documentation behind the forecasts does not meet even the simplest requirements for professional standards. Normally an independently prepared quality assurance would pinpoint such grave deficiencies and suggest corrections before further activities were taken. However, much to the surprise of professionals in the transport sector, the Ministry of Transport appointed a quality assurance consultant who at the time by no means was independent but indisputably disqualified by being prequalified to make bids for three out of four tunnel construction contracts and shortly thereafter in a joint venture won all three at a sum of 3,4 billion €.

This choice of quality assurer was naturally neither a coincidence nor a regrettable mistake. It was a deliberate ministerial action designed to obtain a predetermined external approval of the forecasts.

3. Background

The Role of the Øresund Fixed Link

After decades of asynchronous Danish and Swedish interests in establishing a fixed link across Øresund, the two states finally signed a treaty in 1991 concerning planning and construction. The Danes were primarily interested in linking southern Sweden with eastern Denmark in order to develop a Swedish-Danish regional economic potential. The Swedes were mainly interested in improving access for Swedish industrial interests into Western European markets. As a precondition for the Swedish signature, Denmark accepted pursuing the possibilities of establishing a fixed link across the Fehmarn Belt.

Planning activities for the Fehmarn Belt fixed link were initiated in 1995 and lasted in its first phase until 1999. This planning was to a large extent carried out in order to comply with the Swedish conditions. However, later on the process was driven mainly by Danish political interests in building the third and last leg in the league of mega strait crossings. After 1999 Denmark adopted the Swedish interest in a fixed Fehmarn Belt Link but with a much weaker formulated goal than the Swedish one.

Even several years before signing the Øresund treaty back in 1991, Swedish and Danish industrialists had formed a lobby group called "Scandinavian Link" with former CEO of Vol-

vo, Pehr G. Gyllenhammar as one of the driving front figures. These early ideas, long before the fall of the Berlin Wall in 1989, seem to have been long-lived. The opening up of Eastern Europe in the years after 1989 seems not to have had any implication at all as to what kind of a project should be considered to link Scandinavia with the continent. The plan was, and still is, a fixed link between Rødby and Puttgarden linking Scandinavia with



Western Europe as we knew it from the times during the cold war, before the fall of the Berlin Wall (See illustration above)

The practical aspect of the Swedish Øresund condition was implemented by a mutual major planning task between Germany and Denmark to investigate the feasibility of a fixed link across the Fehmarn Belt. One of several technical / economic tasks was to set up a traffic model that would be used to forecast traffic demand. As for the task of transport modelling, a steering committee was formed with German and Danish governmental representatives. This author had the privilege of being a member of the Danish delegation to this committee. To implement the modelling tasks, a group of five international consulting companies were hired in order to set up a forecast model and as part of this, to prepare and conduct a comprehensive data collection for estimating the transport model.

Back then the ferry line Rødby – Puttgarden was owned mutually by the Danish and the German states. However, years later in 2007 shortly before signing the treaty of a fixed link between Germany and Denmark, the two states decided to sell Scandlines A/S to private capital investors.

Selected Previous Traffic Forecasts

The 1999 traffic model

As mentioned above, a comprehensive governmental cooperation between Germany and Denmark took place in the late 90's in order to analyse the economic feasibility of a fixed link across the Fehmarn Belt. As for the traffic forecasts, results were published in the following reports: Ref.[1], "Fehmarnbelt Traffic Demand Study – Final report January 1999", and ref.[2], "Femer Bælt forbindelsen, forundersøgelser – resumérapport", 1999.

The findings of the 1999 study will not be presented here. However, some important aspects of the model characteristics will nevertheless be highlighted here because the model version used in 2014 is almost identical to the original 1999 version except for the calibrating / updating to a later year of reference.

The figure to the right shows the cordon lines (red fully drawn double lines) used to define

which crossing ferry lines were subject to various forms of interviews describing passenger and goods transport. Air traffic between major Scandinavian airports and major airports on the continent was subject to interviews as well, but the geographical details about these surveys are not shown on the map. For unknown reasons, the northern cordon line in Skagerrak is not extended southward into the Kattegat. However, the ferry lines crossing Kattegat between Jutland



and West-Sweden were subject to interview surveys as well.

In relation to the 2014 forecasts, an interesting missing survey object emerges clearly from the map: no cordon line passes down the strait of Storebælt. At the time, the Storebælt Fixed Link was under construction, which the consultants naturally were well aware of.

The judgement at the time was that the consultants did not expect any significant competition between Storebælt and Fehmarn Belt. This judgement was confirmed many years later in a report from 2014, ref. [8] "Ex post samfundsøkonomisk vurdering af Storebæltsforbindelsen", quotation (in Danish):

> "Det er primært danskere, der bruger Storebæltsforbindelsen. Kun en mindre del af brugerne er udlændinge af den simple grund, at det sjældent er den oplagte vej at rejse, hvis man kommer fra Tyskland, Sverige eller Norge."

Which translated says:

"It is primarily Danes that use the Storebælt fixed link. Only a minor part of the users are foreigners simply because it is rarely the obvious route for traffic coming from Germany, Sweden or Norway."

That statement goes also for traffic between major parts of Zealand and Germany since the transport corridor from Sweden passes south of Greater Copenhagen.

In the 2014 forecasts, this judgement was totally abandoned and instead the Storebælt bridge was considered as a major route for traffic between Zealand/ Scandinavia and Germany with a big potential for diversion of car traffic to The Fehmarn Belt Fixed Link.

Data collection 1996

	Ferry lines	Data from Øresund Fixed Link	Air lines	Total
Passenger interviews	13.620	3.294	1.515	18.429
Stated Preference (SP) survey	449		306	805
Interview of lorry drivers	1.553	4.123		5.676
(SP) cargo handling agents				392
Grand total				25.302

An enormous amount of survey data was made available:

Table 1 Traffic surveys, 1996

This is an impressive amount of data compared to current standards for designing traffic surveys. The passenger surveys were primarily used for estimating flows of traffic between geographical traffic zones in Scandinavia and the Continent. Stated preference interviews however had quite a different purpose. They were used to extract detailed knowledge on individual choices. Stated preference survey data are collected by designing a series of stated choice experiments where an interviewer presents different sets of mode characteristics

to an interviewee. During the interview, these characteristics are varied by the interviewer to learn under which circumstances the interviewee would change his preferred mode or route choice. Stated preference interviews are expensive and take a very long time, but they are essential for creating a trustworthy forecasting model reflecting complex real-life trade-offs.

An important limitation of the use of such Stated Preference (SP) Analyses is that they cannot be used for setting up a model that can handle almost any future scenario. This is because the interviewee cannot answer questions unless the choices presented are precisely described, limited in numbers, and most importantly, relevant for the interviewee in an actual choice context. This means that you can only make SP trade-off interviews for precise and on earlier specified future scenarios.

The key challenge of using traffic models for traffic demand forecasting is that the user of a model can feed it with almost any future scenario and get an output forecast. The problem, however, is that this output is useless if the model has been forced to run outside its limits of validity. In such cases the causality does not exist, leaving the output more or less as a random number but regrettably with no flashing red lights. Traffic models are rarely provided with a guide presenting predesigned and limited use. As a consequence, it takes a professional with deep insight into the design of the model to know what scenarios lie within and what scenarios lie outside the limits of the model. Neither the client nor the consultants have apparently been aware of this crucial limitation in using the traffic model in 2014.

Back in the late 90's it made of course no sense to make SP-interviews about the choice between continued ferry services and a fixed link. In case of a fixed link, the two states would, as owners, shut the ferry line down. Therefore, there was no need at the time for sophisticated modelling to cover such an irrelevant future scenario. However, the ferry line was sold in 2007 and the previously irrelevant scenario became suddenly extremely relevant in relation to designing basic traffic surveys (SP).

The 2003 Forecast

An updated forecast report, ref.[3]: "Fehmarn Belt Forecast 2002, Final Report", was published in 2003. In the preface the following interesting information is given:

"The work has been done by the four FTC partners:

BVU – Beratergruppe für Verkehr und Umwelt GmbH, Freiburg (BVU) Carl Bro a/s, Glostrup (CB) – leading partner Institut für Seeverkehrswirtschaft und Logistik, Bremen (ISL) and Intraplan Consult GmbH, München (ITP).

The fifth FTC partner, the former Hague Consulting Group (HCG), now merged into RAND Europe, Leiden, has not been involved in this project as HCG contributed to the forecast model construction and calibration but not in the forecasting work."

The message is a clear statement that the original partner HCG (now RAND Europe) was the partner that had structured, built and validated the core causal elements of the model and that the technical qualifications of the rest of the partners were primarily concentrated on general administration tasks (Carl Bro A/S), shipping know-how (ISL) and operational skills connected with running the traffic model and first-hand experience with the German National Traffic Model (BVU & ITP). It is noteworthy that precisely the latter two companies BVU and ITP were picked by Femern A/S only to "re-activate" the model and not to reestimate the model which in fact was needed.

According to the 2003-report, there were several reasons for making an updated forecast. The forecast year of the 1999-report was 2010. But the general forecast year in the German Bundesverkehrswegeplanung, BVWP (German federal investment-plan for infrastructure) was 2015, so changing the forecast year was one of the reasons. Another reason was that during 2001 to 2002 an enquiry of commercial interest had been conducted with the aim to check the interest of private capital to finance the investment in a fixed link and to take the commercial risk. The enquiry (ref. [5] and [6]) gave a clear negative result since capital investors required an unconditional minimum advance of one third of the construction costs before they would consider the investment at all. Furthermore, these capital investors were worried by the prospect of:

- Parallel ferry service close to the fixed link and
- Competition from the Great Belt and
- Competition from other ferries across the Baltic Sea.

The 2003 report had the forecast year changed accordingly to 2015 to be in line with the BVWP. Ferry services across the Baltic Sea were updated and two sections about the threats from a parallel ferry service and competition from the Great Belt Bridge were added.

The 2003 forecast report encompasses, quite surprisingly, *trend forecasts* for 2025. The purposes of updating the 1999-forecasts are given in detail in chapters 2.1.1 "Study Objectives" and in chapter 2.1.3 "Need for Updated Forecasts". These specifications of the purpose do not mention any demand for expanding the forecasts further to 2025. Had that been the case, it would of course have been mentioned in either chapter 2.1.1 or in 2.1.3. Nevertheless, chapter 8 deals with trend forecasts for 2025. The beginning of the chapter states as follows: *"Two trend forecasts for the year 2025 have been carried out for each of the base cases A and B"*.



Figure 1 From ref. [3], figure 8.3.2 page 131.

The result is shown in figure 1 above. This 2025 trend-forecast was clearly not part of what the client had ordered. It was, more or less, a speculation made by the consultants themselves. That was unimportant at the time. The problem arose in connection with the 2014-forecasts where the same two consultants presented the *Trend Forecasts* from 2003 as if they were the official *Forecasts* from 2003. This was simply not the case. In 2014 the client was a complete newcomer and had had nothing to do with the forecast work done more than a decade ago and had accordingly no insight into, and perhaps no interest in, the continuities and discontinuities between 2003 and 2014. So, the erroneous interpretation of the 2003 forecast of being forecasts not only for 2015 but for 2025 as well was accepted without protests, only to distort the benchmark in the 2014 forecast relative to the 2003 forecast. But the 2025 forecasts in the 2003-report was pure speculation.

In figure 1 the so-called "low" scenario represents the same yearly average growth in traffic from 2015 – 2025 as in the years 2001 – 2015. So here the consultants have rephrased "trend" to "low" and thus sending a value-laden message, that a trend is something that is "low" of nature. However, a trend is a trend, and a trend forecast is the most information-empty forecast that can be made. The "high" forecast is simply a case where the trend represents a yearly growth that "is at least twice as high as in the low forecasts". Therefore, the "high" forecast is simply introduced by the consultants as the consultants' own suggestion with no solid argumentation.

Parallel Ferry Line

As for the issue of competition from a parallel ferry line and from the Storebælt bridge, the conclusive remarks in the 2003-report, ref. [3], are respectively:

Parallel ferry line

"... A decisive conclusion cannot be drawn out of the national experiences. A parallel ferry service very close to the fixed link on the Great Belt and Øresund has shown not to be able to survive, contrary to the situation on the Channel. As stated, there are great differences between these three situations, which make it rather difficult to transfer the experiences directly to the Fehmarn Belt."

It is noteworthy that the model in 2002/2003 was not able to make any decisive conclusions about this subject.

Competition from Storebælt

"... Furthermore, evaluations and model calculations have shown that the amount of traffic that was transferred from the ferries Rødby - Puttgarden to the Great Belt fixed link after opening in 1998 was approx. 2 %. Correspondingly, this amount can be expected to be transferred back to a Fehmarnbelt fixed link after opening.

The major part of the existing road traffic between Scandinavia (east of the Great Belt) and Northwest Germany passing through Denmark uses the considerably shorter route via Rødby-Puttgarden, because this route is much more costeffective.

Unless the toll rates on the two fixed links will differ substantially in favour of the Great Belt, this will also be the case after establishment of a fixed link across the Fehmarn Belt.

From these conclusions, it is clear that neither in 1999 nor in 2002/2003 did forecasts show any evidence at all that Storebælt was considered to be an important competitor to Fehmarn Belt. The volatility was limited to only 2 pct. of the Fehmarn Belt traffic. In the 2014forecasts however, this traffic was estimated orders of magnitude higher at 8 pct. However it was worse than that because the 2 pct. was to be calculated as 2 pct. of a very small number of cars passing across the Fehmarn Belt. Quite opposite the 8 pct. was to be calculated as 8 pct. of the much larger number of cars crossing The Great Belt. The percentage figure had not just jumped from 2 to 8 pct. In real terms the volatility between the two traffic corridors had risen from 31.000 to 713.000 cars/year. (Both figures represented in traffic level 2011). Not surprisingly, this figure of 713.000 cars/year (increased to 800.000 in forecast years) now in its third year from publication is still subject to "further investigations" with no expected end time.

Lack of Documentation

The two consultants regrettably have the habit of not documenting the reference case or the "do nothing scenario". For a traffic planner this scenario might even be judged to be the most important of all scenarios, because this scenario is needed to evaluate the consequences of all other scenarios being evaluated. The absolute figures resulting from a scenario forecast are in many aspects not of major interest. Oftentimes it is the difference between key figures from the reference case and the same key figures from scenario case that forms the result. The reference case is accordingly extremely important.

In the 2003 forecasts, the client observed this important lack of documentation and the consultants were forced to complete their task and document the reference case in a supplementary report ref. [4] *"Fehmarn Belt Forecast 2002 Reference Cases, Supplement to Final Report of April 2003"*.

Regrettably, this habit of not documenting the reference case was continued by the same consultants in 2014 and the new client did presumably not notice this important lack of documentation. The result was that spotting the flaws in the forecasting was made unnecessarily complicated.

The 2008 Forecast

The 2008 forecast was probably the most important one because it was used in the process leading to the Danish political agreement to build the fixed link. As described earlier, political agreements can in practice not be rolled back, so it might be argued that the initial agreement from 2008 was in fact the final decision as well, leaving passing the law of construction in 2015 as a simple follow up to the 2008 agreement.

The forecast was not a standalone publication but just a chapter of 2½ pages out of a total of 27 pages in the Financial Analysis from 2008, ref. [7]:

Chapter 4 begins with the following text (translated from Danish):

"The expected revenues for the coast to coast link has been calculated on the basis of the traffic forecast prepared by FTC (Fehmarnbelt Traffic Consortium) and published in the report: "Fehmarn Belt Forecast 2002, Final Report, April 2003" "



Figure 2. Traffic forecast 2008. Illustration from ref. [7] page 12

The main problem with this forecast is that the reference to the 2003-forecast is, at best, extremely weak. As mentioned above, the official forecast year in the 2003-publication was 2015. The trend extension unto 2025 shown in chapter 8 was not a forecast but an addendum with a simple trend line combined with pure guesswork.

The client had not commissioned the expressions in chapter 8. This can be seen from the fact that the chapters: *Preface, Background of the Study, Forecast preparation, Base case forecasts, Scenario forecasts 2015* and *Forecast comparison,* do not contain one single word of forecasting further on than 2015. A trend line – not described in the terms of reference - cannot be viewed as being a formal forecast.

But the forecast reference in ref. [7] is even more peculiar. In the Financial Analysis, the construction costs of the fixed link are calculated to be paid back by user charges after 26 years of operation. This implies that in 2008 there was some kind of an undocumented traffic forecast at least until the year 2041.

To make a reference to a documented forecast from 2003 looks at first glance to be reassuring in relation to transparency of the basic presumptions. But to misuse chapter 8 in ref. [7] and to make undocumented forecasts at least all the way until 2041 reveals a weakness in traceability and in documentation of key figures.

4. Overview of the 2014-forecast

Car traffic forecasts

The forecasts are documented in three reports from November 2014. Two technical reports were prepared by the German consultants BVU and ITP: *"Fehmarnbelt Forecast 2014 – Up-date of the FTC-Study of 2002"*, ref. [9] and *"Fehmarnbelt Forecast 2014 – Update of the FTC-Study of 2002, ANNEX"*, ref. [10]. The last of the three reports is a summary report from the Danish Ministry of Transport *"Trafikprognose for en fast forbindelse over Femern Bælt"*, ref. [11]



Figure 3 2014-forecasts compared to 2002-forecasts for year 2015, supplemented with the consultants' choice of possible but undocumented extensions to 2025. *Ref.* [9]: Figure 9.2 p. 190

The above figure shows three different categories of traffic developments:

- Observed traffic on the ferry line Rødby Puttgarden ("real development 2001 2011")
- Traffic forecasts referring to the 2003-report ("FTC 2002" three elements)
- Forecast 2014 ("FTC 2014", Case A: German assumptions referring to BVWP, Case B: Danish assumptions)

As described in the preceding chapter, the reference back to the 2002-forecasts ('low' and 'high') is misleading since the 2002-forecast covered only one forecast year 2015. The linear extensions were not based on professional methods and not part of the client's terms of reference. Moreover, the terms "low" and "high" cannot meaningfully be interpreted as low and high. The "low" is simply the trend line and there is no explanation as to why the trend between 2001 and 2015 should represent something low – low compared to what? The "high" is simply a non-contested suggestion by the consultants.

However, presenting the 2002-forecasts together with the 2014 forecasts in the misleading way shown in figure 3 gives the reader the impression that the 2014-forecasts are totally in line with the 2002-forecasts, i.e. something between 'high' and 'low' compared to 2002.

Ferry Traffic

As for the observed traffic on the ferry line shown in figure 3, it is obvious that demand has not recovered after the financial crisis in 2008. This in turn has led to the need for a lower starting point for the 2014-forecast than that of the 2008-forecast which was 1.89 m cars and busses (level 2007). In the 2014-forecast the base year is 2011 when the observed traffic had dropped from 1,89 m cars and busses in 2007 to 1,59 m. in 2011. Four years of expected traffic growth had been replaced by a drop of 16 pct.

Figure 3 shows that this worrying reduction of 16 pct. in realised ferry traffic seems to have been counteracted by a surprising and suddenly identified much larger generated (diverted) traffic than ever seen before. The undocumented influx of 800.000 cars per year claimed to be diverted from Storebælt to Fehmarn Belt was politically needed in order to meet the requirements not to exceed a politically defined pain threshold of a 36-year payback time.

The base reference in the 2014-forecast was determined by the consultants to be 2011. But since then, transport statistics for the Rødby - Puttgarden ferry line do not detect any sign of recovery with only 1,56 m vehicles in 2016 compared to 1,59 m in 2011 . Furthermore, the three first quarters of ferry traffic statistics for 2017 reveal a reduction of 2,2 pct. It seems that even 800.000 more or less imaginary diverted vehicles from Storebælt are still not enough. Traffic demand has been decreasing since 2007 and even now when European economies have substantially recovered after the financial crisis, traffic in this corridor seems to be stagnating.

million vehi- cles/ year	2001	2002	2007	2011	2012	2013	2014	2015	2016
Passenger cars & bus- ses	1,39	1,62	1,89	1,59	1,58	1,57	1,57	1,57	1,56

Table 2 *Transport statistics for the ferry line Rødby – Puttgarden. Source: Danish Bureau of Statistics (Statistikbanken)*

There is no sign whatsoever that car traffic in the corridor of Rødby – Fehmarn will follow the same general growth in traffic volumes that is seen on the motorway network in Denmark and in Germany as well. The reasons are mainly:

- The Fehmarn Belt corridor has for decades been servicing long distance person transport between Scandinavia and the Continent. Due to dramatic decreases in air fares - as a consequence of air deregulation - this market has changed markedly from car to air transport. The markedly general growth in car traffic on motorways all over Europe cannot be used to argue for a similar growth in the Fehmarn corridor. Passenger car trip purposes like commuting, vans with various service purposes, etc., currently dominating general growth in car traffic, have never affected the ferry line and the former key customer car traffic segment is now passing ten kilometres above the ferry line.
- Long distance car traffic experiences rising congestion problems especially on German motorways.
- The Fehmarn Belt region on both sides of the belt is characterised by a relative lowdensity population with no major population and business centres that might fuel short range traffic development.

The figure below is an update of the above figure 3: The ferry line statistics have been updated to cover the period until 2016 and the "Case A" with German planning presumptions has been removed leaving only the "Case B" with Danish planning presumptions.



Figure 4 Traffic forecasts 2014. This figure is based on figure 3 but updated with the latest available ferry traffic statistics and the 'case A' (German planning) forecast has been removed.

With reference to the first 9 months of 2017, the blue line might even with very little uncertainty have been extended to cover 2017 as well and with a slight decrease relative to 2016 making the gap between forecast and observed traffic even worse.

Lorry Transport

As for lorry transport, the forecasted volumes are not in conflict with other sources of information.

The key question however is - as it is for passenger car traffic - will there be a parallel ferry service taking its share of the total market? For further discussion see chapter 5.2.



Figure 6 Forecast for lorries crossing Fehmarn Belt. Ref [9], Figure 9-3 page 193.

5. Selected Weaknesses

5.1 Missing Market Segmentation

Background Statistics

Before year 2000 the ferry line Rødby – Puttgarden transported passenger cars coming to and from all over the European continent travelling predominantly for leisure, holidays and business.

However, this demand for car traffic began to stagnate around the year 2000; as a countermeasure, the ferry line began to develop a new low fare market with border shopping in Germany.

Wage levels and VAT were and still are considerably lower in Germany than in Denmark, resulting in lower retail prices, which attract Danish and Swedish customers to border shops in Germany. To ensure that normal Europe-traffic did not take advantage of markedly lower fares, Scandlines A/S introduced cheap round trip tickets for border shopping with restricted time limitations on the stay on German grounds.

At its website, Scandlines A/S has published table 3 showing traffic statistics for cars during the years 1998 – 2016. These figures are shown in a diagram on the next page.

	Cars			
	Total	Shopping	Other/ mainly leasure	
1998	935.976	-	935.976	
1999	991.644	-	991.644	
2000	1.158.989	114	1.158.875	
2001	1.357.386	212.381	1.145.005	
2002	1.586.644	361.339	1.225.305	
2003	1.574.369	397.974	1.176.395	
2004	1.734.676	544.444	1.190.232	
2005	1.777.015	595.510	1.181.505	
2006	1.774.270	602.255	1.172.015	
2007	1.858.261	631.861	1.226.400	
2008	1.776.824	592.448	1.184.376	
2009	1.667.080	527.550	1.139.530	
2010	1.611.330	489.320	1.122.010	
2011	1.563.887	486.407	1.077.480	
2012	1.553.028	545.127	1.007.901	
2013	1.538.667	532.379	1.006.288	
2014	1.541.944	533.164	1.008.780	
2015	1.540.915	525.924	1.014.991	
2016	1.529.649	534.517	995.132	

 Table 3 Rødby-Puttgarden car traffic statistics. Reference: scandlines.dk



Figure 7 Development in yearly car ferry traffic in two catategories: shopping and Europetraffic. Reference: scandlines.dk.

If we look at the official transport statistics for passenger cars via Rødby – Puttgarden in a longer perspective from 1990 – 2016 and subtract the shopping segment published by Scandlines A/S, we get the following curve for ordinary Europe bound cars using the Rødby – Puttgarden ferry line:



Figure 8 Rødby-Puttgarden, passenger cars per year excl. shopping. Sources: Danish Bureau of Statistics (Statistikbanken) and scandlines.dk

As can be seen from figure 8, the ordinary Europe-bound car traffic crossing Fehmarn Belt has declined by 15 pct. since 1990 and is currently only seven pct. higher than during the low period in the mid 90's when Germany was reuniting after the fall of the Berlin Wall. During this same period, the number of passenger cars in Denmark has risen by 51,6 pct. and GDP has likewise risen by 51,7 pct. – two indicators that one way or the other should be a driving factor for road traffic in general.

It is astonishing that despite this exceptional track record of more than 25 years with decrease and stagnation in a supposedly key customer segment for the largest transport investment in Denmark ever, no need for further analyses has been addressed. Had private capital been involved in financing this project, such information would have been most alarming and called for thorough investigations including risk analyses long before any binding steps would have been taken.

Making Average where Average Distort Evaluations

The forecast calculations by Femern A/S are based on an average fare for a round trip of 968 DKK (130 €) for all passenger cars. However, since 2000 two much differentiated fare levels have split the market of passenger cars in two: Shopping and Europe. By making averages for demand and fares for these two very different markets, Femern A/S has simply averaged explanatory power away leaving the old traffic model incapable of describing the competition between an array of ferry lines and the fixed link.

The concept of the shopping market is driven by a combination of very low fare tickets for the ferry line and substantially lower retail prices in Germany compared to Denmark. This low fare market covers about 35 pct. of the passenger car market. The German destinations for such round trips are situated rather close to the



Puttgarden harbour because the fare discount is offered on condition of a time limited stay on German soil.

This is completely opposite to the other car market that has substantial higher fares and of course no time limit. Origins and destinations for these trips are spread out on an array of European countries. The fare structure on the ferry line varies over time but under the assumption of a discount fare of 299 DKK for a time restricted shopping ticket and a distribution of 35 pct. shopping and 65 pct. ordinary traffic, we get an estimate for the latter of 1328 DKK for a round trip ticket.

By using an average segment of just "cars" no matter whether we are talking about low fare shopping tickets or full fare Europe traffic tickets, the forecasts from Femern A/S simply violate fundamental economic mechanisms of supply and demand.

Several important conditions must be met to justify making averages of two very different market segments. One of these is that by making an average, demand and fare competition to other markets-- i.e. in this case ferry lines in the rest of Scandinavia-- is not distorted. But that is exactly the case. The perception is that with an average fare much lower than the real fare for Europe-traffic, the fixed link will attract much more traffic from alternative routes compared to what will happen in real-world competition.

This of course leaves a deficit in revenues. However, by using average fares this deficit is counteracted by "hand-moving" all shoppers down into the tunnel at the average fare level of 968 DKK instead of 299 DKK or less and making no correction in the demand resulting from a three time more expensive fare. Obviously, the reason people take the short-term shopping trip is that discount benefits in border shops outweigh the fare for ferry transport. With a round trip fare of DKK 968, the demand for such trips would in actuality disappear.

When confronted with this inconsistent way of traffic forecasting, Femern A/S claims that at the opening date, Femern A/S will adopt its own price differentiated fare strategy with the implicit understanding that such a strategy might turn out to encompass a substantial discount to border shoppers. However, it should be clear that such alternative strategies should be designed under the condition that the total revenue should be as close to, or higher, than the revenue presented to Parliament and was used as a basis for passing the law of construction. If half a million border shoppers – plus the forecasted growth in this segment – do not pay more than about one third of what was presupposed when revenues were calculated, then a considerable amount of money is simply missing in revenues.

No matter how this problem is considered, there is no practical way to rectify traffic volumes and revenues from passenger car traffic with what was presented to Parliament before the passing of the law of construction. At least two thirds of the assumed revenues from border shoppers only exist in spreadsheets; thus, the diverted traffic from other transport corridors has been calculated from an unrealistic assumption of tunnel fare levels.

So why has Femern A/S made such a mistake? The answer is that the traffic model was designed and estimated several years before the concept of low-fare border shopping was initiated. The model was therefore not designed to handle two very different car traffic markets. The model was only set up to handle one single car segment and the consultants had no other choice than to short-circuit the markets, leaving the model unable to handle neither the low fare nor the high fare market.

As in a supermarket, there can be no sensible strategy for selling bananas and pineapples based on an average unit price calculated as the sales weighted average of previously different unit prices. For obvious reasons it doesn't work in the supermarket and for exactly the same reasons, it will not work in the Fehmarn Belt Tunnel.

The lack of professional forecast handling of two currently very different car segments using the ferry line is alarming in relation to estimates of future tunnel traffic demand and revenues as well.

5.2 Traffic Split between Parallel Transportation Services

As clearly stated in ref. [9] *"Fehmarnbelt Forecast 2014 – Update of the FTC-Study of 2002"* the forecast work was just the result of an update of traffic statistics, but the core mechanisms of the traffic model remained unchanged leaving the model in a state from which answers to old questions could be found but not necessarily to new ones:

3 FORECAST METHOD

The FTC 2014 Forecast is an update of the 2002 traffic forecast for the Femern Fixed Link. Therefore the models used both for passenger and freight transportation are highly similar to the ones used in 2002. However methodological improvements in the transportation modelling science made it necessary to improve some parts of the modelling tools used in 2002. Nevertheless the structure of both the passenger and freight transport models remained substantially the same.

Figure 9

Quotation from Ref. [9] page 82 [with added underscores in red]

A Short Introduction to Modelling

The above important statement can be seen as kind of an indirect disclaimer. A transport model is in no way an "oracle" that can calculate consequences for almost any relevant future scenario. A transport model calculates consequences for clearly specified types of scenarios that were designed for and data collected for. It would be technically impossible to set up a transport model that can give answers to almost any thinkable, albeit, relevant question. More importantly: the more designers attempt to create a model to cover wide ranges of different types of scenarios, the more expensive the model will be, and the designers risk losing track of things due technical complexity.

Before a transport model is set up, it is necessary to define which types of tasks the model should be able to evaluate. Such tasks or group of tasks define rather precisely how the model should be structured e.g. into sub-models, and how these sub-models should work and interact with each other. This design phase encompasses also requirements for data collection in order to estimate parameters in the model, i.e. to develop causal mathematical expressions that describe traffic volumes as a function of input data defining a scenario. Thus, when a model has been set up, it has automatically built in limits for the use of the model.

Regardless of these limitations, it is nevertheless operationally possible to run a transport model completely outside its boundaries of validity. This can be the case if the scenario differs markedly from the standard types it was designed for, or it might be because the scenario is based on extreme levels of service that have not been reflected in the data sets that the model was estimated on. Likewise, the model can be forced to work outside its boundaries in case of scenarios with complicated trade-offs that were not reflected in the data sets used for estimating the model.

Route choice in the Fehmarn model

The map to the right shows the ferry lines from which the model originally was designed to calculate diversion of traffic to the fixed link.

From each traffic zone in Scandinavia (east of Storebælt) to each traffic zone in the rest of the continental Europe a total 'generalized cost' was calculated. This cost function reflected driving time, driving distance and a broad set of characteristics for each separate ferry line such as: fares, waiting time at terminals, sailing time, sailing frequencies, etc. By using various weighing factors (or unit prices) all these level of service parameters were added into on single 'cost' estimate for the given route via a given ferry link.



After ensuring that total volumes of traffic had been adjusted to the observed level in the base year, the model was run with these cost functions in order to allow the model to calculate the distribution of car traffic between the different ferry lines. This calculation would not totally reflect the actual volumes on each ferry line. The process will be finalised by a 'calibration' in order to balance the model calculated ferry traffic volumes with observed ferry traffic statistics in the base year.

The Parallel Problem

Seen from a "model perspective", the change from ferry services to a fixed link is rather like introducing a new high-speed ferry line with no waiting time at terminals, much faster 'sailing time' and the introduction of an extra cost equivalent to 18 km's drive.

In the main forecast scenario, Femern A/S claims that there is no business case in a parallel ferry service and the existing ferry line will have to close down and all 'existing traffic', i.e. all forecasted ferry traffic just before opening of the fixed link would be transferred to the fixed link. As previously described, such reasoning violates basic economic principles of supply and demand: One third of all existing car traffic – the border shoppers – will by this

decision be 'forced' to pay a fare of about three times more than in the case of ferry transport but with no implication on demand.

The argumentation for closing down the existing ferry line was based on a model run in which parallel services are available by the ferry line and the fixed link as well. In this model, according to the consultants, the resulting demand for ferry transport was too limited to keep the ferry line running profitably.

The key problem in that argumentation is that the model was never designed to forecast traffic in such a highly competitive situation. In the phase of setting up the model back in the late 90's, the types of scenarios the model should be able to evaluate were sharply defined, and based on that, traffic surveys were designed to estimate the model. Parallel services by tunnel and ferry were simply not relevant at that time because the two states would naturally close down their mutually owned ferry line if a fixed link were established.

Accordingly, in the 90's no data was collected showing trade-offs between two geographically identical choices which differed markedly from each other in respect to level of service expressed in a variety of level of service variables. Should a traffic model be able to handle such a competitive situation, it would have been necessary, for statistical reasons, to have access to data showing travellers' real life trade-offs between different types of supply for competing modes. Such data has not been collected and used for model estimation; therefore, the model does simply not contain causal explanations to handle this very special and specific scenario.

Nevertheless, there are no process-related barriers against letting the model run such a scenario of two parallel services. However, the output from the model cannot be traced back to the result of statistically analysed real life choice behaviour. Such output is accordingly more or less arbitrary.

What should have been done if the goal were to evaluate parallel services was to perform a series of stated choice experiments where an interviewer presented interviewees with different sets of varied characteristics for each of the two possible choices and given these presumptions, asked the interviewee to give his/her preference for one or the other. Such series of interview data are used to estimate a probabilistic model that under given choice characteristics can make a statistical traceable distribution of traffic between the two alternatives. Such interviews are expensive and take a very long time, but they are necessary if central estimates are to be produced.

However, Femern A/S and its consultants have ruled out that a competing ferry will have any chance of surviving economically after the opening. This argumentation relies on a clearly outdated traffic model that was not upgraded to handle this complicated competitive situation, which was unforeseen when the model was set up and estimated back in the late 90's. The rejection of the scenario was not even supported by analysing the ferry line business case. If private capital should have financed the fixed link, this issue of a competing parallel ferry line would have attracted huge attention regarding traffic forecasts and business economics. A competing ferry line is one of the foremost threats against traffic demand for and business economics of the fixed link. Several million DKK would have been spent to come as close as possible to a best estimate of the traffic split between the two alternatives and evaluate the respective risks. Furthermore, as revealed in the next chapter, a private investor would have evaluated all sorts of possible competitive strategies between the two service providers.

Nothing of the kind has been done even though back in 2002 strong warnings on the matter were conveyed by potential private investors, see ref. [5] and [6].

5.3 Ignorance of Competitive Reactions from Ferry Lines

Every forecasted future customer of the Fehmarn Belt tunnel - except those who might be diverted from the Storebælt Bridge, if any - has been attracted away from one of more than twenty privately operated ferry companies. These ferry companies will naturally – if they experience any loss of traffic to the tunnel - act with all kinds of commercial countermeasures in order to minimize, or even to avoid, any loss of customers to the fixed link. Regardless of this fact, the forecasts have been made as if these ferry lines were frozen in an earlier setting of competitive balances between ferry lines and after the opening of the tunnel, would be completely paralysed.

Back in 1999 and likewise in 2002, neglecting such an obvious competitive behaviour when making traffic forecasts was a serious shortcoming. But to repeat such a blunder in 2014 is not acceptable.

Public vs. Private Infrastructure

In mainstream transport modelling, the transport network is usually provided by a national or local government and use of the infrastructure is normally free of charge. In such a planning environment, a transport model can be used to calculate the effect of changes in e.g. infrastructure such as a new road link or potential changes in the future level of service for an existing road link. As a result, traffic on various road links in the influenced area will increase, decrease or stay constant. An example of out-



put from a traffic model in such a planning situation is shown to the right with green signature showing links with decrease in traffic and red signature showing increase in traffic in case of a certain scenario relative to a base scenario. The "attractiveness" of each road link

depends only on road geometry and traffic volumes. This is an ideal situation for automatic calculation of attractive routes from A to B.

In the Fehmarn Belt case, the transportation network of the traffic model consists not only of road links but of ferry links as well. The "attractiveness" of each ferry link is calculated as a function of its main service variables: Fare, departure frequencies, sailing time, waiting time at terminals etc. All these ferry line qualities are by use of statistical methods weighed together in order to bring the ferry line "attractiveness"



in line with the "attractiveness" of road links on a common and comparable standard. The traffic model can now work with all network links on an equal basis and calculate the distribution of traffic over the complete network including traffic on the special links representing ferry lines.

In the base case scenario, the traffic model was fed with the ferry line characteristics prevailing at the time of setting up or calibrating the model. So, the model was fed with what could be described as a certain snapshot of 'competition armistice' between ferry lines.

In the forecast situation, this 'armistice' between ferry lines and more importantly relative to the fixed link is frozen in the traffic model to its original levels of service. This will of course not be the case when the fixed link opens. Each ferry line in the Scandinavian waters which might experience any loss of customers to the fixed link will of course improve its competitive status and fight to keep its customers.

This blunder of neglecting ferry lines as fiercely competitive players in the market was made in the forecasts made in 1999 and in 2002 as well. But to repeat this blunder as late as in 2014 seems unacceptable. In the *"Enquiry of commercial interest for the proposed fixed link across the Fehmarnbelt"*, ref.[5] and [6], it was clearly stated that serious economic competitive risks existed between the fixed link and the ferry lines. This warning should have been sufficient for Femern A/S to ensure that detailed competitive analyses would be carried out. Regrettably, this did not happen.

As a first step it was justified to run the model on previous competitive balanced levels of service for each ferry line. However, this first step should naturally have been followed by an in-depth analysis of which profitable countermeasures each ferry line might adopt in order to keep its customers if the model results showed a loss of customers.

If the forecasting task from the start had been offered by use of a public tender process, consultants with experience in private competition analyses might have provided the necessary knowledge in cooperation with more classic traffic planners like the chosen German companies.

The consequence of not assessing competitive countermeasures has led to substantial overestimation of diverted traffic from a long array of competing ferry routes. This overestimation comes on top of the overestimation due to using average fares instead of segment defined fares for shopping trips and Europe trips.

Special case: Rødby – Putgarden

Chapter 5.2 explained why the traffic model used for the 2014 forecasts was not able to evaluate the split of traffic between a fixed link and a potential parallel ferry line service. Even if we ignore this fundamental lack of ability, Femern A/S and affiliated consultants ought to have been worried by technical requirements that exclude competitive strategies in relation to introducing time dependent departure frequencies:



Figure 10 Due to model restrictions dated back to the late 90's, the consultants had to accept that a competing ferry line service should run 24/7 with constant departure frequencies. Not precisely the prescription for competition.

The consultants could choose between departures each half hour, hourly, every second hour or any other 24/7 service with constant departure frequency all day and night. This feature is one more sign of how unsuitable the model was for evaluating parallel services. If a ferry line was to make a service strategy, it might be relevant to evaluate concentrated services during busy hours and accept the tunnel take over during hours of low traffic demand. However, the model back in the 90's was pre-coded to have fixed frequencies, which of course is not a wise strategy for a competitor.

5.4 Transferred Car Traffic from the Storebælt Bridge

The 2014-forecasts, predicted, without documentation, that 800.000 cars per year would be diverted from the Storebælt Bridge. Before 2014 such markedly volatility in traffic demand between the two transport corridors had been rejected. The German consultants behind the 2014 forecast had back in 2002 made an update of the original 1999 forecast. In this update: "Fehmarn Belt Forecast 2002 Final Report, April 2003", ref. [3], the following conclusion was made about competition between Storebælt and Fehmarn Belt:

"Competition from the Great Belt Link

According to the conclusion in Chapter 10, the competition relationship between the Great Belt link and a fixed link across the Fehmarn Belt is rather modest.

In a recent survey performed by Sund & Belt Ltd., it was found that only 3 percent of the present Great Belt traffic has either destination or origin in Germany; 97 percent is national Danish traffic. Hence, only the 3 percent could consider to use the Fehmarn Belt link in the future.

This result confirms previous FTC forecasts, which showed that only 1,9 % of car traffic and 0,8 % of lorries on the Great Belt link would be attracted by the Fehmarn Belt link in 2010.

The above shows that a[t] Fehmarn Belt link will only be an attractive alternative for a small share of the existing traffic across the Great Belt.

On the other hand, the Great Belt link might be an attractive alternative for some of the travellers that could use a Fehmarn Belt link. This will depend entirely on the difference in the toll levels at the two fixed links. The transport route via Rødby-Puttgarden is approximately 150 km shorter, than the route via the Great Belt. The current cost of travelling via this route including the cost associated with travelling a longer distance is 60-80 Euros, which is substantially higher than the ferry fare at Rødby-Puttgarden of 46 Euro. Unless, there are significant changes in relationship between the tolls at these crossings, the Great Belt link, will not be a significant competitor to a Fehmarn Belt link."

As late as in a report from 2014 ref. [8]: "Ex post samfundsøkonomisk vurdering af Storebæltsforbindelsen" (Ex post socio economic assessment of the Great Belt Fixed Link) it was stated:

> "Det er primært danskere, der bruger Storebæltsforbindelsen. Kun en mindre del af brugerne er udlændinge af den simple grund, at det sjældent er den oplagte vej at rejse, hvis man kommer fra Tyskland, Sverige eller Norge."

Which translated says: "it is primarily Danes that use the Storebælt fixed link. Only a minor part of the users are foreigners simply because it is rarely the obvious route for traffic com-

ing from Germany, Sweden or Norway."

That conclusion goes for major parts of the traffic between Zealand and Germany as well, since the transport corridor from Sweden through Denmark passes south of Greater Copenhagen.

It is well documented ref. [2], [3] that this enormous amount of claimed diverted traffic simply was not part of the traffic model. So, the big question is, on what grounds was this suddenly discovered massive traffic demand based?

Danish media tried to examine the issue and this interest from the media initiated a question from MP Henning Hyllested (Enhedslisten) to the then Minister of Transport, Magnus Heunicke (Social Democrat). The following text is a quote from the official answer, ref. [13] from the Minister of Transport to Henning Hyllested:

> "...Intraplan og BVU oplyser, at de 713.000 personbiler er fremkommet med basis i en række forskellige analyser, herunder analyser af trafikanternes startsted og slutdestination, deres rutevalg, nummerpladescanninger samt analyser af transaktions-data på Storebælt. Sidstnævnte er udarbejdet af A/S Storebælt, mens de resterende analyser i udgangspunktet er udarbejdet af DTU med basis i blandt andet dataindsamling udført af de to danske konsulentfirmaer COWI og Tetraplan. Disse oplysninger er tilgået Intraplan og BVU, der har indarbejdet dem i deres trafikmodel."

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Transportadvalget har i brev af 24, marts 2015 stillet mig folgende sporgenål vedremende L 141 – Forslag til lov om anlæg og dreft af en fast forbindelse over Førnern Bælt med tillsærende landsallag i Danmark, som ige bærned skal be- vare. Spærgenske er stillet efter enske fra Henning Byllesnet (EL).		
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Med venlig hilsen		
Magnus Hennicke		

Translation:

Intraplan and BVU have stated that the 713,000 passenger cars have been established on the basis of a variety of analyses, including analyses of the drivers' origin and end destination, route choice, license plate surveys and analyses of transaction data on the Great Belt. The latter has been prepared by A/S Storebælt, while the remaining analyses were originally prepared by DTU [Danish Technical University], based on data collection by the two Danish consultancy firms COWI and Tetraplan. This information has been passed on to Intraplan and BVU, which have incorporated these findings into their traffic model. Not only was it unprecedented that a client instructs a consultant to incorporate specific client produced extra traffic demand for a specific transport link, but also it turned out that the references were incorrect.

The unusual behaviour by a state authority was given seemingly credibility by referring to

the best Danish university competences. But the references turned out to be a clear-cut falsification. On 15th May 2015 the Danish technical journal Ingeniøren published an interview with one of the leading senior researchers at DTU. The headline shown to the right - in the journal was: "DTU is surprised: Our studies

DTU undrer sig: Vores undersøgelser siger intet om Femern-prognose

Transportministeren henviser til undersøgelser fra DTU som grundlag for prognose om at flytte biler fra Storebælt til Femern-tunnelen. Men forskeren bag dem afviser, at hans data siger noget om det.

Af Magnus Bredsdorff 💙 Felg @mbredsdorff 15. maj 2015 kl. 09:45

do not say anything concerning the Fehmarn forecast"

It must have been embarrassing for the consultants in Munich and Freiburg to receive and to obey instructions by the client to insert Danish fabricated figures into the forecast documentation delivered by November 2014. By accepting this highly unusual behaviour by a client, the consultants made themselves vulnerable and a sign of that was the memo: *"Fehmarn Belt Forecast 2014 – Update of FTC-Study of 2002 – Treatment of Great Belt in Forecast (Passenger Traffic)"* prepared by the German consultants and dated 2015. This memo seems to have been intended as a damage control by the consultants. Instead it turned out to unveil more embarrassing details on an inconceivable incompetent traffic survey made by the Danish client. From the note to be found in ref. [14]:

"...Samples of plate counts in summer indicate a share of 5 to 6 % of foreign cars on GBFL.

Foreigners use the GBFL mainly on North-South traffic. In winter the share is lower, 2 to 3 %, which is logical as in winter the price differences between GBFL (no seasonal or daytime variation of toll rates) and the ferry line Rødby-Puttgarden (much higher prices in peak periods) is lower than in summer.

"...Assuming a similar number of Danish cars using GBFL in north-south traffic instead of domestic traffic between east and west Denmark, in total a share of 8 % of the GBFL traffic can be as-signed to international resp. north-south traffic on GB. This is a quite reliable figure for 2011. In 2014/15 this share should be higher due to a growing "price gap" between GBFL (stable toll rates and



decreasing fuel costs for longer distance) and Rødby-Puttgarden (raising prices).

The numbers for the GB transports in the north-south traffic (713.000 cars in 2011) have been added to the transports on the relevant ferry lines (around 2.9 million cars per year in 2011) to get the totals of north-south traffic. At the same time, it has been used in the same way as the ferry statistics: to calibrate the route choice model for the forecasting...."

A simple licence plate count was carried out and all cars were classified into just two categories: Danish and foreigners. In the above quotations, one short sentence discloses an unbelievable misunderstanding: *"Foreigners use the GBFL mainly on North-South traffic"*. This assumption is however as erroneous as can be – more on that issue in following paragraphs.

The average share of cars with foreign licence plates, estimated by using simple licence plate surveys, was 4 pct. These cars were all erroneously judged to be future customers in the Fehmarn Belt Tunnel. One should think that such a huge analytical blunder would stand alone but there was more to come, as the 4 pct. of foreigners were assumed to have Danish 'mirror effects', i.e. with an equal number of Danish registered cars making the trips in the opposite direction. So, one further huge blunder doubled the figure from 4 to 8 pct.

Based on two grave misinterpretations of the simplest thinkable traffic surveys, the share of the Storebælt car traffic forecasted to be diverted to the Fixed Fehmarn Belt Link ended at a level of 8 pct. To put this figure in perspective, former studies had shown 1 - 2 pct. of the Storebælt traffic to be border crossing D/DK. Furthermore the forecasts in 1999 and 2002 did not incorporate any diversion of cars at all because the potential was insignificant. In 2014 however, one out of each twelve cars passing Storebælt was claimed to be diverted to Fehmarn Belt.

In the following paragraphs these misperceptions are explained in more detail.

Misperception no 1

"Foreigners use the GBFL mainly on North-South traffic"

There is of course no relation at all between the nationality of a car crossing Storebælt and the origin and destination for the trip of that car. So, it is complete nonsense to claim that foreign cars passing Storebælt are mainly North-South bound. There is no documentation whatsoever for such a claim.

A foreign car crossing Storebælt can have all sorts of destinations / origins that would not include the Fehmarn Belt Fixed Link as a future potential route choice. Some examples:

- A Swedish family visiting the Legoland amusement park in Jutland
- A Dutch salesman visiting several Danish customers on both sides of Storebælt
- A German tourist staying in a summer cottage in West Denmark making a round trip visit to Copenhagen
- A Polish guest worker visiting customers or colleagues in Denmark
- A German citizen living in South Schleswig (the German region just south of the green border D/DK) with an errand in East Denmark. Fehmarn Belt will never be the first choice for such a traveller despite German licence plates on the car
- A Danish expatriate living in South France but at the time of



the licence plate survey, visiting friends, family or business contacts in Denmark.

It is astonishing that such a clear-cut blunder can be made by the client in the first place, and in the second place, was not rejected by the German consultants. Nobody, even with the faintest idea of how traffic surveys are carried out, would make such a grave misperception.

Misperception no 2

After having estimated foreign cars passing Storebælt at an average of 4 pct. and erroneously presuming these cars to be future customers of Fehmarn Belt, misperception 1 has led to misperception 2: Each foreign car passing Storebælt is anticipated to have a Danish "counterpart" driving in the opposite direction. Such "opposite" Danish trips makes no sense either. The mirror image of a Danish business man visiting various customers in The Netherlands would not cross the Storebælt Bridge while travelling internally in The Netherlands. Likewise, a Danish technician doing service on technical installations in South Germany would not use the Storebælt Bridge while serving his clients in South Germany.

Everybody understands that a commuter trip from a suburb to a business centre does not necessarily have a "mirror commuter trip" from the business centre to the suburb. But this simple fact is apparently not understood by Femern A/S.

It is alarming that about 25 pct. of the forecasted car traffic demand on the Fixed Fehmarn Belt Link is based on sheer incompetence and the figure is dramatically overestimated compared to earlier analyses based on best practice methods.

5.5 Lorry Transport

Unlike the car market, the forecasts for lorry traffic in the Fehmarn Belt traffic corridor seem to be far more realistic or even conservative of nature. During recent years, realised traffic demand seems to have exceeded forecasts.



Figure 11

Ref [9], Figure 9-3 page 193. Forecast for lorries crossing the Fehmarn Belt. The following changes to the original illustration have been made: Case A has been removed, figures for certain years have been removed; observed traffic for year 2013 has been updated and observed traffic for years 2014 – 2016 have been added.

On the face of it, this development in observed traffic seems reassuring for the fixed link to have revenues from lorries at least as forecasted. However, this development is on the other hand perhaps even better news for a potential continued ferry service because its core customers are expected to be lorries, border shoppers and travellers who dislike long distance tunnel driving or simply travellers who fear tunnels.

As earlier described, in its present version, the traffic model is not able to evaluate the distribution of traffic between the tunnel and a parallel ferry service. That applies to all kinds of vehicles, but this weakness is indeed most significant in the case of lorries.

Since the model was estimated in the late 90's, marked changes have taken place in the road haulage market. Today there is hardly any business sector as cost sensitive as road

haulage. The profit in this sector is made by small margins. One sign of this strong focus on controlling costs can be seen from the fact that big haulage companies are flagging out from their home countries and/or are hiring lorry drivers from countries with low wages. The traffic model does not take this increased cost sensitiveness into account.

With its state guaranteed loans, Femern A/S will always be able to outcompete any parallel ferry line by lowering fares beneath the pain threshold of such a ferry line and thereby closing it. But that would probably be a violation of EU regulations. If Femern A/S have to stick to fares which would provide revenues of a magnitude as stated in the background papers for the decision of the investment – then there will be a clear competitive choice between low cost / high sailing time and high cost / fast driving time.

In this respect, high cost sensitiveness will be an important parameter in hauliers' decision making. However, the current version of the traffic model is not based on detailed analyses on competitive trade-offs and has, accordingly, not given trustworthy outputs.

Another important change since the time of setting up the model is the focus on mandatory rest hours for lorry drivers. Back in the 90's there was only a very inefficient technology available to check whether or not a driver had taken his rest periods as demanded. It was easy to remove the cardboard disc showing recent driving hours and replace the disc with a new, empty one. This situation has dramatically changed since then but with no corresponding changes in the parameters that controls the trade-off calculations in the model.

In a future scenario with parallel ferry services, the sailing time is not necessarily just a waste of time as is the premise for the model forecasts. For each 4½ hours of driving, the lorry driver will have to rest for 45 minutes which is exactly the sailing time. Depending on the precise logistics for each lorry trip, the negative effect of the sailing time can vary between 0 and 45 minutes. This effect will naturally be incorporated in hauliers' evaluation of trade-offs between the two different modes of transport. However as mentioned above, this is not reflected in the traffic model.

The risk that parallel ferry service might undermine the business economics of the fixed link was presented early in the process as part of the conclusions in the *Enquiry of commercial interest in 2002* (Ref. [5] and [6]). The risk presented by potential financial investors has been ignored by Danish politicians throughout their handling of the project. But the risk has proven real by statements from haulage market leaders using the Fehmarn Belt transport corridor.

On 10th June 2014, the Danish business newspaper Børsen interviewed two of the largest Danish hauliers, DSV and HCS, concerning their interest in using the fixed link. The answers had clear messages:

Ole Bolm, CEO, HCS: "International road transport is extremely price sensitive and it will always choose the cheapest solution - even if it may take a little longer".

Simon H. Galsgaard, CEO, DSV Road A/S

"When crossing Øresund, we frequently use the ferries, although it may sometimes be faster via the bridge. If the tunnel becomes significantly more expensive than the ferries, then the ferry service is definitely a future for us. "



Figure 12 Headline in the business newspaper Børsen: Price war tempting lorries away from expensive tunnel fares

Such worrisome market reactions seem to have had no reactions at all, neither from Femern A/S nor from the political backers in Parliament. This message from important market players did even not lead to a raised eyebrow at COWI, when the company undertook the quality assurance of the traffic forecasts.

5.6 No Handling of Risks and Uncertainties

It comes as a surprise that a project worth DKK 62,1 bn (equivalent to \in 8,3 bn) has been approved by the Danish Parliament without evaluations of risks and uncertainties in traffic forecasts - and thereby revenues from users.

However, partial sensitivity analyses of certain figures and parameters have been carried out. But such analyses cannot give a realistic picture because only one parameter has been varied at a time. In the real world all parameters can and will vary simultaneously, some dependently – some independently.

One of the largest risks for the business economics for Femern A/S will become reality if the existing ferry line continues to operate after the opening of the tunnel. This possibility has not been handled as a risk but has simply been rejected based on a deterministic working model outside its limits of validity.

The law of construction was passed in May 2015; nevertheless, the Danish Ministry of Transport waited for about half a year before in total secrecy, hiring the consultancy KPMG to make a business review of future ferry economics under parallel services. To request such a report in secrecy can only be interpreted as an attempt to keep a potential negative result - for the Ministry - secret, because a documentation that a ferry line would be able to exist parallel to the tunnel would have made the Ministry look incompetent or even guilty in misleading the Parliament. However, a leak revealed that a secret report from KMPG, dated 14th January 2016 existed, but this version has never been published.

This disclosure forced the Ministry to publish a revised version by 14th March 2016. Two months elapsed from the disclosure of the existence of a secret report until the publication of a new version. This is a very long time given the embarrassing situation for the Ministry attempting to keep important information from Members of Parliament. The first version must have contained conclusions that would have caused severe problems for the Ministry.

Chapter 6 reveals how The Ministry, in another case, handles consultants to ensure desired outcomes in accordance with predetermined political expectations.

6. Quality Assurance by a Disqualified Consultant

A Message from the Transport Minister

Just before the quality assurance of the traffic forecasts were made public, former Minister of Transport, Hans Chr. Schmidt wrote a letter to the political parties behind the original 2008-agreement on establishing the Fehmarn Belt Fixed Link:

Dear parties behind the agreement,

The Ministry of Transport and Building has conducted an independent quality assurance of traffic forecast for the Fehmarn Belt Fixed Link.

The quality assurance, prepared by COWI, shows, among other things, that:

- The traffic forecast provides a realistic estimate for the expected road traffic on the Fehmarn Belt Fixed Link.
- There is nothing to suggest that the forecast systematically overestimates the total traffic volume.



- The assumptions for the forecast are reasonable, and the forecast models are in line with professional standards for traffic forecasting.
- The traffic forecast is cautious in assessing induced travel because of lack of tools to forecast dynamic effects of the Fixed Link.

COWI finds difficulties in documenting international traffic on the Great Belt Bridge and thereby estimation of diverted traffic to the Fehmarn Belt. However, this does not change the above conclusions by COWI.

I enclose for your information the Quality Assurance Report prepared by COWI.

Yours sincerely

Hans Chr. Schmidt

There are several interesting messages from the Minister to the majority of members of the Parliament. The minister starts off making it clear that this is an independently conducted quality assurance. However, the Minister knew very well that COWI – as part of a joint venture - at the time had been prequalified to make bids for the construction work. It was beyond discussion, and the Minister was of course fully aware that worldwide no company could be more disqualified for the job than precisely COWI.

The next very interesting message is that the Minister in his letter finds it necessary to emphasize to his colleagues in Parliament that they should focus on the blank Quality Assurance given by COWI and not that COWI had waved a red flag because one quarter of all passenger car traffic in the tunnel was not in any way accounted for in the forecasts. The discrepancy between the given blank quality assurance and the red flag shows more than anything what was at stake between the Ministry and COWI and the massive pressure put on COWI.

The Settings for the Quality Assurance

The traffic forecasts published in 2014 were written in English. The geographical market for hiring consultants to perform a quality assurance of the Fehmarn Belt forecasts was accordingly almost worldwide. Nevertheless, the Ministry of Transport limited its search for a consultant to the Danish market of consultancies. The Ministry concluded that only two Danish companies were qualified to do the job: One however was disqualified because of another forecast job for Femern A/S. Back in the basket was not surprisingly the Danish company COWI. This company was at the time prequalified to several of the construction jobs – se ref. [12]. COWI was accordingly with no doubt disqualified for the task. In a



letter of 15th March 2016 (J. nr. 2016-40) to the newspaper Weekendavisen (see ref. [14]), the Danish Ministry explained the choice of COWI in the following most peculiar way:

Text in Danish:

"Valget af COWI til at gennemføre den eksterne kvalitetssikring af trafikprognosen var alene fagligt baseret. Således var vurderingen, at kun to rådgivere i Danmark ville have den nødvendige kompetence til at gennemføre en ekstern kvalitetssikring af trafikprognosen. Alternativet var imidlertid engageret af Femern A/S til at levere et bidrag til trafikprognosen og var dermed inhabil.

Transport- og Bygningsministeriet valgte COWI til at gennemføre den eksterne kvalitetssikring af trafikprognosen i maj 2015. På det tidspunkt var det kun navnene på de virksomheder, der indgik i de af Femern A/S prækvalificerede entreprenørkonsortier på de fire store anlægsentrepriser, der var kendt. Femern A/S offentliggjorde navnene på de prækvalificerede entreprenørkonsortier den 27. maj 2013.

Translation:

"The choice of COWI to perform the external quality assurance of traffic forecast was based only on a judgement of professional skills. Based on that condition the assessment was that only two consultancies in Denmark would have the necessary skills to perform an external quality assurance of the traffic forecast. However, the other possible consultant had been hired by Fehmarn A/S to deliver a contribution to the traffic forecast and was thus disqualified.

The Ministry of Transport and Building chose COWI to perform the external quality assurance of the traffic forecast in May 2015. At that time, only the names of the companies that were prequalified by Femern A/S to each of the four big construction contracts were known. Femern A/S published the names of the prequalified construction consortia on May 27, 2013.

The statements from the Ministry can be commented as follows:

- No explanation is given as to why the consultant had to be a Danish company while the forecast itself had been made by two foreign companies. Logically, this makes no sense.
- Even if there were reasons to limit the field to Danish consultancies, it is surprising
 that only two were believed to have the needed qualifications. Had the Ministry
 followed the principles of public tendering and specified the qualifications, then a
 much larger group of potential consultancies Danish and Internationals as well would have had a chance to show their capabilities. By identifying only two potential consultancies, of which one in advance was known by the Ministry to be disqualified, leaves the impression that the Ministry had designed a process to ensure
 that precisely COWI got the job simply because the prequalification to the much
 larger construction jobs would make it impossible for COWI to deliver nothing but
 green lights for the quality of the traffic forecasts.
- COWI was as part of a consortium prequalified for major parts of the construction jobs as early as 27th May 2013. Femern A/S decided by 4th March 2016 which construction consortiums should be assigned to which technical construction jobs.
 COWI ended up winning three out of four construction tasks. COWI was accordingly and indisputably disqualified during the period from May 2013 until March 2016 concerning evaluation of the fundamental reasons to build the tunnel: traffic demand.

The message: "At that time, only the names of the companies that were prequalified by Femern A/S to each of the four big construction contracts were known" is formulated as if this clears the responsibility of assigning the quality assessment to COWI. But this makes no sense. The one and only piece of information needed to disqualify COWI was precisely that the names of the prequalified companies had been known since 27th May 2013.

Quality Assurance – Conclusions by COWI

The Ministry of Transport achieved the desired conclusion because COWI had no other choice but to deliver a blank quality assurance given the fact that COWI had been prequalified to huge construction tasks.

Danish version first:

Sammenfatning	Den sammenfattende konklusion er, at COWI vurderer, at trafikprognoserne er et realistisk bud på, hvor meget vejtrafik, der kan forventes på en fast Femern Bælt- forbindelse. Der er intet, som tyder på, at prognoserne systematisk overvurderer det totale trafikomfang. Der er usikkerheder i prognoserne, blandt andet fordi ud- gangspunktet med trafik i 2011 er baseret på et svært dokumenterbart datagrund- lag for specielt den nuværende trafik over Storebælt. Endelig er der elementer i prognosen, som forekommer undervurderet, primært i relation til dynamsike effek- ter og nygenereret trafik. Usikkerheden kan reduceres ved bedre dokumentation af data og eventuelt med supplerende trafikanalyser på Storebælt. Det vil dog kræve væsentlig kalendertid og væsentlige resourcer at gennemføre.
Translated:	
Conclusion	The overall conclusion is that COWI has assessed the traffic forecasts to be a realistic assessment of how much road traffic can be expected on a fixed Fehmarn Belt fixed link. There is nothing that indicates that the forecasts systematically overestimate total volume of traffic. There are uncertainties in the forecasts, partly because of data concerning the reference year 2011 are difficult to document especially concerning traffic crossing the Great Belt. Finally, there are elements in the forecast which appear to be underestimated, primarily in relation to dynamic effects and newly gener- ated traffic. Uncertainty can be reduced by better documentation of data and possibly with additional traffic surveys on the Great Belt. It will, how- ever, require significant calendar time and substantial resources to imple- ment.

This is a blank approval of the traffic forecasts.

The issue of the huge diversion of traffic from Storebælt to Fehmarn Belt is in the text presented as an 'uncertainty' and uncertainties can, if not described in further depth, work either way. Consequently, COWI has presented a rather neutral statement in that respect.

Professionals can always desire more accurate data, but the key question that should have been addressed by COWI was whether the amount of transferred traffic was a central best estimate – albeit with uncertainties - or whether it was a highly biased estimate. It must have been crystal clear to an otherwise professional company as COWI that the massive diversion of traffic was based on, at best, embarrassing misperceptions.

Moreover, the potentially highly dangerous uncertainty in forecasting traffic for the fixed link is the risk of continued ferry services. This risk has not been mentioned at all in the summary of conclusions. The report from COWI has two and a half pages in chapter five titled, "Calculations on Sensitiveness with continued ferry services".

This chapter reveals that the German consultants presented their forecasts at a meeting with COWI in Copenhagen 21st August 2015. COWI was appointed to do the job in May 2015. Presumably, this meeting was focussed on the issue of continued ferry services – otherwise, why not make this statement in the beginning of the report and not first in chapter five?

The final report from COWI ref. [15], was submitted by 12th November 2015. In a standard case of a genuine independent quality assurance, such a meeting should only – if at all - take place late in the process in order not to influence the quality assurer in an early phase. A meeting may take place late in the process to give the forecaster a chance to defend himself. By organising such an early meeting - presumably primarily concerning continued ferry services – the Ministry ensured that the quality assurer was not only presented to the forecast as such, but also, more importantly, coached in due time on the big issue of continued ferry services. This strategy seemed to have worked well. COWI did not question the ability of the model as such to run forecasts for parallel services or whether the model was able to forecast traffic under fierce competition between a private ferry line and a publicly run fixed link. Neither did COWI question whether a 24-hour service with constant departure frequencies day and night would be the most probable way to compete with the fixed link.

Many other critical assumptions ought to have been dealt with by the quality assurer. In chapter 1.1 COWI made a description of how the company viewed its methodical approach:

"COWI har gennemført en kvalitetssikring af trafikprognoserne I overensstemmelse med tænkningen i eksterne kvalitetssikring af anlægsprojekter"

"COWI has conducted a quality assurance of the traffic forecasts in accordance with the thinking behind external quality assurance of construction projects"

This interpretation of the task is peculiar. To make a quality assurance of a traffic forecast has very little to do with the quality of technical processes in relation to construction jobs.

Quality Assurance – A Ministerial Procedural Blunder

On the very same day, 12th November 2015, when the Ministry of Transport received an unconditional quality approval by COWI, the Ministry secretly asked Sund & Bælt Holding A/S (the state-owned parent company of Femern A/S) to analyse the magnitude of international traffic crossing Storebælt in order to further document the undocumented diversion of traffic from Storebælt to Fehmarn.

This request to dig further into the quality assurance is totally out of line with the focused ministerial strategy to appoint COWI to carry out the quality assurance job to ensure the desired and expected approval.

It is very unusual by Danish standards that such a request would be sent on the very day of receipt of the COWI report. In ref. [16] Hans Schjær-Jacobsen has given a comprehensive description of how this request - now in its third year - is being sent around in closed circles in order - presumably – to postpone the result until the construction work has been initiated and the point of no return has been passed.

In ref. [16] there is a reference to e-mails showing that Sund & Bælt A/S had got the impression from the Ministry that "..der er ikke et overvældende tidspres på" ("there is no overwhelming time pressure"). The discrepancy between the initial hasty request to Sund & Bælt Holding A/S and the current deliberate delaying of the process supports the theory that the initial request was made by mistake by a person in the Ministry not totally aware of the strategy of having COWI do the quality assurance.

Today, more than two years later, the task to document the huge transfer of traffic from Storebælt to Femern has still not been carried out and there is clearly no incentive for the Ministry or its subsidiaries to close the case before the final environmental approval from Germany, and consequently, the implementation of construction. At that time, the result will be completely unimportant.

It was important for the Ministry and Femern A/S to have the quality assurance of the traffic forecasts in place as the first of several subsequent quality assurances of other matters. These quality assurances would thereby be safeguarded against discussions of uncertainties about traffic forecasts and revenues from users.

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