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PREFACE

A fixed link across Fehmarnbelt for road and railway is recognised as an integrated part of the development of the trans-European transport networks. It would connect Puttgarden on the island of Fehmarn in Northern Germany with Rødby on the island of Lolland in Denmark. The construction of the Fehmarnbelt fixed link would, in conjunction with the Øresund fixed link between Denmark and Sweden, gone into operation in July 2000, provide a substantial improvement of one of the most important landbased corridors connecting the Nordic Countries with Central Europe. It is also aimed at creating an integrated economic region between the Øresund and the river Elbe.

The Danish Ministry of Transport and the German Ministry of Transport, Building and Housing agreed that the coast-to-coast section would be regarded as an investment project with a leading role of the private sector. Financial risk taken by them could be highly beneficial to the project realisation. Thus, it is understood that the design, financing, construction and operation of a fixed link across Fehmarnbelt is targeted to be performed under BOT conditions.

Before selecting a concessionaire both ministries decided to investigate the willingness and ability of the private sector to design, build, finance and operate a fixed link across Fehmarnbelt – with the condition of a later transfer of the construction to the states. This process of investigation having been developed in co-operation between officials from the two ministries is named as an **Enquiry of Commercial Interest (ECI)**. The outcome of the ECI, summarised in a report to be prepared for the ministries until spring 2002, will constitute a basis to decide whether and how the fixed link shall be realised.

A joint Danish-German Project Organisation responsible for undertaking the ECI has been established in early 2001 according to the Memorandum signed by the Danish Ministers for Transport and the German Federal Minister for Transport, Building and Housing on December 6, 2000. This **organisation** consists of:

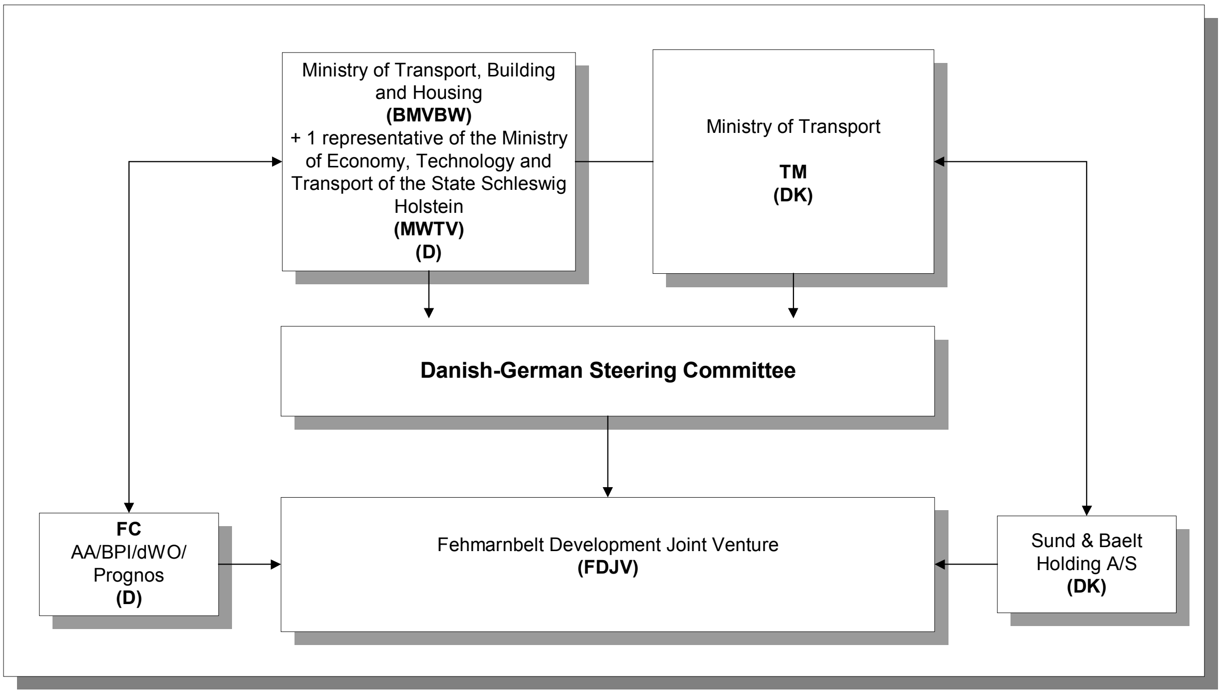
a) the **Fehmarnbelt Development Joint Venture (FDJV)** composed by a Danish and German partner:

- The Danish Ministry of Transport has appointed **Sund & Bælt Holding A/S** as the partner from the Danish side. The Ministry attained parliamentary approval to engage Sund & Bælt Holding A/S directly on its behalf,

- The partner from the German side has been selected after an EU-wide tender procedure in February 2001. The "Fehmarnbelt Consulting" consortium (FC) led by **Arthur Andersen Real Estate** (AA), Berlin, and consisting of **BPI-Consult** (BPI), Berlin, **de Witt Oppler Rechtsanwälte** (dWO), Berlin and **Prognos**, Basel, has been chosen as preferred consultant,

b) a **Steering Committee (SC)** consisting of five persons: two members of the German Ministry of Transport, Building and Housing joined by a representative of the State Schleswig Holstein and two members of the Danish Ministry of Transport. The Steering Committee convenes at regular meetings held in Berlin and Copenhagen alternately.

Figure 1: Project Organisation



The **main elements** of the working programme in the ECI are summarised below:

- Announcement of the ECI in the Official Journal of the EC (May 19, 2001)
- Publication of a project description (Leaflet)
- Selection of the participants in the enquiry

- Preparation and issuing of an Information Memorandum and a Questionnaire to participants
- Dialogue with participants during the enquiry process
- Evaluation of written replies to the Questionnaire
- Reporting of the results to the governments
- Recommendations to the governments

The FDJV has been assigned to carry out the working programme described above and acts in this respect on behalf of the Steering Committee. Delegation of powers and mandates will be agreed upon by the Steering Committee.

The SC will act on behalf of both ministries and is the responsible authority for the ECI. The tasks of the SC include approvals of the reports, the results and all organisational matters of the ECI. It shall also facilitate the dialogue with public authorities as far as contributions from them are needed.

A working period of approximately 15 months is previewed. The activities were initiated in March 2001 with the objective that the working programme is finalised not later than mid 2002.

The **Information Memorandum** presented herewith constitutes the main document addressed to the selected participants of the ECI process. Its purpose is:

- To present the project as it stands by now,
- To introduce and explain the process of the ECI,
- To summarise and highlight the main results of existing feasibility studies available to the participants,
- To raise relevant aspects affecting the realisation of a private financed infrastructure project,

The Information Memorandum is structured in the following way:

- **Part A** presents the project and introduces the ECI
- **Part B**, divided in 10 chapters, describes out the relevant aspects related to the project
- **Appendix**

PART A

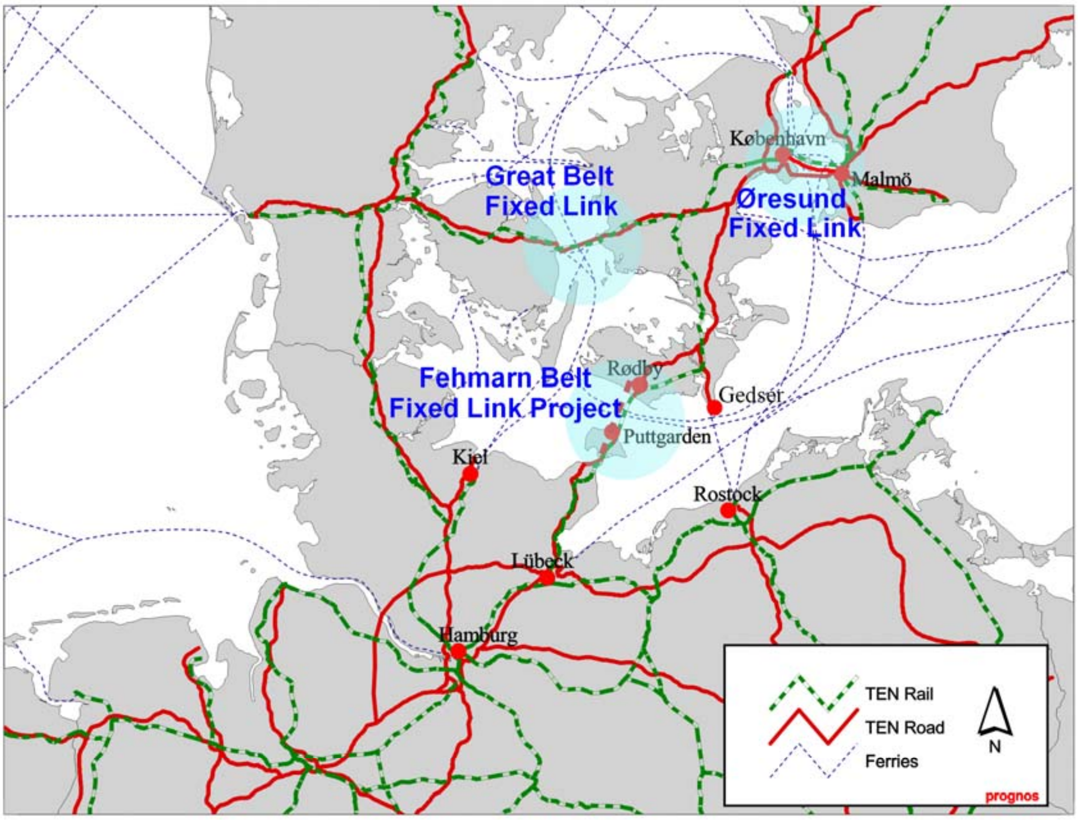
1 FEHMARNBELT LINK

1.1 Background information on the Fehmarnbelt fixed link project

1.1.1 Overview

The Fehmarnbelt crossing between Puttgarden on Fehmarn Island (Germany) and Rødby (Denmark) is part of the trans-European transport networks (TEN) for road and rail on the Hamburg-Copenhagen link. Present traffic on the 20 km coast-to-coast section is serviced by ferries accommodating both trains and road vehicles. Since the opening of the Great Belt fixed link in 1998, all freight trains and passenger night trains between Germany and Denmark and further on to Sweden are channelled via the longer routing across the Great Belt. Only the EuroCity passenger trains between Hamburg and Copenhagen are using the shorter way via Fehmarnbelt.

Figure 2: Fehmarnbelt area



Source: European Commission, June 2001

The idea of a Fehmarnbelt fixed link is not new. One of the first investigations was carried out by the Danish Railway in September 1940 where a bridge constructed on the experience from the bridge over the Little Belt was investigated and calculated to cost DKK670m only for the coast-to-coast part. The project was noted in the Swedish-Danish agreement of 1991 on Øresund fixed link.

In a Memorandum, signed by the two Ministers for Transport on December 6, 2000, the governments agreed that the implementation of a coast-to-coast fixed link could be accelerated if it was in the form of a private sector BOT investment project. At the same time, both governments confirmed that road and rail access routes to the fixed link on both sides would be improved to the required standard with state budget financing. It has been furthermore convened that only a solution for road and rail traffic as well will be pursued.

1.1.2 Technical solutions

The feasibility studies have covered a wide range of functional and technical solutions of bored and immersed tunnels as well as cable-stayed and suspension bridges. These were to accommodate either

- a three-lane roadway together with a single-track railway or
- a four-lane motorway together with a double-track railway

Tunnel solutions with rail only infrastructure including shuttle transfers of road vehicles similar to the Eurotunnel project have also been investigated but are, because of their disadvantages and costs, not considered any further. They are named, if mentioned in the Information Memorandum, **0+2 solution**. Finally, six functional and technical solutions were retained to be considered in the future (**table 1)**.

For the purpose of the present Information Memorandum, we have chosen from each of the two functional alternatives the technical solution with the best financial result (internal rate of return).[1] They are named **business cases** expressing that they are, among the six solution models, those with likely best commercial performance. The two **business cases** are:

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1 See [4]

- **Solution 3**: the **cable stayed bridge** (4+2)
- **Solution 5.1**: the **immersed tunnel** (3+1) which is in fact designed to accommodate 2 traffic lanes and one lane for maintenance and rescue purposes

This selection is by no means meant to reduce the number of solutions but to simplify the presentation in this Information Memorandum and the ECI process. Participants in the ECI process should feel free to comment on other solutions and not to limit their suggestions to these two business cases.

Table 1: Solution models for the Fehmarnbelt

Functional configuration for combined road and railway traffic	Solution Models (outline design)	
	Code	**Technical description**
4 road lanes and 2 railway tracks (4+2 solutions)	3	Cable stayed bridge with 2-level deck
	3.1	Suspension bridge with a 2-level deck
	4	Bored tunnel with 4 separate tubes
	5	Immersed tunnel with separate tubes for each traffic direction in combined tunnel element
3 road lanes (2 lane capacity) and 1 railway track (3+1 solutions)	4.1	Bored tunnel with a separate tube for rail and road respectively
	5.1	Immersed tunnel with separate tube for rail and road in combined tunnel element

A synopsis of the six solution models is attached in the **Appendix**.

The **codes** for the solution models were defined during the investigations before the ECI has been started. They will be kept to better identify the individual solutions when the participants will consult the existing studies.[2]

2 The codes 1 and 2 were used for two alternatives (0+2 tunnel solutions) which were not retained for further consideration.

1.2 Existing studies

During the past decade, the governments of Denmark and Germany have jointly commissioned a series of studies with the objective to establish the environmental, socio-economic and financial viability of a Fehmarnbelt fixed link, whether by a tunnel system or by a bridge. The most important four studies are:

[1] COWI-Lahmeyer Joint Venture: **Fehmarnbelt Feasibility Study Coast-to-Coast Investigations: Investigation of Technical Solutions**; Summary Report; January 1999

COWI-Lahmeyer Joint Venture: **Fehmarnbelt Feasibility Study Coast-to-Coast Investigations: Investigation of Technical Solutions**; Phase 2 Report, Volume 1-5; January 1999

[2] COWI-Lahmeyer Joint Venture: **Fehmarnbelt Feasibility Study Coast-to-Coast Investigations: Investigation of Environmental Impact**; Summary Report; January 1999

COWI-Lahmeyer Joint Venture: **Fehmarnbelt Feasibility Study Coast-to-Coast Investigations: Investigation of Environmental Impact**; Phase 2 Report; January 1999

[3] Fehmarnbelt Traffic Consortium: **Fehmarnbelt Traffic Demand Study**; Final Report; January 1999

[4] PLANCO Consulting; COWI Consulting Engineers and Planners: **Economic and Financial Evaluation of a Fixed Link Across the Fehmarnbelt**; Final Report, June 1999

The following studies are also available in form of a hard copy on request[3]:

[5] Kocks Consult; Institute of Shipping Economics and Logistics (ISL); Carl Bro: **Investigation of Socio-economic and Regional Consequences of a Fixed Link Across the Fehmarnbelt**; Final Report; June 1999

[6] PLANCO Consulting: **Economic Evaluation of an Improved Ferry System Across the Fehmarnbelt**; Final Report; May 2000

[7] IVB Ingenieurgesellschaft für Verkehrs- und Bau Management mbH; Price Waterhouse Coopers Veltins: **Report on the Investigation for the Definition of a Method for the Evaluation of the Possibilities of Private Realisation of the Planned Fixed Link across the Fehmarn Belt;** October 2000

3 The request has to be directed to Sund&Bælt, Vester Søgade 10, DK-1601 Copenhagen V.

[8] Fehmarn Link Consultants: **Geological/Geotechnical Investigations**, Phase 2 Report, Volume 1-2; September 1996

1.3 Traffic patterns of the recent past

In **table 2**, traffic statistics are compiled for the main ferry and fixed crossings for the years 1990 and 1995 through 2000. These figures are provided because of the various shifts in traffic demand between routes in the aftermath of the opening of the Great Belt and Øresund fixed links. It is to note that ferry lines between Sweden and Germany are not included due to the non-availability of traffic statistics.

Table 2: Road Traffic Patterns on Main Crossings 1990 and 1995 - 2000

Route	1990	1995	1996	1997	1998	1999	2000
							Thousand Vehicles
Puttgarden - Rødby ferry, Scandlines A/S							
Cars	1173,7	917,6	924,2	932,9	915,5	991,6	1160,0
Buses	36,8	35,5	35,0	35,3	33,9	31,2	30,6
HGVs	172,1	237,2	233,3	255,0	264,4	259,2	280,2
Rostock - Gedser ferry, Europalinien, Scandlines A/S [1]							
Cars	113,9	104,0	122,2	165,2	164,2	160,1	153,1
Buses	5,9	6,6	9,1	15,5	15,1	14,6	12,6
HGVs	40,1	24,6	20,6	35,8	33,7	33,6	42,2
Rostock - Gedser ferry, Easyline A/S							
Cars					24,2	63,7	41,0
Buses					1,6	3,7	3,1
HGVs					3,6	13,9	13,0
Gedser - Warnemünde, DSB [2]							
Cars	79,9	38,8					
Buses	2,7	2,2					
HGVs	15,5	3,7					
Helsingör - Helsingborg ferry, DSB/Scandlines A/S							
Cars	692,0	1459,9	1413,8	1479,5	1660,4	1774,5	1611,7
Buses	27,6	48,4	42,9	41,7	38,5	40,9	40,6
HGVs	129,2	282,0	279,2	304,6	323,4	349,2	345,6
Helsingör -Helsingborg ferry, HH-Ferries							
Cars			230,2	358,3	493,6	571,1	574,7
Buses			1,5	3,1	7,2	8,0	7,2
HGVs			12,5	24,1	69,3	96,1	114,1
Helsingör -Helsingborg ferry, Scandinavian Ferry Lines [3]							
Cars	806,6						
Buses	22,6						
HGVs	114,4						
Copenhagen - Malmö ferry, Dragør-Limhamn, Scandinavian Ferry Lines [4]							
Cars	338,0	260,3	249,8	262,7	302,8	276,3	
Buses	27,1	21,3	22,0	17,3	15,4	11,2	
HGVs	45,6	39,2	37,0	29,5	29,3	23,1	
Øresund fixed link [5]							
Cars							1569,0
Buses							22,7
HGVs							63,9
Great Belt fixed link [6]							
Cars					3325,7	6101,1	6602,6
Buses					21,6	38,2	38,4
HGVs					352,9	757,7	884,8

1) The Line was Gedser Travemünde until 5 January 1991
2) The Line stopped by September 1995
3) Sold November 1991 to Scandlines
4) The Line stopped by 1. November 1999
5) The Fixed Link opened 1. July 2000
6) The Fixed Link opened June 1998

Sources: Danmarks Statistik, Sund & Bælt and Øresundsbro Konsortiet

2 ENQUIRY OF COMMERCIAL INTEREST (ECI)

On the basis of the studies mentioned in part A section 1.2, the governments have decided to continue to explore ways of realising the fixed link as a BOT (build-operate-transfer) project. With this purpose the governments have agreed to employ a method called **Enquiry of Commercial Interest** (ECI) to investigate the willingness and ability of the private sector to design, build, finance, operate and transfer the fixed link across Fehmarnbelt as a private project.

The ECI is open to individual companies or consortia (including investors, project developers, contractors, consulting engineers operators and financiers). It is a form of market study involving elements of a competition of ideas. Hence, the procedure is no equivalent of the German "Interessenbekundungsverfahren" within the meaning of Sec. 7 Federal Budgetary Regulations (*Bundeshaushaltsordnung – BHO*) as funding from the state budget is not planned. The procedure is designed to obtain reliable information on the feasibility of the project, the design of the general setting and hence of the foundations of a formal contract award procedure to follow later. As this will not be a contract award procedure entailing the placing of an order, the provisions of the EC's public procurement law are not applicable either.

The core elements of the ECI are a **Questionnaire** addressed to and a two-step phased **Interview Session** with selected participants. It is intended to raise all aspects which are related to the realisation of a fixed link across Fehmarnbelt and which could affect the design, finance, construction and operation under BOT conditions. All individual answers will be dealt with in confidentiality. As the word Enquiry of Commercial Interest suggests, opinions, comments, questions and propositions regarding the planned project will be gathered among the participants and subsequently assessed and evaluated.

Experiences from other projects and best practices are welcome. Feedback from participants will be used to prepare tender documents reflecting as much as possible the interests of the private sector.

In return, the companies potentially interested in the fixed link across Fehmarnbelt will obtain much relevant information about the project. By the accomplishment of the ECI in mid 2002 they will be in the position to have a comprehensive view on the project enabling to decide whether they will submit a proposal in the case the project will be tendered (time schedule of the ECI in **table 3**).

This **Information Memorandum** is the main part of the information about the fixed link across Fehmarnbelt. Participants in the ECI process will be provided with an unified update of the main findings about the project as it stands by now. It shall be used as the basis for all further discussions and simultaneously serve as an incentive for the participants. Moreover, the requirements and standards identified in the project specifications and in the Questionnaire will enable the transparency, usability and comparability of the responses made and concepts submitted by the participants. Hence, great importance attaches to the processing of the information received.

Table 3: Time Schedule of ECI

Date	Milestone
May 19, 2001	Announcement of the ECI in the Supplement of the Official Journal of the European Communities
June 22, 2001	Deadline for receiving requests for participation in the ECI
July 10, 2001	Issuing of the **Questionnaire** and the **Information Memorandum** describing technical, business and legal aspects.
Aug 14, 2001	Answering check-backs / colloquium in Lübeck
Until Sep 22, 2001	FDJV is available for questions
Oct 1, 2001	Deadline for sending back the Questionnaires. Acceptance, sifting and preliminary review of the Questionnaires; analysis of received answers
Oct 15, 2001 – Dec 18, 2001	**Interview Phase I** This phase will serve the discussion of specific subject areas.
Jan 7, 2002	**Selection of participants in Interview Phase II** The results of the selection of participants in Interview Phase II will be communicated by Jan 7, 2002
Jan 7, 2002 – Feb 15, 2002	Interviews with the selected participants in **Interview Phase II** will be arranged in order to make more in-depth studies or detailing of particular areas of interest. This phase will primarily serve the verification of findings made in preparation for the final report
April 2002	The **final report** and the subsequent concluding presentation serve as a recommendation for decision-making for the German Federal Ministry of Transport, Building and Housing and the Danish Ministry of Transport and contain a summary of the results from the ECI, besides giving a

	recommendation for a further course of action

Joint participation of companies

Where companies apply jointly for participation in the ECI, they shall name in writing to the FDJV all members of the consortium as well as one authorised representative acting on behalf of all of its members. Changes in the composition of a consortium are permissible just as a first-time combination of participants while the ECI is in progress. In these cases the FDJV shall be promptly advised in writing.

Industrial property rights

If a participant intends to make use for the registration of an industrial property right of data contained in documents submitted in the context of the ECI, he shall so indicate in writing.

Costs

No compensation will be paid for participation in the ECI. The documents will not be returned.

The participants in the ECI will be provided with documents free of charge. The documents are:

- Leaflet
- Questionnaire
- Information Memorandum
- CD-Rom with studies [1] to [4]

Further studies as listed in part A section 1.2 (studies [5] to [8]) may also be obtained. They are available in a form of a hard copy and only on request.

Rights and obligations

The ECI shall not generate any legal rights and/or obligations between the two governments and the participants in the ECI.

PART B

1 AUTHORITIES' APPROVALS

A large infrastructure project like the fixed link across Fehmarnbelt will require a comprehensive co-operation with German and Danish authorities on local, regional and national levels. Furthermore, a number of issues related to international conventions and regulations will be raised requiring co-operation with international organisations and neighbouring countries. In the following an **overview** of the **most important existing legislation** and subsequent authorities' approvals relevant for the Fehmarnbelt project are given.

1.1 Relevant international conventions and regulations

The fixed link crosses international waters according to international law. According to the regulations of the **International Maritime Organisation** (IMO) under the UN, impacts on the ship traffic passing Fehmarnbelt must be investigated and the international community should be notified about the consequences including possible changes of the shipping route through Fehmarnbelt. This notification of the international society should be the responsibility of the Governments of Germany and Denmark. Other international regulations with regard to environmental issues are dealt with in section B2.

1.2 Danish Authorities' approvals

1.2.1 Approvals according to Danish legislation and tradition

In Denmark it is a tradition that all railway and motorway projects are approved by the Danish Parliament through an Act of Law. In case of a Fehmarnbelt fixed link the Act of Law is expected to outline a number of obligations and requirements to be fulfilled by the parties involved, including the Concessionaire and Danish authorities.

The obligations and requirements will probably concern the following:

- That the alignment and the overall design of the link should be approved by the Minister for Transport.
- That overall environmental requirements to minimise permanent as well as temporary environmental consequences should be approved by the Minister for Transport after consultation with the Ministry of Environment and consultation of relevant German authorities before the alignment and the overall design could be approved.
- That the environmental requirements should be approved on basis of an Environmental Impact Assessment according to EU-Directive No. 85/337/EEC and after a public hearing process in accordance with the directive's implementation in Danish legislation.
- That the Danish Government commits itself to plan and construct hinterland road and rail connections.
- That the detailed planning and construction should be approved in accordance with existing relevant Danish legislation – but in due respect of the fact that a co-ordination with German legislation will be necessary.

1.2.2 Approvals and permits for the construction of roads and railways under Danish Law

1.2.2.1 Law on raw materials

According to the Law on Raw Materials, dredging and reclamation works at sea are only allowed if a permit is given by the Danish nature and Forest Agency. Dredging/excavation for foundation of tunnel elements or bridge piers, work harbours, etc. and reclamation of new land (including ship protection islands, ventilation islands) is regulated by this Law. This Law will also apply for winning of sand, gravel and stone materials at Danish Sea Territory.

1.2.2.2 Law on protection of nature

Prior to the decision regarding alignment and type of construction it is required that a number of investigations are carried out to establish if marine archaeological remains or other historical remains exists in the corridor of the alignment. If so, these should either be moved, preserved or registered before constructions works can be allowed.

1.2.2.3 Law on planning

Before construction works and before works to establish temporary fabrication plants and work harbours can be started, the regional and local planning authorities should establish a planning basis upon which permits can be given to a contractor. The Law on Planning also applies for construction works in coastal waters.

1.3 German Authorities' approvals for the construction of roads and railways

In Germany, **roads or railways** that are of more than merely local significance may only be created after a **comprehensive approval procedure** has been carried through (*Planfeststellungsverfahren;* hereinafter "**Approval Procedure**"). With big infrastructure projects, far-reaching basic decisions are usually taken **prior to the beginning of the Approval Procedure (Preparatory Planning).** The planned fixed link across Fehmarnbelt is to be created in **several planning stages**.

1.3.1 Preparatory planning

1.3.1.1 Regional Development Procedure

Big traffic projects cannot be planned and carried out isolated from their surroundings. For this reason, when **federal roads or railway** connections are to be constructed, a Regional Development Procedure (*Raumordnungsverfahren*) is usually carried out prior to the Approval Procedure. In the Regional Development Procedure the planned project is modified according to the requirements of the regional development plans and other significant plans and measures (such as other railway lines, energy infrastructure or construction projects in connection with rivers or canals) concerning the region in question (Sec. 15 Law on Regional Development / *Raumordnungsgesetz - ROG*). In the Regional Development Procedure different alternatives of routes but also alternatives in the execution (bridge or tunnel) are examined at an early stage.

The Regional Development Procedure also includes the initial assessment of the environmental impacts of the project. According to the early stage of the planning the project's impacts on the environmental factors are examined and described. This already involves public information.

The last stage of the Regional Development Procedure is the Regional Development Consent which is not binding the authorities in the subsequent Approval Procedure. The results of the Regional Development Procedure, however, are predetermining for the subsequent Approval Procedure and have to be taken into consideration accordingly.

1.3.1.2 International co-ordination

The planned link across Fehmarnbelt has to be created in co-ordination with the neighbouring state of Denmark. In the case of regional development plans that may have significant impacts on neighbouring states, Sec. 16 ROG provides for the international co-ordination with regard to the regional development. The details of such intergovernmental co-ordination will presumably be determined by the Federal Minister for Transport, Building and Housing.

1.3.1.3 Determining the route

Another - separate - preparatory step only for the construction of the planned **road** connection is the so-called Determination of the Route *(Linienbestimmung)* by the Federal Minister for Transport, Building and Housing (Sec. 16 Law on Federal Trunk Roads / *Bundesfernstrassengesetz – FStrG*). In this step, the alignment of the future road connection is roughly fixed. When determining the alignment, public interests in connection with this project - including the environmental impact assessment and the results of the Regional Development Procedure - have to be taken into consideration. The Determination of the Route is a procedural step handled internally by the authorities and is not yet a pre-decision on the legally binding approval of the planned project.

No comparable determination step applies for railways.

1.3.2 Approval Procedure

The Approval Procedure is completed with a legally binding approval (*Planfeststellungsbeschluss;* hereinafter "**Plan Approval**"), which is the permit for construction. In principle only a non-appealable Plan Approval entitles the concessionaire to start construction works. A characteristic of the Approval Procedure is the involvement of a variety of technical authorities, towns and citizens. Under German planning law, the approval of a fixed link across Fehmarnbelt will only be binding if it has been granted in the course of the Approval Procedure.

The Approval Procedure concerning **federal trunk roads** is governed by Sec. 17 FStrG, while the one concerning **railway** installations is governed by Sec. 20 of the General Law on Railways (*Allgemeines Eisenbahngesetz - AEG*). If there are several separate projects concerning the same issue, only one Approval Procedure is carried through, unless a single approval is impossible (Sec. 78 Law on Administrative Procedures / *Verwaltungsverfahrensgesetz - VwVfG*). Since the two structures in question - road and railway - concern the same issue and run parallel in the same territory, **probably only one single, comprehensive Approval Procedure** will be carried out on the German side. In case of doubts which authority is competent for carrying out the Approval Procedure, the Federal Minister for Transport, Building and Housing is to determine the competent authority.

The Approval Procedure covers all parts of the entire project (i.e. the horizontal and vertical alignments; technical aspects of the design and construction of the guideway, bridges, tunnels, embankments, drainage and ventilation systems, noise barriers etc.), and consequent measures (such as diverting roads, paths and waterways; disposal sites for spoil and excavated mass; ecological protection and mitigation measures; plantings). Therefore the investor’s drawings need to be sufficiently detailed.

The **Approval Procedure** is, as a rule, carried out as follows:

- For **private investors**, the decisive stage starts already prior to the commencement of the procedure as such. In order to speed up the Approval Procedure the project is to a very large extent agreed upon with the relevant authorities and bodies prior to filing the application for approval. In doing so, it is also clarified which application documents, drawings, proofs etc. have to be submitted by the investor. In addition, the subject, scope and methods of the Environmental Impact Assessment are determined in the so-called Scoping procedure. In the case that an Environmental Impact Assessment has already been carried out as part of the Regional Development Procedure, its results have to be taken into consideration.

- The central element is the so-called **Hearing Procedure** *(Anhörungsverfahren)*. It is based on the investor's application documents (incl. various drawings, narratives and studies – including the Environmental Impact Assessment) submitted to the responsible Hearing Authority.

- The Hearing Authority commences the **formal procedure** in which other authorities, towns and districts concerned, but also non-governmental organisations have the possibility to state their opinion. Furthermore, the application documents are open to public participation.

  If objections are raised against the project, the Hearing Authority conducts a **public hearing** *(Erörterungstermin)* and invites the authorities involved and the persons concerned. The purpose of this hearing is to provide the authority granting the Plan Approval with information, and to reconcile the interests affected by the project.

- The **Plan Approval** concludes the procedure. The legal significance of the Plan Approval can be compared to a building permit. The Plan Approval, however, comprehensively governs all relations under public law between the investor and the authorities involved and the public concerned (such as property owners). The investor may realise his project and may make use of water, air and soil; he may produce noise and other emissions to the extent planned and approved. This means that the Plan Approval has a most significant effect since it replaces other permits under public law and there is no requirement of any further permits. In the course of the Approval Procedure, however, other provisions under substantive law (such as the building law) are examined as well, if necessary. Once the project has non-appealably been approved, claims for cancellation or modification are not admissible.

Finally, the Plan Approval is the basis for a subsequent expropriation (if needed). It does not necessarily change the status of ownership, but it does entitle the investor to make use of the properties decided upon in the Plan Approval.

1.3.3 Construction and financing by the private sector

1.3.3.1 Transfer of tasks

The Fehmarnbelt project is to be planned and executed by private investors. In Germany, the execution of the tasks construction, maintenance, operation and financing of federal **trunk roads** may be transferred to the private sector. The according transfer of tasks is governed by Sec. 1 Paragraph 2 of the Law on Privatisation concerning the Construction of Trunk Roads (*Fernstraßenbauprivatfinanzierungsgesetz – FStrPrivFinG)*. Such transfer of tasks is agreed upon in a contractual agreement between the public and the private sector. By means of such agreement, not only the carrying out of the road construction project but also the planning of the project may be transferred to a private investor. However, only preparatory works and services are transferable, the governmental authorities remain competent for deciding on the approval of the project.

Therefore, as far as the planning stage is concerned, one has to differentiate between the preparation of the plan and the legally binding Plan Approval. The planning stage may be transferred to a private investor. This includes in particular

- investigations into transport economy
- Environmental Impact Assessment
- investigation of alternatives
- submission of the documents concerning the Determination of the Route
- compiling the relevant application documents for the Approval Procedure.

The public hearing and the Plan Approval are handled by a governmental authority. With regard to the Fehmarnbelt project, the planning, construction, operation, maintenance and financing are to be transferred to a concessionaire by means of a concession agreement. As a rule, such a concessionaire is a company established under private law for the purpose of a project.

In the present case, such a company carries out the project in its own name. The company will also render planning services already at an early stage of the project and will continue to manage the project after it has been completed. Typically, the company will conclude a building contract with a general contractor or a consortium of building and investment contractors in which the main obligation is that the planned structure shall be ready for use at a fixed date.

1.3.3.2 Conditions for tolling

With the operating model according to the FStrPrivFinG, the private investor is, however, entitled to charge a toll; he is entitled to the revenues from fees (Sec. 2 FStrPrivFinG). The right of charging a toll may, by means of a contract under public law, be transferred along with the transfer of tasks according to Sec. 1 Paragraph 2 FStrPrivFinG, since the construction and the financing of the Fehmarnbelt project are to be refinanced by charging a toll. According to Sec. 3 FStrPrivFinG, a toll may be charged for the use of newly constructed bridges and tunnels if they are part of a federal motorway or a federal road. Such toll must be paid directly before or after or during each use and may, among others, be charged by means of automatic installations (Sec. 6 FStrPrivFinG).

Table 4: Listing of relevant German laws and regulations mentioned

German term	English translation
Verwaltungsverfahrensgesetz – VwVfG, §§ 72 ff. (§ 75)	Law on Administrative Procedures
Raumordnungsgesetz - ROG, §§ 15, 16	Law on Regional Development
Gesetz über die Umweltverträglichkeits-prüfung - UVPG, § 16	Law on Environmental Impact Assess-ment
Bundesfernstraßengesetz – FStrG, §§ 16, 17	Law on Federal Trunk Roads
Allgemeines Eisenbahngesetz – AEG, § 18 ff.	General Law on Railways
Fernstraßenbauprivatfinanzierungs-gesetz – FStrPrivFinG, §§ 1 ff.	Law on Privatisation concerning the Con-struction of Trunk Roads

2 ENVIRONMENTAL ASPECTS

2.1 Introduction

The protection of the marine environment during and after the construction of the fixed link will, in accordance with general principles for a sustainable development be an important and integrated part of the project, both in the decision and approval phase and during design and construction of the link. The concessionaire will be responsible for a number of activities, that will be important parts of an environmental management system. The most important elements will be:

a) **Investigations into important parts of the ecosystem** in order to up-date and complement already executed studies (see below) and to provide a baseline to be used for a control and monitoring programme

b) Elaboration of an **Environmental Impact Assessment** (EIA) in accordance with Council Directive 85/337/EEC (amended by Council Directive 97/11/EC) and these Directives' implementations in German and Danish legislation. Elaboration of other ecologically relevant studies according to national and European Union's requirements.

c) Development of a **monitoring programme**. The Concessionaire will be responsible for documenting compliance with the environmental requirements to design and construction approved by the environmental authorities.

In the years 1995 to 1999 preliminary investigations of the potential environmental impacts arising from the fixed link were conducted. These covered eight solution models and aimed at giving a preliminary assessment of the most important environmental issues to be addressed, and a ranking of the investigated solutions in environmental terms.

The underlying studies of the available "Investigation of Environmental Impact" [2] are not detailed and comprehensive enough to serve as an EIA, and will have to be up-dated and supplemented, when a technical solution has been decided upon. Therefore an EIA will have to be carried out prior to granting the approvals of both Denmark and Germany.

2.2 Findings of the initial environmental investigations

In the following a summary of the COWI-Lahmeyer report ”**Investigation of Environmental Impact**“ (1999) is given:

The investigations were carried out between 1995 and 1999 and included field investigations and hydrographic and ecological modelling. The eight ”Solution Models“ were investigated, assessed, compared and ranked, including the two ECI solution models now under consideration in the Information Memorandum.

The overall result of the assessment was, that all solution models were judged to be environmentally feasible, if appropriate mitigation measures and environmental management was realised. The **major conclusions** were:

- The ranking indicates the least impacts for bored tunnels, followed by immersed tunnels and bridges. (The overall differences between the solution models are small)
- Among the bridges the cable stayed bridge has a lower environmental impact than the suspension bridge.

The advantage of **bored tunnels** is that impacts on the marine environment during construction are insignificant. They also provide a very low hydrographic effect, only caused by the coastal earth depots. On the other hand depot requirements are relatively high.

The **immersed tunnels** also provide a very low hydrographic effect, only caused by the coastal earth depots and depot requirements are also relatively high. But immersed tunnels show the highest adverse impacts on the marine environment during construction. Bored and immersed tunnels have no impact on migrating birds.

The **cable stayed bridge** has a low hydrographic effect although it is higher than that of the tunnels. The impacts of the suspension bridge are generally similar to the cable stayed bridge, but their hydrographic effect is slightly higher. Depot requirements are small, and impacts during construction are in the intermediate range. Impacts of the suspension bridge on the marine environments are higher and particularly its demand for sand resources is higher than those of the cable stayed bridge.

The existing studies identified the following temporary and permanent main impacts caused by a fixed link across Fehmarnbelt:

- **Hydraulic impacts**
  The Fehmarnbelt, Kiel Bight and Mecklenburg Bight are part of the transition area between the Baltic Sea Proper and the North Sea. The inflow of fresh water from rivers combined with the inflow of saline water from the North Sea creates a stratified system in the Baltic Sea. During periods of inflow to the Baltic Sea salt bottom water flows over the Darss Sill, the shallowest point of the transition area. The dense saltwater flows into the Baltic Sea as a dense bottom current and fills up the deep basins.

  The fixed link will result in a minor blocking of the water exchange between the Baltic and the North Sea (0.3% for the cable stayed bridge and close to zero for the tunnel), e.g. due to bridge piers or the ventilation island. **The blocking effects were identified to be lower than the natural background variation of the Baltic Sea** - thus no potential impacts could be expected from blocking effects.

- **Permanent ecological impacts**
  Among the ecological features of the area, the abundant bird life is remarkable. Major sections of the coast and shallow areas are of outstanding and international importance for seabirds. Parts of the shallow areas on both sides of the Fehmarnbelt have status as protected areas, including Special Protection Areas according to EU's Wild Birds Directive.

  Benthic vegetation occurs from the shore to a depth of 10 ~ 15m. The coverage of vegetation West of Fehmarn seems to have decreased in recent years. The common mussel is widely distributed in the Fehmarnbelt area. The mussel beds West of Fehmarn, at Albue Bank and at Sagas Bank, are important as feeding grounds for seaducks. Impacts (not significant) are only expected in the close vicinity of Rødbyhavn and partly near Puttgarden. Benthic fauna in the deeper parts of Fehmarnbelt and surroundings is periodically affected by oxygen depletion. Effects on marine ecology due to physical destruction of flora and fauna were found to be of minor relevance because mitigation and compensation is possible for the depot areas and marine areas occupied by structures.

  Migrating landbirds crossing Fehmarnbelt might collide with bridge pylons and cables at night or during unfavourable weather conditions, but the total number of birds involved are not likely to comprise a significant proportion of the populations concerned. For seabirds no significant levels of mortality are anticipated. However, it is envisaged that a bridge can affect the behaviour of migrating seabirds and thereby increase the energy consumption needed to pass the Fehmarnbelt migration corridor.

For terrestrial soil deposits an area of 1km² (max.) of land is required on each coast, Fehmarn and Lolland.

- **Temporary ecological impacts**
  The main temporary impacts will be caused by sediment dispersal from marine earth works (dredging, deposition). Dense sediment plumes will, from time to time, occur in the entire Fehmarnbelt area, especially the construction sites in the coastal zones on both sides of the Belt will be exposed to these sediment plumes. The most distinctive impact is foreseen for benthic vegetation, the biomass of which will be reduced as a result of shading effects due to suspended sediments and will be even slightly affected in more remote surroundings (Kiel and Mecklenburg Bights).

  Regarding other ecological aspects such as fish, marine mammals, and fisheries, temporary adverse impacts were found to be limited to zones near the construction areas in Fehmarnbelt. Also the important feeding grounds for the wintering seabirds are not expected to be affected. Although these shading effects will be without significance for the ecological conditions in the Fehmarnbelt in general, a careful planning and control of earth works is required.

- **Mitigation measures**
  As a result of reiterated environmental optimisation of the design during the feasibility study [1], mitigation of hydraulic impacts has been implemented to the solutions. Nevertheless, further mitigation shall be achieved in further design phases.

  Compensation dredging was identified to be unfeasible. The earth balance should be optimised by re-use of excavated earth and gravel and thus saving the need of additional raw materials, however, the potential for such measures was considered to be limited.

  The deposition strategy was not yet subject of the past investigations and has to be carefully considered in further project phases.

  In order to avoid, minimise and mitigate adverse impacts, during construction a monitoring system has to be set up and mitigation of impacts has to be managed systematically.

2.3 Environmental requirements

Environmental Impact Assessment

An Environmental Impact Assessment has to be carried out prior to granting the approvals of both Denmark and Germany. The subjects of an EIA are defined in Articles 3 to 10 of the Council Directive 85/337/EEC and in the Danish and German EIA acts. So far it has not been decided whether there will be one comprehensive EIA required, covering the territories of both States or two separate EIAs for either of the States.

The following **EIA procedures** are relevant for a Concessionaire:

- Authorities have to make relevant information in their possession available to the investor.
- Relevant authorities likely to be concerned by the project by reason of their specific environmental responsibilities must be given opportunity to express their opinions.
- Public participation based on the investor's relevant information, i.e. mainly the EIA Report, has to be arranged.
- Bilateral consultations between the two Member States, Denmark and Germany have to be conducted.

In both Denmark and Germany, the Environmental Impact Assessment is an integrated part of the approval procedures. Therefore in **Germany**, typically the authority granting the Plan Approval is also the competent EIA authority responsible for the approval of the EIA. In **Denmark**, the competent authority for approving the EIA will be the Ministry of Environment. Further information about the approval procedures is given in section B1.

The preparation time for an EIA covering all issues pursuant to the Council Directive and according to the Danish and German EIA legislation may be scheduled as of 3 to 4 years.

Environmental Compensation Plan

Besides the EIA Report, in **Germany** the **Environmental Compensation Plan** (*"Landschaftspflegerischer Begleitplan", LBP*) is required in which mitigation measures as well as ecological compensation measures have to be defined in a more detailed scale than EIA level. The compensation measures will be part of the conditions set in the approval. The preparation time for an LBP may be scheduled as of 1 to 1.5 years (mostly parallel to the preparation of the second half of the EIA).

NATURA 2000 Assessment

In case that "Special Protection Areas" (SPA) according to Article 4 of the Council Directive 79/409/EEC (Wild Birds), or "Sites of Community Importance" (SCI) according to the Council Directive 92/43/EEC (Natural Habitats) - both parts of the EU's NATURA 2000 network of habitats - occur in a development area, a special assessment of the project's implications in view of the site's conservation objectives (**NATURA 2000 Assessment**) is required. Even in case of negative assessments of the implications for the sites there are further options pursuant to Articles 6 of both Council Directives to gain approval.

As can be taken from the 1999 "Investigation", on both sides, Fehmarn and Lolland, "key areas for seabirds" are covering wide parts of the coastal regions, although particularly the Puttgarden and Rødbyhavn areas seem to be of less importance so far. Parallel to the EIA it will be required to check whether "Special Protection Areas" or "Sites of Community Importance" may have been classified by the authorities in the project area after finalisation of the 1999 Report [2].

In **Germany**, the Environmental Compensation Plan and the NATURA 2000 Assessments are integrated parts of the Approval Procedure. Therefore typically the authority granting the Plan Approval is also the competent authority responsible for approval of the said plans and assessments. In **Denmark**, the competent authority for approving the NATURA 2000 assessment will be the Ministry of Environment. Further information about the approval procedures is given in section B1.

The preparation time for a NATURA 2000 Assessment, if needed, may be scheduled as of 1 to 2 years (in general parallel to the preparation of the EIA).

Requirements according to ESPOO-Convention

As outlined in chapter B1, both Denmark and Germany have notified the **ESPOO-Convention** (Convention on Environmental Impact Assessment in a Transboundary Context), which requires that affected parties should be notified about potential environmental implications and that provisions are made for control of adverse transboundary impacts.

For the project in question this convention will require that the Baltic Sea Area States be given opportunity to convey their views on the project's potential environmental impacts on the Baltic Sea, on the basis of the EIA. As can be expected from experience with the Øresund and Great Belt projects, the environmental authorities of the Baltic Sea Area States will establish **generally formulated criteria** for water quality, benthic flora, benthic fauna, fish, birds and mammals. The criteria are expected to be as follows:

- **Hydrography**
  Depending on the selected solution model, it is uncertain that a strict zero in terms of no change in the waterflow to and from the Baltic Sea can be implemented.

  Instead, in order to minimise potential effects on the transport of water, salt and oxygen to the Baltic Sea without allowing compensation dredging, a set of criteria for an acceptable maximum change will be laid down by the environmental authorities. Furthermore, there will be the requirement to demonstrate that state-of-the-art design has been applied, in particular regarding streamlining of bridge piers, ventilation island(s), ship protection islands etc, and maximum span widths of approach bridges.

  A criterion for acceptable local changes in the hydrography is also expected.

- **Coastal Morphology**
  A criterion for coastal morphology is expected. This criterion should be combined with requirements to the design of deposits for surplus excavation materials and maximum reuse of such materials for construction purposes.

- **Water Quality**
  A criterion with respect to bathing water quality (sediment plumes) during construction can be foreseen on the German and Danish side of the strait.

Restrictions in outlets of sewage and other pollutants from both permanent and temporary installations can also be expected.

Restrictions are also expected for the changed risk of environmental accidents as a result of ship collisions with temporary or permanent installations.

- **Benthic Flora and Fauna**
  It is expected that the environmental authorities will set broad criteria for benthic flora and fauna. It is assumed that the criteria will be formulated as a maximum relative reduction in biomass for a certain, limited number of species, for example the red algae at deep waters, within a pre-defined area and within a certain time frame.

- **Fish**
  Based on experience from Øresund it is deemed prudent to expect a criterion for fish and especially fish migration, which will include a non-blocking approach for fish migration through Fehmarnbelt. Such a criterion will probably have an impact on the dredging operations, in the sense that a part (up to half of the cross section) of the belt must be kept free of dredging operations while dredging in the other part is in progress.

  A restriction on dredging during the time of the year when herring spawning takes place is a likely requirement.

- **Birds and Mammals**
  Focus on the bird sanctuary area at Rødsand and other Special Protection Areas for wild birds in the vicinity at the fixed link can be expected. Criteria for disturbance and noise effects can be expected.

3 TECHNICAL SOLUTIONS

The six remaining solution models (see chapter A1) are widely determined by the conditions for design which are presented in the following chapter 3.1. The key characteristics of the two business cases are described in more detail in chapter 3.2, the remaining solution models (alternative cases) are documented in chapter 3.3. Chapter 3.4 contains a first approach to authority requirements beyond what is included in the COWI-Lahmeyer feasibility studies.

3.1 Conditions for design

3.1.1 Results of the geological and geotechnical Investigations [8]

The results of the geological and geotechnical investigations [8] are presented in a digital database - the Geomodel. The results have been used and are integrated into the technical solutions. Four geological formations have been found in the investigated corridor:

- Post and late glacial layers, upper quaternary
- Glacial deposits, lower quaternary
- Tertiary layers
- Limestone.

The **post and late glacial layers** vary in thickness from 0 to about 20 m. The upper part of these layers has a considerable organic content and contains furthermore sand, silt and clay and is not feasible for foundation.

The **glacial layers** vary in thickness from 0 to about 60 m. These layers are generally expected to be preconsolidated and feasible for direct foundation of most of the technical solutions.

The **tertiary layers** vary in thickness from 0 to about 200 m. The layers do not exist in part of the eastern and central part of the corridor where the glacial layers rest directly on the limestone. The clay is very plastic and is expected to give rise to considerable settlements when heavy structures are founded. It may be necessary to use piled foundations.

The surface of the top of the **limestone layers** forms a dome structure in the area probably because of salt emerging from the deep. In an area the layers are only 15 m below the sea bottom. The limestone layers are expected to be more than 300 m in thickness and are expected to be feasible for direct foundation of all types of structures.

The dome structure is elevated approx. 150 m compared to the undisturbed limestone surface. The dome is expected to be active and having an upward movement of approx. 0.5 mm a year.

Provided suitable investigations of behaviour of the soils are performed the soil related risks in relation to a fixed link across Fehmarnbelt will be of limited magnitude.

3.1.2 Risk and safety

3.1.2.1 Risk policy

The risk policy which is used for evaluating the technical risks in the feasibility studies is formulated in this way:

- The safety level for the users of the link shall be reasonable and comparable to other traffic installations in Northern Europe.
- Risks shall be systematically identified, evaluated and managed during construction and operation.

The first part of the policy covers individual risks to users. The second part covers operational risks, e.g. disruption of the link, user disturbance, environmental damage and construction risks, which are dealt with as economic consequences.

In order to implement the risk policy, the project organisation will have to reflect the central position of this matter. Risk management shall be regarded as an integral part of project management.

The general risk management methodology for risk to users is the **ALARP principle**: the risk shall be **A**s **L**ow **A**s **R**easonably **P**racticable. This means that a risk shall be reduced as long as the cost of the risk reducing measures is not in (gross) disproportion to the effect of the measures. The ALARP principle hereby controls the cost efficiency. Furthermore, the risk to the users of the link shall not exceed a level, which is unconditionally intolerable.

In the cost analysis the risks are quantified in monetary units and a Risk add-on covering all risks for the specific solution is added.

The upper risk limit for road users on the fixed link is one fatality for each 10 million individual passages. For rail users the corresponding upper limit is defined as 20 times smaller meaning one fatality for each 200 million individual passages.

3.1.2.2 Risk for ship collisions

A special investigation has been performed with the purpose of quantifying the risks for the solution models related to the ship traffic in Fehmarnbelt.

The main risks in relation to the road tunnel solutions concerns the ventilation shafts in the middle of the belt. They are assumed to be 100% protected against ship collisions by the protective islands surrounding them.

The risks for the bridges in connection with ship collision are higher than for the tunnels but the risks are judged to be acceptable. The calculated risk for disruption is one disruption every 1667 year for the cable-stayed bridge solution and one disruption every 2128 year for the suspension bridge.

3.1.2.3 Safety concept

The Safety Concept in the feasibility studies for a fixed link is established in harmony with the risk policy and the risk management. The safety precautions can be classified as follows:

- Precautions which prevent possible accidents: Automatic Train Control systems (ATC), detectors for hot railway brakes, vapour and gas detectors, train profile control, traffic management centre, VTS system for ship traffic etc.
- Precautions which limit the extent of accidents: Single track tunnels, “drive-out” concept, dimensioning of structures for Accidental Load Situations, choice of fire proof materials in train and tunnel, managing of trains with inflammable and dan-

gerous goods, fire detection systems, traffic control and equipment and procedures for stop of traffic in case of accidents, video supervision in road tunnels etc.

- Precautions which improve self-rescuing: Emergency access ways in tunnels and on bridges, access to a safe haven within short distance and time, safe havens in cross tunnels or galleries (in bored tunnels and immersed tunnels respectively), emergency ventilation in tunnels etc.
- Precautions which improve assisted rescuing: Access by means of road vehicles from the neighbouring tunnel, emergency ventilation, special rescue equipment for bridge and tunnel etc.

Due to the location of the link a special organisation is likely to be established to operate the link as well as to manage safety and rescuing.

3.1.3 Architectural and technical requirements

3.1.3.1 Architectural requirements

Architects have continuously been involved in the feasibility studies through meetings with the group of engineers where their comments and ideas including sketches have been presented. All elements of the structures have been commented and special emphasis has been given to create the best aesthetically possible and non-monotonous experience for the users of the link. All solution models are in line with architectural requirements.

3.1.3.2 Technical requirements

The Eurocodes will be used as design code for the project. In line with the philosophy in the Eurocodes a **Project Application Document** will be produced as well as a document containing Design Requirements with project specific loads.

The primary parts of the structures should be designed for a lifetime of 100 years.

In the Design Requirements e.g. the following loads will be defined: Dead loads, superimposed dead loads, live loads, wind, waves, current, ice, ship collisions and earthquake.

3.1.3.3 Environmentally correct design

The main target when designing the different solution models seen from an environmental point of view was to make a hydraulic blocking effect, which is as small as possible. In this way the impact on the current in Fehmarnbelt and thereby on the salinity and oxygen content in the Baltic should be minimised.

The result is streamlined protection islands, tunnel elements submerged below sea bed, large span length for the bridge solutions, elliptical bridge piers with main axis parallel to main current direction, ramps which are as short as possible within the deposit areas for the tunnel solutions and optimisation/minimisation of the necessary deposit areas with regard to shape respectively size.

3.1.4 Functional requirements

3.1.4.1 Functional requirements to the road and railway

The requirements to the road are based on normal practice to major roads respectively motorways.

The requirements to the railway are in accordance with COWI-Lahmeyer’s report [1].

The requirements are based on DB AG “Netzinfrastruktur Technik Entwerfen”.

The clearance profiles include both construction tolerances and possibility for cant of the track and for the bored tunnel solutions “Bautechnischer Nutzraum” as well.

3.1.4.2 Restrictions due to maintenance of the road and railway

Consideration should be given to the traffic flow when planning for **maintenance of the road**. Traffic in both directions should be possible at all times e.g. by a temporary lane relocation.

The **operation of the railway** will be influenced by the maintenance of structures and equipment. The experience from the Great Belt Tunnel and the Øresund Tunnel is that closing for several hours in one tube is necessary every night for maintenance and repair works. Especially the tunnel solutions, which will also be used by diesel trains, need to be closed for cleaning.

3.1.4.3 Restrictions to the transport of dangerous goods.

As a consequence of various tunnel accidents in the recent past, the transport of dangerous goods is a very sensitive issue. Laws and regulations are being discussed and reviewed at European level in order to improve the safety and to avoid further accidents. The conditions for the transport of dangerous goods are collected in the regulations on international rail transport of dangerous goods (RID - Règlement concernant le transport international ferroviaire des marchandises dangereuses) and European agreement on the international road transport of dangerous goods (ADR, including special agreements).

In Denmark and Germany, individual regulations for the transport of dangerous goods by trucks are set up depending on the technical design of the tunnel in consideration. With regard to the Fehmarnbelt project, the transport of **dangerous goods on trucks** will most likely only be allowed in a certain time interval for the tunnel solutions, e.g. in the night. As an example transport of dangerous goods on trucks is only allowed in the Øresund Tunnel between 11.00 p.m. and 06.00 a.m. A maximum tonnage of explosives per truck should be expected (5 tonnes in the Øresund Tunnel).

For the tunnel solutions the **operation of the railway** is also influenced by transport of dangerous goods. If dangerous goods are not shipped by ferry in the future, similar demands to what is allowed in the Great Belt Tunnel and in the Øresund Tunnel should be expected. It means that passenger trains and freight trains with dangerous goods must not be in the tunnel at the same time. It is also likely that normal freight trains and passenger trains must not be in the same tube at the same time. A maximum tonnage of dangerous goods on each wagon should be expected (5 tonnes in Great Belt Tunnel and in Øresund Tunnel).

3.1.4.4 Restrictions due to windy weather

For the **bridge solutions** (solutions 3 and 3.1) the road users are impacted by the weather when crossing the link. The experience from other similar projects is that traffic restrictions for light vehicles are introduced at cross wind speeds at approx. 16 m/s and that the link has to be closed for safety reasons at cross wind speeds at approx. 25 m/s. For the Fehmarnbelt link it is up to the Concessionaire to secure that the link is closed less than a few hours per year due to windy weather. If necessary by introducing windscreens.

3.1.4.5 Other functional requirements

Functional Requirements not mentioned specifically in the text should be expected to have a level like on other comparable links in Northern Europe.

3.2 Business cases

3.2.1 Solution Model 3: Cable-Stayed Bridge (4+2)

The cable-stayed bridge for road and railway has a total length of 21,318 m including a 18,568 m long bridge and is briefly described as follows:

Cable-stayed bridge with 24.70 m wide carriageway for 4 road lanes and emergency lanes and 12.10 m wide, double track railway deck in double deck arrangement, main bridge 3,208 m long with three main spans of 724 m, back spans of 278 m and side spans of 240 m, a southern approach bridge of 6,000 m and a northern of 9,360 m, both with 240 m spans, all truss girders are single or double composite structures.

Two navigation channels with 700 m horizontal and 65 m vertical clearance in the two outer main spans.

Ramp or abutment areas do not protrude into the Fehmarnbelt, deposit areas close to the shores and in the shadow of the existing harbours at Rødby and Puttgarden (this is the typical approach for depositing surplus soils of all solution models), caisson shafts for piers and foundations of pylons are placed in the Fehmarnbelt.

3.2.2 Solution Model 5.1: Immersed Tunnel (3+1)

The immersed tunnel for road and railway has a total length of 20,380 m including a 18,550 m long immersed tunnel and is briefly described as follows:

One combined, immersed road and railway tunnel with overall dimensions of 27.42 m wide and 9.80 m high, subdivided into one roadway tube with 3 lanes and internal dimensions of 13.55 m width and 6.90 m height with one escape corridor 2.90 m wide adjacent to the roadway part, and one single track railway tube with internal dimensions of 6.37 m width and 7.40 m height on the opposite side of the escape corridor.

Deposit areas as above, and an elliptical ventilation island with visible top dimensions of 95 m by 195 m for the required roadway tunnel ventilation shaft placed in the Fehmarnbelt. The submerged part of the island has the shape of an elliptical cone. The cone sides slope at 1:9 in the longitudinal direction and 1:3 in the transverse direction.

3.3 Alternative cases

3.3.1 Solution Model 3.1: Suspension Bridge (4+2)

The suspension bridge for road and railway has a total length of 21,278 m including a 18,528 m long bridge and is briefly described as follows:

Suspension Bridge with 24.70 m wide carriageway for 4 road lanes and emergency lanes and 12.10 m wide, double track railway deck in double deck arrangement, main bridge 3,168 m long with one main span of 1,752 m, side spans of 588 m and 120 m, a southern approach bridge of 6,000 m and a northern approach bridge of 9,360 m with 240 m spans, all truss girders are single or double composite structures, only the main bridge deck is an all steel structure. One navigation channel with 1,700 m horizontal and 65 m vertical clearance.

Ramp or abutment areas do not protrude into the Fehmarnbelt, deposit areas as described above, caisson shafts for piers, foundations of pylons, and two elliptical anchor block protection islands with top dimensions of 220 m by 660 m are placed in the Fehmarnbelt.

3.3.2 Solution Model 4: Bored Tunnel (4+2)

The bored tunnel for road and railway has a total length of 22,815 m including the 19,400 m long bored tunnel and is briefly described as follows:

2 single track, bored railway tunnels, internal diameter 8.00 m, typical lateral spacing between centre lines of 27.50 m, cross passages with 4.75 m internal diameter at 300 m intervals, and 2 double lane, bored road tunnels, internal diameter 10.80 m, typical lateral spacing between centre lines of 25.00 m, cross passages with 4.00 m internal diameter at 350 m intervals, and typical lateral spacing between centre lines of road and rail tunnels of 35.00 m.

Deposit areas as above, and an elliptical ventilation island as described for solution model 5.1.

3.3.3 Solution Model 4.1: Bored Tunnel (3+1)

The bored tunnel for road and railway has a total length of 22,815 m including a 19,400 m long bored tunnel and is briefly described as follows:

One single track, bored railway tunnel internal diameter 8.00 m, cross passages to the adjacent large diameter roadway tunnel at 300 m intervals with 4.75 m internal diameter, and one triple lane bored tunnel, internal diameter 14.18 m, cross passages as defined for the railway tunnel with typical lateral spacing between centre lines of 27.50 m.

Deposit areas as above, and an elliptical ventilation island as described for solution model 5.1.

3.3.4 Solution Model 5: Immersed Tunnel (4+2)

The immersed tunnel for road and railway has a total length of 20,380 m including a 18,550 m long immersed tunnel and is briefly described as follows:

One combined, immersed road and railway tunnel with overall dimensions 43.04 m wide and 9.95 m high, subdivided into 2 roadway tubes with 2 lanes each and internal dimensions of 10.05 m width and 7.05 m height with one escape corridor 1.50 m wide in between, and 2 single track railway tubes with internal dimensions of 6.37 m width and 7.40 m height with one escape corridor of 1.50 m free width in between.

Deposit areas as above and an elliptical ventilation island as described for solution model 5.1 are required.

3.4 Safety and emergency aspects

The feasibility studies are based on “Best Practice”. Simultaneous contact to the Danish and German authorities was not part of the scope of work. It means that no review had been performed of the technical solutions from Danish or German authorities with special knowledge and experience in safety and emergency aspects.

Sund & Bælt Holding A/S therefore arranged during the spring 2001 three meetings with a special safety and emergency group. The group consists of members from the Danish and Swedish police- and rescue authorities and has since 1993 been advisers to the Øresund link project in safety and emergency aspects.

The group’s review of the technical solutions resulted in a number of recommendations which are summarised below for each solution model.

3.4.1 Business cases

3.4.1.1 Solution Model 3: Cable-Stayed Bridge (4+2)

The group concluded that the 4+2 bridge solution is a satisfactory solution. The group proposed lifts at the emergency access stairways between upper and lower deck.

3.4.1.2 Solution Model 5.1: Immersed Tunnel (3+1)

The group recommended that the bi-directional traffic should be avoided and emergency lanes should be introduced. The escape gallery could be moved to separate the roadway lanes. A possible design which reflects the recommendation is as follows:

The emergency footways in the original design has been substituted by 2.50 m wide emergency lanes. A New Jersey barrier has been introduced to the left at the fast lane plus a 0.50 m space between New Jersey barrier (crash barrier in concrete) and edge strip. A 0.9 m thick wall has to be introduced between railway and roadway. The result is an increase in width of 3.10 m of the total tunnel width. It was stated at the seminar that the escape gallery should be next to the emergency lane. This is achieved by leading the traffic in opposite direction in the motorway tubes. One crossover for the motorway has been introduced at each shore to make this possible.

3.4.2 Alternative cases

3.4.2.1 Solution Model 3.1: Suspension Bridge (4+2)

Same comment from the group as mentioned for solution model 3.

3.4.2.2 Solution Model 4: Bored Tunnel (4+2)

The group recommended that an emergency lane in each road tunnel should be introduced. This would result in an extra 2,5 m for the emergency lane and an extra 0,5 m for an edge strip.

3.4.2.3 Solution Model 4.1: Bored Tunnel (3+1)

The group recommended that the bi-directional traffic should be avoided and emergency lanes should be introduced. It would result in an increase of the tunnel diameter of approx. 3.4 m resulting in a total diameter of approx. 17.5 m, which is far beyond today's maximum tunnel size for TBM tunnels. Alternatively 2 single lane roadways with emergency lanes in separate tunnels are proposed.

This can be achieved by changing the solution model 4 in the following way: The slow lane is changed to a 2.5 m emergency lane plus a 0.5 m edge strip. The total diameter of each motorway tube is then reduced by approx. 0.5 m compared to solution model 4.

3.4.2.4 Solution Model 5: Immersed Tunnel (4+2)

The group recommended that an emergency lane in each roadway tube should be introduced. The result of this has been that the emergency footways in the original design have been substituted by 2.50 m wide emergency lanes. A New Jersey barrier (crash barrier in concrete) has been introduced to the left of the fast lane plus a 0.5 m space between New Jersey barrier and edge strip. This results in an increase in width of 2.70 m of the total tunnel width. It was stated at the seminars that the escape gallery should be next to the emergency lane. This is achieved by leading the traffic in opposite direction in the motorway tubes. One crossover for the motorway has been introduced at each shore to make this possible.

4 INVESTMENT AND OPERATION COSTS

4.1 Definitions and sources

The basic cost elements are presented in the COWI-Lahmeyer report [1] (referred to as the C-L report). The report defines the **total project costs** as follows:

Subtotal construction costs
+ Design, supervision and management as 5,5 % of subtotal construction costs
+ Client's organisation as a lump sum
= **Total construction costs**
+ Contingencies as 10 % of total construction costs
+ Construction risk add-on (expressed as costs)
= Total project costs

The estimates of **subtotal construction costs**, which are the contractor's construction costs, are based on the breakdowns of the project into quantities and unit prices. Unit prices are determined on the basis of detailed cost information provided by contractors and manufacturers and/or from reference projects.

The **design, supervision and management costs** are estimated at 5.5 % of the subtotal construction costs. Further, the costs of the **client's organisation** during design and construction have been assessed at €115m for all solution models.

The **contingencies**, which are assumed to be 10 % of total construction costs, cover uncertainties in pricing, quantities and completeness of the works.

Construction risk add-ons for the different solution models are added to be able to consider risks for the solutions in terms of economic comparison. The figures are based on the risk assessment as described in "Risk Aspects", COWI-Lahmeyer Joint Venture (C-L), June 1998, Technical Note No 28110-T-N-2B-013 and summarised in attached **Table 5**. Following those guidelines, bored tunnels require the highest amount of risk add-ons, immersed tunnels the lowest. Bridge solutions are in between.

The basis for all costs is June 1996. Value added tax is not included. Currency exchange rates are taken as: 1 € = 7.4 DKK and 1 € = 1.95583 DM.

Table 5: Construction risk add-ons (Price level June 1996)

Cost items	Business cases		Alternative cases			
	3. Cable st. Bridge 4+2 MEUR	5.1 Immersed Tunnel 3+1 MEUR	3.1 Suspension Bridge 4+2 MEUR	4. Bored Tunnel 4+2 MEUR	4.1 Bored Tunnel 3+1 MEUR	5. Immersed Tunnel 4+2 MEUR
Fatalities	3,3	1,8	3,3	3.3	3,3	3,2
Additional costs	7,5	3,3	7,5	7,7	6,5	4,5
Delays	3,7	1,8	4,3	8,6	7,0	3,4
Environmental Impact	0,5	0,3	0,5	0,1	0,1	0,3
Annual risk add-ons	**15,0**	**7,2**	**15,6**	**16,4**	**16,9**	**11,4**
Construction period [years]	6,5	7,0	7,0	8,0	8,0	7,0
Total construction risk add	**98,0**	**50,0**	**109.0**	**131,0**	**135,0**	**80,0**

4.2 Construction costs by technical solutions

A summary of the total project costs for all solution models is provided in the attached **Table 6**. The costs are shown as total and separated into costs for the rail and the road link for each solution model. The separation into rail/road costs is most obvious for the bored tunnel solutions and is implemented to all solutions for consistency. The **main findings** are:

- The 3+1 solutions (4.1 and 5.1) will result in the lowest construction costs. The total budget amounts to less than €3bn.
- The tunnels with 4+2 capacity (solution models 4 and 5) are the most expensive solutions. The immersed tunnels are less expensive than the bored tunnels. The calculation of investment led to €4.4bn and €3.8bn respectively.
- Among the bridge solutions, the cable-stayed bridge appears to be the cheaper alternative. The total budget amounts to just over €3bn.

The construction period is estimated to be in a range from 6.5 to 8 years.

Table 6: Construction costs by solution models (Price level June 1996)

Cost Items	Business cases						Alternative cases											
	3 (4+2)			5.1 (3+1)			3.1 (4+2)			4 (4+2)			4.1 (3+1)			5 (4+2)		
	Total mEURO	Rail	Road	Total mEURO	Rail	Road	Total mEURO	Rail	Road	Total mEURO	Rail	Road	Total mEURO	Rail	Road	Total mEURO	Rail	Road
Site installation	230	154	76	148	52	96	230	154	76							187	75	112
Major construction equipment				68	24	44				211	91	120	116	46	70	86	34	52
Marine operation, erection works, immersion	173	116	57	128	45	83	180	121	59							128	51	77
Structural works for TBM launch										32	15	17	23	9	14			
Main structures	1.380	925	455	1.132	396	736	1.596	1.069	527	2.579	1.123	1.456	1.718	583	1.135	1.580	632	948
Auxiliary structures				13	2	11				20	1	19	13	1	12	20	8	12
Earth works (ramps, tunnel trench, foundations)	421	282	139	498	174	324	445	298	147	173	86	87	83	41	42	603	241	362
Road pavement	37	0	37	16	0	16	37	0	37	28	0	28	19	0	19	22	0	22
Tracks	26	26	0	24	24	0	28	28	0	42	42	0	27	27	0	38	38	0
Ventilation island / protection island				26	0	26	200	134	66	28	0	28	28	0	28	26	0	26
Ventilation shaft, air ducts, connection tunnels				12	0	12				38	1	37	27	1	26	18	0	18
Finishing work incl. fire protection	35	26	9	65	23	42	35	26	9	159	41	118	109	20	89	115	46	69
Toll station	8	0	8	8	0	8	8	0	8	8	0	8	8	0	8	8	0	8
Fixed equipment	81	43	38	172	65	106	81	43	38	218	83	135	168	64	104	220	84	136
Rolling stock																		
Terminals																		
Road - / railway connections	35	26	9	14	9	6	35	26	9	28	17	11	14	9	6	28	17	11
Subtotal construction costs	**2.426**	**1.598**	**828**	**2.324**	**814**	**1.510**	**2.875**	**1.899**	**976**	**3.564**	**1.500**	**2.064**	**2.353**	**801**	**1.553**	**3.079**	**1.226**	**1.853**
Design, supervision, management, assumed 5.5% of subtotal construction costs	133	88	46	128	45	83	158	104	54	196	83	114	129	44	85	169	67	102
Client's organisation	115	76	39	115	40	75	115	76	39	115	48	67	115	39	76	115	46	69
Total construction costs	**2.674**	**1.762**	**913**	**2.567**	**899**	**1.668**	**3.148**	**2.080**	**1.068**	**3.875**	**1.631**	**2.244**	**2.598**	**884**	**1.714**	**3.363**	**1.339**	**2.024**
Contingencies -10% of total construction costs	267	176	91	257	90	167	315	208	107	388	163	224	260	88	171	336	134	202
Construction risk add-on	98	72	26	51	18	33	110	81	29	158	67	91	135	46	89	80	32	48
Total project costs	**3.040**	**2.010**	**1.030**	**2.874**	**1.007**	**1.867**	**3.573**	**2.369**	**1.204**	**4.421**	**1.861**	**2.560**	**2.993**	**1.018**	**1.974**	**3.780**	**1.505**	**2.274**
Construction period [years]	6,5			7			7			8			8			7		

4.3 Operation and maintenance costs

The annual **operation and maintenance costs** (O&M) vary between €55m and €84m. Bridges cause relatively higher operation and maintenance costs than tunnels due to weather impact but on the other hand there are more installations in a tunnel than on a bridge: the highest operation and maintenance costs were identified for the two bridge solutions (€79m for the cable stayed bridge, €84m for the suspension bridge).

Variations in O&M costs for a bored and an immersed tunnel can be neglected. On the other hand, the 4+2 tunnels will need roughly €14m more than the 3+1 tunnels. The latter are the cheapest solution with respect to O&M: €56m.

It has to be pointed out that the O&M calculation is based on unit costs and/or average costs derived from similar projects. A review with the aim to take project specific conditions into account is recommended in order to better assess the O&M costs. Nevertheless, it can be expected that the order of project specific O&M costs will remain unchanged.

However the order of magnitude is comparable with experience from similar type of infrastructure projects indicating average yearly operation and maintenance costs of around 2 % of the total project cost.

The total project operation and maintenance costs are derived on an annual basis and defined as follows:

Subtotal operation and maintenance costs
\+ Approval, supervision and management as 11% of subtotal O&M costs
= **Total operation and maintenance costs**
\+ Contingencies as 10% of total O&M costs
\+ Operation risk add-on (expressed as costs)
= Total project operation and maintenance costs

The assessment of subtotal operation and maintenance costs for tunnels and bridges are based on the following sources:

- Annual statistics of operation and maintenance for the Gotthard Road Tunnel and the Limfjord Tunnel

- PIARC (Permanent International Association on Road Congresses)
- Economic Evaluation of the Federal Transport Master Plan (Bewertungsverfahren für den Bundesverkehrsplan)
- Life cycle guidelines for bridges (Ablösungsrichtlinien für Brücken, 1980)

According to these sources, maintenance costs for structures have been assessed as a percentage of the relevant subtotal construction costs as follows:

- 0.2 % annually for tunnels
- 1.0 % annually for bridges
- 0.5 % annually for artificial islands
- 0.5 % annually for terminals and buildings
- 3.5 % - 10 % annually for fixed equipment

Checking, approval, supervision, management, administration, etc. have been assumed to be 11 % of the subtotal operation and maintenance costs.

The contingency, which is assumed to be 10 % of total operation and maintenance costs, cover uncertainties in pricing.

Operation risk add-ons for solution models are based on the risk assessment as described in “Risk Aspects“, COWI-Lahmeyer Joint Venture (C-L), June 1998, Technical Note No 28110-T-N-2B-013.

A summary of the total project operation and maintenance costs is provided in attached **Table 7**. The costs are shown as total and separated into costs for the rail and the road link for each solution model.

The distribution over time of the operation and maintenance costs during the lifetime of the fixed link is further elaborated upon in the COWI-Lahmeyer note Fehmarnbelt Feasibility Study, Revisiting the O&M cost assessments, July 31, 2000, Doc. No. 51312-ATS-002.

This note states that the tunnel solution models are not expected to show a distinct variation over time in operation and maintenance costs, apart from the costs for period/random nature of the maintenance and repair works. For the bridges solution models it is assumed that the costs for maintenance and repair works of structures, buildings, pavement and tracks will increase linear from 0 to €36m over the first 15 years of service.

Few structures of similar nature as the Fehmarnbelt fixed link have been designed with an expected 100 year life time and those of direct relevance e.g. the Great Belt fixed link and the Øresund fixed link have only been in operation for a few years. Lack of long time experience with maintenance and repair costs for structures with an expected 100-years lifetime adds considerably to the uncertainty of the estimated maintenance and repair costs for the solution models. These costs may be optimised according to better defined operation and maintenance requirements.

Table 7: Project operation and maintenance cost estimates for the six solution models (Price level June 1996)

Cost Items	Business cases						Alternative cases											
	3 (4+2)			5.1 (3+1)			3.1 (4+2)			4 (4+2)			4.1 (3+1)			5 (4+2)		
	Total mEURO	Rail	Road	***Total mEURO***	Rail	Road	***Total mEURO***	Rail	Road	***Total mEURO***	Rail	Road	***Total mEURO***	Rail	Road	***Total mEURO***	Rail	Road
Civil works																		
Buildings	0,1		0,1	0,2		0,2	0,1		0,1	0,3		0,3	0,2		0,2	0,3		0,3
Tunnels	--			4,1	1,4	2,7	--			6,4	2,7	3,7	4,2	1,4	2,8	5,5	2,2	3,3
Bridges	22,4	15,0	7,4	--			26,9	18,0	8,9	--			--			--		
Terminals incl. buildings	--			--			--			--			--			--		
Artificial island	--			0,1		0,1	--			0,1		0,1	0,1		0,1	0,1		0,1
Track and pavement maintenance	3,9	1,0	2,9	2,7	0,7	2,0	3,9	1,0	2,9	3,2	1,0	2,2	2,7	0,7	2,0	3,2	1,0	2,2
Cleaning and winter service	1,5	0,1	1,4	0,5	0,1	0,4	1,5	0,1	1,4	0,8	0,1	0,7	0,5	0,1	0,4	0,8	0,1	0,7
Administration, marketing, etc.	8,0		8,0	6,0		6,0	8,0		8,0	8,0		8,0	6,0		6,0	8,0		8,0
Staff, labour (average salary)	5,5	1,1	4,4	4,2	0,9	3,4	5,5	1,1	4,4	5,5	1,1	4,4	4,2	0,9	3,4	5,5	1,1	4,4
Insurance (third party)	5,0		5,0	5,0		5,0	5,0		5,0	6,0		6,0	5,0		5,0	6,0		6,0
Consultants	1,5		1,5	1,2		1,2	1,5		1,5	1,5		1,5	1,2		1,2	1,5		1,5
Maintenance equipment, vehicles (roads)	2,0		2,0	1,5		1,5	2,0		2,0	2,0		2,0	1,5		1,5	2,0		2,0
Rolling Stock Shuttles	--			--			--			--			--			--		
Fixed Equipment	3,3	1,3	2,0	10,3	2,5	7,7	3,3	1,3	2,0	12,6	2,9	9,6	10,2	2,5	7,7	12,6	2,9	9,7
Vessel Traffic Surveillance System bridges only	3,0	1,5	1,5				3,0	1,5	1,5									
Auxiliary power	2,5	1,0	1,5	4,0	1,0	3,0	2,5	1,0	1,5	5,0	1,0	4,0	3,0	1,0	2,0	5,0	1,0	4,0
Traction power - shuttles	--			--			--			--			--			--		
Traction power- national railways	3,4	3,4		3,4	3,4		3,4	3,4		3,4	3,4		3,4	3,4		3,4	3,4	
Subtotal O+M costs in mEURO	**62,1**	24,4	37,7	**43,2**	10,0	33,2	**66,6**	27,4	39,1	**54,8**	12,2	42,6	**42,2**	10,0	32,2	**53,9**	11,7	42,2
Approval, supervision, management, administration etc., 11% of subtotal O+M costs	6,8	2,7	4,1	4,8	1,1	3,7	7,3	3,0	4,3	6,0	1,3	4,7	4,6	1,1	3,5	5,9	1,3	4,6
Total O+M costs in mEURO	**68,9**	27,1	41,8	**48,0**	11,1	36,9	**73,9**	30,4	43,4	**60,9**	13,6	47,3	**46,9**	**11,1**	**35,8**	**59,8**	**13,0**	**46,9**
Contingencies 10% total O+M costs	6,9	2,7	4,2	4,8	1,1	3,7	7,4	3,0	4,3	6,1	1,4	4,7	4,7	1,1	3,6	6,0	1,3	4,7
Operational risk add-on	2,9	0,9	2,1	3,6	0,4	3,3	2,3	0,6	1,7	2,4	0,4	2,0	3,6	0,4	3,2	2,4	0,4	2,0
Total project O+M costs	**78,7**	30,7	48,0	**56,4**	12,6	43,8	**83,6**	34,0	49,5	**69,3**	15,3	54,0	**55,2**	**12,6**	**42,6**	**68,2**	**14,6**	**53,6**

5 HINTERLAND INFRASTRUCTURE

As an integrated part of the investigations carried out in relation to establishing a fixed link across Fehmarnbelt, investigations were carried out to establish the need for and consequences of a possible upgrading of the access roads and railway on land in Germany and Denmark. Below is given a brief description of the infrastructure on land for the corridor Hamburg – Copenhagen as it stands today is given, followed by a description of the expected upgrading of the infrastructure in the coming years.

It should be mentioned, that the Governments have decided, that the investments in improvements of the hinterland infrastructure should be funded by the state budgets, and as a consequence not be regarded as part of the project.

A few decisions have been taken by the Danish and German Governments to upgrade the hinterland structures and furthermore the Governments have stated that they will be willing to establish the further upgrading of the road and railway structures if considered necessary to gain the full benefits of the fixed link across Fehmarnbelt.

5.1 Access roads

Germany

Today the German **motorway A1** (2x2 lanes) ends close to Oldenburg, about 50 km South of Puttgarden. Nowadays, it can be reached by Federal Road B 207 (2x1 trunk road). According to the German Federal Transport Master Plan, the section from Oldenburg to Heiligenhafen (11 km) has been ranked in the highest priority category and is expected to be realised as motorway before 2012. For the remaining section from Heiligenhafen to Puttgarden (21 km) no planning procedure has been started so far.

Denmark

In Denmark a motorway exists all the way from Copenhagen to Rødby except for a stretch of approx. 13 km between the cities of Ønslev and Sakskøbing. The Danish parliament has in January 2001 decided that this stretch should be constructed with a stipulated opening in year 2007, meaning that a full 4-lane motorway will exist between Copenhagen and Rødby before 2010.

5.2 Access railways

Germany

The existing railway from Hamburg to Lübeck (Bad Schwartau) is a double track railway. From Lübeck and further on to Puttgarden the railway is single tracked. The railway from Hamburg to Puttgarden is without electrification. An upgrading of the railway including electrification between Hamburg and Lübeck is on the agenda today, the further stretch Lübeck to Puttgarden will be evaluated on basis of the decision about the technical solution for the fixed link across Fehmarnbelt.

Denmark

The existing railway between Copenhagen and the city of Vordingborg is double tracked. From Vordingborg and further on to Rødby the railway is a single track-railway. Only the part between Copenhagen and Ringsted is electrified today.

Neither in Germany nor in Denmark plans have been approved for upgrading of existing or new railway lines – except for Hamburg – Lübeck - in relation to the transport corridor Hamburg – Copenhagen. Several alternatives have been investigated on both the Danish and the German side. The considerations are based on the expected need for improving the capacity in general and as a consequence of the establishment of a fixed link across Fehmarnbelt and the choice of solution (single/double track, electrification).

6 SCOPE OF SERVICES

6.1 Scope of services for concessionaire

The Scope of Services for the Concessionaire is

- Designing
- Constructing
- Financing
- Operating
- Transferring

the fixed link across Fehmarnbelt.

Design

The Concessionaire might be responsible for obtaining the necessary permits and approvals from the Danish and the German authorities regarding design, safety and emergency aspects and the general long term environmental consequences.

Construction

The Concessionaire will be responsible for obtaining the necessary permits and approvals from the Danish and the German authorities regarding all activities related to construction of the fixed link including short term environmental consequences.

Financing

The Concessionaire will be responsible for raising the necessary capital.

Operation

The Concessionaire will be responsible for

- Operation and maintenance of the roadway including traffic control and toll station
- Operation and maintenance of the railway infrastructure
- To establish and manage a safety and rescue organisation
- Obtain all relevant authorities' permits and approvals for the operation

Transfer

The fixed link shall at the end of the concession period be handed over to the two governments as a well-maintained and well-functioning infrastructure.

6.2 Distribution of risks between concessionaire and the states

On risk sharing the fundamental principle should be that a party shall not be required to take responsibility for a risk, which it cannot control or protect against.

The most efficient risk allocation in a **construction contract** is reasonably that the responsibility for each risk is allocated to the party who has the best practical possibility to control the risk or protect against it.

In a BOT contract the concessionaire is given wide freedom in selecting his design, construction and operation methods. The concessionaire thus can control how the effects of different risks are considered and provided against. In principle, he can select to use preventive measures to limit the effects; or save on prevention and take additional costs if the risks materialise. The practical ability of the governments to avoid risks is correspondingly limited. It should thus be provided that all risks are the concessionaire's, except only those which are explicitly specified as the governments' risks.

The different types of risks can be listed as follows in **table 8**. The listing is primarily based on the 'Economic and Financial Evaluation of a fixed link Across the Fehmarnbelt' prepared by PLANCO and COWI in June 1999 [4] and the 'Report on the Investigation for the Definition of a Method for the Evaluation of the Possibilities of Private Realisation of the Planned fixed link across the Fehmarnbelt' prepared by IVB in co-operation with PricewaterhouseCoopers Veltins in October 2000 [7]. Further detailed considerations can be found in the two reports.

Some of the risks in the table are obviously borne by the governments, others by the concessionaire, while others again can be shared.

Table 8: Possible distribution of risks between the governments and the concessionaire

Risks (to be regulated in the Concession Agreement)	Govern-ments	Conces-sionaire
General risks (i.e. adverse events caused by external parties)		
• Changes in project specific requirements (safety, design)	X	
• Delay in access infrastructure (hinterland infrastructure)	X	
• Changes in general road user taxation and in general road user charges (e.g. road pricing)		X
• Demands for regulation of road tolls and railway infrastructure payments	X	
• Changes in Great Belt and Øresund toll	X	
• Other external political risks (risk of war)	X	
• Risk of terrorist attacks		X
• Protestor risks		X
Design and development risks		
• Design contractor fault		X
• Delay in access to site	X	
• Geotechnical conditions		X
• Changed environmental requirements		X
• Delay of permits and approvals (Government responsibility)	X	
• Delay of permits and approvals (Concessionaire responsibility)		X
Construction risks		
• Delays in construction		X
• Environmental risks		X
• Cost overruns		X
• Accidents during construction		X
• Failure of plant to meet performance criteria at completion tests		X
• Force majeure		X
Operation risks		
• Possible underestimation of cost of operation		X
• Accidents (carrying liability or closure of the link for a period of time)		X
• Shortfall in traffic due to operator's fault (malpractice)		X
Financing risks		
• Future development in the general economy (inflation, exchange rates, interest rates)		X
• Financing structure (extent of loan capital, availability of guaran-tees)		X
Market traffic risks		
• Variations in predicted traffic due to general economic development		X
• Variations in predicted traffic due to competitive action (e.g. ferry routes between Scandinavia and Central Europe)		X
Any other risks		X

7 TRAFFIC AND REVENUE FORECAST

All indications in this Information Memorandum related to traffic forecasts are taken from the final reports of the Fehmarnbelt Traffic Demand Study by the Fehmarnbelt Traffic Consortium[4] [3] and of the Economic and Financial Evaluation Study by PLANCO and COWI [4]. The FDJV consultants have not carried out audits of these reports nor had it available any intermediate reports or technical working notes.

7.1 Structure of the traffic model

The whole of Europe including Central and Eastern Europe has been defined as area of influence for the purpose of the traffic study. This area was divided into 207 traffic zones (73 for Germany, 50 for Denmark, 45 for other Scandinavian countries and 39 for Western, Southern and Eastern Europe).

The FTC has developed separate traffic models for passenger and freight traffic. The two models have different base years: 1996 for passenger movements and 1994 for freight movements. The passenger traffic modes include road (cars, buses, trucks), rail, air and ferry (including walk-on foot passengers). The modes for freight transport are road, rail (including combined transport) and ferry.

Comprehensive surveys were carried out by the FTC for in-depth analysis of transport and traffic behaviour including stated preference surveys with travellers on ferries, inside trains and airport lounges as well as with shippers and carriers.

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4 The traffic demand study for the Fehmarnbelt Fixed link were undertaken between 1994 and 1998 by the Fehmarnbelt Traffic Consortium (FTC), a joint venture of five consulting firms:

- BVU Beratergruppe für Verkehr und Umwelt GmbH, Freiburg, Germany
- Carl Bro a/s – Traffic and Transport, Glostrup, Denmark
- The Hague Consulting Group (HCG) bv, The Hague, Netherlands
- Institut für Seeverkehrswirtschaft und Logistik (ISL), Bremen, Germany
- Intraplan Consult (ITP) GmbH, München, Germany

With contributions from three specialised subconsultants:

- TetraPlan Aps, Copenhagen, Denmark
- I&A Research A/S, Frederiksberg, Denmark
- Accent Marketing & Research, London, United Kingdom

Origin-destination matrices were developed separately for each mode of transport as well as trip purposes (10) for passengers and commodity groups (11) for freight. For passenger modes, separate matrices for summer traffic and rest of the year traffic were elaborated.

7.2 Scenarios

The Traffic Demand Study considered the following alternative supply scenarios:

(1) **reference scenario:** without a fixed link, maintaining ferry operations for passenger trains, road vehicles and walk-on foot passengers; access infrastructure improvements by rail and road would be those which have already been decided by the two governments;

(2) **4+2 scenario**: combines a double-track electrified rail crossing for high-speed operations with a four-lane motorway crossing; access infrastructure would be upgraded to the standards of the crossing, allowing for example passenger trains to run between Copenhagen and Hamburg in 160 minutes;

(3) **2+1 scenario**: an intermediate solution combining a single-track electrified rail crossing with a two-lane highway; compared to the 4+2 scenario, an average 30 minutes travel time by rail and 10 minutes by road are added;

(4) **0+2 scenario**: a rail only solution similar to the Channel Tunnel fixed link with shuttle trains for road vehicles as well as through-trains (this solution is not considered any further by the two governments; it is therefore not considered in the ECI process).

The traffic study does not assume that ferry traffic will be abandoned altogether once the fixed link will be operational. Ferries would carry walk-on passengers between Rødby and Puttgarden for shopping and excursion. The Gedser-Rostock ferry link would continue to operate, albeit possibly with lower frequencies.

An **improved ferry system** between Puttgarden and Rødby was also considered at a later stage as an alternative solution (see [6]). It was argued that through improved ferry loading procedures, crossing times could be reduced to that of a rail shuttle system. No detailed traffic forecasts were carried out for this case.

7.3 Main inputs for traffic forecasts

Assumptions for socio-economic growth between the respective base years and the forecast year 2010 are to a large extent based on forecasts[5] covering population, employment, economic output and car ownership adapted to the zoning of the study.

The base fare for an average summer one-way crossing of a passenger car with 4 passengers is assumed to be €58 in 2010. This includes a 10% upward adjustment in real terms due to the abolition of duty free sales on intra-EU sailings in July 1999, as well as 20.5% VAT (25% for Denmark and 16% for Germany).

Table 9: Assumed user charges for 2010 (in 1997 prices)

Mode	Vehicle Toll (€)[1)]	Train Charge (€)
Passenger Cars	58	
Buses	212	
Trucks (HGVs)	212	
Passenger Trains		Not specified
Freight Trains		Not specified

1) including VAT

Source: PLANCO/COWI [4], p. 3-23

The standard one-way fare for a tractor + semi-trailer heavy goods vehicle (HGV) or for a bus was originally assumed by the Fehmarnbelt Traffic Consortium to be €222 in 2010 (1996 prices), net of VAT. The traffic forecast is based on this assumption. In the financial evaluation, however, Planco/COWI have argued that truck operators would benefit from rebates in the order of 20%. As a result, the Planco/COWI report shows a toll for heavy vehicles of €212, this figure including VAT. Revenue figures have subsequently been calculated on these significantly lower toll rates, but with traffic forecasts corresponding to higher tolls. Planco/COWI have argued that this discrepancy constitutes a conservative element in the evaluation.

The mentioned toll rates are assumed to be the same in all scenarios and for all trip purposes.

5 [3], 5-2

No charges are shown for rail crossings because of confidentiality due to commercial sensitivity of such information. It is however assumed that rail charges on the fixed link would be the same as the savings in operating costs of trains diverted from the Great Belt route to Fehmarnbelt with the result that overall train operating costs are equal on the two routes.

7.4 Traffic forecasts

The FTC transport demand and traffic forecasts for the year 2010 are shown in **table 10** below.

Table 10: Transport demand and traffic forecast 2010

Mode		Unit (thousand)	Reference (Trend) Scenario (Ferry)		2+1 Scenario	4+2 Scenario
			Base Year*	2010		
Road	Cars	Passengers	3,195	3,765	5,590	5,792
		Vehicles	994	1,319	2,171	2,268
	Buses	Passengers	1,435	1,642	2,030	2,055
		Vehicles	39	47	58	59
	Trucks	Tonnes	3,241	5,042	5,525	5,553
		Vehicles	272	427	479	481
Rail	Pass. Trains	Passengers	717	633	1,576	1,835
		Trains	4.38	2.19	13.87	13.87
	Freight Trains	Tonnes	3,845	---**	10,725	10,773
		Trains	6.13	---**	16.18	16.26

* 1996 for passengers and 1994 for freight ** routed via Great Belt

Source: FTC [3], pp. 6-2, 6-3

The differences between the 2+1 scenario and the 4+2 scenario are relatively small. This indicates that at least in the early years of the fixed link operation, a 2+1 solution would provide sufficient road and rail capacity.

7.5 Revenues from forecast traffic

Estimated traffic revenues are shown in **table 11** in 1997 prices, net of VAT.

Table 11: Revenue Forecast 2010 (million Euro)

Mode	**2+1**		**4+2**	
	m€	**%**	**m€**	**%**
Passenger Cars	104	38 %	109	39 %
Buses	10	4 %	10	4 %
Trucks	84	30 %	85	30 %
Railway (1996 prices)	76	28 %	76	27 %
Total	**274**	**100 %**	**280**	**100 %**

Note: in this table, toll revenues from road vehicles have been calculated by multiplying the traffic forecasts with the toll rates given in table 9. The total is marginally lower than those used in the cash flow tables in Annex 3.1 of the PLANCO/COWI report (€280m and €285m respectively, in 1996 prices).

Since no traffic forecasts beyond 2010 were available from the FTC study, PLANCO/COWI have assumed for the purpose of the financial analysis that revenues from road vehicle tolls would increase by 1.7% annually while revenues from rail user charges would remain unchanged.

8 FINANCIAL ASPECTS

8.1 Objectives

The financial analysis is aimed at assessing:

- whether the construction and operation of a fixed link across Fehmarnbelt can be paid for in full by user charges;
- whether the project can be implemented by a private sector operator on commercial terms and based on market based financing; and
- to identify those technical alternatives which are most likely to form a viable basis for private sector implementation.

The following **two business cases** will be discussed within this chapter:

- **Solution model 3**: a four-lane dual carriageway motorway and a double-track electrified railway (4+2, cable stayed bridge)
- **Solution model 5.1**: a two lane highway with an emergency lane and a single-track railway (3+1, immersed tunnel)

The business cases are analysed as BOT-projects, where a private sector operator (concessionaire) is assumed to undertake the construction and subsequent operation of the fixed link in return for a concession to collect user tolls (refer to chapter B 9). The revenues generated during the concession period are used to operate and maintain the facility, to service loans, to repay the concessionaire's equity investment in the project and to pay the concessionaire a return on equity reflecting his business risks.

The participants are asked to prepare a **financial model** to be able to answer the questions presented in the questionnaire. To ensure comparability of the participants' findings a few general assumptions/statements are presented in the following which the participants are asked to include in their calculations.

COWI Consulting Engineers and Planners and PLANCO Consulting GmbH have already carried out a financial evaluation of a fixed link for different technical solutions including sensitivity and risk analysis (see [4]). The additional assumptions used for their calculations are stated in the footnotes. The participants are asked to comment on these assumptions and - when found necessary - state clearly which other assumptions have been applied in their calculations.

8.2 Assumptions

The analysis is concerned with the construction and operation of the fixed link and comprises the fixed link infrastructure, associated approaches linking to the existing rail and road network and associated auxiliary constructions. In performing the analysis the following assumptions apply:

- The investor builds and subsequently operates the fixed link for a given period[6]. At the end of the concession period, the fixed link will be transferred to the two governments[7].

- The setting of toll levels for the usage of the road connection is subject to the approval of the governments (see 1.3.3.2). Payments for the usage of the rail connection are agreed on the basis of a negotiated contract with the concerned railway operators.

- Access infrastructure in the fixed link's hinterland is supposed to be upgraded in time and paid for by the state budgets.

8.3 Revenues and costs

The most significant **revenues** can be expected from vehicle tolls and train charges as described in chapter B7 (in total: €274m for the 3+1 solution and €280m for the 4+2 solution as a revenue forecast for the year 2010, net of VAT). There might be additional commercial opportunities which could add up to the revenues[8].

The **investment and operation** costs which were described in detail in chapter B4 are summarised for the two base cases in the following **table 12**.

6 Assumption COWI/PLANCO: period of 30 years starting at the opening of the link.

7 Assumption COWI/PLANCO: fixed link is handed over free of charge

8 For the Øresund-link for example other income comprises revenues from the use of fibre optic and telephone cables on the bridge.

Table 12: Estimated costs of construction and operation (m€ in 1996 prices excl. VAT) for the business cases

Cost items	**Solution 3** **Cable stayed bridge (4+2)**	**Solution 5.1** **Immersed tunnel (3+1)**
Construction (tender price)	2,426	2,324
Design and supervision (5.5%)	133	128
Client's organisation	115	115
Contingencies (10%)	267	257
Risk add-on during construction	98	51
Total project costs	**3,040**	**2,874**
Construction period (years)	**6.5**	**7.0**
Operation and maintenance	62	43
Supervision and management (11%)	7	5
Contingencies (10%)	7	5
Risk add-on during operations	3	4
Total cost of operation per year	**79**[9]	**57**

9 It should be mentioned that this figure represents an average over a 100 year concession period and that the operation costs are expected to increase over the first 15 years from approx. Euro 50 Mill. to a level of Euro 79 Mill. in year 15.

8.4 Financing

External investors could be equity investors providing supplementary equity capital beyond the capital invested by the operator, or lenders providing loan capital to the project.

- **Lending terms and interest rates**
  The applicable interest rate for commercial loans usually consists of a **benchmark**, e.g. the interest rate at which governments and first class financial intermediaries may raise funds in the international financial market and a risk premium which reflects the operator's solidity (credit rating), the risk associated with the project itself and the quality of collateral and guarantees offered.[10]

- **Lending fees**
  The organisation and execution of syndicated lending comes at cost which has to be taken into account[11].

- **Solidity (credit rating)**
  Credit rating is a formal evaluation of a company's credit history and capability of repaying obligations. The solidity of debtors is commonly assessed on the basis of the debtor's debt/equity ratio, defined as long-term debt divided by the company's equity capital. Values of 3 to 5 are common for reputable private companies, whereas borrowers with first class credit ratings and huge assets may borrow up to a debt/equity ratio of up to 10 or more without encountering deteriorating terms of lending.[12]

- **Guarantees**
  Operator requirements may include the issuance of financial guarantees by the two governments which may be linked to external loans (sovereign guarantees) or to revenue generation (revenue guarantees).

---

10 Assumption COWI/PLANCO: „Current" interest rate for 10 year government bonds in Denmark, Germany and the UK are in a range of 2.0% (UK)-3.2%(Germany), with a mean of approximately 2.7% in real terms (as of 01/99). Based on information gathered in an earlier investor survey the risk premium charged for loan financing for this project would seem to be in a range of 0.5%-2.5%. A total initial lending rate of of 3-5% in real terms has been tested. The risk associated with future developments of interest rates has been assessed by performing monte-carlo simulation on random-walk series of possible future market interest rates.

11 Assumption COWI/PLANCO: financing costs of 1.5% of the amount lend are summarily adopted.

12 Assumption COWI/PLANCO: a debt/equity ratio of 5 is taken as the starting point; alternative ratios of 3 and 10 are tested in the sensitivity analysis.

Sovereign guarantees increases an operator's potential for lending at prime terms. This is illustrated by the operator of the Great Belt and the Øresund links, where access to sovereign guarantees allowed the operator to raise financing on prime terms on the basis of rather small equity capital.

However, there is the possibility of obtaining commercial guarantees issued by monoline insurers[13]. Such guarantees can substantially reduce funding costs in the bond markets. A precondition for obtaining such guarantees is that the project itself (without guarantees) obtains a rating of BBB or better.

Revenue guarantees protect the operator if revenues fail to meet expectations (e.g. traffic forecasts) and provides the lenders with a guaranteed minimum cash flow available for the service of loans. Revenue guarantees are usually combined with a profit sharing provision, whereby the guarantor shares in any revenues above expectations, e.g. when traffic develops more favourable than expected.[14] For the time being guarantees have not been earmarked by the governments.[15]

- **Opportunity cost of equity capital invested**
  To assess the **net present value** (NPV) of the project to equity investors, net present value calculations are discounted by a preference rate of return. The discount factor represents the equity investors‘ alternative rate of return, e.g. the return they might receive from alternative investments.[16]

- **European Investment Bank**
  European Investment Bank, the European Union's financing institution, supports investment furthering Europe's knowledge-based economy, regional development, environmental protection, future enlargement and development co-operation. In 2000, EIB advanced €36bn for investment projects, both within and outside the Union.

13 A monoline insurer is an insurer that writes only financial guarantee insurance. Top credit insurers include Ambac, FGIC, FSA, MBIA (each one rateed AAA by all three rating agencies).

14 Assumption COWI/PLANCO: a case with no revenue guarantees; a case where the operator is guaranteed a minimum return on invested capital of 6% in real terms, whereas the guarantor receives all excess payments above a level where the return on capital is 10% in real terms; a similar case, where the lower and upper bounds are 8% and 12% in real terms respectively.

15 Assumption COWI/PLANCO: two cases are tested (no sovereign guarantees; sovereign guarantee coverage of the full cost of constructing the fixed link).

16 Assumption COWI/PLANCO: a rate of return of 10% in real terms has been used as an average estimator for the return required by a suitably assembled group of equity investors.

As a leading source of financing for large European infrastructure projects, in particular Trans European Networks (TEN), EIB is giving special emphasis to the development and support of PPP's as an additional instrument to promote capital investment in economic and social infrastructure.

Since 1993, EIB has financed TEN's transport projects costing a total of €144bn, approving loans for €44bn. Among these were PPPs such as Athens international airport, Vasco da Gama bridge in Lisbon, the Great Belt link, the new Elbe Tunnel in Hamburg, the Øresund link and Europe's high speed rail link network. EIB also supports PPPs in other sectors, including education, health, water and energy.

- **Trans-European Transport Networks (TEN)**
  In July 1996, the European Parliament and the European Council decided on the Community guidelines for the development of the trans-European transport networks to support infrastructure projects inside the European Union (Decision No 1692/96/EC).

  The Fehmarnbelt fixed link was already in the report from the Christophersen group identified as an important project for the European Union and was included in the guidelines as an project of common interest. The European Union has since supported the feasibility studies that have been carried out by the German and the Danish Ministries of Transport. The Enquiry of Commercial Interest is expected to receive support as well.

  For the purpose of planning, the European Union do operate with a Multi-annual Indicative Programme (MIP) and this year the Fehmarnbelt fixed link has been included in this programme with an expected support of €38m in the period 2003 - 2006. The extent of the support in total is estimated at 5% of total construction cost. According to the white book on the Community’s transport policy (draft, June 2001) the European Commission reiteratively proposed to raise the maximum support for certain TEN projects from 10 to 20 per cent.

- **Taxes**
  The operator of the fixed link is assumed to be subject to corporate taxation and is assumed to be incorporated in the EU. Tax base is profit before taxes, calcu-

lated in accordance with normal accounting principles[17].

The current VAT-rate in Denmark is 25% and in Germany 16%.

8.5 Financing risks

A possible distribution of risks is described in chapter B 6[18]. Financing risks include the risks associated with the future development in the general economy[19] (notably inflation and future variations in exchange and interest rates) and risks associated with the financing structure[20] adopted in the project, such as the extent of loan capital employed and the availability of guarantees.

8.6 Summary of results

Basic cash flow projections were carried out by COWI/PLANCO assuming the following financial parameter (base case):

17 Assumption COWI/PLANCO: the operator will be granted the right to fully depreciate the total cost of investments over the concession period; 30-year straight-line depreciation of the initial investment costs, starting in the opening year; to simplify calculations investments during the operations period are treated as operational expenses; the operator will be granted the right to carry past losses forward indefinitely; corporate tax rate represents the consultants‘ assessment of the likely long term corporate tax rates in the EU area and is implemented as a flat rate of 32% on taxable income (derived from the average effective tax rates from firms domiciled in the 15 member states in the EU).

18 Assumption COWI/PLANCO: risks have either been assessed by estimation of upper and lower 95% confidence intervals, the inclusion of contingencies (table B-11) or of a risk add-on (table B-11).

19 Assumption COWI/PLANCO: The impact of price developments could be neutralised by performing the analysis in fixed prices. This approach assumes implicitly that all prices develop in step and furthermore the absence of price illusion on the part of the consumers. The exchange rate risks are considered minimal after the introduction of a common currency and the firm attachment of the exchange rate for Danish Kroner to the Euro. Interest rates are likely to vary significantly over the construction and operation period. Parts of this variation will reflect variations in the level of inflation. These variations could be widely eliminated by the adoption of fixed prices. The remaining part of the variation is treated as an explicit risk parameter in the analysis.

20 Assumption COWI/PLANCO: Conservative financing strategy; equity investor carries all losses by providing additional equity infusion, rather than defaulting on the loans; exception is the case where government guarantees are involved and the guarantor carries the losses.

- Debt/equity ratio 5
- Lending rate (p.a. in real terms) 4%
- Sovereign guarantees none
- Revenue guarantees none
- Corporate tax (flat rate) 32%
- Toll rate (passenger car rate one-way incl. VAT) 58 EUR

Table 13: Summary results of the basic financial cash flow projections in fixed 1996 prices

Business cases	IRR[21] (% p.a. in real terms)	NPV[22] (7%, million EUR)	NPV (10%, million EUR)	Equity Investment required [23] (million EUR)	Break-even[24] (years)	Equity to Total Capital Ratio	Net Government Revenues[25] (million EUR)	Max. Governm. Deficit[26] (million EUR)
Figures according to total project costs								
4+2: Cable Stayed Bridge	7.3%	21	-151	762	14	25%	2,035	-620
3+1: Immersed Tunnel	9.1%	174	-47	720	11	25%	2,409	-586

A synopsis of the key parameters of the two business cases is given in **table 14** on the following page. This table is also presented in the Questionnaire.

21 IRR of Equity Investments, which is the equity investor's return on capital invested over the project period. The item is expressed in per cent per annum in real terms.

22 Net Present Value (NPV) of equity investments, which is today's value of all future project payments for an equity investor with a preference rate of return of either 7% or 10% p.a. in real terms.

23 Equity Investment Required, which is the maximaum balance of net equity investments required during the project period. The maximum balance is reached immediately prior to initiation of operations.

24 Break-even Period, which is the number of years required to repay the equity capital invested in the project. The item is expressed in number of years after initiation of operations.

25 Net Government Revenues, is the sum of the two governments' net receipts from the project, encompassing: VAT, corporate taxes and possible guarantee payments.

26 Maximum Government Deficit, which is the maximum balance of accumulated net government transfers to the project. The temporary deficit stem primarily from VAT refunds in the investment period and from possible guarantee payments.

Table 14: Two possible business cases (based on Planco-COWI report)

Solution model (term used in technical reports)		**Solution 3** Cable stayed bridge (4+2)	**Solution 5.1** Immersed tunnel (3+1)
Costs • Total construction costs • Construction contingencies+risk add-on= *Total project costs*	M€ M€ *M€*	2674 366 *3040*	2567 307 *2874*
• Total operation and maintenance costs • Operation and maintenance contingencies + risk add ons *Total operation and maintenance costs*	M€/year M€/year *M€/year*	69 10 *79*	48 8 *56*
Construction period	years	6 1/2	7
Distribution of costs		Evenly over the construction period	
Market interest rate (real terms)	%	4	4
Lending fees	%	1.5	1.5
Risk premium	%	1.3	1.3
Debt/equity ratio		5	5
Depreciation		Full straight line depreciation of the total cost of investments over the operation period	
Right to carry past losses forward		Granted the right to carry past losses forward indefinitely	
Corporate taxation	%	32	32
VAT during construction		Allowed to deduct VAT in Germany and Denmark (average of 20.5 %)	
VAT during operation	%	Pay VAT according to ordinary rules	
Sovereign guarantees		None	None
Rate of return of capital invested (real terms) [2]	%	7.3	9.1
Revenues TEN support		5 % of construction costs	
Government support	M€	0	0
Road traffic annual growth after 2010 • Number of passenger cars (2010) • Number of busses (2010) • Number of trucks (2010)	% 1000 1000 1000	1.7 2268 59 481	1.7 2171 58 479
i) toll rate passenger cars (VAT included) [1] ii) toll rate buses (VAT included) [1] Iii) toll rate trucks (VAT included) [1]	€ € €	58 212 212	58 212 212
Railway revenue (VAT excluded)	M€/year	76	76
Bonus payment related to performance [3]	€	0	0
Additional commercial opportunities [3]	€	0	0
Revenue guarantee	€	0	0
Payment for transfer of fixed link	€	0	0
Length of concession period [2]	years	7+30	7+30

Price level: 1996

1) Road tolls in 1997 prices to be deflated by 1.5 % to arrive at 1996 prices.

2) In the financial analysis in the Planco-COWI report a construction period of 7 years and an operation period of 30 has been used to calculate the rate of return.

3) The business cases are based on the financial analysis in the Planco-COWI report, but these two opportunities have been added by FDJV.

9 CORPORATE AND LEGAL FRAMEWORK

The term BOT stands for build, operate and transfer, i.e. the tasks involved in this project. The essential feature here is that the government avails itself of private enterprise in that it fully or partly assigns, by contract, tasks originally incumbent on it to a private company for a defined period (so-called contracting out).

9.1 The structure of BOT projects

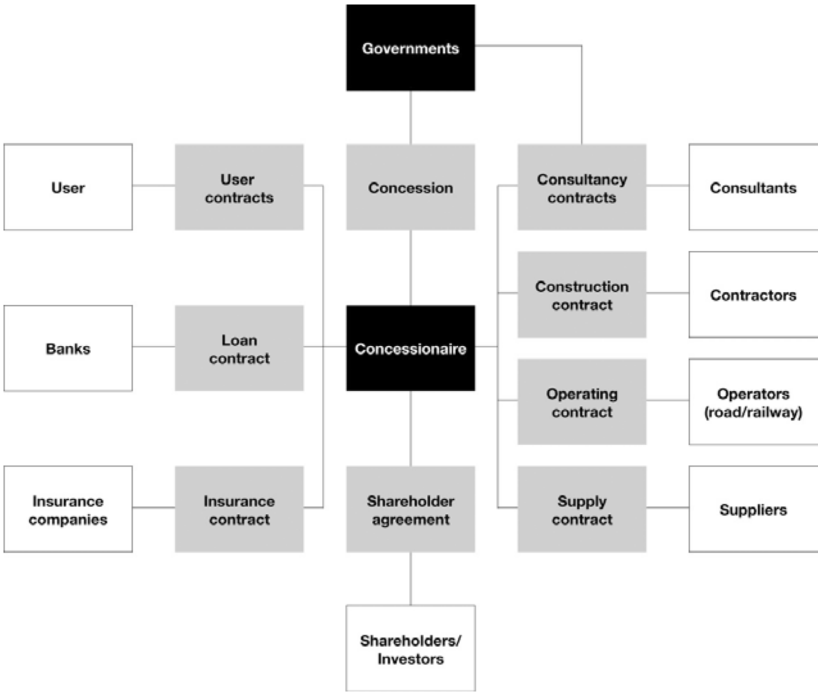
Where BOT projects are designed to implement **infrastructure measures** they are basically structured as follows:

- The public authority concerned/government (grantor) grants a private company (concessionaire) a concession for the planning, realisation and operation of the project for a contractually agreed period (the concession period). Under the concession the concessionaire is entitled to charge a fee to the users of the facility to be built.

- The concessionaire is responsible for funding the implementation of the project and its operation. The proceeds derived from the exploitation of the concession are needed to fund day-to-day operation including maintenance, to repay and pay interest on the loans raised and the equity invested, and to generate a profit. Project risks are adequately contractually shared between grantor and concessionaire.

- Upon expiry of the concession period, the concessionaire will transfer the facility in a technically and economically usable condition to the public authority/government free of charge or for a fixed amount.

Figure 3: Schematic organisational and contractual structure



9.2 The legal design of BOT projects

9.2.1 Applicable contract award provisions

In its notice on public-private partnerships for financing trans-European infrastructure projects - COM(97) 453 of 10 September 1997 - the European Commission recognises the need for the promotion of major infrastructure projects by securing the participation of private enterprise in their financing, realisation and subsequent operation. For one thing, public authorities often lack the necessary funds, and for another they can thus divest themselves of at least part of the risk, while tapping the experience and know-how of private investors. Following the Commission's interpretative notice 2000/C 121/02 of April 29, 2000 on concessions under Community law, growing importance attaches in particular to the award of concessions. This notice informs about the rules and principles which the Commission feels apply to concessions under Community law as it stands (esp. following Council Directive 93/37/EEC). These rules and principles are designed to give Community firms free access to public service concessions and to ensure that Community law is fully respected by Member States when concessions are awarded.

For the implementation of the "ideal version" of the BOT project structure relating to a fixed link across Fehmarnbelt, the award of a concession is a possible legal instrument. The subject matter of such a concession could be the construction, maintenance, operation and funding of the link. Thus, the concession would not be limited to building performances, but would rather, as a necessary consequence of the concession for the construction work, also cover services, viz. in the areas of financing and operation, and in part also where the maintenance of the link is concerned.

9.2.1.1 Concessions with special emphasis on work concessions

In European Community law there is neither a general definition of "concession" nor are there special provisions applicable thereto. An exception is the work concession which is subject to certain provisions of Council Directive 93/37/EEC concerning the co-ordination of procedures for the award of public works contracts of June 14, 1993 as amended by Directive 97/52/EC of October, 13 1997 (works contracts co-ordination directive). Article 1 lit. d) of the above Directive defines public work concessions as "contracts" which deviate from public works contracts only in so far as the consideration for the works is exclusively confined to the right to use the link construction or to that right plus payment of a certain price.

This means that

a) leaving the **property to the concessionaire** for its use, where appropriate for payment of a price and

b) the **assumption of risks by the concessionaire** are the two key elements of a work concession:

- The **right of use** entitles the concessionaire to charge a fee to the users of the link during the concession period. Hence, the concessionaire is not remunerated directly by the grantor, but is rather enforced by the latter to retain the proceeds it derives from the use of the link. This right of use may be supplemented by the payment of a price by the grantor.
- Along with the right of use, the **risks** associated with the nature of such use are to a great extent transferred to the concessionaire. However, there is no law or regulation determining how much or how little of the risk must or can be assumed by the private investor. Rather, whether a given instrument qualifies as a work concession or a public works contract must be determined on a case by case ba-

sis. The fundamental criterion of a work concession is that the concessionaire, apart from being responsible for both the technical and the financial aspects involved, also bears the risks associated with the nature, the management and the degree of utilisation of the link.

The granting of a right of use plus payment of a price by the grantor does not conflict with the assumption of a (building) concession. European Community law and/or the practice of the European Court of Justice do not impose a precise limit on the remuneration in proportion to the value of the right of use. In practice, governments sometimes bear part of the cost of use of the concession in order to lower the price payable by the user, e.g. where the concessionaire may charge only certain "socially acceptable prices" and the government therefore contributes financially to the day-to-day operating costs.

Such government intervention, which assumes part of the risk, may take various forms such as a **contractually guaranteed lump-sum** or fixed contributions depending on the number of users. The nature of such a contract is not necessarily different if the amount paid out to the concessionaire covers only part of the cost of erecting and utilising the link. Where, however, the government subsidises the cost of construction and operation to such an extent that it more or less assumes the risk, the instrument qualifies as a public works contract. This is the case e.g. where the government undertakes to balance potential shortfalls in user fees. So, on the whole, it is the kind of remuneration paid to the private investor in a given case that determines who bears the risk of use.

Incidentally, where mixed contracts are concerned it may prove difficult to differentiate between a work and a services concession. In practice, the holder of a work concession in most cases also renders a service to the user in the context of the link erected by it. According to the Commission, the criteria of a work concession are met if the principal subject matter of a contract is the construction of an link.

9.2.1.2 Regulations governing the award of work concessions

As follows from the above, the principles of the above mentioned Directive are applicable to work concessions whose contract value exceeds the threshold value of €5m laid down in works contracts co-ordination directive 93/37/EEC. Since in the present case no remuneration is to be paid to the concessionaire, there will be no aggregate contract value which otherwise would be decisive in calculating the threshold value. Rather, the decisive criterion here is the total value of the performances to be rendered by the concessionaire.

As the object of a work concession is the rendering of economic performances, its award is also subject to articles 28 to 30 and 43 to 55 of the Treaty establishing the European Community as amended in Amsterdam and to the principles developed by the European Court of Justice, i.e. in particular on non-discrimination, equal treatment, transparency, reciprocal recognition and proportionality.

9.2.2 Definition of an appropriate legal framework for awarding concessions

The legal structure of a BOT project consists of a network of complex long-term contracts between the various parties involved. Central to it is the concession agreement between the public authority concerned and the concessionaire. The latter is always a project development company whose parties are the project developer, notably the building contractors and equipment suppliers, and, where appropriate, also the later operator.

The **concession agreement** defines the subject matter of the concession and its terms and conditions, i.e. the basic framework of the project. Where the project development company does not itself take charge of the operation and maintenance of the project, it will conclude a corresponding agreement with an operating company.

9.3 Examples

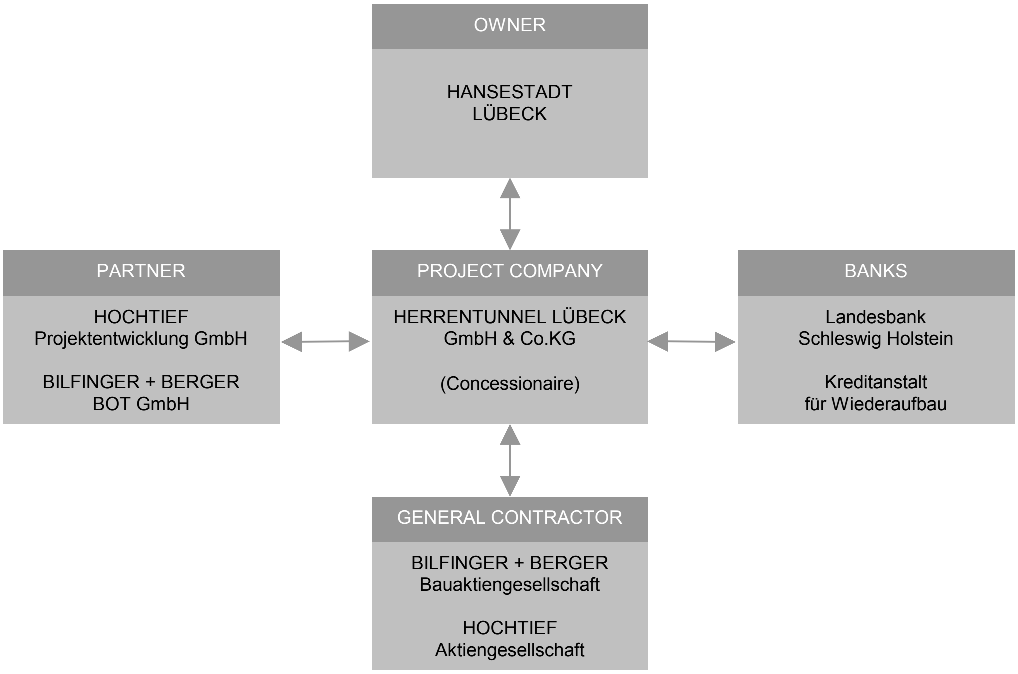
9.3.1 Herrentunnel Lübeck

9.3.1.1 Description of project structure

The purpose of this project is to replace the dilapidated so-called “Herrenbrücke” (drawbridge) across the River Trave with a tunnel of approximately 1,000 meters in length. This is intended to enable uninterrupted automobile and nautical traffic.

The concession agreement was signed on March 12, 1999. Owner of the object and licensor is the Hansestadt Lübeck (Hanseatic City of Lübeck). The project company “Herrentunnel Lübeck GmbH & Co. KG” is the concessionaire for the project, assuming responsibility for planning, financing, construction and operation of the tunnel. Equal shareholders in the consortium are HOCHTIEF Projektentwicklung GmbH (managing) and BILFINGER + BERGER BOT GmbH.

Figure 4: Organisational structure of Herrentunnel Lübeck project



The entire works will be planned and completed by a general contractor and planner, a consortium comprising Bilfinger + Berger Bauaktiengesellschaft (managing) and HOCHTIEF Aktiengesellschaft. Advisors to the project for toll technology and operating processes (charging tolls) are the TÜV Rheinland and Autostrade International.

Financial advisors during the bidding process were Landesbank Schleswig-Holstein and die National Westminster Bank.

The concession is for a term of 30 years after which the object is to be delivered to the City of Lübeck in irreproachable condition. The city may then choose either to operate the tunnel on its own, grant a new concession or transfer the object to the federal government. The economic risk is assumed by the concessionaire.

9.3.1.2 Financing structure

The sum that would be necessary for the repair and restoration of the draw bridge totalling €88m will be provided by the German Federal Ministry of Transport, Building and Housing as a subsidy. During the construction phase approximately €82m will be disbursed. The rest is to be paid as an operating cost subsidy after opening. No sovereign guarantees or soft loans are granted from the public purse.

The financing requirements are estimated at the time to lie around €162m minus the subsidy of €88m. Both partners will contribute 25% of this sum (approx. €18m) in the form of equity. External capital is planned in the form of bonds and fixed interest, long-term/ revolving loans with an expected maturity between 15 and 20 years.

Since this project deals with non-recourse financing, the project itself becomes the collateral for the banks. No sovereign guaranties or revenue guaranties will be issued. The banks have a right, under certain defined conditions, to enter the project company. Financing commences once the planning has been approved, whereby planning and government approval risks are precluded. The general contractor is responsible to perform all planning and construction work and to deliver a turnkey project at the agreed total price and on the agreed completion date. Since the tunnel is a replacement object for traffic volume which already exists, there is a lower traffic risk threshold than with a “green fields project”.

9.3.1.3 Refinancing

Refinancing takes place in the course of the concession’s term (30 years). The cash flow after service on capital is available for e.g. deposits in a reserve account for capital service or payments to the partners (dividends and return of equity provided). The decisive parameter for the banks is the Annual Dept Service Cover Ratio (DSCR).

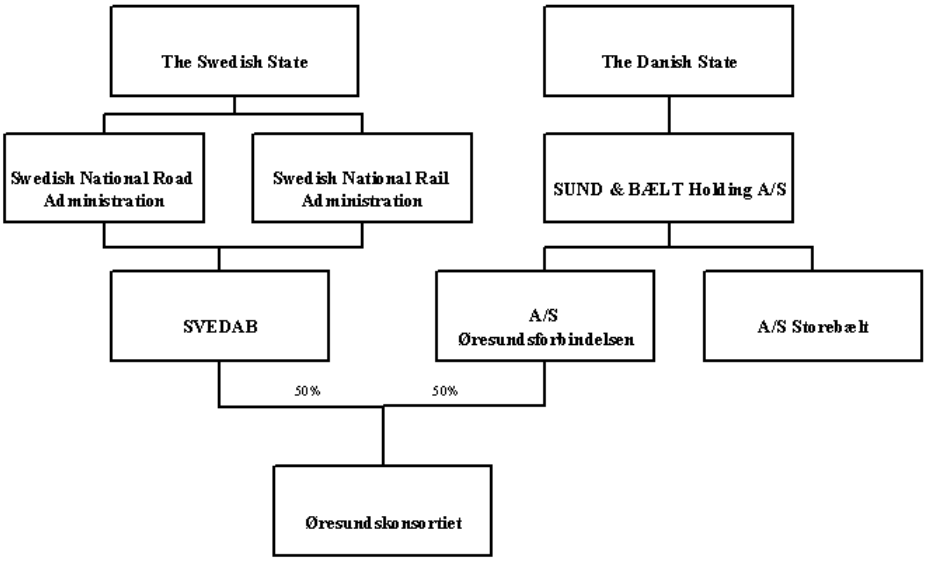
The cost types to be refinanced in part by tolls are defined in the **Law on Privatisation concerning the Construction of Trunk Roads** (Fernstraßenbauprivatfinanzierungsgesetz). The toll ordinance is to be promulgated in close co-ordination between the Hansestadt Lübeck and the German Federal Ministry of Transport, Building and Housing. The traffic risk is to be carried by the private sector partner. German law does not allow a prohibition of competing routes. The toll must be in appropriate proportion to the advantage (shorter route, time-saved) gained by the user (equivalence principle, cost coverage principle).

9.3.2 Example Øresund

9.3.2.1 Description of project structure

With planning and construction completed and the inauguration on July 1, 2000, Øresundsbro Konsortiet is now responsible for the operation of the 16 km coast-coast link between Denmark and Sweden. The inauguration marked the completion of 4.5 years' construction work which was carried out on schedule and within budget. A/S Øresundsforbindelsen (A/S Øresund) and Svensk-Danska Broförbindelsen SVEDAB AB (SVEDAB) are responsible for the operation of the landworks in Denmark and Sweden respectively. A/S Øresund and SVEDAB are wholly owned by the Danish and Swedish states.

Figure 5: Organisational structure of the Øresund fixed link



Øresundsbro Konsortiet was established and is regulated in accordance with a special agreement between the two governments. Each country holds 50 % of Øresundsbro Konsortiet and ownership is exercised through A/S Øresund and SVEDAB which have each invested approx. €3.4m (DKK25m) in Øresundsbro Konsortiet.

Øresundsbro Konsortiet's Technical Department is a small unit with responsibility for maintenance on the bridge as well as a number of other functions relating to quality management, contract administration, the environment, the working environment, risk management and insurance and road patrols, road operations and winter services. In practice, operations and management are handled via a number of service contracts. The Technical Department also handles the monitoring and maintenance of the Øresund Bridge's optical cable link which is leased out for a typical agreed period of 25 years.

Øresundsbro Konsortiet is infrastructure administrator and track owner of the approx. 16 km of Øresund Line which comprises the coast-coast section of the Øresund link. Øresundsbro Konsortiet, therefore, has responsibility for the operation and maintenance of the coast-to-coast section of the railway. Øresundsbro Konsortiet is also responsible for ensuring that allocation of capacity on the line is in accordance with objective and fair criteria and that safety risks are as low as practically possible.

This task is carried out by a small unit charged with traffic management, allocation of capacity, rail operations and track maintenance. In practice, several of these tasks have been outsourced to contractors. The Danish National Railways Agency and

Bankverket of Sweden are, for instance, responsible for day-to-day traffic management and rail operations for the Danish and Swedish sections of the system respectively. Øresundsbro Konsortiet signed a contract for maintenance of the railway engineering installations on the entire stretch – from Kastrup to Lernacken – with the Danish National Railways Agency's Service Division.

9.3.2.2 Financing

At the end of 2000, a number of minor construction tasks were outstanding. The construction costs are expected to be lower than the budget of approx. €2bn (DKK14.8bn). The above comprises the bonus agreed with the contractors in 1998 which ensured the construction work's efficient and controlled completion. The construction budget includes the subsidy received from the EU commission under the Trans European Network programme, under which the fixed link across Øresund has been designated as a priority project. Subsidies for the coast-coast section of the project sum up to €127m (DKK780m) in 1990 prices.

In 2000, Øresundsbro Konsortiet raised loans totalling €0.7bn (DKK5.2bn). The total gross borrowing was thus €3.0bn (DKK22.5bn) at year end while interest bearing net debt was €2.6bn (DKK19.4bn).

Øresundsbro Konsortiet raises loans in international, Danish and Swedish financial markets at the most favourable terms available at any given time, i.e. expiry dates, loan size etc. All loans, swaps and other financial contracts and commitments are guaranteed jointly and severally by the Danish and Swedish states. The Consortium has an AAA/Aaa rating from the international credit rating bureaux Standard & Poor's and Moody's.

In 2000, loans were obtained in several markets. 48 % of the loans were raised under Øresundsbro Konsortiet's standard loan documentation while 41 % was raised with the European Investment Bank.

At the end of 2000, approx. 54 % of Øresundsbro Konsortiet's net debt carried variable interest rates while approx. 37 % was fixed rate. The remaining 9 % was based on real rate of return terms.

Total financing costs for 2000 were 4.85 % against the budgeted 5 %. Exchange rate adjustments aside, financing costs were 3.9 %. The difference is attributable to an unrealised exchange rate loss in CHF. The real – i.e. inflation adjusted, financing costs can be calculated at 1.8 %. For the period 1994-2000 the average real rate of return can be calculated at approx. 2.3 % p.a., i.e. clearly below the long-term objective of 4 %.

The financial strategy aims at achieving the lowest possible long-term financing costs during the lifetime of the project, while monitoring and managing the financial risks within the guidelines established by the company's Board of Directors.

9.3.2.3 Refinancing

Total vehicle traffic across Øresund Bridge and on the competing ferry routes rose by 61 % following the bridge's opening. However, two traffic categories have so far fallen short of expectations – the important Heavy Goods Vehicles (HGV) traffic and the so-called "novelty value" traffic.

Within the first five month of operation 1,680,000 vehicles crossed the Øresund Bridge motorway (approx. 700,000 fewer than anticipated, which amounted to revenues of €42.1m (DKK315m). This corresponds to an average of almost 9,200 vehicles per day or to an average net turnover of €25 per vehicle.

During the same period, approx. 2,75 million passengers travelled on the Øresund Bridge railway between Malmö and Copenhagen, i.e. 30 % more than envisaged by the operators (net turnover of €25.1m as set out in the Government Agreement or an average of €9.1 per passenger). Other revenues included income from a number of tele-operators for reservation and use of the optical fibre cables which cross Øresund via the fixed link.

Øresundsbro Konsortiet's first half year of operations resulted in an accounting loss of €14.8m. Equity capital as of December 31, 2000 showed a capital deficit of €8.1m. The result is approx. €8.6m below the operations budget, which is partly attributable to less earnings from the road section, partly to higher operating costs due to the fact that maintenance contracts proved to be significantly more expensive than expected.

Current expectations are that profits will materialise only after a period of 18 years. Based on the forecast, Øresundsbro Konsortiet's debt is expected to be repaid in 2031.

9.3.3 Experience with PFI-projects (private finance initiative)

Although advantages of PFI-projects for the public sector are quite obvious the number of projects that have been carried through are rather low, both in Germany and Denmark. However, there is sufficient experience from such projects in Great Britain, France as well as in the United States of America. In July 1999 Arthur Andersen and Enterprise LSE were appointed to undertake a study to examine "value for money aspects" of so-called Private Finance Initiative (PFI) projects in Great Britain. By 1999 agreements for over 250 PFI projects had been signed by central and local government for procurement of services across a wide range of sectors, including roads and rail. These projects have an aggregate capital value of approximately 16 billion British Pounds. The following is a summary of key findings of the survey:

The current weighted average cost of private sector capital on PFI projects is 1-3 percentage points higher than public sector borrowing as measured by current gilt rates. This gap has been narrowing as the PFI sector matures and the public sector gains in experience. The public sector cost of capital is in any case arguably underpriced if account is taken of the macroeconomic reasons for maintaining constraints on the availability of that capital. Competition for the provision of equity and debt has intensified with new entrants into the market, e.g. equity funds, building societies (some are now banks) and the wider use of capital markets. Eight PFI road schemes were analysed and it was found that loan margins, on average, for both construction and operation have been falling, and loan terms extending, with maturities of 25 years and beyond now common place. Private finance may, therefore, represent an additional cost, but it is not such a significant cost that value for money is inherently likely to be imperilled.

In an analysis of the rankings given by public sector project managers to 18 individual "value for money drivers" the following six were identified as the six primary drivers (in descending order of perceived importance):

- Risk transfer: the transfer to the private sector of those risks which it is better able to manage than the public sector (see chapter B 6);
- Output based specifications: services provided under PFI contracts are specified as outputs and payment is linked to the quality and timing of their delivery;
- Long term nature of contracts (including whole life costing): this is seen as a key condition for delivering value for money because the scope it gives to recover the initial investment, develop alternative approaches to service delivery and focus on whole life costing;

- Performance measurement and incentives: these act as a means of securing the delivery of the value for money promised by the original priced deal;
- Competition: the value for money of a project is easier to demonstrate where there has been an effective price-led competition;
- Private sector management skills: the ability of the private sector to deliver management and operational efficiencies remains crucial to the success of the project.

10 IMPLEMENTATION

The FDJV will report to the German and Danish Ministries on basis of the responses from the Market in April 2002. After having presented the results to the Ministries the next step for realising the project will be negotiations between the two Governments in order to decide whether the project should be realised and under which conditions. These conditions will be formalised in government agreements on basis of which the project will be realised.

Before the procurement process can be started a government agreement will have to be presented to the parliaments of Germany and Denmark prior to the Governments‘ ratification.

The government agreement is anticipated to include the following:

- A description of the general requirements to the selected technical solution
- The Governments‘ commitments regarding hinterland infrastructure, regarding support in the approval procedure (co-ordination between the two countries), regarding taxation and regarding financial contributions
- That the Governments free of charge give the right to use the necessary area in territorial waters to the Concessionaire for investigations and construction of the fixed link
- Responsibility for planning, authorities approval, design, construction, operation, financing and transferring the fixed link
- Principles for administration of the interfaces between road and railway infrastructure on land and on the fixed link
- Principles for the Governments‘ handling of questions related to border control (customs, passport control, etc)
- Principles for arbitration between the two Governments
- General statements regarding the Governments‘ requirements and commitments to be regulated in the Concession Agreement

Under the assumption, that the governments decide to proceed with the project the implementation process could consists of the following steps/activities:

- Government decision on further procedure
- Preparation to start a public procurement process for realising the project
- Government agreement to specify rights and obligations of the parties involved before launching a public procurement process
- Public procurement procedure
- Government agreement concerning Concession Agreement
- Preparation, planning, design and technical studies by Concessionaire
- Authorities' approvals, incl. public hearings
- Construction

Appendix

Appendix: Definitions of individual solution models

Feasibility Study Definition	**Solution Models**					
ECI Definition	**Business Cases**		**Alternative Cases**			
Code	**3**	**5.1**	**3.1**	**4**	**4.1**	**5**
Functional design* ➢ **Technical** ➢ **Economical**	4+2 4+2	3+1 2+1	4+2 4+2	4+2 4+2	3+1 2+1	4+2 4+2
Short technical solution	Cable stayed bridge	Immersed tunnel	Suspension bridge	Bored tunnel	Bored tunnel	Immersed tunnel
Full description	Cable stayed bridge with two-level deck	Immersed tunnel with a separate tube for rail and road respectively	Suspension bridge with a 2-level deck	Bored tunnel with 4 separate tubes	Bored tunnel with a separate tube for rail and road respectively	Immersed tunnel with separate tubes for each traffic direction in combined tunnel element

* = Number of lanes for road traffic + number of tracks for railway traffic