Groningen, May 9, 2013

Dear Mr. Overwater,
Dear members of the board,

First of all, we would like to thank the Executive Board and Management of Dinalog for the constructive feedback we received in the first round. We are very happy to respond to your invitation to submit a full proposal for project "Design of LNG networks". Based on your recommendation, we have described in much more detail the benefits for the logistics sector. To demonstrate this change, we also had some changes in the consortium by adding two logistics service providers (Jan de Rijk Logistics and Intermodal Solutions) as well as a ship owner (Feederlines).

Our project unites now representatives of all relevant stakeholders in the LNG supply chain: production of bio LNG (Ecos Energy B.V.); infrastructure (Gasunie, Vopak); refueling stations (GDF Suez); locations for establishing business (Groningen Seaports; Nederlandse Vereniging van Binnenhavens), manufacturers of trucks (Volvo); ship-to-ship supply (Oliehandel Klaas de Boer); government (via Energy Valley Foundation); users (Feederlines, IMS, Jan de Rijk Logistics) and the National LNG Platform (with Shell Nederland, Port of Rotterdam and others as its participants). Your advice to include Gasterra was not followed by us since -as we were informed- Gasterra is not involved in LNG, since its shareholder Shell decided to take LNG on by itself. If unexpectedly needed, however, we do have direct access to Gasterra via consortium partner Energy Valley Foundation.

We have downsized the budget considerably as can be noticed in the attached budget plan. Both the word file of the proposal and a "pdf file" containing signatures have been attached to this message. The original word file will be submitted by regular mail. We would appreciate it if you could confirm receipt of this submission and we are looking forward to receive your decision.

As mentioned earlier, I will be a visiting professor in Canada starting May 16 to August 19. In case of any questions you can reach me at my cell phone 06-23866884, via email (i.f.a.vis@rug.nl) or skype (iris.f.a.)

Yours sincerely,

Prof. dr. Iris F.A. Vis
project leader

Nationaal LNG Platform

Rijksuniversiteit Groningen
T.a.v. mevrouw I. Vis
Nijenborgh 4
9747 AG GRONINGEN

Rotterdam: 7 mei 2013

Kenmerk: X:/LNG/Corresp/20130507

Betreft: Steun onderzoek door Nationaal LNG Platform

Geachte professor Vis,

Het Nationaal LNG Platform is het uitvoeringslichaam voor de doelen en doelstellingen zoals beschreven in de Green Deal LNG Rijn & Wadden.

Het Nationaal LNG Platform steunt uw onderzoek gericht op de ontwikkeling van logistieke modellen die de introductie van LNG als nieuwe brandstof voor de scheepvaart en het zware wegtransport zal versnellen. De ontwikkeling van strategieën ondersteunend aan de ontwikkeling van LNG infrastructuur langs de nautische en weginfrastructuur is daarbij onontbeerlijk.

Met vriendelijke groet,
Ger van Tongeren

Voorzitter Nationaal LNG Platform

Nationaal LNG Platform - Deltalinqs, Havennummer 2235, Waalhaven Z.z. 19, 3089 JH ROTTERDAM
Postbus 54200, 3008 JE ROTTERDAM, (010) 4020399
www.nationaallngplatform.nl, support@nationaallngplatform.nl

Full proposal

DESIGN OF LNG NETWORKS

Application Form

A. Project name and duration

Project name:	Design of LNG Networks
Commencement date:	September 1, 2013
End date:	December 31, 2016

B. Project applicant and project leader

Company / organization:	Rijksuniversiteit Groningen	
Contact person:	Prof. dr. Iris F.A. Vis	
E-mail address:	i.f.a.vis@rug.nl	
Phone number:	+31-50-3637491	Mobile:+31-6-23866884

Authorized to sign:	Prof. dr. S. Poppema

Financial administrator:	H.W. van Dam	
E-mail address:	h.w.van.dam@rug.nl	
Phone number:	+31-50-3637091	Mobile:

Applicant's visiting address :	Nettelbosje 2		
Postal code:	9747 AE	City: Groningen	
Postal address:	P.O. Box 800		
Postal code:	9700 AV	City: Groningen	
Bank account number:	44.64.52.513	Bank: ABN-AMRO	City:Groningen

Project leader

Company / organization:	Rijksuniversiteit Groningen	
Contact person:	Prof. dr. I.F.A. Vis	
E-mail address:	i.f.a.vis@rug.nl	
Phone number:	+31-5053637491	Mobile: +31-6-23866884

C. Partners in consortium

Organization's name	Type of organization	SME	Contribution in cash or kind (in €)	Partner will make use of IKS* costing method
University of Groningen	Knowledge institute	No	233,840 in kind	No
TU Eindhoven	Knowledge institute	No	80,000 in kind	No
Gasunie	Company	No	9,600 in kind 50,000 cash	No
Vopak	Company	No	21,320 in kind	No
Ecos-Energy BV	Company	Yes	11,200 in kind	No
Stichting Ubbo Emmius Fonds (on behalf of Groningen Seaports)	Company	No	100.000 cash	No
Groningen Seaports	Company	No	16,000 in kind	No
Stichting Energy Valley	Company	No	5,000 in kind 20,000 cash	No
Feederlines	Company	Yes	6,720 in kind	No
IMS	Company	Yes	20,000 in kind	No
Oliehandel Klaas de Boer BV	Company	Yes	8,000 in kind	No
GDF Suez*	Company	No	8,000 in kind* 30,000 in kind*	No
Jan de Rijk Logistics*	Company	No	8,000 in kind*	No

* Written approval still pending.

Transport en Logistiek Nederland is currently considering our proposal to decide if they would like to join the consortium on behalf of the logistics and transportation field in the Netherlands.

The following organizations expressed that they support the project and/or are willing to consider to take place in an advisory board to the project:

- Volvo
- Nederlandse Vereniging van Binnenvaarthavens
- Nationaal Platform LNG with board members Deltalinqs RCI, Port of Rotterdam, Shell Nederland, Vopak, Energy Valley, Gasunie, GDF Suez, LNG TR&D (see attached letter).

The IKS method for this partner will be applied in this project based on an existing IKS agreement with Agentschap NL. Please provide Dinalog with a copy of the written statement from Agentschap NL stating that this partner is allowed to use the IKS costing method.

D. Project budget

Total direct project costs:	1,144,566
Contribution to Dinalog: *(8% of Total direct project costs)*	91,565 (incl. BTW: 110,794)
Total project costs	1,255,360
Requested grant: *(Max 50% of total project costs)* *(Max € 1,000,000)*	627,680
Total amount of co-financing:	627,680
Other grants requested / awarded:	0
Source of other grants:	-
Kind of grants:	-

E. Signature

By signing this form I certify that all the required documents are attached and that I am familiar with the conditions and procedures of Dinalog.

Applicant organization:	**Rijksuniversiteit Groningen**
Authorized to sign:	Prof. dr. S. Poppema
Function:	Voorzitter College van Bestuur
City:	**Groningen**
Date:	8-5-13
Signature:	

Submit to Dinalog:

- E-mail, all documents in PDF, but also original Word and Excel documents to tenders@dinalog.nl;
- Post, printed versions of all documents requested to **Dinalog Management, Princehagelaan 13, 4813 DA Breda**

Summary

Motivation and goals

LNG will become a prime fuel for ships and trucks in the foreseeable future. The European Union and national governments have outlined their policies, and many companies are preparing for a transition period towards intensive use of LNG. There is a strong need in industry for the development of the building blocks needed to develop their business cases. We develop these building blocks, some business cases, as well as methods for planning and control of the logistics in LNG synchromodal transportation networks.

Activities / work packages

I. **LNG supply chains and synchromodal transport networks:** providing an identification of markets and demand to serve, economic and sensitivity analyses, definition of logistical requirements and options for synchromodal transportation.
II. **Multi-modal inventory-routing problems:** deriving tools to enable an efficient and effective supply to distribution points in the network through synchromodal operations.
III. **Direct delivery multi-modal transportation problems:** deriving decision tools to enable efficient direct ship-to-ship refuelling at sea.

Expected results:

The main objective is to derive solution approaches to design LNG synchromodal transportation networks and tools for planning of transportation and replenishment operations to enable accessibility and efficient usage of this type of fuel for all modes of transport. Market identification, demand forecasts, economic analyses and business cases are intended outcomes of this study. The developed knowledge base on LNG-specific aspects in logistics can strengthen the development efforts of the sector in The Netherlands and can aid to position Dutch companies at the frontier of development of LNG networks in Europe.

Innovativeness:

Due to changes in European laws, an increased usage of LNG as fuel for ships, barges and trucks is to be expected. Currently, we notice a lack of infrastructure in The Netherlands as well as neighbouring countries. New methods and approaches are to be designed to create the required infrastructure to enable high accessibility for all users as well as the efficient planning of replenishment and refuelling operations. To this end we will define, study and solve entirely new classes of multi-modal inventory-routing problems and dynamic direct delivery routing problems.

Valorization and implementation strategy:

As part of the Green Deal LNG Rhine and Wadden, the goal for 2015 is to have at least 50 barges, 50 sea vessels and 500 trucks use LNG. The results of this project can directly be used by participating companies and others to make their investment decisions in the process of the network creation in The Netherlands and beyond. Tools developed will be pivotal in the earlier investment stage, as well as in achieving operational efficiency later on. To reach these goals, this project unites representatives of all relevant stakeholders in the LNG supply chain: production of bio LNG (Ecos Energy B.V.); infrastructure (Gasunie, Vopak); refuelling stations (GDF Suez); locations for establishing business (Groningen Seaports; Nederlandse Vereniging van Binnenhavens), ship-to-ship supply (Oliehandel Klaas de Boer); government (via Energy Valley Foundation); users (Feederlines, IMS, Jan de Rijk Logistics) and is supported by the National LNG Platform (with Shell Nederland, Port of Rotterdam and others as its participants).

Contents

Part A: Orientation and Project Goals

Motivation

Liquefied Natural Gas (LNG) is a more sustainable and much cheaper alternative to currently used fuels for the transport and maritime sector. The world market for LNG is showing a rapid rise due to the search for more environmentally friendly types of fuels. Natural gas has one of the lowest CO_2 emissions per unit of energy. New legislation with regard to, for example, emissions for ships trigger companies to invest and change to LNG as fuel. Already in 2015, the International Maritime Organization demands that the sulphur content in maritime fuel used in the North Sea needs to be decreased from 1.0% to 0.1% (Danish Maritime Authority, 2012).

Storage and transportation are key aspects in the supply chain of LNG. Natural gas is transhipped through pipelines and liquefied to LNG at LNG plants at the end of the pipeline. Next, LNG is typically transported over sea from an LNG plant to an import terminal (e.g., the GATE terminal in Rotterdam). Short pipelines are used to make the transfer from the vessel to the on-shore storage facilities at the import terminal. Inland transportation of LNG can be done by a variety of transport modes such as ship, rail and truck.

To enable broad adoption of LNG an infrastructure and network of facilities (e.g., bunker terminals) need to be in place. In the current situation, all stakeholders involved note a chicken and the egg problem. Users do not make the transition to LNG since no infrastructure is in place. Investments in new infrastructure are not initiated due to uncertain future usage. The goal of this project is to fill this void by picturing the supply chain of LNG and Liquefied Bio Gas (LBG), perform market analyses for the medium and small-scale market for LNG and LBG, derive tools for designing core networks, as well as tools for synchronizing the planning of transportation operations and performing business cases.

Our focus is on the design of a new network for the distribution and storage of LNG/LBG via all modes of transportation. This will support the path towards lower carbon emissions in the logistics sector, by enabling better accessibility and more efficient usage of this fuel type for all modes of transport.

The LNG supply chain

The LNG supply chain is defined as all processes from extraction of the natural gas until consumption by the end users. Figure Part A.1 shows the LNG Supply Chain based on Gronhaug and Christianssen (2009). In the exploration and extraction stage, natural gas is extracted from reservoirs. We mention here the on-going discussion on environmental effects of extracting natural gas. A sustainable alternative is Liquefied Bio Gas (LBG). The main difference with LNG is the source. LBG can be produced in industrial bio-digesters by fermentation of manure or garbage without using fossil products. LBG typically can be used for the trucking industry. From a supply chain perspective, LBG is one of the cleanest fuels available. In this project, we exclude the extraction stage of natural gas and the actual production of LBG. We focus on the logistics aspects with regard to transportation and distribution. In this project, *Ecos Energy B.V.* participates to study market niches for the usage of LBG by the transportation sector in The Netherlands.

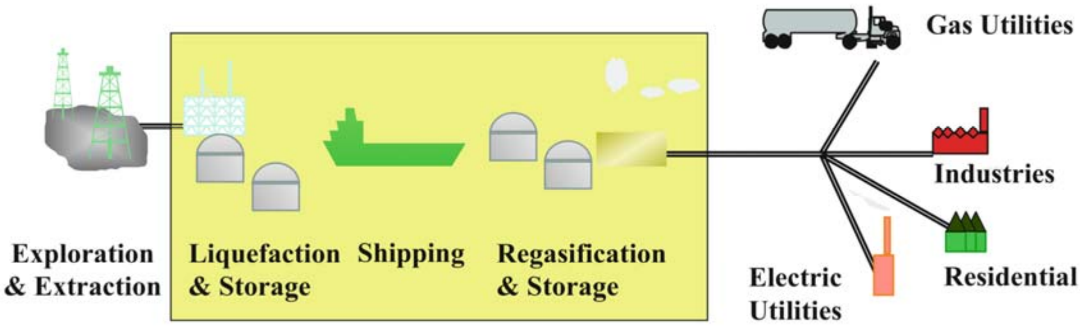

Figure Part A.1: The LNG Supply Chain (Gronhaug and Christianssen, 2009)

Purified natural gas is liquefied by cooling it to -162^{o} C at a liquefaction terminal and stored upon further transport[1]. LNG has a much lower volume than natural gas which allows for transport over sea by ships. Typically at port areas, regasification and storage terminals are located, to enable storage and regasification before further distribution via bunker terminals or pipelines. In this project, both *Gasunie and Vopak* participate who can provide the required LNG infrastructure and introduced the GATE terminal in the port of Rotterdam. Port authorities and governmental organisations can be seen as facilitators in this supply chain. *Groningen Seaports*, port authority of the Eemshaven and port of Delfzijl, participates in this project. *Energy Valley foundation* will provide a direct link with governmental organisations.
The demand locations include (floating) refuelling stations for road and (inland) waters, but are also industrial organizations, governments, and residential users (e.g. heating applications).

Typically LNG can be used as a fuel for the maritime sector (both sea and inland shipping), as well as transport over road and rail. In this project *IMS, Feederlines and Jan de Rijk Logistics* will represent these stakeholders. Refuelling locations need to be in place to supply end users of LNG. *GDF Suez* is one of the companies investing in refuelling locations for road transport[2]. Two options exist for refuelling seaships that run on LNG: ship-to-ship transfer off-shore or via bunker terminals on-shore. Barges can be refuelled at bunker terminals or with tank trucks. Trucks typically use LNG stations to fill up. In this project we study the selection of refuelling locations as well as planning of ship-to-ship refuelling and LNG inventory routing decisions.

An important advantage of a floating infrastructure can be found in the fact that less static landside infrastructure needs to be in place. For example in the earlier stages of the network development, such option may provide coverage in areas with a low density of fixed bunker facilities. Thus it can aid in development of the market by reducing risk of coverage issues for users. Furthermore, ship-to-ship (STS) transfers can be made at locations without land in sight, thus potentially reducing distances travelled by the ship that is to be refuelled. Another aspect mentioned in this context is that safety is likely to be easier to be guaranteed by deliveries on open sea, without residential areas nearby. In this project, *Oliehandel Klaas de Boer* participates to study ship-to-ship refuelling options.

Figure Part A.2 pictures all relevant stakeholders in the distribution and transportation network of LNG and shows all consortium partners.

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[1] http://www.natgas.info/html/liquefiednaturalgaschain.html
[2] http://www.gdfsuez-lngsolutions.nl/gdf-suez-lng-solutions/nieuws.php

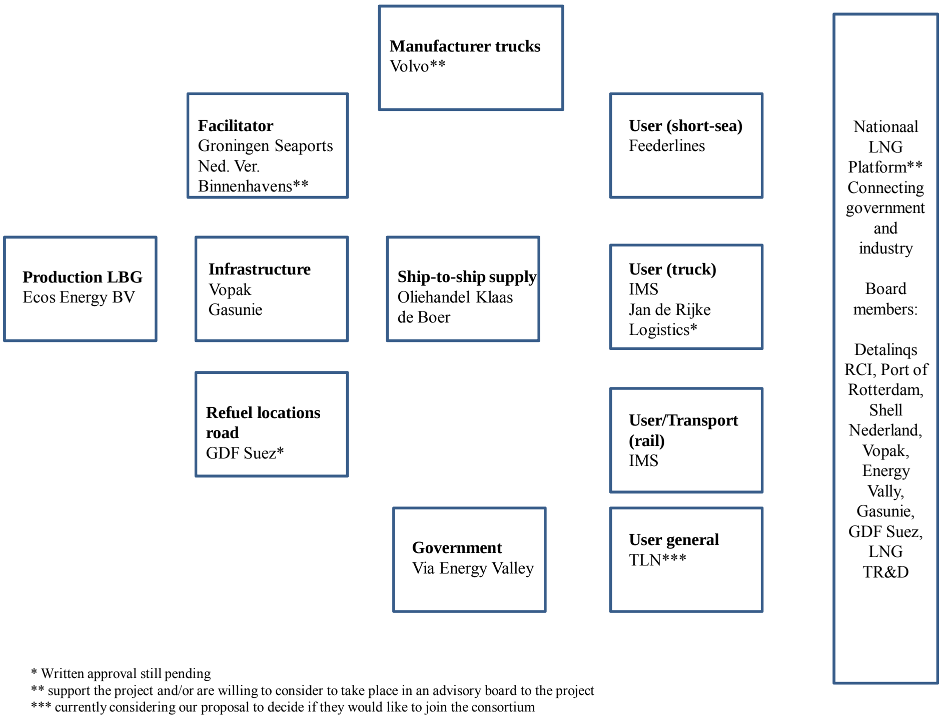

Figure Part A.2: Important stakeholders (and consortium partners) in the LNG distribution and transportation network

The boxed part in Figure Part A.1 (liquefaction-shipping-regasification) of the LNG supply chain indicates the main focus of current state-of-the-art literature in the area of logistics and supply chain management (see e.g. Gronhaug and Christianssen, 2009; Andersson, 2010a and 2010b; ETC). In the liquefaction-shipping-regasification part of the LNG supply chain, two types of decisions are important: shipping decisions and inventory management decisions (at the liquefaction plants and regasification terminals). This results in integrated inventory-routing problems. In general, this is a difficult and complex problem assuming a high level of coordination (e.g., via VMI). Moreover, uncertainty, stochasticity and dynamics is absent, with the exception of Halvorsen-Weare et al. (2013). These authors create routes and schedules for the vessel fleet that are more robust with respect to uncertainty such as in sailing times due to changing weather conditions. Another approach to dynamics is covered in Rakke et al. (2011), where a rolling horizon setup is considered. In contrast to the above scoping in the literature (liquefaction-shipping-regasification part), the scope for this research project is focused on the linkage between supply of LNG and the distribution to medium- and small scale markets. At this moment, no literature exists here to our knowledge.

Designing and planning of storage and transportation operations

The supply chain of LNG has some complicated aspects that have to be taken into account in designing and planning storage and transportation operations. Typically, vaporisation of LNG during transportation reduces stock levels and is undesired regarding the greenhouse gas potential of methane, the principal component of LNG. Furthermore, ships run on the same fuel that they transport, which causes the volume that reaches the final destination, to decrease with increases in travel distance. Next to that, future demand and supply are uncertain. Safety analysis is an important aspect of decision making in the supply chain of LNG, for example, with respect to location decisions (Vinnem, 2010; Vanem et al., 2008). Specifically for the maritime sector, a formal safety assessment process is in place that uses five sequential steps to study the probability of potential risks, their consequences, control options and cost benefit assessment[3] So far, it can be noted that building LNG terminals raises high levels of concerns and questions in the local community and many differences in location regulations can be found. Business cases for specific plans are needed to clearly describe how the business should be organised in a sustainable way (Danish Maritime Authority, 2012).

To enable small-scale usage of LNG a totally new network needs to be designed. Important questions in this context are a definition of the actual core network of users in the hinterland to connect large terminals to bunker facilities and refuelling stations. To enable an efficient and effective distribution structure to resupply each of those locations, the potential of synchromodal transportation networks has to be explored as indicated by many stakeholders in industry. We will study in more detail the potentials of having a coordinator (4C) in the supply chain to coordinate all activities to enable quick adoption of LNG as fuel for the transportation sector as well as an efficient distribution of LNG.

Work packages

In more detail, we propose the following work packages (for a detailed description and the role of each of the partners we refer to part B of this proposal):

I. LNG supply chains and synchromodal transport networks

Most stakeholders realize that LNG will play an important role in transportation in the foreseeable future. The European Union and national governments have outlined their policies, and companies are preparing for a transition period towards intensive use of LNG. The speed at which this transition process can take place, however, is hindered by a lack of a proper foundation for the development of strategic plans at companies. There is a strong need for building blocks that can serve as a foundation for strategic plans. The building blocks that are searched for include an identification of markets to serve, demand forecasts, economic analyses of the LNG supply chain, definition of logistical requirements, options for synchromodal transportation, intermediate storage issues, and the impact of potential future changes in government policies.

This work package aims at developing the necessary building blocks through academic research, as well as the development of business models based on these building blocks by the companies of the consortium. The developed knowledge base on LNG-specific aspects in logistics can strengthen the development efforts of the sector in The Netherlands and can aid to position Dutch companies at the frontier of development of LNG networks in Europe.

II. Multi-modal inventory-routing problems

In the base situation, a LNG network with known supply and demand locations is given. We consider single-period multi-modal replenishment of stock locations as well as serving orders of individual customers. In this multi-modal discrete transportation problem, we need to make the following decisions for each supply: 1) what mode(s) of transport are used to perform the supply of each of the LNG storage points; 2) when to deliver supplies from which locations; 3) how to route the modes of transport in delivering LNG. Gronhaug et al. (2010) present a first model to study inventory routing problems for LNG. We explicitly allow for synchromodal operations in the sense that the modes of transport and routing decisions can differ per replenishment.

[3] MSC/Circ.1023, International Maritime Organization, 2002

III. Direct delivery multi-modal transportation problem

In this work package we consider off-shore bunkering of ships and barges by means of truck-to-barge and ship-to-ship deliveries. Decision problems both arise for shipowners as well as suppliers. Ship owners need to decide what option(s) are selected for bunkering by comparing on-shore and off-shore options such that route-deviation times and waiting times are minimized. Supply ships deal with a dynamic dispatching and routing problem in which needs to be decided what supply ship serves what ship at what moment and which location. In the planning, specifically the latter creates a complex challenge, due to the real-time changes in the exact locations of both the supply ship as well as the customer. The latter is an important aspect of dynamic vehicle routing problems (Pillac et al., 2013).

Relation to Dinalog´s innovation themes

The project relates to the themes Core networks of (inter)national connections and multimodal hubs, Synchromodal transport and 4C. LNG is noted as the fuel of the near-future in transportation networks to offer a sustainable alternative for traditional fuels and to enable ship owners to meet new emissions regulations. The European Union and national governments have outlined their policies, and companies are preparing for a transition period towards intensive use of LNG. The speed at which this transition process can take place, however, depends on the design of the required infrastructure and investments to enable supply and actual usage. Business plans supporting these investments need additional studies into market and economic analyses of the LNG supply chain, a definition of logistical requirements in designing the network and planning and controlling operations, options for synchromodal transportation and intermediate storage issues. Coordination over all stakeholders seems to be a must to bundle all efforts in enabling the transition to LNG usage in mid-scale and small-scale markets. In taking the lead in The Netherlands, with the presence of the GATE terminal (which can serve as an important hub for the rest of Europe as well) it might be expected that exporting knowledge created and experience with LNG as an important fuel for the transportation sector might create additional benefits for the Dutch economy.

We notice a strong link with the topsector Energy - Gas. To create synergy effects, prof. Dam (TUE, extraordinary professor of LNG and active in the topsector GAS) will be involved in this project.

Objectives and goals

The main objective is to study the design of LNG synchromodal transportation networks for storage and distribution of LNG to mid-scale and small-scale markets. We intend to provide a thorough analysis of the supply chain of LNG and detailed market analyses of potential users. Next, we study opportunities for synchromodal transportation networks for LNG and to derive solution approaches to design these LNG networks. Tools for planning of LNG transportation and replenish operations are designed to enable accessibility and efficient usage of this type of fuel for all modes of transport.

All-in-all this will support the aim for lowering carbon emissions by the transport sector. We consider both ship-to-ship refuelling as well as stock locations for ships and trucks. Overall we aim for business cases, pilots, demonstrations and knowledge-transfer in the sector to enable implementation in The Netherlands.

In the section above we described the motivation for each of the work packages. Here we give the goals for each work package. The academic relevance will be summarized in the section Orientation and described in detail in part B of this proposal.

Work package I: LNG supply chain and synchromodal transportation networks

- Provide a detailed description of the supply chain of LNG, a definition of the relevant stakeholders, their roles and power relations, LNG supply chain risk management and LNG characteristics.
- Conduct market analyses of the market for LNG and identifying promising market niches; specifically a market analysis of the market for LNG in North Netherlands and make predictions of potential demand.
- Formulate a business case in close cooperation with Groningen Seaports, Vopak, Gasunie and other stakeholders for the network design in the Northern Netherlands.
- Formulate business cases for Intermodal Solutions and Feederlines for the analysis of a possible transition from one or more modes of transport to use LNG compared to traditional fuels and the corresponding design of the required infrastructure.
- Analyze effects of government measures as tax increases, and local policies that affect the network design, demand and market price in close discussion with Energy Valley and local and national government agencies.
- Design models and tools to perform economic analyses of the supply chain of LNG in relation to revenue models for relevant parties.
- Perform an analysis of the (investment) opportunities, and logistical constraints in the design of synchromodal transport networks with intermediate storage and related logistics processes
- Analyze impact of possible innovations (e.g., standardization of transport of LNG in containers; indirect usage of LNG characteristics to cool stock aboard ships) in relation to the robustness of the network design.

Work package II: Multi-modal inventory-routing problems

- Designing a conceptual model for the LNG-Inventory Routing Problem
- Formulating inventory and inventory-routing models for the refuelling stations located in a dispersed network and the individual customers.
- Defining tools for mode selection for replenishment operations in synchromodal networks
- Input for business cases on planning of operations in LNG networks

Work package III: Direct delivery multi-modal transportation problem

- Models and solution approaches for planning of ship-to-ship deliveries and refuelling operations.
- Tools to compare direct delivery with using land-based bunker options
- Input for business cases on planning of operations for ship owners

Expected results

Studies show that the total demand of LNG is forecasted to increase by 140% in the next years. The largest increase in usage is to be expected in the United Kingdom, directly followed by The Netherlands (Danish Maritime Authority, 2012). Coordinated efforts of all stakeholders are needed to design LNG supply chains and transportation networks (Danish Maritime Authority, 2012). In the coming years high investments in creating the required infrastructure will be done. Basically, we deal with an entirely new market for which both the supply and demand side and the related logistics network still need to be designed.

We distinguish in the following description between investments in creating a new logistics network to enable distribution and storage of LNG as well as investments and benefits for suppliers and users of LNG in different modes of transportation.

Infrastructure
Based on conversations with the partners in the consortium and from professional and web publications and learning from the experiences of early adopters in Scandinavia, we derive the conclusion that the main economical effects for The Netherlands most likely can be linked to investments in newly purchased or altered trucks and ships, investments in the actual infrastructure (e.g., bunker facilities and tank stations) as well as the investments in the production of bio LNG. So far, hardly any infrastructure exists in The Netherlands and the rest of Europe for small and midscale usage of LNG. Next to the ambition of the European Union with regard to the road LNG stations, other studies demonstrate that to meet ship owners' demand for LNG more than 40 small-scale LNG terminal will have to be established in 2015, as well as a package of medium-size terminals, tank-trucks and bunker vessels (Danish Maritime Authority, 2012). The following estimates are available for economic life times: for a terminal around 40 years, bunkering vessels and trucks around 20 years (Danish Maritime Authority, 2012). Data for a medium scale LNG terminal with passing traffic provide an example of infrastructure and transhipment costs (Danish Maritime Authority, 2012): total investment costs 137 million euro and total operational costs 17 million euro.

The European Union formulated January 2013 an ambitious work package in which it is stated that in 2020 each 400 kilometres an LNG station needs to be located along each highway[4]. In this case, there should be more than 180; currently there are only 38 fuel stations in the EU, of which 22 are located in the UK. An average LNG fuelling station to dispense fuel to trucks costs about $1 million[5] .

This project will support companies in making the right investment decisions, as well as give companies the tools they need when exporting their knowledge on LNG infrastructure for application outside The Netherlands.

Users
Studies show that the value of a single shipload of LNG is 20-30 million dollar which pictures a profitable market (Stålhane, 2012). Stålhane (2012) also indicates that a ship to supply LNG with a capacity of 145,000 m^3 costs roughly 200-250 million dollar to build. Consequently, high investments are needed to supply LNG to distribution points. Early 2015 new regulation becomes effective for the sulphur content of fuel for ships operating in the Baltic Sea, the

[4] http://www.lng24.com/nl/nieuws/over-lng/2013/01/eu-wil-om-de-400-km-lng-station/
[5] http://www.consumerenergycenter.org/transportation/afvs/lng.html

North Sea and the English Channel. Ship owners either need to adjust their ship with scrubbers to lower emissions, invest in new ships or adopt engines to run on other types of fuel as LNG.

In The Netherlands some logistics service providers started to use trucks using LNG. Main advantages are a decrease in emissions, costs as well as sound reduction[6]. Estimates show that using LNG instead of conventional fuels results in a cost reduction of 15-25%[7]. Costs for maintenance and insurances, as well as economic life times are similar to the current situation. Sound reduction is a highly important aspect in the context of regulations in urban distribution. Trucks driving on LNG are allowed to deliver stores outside regular delivery time-slots.

Overall

In taking the lead in The Netherlands, with the presence of the GATE terminal (which can serve as an important hub for the rest of Europe as well) and plans of Gasunie and Vopak to set-up small-scale terminals as well[8] it can be expected that exporting knowledge created and experience with LNG as an important fuel for the transportation sector might create additional benefits for the Dutch economy.

In the consortium both stakeholders with a broad knowledge and experience in the supply chain of LNG participate as well as potential early adopters in the mid-scale and small-scale market. The expected results include:

- business cases for network design and investments in infrastructure
- business cases for LNG users to study possible transition from one or more modes of transport to use LNG compared to traditional fuels
- market studies and definition of market niches for usage of LNG/LBG
- tools for planning and control of operations in LNG transportation networks
- awareness creation via proof of concepts, pilots and demonstrations
- webinars and seminars to inform industry and governmental organizations
- academic papers
- master thesis projects
- Dinalog thesis group on LNG where students of professional universities (e.g., Stenden and NHTV) and universities (e.g., RuG and TUE) share ideas with each other as well as with companies involved.

[6] http://www.schonevoertuigenadviseur.nl/lng
[7] http://www.fuelswitch.nl/index.php?mod=pages&item=53
[8] http://www.vopaklng.com/media/LNGBreakBulk_Factsheet_NED_DEF27aug.pdf

Relation to government policy

The Netherlands is the largest producer and exporter of gas in the European Union. The Dutch government strives to make The Netherlands the gas roundabout of North West Europe. The European Union formulated constraints on reductions in CO_2 emissions of 60% in 2050. It is expected that this goal can only be met with LNG (www.rijksoverheid.nl). In the Green Deal, three key goals for the coming years have been formulated: 1) removing barriers to use LNG as fuel; 2) promoting social acceptance of LNG; 3) fully exploit the economic opportunities of LNG. Our research directly contributes to the first and third goal by designing LNG networks and efficient and effective planning mechanisms for LNG transportation and replenishment operations.

Nationally, as well as in this project, Energy Valley Foundation, and Nationaal LNG Platform provide the linkage between industry and governmental organizations.

Orientation

Due to changes in European laws, an increased usage of LNG as fuel for ships, barges and trucks is to be expected. Currently, we notice a lack of infrastructure in The Netherlands as well as neighbouring countries. New methods and approaches are to be designed to create the required infrastructure to enable high accessibility for all users as well as the efficient planning of replenishment and refuelling operations.

In the consortium both stakeholders with a broad knowledge and experience in the supply chain of LNG participate as well as potential early adapters in the mid-scale and small-scale market. The expertise of the academic researchers involved concerns LNG, port and transportation networks, freight logistics and distribution logistics. In **part C** we discuss in more detail the companies and their orientation on LNG projects. We notice a strong link with the topsector Energy - Gas. To create synergy effects, prof. Dam (TUE, extraordinary professor of LNG and active in the topsector GAS) will be involved in this project.

We notice that most effort in the literature is related to the liquefaction-shipping-regasification part of the LNG supply chain (see Andersson, 2010a). To our knowledge hardly any literature is available on the last part of the LNG chain focusing on storage of LNG and the distribution to the demand locations). In **part B**, we discuss in more detail the added value compared to literature for each of the deliverables formulated in each of the work packages.

Part B: Activities and Work Packages

Introduction

In this part we provide a detailed description of each of the work packages as defined in part A of this proposal. Per work package we describe the goals, activities and show the academic value of this research project as well as the link with questions formulated by our partners in industry and governmental organizations.

Work package 1: LNG supply chain and synchromodal transportation networks

Most stakeholders realize that LNG will play an important role in transportation in the foreseeable future. The European Union and national governments have outlined their policies, and companies are preparing for a transition period towards intensive use of LNG. The speed at which this transition process can take place, however, is hindered by a lack of a proper foundation for the development of strategic plans at companies. There is a strong need for building blocks that can serve as a foundation for strategic plans. The building blocks that are searched for include an identification of markets to serve, demand forecasts, economic analyses of the LNG supply chain, definition of logistical requirements, options for synchromodal transportation, intermediate storage issues, and the impact of potential future changes in government policies.

This work package aims at developing the necessary building blocks through academic research, as well as the development of business models based on these building blocks by the companies of the consortium. The developed knowledge base on LNG-specific aspects in logistics can strengthen the development efforts of the sector in The Netherlands and can aid to position Dutch companies at the frontier of development of LNG networks in Europe.

At this moment we notice both in practice and literature that the supply side of LNG has been studied and actual implementation and usage in the large-scale market can be noticed (e.g., Gronhaug and Christianssen, 2009 and Danish Maritime Authority, 2012). However, relevant stakeholders and reports indicate that for the distribution of LNG to end-consumers still a gap exist both in knowledge how to reach which customers at what locations as well as what investments are needed and who is going to take the lead into designing infrastructure and providing resources as new trucks and ships to actually enable usage of LNG in transportation (e.g., Danish Maritime Authority, 2012).

Mainly, we deal with a "*chicken and the egg problem*" as mentioned in many conversations as well as reports (e.g., Danish Maritime Authority, 2012). Investments in new resources by users will not be made as long as no infrastructure is in place to facilitate usage of LNG. On the other hand, making investments in LNG infrastructure requires a proper analysis of the potential market of LNG users. This work packages aims to fill this gap by providing an answer to questions asked by both suppliers, as well as distributors and users. In close cooperation with stakeholders of all nodes in supply chains we aim to provide the essential information on markets, and logistics constraints in designing LNG networks and synchromodal transportation. For example, Dieckhöner et al. (2013) propose scenarios for LNG demand in Europe for 2019. Our study focuses on market analyses presenting more detailed information for specific regions. The outcomes directly serve as input for work packages 2 and 3 where we focus on planning and control in those networks, as well as input for concrete business cases for the stakeholders involved in the project. An European study shows a clear need for deriving business cases and plans for specific investment projects, which will be one of the main deliverables of this work package (Danish Maritime Authority, 2012).

We start with a description of the supply chain of LNG by specifying all relevant stakeholders, their role and relationships. We will study in more detail the potentials of having a coordinator (4C) in the supply chain to coordinate all activities to enable quick adoption of LNG as fuel for the transportation sector as well as an efficient distribution of LNG. We also study supply chain risk analysis and management and safety aspects for LNG networks (e.g., Zheng and Pardalos, 2010; Vinnem, 2010; Parihar et al., 2011; Bubbico and Salzano, 2009; Cheng et al., 2009; Hara and Nakamura, 1995) In work packages 2 and 3 we focus on the planning and control of operations performed by an 4C[9] in LNG networks. Studies indicate the need for coordinated efforts on investments to avoid sub-optimization of the infrastructure and creating a critical minimum level of LNG users in the supply chain (Danish Maritime Authority, 2012).

Synchromodal transportation networks with storage locations for LNG seem to offer high opportunities for the adoption of LNG as fuel in the transportation sector. Offering a variety of transportation options (pipelines, trucks, ships and potentially trains) allow for flexibility in the delivery of LNG to storage locations. Lai et al. (2011) study the value of storing LNG at regasification facilities in the presence of a market of users of LNG. Given the specific characteristics of LNG, the requirements in transport and safety restrictions studies are needed to formulate the specific logistics constraints in designing synchromodal networks. We deal with a totally new network and as a result, we might directly implement synchromodal operations instead of adopting existing transportation networks to allow for synchromodal transportation. We will start our analyses with studying outcomes of already running Dinalog projects and pilots on synchromodal transportation[10] to examine in what way these outcomes can be used or that changes are required.

In parallel market studies will be performed to get an overview of the size and geographical orientation of the medium- and small-scale market for LNG in The Netherlands. We focus both on LNG as well as the production and local usage of bio-LNG. The results (e.g., analysis of truck and ship movements, geographical locations) will be direct input for the network design. In the design of the LNG network we aim for selecting locations for bunker facilities and tank stations to ensure accessibility for all modes of transport given their origins, destinations, and capacities. Other input in this process is an analysis of costs, safety analyses (e.g., accidental spills see Ivings et al., 2013), risk control (Zheng and Pardalos, 2010) and demand for LNG storage as well as design parameters for LNG terminals (e.g., Özelkan et al., 2008). Extensive simulation studies will be executed to test the robustness of the LNG network given specific demand scenarios for LNG for road, sea and inland transport. Villada and Olaya (2013) did a similar study for the supply of natural gas in Colombia. Sensitivity analyses will be performed to test the impact of governmental policies impacting LNG market prices as well as innovations. For example, the usage of containers as fuel tanks on ships may be a innovation that can serve as a complement in a growing maritime LNG market (Dutch Maritime Authority, 2012). As a result, standardization in transport might result, which might change the actual distribution of LNG. Sönmez et al. (2013) perform a strategic analyses on different technological innovations with regard to the regasification process.

The LNG supply chain also needs adequate business models that are sound and clearly describe how the business should be organised in a sustainable way. Following Teece (2010) a business model should outline how a business enterprise delivers value, considering the revenues, costs and profits. Osterwald (2004) distinguishes four areas (including nine

[9] http://www.dinalog.nl
[10] http://www.dinalog.nl

building blocks) that a business model must address. Chesbrough (2010) argues that this approach to construct maps of business models (see Figure Part B.1) is useful to experiment with different business models.

Based on the developed cases for the LNG supply chain, the business models following the above outline are developed and validated in practice. One or multiple business cases will be performed for specific end-users to test when and how they can adapt LNG as fuel for one or more modes of transportation. The planning and control concepts resulting from work packages 2 and 3 will serve as a direct input. Ship owners basically have the choice to add scrubbers to their ships to reduce emissions in Sulphur Emission Control areas or to change to another type of fuel, such as LNG. In the latter case, they have the choice to either reconfigure their engine (with high investments) or to purchase new ships. Next to that, additional investments as, for example, training of staff to use these new engines are needed. In this study, we make the link with asset management to do a life-cycle assessment of the current fleet and to study the benefits of using cheaper fuels and having a green image compared to the high investments needed. For example, Chang et al. (2008) study the availability and safety of several types of dual-fuel propulsion systems for LNG carriers. In another business case we intend to study third party logistics providers that would like to use trucks running on gas and their requirements for the transportation network. We focus for a start on third party logistics providers operating in local networks with on average fixed routes and fixed demand.

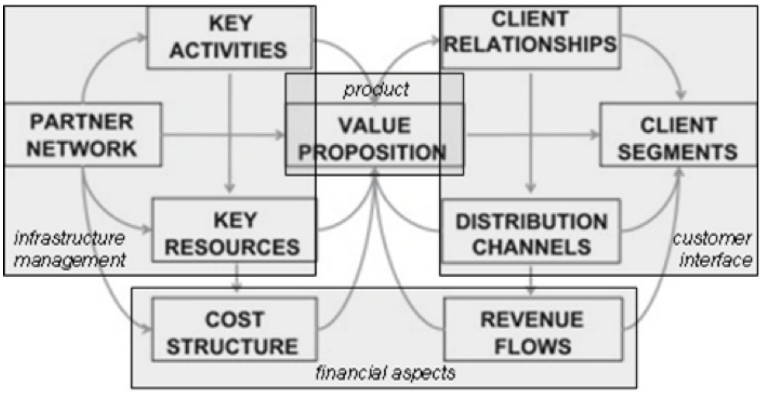

Figure Part B.1 Decomposition of a business model (Chesbrough, 2010)

Note that in the business model descriptions (see Osterwald, 2004), financial aspects are important as well. This also relates to the discussion of re-distributing gains and costs in the LNG supply chain and will be integrated in an economic analysis of this supply chain. Cooperative game theory offers a good framework for analysing these situations. Game theory deals with the mathematical modeling and with the analysis of the models using mathematical techniques of decision making by individuals that can result in conflicts or cooperation between them. This theory is often discussed and applied in scientific researches after the publication of the book "Theory of Games and Economic Behavior" by Von Neumann and Morgenstern (1944). In contrast to non-cooperative game theory the cooperative part of game theory focuses on working together. Cooperative game theory focuses on coalitions with binding agreements and on issues which arise when coalitions are formed, such as: value allocation. Cooperative game theory primarily deals with obtained joint profits by groups of players if they coordinate their actions or work together.

The literature on applications of game theory to cooperation in transport and logistics is scarce. Some interesting studies in which game theory is applied in a transport and logistics context are studies by Frisk et al., (2010), Liu et al., (2010), Ozener and Ergun

(2008) and Theys et al. (2004). Frisk et al. (2010) study the allocation of costs in a forest transportation problem in a cooperation between eight companies that started collaborative planning. Liu et al. (2010) follow a similar approach in their study on the allocation of collaborative profits in a Less-Than- Truckload carrier alliance. Another approach is followed by Ozener and Ergun (2008), who study cost allocations in a collaborative transportation procurement problem. Finally, to the best of our knowledge, the only study applying cooperative games to an intermodal supply chain context is a study of Theys et al. (2004). Although this research gives insights in the difficulties that arise with formulating cooperative games in this context, it is a very basic research.

Summarizing, we have formulated the following 8 activities:

Year 1	Activity 1: Supply chain of LNG in more detail, SC safety and risk management
	Activity 2: Market analyses and market niches
	Activity 3: logistical constraints in the design of synchromodal transport networks
Year 2	Activity 4: business case for the network design in the Northern Netherlands
	Activity 5: business case for analysis possible transition from one or more modes of transport to use LNG
	Activity 6: economic analyses of the supply chain of LNG.
Year 3	Activity 7: effects of government measures affecting the network design, demand and market price
	Activity 8: impact of innovations on the robustness of the network design

In more detail:

Activity 1: Supply chain of LNG in more detail
Description: Provide a detailed description of the supply chain of LNG, a definition of the relevant stakeholders, their roles and power relations and LNG characteristics. We will study in more detail the potentials of having a coordinator (4C) in the supply chain to coordinate all activities to enable quick adoption of LNG as fuel for the transportation sector as well as an efficient distribution of LNG. We also study supply chain risk analysis and management and safety aspects for LNG networks
Planning: September 2013 – January 2014
Work distribution: Lead: RUG (post-doc and Vis), TUE (post-doc, Dam) and Energy Valley Input: Groningen Seaports; VOPAK; Gasunie; Feederlines; IMS; Ecos Energy; Jan de Rijk Logistics; GDF Suez
Expected results/deliverables/milestones: Academic paper, White paper Input for work packages 2 and 3

Activity 2: Market analyses and market niches
Description: Conduct market analyses of the market for LNG and identifying promising market niches; specifically a market analysis of the market for LNG in North Netherlands and make predictions of potential demand
Planning: November 2013 – March 2014
Work distribution: Lead: RUG (post-doc and Vis) and Energy Valley Input: Ecos, Groningen Seaports; VOPAK; Gasunie; GDF Suez; Oliehandel Klaas de Boer
Expected results/deliverables/milestones: White paper and market studies Input for work packages 3, 4, 5

Activity 3: logistical constraints in the design of synchromodal transport networks
Description: Perform an analysis of the(investment) opportunities, and logistical constraints in the design of synchromodal transport networks with intermediate storage and related logistics processes
Planning: February 2014 – August 2014
Work distribution: Lead: RUG (post-doc and Vis), TUE (post-doc, Dam) and Energy Valley Input: Groningen Seaports; VOPAK; Gasunie; IMS; Feederlines; Nederlandse Vereniging Binnenhavens; Nationaal LNG Platform; GDF Suez.
Expected results/deliverables/milestones: White paper; Input for work packages 4 and 5

Activity 4: business case for the network design in the Northern Netherlands
Description: Formulate a business case for the network design in the Northern Netherlands with naming investments and location decisions considering the results of activity 2
Planning: September 2014 – January 2015
Work distribution: Lead: RUG (post-doc Vis), TUE (post-doc, Van Woensel) and Energy Valley Groningen Seaports; VOPAK; Gasunie; IMS; Feederlines; GDF Suez; Oliehandel Klaas de Boer;
Expected results/deliverables/milestones: White paper; Input for work packages 6,7,8

Activity 5: business case for analysis possible transition from one or more modes of transport to use LNG
Description: Formulate business cases for analysis possible transition from one or more modes of transport to use LNG and the corresponding design of the required infrastructure.
Planning: January 2015 – December 2016
Work distribution: Lead: RUG (post-doc, PhD candidate, Roodbergen, Vis), TUE (post-doc, Van Woensel, Dam) and Energy Valley Input: Groningen Seaports; VOPAK; Gasunie; Feederlines; IMS; Jan de Rijk Logistics;
Expected results/deliverables/milestones: White paper; Input for work packages 6, 7, 8

Activity 6: economic analyses of the supply chain of LNG
Description: Design models and tools to perform economic analyses of the supply chain of LNG in relation to revenue models for relevant parties
Planning: September 2015 – August 2016
Work distribution: Lead: TUE (Van Woensel and others) Input: Vopak, Gasunie
Expected results/deliverables/milestones: Academic paper

Activity 7: effects of government measures affecting the network design, demand and market price
Description: Analyze effects of government measures as tax increases, and local policies that affect the network design, demand and market price in close discussion with Energy Valley and local and national government agencies
Planning: September 2015 – February 2016
Work distribution: Lead: RUG (post-doc and Vis), and Energy Valley Input: Groningen Seaports; Vopak; Gasunie;
Expected results/deliverables/milestones: White paper

Activity 8: impact of innovations on the robustness of the network design
Description: Analyze impact of possible innovations (e.g., standardization of transport of LNG in containers) in relation to the robustness of the network design
Planning: February 2016 – December 2016
Work distribution: Lead: RUG (post-doc Vis), TUE (post-doc, Dam) and Energy Valley Input: Groningen Seaports; Vopak; Gasunie
Expected results/deliverables/milestones: White paper

Work package 2: Multi-modal inventory-routing problems

The main objective of this work package is to establish inventory and inventory-routing models for refuelling stations located in a dispersed network, for known demand and supply locations. In doing so, different modes of transportation (trucks, trains and barges) are employed synchromodally. In this case, only the origins and destinations are specified, the actual mode selection is managed via the 4C partner.

Specifically, this work package involves the development of methods to take operational decisions related to (1) the mode(s) of transport used to replenish the LNG refuelling stations; (2) the time of delivery and the selection of supply locations used for the replenishments; (3) the routing of the transport modes. We assume that the liquefied variant of the product is also used during transportation in this last part of the supply chain, i.e. regasification is done at the refuelling stations. Of course, the regasification stations may also serve as points to serve end consumer demand.

The methods that are to be developed in this work package, assume that they can build upon strategic decisions taken earlier concerning the network design. Such design choices follow from investments that are based on the business cases and building blocks thereof, as foreseen in work package 1. In this sense, work package 2 chronologically follows after work package 1. However, outcomes from the models developed in work package 2 also provide an essential input as a network efficiency indicator for the business cases in work package 1. It is for this reason that work packages 1 and 2 are executed in parallel, to enable this mutual strengthening of results. Parallel development is possible since the models and tools developed in work package 2 will be generic, i.e. suitable for any configuration of the LNG network.

In many cases, distribution points, such as the LNG refuelling stations, are served based on a Vendor Managed Inventory system (VMI). Many authors (Waller et al., 1999) focus on the value of VMI to facilitate coordination among different participants in the supply chain. VMI is one of the most widely discussed partnering initiatives for improving multi-firm supply chain efficiency. With VMI, greater coordination supports the supplier’s need for smoother transportation without sacrificing the service and inventory objectives. The VMI idea fits very well the idea of 4C in the supply chain, where cooperation, coordination and consolidation is managed over all supply chain partners.

The Inventory-Routing Problem is a very difficult mathematical problem (Bertazzi et al., 2008). As reported in Coehlo et al. (2011), compared to other optimization problems, this research area is relatively recent. Nevertheless, in the last years, many different solution approaches have been proposed, and therefore the class of IRP problems is relatively large. Furthermore, many of these problems are case-specific. This means that there is a bunch of characteristics, as the length of the planning horizon, the production or consumption rates and many others, which depends on the configuration of the distribution network (Bertazzi et al., 2008). These parameters may change significantly the structure of the problem. Despite the richness of the class of IRP problems, some typical aspects of the urban distribution systems have not been addressed in the existing literature. One of these is the presence of service time windows, which has been taken into account only in very few case-specific studies. For a complete view on the state-of-the-art on this field we refer to recent surveys by Bertazzi et al. (2008) and Cordeau et al. (2009).

In general, the considered LNG-IRP is defined as the problem to jointly optimize inventory and routing considering perishable items (due to the vaporization of LNG in both transport and in stock), time windows and heterogeneous fleet (due to synchromodality). As far as we know, the problem is not defined in the literature (not even for the liquefaction-shipping-regasification part of the LNG supply chain) and no exact methods or heuristics exist to solve this LNG-IRP problem. Moreover, any discussions on the role of (demand and/or supply and/or travel) uncertainty are not covered. For some reduced IRPs, literature is available on heuristic solution techniques (Goel et al., 2008; Stålhane et al., 2012) and exact solution methods (Grønhaug et al., 2010).

We distinguish between the following activities:

Phase 1	Activity 1: Review the relevant literature on LNG supply chain networks Activity 2: Review the relevant literature on Inventory Routing Problems (IRP) Activity 3: Build a conceptual model for the LNG-IRP based on the literature and on the input coming from the companies involved Activity 4: Present results in scientific papers Activity 5: Present results on academic and industrial conferences Activity 6: Actively involve the relevant partners from the consortium
Phase 2	Activity 7: Build mathematical models for the LNG-IRP Activity 8: Obtain solutions for the LNG-IRP using exact and heuristic solution techniques Activity 9: Present results in scientific papers Activity 10: Present results on academic and industrial conferences Activity 11: Actively involve the relevant partners from the consortium

In more detail:

Activity 1: Review the relevant literature on LNG supply chain networks
Description: Literature review on LNG supply chain networks based on: • Academic literature • Industrial literature • Company interviews • Work package 1 input
Planning: Year 1: M1-M3
Work distribution: TU/e – PostDoc and Van Woensel
Expected results/deliverables/milestones: Working paper report in M3

Activity 2: Review the relevant literature on Inventory Routing Problems (IRP)
Description: Literature review on IRPs based on: • Academic literature • Industrial literature • Company interviews
Planning: Year 1 M3-M6
Work distribution: TU/e – PostDoc and Van Woensel
Expected results/deliverables/milestones: Working paper report in M6

Activity 3: Build a conceptual model for the LNG-IRP based on the literature and on the input coming from the companies involved
Description: Combine the outputs of Activity 1 and 2 into a sound and coherent conceptual model sufficiently describing the real-world LNG-IRP problem. Confront this conceptual model with the companies in different meetings.
Planning: Year 1 M6 – M12
Work distribution: TU/e – PostDoc and Van Woensel
Expected results/deliverables/milestones: Meetings with companies Working paper report in M12 Scientific paper in M12 to be submitted to ISI journal input for business cases in work package 1

Activity 4/9: Present results in scientific papers
Planning: Year 1-2
Work distribution: TU/e – PostDoc and Van Woensel
Expected results/deliverables/milestones: Scientific papers in M12/M24 to be submitted to ISI journal input for business cases in work package 1

Activity 5/10: Present results on academic and industrial conferences
Description: Present the work done on various conferences both academic and industrial.
Planning: Year 1-2
Work distribution: TU/e – PostDoc and Van Woensel
Expected results/deliverables/milestones: Conference proceedings and presentations

Activity 6/11: Actively involve the relevant partners from the consortium
Planning: Year 1-2
Work distribution: TU/e – PostDoc and Van Woensel
Expected results/deliverables/milestones: Various meetings and workshops with companies Meeting reports

Work package 3: Direct delivery multi-modal transportation problem

Besides classic product transfers at fixed locations in the network, with LNG there is also the option of direct ship-to-ship or barge-to-truck transfers. This option is technically feasible and already in use in practice. Besides the issues addressed in work package 2, we therefore also have the option of refuelling ships, barges and trucks from storage facilities that are themselves capable of moving (since the storage facility is actually a ship or barge itself).

An important advantage of such floating infrastructure can be found in the fact that less static landside infrastructure needs to be in place. For example in the earlier stages of the network development, such option may provide coverage in areas with a low density of fixed bunker facilities. Thus it can aid in development of the market by reducing risk of coverage issues for users. Furthermore, ship-to-ship (STS) transfers can be made at locations without land in sight, thus potentially reducing distances travelled by the ship that is to be refuelled. Another aspect mentioned in this context is that safety is likely to be easier to be guaranteed by deliveries on open sea, without residential areas nearby.

In this work package we study the routing of LNG supply ships in conjunction with the routes of ships that are on their way to deliver goods (LNG or other goods such as containers). Given a number of LNG supply ships and a set of customer ships that need refuelling, the issue is to decide which LNG supply ship refuels which customer ship, in which sequence each LNG supply ship meets the assigned customer ships, and the locations for the various meetings. Consequently, the decisions on transfer locations become part of the daily routing problems. Additional issues that may need to be addressed include (1) limits on the storage capacity of the LNG supply ship, and the consequential need to refuel the supply ships themselves, and the location for that (2) the risk and associated costs of stalling of customer ships due to running out of fuel, (3) the fact that the available LNG inventory of the supply ship changes due to vaporisation over time, and (4) the fact that the LNG inventory available for customers decreases based on the distance travelled by the supply ship, since it uses LNG from the general stock for its own propulsion.

In solving this problem, we can learn from the surveillance routing problem, which is an extension of the on-line TSP. In this problem, surveillance ships need to determine a path to detect ships that need to be visited to maximize the total operational effectiveness. A possible solution might be to define so-called "milk-rounds" where a supply ship starts and ends at a land-side bunker facility to get a new supply of LNG and visits ships at pre-defined locations to provide customers with high quality LNG that hardly had the opportunity to age and was not stored. Both dispatching (what bunker ship serves what ship) and routing decision need to be made. A parallel can be noticed with the dispatching and routing problem for the milk-run problem (representing the delivery to a set of stores, or the collection of milk products at dairy farmers (e.g., Laporte, 2007; Du et al., 2007). However, in the planning we need to deal with the complexity that information on the exact location of each ship changes real-time and need to be incorporated by the planner. This is an important aspect of dynamic vehicle routing problems (Pillac et al., 2013). Clearly, for suppliers with bunker ships penalties are high if ships of their customers get stalled when refuelling occurs too late.

Ship owners need to decide what option(s) are selected for bunkering. Flexibility is key to take, for example, changing weather conditions into account. Severe weather might result in high waiting times as well as the unavailability of floating bunker locations. Ship owners need to hold transfers at sea against transfers at on-shore facilities. In the latter cases the willingness to deviate from routes to bunker and/or to allow for additional non-added value time to the ships' routing times need to be taken into consideration. We intend to propose a tool to allow ship owners to decide for each ship what option is selected in such a way that deviation of ship routes is minimized as well as waiting times of ships.

Suggestions for numerical and mathematical modelling of the identified characteristics of LNG resulting will be used in OR decision modelling to determine the impact of probability of routing options. For example, Roh et al. (2013) study the effects of convection in LNG storage tanks. Models for vaporisation can, for example, serve to determine the initial volume loaded into a ship such that upon arrival -after part of the volume has disappeared due to vaporisation and usage as fuel by the ship itself- the right quantity remains to fulfil the client's order, with a minimum of leftovers.

The results will be used among other things in the business cases designed in work package 1 and in specific business cases for consortium partners as Feederlines, IMS and Oliehandel Klaas de Boer.

Year 1	Activity 1: Reviewing literature on dynamic vehicle routing problems and online TSP Activity 2: conceptual model to picture routing decisions in relation to static bunker locations and floating infrastructure Activity 3: Present results in scientific papers Activity 4: Present results on academic and industrial conferences Activity 5: Actively involve the relevant partners from the consortium
Year 2	Activity 6: design of a decision tool to route bunker ships to serve ships efficiently and effective Activity 7: Present results in scientific papers Activity 8: Present results on academic and industrial conferences Activity 9: Actively involve the relevant partners from the consortium
Year 3	Activity 10: design of a decision tool for ship owners to trade-off ship-to-ship bunkering and static bunker locations Activity 11: Present results in scientific papers Activity 12: Present results on academic and industrial conferences Activity 13: Actively involve the relevant partners from the consortium

In more detail:

Activity 1: Reviewing literature on (dynamic) vehicle routing problems and online TSP
Description: Reviewing literature, and defining a research proposal; interviews with stakeholders
Planning: September 2013 - August 2014
Work distribution: Lead: RUG (PhD candidate, Roodbergen)
Expected results/deliverables/milestones: Literature review and a research proposal

Activity 2: conceptual model to picture routing decisions in relation to static bunker locations and floating infrastructure
Description: By reviewing literature, observations and interviews with stakeholders the goal is to derive a conceptual model showing the relations between routing decisions and static and floating bunker locations in LNG networks.
Planning: September 2014 - November 2014
Work distribution: Lead: RUG (PhD candidate, Roodbergen)
Expected results/deliverables/milestones: Conceptual model and report to summarize findings from practice

Activity 6: design of a decision tool to route bunker ships to serve ships efficiently and effective
Description: Deriving a model and solution approach to decide on 1) what bunker ship supplies what ship; 2) in what order are ships handled by a bunker ship; 3) at what location will bunkering take place?
Planning: December 2014 - September 2015
Work distribution: Lead: RUG (PhD candidate, Roodbergen, Vis),
Expected results/deliverables/milestones: Academic paper, case study, input for business cases in work package 1

Activity 10: design of a decision tool for ship owners to trade-off ship-to-ship bunkering and static bunker locations
Description: Deriving a model and solution approach to decide for each ship what bunker option to use.
Planning: September 2015 - September 2016
Work distribution: Lead: RUG (PhD candidate, Roodbergen),
Expected results/deliverables/milestones: Academic paper, case study, input for business cases in work package 1

Activity 3/7/11: Present results in scientific papers
Planning: Year 1-2-3
Work distribution: RuG - PhD candidate and Roodbergen and Vis
Expected results/deliverables/milestones: Scientific papers to be submitted to ISI journal

Activity 4/8/12: Present results on academic and industrial conferences
Planning: Year 1-2-3
Work distribution: RuG - PhD candidate and Roodbergen
Expected results/deliverables/milestones: Conference proceedings and presentations

Activity 5/9/13: Actively involve the relevant partners from the consortium
Planning: Year 1-2-3
Work distribution: RuG - PhD candidate and Roodbergen and Vis
Expected results/deliverables/milestones: Various meetings and workshops with companies Meeting reports

Planning

A summary of the planning is provided in Figure Part B.2

ID	Planning WP 1, 2 and 3	Start	Finish
1	WP 1, Activity 1. Supply chain LNG	2-9-2013	1-1-2014
2	WP 2, Activity 1 and 2. literature review	2-9-2013	28-2-2014
3	WP 3, Activity 1. literature review, proposal	2-9-2013	2-9-2014
4	WP 1, Activity 2. market analyses	1-11-2013	1-4-2014
5	WP 1, Activity 3. synchromodal transport	3-2-2014	4-8-2014
6	WP 2, activity 3. conceptual model	3-3-2014	1-9-2014
7	WP 2, activity 4 -11	1-8-2014	31-8-2015
8	WP 3, activity 2: conceptual model	1-9-2014	31-10-2014
9	WP 1, activity 4: business case	1-9-2014	1-1-2015
10	WP 3, activity 6: decision tool	1-12-2014	30-9-2015
11	WP 1, activity 5: business cases	1-1-2015	30-12-2016
12	WP 3, activity 10: decision tool	1-9-2015	1-9-2016
13	WP 1, activity 6: economic analysis	1-9-2015	31-8-2016
14	WP 1, activity 7: government measures	1-9-2015	29-1-2016
15	WP 1, activity 8: impact of innovations	1-2-2016	30-12-2016

Figure Part B.2: Summary planning

The relation between the work packages can be summarised as follows and is pictured in Figure Part B.3: activities 1-3 of work package 1 serve as input for designing planning and control tools in work packages 2 and 3. The resulting models and solution approaches of these work packages can subsequently be used in deriving the business cases in activities 4 and 5 of work package 1 and the economic and sensitivity analyses of activities 6-8 of work package 1.

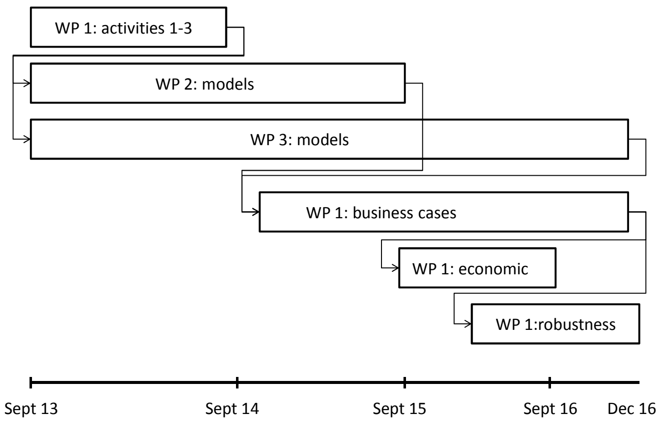

Figure Part B.3: Relation work packages

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Part C: Consortium and Project organization

Research Team - Academic Researchers

Short CVs of the scientific researchers in this project can be found in part G. Descriptions of the companies are given here. Specific activities of the researchers and each of the consortium partners are described in part B.

Name	Role and input	Specific competence
Iris F.A. Vis	Project leader Leader Work package 1	Port and transportation network design
Tom van Woensel	Leader work package 2	Freight logistics
Kees Jan Roodbergen	Leader work package 3	Quantitative logistics
Jacques Dam	Expertise on LNG, link with TKI Gas	LNG
Other researchers department Operations, University of Groningen	Researcher	operations
Other researchers department OPAC, Eindhoven University of Technology	Researcher	Operations, planning, accounting and control

Research Team - Companies

The following companies, each (potentially) representing an important stakeholder in the supply chain of LNG (see Figure part A.2), participate in the consortium of the R&D project. Both partners already active in the supply of LNG as well as potential *early adapters* decided to join the consortium.

Stakeholder "Producer Bio-LNG": Ecos Energy B.V.

Ecos Energy B.V. has the intention to build a industrial bio-digester in the industrial area Europapark, south of the city of Coevorden, to produce bio-LNG[11]. Knowledge contributions in this project might be, among others, sharing information on designing and constructing industrial bio-digesters, formulating business cases for production of bio LNG including cost calculations, and potential of upgrading biogas into LBM (liq. bio methane). Important questions to be answered (which are included in work package 1) concern more information on the expected market prices, and the relation with production costs as well as a study into markt niches with a high added value.

Stakeholder "Facilitator LNG terminal": Groningen Seaports[12]

Groningen Seaports is the port authority for the port of Delfzijl, Eemshaven and the adjoining industrial sites. The organisation provides the complete package of port services to its industrial and commercial clients, from logistics and infrastructure services to the issue and maintenance of the sites in both port regions. As well as the two excellently equipped ports, Groningen Seaports manages the industrial sites around the ports and at other areas in the Eemsdelta. In the supply chain of LNG, Groningen Seaports positions itself as potentially a port for LNG at three levels (large scale LNG terminal; midscale LNG for regional distribution in the North of the Netherlands as well as North-West Germany; LNG bunkerstation/fuel station for ships and trucks). Groningen Seaports demonstrates her LNG

[11] www.provincie.drenthe.nl
[12] http://www.groningen-seaports.com

ambitions by encouraging users by favorable rates for clean shipping, as facilitator, joining cooperating initiatives as LNG platform, and adjusting port regulations for LNG developments in shipping.

Stakeholder "LNG infrastructure": Nederlandse Gasunie NV[13]

Gasunie is a European gas infrastructure company providing the transport of natural gas and green gas in the Netherlands and the Northern part of Germany. To get the gas to the end-user safely and reliably, Gasunie has a high-grade gas transmission grid for end-users as well as customers using this grid to transport gas on to end-users. All activities are geared to facilitating both the industrial and domestic gas markets This varies from providing gas transport to constructing new infrastructure; from participating in new projects to develop new services. Gasunie also provide thes market with gas storage facilities (Gasunie Zuidwending), the pipeline to England (BBL) and the *LNG* terminal Gate at Maasvlakte. Gasunie and Vopak (see below) announced in August 2012 that they have signed an agreement with Royal Dutch Shell (Shell) as launching customer for their *LNG* Break Bulk terminal, to be constructed at the Maasvlakte near Rotterdam. The purpose of this terminal is to make *LNG* available for distribution to marine bunkering and truck fuelling stations[14]

Stakeholder "LNG infrastructure": Royal Vopak[15]

Vopak - with its headquarters in Rotterdam, the Netherlands - is the world's largest independent tank storage provider, specialized in the storage and handling of liquid chemicals, gasses and oil products. Vopak operates 85 terminals with a combined storage capacity of nearly 30 million cubic meters in 31 countries. The terminals are strategically located for users along the major shipping routes. The majority of customers is active in the chemical and oil industry, for which Vopak stores a large variety of products destined for a wide range of industries. Vopak's mission is to make a sustainable contribution to ensure more efficient logistics processes by being the leading provider of an independent, optimum tank terminal infrastructure at locations that are critical to Vopak's customers in all regions of the world. In the Gate terminal Vopak and Gasunie have combined their experience in running independent terminals, handling cargoes brought in by ship, efficient stock management for a variety of customers, LNG storage, regasification, gas quality monitoring and safe and efficient connection to the European gas transport network[16].

Stakeholder "Mid and small scale market": Intermodal Solutions[17]

Intermodal Solutions (IMS) provides door-to-door intermodal solutions by arranging the transportation of maritime and continental cargo flows between Northern Netherlands, ports and major industrial areas in the European hinterland. IMS is a specialist in the optimal usage and combination of the different modes of transportion modes rail, water and road at different inland terminals. IMS is interested to explore the possibilities of LNG as fuel for the different modes of transportation.

[13] http://www.gasunie.nl/en/about-gasunie
[14] http://www.gasunie.nl/en/news/gasunie-en-vopak-tekenen-overeenkomst-met-shell-als-launching-cus?q=lng
[15] http://www.vopak.com
[16] http://www.vopak.com/press-releases-2006/major-european-gas-companies-committed-to-gate-terminal-lng.html
[17] http://www.intermodal-solutions.nl/

Stakeholder "Mid and small scale market": Feederlines[18]

Feederlines BV was founded as part of the Hartmann Group in 1995. From the beginning, Feederlines BV aimed at the ever expanding Short Sea sector. The company owns dry cargo vessels from 2,500 up to 9,000 DWT and container feeder vessels from 290 TEU up to 750 TEU. These vessels were built in the Netherlands, China, Rumania and Bulgaria. The Group's take over of the chartering organisation MTL in Duisburg in 1998 has given the shipping company a further lift. A strong position was built with the transport of forest products. Furthermore, regular services are provided for a large number of operators. The organisation is characterised by a strong communication network, which makes it possible to respond fast and adequately to the needs of charterers and operators. Feederlines is interested to explore the possibilities of LNG as fuel for short-sea shipping and study trade-offs as purchasing new vessels versus adopting the existing fleet.

Stakeholder "Mid and small scale market": Jan de Rijk Logistics[19]

Jan de Rijk Logistics provides leading-edge transportation management and integrated logistics services to key industries in Europe, using (mainly) their own assets. Sustainability, competitiveness, reliability and a strong customer focus are key in offering transportation and logistics solutions.

Stakeholder "Bunkering and physical delivery": Oliehandel Klaas de Boer B.V.[20]

Klaas de Boer is an independent supplier of heavy fuel, gasoil and lubricants performing physical deliveries across the Netherlands. Klaas de Boer was founded in 1914 and has an excellent track record in terms of service and reliability. Due to the modest size of the company we are flexible in our way of working and have short communication lines to ensure quick follow up to your requirements. Klaas de Boer is also active around the globe for it's clients, making sure we obtain the best quality for the best price available. Klaas de Boer is specifically interested in the potentials of LNG compared to traditional types of fuel (and their developments), market analyses as well as planning of operations in a floating network infrastructure as being studied in work package 3.

Stakeholder "Government, policies and connecting stakeholders": Energy Valley Foundation[21]

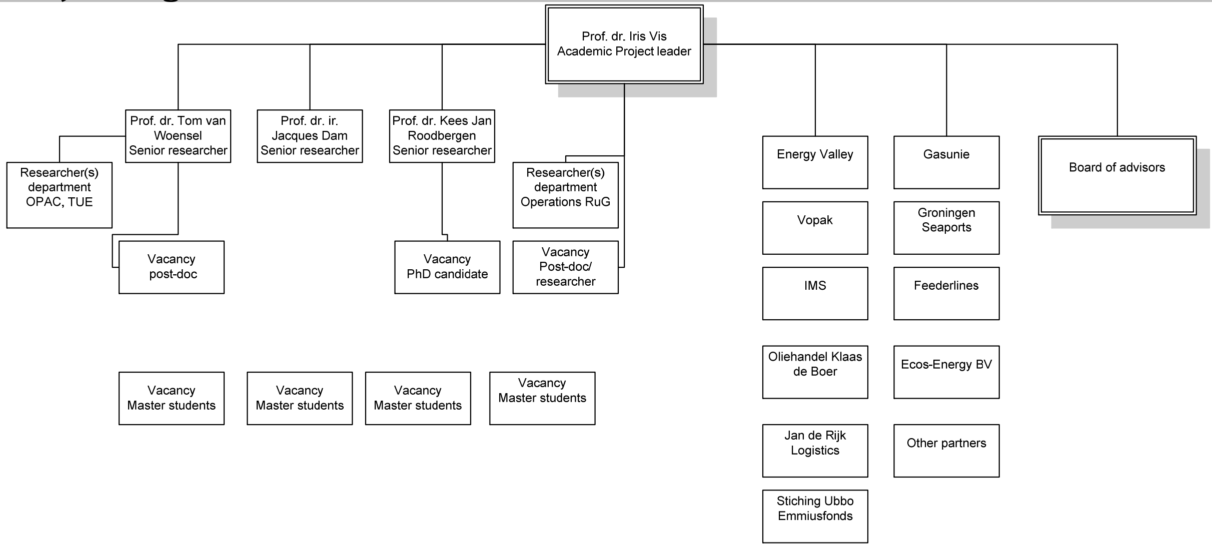
The Energy Valley Foundation has been in existence since 2003 as a network organisation working together with public and private partners to explore regional growth opportunities in the energy sector. The institute acts as an intermediary to accelerate projects, promote knowledge sharing and strengthen the northern energy region. The institute is made up of a team of energy professionals who, in consultation with the Supervisory Board and relevant government bodies, support initiative-takers in implementing energy projects. Their focus lies on energy innovations which link up directly with national and international energy ambitions and regional strengths.

[18] http://www.feederlines.nl/en/organisation/
[19] http://www.janderijk.com/mission
[20] http://www.klaasdeboer.nl/
[21] http://www.energyvalley.nl/EN/about/about-the-foundation

Stakeholder "Production and distribution": GDF Suez[22,23]

GDF SUEZ Energy Netherlands is a leading energy player in the Dutch market. Besides being a producer of energy, the company is also the energy specialist for the business market. In the consumer market, we operate under the brand Electrabel. GDF SUEZ Energy Netherlands invests over the energy mix by using new technologies to increase the efficiency of existing power plants, by building new, more efficient and flexible power plants and by investing in renewable sources such as onshore wind and biomass. GDF SUEZ Energy Netherlands is part of GDF SUEZ, a global player in the field of energy services, water and environment.

Project organization



A program committee, with a representative of each partner and chaired by the academic project leader will lead the project. Leaders of important LNG supply chain stakeholders as well as scientists focusing on network design, hinterland transportation and vehicle routing participate in the consortium (see figure). 3-monthly meetings will be organized with the consortium to monitor progress and set new goals for each of the work packages. In parallel, bilateral meetings will be organised between researchers and partners in the constortium to discuss specific projects.

A board of advisors will be established. Via this board of advisors direct input on relevant trends, innovations and research questions will be acquired. At the same time, members of the board of advisors can serve as access point to other relevant parties in the supply chain of LNG. Currently, the following parties have expressed their support for the project and/or are willing to consider to become member of this board of advisors.

- Volvo[24]
- Nationaal LNG Platform[25,26] (boardmembers: Port of Rotterdam, Shell Nederland, Vopak, Gasunie, EnergyValley, Deltalinqs RCI, GDF Suez, LNG TR&D)
- Nederlandse Vereniging van Binnenhavens[27]

[22] participation pending (see application form)
[23] http://www.gdfsuez.nl/
[24] http://www.logistiek.nl/Distributie/duurzaam-transport/2013/3/Volvo-en-Shell-sluiten-wereldwijd-LNG-contract-1212531W/
[25] http://www.nationaallngplatform.nl/
[26] http://www.nationaallngplatform.nl/wp-content/uploads/Leaflet_Algemene-Infol-LNG-Platform_11-september-2012_last.pdf
[27] http://www.havens.binnenvaart.nl/

Part D: Evaluation and monitoring

Evaluation

In parts A and B we have specified for each work package and activity the expected results and contributions of all consortium partners. Both 3-monthly meetings with the consortium and bilateral meetings will be scheduled to monitor progress, discuss outcomes and if needed make project adjustments.

We designed a portfolio of activities to evaluate the project in terms of innovation, process, cooperation and results. Namely:

- knowledge dissemination via a website, publications and seminars
- meetings with researchers in the project
- meetings with the advisory board
- individual and workshop meetings with partners in the consortium
- peer review assessment
- progress reports and a final report

We will discuss each of these aspects in more detail below.

Knowledge dissemination
A website will be used to share information via an open-access channel as well as intranet platform. The open access site will be used to share outputs with a larger audience of both academics and professionals. The intranet pages will be used to share internal communications such as reports of meetings, special notes on case studies for a specific company, progress reports, unfinished papers, preliminary management reports and suggested project adjustments. We will use professional and academic journals as well as white papers to publish results. Practice-oriented and academic conferences are targeted to create awareness for LNG as fuel for the transportation sector. In this way, partners in the consortium as well as outside parties can decide which approaches are appealing to them to implement.

Researchers' meetings
The lead researchers will meet regularly (in person or via skype) to evaluate the results and the status of the project. Post-docs and a PhD candidate will have informal and formal contacts to share research outcomes and ideas.

Meetings with the advisory board
A board of advisors will be established. Currently, the following parties have expressed their support for the project and/or are willing to consider to become member of this board of advisors.

- Volvo[28]
- Nationaal LNG Platform[29,30] (boardmembers: Port of Rotterdam, Shell Nederland, Vopak, Gasunie, EnergyValley, Deltalinqs RCI, GDF Suez, LNG TR&D)
- Nederlandse Vereniging van Binnenhavens[31]

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[28] http://www.logistiek.nl/Distributie/duurzaam-transport/2013/3/Volvo-en-Shell-sluiten-wereldwijd-LNG-contract-1212531W/
[29] http://www.nationaallngplatform.nl/
[30] http://www.nationaallngplatform.nl/wp-content/uploads/Leaflet_Algemene-Infol-LNG-Platform_11-september-2012_last.pdf
[31] http://www.havens.binnenvaart.nl/

Quite regularly the researchers in the consortium will have contact with representatives of the advisory board. The overall goal is to (1) discuss new insights and methods resulting from the research being performed; (2) out-of-the-box discussions to come up with innovative ideas; (3) discuss actual themes and new technological innovations that were initially not covered in the project plan, but that might be of interest for this project. At the same time, members of the board of advisors can serve as access point to other relevant parties in the supply chain of LNG.

Individual and work shop meetings with partners in consortium

3-monthly meetings will be organized with the consortium to monitor progress and set new goals for each of the work packages. In parallel, bilateral meetings will be organised between researchers and partners in the consortium to discuss specific projects.

Peer review assessment

Academic output will be reviewed by colleagues in the field when papers or theses are submitted for publication. Next to that, the models and related business cases will be discussed with the partners in the consortium to discuss the feasibility of implementation in practice. Finally, assessment of case studies will be discussed in the consortium and on professional and academic conferences to receive feedback on the methods and outcomes. All feedback will be used to improve the results.

Progress reports and a final report

Each year, a short report will be composed in which a detailed summary of the results so far and if applicable project adjustment are described. This report will be submitted to all partners in the consortium for feedback. A final report summarizing the results (academic output, pilots and implementation) will be composed.

Part E: Valorization and implementation strategy

Valorization and knowledge dissemination

Organization

We have defined 3 work packages to structure our research project each containing several activities. The activities contain both academic research, market studies, and business cases. Valorization activities might directly follow from the business cases designed both for the design of LNG networks as well as for users changing to using LNG as fuel for one or more modes of transportation. In each work package one or more companies take the lead for the valorization part. Deliverables have been formulated in part A. Clear insights can be obtained in the potential applicability of the developed concepts due to the breath of the consortium in which each relevant stakeholder for transportation and storage activities for LNG is included. Energy Valley Foundation and Nationaal LNG Platform will enable a linkage between governmental organisations and industry and a wider knowledge dissemination outside the consortium.

Making knowledge and results widely available

As stated in Part D, we will design a website to share outcomes of the project. We will publish academic and professional papers and present results at conferences. Regularly updates will be shared with the Dutch press and professional journals in logistics (www.logistiek.nl). Outcomes of the projects will be translated to be used in research driven education. Both participating universities offer Bachelor, Master and PhD courses to directly transfer knowledge to students. Master students will participate in the research project as well. We will organise thesis project meetings with groups of students of both universities and professional universities and participating companies via Dinalog.

Transfer beyond the consortium

The Energy Valley foundation and Nationaal LNG Platform will serve as the platform for dissemination of knowledge and providing workshops and training to all relevant stakeholders in the supply chain of LNG.

The Center of Operational Excellence (COPE), being the valorisation center of the department of Operations at the University of Groningen, will also serve as a platform to share knowledge via regularly newsletters, workshops and conferences.

Market analyses will be performed in The Netherlands beyond the partners of the consortium. We intend to validate all models and solution approaches by means of performing a case study and designing business cases. If the designed methods are valuable, but not suitable for the partners in the consortium, we will actively search for other partners. Organisations as Nederlandse Vereniging Binnenvaarthavens, TLN and Nationaal LNG Platform will enable participation of other relevant companies.

Implementation

As mentioned earlier, we notice a lack of LNG infrastructure in The Netherlands as well as neighboring countries. At the same time, stakeholders indicate that LNG will become a prime fuel for ships and trucks in the foreseeable future. The European Union and national governments have outlined their policies, and many companies are preparing for a transition period towards intensive use of LNG. In this project, we aim for designing new methods and approaches to create the required infrastructure to enable high accessibility for all users as well as the efficient planning of replenishment and refueling operations.

It is to be expected that the coming years high investments in creating the required infrastructure will be done. Basically, we deal with an entirely new market for which both the supply and demand side and the related logistics network still need to be designed. More specific investments will be made in newly purchased or altered trucks and ships; investments in the actual infrastructure (e.g., bunker facilities and tank stations) as well as the investments in the production of bio LNG. Our market and economic analyses as well as business cases derived might lead to implementation of the outcomes by partners in doing these investments.

For 2015 already specific goals have been formulated as part of the Green Deal LNG Rhine and Wadden. Namely, at least 50 barges, 50 sea vessels and 500 trucks use LNG. We expect that the results of this project can directly be used by participating companies and others to make their investment decisions in the process of the network creation in The Netherlands to support these goals and at the same time use the knowledge to expand beyond The Netherlands. In work packages 2 and 3 we develop tools that can be used in designing business cases to assist in decision making in the earlier investment stage, as well as in achieving operational efficiency later on.

To reach these goals, this project unites representatives of all relevant stakeholders in the LNG supply chain: production of bio LNG (Ecos Energy B.V.); infrastructure (Gasunie, Vopak); refueling stations (GDF Suez); locations for establishing business (Groningen Seaports; Nederlandse Vereniging van Binnenhavens), manufacturers of trucks (Volvo); ship-to-ship supply (Oliehandel Klaas de Boer); government (via Energy Valley Foundation); users (Feederlines, IMS, Jan de Rijk Logistics) and the National LNG Platform (with Shell Nederland, Port of Rotterdam and others as its participants).

Part F: Consortium collaboration agreement

Consortium collaboration agreement

Undersigned consortium partners:

Rijksuniversiteit Groningen, Faculty of Economics and Business based in Groningen and represented by S. Poppema, being applicant of the project,

and

Groningen Seaports based in Delfzijl and represented by R. Genee
Vopak LNG Holding BV based in Rotterdam and represented by E. Groensmit
NV Nederlandse Gasunie based in Groningen and represented by U. Vermeulen
Oliehandel Klaas de Boer B.V. based in Urk and represented by J. Heijne
Stichting Ubbo Emmiusfonds based in Groningen and represented by J.J. Koning
IMS based in Veendam and represented by F. Fokkens
Feederlines based in Groningen and represented by H. van der Ent
Ecos Energy B.V. based in Nijmegen and represented by A. Roland Holst
Eindhoven University of Technology based in Eindhoven and represented by H. Roumen
Stichting Energy Valley based in Groningen and represented by G. van Werven
Jan de Rijk Logistics based in Roosendaal and represented by C. Lievaert[32]
GDF Suez based in Zwolle and represented by J. van Dijk[33]

Declare that:

- The partners in the Consortium authorize the Applicant to submit the project application for the project Design of LNG Networks on behalf of the Consortium;
- The partners will execute the project as described in the project plan and share cost and risks. In the case of partners that want to make use of IKS (through an agreement with Agentschap NL), this must be noted on the subsidy application form and properly discussed with and supported by the other partners in the project and included in the budget;
- This partner agreement will run from September 1,2013 until December 31, 2016; if the project and subsidy will be approved by Dinalog, this partner agreement will be replaced by a consortium agreement within 3 months after start of the project.
- The partners commit to the content and financial contribution as described in the application form and in the project plan;
- The partners commit to the rules and guidelines of Dinalog as written down in the Guideline for R&D projects, including the IP rules;
- Partners will take care of public availability and knowledge dissemination of the project results, which includes making project results and information digitally available on the Internet free of charge.

[32] Written approval still pending.
[33] Written approval still pending

Applicant	
Company/organization	Rijksuniversiteit Groningen
Name	S. Poppema
Place and date	Groningen 8. 5-13
Signature	

Applicant	
Company / organization	Technische Universiteit Eindhoven
Name	
Place and date	
Signature	

Applicant	
Company / organization	NV Nederlandse Gasunie
Contribution	CASH €50.000 for the project period IN KIND 240 hours for the project period
Name	U. Vermeulen
Place and date	May 8, 2013
Signature	p.o.

Applicant	
Company / organization	Vopak LNG Holding BV Westerlaan 10 3016 CK Rotterdam
Contribution	CASH IN KIND Providing LNG market development information and logistic background to bring LNG to the North of the Netherlands and into the German/Danish coastal waters 20 mandays/y
Name	Ernest Groensmit
Place and date	Rotterdam, May 6, 2013
Signature	

Applicant	
Company / organization	ECOS Energy BV
Contribution	CASH IN KIND 280 manuren over de looptijd
Name	A. Roland Holst
Place and date	Nijmegen, 7 mei 2013
Signature	

Applicant	
Company / organization	Stichting Ubbo Emmius Fonds
Contribution	100.000 euro
Name	J.J. Koning
Place and date	7 mei 2013
Signature	

Applicant	
Company / organization	Stichting Ubbo Emmius Fonds
Contribution	75.000 euro
Name	J.J. Koning
Place and date	9 mei 2013
Signature	

Applicant	
Company / organization	Groningen Seaports
Contribution	120u per jaar
Name	R.O. Genee
Place and date	3 mei 2013
Signature	

energy valley
Postbus 11073
9700 CB Groningen

T +31 0 50 789 00 10
F +31 0 50 798 00 19

info@energyvalley.nl
www.energyvalley.nl

KvK 02083245
BTW 8128.73.312.B.01

Applicant	
Company / organization	Stichting Energy Valley
Contribution	CASH € 20.000,- IN KIND € 5.000,-
Name	Drs. G. van Werven
Place and date	Groningen, 07-05-2013
Signature	

energy valley
Laan Corpus den Hoorn 300
9728 JT Groningen

Applicant	
Company / organization	Feederlines BV
Contribution	Hours for the total period 168
Name	Bootsma/van der Ent
Place and date	Groningen 7 mei 2013
Signature	

Applicant	
Company / organization	3ms Veendam.
Contribution	CASH IN KIND => 150h per jaar!
Name	F. Folkens.
Place and date	Veendam. 7/5/2013.
Signature	

Applicant	
Company / organization	Oliehandel Klaas de Boer B.V.
Contribution	IN KIND
Name	Jeroen Heijne
Place and date	Groningen, May 8th 2013
Signature	

Applicant	
Company / organization	GDF Suez
Contribution	CASH IN KIND
Name	
Place and date	
Signature	

Applicant	
Company / organization	Jan de Rijk Logistics
Contribution	CASH IN KIND
Name	
Place and date	
Signature	

Part G: Curricula Vitae of the lead Scientific Researchers

Here we provide the CVs of the 4 lead researchers in the project. Other researchers of the Department of Operations of the University of Groningen[34] and the Department Operations, Planning, Accounting and Control of the Eindhoven University of Technology[35] will join in the project.

I.F.A. Vis

Dr. Iris F.A. Vis is professor of Industrial Engineering at the University of Groningen, The Netherlands. She holds an M.Sc. in Mathematics (specialisation Operations Research) from the University of Leiden, and a Ph.D. from the Erasmus University Rotterdam. She was an Associate Professor at the VU University Amsterdam and a Visiting Professor at the Virginia Polytechnic Institute and State University before joining the University of Groningen in February 2011. Vis is a fellow of the research institute SOM and program chair of the master programmes Supply Chain Management and Technology & Operations Management.
The research interests of Vis are in the design and optimisation of port network and transportation network design, container terminals, vehicle routing, supply chain management and inventory management. She has performed numerous projects in cooperation with companies, resulting in a blend of rigorous academic work with practical applicability.
Her articles have been published in scientific journals as Operations Research, Transportation Science, European Journal of Operational Research, and IIE Transactions. She serves as area editor for *Computers & Industrial Engineering* and as an associate editor for *OR Spectrum*. Several awards have been given for her scientific work, including the INFORMS Transportation Science Section Dissertation Award 2002.

Five selected publications for Iris Vis:

- Carlo, H.J., Vis, I.F.A. (2012), Sequencing Dynamic Storage Systems with Multiple Lifts and Shuttles, International Journal of Production Economics 140, 844-853.
- Bijvank, M., Vis, I.F.A. (2011), Lost-sales inventory theory: a review, European Journal of Operational Research 215, 1-13.
- Vis, I.F.A., Carlo, H.J. (2010), Sequencing two cooperating automated stacking cranes in a container terminal, Transportation Science 44(2), 169-182.
- Vis, I.F.A., Roodbergen, K.J. (2009), Scheduling of container storage and retrieval, Operations Research, 57, 456-467.
- Vis, I.F.A., De Koster, R., Savelsbergh, M.W.P. (2005), Minimum vehicle fleet size under time window constraints at a container terminal, Transportation Science 39(2), 249-260

T. van Woensel

Dr. Tom van Woensel is professor of freight transport and logistics. He is executive board member of the European Supply Chain Forum and a member of the BETA Research School for Operations Management and Logistics. He holds an M.Sc. in Applied Economic Sciences (cum laude) with specialisation Quantitative Economics of the University of Antwerp. He finalised his doctoral program in Applied Economic Sciences with degree magna cum laude and obtained an PhD. in Applied Economic Sciences (Operations Management) of the University of Antwerp.
Five selected Publications for Tom van Woensel:

[34] http://www.rug.nl/feb/organization/scientific-departments/operations/
[35] http://opac.ieis.tue.nl/

- Van Donselaar K., V. Gaur, T. Van Woensel, R.A.C.M. Broekmeulen, J.C. Fransoo, Ordering Behavior in Retail Stores and Implications for Automated Ordering, Management Science, forthcoming
- Gabali, O., T. Van Woensel, A.G. de Kok, C. Lecluyse and H. Peremans,Time-Dependent Vehicle Routing Subject to Time Delay Perturbations, IIE Transactions, forthcoming
- Gür Ali O., S. Sayžn, T. Van Woensel and J. Fransoo (2009), Pooling Information Across SKUs for Demand Forecasting with Data Mining, Expert Systems with Applications, Volume 36(10), 12340-12348
- Van Woensel T. and F.R.B. Cruz (2009), A stochastic approach to traffic congestion costs, Computers and Operations Research, 36(6), 1731-1739.
- Van Woensel, T., R. Creten and N. Vandaele (2001), Managing the environmental externalities of traffic logistics: the issue of emissions, Production and Operations Management journal, Special issue on Environmental Management and Operations, 10(2).

K.J. Roodbergen

Dr. Kees Jan Roodbergen is professor of Quantitative Logistics at the University of Groningen, The Netherlands. In his academic research, Roodbergen has a diverse interest, ranging from e-commerce logistics, supply chain management, logistics of temperature-controlled (food) products, facility logistics, and traveling salesman problems. He has published in international journals such as Operations Research, IIE Transactions and the European Journal of Operational Research and has been a visiting researcher at the Georgia Institute of Technology.
Roodbergen serves on the Scientific Advisory Council of the World Food Logistics Organization, an organization that represents 3500 companies specialized in handling cooled and frozen food products. Next to that he is a member of the College-Industry Council on Material Handling Education in the USA. This council is affiliated with the Material Handling Industry of America (800 companies) and facilitates the information interchange between industry and academia. His solution approaches have been successfully applied at a number of companies, and have been included in a SAP add-on.
His teaching activities span the whole spectrum of Operations Management and Supply Chain Management at all levels, ranging from first-year Bachelor courses to post-experience programs.

Five selected publications for Kees Jan Roodbergen:

- Van der Heide, G., Roodbergen, K.J. (2013), Transshipment and rebalancing policies for library books, European Journal of Operational Research 228, 447-456.
- Roodbergen, K.J. and Vis, I.F.A. (2009), A survey of literature on automated storage and retrieval systems. European Journal of Operational Research 194(2), 343-362.
- Vis, I.F.A., and Roodbergen, K.J. (2009), Scheduling of container storage and retrieval, Operations Research 57(2), 456-467.
- Roodbergen, K.J., Sharp, G.P., and Vis, I.F.A. (2008), Designing the layout structure of manual order-picking areas in warehouses. IIE Transactions 40(11), 1032-1045.
- De Koster, R., Le-Duc, T., Roodbergen, K.J. (2007) Design and control of warehouse order picking: a literature review. European Journal of Operational Research 182(2), 481-501.

J.A.M. Dam

Jacques Dam is part-time professor of LNG Systems in the Department of Mechanical Engineering at Eindhoven University of Technology. He graduated in Applied Physics at the Technische Hogeschool Delft where he also obtained his PhD in 1989 then named the Technical University Delft. He then joined the design team of the superconducting AGOR cyclotron, now in operation at the University of Groningen (RUG). From 1996 to 2001, he worked for Stirling Cryogenics, and from 2001 to 2006, for ESA and Thales Cryogenics. In 2006, he joined Stork Inoteq, working to develop cryogenic systems and components for the LNG industry. In 2009, he was appointed associate professor in the TU/e CASA group, developing efficient numerical calculation methods for the LNG industry. In 2011, he became the science director of the LNG TR&D Foundation, and in 2012, he was appointed LNG Senior Manager at the Energy Valley Foundation, where he is working to develop a European LNG fuel supply chain.

Five selected publications for Jacques Dam:

- Rosen Esquivel, P.I., Thije Boonkkamp, J.H.M. ten & Dam, J.A.M. (2012), An asymptotic formula for the friction factor of laminar flow in pipes of varying cross section, Mathematics in Engineering, Science and Aerospace 3(1), 63-78.
- Rosen Esquivel, P.I., Thije Boonkkamp, J.H.M. ten, Dam, J.A.M. & Mattheij, R.M.M. (2012), A parametric study of the effect of wall-shape on laminar flow in corrugated pipes, Proceeding of the Proceedings of the ASME-ISME-KSME Joint Fluids Engineering Conference 2011 (Hamamatsu, Japan, July 24-29, 2011)), (pp. 1389-1398).
- Rosen Esquivel, P.I., Thije Boonkkamp, J.H.M. ten, Dam, J.A.M. & Mattheij, R.M.M. (2012), Wall shape optimization for a thermosyphon loop featuring corrugated pipes, In J.G. Weisend II (Ed.), Proceeding of the Proceedings of the 2011 Cryogenic Engineering Conference & International Cryogenic Materials Conference (CEC-ICMC 2011, Spokane WA, USA, June 13-17, 2011), (AIP Conference Proceedings, 1434, pp. 724-731).
- Pisarenco, M., Linden, B.J. van der, Tijsseling, A.S., Ory, E. & Dam, J.A.M. (2011), Friction factor estimation for turbulent flows in corrugated pipes with rough walls, Journal of Offshore Mechanics and Arctic Engineering 133(1), 011101-1/9.
- Knoopers, H.G., Krooshoop, H.J.G., Kate, H.H.J. ten, Pieterman, K. & Dam, J.A.M. (1994), The superconducting extraction magnet system EMC2 for the AGOR cyclotron, IEEE Transactions on Magnetics 30(4), 2022-2025.

Naam project:	Design of LNG Networks
Datum aanvang project:	1-Sep-13
Datum einde project:	31-Dec-16

KOSTEN

Posten		Participanten																					Totaal
		Penvoerder	Participant 2	Participant 3	Participant 4	Participant 5	Participant 6	Participant 7	Participant 8	Participant 9	Participant 10	Participant 11	Participant 12	Participant 13	Participant 14	Participant 15	Participant 16	Participant 17	Participant 18	Participant 19	Participant 20	
Omschrijving	Eenheid	RUG	TUE	Gasunie	Vopak	Ecos-Energy B.V.	St. Ubbo Emmius Fonds	Groningen Seaports	Stichting Energy Valley	Feederlines	IMS	Klaas de Boer	GDF Suez*	Jan de Rijk Logistics*	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Totale tijdsbesteding (in uren)	Uren	10,912	3,500	240	533	280	0	400	125	168	500	200	200	200	0	0	0	0	0	0	0	17,258
1. TOTAAL PERSONELE KOSTEN (Σ a x b)	Euro	739,703	291,023	9,600	21,320	11,200	0	16,000	5,000	6,720	20,000	8,000	8,000	8,000	0	0	0	0	0	0	0	1,144,566
- TOTAAL DIRECTE PERSONELE KOSTEN (Σ a x b)	Euro	410,470	167,500	9,600	21,320	11,200	0	16,000	5,000	6,720	20,000	8,000	8,000	8,000	0	0	0	0	0	0	0	691,810
- TOTAAL OPSLAG VOOR SUPERVISIE/BEGELEIDING	Euro	49,600	15,909	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	65,509
- TOTAAL OPSLAG 50% VOOR ALGEMENE KOSTEN	Euro	230,035	91,705	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	321,739
- TOTAAL BENCHFEE VOOR REIS-/CONGRESKOSTEN, OPLEIDING/TRAINING	Euro	49,600	15,909	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	65,509
2. TOTAAL KOSTEN VAN INHUUR DERDEN (max. 10% van totale projectkosten)	Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. TOTAAL OVERIGE PROJECTGERELATEERDE KOSTEN	Euro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4. TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	Euro	739,703	291,023	9,600	21,320	11,200	0	16,000	5,000	6,720	20,000	8,000	8,000	8,000	0	0	0	0	0	0	0	1,144,566
- Opslag Dinalog (8% met een maximum van 160.000 Euro), **incl. BTW**	Euro	71,603	28,171	929	2,064	1,084	0	1,549	484	650	1,936	774	774	774	0	0	0	0	0	0	0	110,794
5. TOTAAL BEGROTE PROJECTKOSTEN (gelijk aan totaal 6)	**EURO**	**811,307**	**319,194**	**10,529**	**23,384**	**12,284**	**0**	**17,549**	**5,484**	**7,370**	**21,936**	**8,774**	**8,774**	**8,774**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	1,255,360

FINANCIERING

Bijdrage participant in natura	Euro	233,840	80,000	9,600	21,320	11,200	0	16,000	5,000	6,720	20,000	8,000	8,000	8,000	0	0	0	0	0	0	0	427,680
Bijdrage participant in cash	Euro	0	0	50,000	0	0	100,000	0	20,000	0	0	0	30,000	0	0	0	0	0	0	0	0	200,000
Totale bijdrage participant	Euro	233,840	80,000	59,600	21,320	11,200	100,000	16,000	25,000	6,720	20,000	8,000	38,000	8,000	0	0	0	0	0	0	0	627,680
Subsidiebijdrage	Euro	405,653	159,597	5,265	11,692	6,142	0	8,774	2,742	3,685	10,968	4,387	4,387	4,387	0	0	0	0	0	0	0	627,680
6. TOTAAL PROJECTFINANCIERING (gelijk aan totaal 5)	**EURO**	639,493	239,597	64,865	33,012	17,342	100,000	24,774	27,742	10,405	30,968	12,387	42,387	12,387	0	0	0	0	0	0	0	1,255,360
		639,493	**239,597**	**64,865**	**33,012**	**17,342**	**100,000**	**24,774**	**27,742**	**10,405**	**30,968**	**12,387**	**42,387**	**12,387**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1,255,360**

* deelname nog conditioneel

Check op verhouding Totaal kosten van inhuur van derden / directe projectkosten (max. 10%)	
TOTAAL KOSTEN VAN INHUUR DERDEN	0
TOTAAL (directe) PROJECTKOSTEN (4)	1,144,566
Verhouding	**0.0%**

Naam organisatie:	RUG
Type organisatie:	Kennisinstelling
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN

	DIRECTE PERSONELE KOSTEN			OPSLAG SUPERVISIE / BEGELEIDING EN DIRECTE ONDERZOEKSCAPACITEIT (naar rato) **Alleen voor onderzoekers van kennisinstellingen**		SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	BENCHFEE REIS- / CONGRESKOSTEN, OPLEIDING EN TRAINING (naar rato) **Alleen voor onderzoekers van kennisinstellingen**	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding Aantal uren (max. 1650 p.j.)	Tarief Euro / uur	Kosten Euro	Functienaam (AIO, P-doc,UD, UHD)	Opslag Euro	Euro	Euro	Euro	Euro
IFA Vis	312	73	22770	HL	1,418	24,187	12,094	1,418	37,699
KJ Roodbergen	150	73	10950	HL	682	11,632	5,816	682	18,130
AIO (3 jaar 4 mnd)	5500	28	154000	AIO	25,000	179,000	89,500	25,000	293,500
postdoc (vacature)	4950	45	222750	postdoc	22,500	245,250	122,625	22,500	390,375
			0		0	0	0	0	0
			0		0	0	0	0	0
			0		0	0	0	0	0
			0		0	0	0	0	0
			0		0	0	0	0	0
			0		0	0	0	0	0
TOTAAL	**10,912**		**410,470**		**49,600**	**460,069**	**230,035**	**49,600**	**739,703**

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)

	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN

a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	**739,703**
Opslag Dinalog (8%)	71,603
5 TOTAAL BEGROTE PROJECTKOSTEN	**811,307**

FINANCIERING

Bijdrage participant in natura	233,840
Bijdrage participant in cash	
Totale bijdrage participant	233,840
Subsidiebijdrage	**405,653**
6 TOTAAL PROJECTFINANCIERING	**639,493**

Naam organisatie:	TUE
Type organisatie:	Kennisinstelling
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN

	DIRECTE PERSONELE KOSTEN			OPSLAG SUPERVISIE / BEGELEIDING EN DIRECTE ONDERZOEKSCAPACITEIT (naar rato) **Alleen voor onderzoekers van kennisinstellingen**		SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	BENCHFEE REIS- / CONGRESKOSTEN, OPLEIDING EN TRAINING (naar rato) **Alleen voor onderzoekers van kennisinstellingen**	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding	Tarief	Kosten	Functienaam	Opslag				
	Aantal uren (max. 1650 p.j.)	Euro / uur	Euro	(AIO, P-doc,UD, UHD)	Euro	Euro	Euro	Euro	Euro
T. van Woensel	135	95	12825	HL	614	13,439	6,719	614	20,772
J Dam	65	95	6175	HL	295	6,470	3,235	295	10,001
postdoc (vacature TvW)	2200	45	99000	postdoc	10,000	109,000	54,500	10,000	173,500
postdoc (vacature, JD)	1100	45	49500	postdoc	5,000	54,500	27,250	5,000	86,750
			0		0	0	0	0	0
			0		0	0	0	0	0
			0		0	0	0	0	0
			0		0	0	0	0	0
			0		0	0	0	0	0
			0		0	0	0	0	0
TOTAAL	**3,500**		**167,500**		**15,909**	**183,409**	**91,705**	**15,909**	**291,023**

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)

	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN

a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	**291,023**
Opslag Dinalog (8%)	28,171
5 TOTAAL BEGROTE PROJECTKOSTEN	**319,194**

FINANCIERING

Bijdrage participant in natura	80,000
Bijdrage participant in cash	
Totale bijdrage participant	80,000
Subsidiebijdrage	**159,597**
6 TOTAAL PROJECTFINANCIERING	**239,597**

Naam organisatie:	Gasunie
Type organisatie:	Private onderneming
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN

	DIRECTE PERSONELE KOSTEN			SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding	Tarief	Kosten			
	Aantal uren (max. 1650 p.j.)	Euro / uur	Euro	Euro	Euro	Euro
G Dijkstra e.a.	240	40	9600	9,600		9,600
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
TOTAAL	**240**		**9,600**	**9,600**	**0**	**9,600**

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)

	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN

a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	**9,600**
Opslag Dinalog (8%)	929
5 TOTAAL BEGROTE PROJECTKOSTEN	**10,529**

FINANCIERING

Bijdrage participant in natura	9,600
Bijdrage participant in cash	50,000
Totale bijdrage participant	59,600
Subsidiebijdrage	**5,265**
6 TOTAAL PROJECTFINANCIERING	**64,865**

Naam organisatie:	Vopak
Type organisatie:	Private onderneming
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN

	DIRECTE PERSONELE KOSTEN			SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding	Tarief	Kosten			
	Aantal uren (max. 1650 p.j.)	Euro / uur	Euro	Euro	Euro	Euro
E Groensmit e.a.	533	40	21320	21,320		21,320
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
TOTAAL	**533**		**21,320**	**21,320**	**0**	**21,320**

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)

	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN

a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	**21,320**
Opslag Dinalog (8%)	2,064
5 TOTAAL BEGROTE PROJECTKOSTEN	**23,384**

FINANCIERING

Bijdrage participant in natura	21,320
Bijdrage participant in cash	
Totale bijdrage participant	21,320
Subsidiebijdrage	**11,692**
6 TOTAAL PROJECTFINANCIERING	**33,012**

Naam organisatie:	Ecos-Energy B.V.
Type organisatie:	Private onderneming
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN	DIRECTE PERSONELE KOSTEN			SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding Aantal uren (max. 1650 p.j.)	Tarief Euro / uur	Kosten Euro	Euro	Euro	Euro
A Roland Holst	280	40	11200	11,200		11,200
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
TOTAAL	280		11,200	11,200	0	11,200

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN	
a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	11,200
Opslag Dinalog (8%)	1,084
5 TOTAAL BEGROTE PROJECTKOSTEN	12,284

FINANCIERING

Bijdrage participant in natura	11,200
Bijdrage participant in cash	
Totale bijdrage participant	11,200
Subsidiebijdrage	6,142
6 TOTAAL PROJECTFINANCIERING	17,342

Naam organisatie:	St. Ubbo Emmius Fonds
Type organisatie:	Private onderneming
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN	DIRECTE PERSONELE KOSTEN			SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding	Tarief	Kosten			
	Aantal uren (max. 1650 p.j.)	Euro / uur	Euro	Euro	Euro	Euro
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
TOTAAL	**0**		**0**	**0**	**0**	**0**

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)	
	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN	
a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	**0**
Opslag Dinalog (8%)	0
5 TOTAAL BEGROTE PROJECTKOSTEN	**0**

FINANCIERING

Bijdrage participant in natura	0
Bijdrage participant in cash	100,000
Totale bijdrage participant	100,000
Subsidiebijdrage	**0**
6 TOTAAL PROJECTFINANCIERING	**100,000**

Naam organisatie:	Groningen Seaports
Type organisatie:	Private onderneming
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN

	DIRECTE PERSONELE KOSTEN			SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding	Tarief	Kosten			
	Aantal uren (max. 1650 p.j.)	Euro / uur	Euro	Euro	Euro	Euro
T Smit e.a.	400	40	16000	16,000		16,000
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
TOTAAL	**400**		**16,000**	**16,000**	**0**	**16,000**

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)

	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN

	Euro
a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	**16,000**
Opslag Dinalog (8%)	1,549
5 TOTAAL BEGROTE PROJECTKOSTEN	**17,549**

FINANCIERING

Bijdrage participant in natura	16,000
Bijdrage participant in cash	
Totale bijdrage participant	16,000
Subsidiebijdrage	**8,774**
6 TOTAAL PROJECTFINANCIERING	**24,774**

Naam organisatie:	Stichting Energy Valley
Type organisatie:	Private onderneming
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN

	DIRECTE PERSONELE KOSTEN			SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding	Tarief	Kosten			
	Aantal uren (max. 1650 p.j.)	Euro / uur	Euro	Euro	Euro	Euro
P. Cnubben	125	40	5000	5,000		5,000
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
TOTAAL	**125**		**5,000**	**5,000**	**0**	**5,000**

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)

	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN

a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	**5,000**
Opslag Dinalog (8%)	484
5 TOTAAL BEGROTE PROJECTKOSTEN	**5,484**

FINANCIERING

Bijdrage participant in natura	5,000
Bijdrage participant in cash	20,000
Totale bijdrage participant	25,000
Subsidiebijdrage	2,742
6 TOTAAL PROJECTFINANCIERING	**27,742**

Naam organisatie:	Feederlines
Type organisatie:	Private onderneming
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN

	DIRECTE PERSONELE KOSTEN			SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding	Tarief	Kosten			
	Aantal uren (max. 1650 p.j.)	Euro / uur	Euro	Euro	Euro	Euro
Bootsma	84	40	3360	3,360		3,360
Van der Ent	84	40	3360	3,360		3,360
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
TOTAAL	**168**		**6,720**	**6,720**	**0**	**6,720**

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)

	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN

a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	**6,720**
Opslag Dinalog (8%)	650
5 TOTAAL BEGROTE PROJECTKOSTEN	**7,370**

FINANCIERING

Bijdrage participant in natura	6,720
Bijdrage participant in cash	
Totale bijdrage participant	6,720
Subsidiebijdrage	**3,685**
6 TOTAAL PROJECTFINANCIERING	**10,405**

Naam organisatie:	IMS
Type organisatie:	Private onderneming
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN	DIRECTE PERSONELE KOSTEN			SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding	Tarief	Kosten			
	Aantal uren (max. 1650 p.j.)	Euro / uur	Euro	Euro	Euro	Euro
F Fokkens	250	40	10000	10,000		10,000
B Dekkers	250	40	10000	10,000		10,000
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
			0	0		0
TOTAAL	500		20,000	20,000	0	20,000

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)	
	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN	
a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	20,000
Opslag Dinalog (8%)	1,936
5 TOTAAL BEGROTE PROJECTKOSTEN	21,936

FINANCIERING

Bijdrage participant in natura	20,000
Bijdrage participant in cash	
Totale bijdrage participant	20,000
Subsidiebijdrage	10,968
6 TOTAAL PROJECTFINANCIERING	30,968

Naam organisatie:	Klaas de Boer
Type organisatie:	Private onderneming
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN

	DIRECTE PERSONELE KOSTEN			SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding	Tarief	Kosten			
	Aantal uren (max. 1650 p.j.)	Euro / uur	Euro	Euro	Euro	Euro
J Heijne	200	40	8000	8,000		8,000
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
TOTAAL	**200**		**8,000**	**8,000**	**0**	**8,000**

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)

	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN

a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
database access	
unused value of database access	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	**8,000**
Opslag Dinalog (8%)	774
5 TOTAAL BEGROTE PROJECTKOSTEN	**8,774**

FINANCIERING

Bijdrage participant in natura	8,000
Bijdrage participant in cash	
Totale bijdrage participant	8,000
Subsidiebijdrage	**4,387**
6 TOTAAL PROJECTFINANCIERING	**12,387**

Naam organisatie:	GDF Suez*
Type organisatie:	Private ondememing
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN

	DIRECTE PERSONELE KOSTEN			SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding	Tarief	Kosten			
	Aantal uren (max. 1650 p.j.)	Euro / uur	Euro	Euro	Euro	Euro
medewerker	200	40	8000	8,000		8,000
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
TOTAAL	**200**		**8,000**	**8,000**	**0**	**8,000**

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)	
	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN	
a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	**8,000**
Opslag Dinalog (8%)	774
5 TOTAAL BEGROTE PROJECTKOSTEN	**8,774**

FINANCIERING

Bijdrage participant in natura	8,000
Bijdrage participant in cash	30,000
Totale bijdrage participant	38,000
Subsidiebijdrage	4,387
6 TOTAAL PROJECTFINANCIERING	**42,387**

Naam organisatie:	Jan de Rijk Logistics*
Type organisatie:	Private onderneming
Aanvang projectactiviteiten:	1-Sep-13
Einde projectactiviteiten:	31-Dec-16

KOSTEN

1 PERSONELE KOSTEN	DIRECTE PERSONELE KOSTEN			SUBTOTAAL PERSONELE KOSTEN PER MEDEWERKER (excl. 50% alg. kosten)	OPSLAG 50% (alg. Kosten)	TOTAAL PERSONELE KOSTEN PER MEDEWERKER (incl. 50% alg. kosten)
	Totale Tijdsbesteding	Tarief	Kosten			
	Aantal uren (max. 1650 p.j.)	Euro / uur	Euro	Euro	Euro	Euro
medewerker	200	40	8000	8,000		8,000
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
			0	0	0	0
TOTAAL	**200**		**8,000**	**8,000**	**0**	**8,000**

2 KOSTEN VAN INHUUR VAN DERDEN (max. 10% van de totale projectkosten)	Euro
Naam derde partij 1	
Naam derde partij 2	
Naam derde partij 3	
Naam derde partij 4	
Naam derde partij 5	
TOTAAL	0

3 OVERIGE PROJECTGERELATEERDE KOSTEN	
a. Kosten voor te gebruiken materialen en hulpmiddelen (o.b.v. historische aanschafprijzen)	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
b. Kosten voor verspreidingen en overdracht van kennis	Euro
Kostenpost 1 (conform opgegeven post uit projectplan)	
Kostenpost 2 (conform opgegeven post uit projectplan)	
Kostenpost 3 (conform opgegeven post uit projectplan)	
Kostenpost 4 (conform opgegeven post uit projectplan)	
Kostenpost 5 (conform opgegeven post uit projectplan)	
Kostenpost 6 (conform opgegeven post uit projectplan)	
Kostenpost 7 (conform opgegeven post uit projectplan)	
TOTAAL	0
TOTAAL	0

4 TUSSENTOTAAL BEGROTE PROJECTKOSTEN (1 + 2 + 3)	**8,000**
Opslag Dinalog (8%)	774
5 TOTAAL BEGROTE PROJECTKOSTEN	**8,774**

FINANCIERING

Bijdrage participant in natura	8,000
Bijdrage participant in cash	
Totale bijdrage participant	8,000
Subsidiebijdrage	**4,387**
6 TOTAAL PROJECTFINANCIERING	**12,387**