

# Modal shift for an environmental lift - MOSEL

## 1. Objective and questions

The project addresses aspects of all three research priorities in the Swedish Environmental Protection Agency's call for proposals; the focus, however, is on the transport policy instruments in the third priority. Principally, four different approaches to achieving the environmental objectives within the transport sector are differentiated: a) improvement of transport energy efficiency, b) a shift to less environmentally damaging fuels/ sources of energy, c) a shift to less environmentally damaging transport modes and d) a reduction in transport demand. Especially for long distance freight transport within Europe, many policy makers advocate a shift to less environmentally damaging modes as a tool to achieve the environmental objectives. This is justified as the share of CO<sub>2</sub>-equivalents for road freight transport is about twice the share of tonne-km. See Table 1.

*Table 1. Share of tonne-km and share of CO<sub>2</sub>-equivalents 2015 in Sweden*

|  | Share of tonne-km (freight) 2015 | Share of CO <sub>2</sub> -equivalents 2015 |
|--|----------------------------------|--|
| Road (heavy trucks) <sup>1</sup>       | 48%                              | 89%  |
| Rail (passenger and freight)           | 19%                              | 1%   |
| Sea transports (passenger and freight) | 33%                              | 10%  |

Sources: Trafikanalys (<http://www.trafa.se/sok/?q=Transportarbete> and <http://www.naturvardsverket.se>) and Naturvårdsverket (/Sa-mar-miljon/Statistik-A-O/Vaxthusgaser-utslapp-fran-inrikes-transporter/)

The overall objective is to analyse under which conditions the shift of goods from road to rail and to waterborne transport can contribute to the fulfilment of the relevant Swedish environmental objectives 2030. Waterborne transport comprises short sea shipping as well as inland waterway transport, with the latter being only of marginal importance in Sweden.

The overall objective can be divided into sub questions:

- 1) Which policy instruments have the goal to shift goods from road to less environmentally damaging modes?
- 2) What is their potential to achieve desired modal shifts?
- 3) If, and how much, do they contribute to the different Swedish environmental objectives 2030?
- 4) If not, which policy instruments are needed to increase/optimize freight transport's contributions to the Swedish environmental objectives?

Focus is on freight transport and shifts between road, rail and sea transport, except overseas transport.

---

<sup>1</sup> 20% of all road transport is freight transport (see SOU 2016:47, p 217)

## 2. Research task/Theory and method

### 2.1 Research task

Relevant government investigations that have been carried out recently in Sweden, other countries and at the European level (see section 4) mention modal shift as a means or guiding action to reach environmental objectives. This is especially true for national and international long distance freight transport within Europe. Short distance transport is usually captive to road. It is important to recognise that a high proportion of long-distance freight transport comprises several modes and transshipments in terminals.

So far, the policy instruments to reach the desired modal shift have not been very successful (see Section 3.2 and Table 3) or have not been evaluated. The overall research question is how modal shift can be a successful guiding policy action and contribute to the fulfilment of the Swedish environmental objectives. We apply different methods to answer the question:

- To identify effective policy instruments aiming to achieve modal shifts, a review and evaluation of national and international experience is carried out. This will look at questions such as what are the expectations connected with these and what incentives are there? What impacts on modal split are achieved? Have *ex post* and *ex ante* analyses been carried out?
- When effective policy instruments are identified, we design scenarios of different policy instruments and packages, taking into account the conditions at the disaggregated firm level where mode choice decisions are taken. The research implies that flow data underpins contemporary assessments of alternative policy scenarios - which should be built around packages, rather than individual measures. We then aggregate the information on firm level to traffic flows per mode, as recommended in the literature, see Section 3.1.
- Based on the traffic flows in the different scenarios, we estimate the probable contribution of modal shift to the fulfilment of the environmental objectives *Reduced climate impact, Clean air, Natural acidification only and Zero eutrophication* to 2030, and assess the contribution to further environmental objectives in qualitative terms. The estimations may also reveal any conflicts between the environmental objectives.
- Finally, we give policy relevant recommendations for Sweden based on the results.

### 2.2 Work packages

#### WP1 Policy instruments to achieve modal shifts

Different types of policy instruments to achieve modal shifts have been applied or considered all over Europe. The experiences in other countries and at the European level are analysed based on reviews of the academic and grey literature and by using researcher contacts in several countries. However, since there is often a lack of data and *ex post* evaluation we identify the most effective policy instruments by analysing the revealed but also *expected* modal shifts.

We distinguish the policy instruments according to the classification of the Swedish Environmental Protection Agency (Naturvårdsverket, 2017b). Below we present some examples for policy instruments within these categories.

### *Administrative policy instruments*

Regarding the infrastructure in Sweden, the Swedish Transport Administration's (STA) proposal for the national infrastructure plan 2018-2029 (Trafikverket, 2017) has a focus on rail investments, to improve the possibilities of the rail transport system to cope with increased passenger- and freight volumes. The plan also comprises infrastructure measures in fairways to promote the shift from road to sea. In addition to these measures, subsidies like the eco-bonus (see below under economic policy instruments) are deemed to be necessary to reduce the relatively high transshipment costs in ports. Also, the investigation *Fossilfrihet på väg* (SOU 2013:84 , 2013) mentions that rail investments are needed. Their model calculations indicate that a 40% increase of the road transport costs, plus new investments in new rail capacity, are needed to achieve a 15% reduction of the road tonne-km.

In some countries rail is promoted via advantageous regulations for the pre- and post-haul to/from terminals. In Germany, trucks with a maximum gross weight of 44 tonnes (instead of the general maximum of 40 tonnes) are allowed to be used to and from intermodal terminals where load units are transhipped to rail (Liedtke and Carill Murillou, 2012). For example, France, Belgium, The Netherlands and Germany subsidize intermodal terminals. In Germany, this subsidy represents up to 80% of costs for land acquisition, infrastructure and transshipment equipment (EBA, 2017).

### *Economic policy instruments*

Between 2003 and 2013 the European Marco Polo programmes I and II funded projects that sought to shift goods from road to rail and waterborne transport. The aim was to reduce international road freight traffic, thereby improving the environmental performance of freight transport, reducing congestion and increasing road safety. The total budget was € 552 million. The European Court of Auditors (ECA, 2013) finds that the programmes were ineffective, as they had little impact on shifting goods off the roads. Furthermore, the ECA states that there are no data to assess the expected benefits of diminishing the environmental impact of freight transport, easing congestion and improving road safety. Given the poor results, the ECA recommends to consider discontinuing EU funding for transport services following the same design as the Marco Polo programmes which led to weaknesses like insufficient market uptake, absence of evidence of achieving the objectives, high administrative burden and making continuation of such funding conditional upon an *ex ante* impact assessment showing whether and to what extent there is any added value.

Recently, the Swedish agency Transport Analysis (TA) has investigated the conditions for an ECO-bonus system to promote the shift from road to sea (Trafikanalys, 2017a). TA recommends, providing support to applicants that can show projects that a) lead to modal shifts and b) are financially sustainable after a maximum of three years. TA recommends to exhaust the highest possible subsidies that EU regulation EEG 4055/86 allows; this means that the ECO-bonus-support can either cover up to 30 % of the operating costs of a maritime route or up to 10 % of the investment costs in transshipment equipment. TA's report includes short descriptions of the corresponding systems in Italy (Marebonis), the UK (Waterborne Freight Grant) and in Norway (Tilskud for godsoverføring). The financial support in the Norwegian system is based on the difference of the environmental costs in the road versus sea alternative, while the support in Italy and the UK is based on the road tonne-km that are shifted. TA prefers the latter approach because of its simplicity.

TA uses the example of a freight transport movement between the Stockholm region and Northern Germany to illustrate how a shift from road to sea (roro-vessel) can contribute to the reduction of about 130 million road tonne-km per year. It is assumed that an ECO-bonus of maximum SEK 1.2 million per year can prompt different mode choices within firms. TA calculates, based on aggregated figures, that a shift from road to sea can halve the CO<sub>2</sub>-emissions per tonne-km. This reduction is expected to be higher if the shift is made from lorries without trailers and if the shift is made towards vessels with emission levels that are below the average.

VTI uses a very similar example in their calculation of the environmental and other external costs due to a shift from road to sea (Vierth and Sowa, 2015). The share of the environmental costs of all external costs is 55% in the road alternative and 100% in the sea alternative. VTI's study is based on detailed information on typically used vehicles: a EURO 5 truck and a roro-vessel with a Tier 2 NO<sub>x</sub> emission standard and finds that a shift from road to sea would not lead to a benefit for society, as the level of the external costs is about the same in the road and the sea alternative. The reason is that the requirements regarding air pollution (EURO classes) are stricter for trucks than for roro-vessels. However, the sensitivity analysis with a Tier 3 roro-vessel, which implies lower NO<sub>x</sub>-emissions per vessel-km, shows lower external costs in the sea alternative than in the road alternative. This indicates that the incentives to use less environmentally damaging vessels probably have a greater impact on the environmental objectives than incentives to shift mode.

SOU 2013:84 identifies increased CO<sub>2</sub>-taxes, increased energy-taxes and distance based infrastructure charges for heavy trucks as policy instruments to reduce road freight transport. The investigation stresses that the cost increases for road transport need to be combined with measures that lead to cost decreases for the other modes in order to protect domestic industry. Among others, investments in rail capacity and simplification of the regulations for sea transport, are mentioned.

Based on a referendum in 1994, Switzerland combines administrative and economic policy instruments to achieve a modal shift from road to rail. The revenues from distance-based road user charges for trucks are used to fund rail investments. Several countries have introduced distance-based road user charges for heavy trucks to fund road infrastructure. These charges can have an indirect impact on modal split, even though modal shift is not a direct or primary goal.

#### *Information as a policy instrument*

Campaigns are, for example, used to inform industry about the possibilities to apply for the Waterborne Freight Grant in the UK (Freight by water, 2017).

An important part of 'information' is the ability for decision makers to compare alternative transport chains. Emissions calculators are an important part of this. In Sweden, the Network for Transport Measures, NTM aims at establishing a common base of values on how to calculate the environmental performance for all the various modes of traffic, including goods transport and passenger travel (Network for Transport Measures, 2017). NTM has about 200 private and public members.

### *Research as a policy instrument*

Research as a policy instrument includes research (see section 3.1) as well as development/innovation and demonstrations projects. Shift2Rail (2017) is a Horizon 2020 initiative to seek research and innovation market-driven solutions by accelerating the integration of new technologies into innovative rail product solutions. The initiative promotes the competitiveness of the European rail industry and aims to double the capacity of the European rail system and to increase its reliability and service quality by 50 %.

### *WP2 Modal shift and technical development scenarios*

WP2 estimates the potential to achieve modal shifts applying different policies and packages – based on the results in WP1 – in at least five different scenarios. The scenarios consider factors that influence shippers’ mode choice and potential technical developments in the transport sector.

Transport cost is generally the most important mode choice criterion for firms, provided that sufficiently high requirements on time and reliability are met, see for example Lindgren and Vierth (2017). The Swedish purchase panel finds that shippers often require environmental certifications, but that environmentally efficient transport is not a priority in relation to price and time aspects (IVL, 2017). However, it is obvious that the tendency to shift mode due to policies differs between different market segments. We analyse these differences with the help of reviews of the academic and grey literature. Starting point for the analyses are several Swedish studies; Vierth et al. (2014) study the competition between sea transport and land-based transport for around thirty commodities. (Nelldal, B-L, 2013) analyses the transport distances for which road and rail compete. CERUM (2013) study the potential modal shifts for different regions and highlight the regional differences and the availability of alternative modes. A 10 % increase in road transport cost, for example, leads to higher cost increases in the North of Sweden than in the South of Sweden (where rail is available in more regions).

The tendency to shift mode also differs between different firms (Vierth 2012). We see a need to study the decision making at the (disaggregated) firm level and we will collect information about the driving factors and barriers from Swedish firms that have/have not changed from road to rail or sea via interviews and a survey. Examples of questions are: How do shippers (firms that buy transport or perform in-house transport) decide between different modes? What are the firms’ driving forces and barriers when it comes to modal shift? How do shippers react to “modal shift policy instruments”? What incentives do they receive?

Important regarding the achievement of the environmental objectives is not only the mode, but also the applied technologies. Potential technical developments and implementation schemes will be compiled and analysed based on a review of the literature, and current and forthcoming regulations. This will be complemented by interviewing policy makers, transport service providers, manufacturers of vehicles and fuels, as well as infrastructure and material developers.

We use the information on effective policy instruments from WP1 and the information on shippers’ tendency to shift mode and information on the development of the different technologies from WP2. Based on these inputs we specify a base scenario and at least five policy scenarios where we simulate the impact of different policy instruments one by one and in different combinations for Sweden 2030. We consider how the technical development influences the costs for different modes and vehicle types.

The simulations will be carried out with help of the Swedish national freight transport model Samgods, that calculates annual traffic and transport flows in Sweden based on cost minimization. Samgods has three sub modules: (i) Transport demand is described in 34 fixed commodity-specific zone-to-zone production consumption matrices (PC-matrices) for 464 zones (290 municipalities in Sweden and 174 larger administrative regions outside Sweden), (ii) The logistics model has an ADA-structure (Aggregated-Disaggregated-Aggregated) where the aggregated PC-matrices first are disaggregated from zonal PC-flows to annual firm to firm flows, and (iii) The network model distributes the selected transport chains over the transport infrastructure. The model contains 33 vehicle types: five for road, eight for rail and 19 for sea.

The Samgods model calculates, per commodity and for the whole transport system, tonne-km and vehicle-km, as well as inside and outside Sweden for the different modes and vehicle types. Vessel movements between Swedish ports can be identified, this is important as a goal to reduce the climate impact is related to domestic sea transport only, see Section 4. It also shows the amount of tonne-km that are transferred between road, rail and sea – desired or not desired. Reasons for the not desired outcomes are studied.

WP3 Assessment of fulfilling the environmental objectives

WP3 makes an assessment of the different policy scenarios in WP2 and calculates how much the emissions differ between the different policy scenarios using the base line scenario 2030 as reference. The output from WP3 may also reveal any conflicts between the above mentioned environmental objectives.

By using the vehicle-km and vessel-km for the different modes and vehicle types from WP2, we calculate how much the emissions of CO2, sulphur oxide and NOx will change depending on the size and direction of the modal shift. Some technical development is integrated via the costs in the simulations in WP2. However, WP3 will make further assumptions regarding the technical development that are not automatically influencing the transport cost for the different modes, such as the use of different energy sources, etc.

Different indicators address different environmental objectives. The quantitative analysis described relate to the he first four objectives in Table 2. A qualitative assessment will be undertaken regarding the last three environmental objectives. This qualitative analysis will be based on a literature survey complemented with interviews with experts from authorities and established scientists within the different areas.

Table 2: Environmental objectives (and indicators)

| Environmental objectives 2030   | Indicators              |
|---|-------------------------|
| Reduced climate impact  | Energy use and CO2      |
| Clean air   | NO2 and NO, SO2, PM 2,5 |
| Natural acidification only  | NO2 and NOx, SO2        |
| Zero eutrophication   | NOx                     |
| A rich diversity of plant and animal life                                 | Qualitative analysis    |
| A balanced marine environment, Flourishing coastal areas and archipelagos | Qualitative analysis    |
| Good built environment (i.e. traffic noise)                               | Qualitative analysis    |

Source: Naturvårdsverket, 2017a

Conflicts between different environmental objectives can arise. These potential conflicts will be studied. One example is that a shift from road to rail leads to a reduction of the CO<sub>2</sub>-emissions but it can also lead to an increase of noise emissions (Ögren, et al., 2015). Another example is that a shift from road to sea can reduce CO<sub>2</sub>-emissions but lead to an increase of sulphur and NO<sub>x</sub> emissions.

Another factor to consider is infrastructure availability and capacity. As mentioned above, STA's proposal for the national infrastructure plan 2018-2029 (Trafikverket, 2017) includes both infrastructure measures related to rail and sea. Questions may arise as to what extent a modal shift is possible without increasing capacity? And what is the environmental impact if we need to invest in infrastructure capacity. A Life Cycle Analysis approach is taken based on general values for building infrastructure to include those secondary environmental impacts.

#### WP4 Policy recommendations

WP4 will give policy recommendations based on the results in WP1-WP3 that will give answers to if and how modal shift can be an effective tool to achieve the Swedish environmental objectives. If not, we will discuss other policy instruments that should be considered to increase freight transport's contributions to the objectives.

### 3. State of the art

#### 3.1 Scientific state of the art

Compared to passenger transports, there is much less research on policy instruments for freight transport.

The outcomes of a number of research projects have sought to inform policy making with respect to facilitating freight modal shift from road to either rail or sea, largely within the context of promoting intermodal transport solutions. Much of this work advocates either the use of differential taxes and subsidies (Ballis and Golias, 2004; Burkhard and Toshinori, 2005; Macharis and Pekin, 2009;) or policies which facilitate an improvement in the quality of rail and sea transport relative to the road transport alternative, very often involving infrastructure investment (Woodburn, 2003; Tsamboulas et al., 2007; Janic, 2008; Ishfaq and Sox, 2010; Bergqvist and Cullinane, 2013).

Choi et al. (2014) identify the degree of interdependence between the following policies in facilitating freight modal shift: subsidy, tax and pricing; quality of service; strategic planning and operation and; infrastructure. Similarly, while specifically investigating the impact of subsidies on modal shift, Tao et al. (2017) find that subsidies are successful in prompting a short-term modal shift, but that a policy package encompassing financial, technological, operational, and managerial measures is required in the long-term. This suggests that focussing on packages of policy instruments is a more appropriate approach than analysing the potential impact of individual policy instruments.

Contemporary research into the impact of policy instruments on freight modal choice is conducted at both aggregate and disaggregate levels. For instance, Frey et al. (2014) model the potential impact of a raft of policy instruments on freight modal choice within Germany, identifying specifically the rail capacity problems that might ensue. Meers and Macharis (2015) suggest that if geographic entities are ranked and then targeted according to their modal shift potential, then this will allow policy makers to focus their modal shift efforts on a limited

number of transport flows and achieve a higher success rate. In both cases, the practical usefulness of the results of these analyses is obviously highly dependent on the quality and the level of detail of the transport flows input data. Other important streams of recent research on the influence of policies in stimulating freight modal shift relate to the role of contractual arrangements (Eng-Larsson and Norrman, 2014) and the importance of information (Holloway, 2017).

### 3.2 Policy state of the art

The European Commission has developed a *guiding policy action* to “...switch 30 % of road freight travelling over 300 km to rail and waterborne transport by 2030, and over 50 % by 2050” to reduce the EU’s dependence on imported oil and cut transport carbon emissions by 60 % by 2050 (European Commission, 2011). The Swedish government has the ambition to promote the shift of long-distance freight transport from road to rail and sea (Regeringskansliet, 2017).

Relevant Swedish government investigations mention modal shift to reach the environmental objectives. The investigation *Miljömålsberedningen* (SOU 2016:47) stresses that sea transport needs to be seen as part of the transport system, where the shift of goods from road to sea is desirable to reduce the emissions caused by road transport. The SOU 2013:84 identifies a large potential for shifting transport from road to rail and waterborne transport and finds that powerful, expensive policy instruments are needed to shift freight transport from road to rail. The investigation *Strategisk plan för omställning av transportsektorn till fossilfrihet* (Energimyndigheten, 2017) finds that a combination of different carrots and sticks are needed to achieve modal shifts. Regarding freight transport, policy instruments that influence transport costs and transport times, as well as the services offered, are mentioned.

The STA investigation *Åtgärder för att minska transportsektorns utsläpp av växthusgaser - ett regeringsuppdrag* (Trafikverket, 2016) sees a potential to reduce CO<sub>2</sub>-emissions by increasing rail- and sea-shares in transport chains. Shifting 30% of the heavy road transport over 300 km to rail and sea by 2030 is expected to lead to a 13% reduction of the road tonne-kms. This implies a 25% increase in rail transport and a 16% increase in domestic sea transport. The STA proposal for the national infrastructure plan 2018-2029 (Trafikverket, 2017) promotes the shift of freight transport from road to rail and sea to contribute to the fulfilment of the transport policy goals. The Infrastructure proposition (Prop.2016/17:21) concludes that further analyses are needed to be able to specify the design, costs and impacts of the different measures that can lead to a reduction of the CO<sub>2</sub>-emissions.

Generally, the policy instruments to reach modal shifts have not been very successful so far. Table 3 shows that the road share in Sweden has increased slightly during the last 16 years. The SOU 2013:84 finds that the development of the modal split has so far not matched the expectations and that this can be explained, among other things, by shippers’ requirements for reliable, flexible and fast transport of small shipments, that have favoured road transport.

Table 3. Modal split (measured in tonne-km in Sweden) 2000-2016

| Year | Road  | Rail  | Sea   |
|------|-------|-------|-------|
| 2000 | 47,1% | 19,5% | 33,5% |
| 2005 | 47,5% | 18,4% | 34,1% |
| 2010 | 46,6% | 19,4% | 34,0% |
| 2015 | 47,7% | 18,4% | 33,9% |

Source: Trafikanalys (<http://www.trafa.se/sok/?q=transportarbete>)

The risk of so-called “modal backshifts” is discussed in those cases where policy instruments are implemented and measures are undertaken that can lead to a shift from the less environmentally damaging modes to the road mode. One example is the implementation of the Sulphur directive in the Baltic Sea, North Sea and English Channel in 2015 (MARPOL Annex V1 and EU 2016/802) that implies stricter environmental requirements and, therefore, higher transport costs for sea transport. However, TA’s evaluation for the period 2001-2015 does not identify shifts from sea to road due to the Sulphur Directive (Trafikanalys, 2017b). TA mentions that the about 50 % decrease in the crude oil price in 2014/2015 has influenced the development. Another example is that the increase in rail track charges, to raise the degree of internalization of external costs, is expected to contribute to a shift from rail to road. STA (2013) estimates that 3 % higher rail track fees will lead to about 1% less rail tonne-kms. A third example is the allowance of longer and heavier trucks and other policies that improve the efficiency of road transport and could lead to undesired shifts. Recently, the OECD International Transport Forum organized a workshop on the topic “Road freight efficiency versus freight modal split: reconciling environmental objectives” (OECD/ITF, 2016) discussing the possible shifts from other modes to road.

It is important to bear in mind that the different policy instruments are not implemented at the same time for all modes. At the European level, for example, environmental classes for new trucks (EURO-classes) have been used since the 1990s to reduce air pollution from road transport, while corresponding measures for sea transport (e.g. the Sulphur directive, Tier classes to reduce NOx emissions etc.) have only been implemented quite recently. In Sweden, the introduction of distance-based infrastructure fees for trucks, to internalize the external costs, has been postponed, while the decision has already been taken on how to increase rail track fees over time. The use of longer and heavier vehicles is discussed for both road and rail, but not with the same timetable.

#### 4. Practical relevance

The results of the project will provide knowledge on if, to what extent, and in which way modal shift can contribute to the fulfilment of Swedish environmental objectives 2030, taking into account shippers’ driving forces and barriers when taking transport decisions and also different expectations on the technical development in the transport sector.

The Swedish parliament set up the goal to reduce the CO<sub>2</sub>-emissions caused by domestic transports by 70 % by year 2030 compared to year 2010 (Regeringskansliet, 2017). Modal shift is often suggested as one important means to reach the Swedish environmental objectives. There are, however, few studies on the potential and effectiveness of policy instruments with modal shift as a goal. This is especially true for freight transport.

Therefore, the results of the project are important support to the Swedish Environmental protection agency, the Swedish Agency for Marine and Water Management, the Swedish Transport Administration and other authorities responsible for developing policies to achieve the Swedish environmental objectives.

## 5. Organization and project leading

### 5.1 Interdisciplinary researcher group

The project team has a genuine competence and the participants complement each other cognitively. Economist *Inge Vierth* and mathematician *Rune Karlsson* at VTI have carried several mode choice and policy impact analyses, applying both the Swedish national freight transport system and other methods. They are also part of “ELINA - Energy and climate efficient freight transport from a national systems perspective”, a project funded by the Swedish Environmental Agency 2016-2019. Economists *Hanna Lindgren* and *Tobias Lindé* at VTI were involved in studies related to freight transport by road, rail and sea. Inge Vierth has over 20 years of experience as project leader.

*Prof Yvonne Andersson-Sköld*, VTI and Chalmers University, worked over 25 years with life cycle cost analyses and integrated assessments focusing on how environmental and health aspects are affected by different policy measures. The assessments include impacts on resource consumption and CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub> and PM emissions, ground-level ozone formation and exposure estimates. *Mikael Johannesson*, VTI, worked 15 years at the Swedish Environmental Protection Agency with policy instruments, transport, environment and research. He was among others head of the unit “Policy instruments Climate and air”. *Anders Genell*, VTI, is physicist and noise expert and *Georg Tschan*, VTI, biologist.

*Prof Kevin Cullinane*, VTI and Göteborg University (GU), has among others technical knowledge and empirical experience in the field of estimating elasticities, choice modelling and environmentally differentiated pricing. *Anastasia Christodoulou* and *Marta Gonzalez-Aregall* are postdoctoral researchers at GU. Their research experience is in the field of external cost of CO<sub>2</sub>-emissions from shipping and the exploration of various technical, operational and market-based policies and incentives and the use of port regulations to reach sustainable transports. 2016-2018 GU and VTI work also together in the VINNOVA-funded project “Environmental incentive schemes for ports” and the STA-funded project “Carrots and sticks in shipping to achieve environmental goals”.

### 5.2 Reference group

A reference group of stakeholders will be established a) to facilitate some of the actions required within the research; i.e. collaboration with shippers, b) to provide informed feedback and advice on project direction and progress, as well as on the most appropriate communication channels for research outputs and c) to ensure the direct dissemination of results to relevant policy and decision makers (see Section 7).

We plan to use relevant persons of the reference group in the project “Carrots and sticks in shipping to achieve environmental goals”: Leif Holmberg, Swedish Environmental Protection Agency, Reidar Grundström, Swedish Maritime Administration, Katarina Wigler, Swedish Transport Agency, Katarina Händel, Swedish Environmental Agency, Christer Ågren, AirClim, and to include NN from the Swedish Agency for Marine and Water Management, Sven Hunhammer from STA, Kjell Håkansson from COOP (confirmed) and further shippers. At least

five reference group meetings are planned and these will be coordinated with open seminars (see Section 7).

## 6. Open access – data and scientific articles

Non-confidential data from the project will be made openly available in an appropriate and easily accessible electronic format. Details on how to gain access to the dataset will be disseminated on the project website and on all published and/or publicly disseminated documentation. The latter includes a range of scientific deliverables, reports and articles that will be produced as substantive outputs from the project. The scientific articles that are not VTI-publications will be published in open-access journals.

## 7. Communication

Major communication efforts will be made to reach the main stakeholders and other interested parties such as authorities and policy makers, shippers, forwarders and carriers, and environmental organizations. Responsible for the communication will be communication strategist Eva-Mari Löfqvist and communication officer Annika Johansson at VTI.

The following communication activities are planned:

- Information about the project will be presented on a VTI web site. This information will include research questions, expected results, people and institutions involved and how to contact them, publications, seminars, finances of the project etc. The webpage will be designed to serve as a one-stop solution with integrated partner-matching and knowledge-sharing platform. It will be continuously updated with news and results from the project.
- The communication channels of umbrella organisations and European Networks will be used to establish close relationships with other organisations & projects covering similar problems within EU-funded or national programs.
- The project results will be disseminated in a series of conference papers and presentations at local, national and international level. This will encompass both academic and industry fora.
- For each WP one or more reports will be published and presented at open seminars where the project group and the reference group will be participating (see Activity plan).
- For each WP, we will also produce a short publication (maximum 8 pages) that summarizes the most important findings in a manner that makes it accessible for people that not are experts in this area.

The media provides crucial channels for the diffusion of information about the project to a wide range of stakeholders and the general public. The VTI Communication Officer will have overall responsibility, supported by other project members, to address the coverage issues with press (digital/print) and other media (TV/radio). Articles and information material will be published in journals, newsletters and the popular press. Press releases are foreseen for kick-off and in conjunction with major milestones. Results from the project that are considered to be of interest for the media will be made public by press announcement, VTI-aktuellt or by contacting journalists. All materials will be freely circulated for project information and promotion at workshops, congresses and other events.

## 8. Activity plan

The overall time plan for the project, including the milestones and deliverables are shown in Table 4.

Table 4 – Activity plan

|               | 2018 |    |       |    | 2019 |    |    |    | 2020 |    |      |    |
|---------------|------|----|-------|----|------|----|----|----|------|----|------|----|
|               | Q1   | Q2 | Q3    | Q4 | Q1   | Q2 | Q3 | Q4 | Q1   | Q2 | Q3   | Q4 |
| WP1           |      |    | 1     |    |      |    |    |    |      |    |      |    |
| WP2           |      |    | 2,3,4 |    | 5    |    |    |    |      |    |      |    |
| WP3           |      |    |       |    |      |    | 6  |    |      |    |      |    |
| WP4           |      |    |       |    |      |    |    |    |      |    | 7, 8 |    |
| Communication | KO   |    | M1    |    |      | M2 |    | M3 |      |    | M4   |    |
| Milestones    |      |    | M1    |    |      | M2 |    | M3 |      |    | M4   |    |

Note: Numbers are deliverables which are described in the text.

### Kick-off

Start of the project with a meeting of the project team and the reference group.

### Milestones

M1. Milestone 1 – WP1 finalised with a public seminar. An easily accessible summary of the results will be published in Swedish and English (max 8 pages).

M2. Milestone 2 – WP2 finalised with a public seminar. An easily accessible summary of the results will be published in Swedish and English (max 8 pages).

M3. Milestone 3 – WP3 finalised with a public seminar. An easily accessible summary of the results will be published in Swedish and English (max 8 pages).

M4. Milestone 4 – WP4 finalised with a public seminar. Short publication to summarize the most important findings, highlighting the policy recommendations. Published in Swedish and English (max 8 pages).

### Deliverables

1. Deliverable 1, WP1 – review and identification of effective policies (based on literature)
2. Deliverable 2, WP2 – Study of differences between different market segments within the freight transport sector (based on literature)
3. Deliverable 3, WP2 – Study of firms' decision making regarding mode choice (based on interviews and survey)
4. Deliverable 4, WP2 – Study of expected technical development (based on literature, regulations and interviews)
5. Deliverable 5, WP2 – Analysis of how different policies and packages influence the size and direction of modal shift (based on simulations using the Samgods model)
6. Deliverable 6, WP3 – Estimations of the policies and the packages' contributions to the fulfilment of the environmental objectives (based on the results in Deliverable 4, using emission factors)

7. Deliverable 7, WP4 – A report in Swedish will be published which includes policy recommendations connected to the overall research question; how modal shift can be a successful guiding policy action and contribute to the fulfilment of the Swedish environmental objectives (including results from all WPs)
8. Deliverable 8, WP4 – Two drafts for journal papers based on mainly WP2 and WP3.

## 9. Budget

**Title of the project proposal:** Model Shift for an Environmental Lift -MOSEL

|  | SEK year 1          | SEK year 2          | SEK year 3       | Total               |
|--|---------------------|---------------------|------------------|---------------------|
| <b>Project costs</b>   | WP1, WP2            | WP2, WP3            | WP4              |                     |
| <b>1. Salaries</b>   |                     |                     |                  |                     |
| VTI - TEK  | 340 000             | 185 000             | 265 000          | 790 000 kr          |
| VTI - Miljö  | 200 000             | 300 000             | 100 000          | 600 000 kr          |
| VTI - TAL  | 0                   | 300 000             | 0                | 300 000 kr          |
| VTI Communication officers   | 60 000              | 60 000              | 60 000           | 180 000 kr          |
| Göteborgs Universitet  | 105 000             | 105 000             | 100 000          | 310 000 kr          |
| <b>2. Travels</b>  |                     |                     |                  |                     |
| Travels<br>(e.g. participation in<br>conferences and meetings)   | 80 000              | 60 000              | 40 000           | 180 000 kr          |
| <b>3. Other costs</b>  |                     |                     |                  |                     |
| Other project costs<br>(Data, books, conference<br>fees, etc.)   | 30 000              | 30 000              | 30 000           | 90 000 kr           |
| <b>4. Communication</b>  |                     |                     |                  |                     |
| 4.1. Open access publications  |                     |                     | 60 000           | 60 000 kr           |
| 4.2. Seminars and<br>publications  | 20 000              | 35 000              | 35 000           | 90 000 kr           |
| <b>Total 1-4</b>   | <b>835 000</b>      | <b>1 075 000</b>    | <b>690 000</b>   | <b>2 605 000 kr</b> |
| <b>5. Overhead costs</b>   |                     |                     |                  |                     |
| Overhead costs at the<br>university/college/institute<br>where the funds will be<br>administered (%)<br>Use column E "Total" |                     |                     |                  | 65%                 |
| <b>Total sum</b>   | <b>1 377 750 kr</b> | <b>1 773 750 kr</b> | <b>1 138 500</b> | <b>4 290 000 kr</b> |

## 10. References

- Ballis, A. and Golias, J. (2004) Towards the improvement of a combined transport chain performance, *European Journal of Operational Research*, 152, 420–436.
- Bergqvist, R. and Cullinane, K.P.B. (2013) SECA Regulations, Modal Shift and Transport System Effects: The Case of Sweden, Report for the Swedish Transport Administration (Trafikverket), Stockholm.
- Burkhard, E.H. and Toshinori, N. (2005) Intermodal logistics policies in the EU, the U.S. and Japan. *Transport Policy Studies Review*, 7, 2–14.
- CERUM, 2013. *Trafikslagsbyte för godstransporter - Underlagsrapport till utredningen om fossilfri fordonstrafik*, Umeå: CERUM.
- Choi, B.L., Chung, K.Y. and Lee, K.D. (2014) The impact of policy measures on promoting the modal shift from road to rail, *Personal and Ubiquitous Computing*, 18(6), 1423–1429.
- de Jong, G. et al., 2010. *Price sensitivity of European road freight transport - towards a better understanding of existing results - A report for Transport & Environment*, Delft: Significance & Delft.
- EBA, 2017. *Richtlinie zur Förderung von Umschlaganlagen des Kombinierten Verkehrs nicht bundeseigener Unternehmen vom 04.01.2017*. Retrieved May 2017. s.l.:EBA (2017) Richtlinie zur Förderung von Umschlaganlagen des Kombinierten Verkehrs nicht bundeseigener Unternehmen vom 04.01.2017. Retrieved May 2017, [https://www.eba.bund.de/SharedDocs/Downloads/DE/Finanzierung/KV/44\\_FRL\\_%20KV.pdf?\\_\\_blob=publicationFile&v](https://www.eba.bund.de/SharedDocs/Downloads/DE/Finanzierung/KV/44_FRL_%20KV.pdf?__blob=publicationFile&v).
- ECA, 2013. *Have the Marco Polo programmes been effective in shifting traffic off the road?, Special Report No 3*, s.l.: European Court of Auditors (ECA).
- Energimyndigheten, 2017. *Strategisk plan för omställning av transportsektorn till fossilfrihet (Framtagen av Boverket, Energimyndigheten, Naturvårdsverket, Trafikanalys, Trafikverket och Transportstyrelsen inom ramen för Energimyndighetens regeringsuppdrag*, Eskilstuna: Energimyndigheten (ER 2017:07).
- Eng-Larsson, F. and Norrman, A. (2014) Modal shift for greener logistics– exploring the role of the contract. *International Journal of Physical Distribution & Logistics Management*, 44(10), 721-743.
- EU 2016/802, 2016. *Directive (EU) 2016/802 of the European Parliament and of the Council of 11 May 2016 relating to a reduction in the sulphur content of certain liquid fuels*, Brussels: EU.
- European Commission, 2011. *Roadmap to a single European transport area – Towards a competitive and resource-efficient transport system, White Paper (COM (2011) 144 final.* Brussels: European Commission.
- Freight by water, 2017. *Facilitating the transport of freight by water in and around the UK*. [Online]

Available at: <http://freightbywater.fta.co.uk/>  
[Accessed 15 09 2017].

Frey, K., Hartwig, J. and Doll, C. (2014). Accelerating a shift from road to rail freight transport in Germany—Three scenarios. In Transport Research Arena (TRA) 5th Conference: Transport Solutions from Research to Deployment, April.

Holloway, T. (2017). Building Better Understanding of Sustainability and Freight Transport (No. CFIRE 06-04).

Ishfaq, R. and Sox, C.R. (2010) Intermodal logistics: the interplay of financial, operational and service issues. *Transportation Research Part E*, 46, 926–949.

IVL, 2017. *Transportinköpspanelen: Samarbeten - en väg till grönare transporter*. [Online] Available at: <http://www.ivl.se/sidor/publikationer/publikation.html?id=5203>  
[Accessed 8 9 2017].

Janic, M. (2008) An assessment of the performance of the European long intermodal freight trains (LIFT). *Transportation Research Part A*, 42, 1326–1339.

Liedtke, G.; Carillo Murillo, D.G., 2011. Assessment of policy strategies to develop intermodal services: the case of inland terminals in Germany. *Transport Policy*, Volume 24, pp. 168-178.

Lindgren, S. and Vierth, I. (2017) Vad styr valet av godstransporter? En kunskapsöversikt. Linköping: VTI (Notat 3-2017)

Macharis, C. and Pekin, E. (2009) Assessing policy measures for the stimulation of intermodal transport: a GIS-based policy analysis. *Journal of Transport Geography*, 17, 500–508.

MARPOL Annex VI, 2017. *International Maritime Organization (IMO), Prevention of Air Pollution from Ships, Revised MARPOL Annex VI*. [Online] Available at: <http://www.imo.org/en/OurWork/environment/pollutionprevention/airpollution/pages/air-pollution.aspx>  
[Accessed 2017].

Meers, D. and Macharis, C. (2015). Prioritization in modal shift: determining a region's most suitable freight flows. *European Transport Research Review*, 7(3), 1-12.

Naturvårdsverket, 2017a. *Miljömål.se*. [Online] Available at: <http://www.miljomal.se/Miljomalen/>  
[Accessed 15 09 2017].

Naturvårdsverket, 2017b. *Styrmedel och åtgärder*. [Online] Available at: <http://www.naturvardsverket.se/Miljoarbete-i-samhallet/Miljoarbete-i-Sverige/Uppdelat-efter-omrade/Luft/Styrmedel-och-atgarder/>  
[Accessed 15 09 2017].

Nelldal, B-L, 2013. *Effektiva gröna godståg - Åtgärder för ökad kvalitet, kapacitet och minskad kostnad*, Stockholm: KTH.

Network for Transport Measures, 2017. *Network for Transport Measures*. [Online]  
Available at: <https://www.transportmeasures.org/en/>  
[Accessed 15 09 2017].

OECD/ITF, 2016. *OECD / International Transport Forum workshop on modal shift, International Workshop: Road freight efficiency versus freight modal split: reconciling environmental objectives*. [Online]  
Available at: <http://www.csrf.ac.uk/event/oecd-international-transport-forum-workshop-on-modal-shift/>

Prop.2016/17:21, 2016. *Infrastruktur för framtiden Innovativa lösningar för stärkt konkurrenskraft och hållbar utveckling*. Stockholm: Regeringskansliet  
(<http://www.regeringen.se/pressmeddelanden/2016/10/ny-infrastrukturproposition-presenterad/>).

Regeringskansliet, 2017. *Det klimatpolitiska ramverket*. [Online]  
Available at: <http://www.regeringen.se/artiklar/2017/06/det-klimatpolitiska-ramverket/>  
[Accessed 12 6 2017].

Regeringskansliet, 2017. *Infrastrukturministern inleder regeringens arbete för Framtidens logistik*. [Online]  
Available at: <http://www.regeringen.se/artiklar/2017/01/infrastrukturministern-inleder-regeringens-arbete-for-framtidens-logistik/>

Shift2Rail, 2017, Shift2Rail, <https://shift2rail.org/about-shift2rail/> (2017-09-15).

Sjöfartsverket, 2016. *Analys av utvecklingspotentialen för inlands- och kustsjöfart i Sverige (Regeringsuppdrag)*, Norrköping : Sjöfartsverket.

SOU 2013:84 , 2013. *Fossilfrihet på väg*, Stockholm: Regeringskansliet.

SOU 2016:84, 2016. *En klimat- och luftvårdsstrategi för Sverige*, s.l.: Regeringskansliet,  
<http://www.regeringen.se/pressmeddelanden/2016/06/forslag-till-nya-mal-och-atgarder-for-klimat--och-luftpolitiken/>.

Tao, X., Wu, Q. and Zhu, L. (2017). Mitigation potential of CO<sub>2</sub> emissions from modal shift induced by subsidy in hinterland container transport. *Energy Policy*, 101, 265-273.

Tsamboulas, D., Vrenken, H. and Lekka, A. (2007) Assessment of a transport policy potential for intermodal mode shift on a European scale. *Transportation Research Part A*, 41, 715–733

Trafikanalys, 2017a. *Eco bonus för sjöfart*, Stockholm: Trafikanalys (Rapport 2017:11).

Trafikanalys, 2017b. *Överflyttningseffekter inom SECA - regionala utvecklingsmönster av sjöfarts- och lastbilsgods mellan 2001 och 2015*, Stockholm: Trafikanalys (Rapport 2017:13).

Trafikverket, 2013. *Trafikslagsövergripande effekter av höjda banavgifter*, Borlänge: Trafikverket

([http://www.trafikverket.se/contentassets/34a65a31f99f4ae39d870cfa20a0a222/bilaga\\_3\\_trafikslagsovergripande\\_effekter\\_av\\_hojda\\_banavgifter.pdf](http://www.trafikverket.se/contentassets/34a65a31f99f4ae39d870cfa20a0a222/bilaga_3_trafikslagsovergripande_effekter_av_hojda_banavgifter.pdf)).

Trafikverket, 2016. *Åtgärder för att minska transportsektorns utsläpp av växthusgaser - ett regeringsuppdrag*, Borlänge: Trafikverket (Rapport 2016:111).

Trafikverket, 2017. *Förslag till nationell plan för transportsystemet 2018-2029*. [Online] Available at: <http://www.trafikverket.se/for-dig-i-branschen/Planera-och-utreda/Planer-och-beslutsunderlag/Nationell-planering/nationell-transportplan-2018-2029/> [Accessed 2017].

Vierth, I.; Sowa, V., 2015. *Externa kostnader i transportsceanrier med utökad användning av sjöfart*, s.l.: VTI (Rapport 848/2015).

Vierth, I., 2012(a). *Vad skulle en likabehandling av trafikslagen innebära för näringslivets transportval: exemplidiering för ett antal varuslag och relationer*. s.l.:CTS (CTS Working paper No 2012:20).

Vierth, I., Jonsson, L., Karlsson, R. & Abate, M., 2014. *Konkurrensytta land – sjö för svenska godstransporter. Studie på uppdrag av Trafikverket*, s.l.: VTI (VTI Rapport 822/2014).

Ögren, M., Andersson, H. & Jerson, T., 2015. Noise and vibration mitigation for rail transportation systems. *Notes on Numerical Fluid Mechanics and Multidisciplinary design*, Volume 126, pp. 79-84.

Woodburn, A.G. (2003) A logistical perspective on the potential for modal shift of freight from road to rail in Great Britain. *International Journal of Transport Management*, 1, 237–245.