senter for teknologi og samfunn

STS

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A TOUCH OF TECHNOCRACY? Technology policy and transport in the European Union exemplified by Trans-European Networks for Transport and road pricing

STS-working paper 4/01

ISSN 0802-3573-175

arbeidsnotat
working paper

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1. Introduction

The aim of this paper is to provide an overview of technology policy and, more specifically, technology policy related to transport in the European Union. Written within the frames of the INTEPOL project we view technology policy in the same manner and consider thus *innovation*, *regulation* and *infrastructure* as the main signposts to identify this vast area.

Innovation policy represent the systematic effort to stimulate industrial capacity to innovate through a series of different policy instruments related to R&D, financial incentives, institutional arrangements, governmental procurements etc. Where innovation policy aims at stimulating new technologies, regulation is about reducing the space for development of technology. Through the setting of standards, either by specifying interfaces between different sorts of technology or by specifying requirements regarding maximum or minimum characteristics, technology is shaped. Infrastructure is the latest element of technology policy. The construction of infrastructure is a large-scale governmental effort where the aim is to facilitate the flow of goods, people and information. Efficiency and profit are seldom decisive arguments, instead enhanced national and regional welfare are the goals. The interactivity between these three elements constitutes then a basis for the development of ITP (Sørensen 1999).

The paper is divided in three parts. The first part (section 2) discusses some general features of the European Union that are relevant as context for the analysis of technology policy in transport. The second part gives an overview of technology policy (section 3) and transport policy (section 4), while the third part presents briefly two case-studies of Trans-European Networks in Transport and of road pricing, in order to explore in some detail aspects of transport technology policy in the EU.

1.1. From ECSC to EU

In 1951 Belgium, France, West Germany, Italy, Luxembourg and the Netherlands signed the Treaty of Paris to found the European Coal and Steel Community (ECSC). In 1957 the same countries signed the Treaties of Rome, and thereby established the EEC and Euratom. This was the very beginning of the European Union, which today comprises fifteen member states. Further enlargement is also likely to happen. Through its relatively short history the EU has grown greatly, not just in terms of the area it covers, but also in terms of its political significance and its institutions. The founding Treaties have furthermore been revised three times: in 1987 (the Single European Act), in 1992 (the Treaty on European Union) and in 1997 (Treaty of Amsterdam).

The benefits of integration have always been - and still are - the cornerstone in the Community. However, previous to the founding of the ECSC the six founding states acted cautiously and not without reservations with the view on giving up some of its sovereignty. Nonetheless, the potential benefits of integration outweighed the reservations and the establishment of the ECSC made one step towards an integrated Europe. Today the ultimate goal of the European Union is "an ever closer union…", and the objectives of the EU is "to promote economic and social progress which is balanced and sustainable, assert the European identity on the international scene and introduce a European citizenship for the nationals of the member states" (Nugent 1999:23).[1]

To obtain for an integrated Europe and an ever closer Union one of the most important means of its development, is to remove barriers for the free movement of goods, services, capital and labour, together with providing freedom for establishment. These objectives may be reached through another priority area: Co-ordination and regulation. There is an objective of co-ordination of rules concerning public procurement, financial services, postal services, industrial and intellectual property, commercial communications and electronic commerce etc. in the EU.[2] In its strategy for the internal market over the next five years the Commission includes inter alia a continued effort to press for full and effective implementation by all member states of Internal Market Directives and to bring forward proposals to modernise and streamline public procurement legislation.[3]

Setting standards and making regulations within different policy areas has been of significant importance from the Community's earliest years and forward due to the objective of integration. This emphasis on regulations may lead us to believe that EU technology policy is strong in the field of regulation, but weaker in the fields of innovation and infrastructure. *Our aim in this paper will thus be to investigate to which degree the EU stimulate innovation and build infrastructure, compared to the regulatory effort we expect to find.*

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[1] http://europa.eu.int/abc-en.htm#en, 07.02.2000.
[2] http://europa.eu.int/comm/dg15/en/direct.htm, 07.02.2000.
[3] http://europa.eu.int/comm/dg15/en/update/strategy/strategy2.htm, 07.02.2000.

After this brief description of the origin of the EU, we continue this paper by outlining the main features of EU policy-making. Then we look in a more detailed way at the development of EU technology policy. We will give a historical review before looking at how technology policy is organised and finally we describe the current status of the area. We continue the next section by focusing specifically on EU transport policy, and the various R&D programmes and projects are described. At last we examine two parts of technology- and transport policy closer; respectively the Trans-European Networks and road pricing. They thus serve as illustrations of modern and technologically advanced transport systems.

2. Policy-making in the European Union

EU policy-making and decision-making processes are multi-faceted in nature. These complex processes are characterised by a host of actors, operating within the context of numerous EU and national-level institutions and interacting with one another on the basis of an array of different decision-making rules and procedures (Nugent 1999:352f). In a submission[4] even the Commission itself argued that existing decision-making procedures are complex, illogical and inconsistent, there being no less than twenty separate procedures for adopting legislation (Jordan et al. 1999:381). However, there are a number of factors identified as being especially important in determining the form of decision-making used and there are some common, shared and recurring features in the policy-processes (Nugent 1999:352f).

The four treaties on which the EU is based is an important determinant of normal forms of decision-making.[5] One function of the treaties is to lay down the different decision-making procedures and specify the circumstances in which they are to be used. The treaties are therefore of significant importance in shaping the nature of the EU's policy-processes and determining the powers exercised by institutions and actors within these processes. There are four standard procedures for legislation of which the different institutions exercise a varying degree of power (Nugent 1999:353).

2.1. Institutions

The different institutions of the European Union each have their distinct role in the policy-making process. Of the institutions, the Commission, the Council and the EP are the most important actors in the policy-making process inside the Union.

[4] Resulting from the Amsterdam Intergovernmental Conference 1995.
[5] The EU is based on four treaties: the Treaty on the European Union (TEU), the Treaty Establishing the European Community (TEC), the Treaty Establishing the European Coal and Steel Community and the Treaty Establishing the European Atomic Energy Community (Nugent: 1999:353).

The European Commission is the biggest of the European institutions. It comprises 20 Commissioners and a staff of about 15,000 people. The Commission has three distinctive functions: initiator of proposals, guardian of the Treaties, and the manager and executor of Union policies and of international trade relations.[6] The Commission as a whole is divided into 36 directorates-general (DG) and specialised services, and each Commissioner is responsible for one or more DGs. The DGs are the hub of the Commission's and hence the Community's administration and the source of the most proposals (Salmon 1996:17) and has as such a unique role as policy initiator. Before the Commission issues an item of draft legislation, it carries out extensive preliminary soundings and discussions with representatives of governments, industry, the trade unions, special interest groups, and technical experts. In this way there are possibilities for influence from the involved sectors in the initiating process. Salmon (1996:18) points to the fact that in 1995 80% of the Commission's proposals originated outside the Commission itself. The ideas come from member states, the European Parliament (EP) and national and transnational pressure groups, but the formal proposal is that of Commission. The act of legislating the proposals is, however, in the hands of the Council of the European Union, often in codecision with the EP.[7]

The Council of the European Union is commonly known as the Council of Ministers. Referred to as 'the Council', it also comprises the European Council; the meeting of Heads of State or Government – and the subsystem of Coreper; the Committee of Permanent Representatives whom prepare the Council's work (Salmon 1996:18ff). The Council is inter alia the Community's legislative body. When recieving proposals from the Commission, the Council examines it and may amend it before adoption. In the acts that it adopts, the Council may confer implementing powers on the Commission.[8]

The European Parliament (EP) represents the 370 million citizens of the Union, and is the largest multinational Parliament in the world. Its primary objectives are like those of any Parliament – to pass laws and to scrutinise and control the use of executive power. The EP's strength have been gradually widened, first by the Single European Act (SEA) of 1987 and then by the Treaty of European Union of 1993. Originally the EP only had a consultative role in legislation, but through the *co-operation procedure* the EP is now allowed to improve proposed legislation by amendment. The EP toady also share decision-making power with the Council through the *co-decision procedure*.[9]

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[6] http://europa.eu.int/inst-en.htm, 30.11.1999.
[7] http://europa.eu.int/comm/role_en.htm , 06.01.2000.
[8] http://ue.eu.int/en/info/main3.htm , 07.02.2000.
[9] http://europa.eu.int/inst-en.htm , 30.11.1999 and http://europa.eu.int/inst/en/ep.htm , 06.01.2000.

2.2. Opportunity structures and interests

The institutions of the EU form a skeleton of the European policy process, but due to the diffuse nature of the European policy arena it is possible for an unusual range of outside actors to intervene (Wallace 1996a: 24). Like all bureaucracies, the EU-bureaucracy has developed some kind of relationship with other groups - a process of interest group intermediation - in order to function effectively. The EU thus functions as a *opportunity structure* or venue for interest groups of all kinds, which have played a key role in stimulating the emergence of a fully-fledged EU interest group intermediation system. A dense European lobbying system has consequently emerged over time (Mazey and Richardson 1999:105-106). Organisations involved in lobbying processes at the European level can be divided under at least seven headings, according to Mazey and Richardson (1999:108):

1. European associations
2. National associations
3. Individual firms
4. Lobbying consulting companies
5. Public bodies, such as regional governments and local authorities
6. Ad hoc coalitions for a single issue
7. Organisations of experts and epistemic communities.

Through lobbying such groups try to influence the policy process and further their view, and they will operate on whichever level of governance they believe to be the most receptive to their preferences and demands (Wallace 1996a:24).

Although the EU policy process takes place on multi-levels and multi-arenas, all policy processes invariably have to pass through the Commission gateway, because of its key policy formulation role. In addition, much of the policy *details* are decided in the Commission – and the Commission is therefore an especially attractive opportunity structure for lobbying. By 1992 the Commission estimated that there were 3000 special interest groups in Brussels with up to 10,000 employees working in the lobbying sector (Mazey and Richardson 1999:108-112). Both the EP and the European Court of Justice (ECJ) also serves as opportunity structures. The EP has in fact attracted so much lobbying that regulating lobbying has been a key issue within the EP for several years. The ECJ is in many ways perceived as the last lobbying alternative, where groups can bring cases before the Court and thereby influence policy decisions. Indirect lobbying of the Council through own national governments is another option. Several authors do in fact see national governments as the main opportunity structure for interest groups. Finally there is the possibility to try influencing through the media (Mazey and Richardson 1999:111-121).

2.3. Segmentation of policy-making

This paper concentrates on a few policy sectors in the EU. It is therefore important to notice that institutional behaviour differs quite significantly from one sector to another, engaging policy interests in different kinds of ways and producing different kinds of outcomes (Wallace 1996b: 39).

A segmented pattern of policy-making was developed during the 1970s, which gave rise to both costs and benefits. Within the Commission individual DGs took on increasingly distinct personalities and developed different working methods. An obvious cost was the diminished cohesion of the Commission as a collective institution and a lack of control over its working practices. However, one benefit was the blossoming of individual policy areas, and the Commission played a pioneering role in developing transnational environmental regulation, as it did in what became the research framework programme. In the early 1980s, especially after the implementation of the SEA, an institutional innovation took place. The Commission began to develop different and more strategic relationships with several of its policy clients. The result was to co-opt the outside clients of policy as the architects and engineers of policy. This line of action was similar to the Davignon strategy for developing R&D programme, in which he sought very deliberately to build a new policy coalition with leading IT companies. In the end of the 1980s and forward the policy-making processes were characterised of being more effective than earlier and they had a more strategic feel (Wallace 1996b: 48-54).

2.4. The transport sector and adjacent areas

DG Transport (prev. DG VII) is responsible for transport policy. Its mission is "to work with national, regional and local authorities, business and non-governmental organisations to improve the way in which Europe's transport system serves the economic, environmental and social aspirations of European citizens".[10] These main areas of work is set out in the White Paper on the Common Transport Policy and the Common Transport Policy action plan (1998-2004) (ibid.).

The legislation is largely dealt with under the co-operation procedure, but in cases of establishing guidelines for TENs (Trans European Networks), the codecision procedure requires that the EP and the Council reach an agreement both can support.[11] Besides DG Transport other sectors and their respective DGs will also influence innovation and development in the transport sector. This may include DG Research, DG Information Society, DG Energy and so on. This is due to that many of the challenges in transport are interrelated and policies affecting one area invariably spill over to others. Energy use and fuel consumption by road transport is an example (Koopman

[10] http://europa.eu.int/en/comm/dg07/mission.htm , 10.01.2000.
[11] http://europa.eu.int/pol/trans/ino_en.htm, 01.11.1999.

1997:1151). Several sectors have interest in this, and several actors may consequently be involved in policy-making. Joint research programmes is thus an option. We will return to the more specific organisation of transportation R&D later.

As described earlier, different interest groups will try to influence decision-making, so also in the field of transport. One example is European automobile manufacturers. Due to significantly tightened environmental regulations, they have taken an active part in anticipating the prospective legal and technical directions surrounding the private use of the car. European automobile manufacturers consequently lobby intensively at the EU level for a pace of change which they can accommodate (Grieco and Jones 1994:1523f).

The industrial sector in general is lobbying with great effort at the European level. McCormick (1999:203) argues that industry has considerably more influence over policy-processes regarding environmental legislation than environmental NGOs. The result is that EU environmental law and policy reflects more fully the priorities of corporate Europe than it does of NGOs and European consumers. In general, corporations and industrial federations which represent specific interests are well organised and funded, and employ technical experts who can respond persuasively to the often-detailed technical content of the proposals. Such firms have a vested interest in the negotiations given that they are centrally involved in the implementation of subsequent legislation. The result is that they have developed a symbiotic relationship with the Commission and are actively involved in the development of new laws and policies from the earliest stage (McCormick 1999:203).

The individual member states are also actors in the policy-processes. They too may act strategic to maximise their utility in European policy-making in the context of existing institutions and they will seek to shape institutional rules in order to enhance their national policy interests (Héritier 1996:150). To a significant extent new initiatives in European regulatory policy-making are engendered by the competition among highly regulated member states which seek to influence European policy-making in order to shape it according to their own traditions. The Member State that initiates a regulation (the "first-mover") is nonetheless still dependent on the Commission to adopt the proposal to be considered successful. However, to be first-mover may represent an advantage in the next phases of policy-making; defining the scope and nature of the problem dealt with and suggesting a practical solution - thereby having a considerable advantage in policy definition (Héritier 1996:150).

2.5. Policy initiatives in great numbers, but implementation deficit?

European policy-making unfolds in the context of diverse interests and traditions of member states and interest groups, each trying to further their view. It is a complex process; it is multi-level and there exist different procedures for legislation, depending on which policy area we are talking

about. Nor is the distinctive regulatory elements systematically linked in a comprehensive European policy scheme. They are rather added to one another in such a way that the policy scheme often acquires features of a "policy patchwork", in which diverse regulatory approaches are linked under the roof of the same Directive (Héritier 1996:149). Even though there may be a great number of initiatives for legislation - and a lot of legislation actually adopted, there still remains the question of successful implementation. There is no doubt that there is a gap between institutional initiatives and impact in the EU (Jordan 1999: 83ff). The Commission has even considered unimplemented directives the main obstacle to efficient enforcement of Community law (Lampinen and Uusikylã 1998:233)

3. Technology policy in the European Union

Authors discussing "technology policy" in the EU, point at the fact that in the original EEC treaty there was no mention of technology (e.g. Nugent 1999:332). This is undoubtedly true, but there has nevertheless always existed policies in the EU dealing with issues like industry, transport, R&D etc., hence also technology. What is of a more recent date is the great extent of technology policy and that today's technology policy is expressed out loud. Our view is, however, that the EU since its founding has been carrying out technology policy. Whether all aspects of technology policy (innovation, regulation and infrastructure) have been covered is yet another question.

3.1. Developing a fully-fledged technology policy

There is especially one factor that is of significant importance to understand the development of the technology policy, namely competition. An explicit desire of enhanced economic competitiveness in the EU is the driving force behind several political initiatives. The strive for competitive ability obviously actualises economic questions, but it also gives political implications.

We shall, however, start at the beginning. When the Treaty of Rome was ratified in 1957, science and technology policy was not considered a problem in Western Europe and hence was not mentioned in the Treaty. This was a time of technological optimism, but soon after the optimism had given way to anxieties about a "technology gap" that loomed between the United States and Europe. National governments and policies therefore rapidly filled the technology policy void in the Treaty. The 1960s and especially the 1970s thus became the age of the "national champions" (Peterson and Sharp 1998:4).

In the late 1970s a more distinctly expressed technology policy nonetheless began to be developed in the Community. This was due to the concern that the EC's member states were not sufficiently promoting innovation or adapting to innovation, especially in high-tech and other advanced sectors. The perception of external threats and concern about

Europe's economic and political survival created a driving force strong enough to acquire sufficient political support for new initiatives in Community research policy (Dinan 1994, Luukkonen 1998:601, Nugent 1999:229).[12]

Despite collaborative and Community efforts, by the end of the 1970s Europe's high technology sector seemed as badly off as ever before. Consequently, political and ideological discussions regarding the Community's lack of success in industry and R&D was set on the agenda. Governments disputed the benefits of cross-border industrial co-operation and within the Commission, the DG Competition (DG IV) kept an close eye on DG Industry's (DG III) potentially interventionist activities, which was not considered ideologically correct at a time where market liberalism was the ruling theology. Yet the Community's acute industrial difficulties, the soaring cost of R&D, the increasing importance of new technologies and the continuing U.S. and Japanese threat convinced many European manufacturers, politicians and government officials that closer collaboration under the Community's auspices held the key to European industry's survival and success (Dinan 1994:366).

On the initiative of E. Davignon (the European Commissioner for Industry 1977-1985 and also for R&D from 1981-1985) a "Round Table" of top industrialist was organised. The most important outcome of this gathering was the launching of two major information technology and telecommunications programmes in 1982, respectively ESPRIT (The European Strategic Programme for Information Technology) and RACE (advanced communications technology). Later related programmes, such as BRITE/EURAM (advanced technologies and advanced materials and BAP (biotechnology) was launched (Dinan 1994:368, Peterson and Sharp 1998:5-6). The Commission also requested - and received - stronger competence in technology policy, and through the SEA's Article 130 the new EC funding to subsidise cross-border RTD was sanctioned (Peterson 1996:178).

In 1984 the clustering of specific programmes under a broader umbrella led to the establishment of the *framework programmes*. The framework programmes are multi-annual programmes aimed to co-ordinate and give strategic direction to the EU's R&D policies and activities (Luukkonen 1998:601, Nugent 1999:340). Today the EU is managing its 5th framework programme (FP5).

In 1985 the EUREKA programme came into existence. It was launched not as an EU programme, but as a loose intergovernmental initiative designed "to develop and exploit the technologies crucial to global competitiveness and a better quality of life".[13] EUREKA projects tend to focus more on the development of marketable products and services than on pre-competitive research, as the EU's FPs do. The EC joined the EUREKA in 1985, but in the first years EUREKA was often bitterly criticised by Commission officials,

[12] There were however some attempts to fight "the American challenge" before this time. In 1967 the Commission established Directorate for industrial affairs (DG III) to encourage cross-border cooperation and in 1971 COST was established (Dinan 1994:366).
[13] http://www3.eureka.be/Home/, 07.02.2000.

who viewed it as detracting political support for the Community's own programmes (Peterson 1996:178, Peterson and Sharp 1998:7f)

When the SEA was ratified in 1987 and later the Maastricht Treaty in 1993, the Community was finally given competence in research and technology. Both Treaties made it clear that the objectives of EU policy was, first to strengthen Europe's science and technology capabilities, and, second to promote its competitiveness at an international level (Peterson and Sharp 1998:8). The Treaties meant completion of the single market, and the competitive discipline imposed by this forced national industry to restructure radically. Thus the single market program became the most important instrument of Community industrial policy in the late 1980s (Dinan 1994:368).

In the period after the SEA the EU has put forward several papers regarding RTD. Some of the most significant are:

1990: "Industrial Policy in an Open and Competitive Environment: Guidelines for a Community Approach" (European Commission 1990).

1993: "White Paper on Growth, Competitiveness and Employment". Here the Commission identifies the Union's limited capacity to convert scientific breakthroughs and technological achievements into industrial and commercial successes as one of the greatest weaknesses of the Union's research and industrial base (European Commission 1993).

1995: "Green Paper on Innovation". In this paper the Commission set out proposals for a number of priority actions and identifies factors- positive or negative- on which innovation in Europe depends (European Commission 1995a).

1997: "The Treaty of Amsterdam". The Treaty states that environmental policy is to be integrated into all other Community policies. The fifth environmental action programme has established this objective as a priority.

3.2. Organising European technology policy

In this section we will look closer at how the current R&D policies in the EU are organised. There are four main forms (Nugent 1999:340):

1. Research is undertaken directly by the EU itself at its Joint Research Centre (JRC). The mission of the JRC "is to provide scientific and technical support for the conception, development, implementation and monitoring of the EU policies". As a service for the Commission, the JRC functions as a reference centre of S&T for the Union. The JRC focuses on 8 main areas, among them environment, transport & mobility and the information society.[14]
2. The largest part of EU R&D consists of shared-cost or contract research. This research is not undertaken by the Commission, but by universities, research institutes and public and private companies. The EU's role is to

[14] http://www.jrc.org/jrc.home.asp, 02.11.1999.

develop and agree the principles, aims and conditions of the programmes under which the research is conducted. It also co-ordinates activities and provide some of the finance (usually 50 per cent). Illustrations are ESPRIT and RACE.

3. Concerted action-research projects where the EU does not finance the actual research, but facilitates and finances the co-ordination of work being done at the national level.
4. Some of the research activity takes none of the above forms, but consists of arrangements in which, for example, non-member states participate, or in which the EU co-operates with non-member states and international organisations. Work undertaken within EUREKA is of this type (Nugent 1999:340).

In addition to the above forms of organising R&D, the framework programmes are of great importance for co-ordinating R&D in the Union. Since the beginning in 1984, over 7,000 projects across a wide variety of sectors have been funded by the framework programmes.[15] The framework programmes' priority areas have all reflected the scientific and technological priorities of their particular time. In turn, this has reflected the political agenda.

The ongoing FP5 sets out the priorities for the EU's R&D activities for the period 1998-2002. Its objective is to respond to the major socio-economic challenges facing Europe. To maximise its impact, it focuses on a limited number of research areas combining technological, industrial, economic, social and cultural aspects.[16] There are four thematic- and three horizontal programmes, besides the Euratom FP. The technology policy is covered notably through "User –friendly information society" (IST), "Competitive and sustainable growth", including key actions such as "Sustainable mobility and intermodality" and "Land transport and marine technologies" and "Energy, environment and sustainable development".[17]

Several studies have been conducted, discussing the contribution of EU framework programmes to furthering the competitiveness of European industries, their prime objective. In general, discussions of the impact of the programmes have a similar conclusion: The framework programmes have not been successful in raising the level of competitiveness of European industries (Luukkonen 1998:599). In the future planning and development of the Community R&D this should be borne in mind.

Describing the RTD policy of the EU is somewhat complicated because of the great amount of different organisations, programmes and groups and they will not be described in details here. We will however, as an example, shortly describe the "Task Forces". There are eight task forces established in response to the need to stimulate and better co-ordinate the European research

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[15] FP1 (1984-87), FP2 (1987-91), FP3 (1990-4), FP4 (1994-98), FP5 (1999-2002). For further information on FP4, see http://cordis.lu/src/f_002_en.htm and for FP5 http://www.cordis.lu/fp5/home.html, 07.02.2000.

[16] http://cordis.lu/src/i_005_en.htm, 11.11.1999.

[17] The programmes have their respective websites: http://www.cordis.lu/ist/home.html, http://www.cordis.lu/growth/home.html and http://www.cordis.lu/eesd/home.html, 07.02.2000.

effort in a number of key strategic sectors. The task forces are focused on clearly defined areas and are aimed at identifying and co-ordinating the research efforts being made in each area (Peterson and Sharp 1998:154). There is also an objective to redress the current situation where only 13% of public research budgets are allocated to research projects involving European co-operation, as opposed to 87% for strictly national research. Thus there is still a way to go before the Union R&D catches up with the national levels. Among the areas covered by the task forces are "the car of the future", "the train of the future" and "transport intermodality". More task forces may be established in the future.[18]

3.3. Governmental economic policy tools

Funding and promoting R&D policy and innovation can be done mainly in two ways. One option is direct provision of funds for R&D. Another option is the use of indirect means, such as tax and economic policy, guaranteed procurement contracts, export assistance etc. To illustrate; R&D tax incentives could be targeted towards narrow policy objectives such as encouraging diffusion, training, university-industry collaboration, or specific stages of firm development (Dinan 1994:363, Branscomb et al. 1997). Governmental use of economic tools is a classic means to promote innovation and is being used in the Union. However, to promote a fully-fledged technology policy the EU should utilise the full range of economic policy tools, recognising that different industries, technologies and regions my call for different mixes of these policy tools.

3.4. The current situation

In the past decades there has been an increasing effort to develop a successful R&D policy. However, it seems like there still is a way to go. Among several problems, one is the attempt to establish a common and integrated Union policy. According to Peterson (1996:182), a "common European interest" in such a policy exists mostly in the Commission's rethoric. The EU's R&D policy tools are viewed by member states mainly as opportunities for bringing benefits to their national industries via transnational menus (ibid.). The same can be said about research under the EUREKA umbrella. Many EUREKA projects only have a weak *European* dimension, so it has been claimed that the growth of EUREKA mainly represents the desire of national governments to check and control the "shift to Brussels" by retaining national control over collaborative research (Peterson 1996:181, Peterson and Sharp 1998:223).

Enhanced competitiveness, the prime objective and driving force behind many R&D initiatives is yet another problem. Compared to the U.S. and Japan, the EU is still lacking behind in the high-tech sector. The RTD

[18] http://cordis.lu/src/i_007_en.htm, 13.01.2000.

programs appears inadequate in this respect, and ESPRIT had only limited success (Dinan 1994:372). In addition, the total EU research investment is well below that of its major competitors (Peterson 1996:180).[19]

However, there also has been a positive development. The framework programmes are steadily growing and R&D accounts for more EU funding than any other policies apart from agriculture and regional development. The EU programmes are furthermore more focused on leading edge technologies or new applications of existing technologies than many of the individual member states (Peterson 1996:182). Based on the previous experiences, the future challenges in EU R&D are considered as following:

- The level of investment in R&D is proportionately lower than its main competitors and needs to be raised.
- Strengthen the co-ordination at the various levels of the research and technological development activities, programmes and strategies in Europe.
- Increase the capability to convert scientific breakthroughs and technological achievements into industrial and commercial successes.[20]

4. Transport policy

Transport technologies and hence transport R&D are essential elements of a technology policy. Transport also occupies an important industrial position in the Community, accounting for 7% of its GNP, 7% of total employment, 40% of member states' investment and 30% of Community energy consumption. The demand for transport is steadily growing, particularly the demand for intra-Community traffic has grown more or less constantly for the last 20 years. Goods transport and passenger transport has grown respectively by 2.3% and 3.1%.[21] Moreover, overall 73% of EU household have at least one car.[22] In this paper we mainly delimit transport to include road transport and rail, and we essentially discuss passenger transport. Studying transport and transportation technology also give us a good opportunity to explore EU infrastructure development, which will correspond to the third element of technology policy.

As described earlier, DG Transport is responsible for the EU's transport policy. Its main areas of work are set out in the White Paper on the Common Transport Policy and the Common Transport Policy action plan 1998-2004 (European Commission 1998). They cover:

- Environmental, safety and social standard for transport
- Competition, market forces and fair and efficient pricing in transport
- Catalysing investment in transport
- Supporting research and technical development in transport

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[19] http://cordis.lu/src/i_005_en.htm , 12.01.2000.
[20] http://cordis.lu/src/i_005_en.htm , 12.01.2000.
[21] http://europa.eu.int/scadplus/leg/en/lvb/124040.htm, 10.11.1999.
[22] http://europa.eu.int/en/comm/eurostat/compres/en/6199/6106199a.htm, 07.02.2000.

- Transport links with countries outside the European union.[23]

Initiatives in three fundamental areas are put forward to achieve the goals:

1. Quality is to be improved by developing integrated transport systems based on advanced technologies that also contribute to environmental and safety objectives.
2. The functioning of the single market is to be improved in order to promote efficiency, choice and user-friendly provision of transport services while safeguarding social standards.
3. Improving transport links between the EU and third countries and promoting the access of EU operators to transport markets in other parts of the world will broaden the external dimensions.[24]

4.1. Transport policy-making

European transport policy-making has always been rather nationalistic in character. Policies are developed and implemented in a segmented way, each country seeking its own solution for each transport mode. The results of this are i. a. uncoordinated infrastructures causing bottlenecks and inefficient use of vehicles because of cabotage restrictions. In addition, national infrastructure-building companies, vehicle producers and transportation companies are often given a competitive advantage at the cost of their foreign counterparts. Instead of improved ability to compete through European collaboration, such behaviour may lead to external (e.g. American Companies) competitors outperforming European companies (Nijkamp and Vleugel 1995:6-7). We have noted earlier that a desire to enhance the ability to compete has been crucial in the development of different policies, the same is true in the case of transport policy.

A common transport policy (CTP) was envisaged in the treaties of Paris and Rome and has been the subject of several Commission proposals since the founding of the Community. Despite this, a CTP has proved an elusive goal for much of the EU's history. Blueprints for such a policy has generally comprised a mixture of *harmonisation* and *liberalisation*: Co-ordination and regulation of investments and common rules would allow for lower logistical costs, while an integrated open market would deliver competitive benefits. However, the pervasiveness of government intervention in national transport markets and public ownership of many transport industries has meant that relatively little was achieved for a long time (McGowan 1998:460).

The lack of progress in agreeing on a CTP was such that in 1983 the EP took the Council of Ministers to the ECJ on the ground that it had failed to act on its treaty obligations. The ECJ judged in favour of the EP and obliged the Council to move more substantially on a common policy. The ECJ's ruling underpinned in this way the Commission's decision to make transport one of the priorities of the single market initiative. The 1985 White Paper outlined a

[23] http://europa.eu/int/en/comm/dg07/mission.htm, 10.01.2000.
[24] http://europa.eu/int/scadplus/leg/en/lvb/124040.htm, 10.11.1999.

number of initiatives designed to open up transport services, and finally by 1997 the introduction of market forces was almost complete (McGowan 1998:461).

However, market liberalisation has never been the only objective of European transport policy. During the 1980s particularly two issues gained higher profile. The *infrastructural* issue came to the fore with the initiative on Trans-European Networks (TENs). TENs are also covering telecommunications and energy, but transport is by far the most important network industry in the program. We will return to the issue of TENs in transport. Another issue brought forward during the 1980ies and often seen as being at odds with liberalisation and TENs, was protection of the environment, consequently transport's *environmental impacts*. For years, environmental considerations had been invoked in transport policy, but it was first in the mid-1990ies that the issue was taken seriously. The paper, *The Future Development of the Common Transport Policy,* introduced in 1992 the concept "sustainable mobility" and thus shifted the focus of transport policy from liberalisation and open market to social and environmental dimensions (McGowan 1998:461). In the Maastricht Treaty it is stated that the EU aims to "promote a stable and non-inflationary growth which respects the environment". The aim was restated in the Amsterdam Treaty in 1997. As part of the required action, it calls for the integration of the principles of sustainable development into all EU policies (Hey et al. 1999:171).

A noteworthy point regarding the Union's environmental policy is that measured by the output of laws and policy statements alone, the EU has established an impressive record in the field of environmental policy. However, given the broad-ranging nature of environmental problems, and the growing complexity of EU decision-making processes, the time taken to develop new environmental laws and policies has lengthened. Previously it took between 2 and 3 years to develop new legislation, now the process may take as long as 6 or 7 years, which makes it difficult for the EU to respond quickly to worsening problems (McCormick 1999:201-202). Such a long process for developing new legislation is definitively unfortunate considered that sustainability is an objective in transport policy.

4.2. Transport trends, challenges and solutions

To comprehend transport policy in the EU we shall in the following present a general review of transport trends in Europe, challenges related to transport and possible solutions to the challenges.

4.2.1. Trends

In the last three decades, there has been a strong growth in transport and mobility in all West European Countries. The volume of passenger kilometres

by car, train and bus in Western Europe has increased by 246% between 1965 and 1989 (Rienstra et al. 1996). Moreover, this growth has been very unequal for the distinct transport modes; described as the *modal split*. The highest mobility growth is to be found in air transport plus private car use, while the use of collective modes grew much less. In addition, the developments taking place in information and communication technologies have dramatically altered the possibilities for telematics inventions that are needed for sustainable mobility, even though there still is more R&D to be done (Hepworth and Ducatel 1992, Grieco and Jones 1994:1517, Nijkamp et al. 1998:308ff).

Road transport is the dominant form of transport within the EU. During the last decades, road transport has grown significantly more rapidly than train, and this trend is even more pronounced in the freight sector than with regard to passenger transport. Forecasts of a doubling of road traffic within the EU between 1995 and 2015 are not uncommon. Road transport is also the form of transport that has attracted the most criticism of all transport modes because of increasing congestion, gaseous emissions and their land usage (Johnson and Turner 1997:50, 60, Nijkamp et al. 1998b:310).

Rail is the biggest investment area in EU transport policy, despite the fall in rail's share of goods transport as well as the number of passengers. High amongst the attractions of rail are more economic use of land, lower energy consumption and air pollution and the opportunities for developing advanced European technology such as high speed trains (HST) and traffic management systems (Johnson and Turner 1997:53-54).

There is no doubt that transport represents several positive externalities. A developed transport infrastructure is a critical success factor for obtaining the EU's objectives of improving the economic, environmental and social aspirations of European citizens. However, the positive externalities of transport networks and operations run sometimes the risk of being offset by negative externalities.

4.2.2. Challenges: negative externalities

One of the consequences of the large increase in transport and mobility is a growth in the quantity of negative externalities caused by transport. To be able to develop an adequate transport policy it is necessary to identify these externalities. Main forms of negative environmental and social externalities resulting from road transport may be described as:

- Air pollution, including green house gases and ozone depleting substances
- Noise
- Congestion,
- Accidents/ lack of road safety.

In addition, road transport may represent land take, visual annoyance, colonisation of various public spaces by illegally parked cars and the general

unpleasantness of using street spaces on foot. Transport energy use is yet another important issue, which also may be considered a negative externality (Jones and Hervik 1992:133, Nijkamp and Vleugel 1995:3, Rienstra et al. 1996:221, Koopman 1997, OECD 1997:11). Taken together, these externalities impose large costs on society.

The modal split which favours modes that causes the most negative external effects (e.g. road transport) contributes to intensify these effects (Nijkamp et al. 1998:310,12, Rienstra et al. 1996:221). In the EU the most serious charges of environmental pollution are laid at the door of road transport and road transport is responsible for over 75% to the total CO2 output in the Community. The Commission has accordingly put special emphasis on the need to create a better balance between road and other means of transport so as to reduce pollution and congestion and increase safety.[25]

4.2.3. Solutions: policies

The Union's late policy initiatives in relation to the CTP are indeed very much directed towards the most serious problems that are related to transport, such as environmental pollution and congestion. Thus, in this section we will look more closely at EU environmental policy in transport.

The sustainable mobility 2000-2004 action programme aims at implementing a CTP that is "safe, efficient, competitive and socially and environmentally friendly". The Commission is consequently giving priority to sustainable forms of transport. In accordance with the guidelines laid down at the Kyoto Conference, it will give particular attention to measures to limit the extent to which transport systems contribute to climate change. However, at present the implementation deficit is prominent, and the EU has still not set concrete measurable targets for the CTP (Hey et al. 1999:189)

One of the major environmental policy challenges in transport is the forecast growth in fuel consumption by road transport. This is due to concerns about fuel consumption-related emissions of CO2 and the rising dependence on imported oil in the EU (Koopman 1997:1151). The EU is thus moving towards harmonising technical standards for vehicles and fuels. Restriction of lead content is consistent with this approach and is required to protect the catalytic converter necessary for meeting new exhaust standards as well as to protect public health (Hall 1998:217).

Environmental reduction targets of the EU include the following:
CO_2 emissions:

2000: Stabilisation at 1990 levels (COM (95) 689)

2008: Achieving a target of 140g/km CO2 emissons for the average of new cars sold in the EU, representing a reduction of about 25%. This reduction objective is laid down in an agreement between the EU and

[25] http://europa.eu.int/pol/trans/info_en.htm, 01.11.1999.

the European Automobile Manufactures Association (ACEA) (COM 98 (495).

NO_x emissions:

2005: 30% reduction, compared to 1990 level (Hey et al. 1999:177).

In a communication from the Commission (COM (98) 204), policy approaches to reduce CO_2 emissions are described. These includes improved logistics, introduction of pricing in all modes of transport, land use planning and promotion of different and more environmentally friendly transport modes than car use. However, as car transport seems to continue to be the predominant transport mode, development of *alternative fuels* may be another option to reduce emissions of harmful gases. This may include different forms of methanol, compressed natural gas (CNG), electricity, hydrogen etc. (Rienstra et al. 1996:230, Hall 1998:207).

Furthermore, the role of *public transport* has been identified as necessary in any strategy towards more sustainable transport patterns, as the awareness of environmental impacts of transport has increased. Public transport is more energy efficient per passenger kilometre and is less polluting than cars (or air travel). Thus there is a scope to increase the attractiveness of public transport through extension of network coverage, capacity and frequency, enhancement of speed and accessibility, reduced or simplified fare structures, improved comfort and security, expanded parking at main transit terminals etc. (OECD 1997:20, Potter and Enoch 1997:271)

Despite the available policy instruments, transport still represent environmental challenges. Koopman (1997) argues therefore that new policy instruments must be developed and used to deal efficiently with the two main challenges – congestion and CO2 emissions. The EU's aim of using pricing schemes is thus in line with Koopman's arguments for the need of new policy instruments. New policies, such as road pricing and differentiated vehicle taxes and measures to deal with the "no-regrets"-potential in passenger car fuel economy, are likely to be required – and may constrain growth in fuel use and CO2 emissions from transport (Koopman 1997:1151). The new technology is the necessary tool for developing most of these new policies.

4.3. Technology's role in transport

The so-called information society is seen as creating new opportunities for the transport sector. New technologies may be used to obtain a sustainable transport system, mitigating the environmental effects of transport (Rienstra et al. 1996:221, Hey et al. 1999). However, until now, new transport modes have failed to *compete* with existing technologies. To a large extent this is an economic failure,[26] because current technologies have proved cheaper than new and more environmentally benign technologies. This has made investments in new technology unprofitable (Rienstra et al. 1996:223).

[26] However, also spatial, institutional, social/psychological and technical factors may prevent the development and implementation of new technologies (Rienstra et al. 1996:223ff).

In the Union's transport sector, ICT systems are already an established competitive element. They have significantly improved the productivity and the eco-efficiency of transport and will be among the central means of curbing the external costs of mobility. However, the potential of ICT to contribute to sustainability is in no way yet fully utilised. Action Group 4: Mobility and Transport (located under the JRC/EEA umbrella) aims at develop benchmarks and guidelines to policy makers based on R&D in a number of fields. They see several ways through which ICT may bring about a win-win scenario of cost reduction, improved service and reduced environmental impact in the transport sector:

1. Telematics may provide solutions for smooth traffic flow thus reducing environmental impacts and loss of time caused by congestion. In addition, incorporating intelligent road pricing systems will help in better reflecting the infrastructure costs of road traffic.
2. Standardised data communication systems, such as barcodes and Electronic Data Interchange (EDI) will ease the information exchange and therefore provide the possibility to co-ordinate material flows over organisational boundaries. This offers the basis for the optimal use of transport capacity.
3. Transport vehicles can be routed more effectively by mobile telecommunication and on-line centralised information systems.[27]

Concrete examples of new transport modes using new technology may be (Rienstra et al. 1996:226ff):

- For short distances (<20km): Electric car, people mover, (an automatically driven train gliding on an electromagnetic field connected to a monorail infrastructure, Maglev technologies).
- For short and long distances: Subterranean infrastructure.
- For long distances: High speed train (HST) HST is already under development in almost every European country. Maglev technologies are also being developed. Shuttles through vacuum tunnels.

Another option for reducing negative impacts from transport is "simply" to curb the demand for travel. One does not necessary need new technologies to do so; land-use planning may reduce the demand for travel, together with alternative modes of physical planning (compact city design) (Newman 1996:80-81, OECD 1997:19). With the use of telecommunications technologies, *telecommuting* is also an option for reducing the need for physical mobility. Telecommunications technologies have dramatically widened the choice of location for many workers, allowing them to work whenever and wherever such technologies are available. This means a high potential for reducing mobility for journey to work trips (Camagni et al. 1999:230). There are usually high expectations attached to the use of activities like telecommuting and tele-shopping regarding the positive environmental effects. However, Camagni et al. (1999:232) maintain that even if positive effects are envisaged as a consequence of the introduction of transport substituting activities, in the long run there is uncertainty regarding the side

[27] http://asis.jrc.es/html/ag4more.asp, 20.01.2000.

effects of for instance telecommuting. Only one thing is for sure; there will be a considerable redistribution of travel in time and space.

4.4. EU transport R&D projects

The EU's future strategic objectives for the CTP was set out in "The Common Transport Policy Action Programme 1995-2000" (COM (95) 302) and adopted by the Commission. In "The Common Transport Policy Sustainable Mobility: Perspectives for the Future" (1998-2004) (COM (98) 716) the Commission further outlines its objectives in the CTP. In this communication the Commission concludes that considerable progress has been made over the past years in the framework of the CTP. There has been a strengthening of the single market, development of more integrated transport systems, compatible traffic management systems, promotion of intermodality and best practices in local and regional passenger transport, improvement in safety and environmental protection and development of research activities. However, in certain areas, progress has been slower than expected, and a great deal of R&D remains to be done. The development of new transport technology is of particular importance, according to the Commission.

The EU manages an impressive amount of transport R&D projects, and we will try to give a brief summary. There are three main programmes managed by DG Transport:

TENT (the trans-European transport network)
PACT (Pilot Actions of Combined Transport)[28]
Transport research and technical development programme[29]

The TENT programme (TEN for transport) is the co-ordinating programme for transport whilst building the Trans-European Networks, and we will discuss this further later in the paper. PACT is a promotion of combined transport programme. It covers rail, inland waterways, several modes and maritime R&D. The more general Transport RTD Programme supports the development and implementation of the CTP. The related research will "contribute to the development, integration and management of a more efficient, safer and environmentally friendly transport system...".[30] The Transport RTD Programme is divided into seven areas:

1. Strategic Research http://www.cordis.lu/transport/src/strat.htm
2. Rail Transport http://www.cordis.lu/transport/src/rail.htm
3. Integrated Transport http://www.cordis.lu/transport/src/integrat.htm
4. Air Transport http://www.cordis.lu/transport/src/air.htm
5. Urban Transport http://www.cordis.lu/transport/src/urban.htm
6. Waterborne Transport http://www.cordis.lu/transport/src/water.htm
7. Road Transport http://www.cordis.lu/transport/src/road.htm

[28] http://Europa.eu.int/en/comm/dg07/pact/, 07.02.2000.
[29] http://www.cordis.lu/transport/src/project.htm, 07.02.2000.
[30] http://www.cordis.lu/transport/src/outline.htm, 17.01.2000.

The different projects sum up to approximately 260 different RTD projects, and spans over a wide number of areas.

4.4.1. Task-forces

Among the different task forces managed by the Commission, the "Transport Intermodality" and "Car of tomorrow" are conducting transport RTD. The task-forces performs its activities principally through the mechanisms of the Community's research programmes (e.g. FP5), but also through other Community programmes (e.g. PACT) and through multilateral co-operation actions in Europe (e.g. COST) which aim at achieving a high-quality, economic and sustainable transport system through intermodal solutions.[31]

4.4.2. Framework programmes

During the period 1994-98, all Community R&D activities were carried out under the FP4,[32] and the research activities was thus organised by policy areas. Today, the research activities conducted under the FP5 umbrella is, as noted earlier, organised under thematic- and horizontal programmes. Transport R&D may thus be conducted under several of these programmes (e.g. key actions such as "Sustainable mobility and intermodality", "Land transport and marine technologies" and "New methods of work and electronic commerce").

4.4.3. JRC

The JRC (Joint Research Centre) also provides transport related scientific and technical support for the development, implementation and monitoring of EU policies. The "Transport & Mobility" project focuses on the impact of innovations and regulatory frameworks on mobility. One area covers the analysis of organisational measures and technologies of multi-modal application (e.g. alternative propulsion systems such as hybrid, electric, fuel cell and hydrogen) in addition to advanced materials and ICT technologies (e.g. intelligent transport systems and logistics). The other area is occupied with the analysis of new regulatory frameworks and their impacts on the single market and competitiveness at a regional and global level. The JRC also engages in projects in collaboration with European consortia:

> FANTASIE (DG Transport): Forecasting and assessment of new technologies and transport systems and their impacts on the environment.[33]

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[31] http://www.cordis.lu/transport/src/taskforce/src/intbrch2.htm, 07.02.2000.
[32] http://cordis.lu/src/f_002_en.htm, 07.02.2000.
[33] http://www.etsu.com/fantasie/fantasie.htm, 07.02.2000.

RECONNECT (DG Transport) Reducing congestion by introducing new concepts of transport.[34]

EU-Spirit (DG Development): European system for passenger services with intermodal reservation, information and ticketing.[35]

Besides the specific transport programmes and projects, a lot of research is carried out in other areas relevant for the transport sector. R&D in energy, environment, materials technologies, information and communication technologies and telematics may all be useful for developing a sustainable transport system and improve the infrastructure in Europe. An illustration may be DRIVE I and II, which are schemes developed to assist in the application of telematics in the transport sector. DG Telecommunications, Information Market and Exploitation of Research (prev. DG XIII) managed the DRIVE programmes.

5. Transport technology: two cases

So far in this paper we have discussed technology and transport in a very general way. In this section we will elaborate the use of technology in transport through two cases, respectively the *Trans-European Networks (TENs)* and *road pricing*. They are in several respects two distinctively different cases, but they both draw heavily on the use of advanced technology and are thus good examples of EU transport technology projects.

5.1. Trans-European networks: transforming a patchwork into a network

The Trans-European Networks are perhaps the Union's greatest task at the moment. Major efforts (and funding) are invested in developing TENs. TENs are modern and technologically advanced infrastructures and include both transport and energy, together with telecommunications. TENs for transport is however by far the most dominant TEN-sector (Johnson and Turner 1997:45).

The rationale behind TENs differs considerably. Essentially it is a campaign to achieve comprehensive, continuos physical infrastructure across the EU. At one level, TENs are thus concerned merely with building roads, rail lines and so on. However, at a more profound level, TENs represent the latest "big European idea" where European *integration* is the key word (Johnson and Turner 1997:16-17). Besides being an important unifying tool of political and economic integration, TENs also have ambitions and implications beyond this. The objectives of the transport network is to:

1. Create a more vigouros, competitive economy capable of generating many more new jobs

[34] http://www.etsu.com/reconnect/reconnect.html, 07.02.2000.
[35] http://eu-spirit.jrc.es/ , 07.02.2000.

2. Embody the concept of sustainable mobility which seeks to improve the environment and preserve tomorrow's natural resources without sacrificing today's economic growth
3. Guarantee higher personal safety and a decline in traffic congestion and pollution
4. Offer travellers and goods a wider choice of transport means and deliver them to their destinations more quickly
5. Establish better connections between regions on the periphery of the Union and those at its centre
6. Include links with partner countries in central and eastern Europe moving towards membership of the Union.[36]

From the official objectives, stated by the Commission, one can notice that there are a number of broadranging objectives, such as economic growth, environmental concerns, social cohesion and relations with third countries. There has also been a rise of TENs upwards within the industrial policy agenda, which is quite indicative of the emerging trend for EU industrial policy to become more generalist in nature - and move away from the sectoral approach that previously dominated (Johnson and Turner 1997:24). The TENs programme's key themes may be summed up under the terms *interconnection, interoperability* and *access*, and their attainment is set firmly within the context of "open and competitive markets" (Johnson and Turner 1997:20-21). Several transport projects is underway, but many more are at the planning stage.

5.1.1. Establishing TENs for transport

The idea of a CTP was apparent from the founding of the Community, and the first attempts to launch such a policy took place in 1961 (Memorandum on the General Lines of the Common Transport Policy, also known as the Schaus Memorandum). The objectives and principles set forward at that time are entirely consistent with the rationale for the modern TENs programme of today (Johnson and Turner 1997:7). To make a long story short; after decades of little headway on the CTP front, finally in 1990 the Commission put forward the TENs Action Programme (COM (90) 585). This may be regarded as a landmark document and the launch of the modern campaign to develop a trans-European infrastructure within the EU (Johnson and Turner 1997:x). Throughout the 1990ies great progress has been made to further the TENs goals. Today, this "big European idea" is well established.

The Commission's design proposal for TENs requires 70,000 km of railways, including 22,000 km of new and upgraded track for High Speed Trains and 15,000 km of new roads. Of the latter, nearly half is to be constructed in the regions on the outskirts of the union to complete a 58 000 km network already largely built. Combined transport corridors and terminals,

[36] http://europa.eu.int/pol/ten/transp_en.htm, 10.11.1999.

networks of inland waterways and seaports together with 267 airports are furthermore required.[37]

The application of telematics is essential in the building of TENs for transport. More effective co-ordination and harmonisation between adjacent traffic management areas are especially relevant in the TEN contexts. As discussed earlier, different projects are already under way to improve and develop telematics applications needed in transport. Regarding road transport, the immediate priority is the implementation of a basic inter-operable telematics infrastructure for the collection, validation and dissemination of information to road users on a European scale. The first step is to be based on the radio data system-traffic management channel (RDS-TMC) on major trans-European traffic corridors. In the longer term, tools for incident detection, travel and traffic information services, electronic debiting systems for automatic fee collection or access control purposes and satellite positioning systems will be developed. At present time, the implementation of the project is at the study stage (Johnson and Turner 1997:74ff). Also for train, a traffic management system is being developed. It is intended to replace incompatible national signalling and management equipment. Safety and reliability will also be significantly improved.[38]

The Essen European Council endorsed in Dec. 1994 14 TEN priority projects. The projects are in no way completed, but in the period 2000-2006, also the largest projects will move into full construction phase:

High Speed Train/Combined Transport North-South
High Speed Train (Paris-Brussels-Cologne-Amsterdam-London)
High Speed Train South
High Speed Train Paris-eastern France-southern Germany
Conventional rail/combined transport Betuwe line
High Speed Train/Combined transport France-Italy
Greek Motorways PATHE and Via Egnatia
Multimodal Link Portugal.Spain-Central Europe
Conventional Rail Link Cork-Dublin-Belfast-Larne-Stranraer
Malpensa Airport, Northern Italy
Fixed rail/road link between Denmark and Sweden-Øresund Fixed Link
Nordic Triangle
Ireland-United Kingdom-Benelux road link
West Coast Main Line (UK) High Speed Train/Combined Transport North-South

Of the priority projects, to be completed by 2010, 80 per cent of the financial spending is destined for rail, while road transport will receive about 20 per cent of the investment (Johnson and Turner 1997:61). This reflects the EU's desire to put stronger emphasis on rail in order to obtain a better balance between different transport modes.

[37] http://europa.eu.int/pol/ten/transp_en.htm, 10.11.1999.
[38] http://europa.eu.int/pol/ten/transp_en.htm, 10.11.1999.

5.1.2. TENs and the environment

Apart from within the EP, surprisingly scant attention has been given to environmental considerations in the formative stages of TENs. The Commission proposes the design, but individual TENs projects must undergo an environmental impact assessment and need a final approval by the other legislative institutions (Council of Ministers and EP).[39] However, TENs as a whole network has never been subject to scrutiny. The environmental impacts of TENs is rather complex and most likely there will be both positive and negative impacts (Johnson and Turner 1997:37f).

The major emphasis put on developing HST among the priority projects, should indicate environmental gains by diverting traffic from the roads and passengers from short-haul flights to rail. A modal shift towards further train usage could also mean the elimination of bottlenecks of the road network. This shift could in its turn unfortunately encourage further road usage. Moreover, if the TENs initiative fulfils its objective of economic growth, the total demand for transport will increase, which will imply environmental damage (Johnson and Turner 1997:38). The environmental effects from TENs is thus difficult to grasp, and further research is required in this area.

5.2. Road pricing

When we in an earlier section looked at possible "solutions" to transport externalities, road pricing was mentioned as a possible means to mitigate externalities. In the traditional economic sense road pricing is congestion pricing, as delineated by Pigou (Button 1998:113). However, we will use the term road pricing in a broader sense, including road pricing with more aims than just curbing congestion. Such a view agrees with the fact that interest in pricing is now spreading to other areas such as health effects, environmental effects, accidents etc. (Johansson-Stenman and Sterner 1998:150). Through the Green Paper on fair and efficient pricing in transport (European Commission 1995b), the increasing European interest in use of more effective pricing within the transport sector is made explicit.

Road pricing may then be understood as a generic term for a variety of measures and practices that involve levying charges for the use of a road. A flexible road-pricing scheme would require the direct charging of a fee for the motorist's use of a given stretch of road at a given time. The charge should reflect the "real costs" or marginal costs of using the road space, beyond the motorist's personal costs of fuel consumption, wear and tear of the vehicle and lost time (Hepworth and Duacatel 1992:89, Langmyhr 1996:4).

The idea of road pricing is nothing new, and simple road pricing mechanisms have been used for centuries (ibid.). However, recent

[39] http://europa.eu.int/pol/ten/transp_en.htm, 10.11.1999.

technological breakthroughs in automatic road use charging have brought electronic road pricing much closer to reality. These new technologies are moreover being backed heavily in Japan, the US and in Europe by universities, research institutions and powerful industries such as defence, oil, electronics, semiconductor and motor manufacturers; industries which all are looking for new markets (Marvin and Slater 1997:307). So far, there are however only a few road pricing systems operating, while there are a number of electronic toll collection systems in use (e.g. in Norway, Italy, France, Japan to mention a few) (Hau 1998:39).

5.2.1. Objectives for road pricing

The EU transport policy goals are mainly set out by central institutions in the EU. However, Grieco and Jones (1994:1524) points out that an important aspect of the current set of road-pricing developments is their *local character.* Cities and regions of Europe have on their own initiative begun a political process of co-ordination that cuts across national boundaries. Still, such co-operation often is co-ordinated through EU technology programmes.

There are several different objectives for implementing road pricing (Hepworth and Ducatel 1992:92, Jones and Hervik 1992:138, Lewis 1996:125), for example:

- Provide a source of supplementary revenue (e.g. for infrastructure building)
- Reduce congestion
- Reduce non-essential travel demand and consequently the level of environmental pollution
- Generate higher returns on privately financed infrastructure
- Level the field between private and public transportation

The Commission refers to the aims of reducing congestion, accidents and environmental problems as reasons for implementing road pricing and make the pricing schemes more efficient (European Commission 1995b).

5.2.2. Obstacles to road pricing implementation

Road pricing is widely advocated as a measure to obtain goals as listed over. Nevertheless, despite well-grounded arguments, convincing theoretical support and the most technical and operational issues solved, road-pricing schemes are extremely uncommon. Road pricing schemes seldom come further than to the planner's desk (Langmyhr 1999:255). Though it is true to say that there has been an increasing acceptability of road pricing amongst policy-makers and transport-planners, and economists have long maintained that road pricing results in welfare to society. The public, however, have always regarded road pricing with scepticism. The acceptance of road pricing to the public is therefore viewed by many as the key factor that will determine

whether or not road-pricing schemes will proliferate across Europe (Grieco and Jones 1994:1525f, Lewis 1996:127, Hau 1998:47, Jones 1998:263).

The lack of public support is probably the greatest obstacle for implementing road pricing in the EU. To be able to utilise the potential of road pricing it is therefore important to educate and persuade the public that road pricing is necessary. The main stumbling block to public acceptance seems to be how the issue of *equity* is handled (Langmyhr 1996:1, Jones 1998:283). Considerations of road pricing and equity should deal with principles for allocating burdens and benefits. The goal must be that road users feel that they benefit from the implementation of road pricing, and that they are "compensated" for their toll payment by satisfying some commonly accepted notion of fairness (Hau 1998:47).

The Commission's Green Paper on fair and efficient pricing in transport addresses such questions. The objective of the Commission is to ensure that prices reflect costs so that businesses and citizens base their decisions on the right price signals. The principles underlying this strategy are i. a. that charges should be linked as closely as possible to the underlying costs. This will enhance both the equity and the cost-effectiveness of the system. Charges should hence be highly differentiated. Moreover, the price structure should be clear to the transport user. To impose additional charges for simple revenue raising purposes is likely to lead to distortions, according to the Commission, and these costs should rather be compared with alternative ways of raising revenues (European Commission 1995b: 39).

5.2.3. EU programmes on road pricing

Among the various transport R&D programmes carried out in the Union, a number of them are concerned with road pricing. This R&D cover different aspects of technology policy, e.g. the development of telematics and telecommunications systems architectures and technologies necessary for applying road-pricing schemes. Another issue is the need to ensure technological and administrative compatibility between member states in order to implement road pricing (Jones and Hervik 1992:143). Regulating and harmonising road pricing technology is thus of great importance. The DRIVE programmes were among the first dealing with road pricing technology. During the last decade others have been put forward:

- DRIVE 1 (1988-1991) Goal: To promote road transport efficiency, safety and environmental protection within the Community by the application of Road Transport Informatics (RTI) and telecommunications.
- DRIVE 2 (1990-1994): Goal: To contribute to the development, in the field of transport, of integrated trans-European services using advanced IT and communications to improve the performance (safety and efficiency) of passenger and goods transport services, and at the same time reduce the impact of transport on the environment.

- SAVE 1 (1991-1995) (under DG XVII) Goal: The promotion of energy efficiency in the Community. Objectives: To achieve a more rational use of energy through improved energy efficiency with a view to procuring more secure conditions of energy supply in the Community and to reducing the negative impact of energy on the environment. Energy efficiency in the transport sector (e.g. improving traffic flow in towns, toll systems, etc.).
- TELEMATICS 2C (1994-1998) (under DG XIII) A specific programme of research and technological development and demonstration in the area of telematic applications of common interest. Objectives: To develop and technically validate telematics systems and services that are interoperable throughout the European Union, satisfy user requirements and, maximise the use of generic infrastructures and equipment to them as economically viable as possible.
- PRIMA (1999-2000) Capabilities of advanced traffic management tools. PRIMA will assess the acceptance of road pricing schemes, it will evaluate different scheme designs, and it will develop guidelines for removing barriers to implementation. PRIMA follows up on the Commission's Green Paper on fair and efficient pricing and the White Paper on fair charging for infrastructure use.

5.3. Technology in transport – the future?

The brief analysis of TENs in transport and of road pricing is meant to highlight some important aspects of transport technology policies in the EU, even though their scope is different. The TENs initiative may be said to express almost the whole value system and objectives of the Union at one time by focusing on integration and cohesion and the dominant objective of economic growth. In addition, more "modern" objectives such as sustainable mobility and enhanced environmental concerns through the use of technology are also present. The TENs initiative furthermore illustrates in an explicit way that infrastructural issues are central to EU technology policy. Today the TENs are in construction phase, but yet not completed.

The objectives of road pricing are somewhat more limited, but road pricing are by many considered "the future" in an attempt to achieve a sustainable transport system. However, in contrast to TENs, road-pricing schemes have yet not been implemented in the EU, much due to the lack of public acceptance. The Commission is now nevertheless eager to use road pricing, but they maintain that implementing road pricing is to be seen as a complement to regulatory policies, not a substitute. Further use of public transport is among other alternative means to curb transport problems. The Commission's view is that they want a sound re-balancing rather than a revolution in transport policy (European Commission 1995:2). Irrespective of which transport policies adopted in the following years, technology will without doubt play a major role.

6. Summary and conclusions

In this paper, we have been investigating EU technology policy. Our point of departure was an assumption that the EU conducts a limited technology policy, where the emphasis is strictly on regulation. Through this exploration of EU technology policy, and more specifically transport policy, we have learnt otherwise. Today the EU has a fully-fledged technology policy, promoting innovation, making regulations and building infrastructure.

Promoting innovation is of great significance in the EU. This is much due to the Union's strive for economic competitiveness, but lately also objectives such as environmental protection and better quality of life for the citizens has been put forward. A variety of measures are used in the innovation policy. Different financial means and stimulating R&D are among them, of which R&D has been in our focus. There exist an enormous amount of technology R&D programmes in the EU. Some of the programmes are of a pre-competitive and generic nature, while others are more market-oriented.

Making regulations has been a core task in the EU since its founding – and it still is. The looming idea of a common and integrated Europe requires by nature regulation and harmonisation. In the transport sector regulations take forms like harmonising telematics to be used in transport, specifying environmental reduction targets from vehicles and standardising railway lines, etc.

Infra-structural issues came to the fore in the 1980ies in the EU. The increased interest in developing and expanding the infrastructure has manifested itself in the construction of the Trans European Networks, which cover transport, energy and telecommunications. The objectives for TENs are several, but a better-integrated Union is at the forefront, which give the TENs much of the same function as regulation is holding. However, since the TENs also have additional objectives it thus represents a more complex policy than regulation alone does.

In our opinion the EU has developed a technology policy that today has a quite clear logic and architecture, related to the basic political and economical aims of the union related to harmonisation and efficiency. It is a technology policy where the three elements of innovation, regulation and infrastructure are clearly present. However, we may observe that the supra-national decision-making needed may make it more difficult to integrate social concerns and technological opportunities. Thus, there is a distinct technocratic touch to the technology policy of the Union.

7. References

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