iTREN-2030

Integrated transport and energy baseline until 2030

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iTREN-2030

Integrated transport and energy baseline until 2030

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List of Abbreviations

ASTRA	Assessment of Transport Strategies, iTREN-2030 model
CCS	Carbon Capture and Sequestration
CNG	Compressed Natural Gas
CO_2	Carbon dioxide
EC	European Commission
ETS	Emission Trading System, Emission trading scheme
EU	European Union
EU12	Member states that joined the European Union after 2003
EU15	Member states that joined the European Union before 2004
EU27	All member states of the European Union as of today (2008)
EU27+2	EU27 countries plus Norway and Switzerland
EU-ETS	European Emission Trading System
FFV	Flexi-fuel vehicle that may consume bio-ethanol and gasoline
GDP	Gross domestic product
GHG	Greenhouse gases
HDV, HGV, HDT	Heavy Goods Vehicle (>3.5 ton gross vehicle weight)
IEA	International Energy Agency
INT	Integrated Scenario of iTREN-2030
IPCC	Intergovernmental Panel on Climate Change
LDV, LDT	Light Duty Vehicles (<3.5 ton gross vehicle weight)
LPG	Liquefied Petroleum Gas
Mt, Mt CO_2	Mega-tons, million tons of CO_2 emissions
Mtoe, mtoe	Million ton of oil equivalent – energy unit
Pass-km, pkm	Passenger-kilometre, 1 person transported over 1 km distance = 1 pkm
POLES	Prospective Outlook on Long term Energy Systems, iTREN-2030 model
REF	Reference Scenario of iTREN-2030
TEN-T	Transport projects belonging to the Trans European Transport Network
Tonnes-km, tkm	Tonnes-kilometre, 1 ton transported over 1 km distance = 1 tkm
TRANSTOOLS, TTv1	TOOLS for TRansport Forecasting ANd Scenario testing, iTREN-2030 model
TREMOVE	Vehicle fleet and emission model, iTREN-2030 model
Veh-km, vkm	Vehicle-kilometre, 1 vehicle that drives a distance of 1 km = 1 vkm
WEO	World Energy Outlook, series of reports from IEA
WTW	Well-to-wheel

Executive Summary

iTREN-2030 - Integrated TRansport and ENergy baseline until 2030 – is a research project conducted on behalf of the European Commission (EC) DG TREN funded by the EC 6th Research Framework Programme. The objective of iTREN-2030 is to design a powerful toolbox for European transport policy-making by creating an integrated model system of transport, economics, energy and the environment.

During the 1990s the transport policy focus was laid on issues like facilitating intermodal transport, achieving modal shift, implementing the Trans-European Transport Networks (TEN-T), introducing transport pricing and reducing environmental impacts of transport. In particular, the sharp oil price jumps brought further priority issues onto the agenda of transport policy-making:

- the security of energy supply for the mobility of goods and services;
- the transition from a purely fossil-fuel-based transport system to a transport system based on a diversity of fuels.

This implies that the energy and transport systems are becoming more closely interlinked and the newly emerging policy issues require a substantial extension of the available toolbox, which is used in Europe for scenario analysis and transport policy assessment. In particular, this is necessary in order to register the implications of alternative technologies and new energy carriers entering the transport markets and affecting the energy system, the transport system and the economic system. iTREN-2030 is contributing to the extension of the European policy assessment toolbox by providing improved tools as well as a consistent energy and transport baseline scenario for the EU until 2030, which is called the Integrated Scenario.

Methodology and further use

iTREN-2030 applied a methodology to create consistent scenarios for the energy and transport systems until 2030, which combines developing an integrated model system with an intensive stakeholder approach to construct policy scenarios and validate the intermediate findings of these scenario results obtained via the model system. This methodology has proved particularly useful in developing consistent scenarios for the integrated energy and transport field, but it seems that as far as the analysis of single policies is concerned, a subset of the model system is usually sufficient to carry out policy assessment.

In order to create the new assessment toolbox, the following four models - each with a specific focus of application - are linked with each other.

- TRANSTOOLS: the multi-modal tool for transport network analysis for the EU, with links to global transport flows.
- POLES: a multi-sectoral world energy system model integrating energy supply and demand and estimating energy prices.
- TREMOVE: an environmental and vehicle fleet model calculating emissions, fuel consumption and accidents from transport.
- ASTRA: a strategic transport-economy-environment assessment model which provides an economic baseline and estimates the economic impacts of policies, as well as incorporating transport demand and vehicle fleet projections.

The steps by which iTREN-2030 developed its activities included (1) implementation of a model-based Reference Scenario in a consistent manner and as a methodological step to link the four models, (2) communication with and consideration of comments of stakeholders concerning their user needs and their expectations of a scenario to 2030, and (3) development of transport policy packages that would constitute an Integrated Scenario for energy and transport, taking into account the requirements emerging from climate policy and the growing scarcity of fossil energy resources.

The methodological step that posed the biggest challenge, and to which the project contributed significantly, is the integration of models from different fields related to the energy and transport system. The challenge consists in making the models sufficiently consistent so that they can be used to quantify an energy-transport-environment-economy scenario in which the different scenario indicators are provided by different models, but together form a coherent scenario. iTREN-2030 succeeded in this attempt, but it must be noted that the consistency could still be improved, although in most cases this would require model modification to adapt structures, which can become a resource-consuming task.

We conclude that the iTREN-2030 approach to apply such a model suite consisting of ASTRA, POLES, TREMOVE and TRANSTOOLS is particularly useful to generate baseline or reference scenarios, as in such cases the models cross-validate each other. When supported by a sound stakeholder process it can also be guaranteed that such a validation process improves the results, if the stakeholder inputs do not become the dominant force shaping them.

The linkages between the models of the model system were implemented by soft links, i.e. they require the manual exchange of files and individual input-output procedures for each model. This approach can be improved by using semi-automated linkages as developed in the European ADAM project [SCHADE/JOCHEM ET AL. 2009]. In ADAM a web-based application was developed that collected the outputs from all models, stored them in a database, provided the conversion of numbers (e.g. for differing units of measurements, auxiliary variables) and supplied each model with the inputs in their particular formats. This replaces the bilateral linkages between models by a central operating system that reduces the number of interactions and accelerates the process of consistency building and scenario construction of a linked model system.

However, sophisticated interaction and feedbacks between models, even using such a system, require short response times of involved models as well as a limitation of size and number of variables to be transferred. In the iTREN-2030 model suite this is not given for the TRANSTOOLS and TREMOVE models in particular, as both have longer response times and the amount of exchanged data from TRANSTOOLS to TREMOVE can hardly be stored within an MS Access database. Therefore it is proposed that leaner and/or faster versions of both models should be developed to be more easily integrated into a model system with energy and economic models like POLES and ASTRA. For TREMOVE this has already been initiated, with its conversion into a system dynamics model (like ASTRA, POLES), while for TRANSTOOLS the discussion is concentrated on developing a strategic and thus leaner version of the model.

The further use of the model system can be recommended for both approaches, though significantly longer time resources will be needed in the case of keeping the soft links and maintaining modelling approaches. In fact, having applied two different approaches for the Reference Scenario (including TRANSTOOLS) and the Integrated Scenario (excluding TRANSTOOLS), the iTREN-2030 project has developed a scenario approach with detailed network analysis capabilities as well as a strategic integrated energy and transport assessment approach without network analysis capability.

Scenario conclusions

The iTREN-2030 project developed two scenarios: a Reference Scenario (REF) that describes a world in which current trends are continuing and policies are frozen in 2008, and an Integrated Scenario (INT) that is driven by changing framework conditions, a few breaks-in-trend as well as by energy and transport policies until 2030. The Reference Scenario constituted a methodological step to link and harmonize four models, while the Integrated Scenario applied the model suite to create a scenario that includes relevant and likely energy and transport policies.

Both scenarios are supplied with very detailed quantified indicators by Member State and EU region for energy, transport, vehicle fleets, environment and economic development until 2030. The quantified indicators are provided as an annex to the respective deliverables.

While the Reference Scenario neglected the financial and economic crisis of 2008/2009, the iTREN-2030 Integrated Scenario described a world shaped by the economic crisis, but which is also gradually recovering from it. Transport policy is leaving its traditional paths and instead is being driven by newly emerging issues, i.e. climate policy and growing GHG mitigation requirements for the transport sector, demand- and supply-driven fossil fuel scarcity and new propulsion technologies, leading to the application of a diversity of fuels and engine technologies in the transport sector. However, behavioural change in the scenario remains limited to adopting new engine technologies, without changing urban settlement structures, travelling behaviour or mobility concepts.

The result of such a scenario is an increase of transport activity until 2030 compared with 2005, for passenger transport by +17% and for freight transport by +41%, while for the Reference Scenario the growth in this period was +21% and +48%. Despite this growth in transport, the energy demand of transport in the EU27 is slightly reduced, by -2% in the Integrated Scenario. Consequently, the greenhouse gas emissions of transport also decline, achieving a reduction of -7% until 2020 and of -12% by 2030 compared with 2005. In the Reference Scenario, a continuous growth of +17% of these emissions was estimated. However, the objective of reducing these emissions from transport by -10% by 2020 has failed, even though the economic crisis contributed towards reducing energy and transport demand growth. Even more important is that stronger policies will have to be implemented for the period after 2020 so that transport contributes to the -80% GHG target of the EU until 2050. This target would require transport GHG reductions until 2030 of about -30%, as other studies indicate.

The aggregate target of a -20% reduction of total GHG emissions by 2020 in the EU27 is achieved in the Integrated Scenario. The main elements of this success are increased energy efficiency and increased use of renewable energy, that are supported by GHG emission reductions as a result of the economic crisis. This means that sectors other than transport have done their homework; this holds for the energy conversion sector in particular.

An important break-in-trend is also observed for final energy demand that reverts from the ever increasing path of the past to a stagnating path over the next two decades in the Integrated Scenario. Together with the decarbonization of energy production, this causes the decrease of GHG emissions in the EU27.

Policy conclusions

The pricing policies implemented by iTREN-2030 fall short of what could be achieved with transport pricing, due to the low levels of charges. This also holds for the impacts of the EU-ETS, which requires a more ambitious cap to increase CO_2 certificate prices above the 28 $€_{2005}/tCO_2$ that was estimated for 2030. In both cases, if implemented, the policies could contribute to greater reductions in transport GHG emissions, and depending on the mode of implementation, enable co-benefits like improved traffic flows.

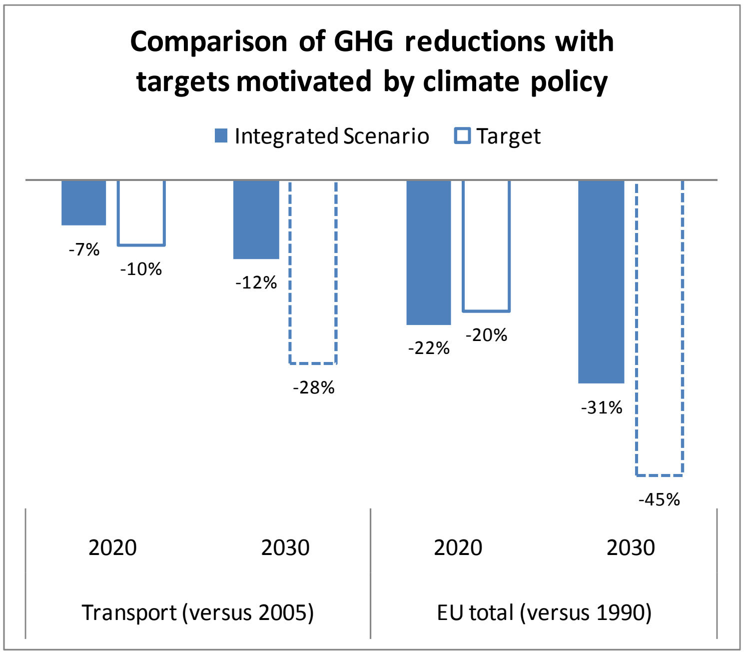
In general, and with the particular settings of the Integrated Scenario, the binding regulation for CO_2 limits of cars and light duty trucks is the most effective measure to reduce transport CO_2 emissions. It is important to consider an extension of this policy after 2020 and to reduce the CO_2 emission limits further. In doing so, it must be taken into account that vehicle manufacturers require a lead time of 5 to 7 years to organize their vehicle concepts accordingly, which means that such limits for the period after 2020 should be defined and implemented into legislation by 2015 at the latest. Also, the manufacturers benefit from such a policy, as it provides them with planning certainty in an uncertain world with a diversity of fuels and engine technologies available that can potentially gain market shares in the next decades.

The requirement to support R&D and market introduction of alternative engine technologies is related to this. In particular, this holds for battery electric vehicles, advanced battery systems for transport applications and hydrogen fuel cell systems, including hydrogen storage. This will enable Europe to develop its required portfolio of alternative engine technologies, but efficiency improvements of conventional fossil engines must not on any account be neglected. However, such technologies are already mature and should be fostered by the enforced CO_2 emissions limits.

An issue that was not implemented in the Integrated Scenario but is of high importance for policy-making concerns the future change in urban mobility. It can be expected that the new electric vehicles, together with the extension of environmental zones in cities and the changing mobility behaviour of future young generations will prepare the grounds for genuine passenger multi-modality, involving the massive use of car-sharing and bike-sharing in seamless connection with public transport in urban areas. Policy-making can support this process by removing barriers for car- and bike-sharing and by supporting IT technologies to connect these modes and standardize the systems so that they become interoperable between cities, as well as between EU countries.

Policy targets for GHG emissions of the EU27 are shown in Figure 1. Until 2020 total EU GHG emissions should be reduced by -20% compared with the base year 1990. For transport, GHG emissions should be reduced by -10% compared with 2005, assuming that transport should contribute a share of reductions equal to the other non-ETS sectors. In the Integrated Scenario, the total GHG emission reduction for 2020 amounts to -22%, i.e. an over-fulfilment of 2%, which could be assigned to the economic downturn of 2008/2009. However, transport only achieves -7% instead of -10%.

For 2030 the objective of limiting the global temperature increase to 2° Celsius until 2100 has to be considered, in order to derive a benchmark for 2030. Such a benchmark can be taken from the European ADAM project, that developed a so-called 2-degree scenario that puts Europe onto a pathway towards -80% reduction of GHG emissions until 2050 [SCHADE/JOCHEM ET AL. 2009]. The benchmark of this pathway for 2030 would then be a reduction of -45% for the EU total GHG emissions and a reduction of -28% for the transport sector. These benchmarks are indicated by dashed rectangles in Figure 1. Obviously the Integrated Scenario falls short of achieving these benchmarks. This reflects that major policies of the Integrated Scenario are only focused on 2020 (e.g. CO_2 emission limits for cars and LDVs, CO_2 emissions cap), but require to be toughened after 2020 to generate the required GHG reductions.



Source: iTREN-2030

Figure 1: Reductions of CO_2 emissions compared with policy targets

The final conclusion is thus: politics will be of utmost importance in the next years. It must implement both a framework that stabilizes the economic and financial system, as well as energy and, in particular, transport policies that support climate policy effectively towards and after 2020.

1 Introduction

iTREN-2030 - Integrated transport and energy baseline until 2030 – is a research project on behalf of EC DG TREN co-funded by the European Commission (EC) 6th Research Framework Programme.

During the 1990s the transport policy focus was laid on issues like facilitating intermodal transport, achieving modal shift, implementing the Trans-European Transport Networks (TEN-T), introducing transport pricing and reducing environmental impacts of transport. In particular, the sharp oil price jumps brought further priority issues onto the agenda of transport policy making:

- the security of energy supply for the mobility of goods and services;
- the transition from a purely fossil-fuel-based transport system to a transport system based on a diversity of fuels.

These newly emerging policy issues require a substantial extension of the available toolbox, which is used in Europe for scenario analysis and transport policy assessment. In particular, this is necessary in order to register the implications of alternative technologies and new energy carriers entering the transport markets and affecting the energy system, the transport system and the economic system. iTREN-2030 contributes to the extension of the European policy assessment toolbox by providing improved tools as well as consistent energy and transport scenarios for the EU until 2030.

The objective of iTREN-2030 is to design a powerful toolbox for European transport policy-making by creating an interface for transport, economics, energy and environment. To this end, it was planned that iTREN-2030 should develop a European model system, integrating four existing models and making them consistent, to enable coherent scenario and policy analysis. The capability to complement each other, and the synergies between the models, would then benefit interdisciplinary transport policy-making at a European level. For this purpose, the following four models - each with a specific focus of application - are linked with each other.

- TRANSTOOLS: the multi-modal tool for transport network analysis for the EU, with links to global transport flows.
- POLES: a multi-sectoral world energy system model integrating energy supply and demand and estimating energy prices.
- TREMOVE: an environmental and vehicle fleet model calculating emissions, fuel consumption and accidents from transport.
- ASTRA: a strategic transport-economy-environment assessment model which provides an economic baseline and estimates the economic impacts of policies, as well as incorporating transport demand and vehicle fleet projections.

The steps through which iTREN-2030 developed its activities included (1) implementation of a model-based Reference Scenario in a consistent manner and as a methodological step to link the four models; (2) communication with and consideration of comments of stakeholders concerning their user needs and their expectations of a scenario to 2030; and (3) development of transport policy packages that would constitute an Integrated Scenario for energy and transport, taking into account the requirements emerging from climate policy and the growing scarcity of fossil energy resources.

Before iTREN-2030, the four models applied had already been used to develop scenarios for different time horizons, i.e. some to 2020 and others as far as 2050. The added-value of iTREN-2030 is the enrichment of these scenario projections by testing the individual forecasts against the other models and by learning from each other, adapting the four models to come to a joint and better founded scenario until 2030. In iTREN-2030 two such scenarios have been developed:

- A **Reference Scenario (REF)** that describes a world in which current trends continue and policies are frozen in 2008. The REF was described in iTREN-2030 deliverable D4 [FIORELLO ET AL. 2009].
- An **Integrated Scenario (INT)** that is driven by changing framework conditions, a few breaks-in-trend as well as by energy and transport policies until 2030. The INT is explained in deliverable D5 [SCHADE ET AL. 2010].

Both scenarios are supplied with very detailed quantified indicators by Member State and EU regions for energy, transport, vehicle fleets, environment and economic development until 2030. The scenario quantifications are provided as an annex to the respective deliverables.

The development of the scenarios benefited from informative inputs from the stakeholders obtained during a series of four workshops that were organized at appropriate stages of the project. Stakeholders' suggestions included the request for transparency of key assumptions, the strong suggestion to include the economic crisis in scenario development, as well as the clear expectation that within the given time horizon of 2030 we will have to face significant breaks in trends within the energy and transport systems.

For the **Reference Scenario**, the three other modelling tools are harmonized with TRANSTOOLS and made consistent with each other. This results in a coherent scenario for Europe until 2030 for technology, transport, energy, environment and economic development that can be compared with results of previous studies. So the Reference Scenario has to be seen as a methodological step of iTREN-2030. The basic concept of the Reference Scenario is **Frozen Policy 2008**, i.e. the scenario considers only policies that were decided by the EU Council and/or EU parliament by mid 2008. After 2008 the policies are frozen, i.e. remain as they were decided and implemented and no further new policies are applied. This excludes the ambitious climate, energy and transport policies decided or proposed in 2008/2009, as well as any other policies that would be developed under a new international climate policy agreement until 2030. The economic and financial crisis of the years 2008/2009 is excluded from the Reference Scenario as well.

The setting of the **Integrated Scenario** brings us into a completely **different world**. This scenario includes (i) the economic and financial crisis of 2008/2009 as well as the economic recovery programmes implemented by the EU and the Member States and (ii) ambitious climate, energy and transport policies that are implemented between 2009 and 2025. These policies include pricing measures, regulation, technology support and diffusion measures, as well as information measures and behavioural adaptations. The impacts of the crisis compared with the Reference Scenario can be observed over the full scenario period until 2030, and its socio-economic effects are more substantial than the impact of the policies. Thus, though the Integrated Scenario builds on the Reference Scenario, the comparability between the two scenarios is limited. At least we must caution against assigning the full differences between the scenarios to the impacts of the policies. For instance, when observing the impacts on energy and environmental indicators, the impacts of policies are stronger than the impacts of the economic and financial crisis.

Likely policies were proposed in the iTREN-2030 project in order to develop the Integrated Scenario. In discussions with stakeholders at workshops as well as by considering ongoing policy processes, the proposed policies were reviewed and adapted to be finally implemented in the Integrated Scenario. Further selected policies were grouped to form policy packages that are analyzed in different set-ups of the iTREN-2030 modelling suite to demonstrate both the integrated assessment capability of the full suite as well as of its partial application. The final outcome of iTREN-2030 consists of a coherent modelling suite that reflects the narrative storyline describing the Integrated Scenario and that provides a comprehensive set of very detailed quantified indicators from energy, transport, environment and economic fields by Member State and EU regions.

This deliverable D6 summarizes the iTREN-2030 project approach and the project findings in the following sequence of sections. After this introduction, the methodology to create and apply the modelling suite is explained. This is followed by the description of the Reference Scenario and the Integrated Scenario. Then applicable assessment approaches and the stakeholder process are described and finally, conclusions of the iTREN-2030 project are presented.

2 Methodology

This section describes the approach of the iTREN-2030 project, i.e. the steps that the project has taken to produce results. This is followed by a summary of major updates of the models and by the approach chosen to create a coherent model system from the four models.

2.1 Approach

The approach of iTREN-2030 consisted originally of four major steps (user needs analysis, model update, model integration to prepare baseline scenario, comparison with previous studies). During the course of the iTREN-2030 project, the approach was refined and improved, driven by the requirements of the stakeholders and the client as well as by developments of the TRANSTOOLS model occurring outside the framework of the project. The refined approach then comprised the following eight steps.

1. To analyse and agree on the user needs of an EU energy-transport modelling suite.
2. To update the models involved, in particular TRANSTOOLS and TREMOVE.
3. To (re-)define the structure and purpose of the scenarios:
   - Reference Scenario (REF): is a methodological step to harmonize models, with frozen policy.
   - Integrated Scenario (INT): is the final result including trend-breaks and the economic crisis.
4. To discuss and agree on energy and transport policies which are both relevant and likely to be implemented until 2030.
5. To implement the Reference Scenario in all four models of iTREN-2030, making them coherent.
6. To consider and implement the impact of economic crisis and economic recovery programmes in three models of iTREN-2030 (i.e. ASTRA, POLES, TREMOVE).
7. To implement the Integrated Scenario in the three models by including the relevant and likely policies decided on in the models.
8. To describe and assess the impacts of the policies / policy packages.

The two core elements of the iTREN-2030 methodology are the integrated application of models and the involvement of stakeholders. The latter is explained in section 6. The application of models starts with an analysis of user needs as part of the stakeholder process and continues with the update, improvement, integration and application of the four models, TRANSTOOLS, TREMOVE, POLES and ASTRA. An overview of the characteristics of the models is presented in Table 1. This comparison shows that spatial coverage and time horizon are similar across the models. For TRANSTOOLS and TREMOVE the year 2030 is indicated in brackets, as this time horizon prior to iTREN-2030 reached only to 2020 and 2030 was only achieved during the iTREN-2030 project activities. However, the models are implemented using different modelling approaches, i.e. equilibrium modelling, optimization and simulation. The modelling approach is not decisive for the integration of the models, whereas the space and time dimensions need to be consistent, and the purpose of each model should be clearly defined and distinct. Despite several overlaps in the model purposes, the models complement each other.

Table 1: Overview of the characteristics of the four iTREN-2030 models

Model	**Purpose**	**Approach**	**Type / Scope**	**Coverage**	**Time**
TRANSTOOLS	Detailed network-based analysis of transport. Corridor analysis.	Stochastic equilibrium	Transport bottom-up	EU31	Static, 2005, 2010, 2020, (2030)
TREMOVE	Transport trend as input and vehicle fleets, energy and emissions as output.	Optimization	Strategic, Fleet bottom-up	EU31	Dynamic, 1995 to 2020 (2030)
POLES	Supply and demand of world energy system. Global energy emissions.	Simulation	Strategic, Energy bottom-up	Global, EU27	Dynamic, 2000 to 2030
ASTRA	Integrated assessment of economy, trade, transport, fleets, energy and emissions.	Simulation	Strategic, Integrated	EU27+2	Dynamic, 1990 to 2030

Source: iTREN-2030

For more details of the models, we suggest referring to Deliverables D4 and D5 or the model summaries provided at the iTREN-2030 website (http://isi.fraunhofer.de/isi-de/projects/itren-2030/structure/models.php).

Finally, the results of the models are aggregated into an indicator template that covers indicators of energy, transport, vehicle fleets, environment and economy for each Member State as well as for EU groupings of countries, i.e. EU27, EU15, and EU12. The values for the indicators are taken from those models that are agreed to be most appropriate for this estimation of a specific indicator. The filled in indicator templates are provided for the Reference Scenario as an Annex to Deliverable D4 [Fiorello et al. 2009] and for the Integrated Scenario as an Annex to Deliverable D5 [Schade et al. 2010].

2.2 Model updates

The two models for which major model updates were conceived in the iTREN-2030 work plan were TRANSTOOLS and TREMOVE. It was intended that iTREN-2030 would take over the development of TRANSTOOLS Version 1 (TTv1) and extend it to produce a forecast for 2030 with suitable interfaces to allow the assumptions of the iTREN-2030 models to be harmonized. It was also intended that the geographical scope of the model would be extended to 29 countries.

In practice, responsibility for developing TRANSTOOLS was passed to the TEN-CONNECT consortium, resulting in a TRANSTOOLS Version 2 (TTv2) which the iT-REN-2030 consortium was not authorized to modify until the TEN-CONNECT results were fully evaluated. This required an updating of the iTREN-2030 work programme due to (1) incompatibility with the timing of iTREN-2030 and (2) incompatibility with improvements developed by iTREN-2030 itself.

From this position, the updated work programme of iTREN-2030 was guided along three paths:

- First, the original improvements for TRANSTOOLS in terms of extending its forecasting ability and geographical scope were completed, by the consortium.
- Second, the partly complementary and partly overlapping TEN-CONNECT modifications were assessed, and the forecasts of this study were evaluated within iTREN-2030.
- Third, by comparing the results of the two strands of work, it was possible to review the validity of the TEN-CONNECT forecasts, and to make recommendations for further development within TRANSTOOLS.

Since the TEN-CONNECT project did not document the new model version and source code is not included within their deliverables, it is not possible to attempt to integrate TRANSTOOLS as planned. TEN-CONNECT forecasts can be used as inputs for other models, but it is not possible to attach new inputs or new responses to TRANSTOOLS. Therefore it was decided that TRANSTOOLS should only be included in the attempt to make the models consistent and create the Reference Scenario, but had to be excluded from the Integrated Scenario, which intended to implement trend-breaks that must also show up in revised TRANSTOOLS results. The model improvements carried out within iTREN-2030 nevertheless remain and can potentially become part of an improved TRANSTOOLS version 3 to be incorporated later in the iTREN-2030 model suite.

TREMOVE, the second model that required major updates, could be improved as originally planned. The improvements concerned the

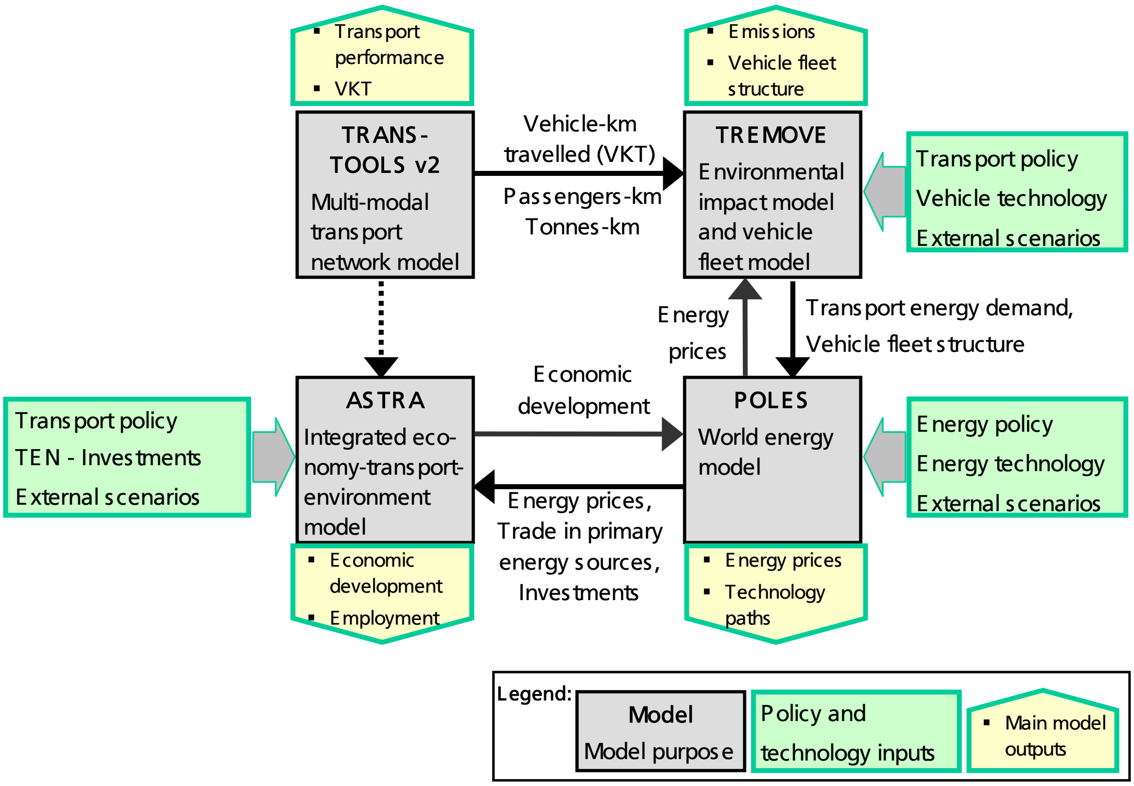
- extension of the time horizon of the model from 2020 to 2030;
- extending the model from the coverage of 21 countries to 31 countries;
- restructuring the model to enable data exchange with TRANSTOOLS, POLES and ASTRA models.

These model updates led to a TREMOVE Version 3.0 model that could technically be integrated into a model suite that simulates scenarios and policies until 2030 and for the EU27 countries. The results of the update were documented in Deliverable D2 [NEWTON ET AL. 2009]. However, TREMOVE was subject to three updates in the project: first, the above update for spatial coverage and time horizon, second the update to become consistent with the Reference Scenario (e.g. incorporating a revised GDP trend and other transport demand), and third, the update to include the economic crisis and the policies as part of the Integrated Scenario.

As part of the stakeholder process it also became obvious that the iTREN-2030 Integrated Scenario must include the economic and financial crisis of 2008/2009. This required model updates of the ASTRA model as the tool that generated the economic indicators within the model suite. ASTRA was improved to reflect the activators of the crisis to project an economic scenario from 2009 onwards, including both the crisis and the economic recovery programmes of the EU and the Member States implemented in the years 2009 to 2012.

2.3 Model integration

The concept of integration in iTREN-2030 is developed in terms of linkages between the four modelling tools: TRANSTOOLS, ASTRA, POLES and TREMOVE. Figure 2 shows the linkages implemented between the four models for the Reference Scenario. With respect to the data flows, the role of the TRANSTOOLS model was reduced compared with the original work plan. Now, TRANSTOOLS only acts as a data provider of transport demand projections developed in the TEN-Connect project, but not as a receiver of input data from the other three models. The dotted line linking TRANSTOOLS to ASTRA indicates that demand data is not actually transferred from the former to the latter, rather, ASTRA transport demand projections have been re-calibrated to be harmonized with TRANSTOOLS forecasts. However, the other linkages between the models were activated as planned.



Source: iTREN-2030

Figure 2: Models linkages activated between the iTREN-2030 models

Although some linkages could not be achieved, the iTREN-2030 methodology is still based on the integration of analysis domains and tools for energy, transport and technology. Integration is put in practice in two ways: **data exchange** and **data harmonization** across models.

Data exchange means that one model uses the output of another model as its input. In this way, the perfect consistency between the tools is guaranteed. Examples of exchanged data between models are

- GDP growth rates for the period 2005-2030 are estimated in ASTRA and sent to POLES and TREMOVE;
- Pure fuel prices for the period 2005-2030 are estimated in POLES and sent to ASTRA and TREMOVE.

Data harmonization means that each model uses its own parameters and these are recalibrated in order to produce common modelling results in line with the other models.

For instance, both ASTRA and TREMOVE estimate vehicle fleet development, the target of the harmonization work is that the estimations of the two models are in line.

Data harmonization is used instead of data exchange for complex variables that are key results of different models and therefore cannot be merely replaced by external data. But data harmonization will never deliver the exact consistency achieved by data exchange.

Model results to be harmonized are produced by more models, since each tool has a specialization in a given domain of analysis, the “leader model” for each element is generally defined and harmonization means that the other tools adapt to the leader. Vehicle fleet is an exception, because ASTRA and TREMOVE are at the same level of leadership due to their complementarity: TREMOVE is the reference model for vehicle fleet, but ASTRA includes new technologies which are not available in TREMOVE. Thus, the reference fleet development with which both models have been harmonized is different from the original results of both ASTRA and TREMOVE. The following elements have been harmonized:

- Transport demand growth rates by mode of transport between TRANSTOOLS (leader model), ASTRA and POLES;
- Energy consumption between POLES (leader model), ASTRA and TREMOVE;
- CO_2 emissions between TREMOVE (leader model), ASTRA and POLES;
- Vehicle fleet between ASTRA and TREMOVE.

Additionally, the fuel taxes trend has been harmonized in POLES and TREMOVE according to assumptions applied in TRANSTOOLS (in the TEN-Connect project), given that TRANSTOOLS could not have been adapted to POLES. Namely, TRANSTOOLS, as used in TEN-CONNECT runs, assumes stable fuel taxes for both gasoline and diesel from 2005 to 2030 and this assumption has been included in the other models.

In conclusion, the assumptions behind TRANSTOOLS results are sometimes slightly dissimilar to those adopted in iTREN-2030 for the other models. The two main differences concern fuel prices and GDP growth until 2020. In both cases, TRANSTOOLS is more optimistic. However, such differences do not affect the Reference Scenario, but only the elasticities that can be derived from looking at the pure TRANSTOOLS model compared with looking at the TRANSTOOLS model in the context of the iTREN-2030 model suite. TRANSTOOLS transport demand trends are now combined with lower GDP growth, indicating a slightly higher elasticity to GDP growth. Further, given the small size of differences, it is expected that the impact on models' responsiveness when alternative scenarios are modelled remains negligible.

3 Reference Scenario

The iTREN-2030 Reference Scenario should not be regarded as a forecast of the most likely future until 2030. It is a set of projections under given, reasonable assumptions concerning both the socio-economic environment and a kind of frozen policy environment. From this point of view, only policies approved by mid 2008 are included in the Reference Scenario.

The iTREN-2030 Reference Scenario does not assume relevant shocks in the exogenous elements. In particular, the global economic crisis that started in 2008 is not reflected in the modelling estimations. Nevertheless, the economic forecast applied in iTREN-2030 was already moderate and at the lower end of available projections.

The storyline of the Reference Scenario is one of an overall stagnant population combined with the ageing of this population, i.e. with a strongly growing share of population of 65 years of age and older. Economic development still sees an increase of income expressed as moderately growing GDP, though the average growth rate is expected to be lower than in the past two decades. Oil prices continue to grow moderately. In the transport sector the opportunities of introducing and harmonizing pricing and taxation are not taken by most Member States, preserving the scattered and unbalanced level of charges and taxes across countries and modes. The TEN-T networks are slowly being implemented. Advanced regulation e.g. driven by ambitious climate policy or energy security issues is not implemented, so that R&D and innovation efforts are not stimulated by adequate regulation.

3.1 Policies

The Reference Scenario only includes policies approved by mid 2008. The policies can be briefly summarized as follows: in terms of pricing and taxation, the scattered and unbalanced level of charges and taxes across countries and modes remain. The opportunities for harmonization provided by several EC directives are not taken by most Member States. The TEN-T networks are slowly being implemented following the TEN-Connect project framework [RICH ET AL. 2009]. No acceleration of implementation is expected. Climate gas emission trading is not extended to transport sectors and for others remains at the level of the emission cap of the Kyoto Protocol. Regulation in road emission standards is not transferred to other modes, in particular to rail and air. Although the development of LPG and CNG vehicles and fuel supply will increase, new vehicle concepts will not enter the market, by and large. Table 2 below summarizes the policy measures included in the Reference Scenario.

Table 2: Policy measures considered in the iTREN-2030 Reference Scenario

	Road	Rail	Aviation	Shipping
Transport pricing and taxation	Distance-based interurban charges for HGVs	-	-	-
Transport Investment	TEN network as implemented in TEN-Connect project [RICH ET AL. 2009]			
Energy	CO_2 emission targets agreed by Kyoto Protocol and implemented in national allocation plans (NAP I + II). Existing national regulations e.g. phasing-out of nuclear energy for some countries and quotas for renewables incl. biofuels. Share of renewable energy in the electricity production. Energy efficiency improvements, reduction of final energy consumption e.g. in buildings.			
Environment, Fleet	Voluntary CO_2 reduction target for cars LPG / CNG / E85 adaptation and infrastructure Euro-V for HGVs / Euro-VI for cars	Emission standards for diesel trains (UIC Stage IIIA)	ICAO Chapters 3 (emissions) and 4 (noise)	-

Source: iTREN-2030

3.2 Transport-energy-environment-economic trends

Population projections are based on UN population projections to 2050 that are incorporated in the ASTRA model. Population is essentially projected to be stagnant in the EU up to 2030, with only a very small net growth. While low birth rates in the EU15 may be compensated by immigration, part of this immigration may come from the EU12 countries. Together with a decreasing birth rate and rapidly increasing prosperity, this is projected to lead to a decline in population in the EU12.

While the economy of the EU27 is expected to grow on average at 1.6% per year until 2030 (but with a decreasing level of employment), and transport to increase at a slightly lower rate, final energy demand is expected to grow less than 1% per year. This means that the EU27 should become slightly more energy-efficient with the contribution of all aggregate sectors (industry, transport, residential and services). Higher costs for energy should provide an incentive for the efficiency gains and also for some penetration of renewable sources, which are forecast to satisfy 16% of demand (26% of electricity production).

The iTREN-2030 Reference Scenario shows that transport demand will increase until 2030, especially freight demand, which is projected to be 50% higher in the year 2030 than in 2005, while passenger demand should grow more slowly. Therefore, for the EU27 as a whole, some relative decoupling between economic growth and transport demand is expected, only for passengers but not for freight. Freight demand should increase especially in the EU12 countries, driven by the stronger economic growth. Actually, freight transport performance is expected to grow even faster than GDP because of the increment of average distances. Instead, both passenger and freight growth rates are below GDP in the EU15.

In the transport sector, the penetration of renewable sources is reflected in innovative technologies entering the car fleet, even though the share is small: 8 millions cars - mainly bio-ethanol and hybrid cars - equivalent to 2.5% of the whole fleet in the year 2030. Energy efficiency and renewable sources (bio-fuels) in the transport sector will not be sufficient to stop the growth of CO_2 emissions, which are expected to be 17% over the level of the year 2005. However, polluting emissions should substantially decrease.

Nevertheless, with given conditions for bio-fuels, their share is expected to increase. We estimate that in 2010 the bio-fuels share in the EU27 will be around 3.4%, falling short of the 5.75% target of the Bio-fuels Directive. Nevertheless, in such a Reference Scenario we would already expect bio-fuels consumption to increase to 6.6% in 2020 and to almost 10% in 2030. The increase of bio-fuels consumption is driven by the high oil prices and by a decrease in the production cost of bio-fuels, whose price is however ultimately forecast to increase under demand pressure.

The increase of total final energy demand is assumed to continue, but at a slower pace than in the past. For the residential and service (including agricultural) sectors, we foresee a growth around +13% between 2005 and 2030, taking the implemented policies to improve energy efficiency into consideration. The increase in the industrial sector might be somewhat higher at +21%. For the transport sector, the final energy demand is expected to increase in the EU27 by around +0.8% per year, i.e. +20% as a whole over the time period considered.

Among the fossil fuels a shift from oil and coal towards gas is expected, so that the share of gas on gross inland consumption would increase from 24% to 26% in 2030. Remarkable is the increase of the share of biomass and other renewables to gross inland consumption, from 5% respectively 2% in 2005 to almost 10% respectively 5% in 2030.

These trends are summarized in the following Table 3.

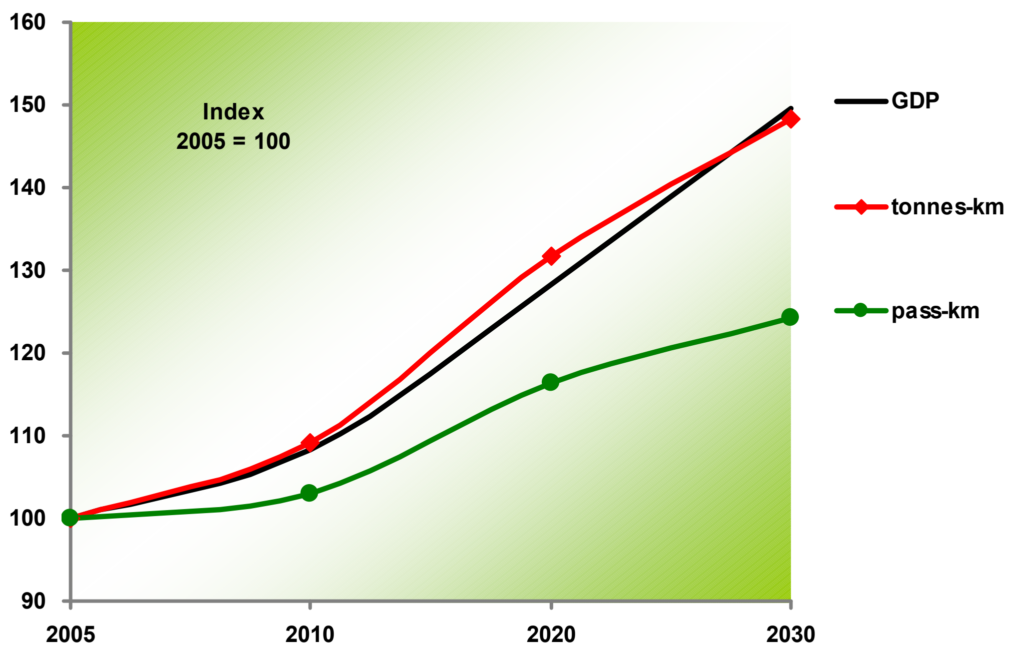
Table 3: Key indicators for the iTREN-2030 Reference Scenario (EU27)

Indicator	**Absolute values**		**Aver.% change per year**
	2005	**2030**	
Population total (1,000 persons)	488,594	494,331	0.0
GDP (billion euros 2005)	10,573	15,772	1.6
Oil price (euro 2005 per bbl)	44	90	2.9
Freight transport activity (billion tkms)	6,875	10,193	1.6
Road	*2,073*	*3,056*	*1.6*
Rail	*447*	*798*	*2.3*
Inland navigation	*192*	*335*	*2.2*
Maritime	*4,162*	*6,004*	*1.5*
Passenger transport activity (billion pkms)	6,457	7,873	0.8
Car	*4,665*	*5,633*	*0.8*
Bus	*615*	*585*	*-0.2*
Rail	*477*	*695*	*1.5*
Air	*442*	*628*	*1.4*
Slow	*259*	*333*	*1.0*
Gross Inland Energy Consumption (ktoe per year)	1,821,472	2,149,186	0.7
Oil	*669,119*	*646,031*	*-0.1*
Gas	*442,979*	*551031*	*0.9*
Coal, Nuclear	*582,937*	*641,535*	*0.4*
Renewables	*126, 437*	*310,589*	*3.7*
Share of renewables in final energy demand	8.3%	16.1%	2.7
Share of bio-fuels in transport demand	1.0%	9.9%	9.6
Car fleet size (1,000 vehicles)	211,062	294,212	1.3
Gasoline	*149,304*	*148,788*	*0.0*
Diesel	*57,588*	*135,371*	*3.5*
LPG/CNG	*3,229*	*2,016*	*-1.9*
Innovative	*941*	*8,037*	*9.0*
CO2 Transport emissions (million tonnes)	1,268	1,485	0.6

Source: iTREN-2030

Figure 3 brings together the trends of economic development and of transport development for the EU27. GDP growth and freight transport demand growth between 2005 and 2030 both reach an average annual growth of +1.6%, though as the figure reveals, in the first decade after 2010 freight is growing faster than GDP, while in the second decade it is growing more slowly. In total, between 2005 and 2030 both grow by about +50%.

Passenger transport grows by an annual average rate that is about half that of GDP and freight. Therefore, over the whole period the growth achieved is only somewhat over +20% until 2030. Thus relative decoupling between economic growth and transport demand is expected only for passenger transport, but not for freight transport.



Source: iTREN-2030

Figure 3: Transport demand trend compared to economic trend for the EU27 countries

The picture differs for the EU15 and EU12. In the EU15 a relative decoupling is observed also for freight transport, while in the EU12 freight transport grows much faster than GDP, reflecting the deepening of trade relationships of the new Member States with the rest of the EU and with non-EU countries.

4 Integrated Scenario

The setting of the **Integrated Scenario** brings us into a completely **different world**. It is not simply a variation upon the Reference Scenario, with stronger policies. This scenario includes (i) the economic and financial crisis of 2008/2009 as well as the economic recovery programmes implemented by the EU and the Member States and (ii) ambitious climate, energy and transport policies that are implemented between 2009 and 2025. The impacts of the crisis compared with the Reference Scenario can be observed over the full scenario period until 2030, and its socio-economic effects are more substantial than the impacts of the policies. Thus, although the Integrated Scenario builds on the Reference Scenario, the comparability between the two scenarios is limited, as different model techniques and adapted assumptions (e.g. the economic crisis) had to be used. At least, we must caution against ascribing the full differences between the scenarios to the impacts of the policies. However, when considering impacts on energy and environmental indicators, the impacts of policies in the medium to long term are stronger than the impacts of the economic and financial crisis.

In order to develop the Integrated Scenario, **likely** policies were proposed by the iTREN-2030 project. In discussions with stakeholders at workshops, as well as by considering ongoing policy processes, the proposed policies were reviewed and adapted to be finally implemented in the Integrated Scenario. The selected likely policies include pricing measures, regulation, technology support and diffusion measures, as well as information measures and, to a limited extent, also behavioural adaptations.

The Integrated Scenario developed as final outcome of iTREN-2030 consists of both a narrative storyline describing the Integrated Scenario as well as a comprehensive set of very detailed quantified indicators from the energy, transport, environment and economy fields by Member State and EU regions. The detailed indicators are shown in Deliverable D5 of iTREN-2030 [SCHADE ET AL. 2010]. In the following sections, first the storyline is presented, describing the changing drivers of energy and transport. Secondly, the impact of the economic crisis on scenarios until 2030 is explained. Third, the policies considered in the Integrated Scenario are listed and finally, the major trends and results of the scenario are presented.

4.1 The changing drivers of energy and transport systems

The discussion with the iTREN-2030 stakeholders resulted in their strong recommendation to expect breaks-in-trend for the next 20 years for the energy and transport systems as well as for their framework conditions. Examples that were mentioned include scarcity of fossil fuels causing high volatility and growth in fuel prices, the implementation of ambitious climate policies and the emergence and breakthrough of new technologies, like battery electric vehicles [SCHADE 2007, SCHADE 2008].

The iTREN-2030 project team also pointed out that in future decades economic growth rates would be lower than in the past, due to fundamental reasons like shrinking populations and ageing societies. Additionally, the project team highlighted the risk of economic crises due to the US sub-prime crisis and the imbalances in the financial markets [SCHADE/FIORELLO ET AL. 2008]. In spring 2008 many stakeholders were arguing against the likelihood of a hard landing for the world economy. Half a year later, the Lehmann Brothers' bankruptcy left few in doubt about the risk posed by the extent of the market imbalances. This crisis constituted another changing framework condition for the Integrated Scenario, as mitigating the impacts of the crisis forced the European governments to increase public spending, which drove the growth of public debt to levels above the criteria of the Maastricht Treaty in most EU Member States. In a joint effort, the EU set up a European Economic Recovery Plan [EUROPEAN COMMISSION 2008a] which, together with national strategies, until now has stabilized the economic development of the Union. However, in the years to come the accumulated public debts will have to be repaid, thus reducing the leeway for pro-active policy-making in the fields of energy and transport. Nevertheless, the EU Recovery Plan as well as some plans of the Member States included elements that will also positively affect trends in energy and transport, like the support for R&D and market introduction of electric mobility, implemented via the Green Cars Initiative.

Finally, a trend that is certain and has already started is the ageing of the European population. The recent EU ageing report established that from 2008 onwards until 2060 the labour force in the EU will decline and the share of persons above 65 years of age will continuously grow [EUROPEAN COMMISSION DG ECFIN 2009]. Since mobility patterns are age-dependent as well as being shaped by the employment status, this will have implications for the transport system.

Core transport policy focuses on increasing the efficiency of transport, reducing congestion and improving accessibility. This was the line of action defined by the last Transport White Paper of 2001 [EUROPEAN COMMISSION 2001], which defined four action priorities that should be implemented via 76 measures

- shifting the balance between modes of transport
- eliminating bottlenecks
- placing users at the heart of transport policy and
- managing the globalization of transport.

The mid-term assessment of the White Paper confirmed progress in many of the 76 measures, stating that lack of progress was particularly observed for the implementation of pricing measures. It then adapted the focus from shifting demand towards environmental modes to the concept of co-modality and the objective of strengthening the performance and efficiency of the major modes [DE CEUSTER ET AL. 2005, EUROPEAN COMMISSION 2006].

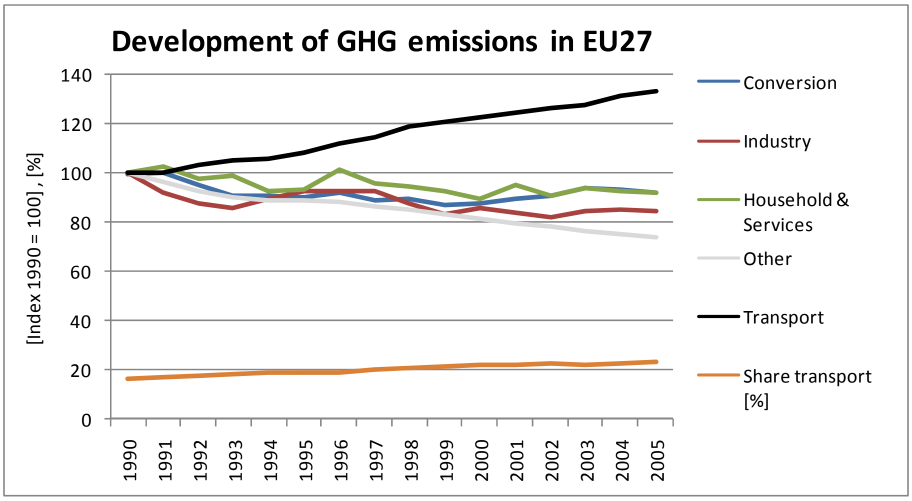
In the years after the mid-term review of the White Paper, the close connection between energy policy and transport policy became rather obvious and more important, e.g. due to the high oil prices of 2007/2008. Linking transport policy with energy policy widens the scope to such issues as the security of energy supply for transport (as well as competing energy uses). Another important link between transport and energy policy exists at the technological level: the use of specific propulsion technologies determines the energy demand and the type of primary energy sources that are required for transport, e.g. replacing fossil fuel by potentially renewable-based electric energy. And finally, the choice of energy sources as well as the energy efficiency of transport and its energy use determines the environmental impacts of transport, the most relevant of which will be the climate impact, in the long run. Given this framework, the three most important drivers of an integrated energy and transport scenario are

- climate policy (and growing signals of climate change)
- fossil fuel scarcity and
- new technologies for coping with the challenges posed by the first two drivers.

The following three sections briefly highlight these three drivers as they are important elements of the Integrated Scenario defined by iTREN-2030, as well as of any other transport and energy scenario for the next decades.

4.1.1 Driver 1: Climate policy

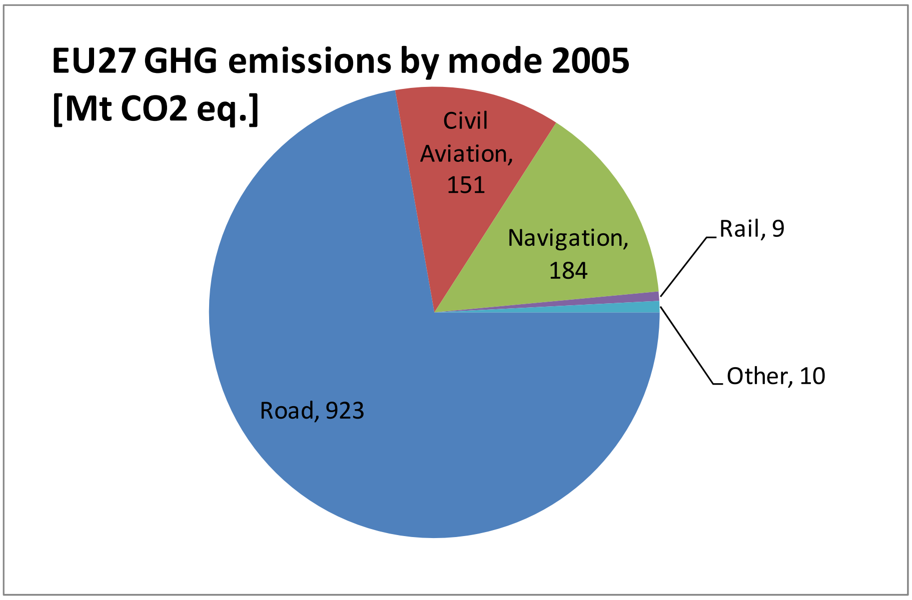
The transport sector in Europe contributed more than 23% of the EU27 greenhouse gas (GHG) emissions in 2005 (1,277 Mt CO_2 eq.). Due to the high share of fossil fuel use, the share of CO_2 emissions is even higher, amounting to more than 27% of the EU27 CO_2 emissions in 2005 (1,247 Mt CO_2). As Figure 4 reveals, the transport sector is the only major sector in the EU27 in which GHG emissions have risen compared with 1990. The same holds for the CO_2 emissions of transport [EUROPEAN COMMISSION 2007a]. Despite this growth trend, the European Commission has agreed on a target of a -10% reduction of GHG emissions by 2020 compared with the year 2005 for the non-ETS sectors, which include the transport sector [EUROPEAN COMMISSION 2008b].



Source: European Commission, 2007a

Figure 4: Development of GHG emissions of transport compared with other sectors in the EU27 (1990 to 2005)

The split of GHG emissions across the major modes of transport is presented in Figure 5. With more than 70%, road generates by far the largest quantity of GHG emissions. Navigation and civil aviation, both including international bunkers, generated about 14% and 12% in 2005, respectively.



Source: European Commission, 2007a

Figure 5: EU27 GHG emissions of transport by major mode in 2005

The EU has developed its position on climate change and climate policy through a number of communications, which all emphasize the target of stabilizing temperature increase at 2-degree Celsius compared with pre-industrial levels [EUROPEAN COMMISSION 2007b, EUROPEAN COMMISSION 2009]. For 2020 this would imply that the EU will reduce its GHG emissions by -20% by 2020 compared with 1990, if the rest of the world does not agree on reductions. However, if a joint global agreement similar to the Kyoto Protocol is achieved for the post-Kyoto period after 2012, the EU would accept a reduction target of as much as -30% by 2020. At the global level, the EU formulated the target of a reduction of -50% GHG emissions by 2050 compared with 1990, which according to the Intergovernmental Panel on Climate Change (IPCC) means a reduction of -80 to -95% by the industrialized countries by 2050. In other words: in 2050 the EU must emit less than 20% of the greenhouse gases emitted today. This means that a transport sector that today already emits more than 23% of EU GHGs, i.e. more than it will be allowed in total for the EU in 2050, has to deliver significant reductions of GHGs over the next four decades. Thus climate policy can be seen as the strongest driver shaping transport policy already today.

A few analyses of what such a 2-degree scenario would imply for transport exist. The European ADAM project developed a 400 ppm $CO2_{eq.}$ concentration scenario, with a 70% likelihood of achieving the 2-degree world. In this scenario the EU would reduce its GHG emissions by -80% until 2050 compared to 1990. Compared with the level of 2010, the transport sector would reduce its GHG emissions by -62% by 2050, while housing and energy conversion decarbonize more drastically, at close to -90% [SCHADE/JOCHEM ET AL. 2009]. The IEA developed scenarios in which European OECD countries would reduce their GHG emissions from transport until 2050 by about -70% compared with 2005 [Blue Map / Shift scenario in IEA 2009].

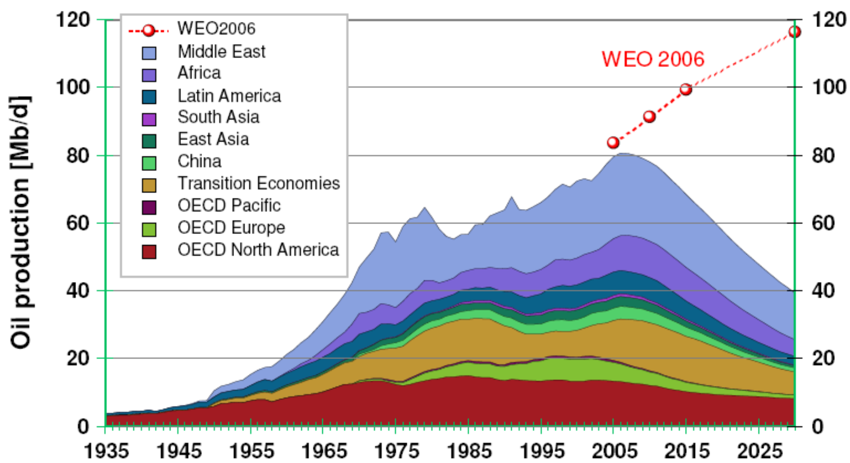
4.1.2 Driver 2: Fossil fuel scarcity

In 2008 the price of crude oil peaked at about 150 $/bbl, increasing from about 20 $/bbl a few years ago. The economic crisis made it drop to about 55 $/bbl again. However, the fundamentals of crude oil supply and demand clearly suggest that crude oil prices on average will increase in the near future. At the beginning of 2010, the oil price increased again to levels above 80 $/bbl.

On the demand side, new players like China and India will increase world crude oil demand to fuel their economic growth, in particular their growth in transport demand. It seems that only economic turbulence, as happened during the economic crisis of 2008/2009, or a large-scale shift to non-fossil energy sources could slow down or even stop this growth in demand. The latter shift would need a considerable period for implementation.

On the supply side, there is a more controversial discussion. However, consider (1) that the largest numbers of new oil wells were discovered during the last century in the 1960s to 1970s, and (2) that geophysical laws shape a typical time-path of extraction of oil from each well with growing extraction over a period of 10 to 30 years and after the production peak extraction declines at annual decline rates of about -3 to -10%. The IEA estimates that, from their worldwide observation, the average decline rate of such post-peak fields is -6.7% annually. The natural decline rate, i.e. the rate without any post-peak investment in declining oil fields, would even be close to -10% [IEA 2008]. This means that after only a few decades of such an oil production regime, the maintenance alone of oil extraction levels requires new discoveries of more than 6% annually. The same holds for new production to come on stream, i.e. each year new wells amounting to a capacity of 6% of current extraction have to go on stream just to maintain current production levels.

The Association for the Study of Peak Oil (ASPO) and others point to this fundamental time-sensitive structure of oil extraction and supply [e.g. ALEKLETT 2007]. Figure 6 is estimated on behalf of the Energy Watch Group (EWG) and concludes that today we are at the peak of oil production [EWG 2007], while the World Energy Outlook (WEO 2006) of the International Energy Agency (IEA) in 2006 expected a continuous growth of oil supply to reach 116 Mb/day until 2030 [IEA 2006]. Recently, the IEA revised their expectation for 2030 downwards, so that oil production would reach 106 Mb/day, growing from the 83 Mb/day of today. However, the IEA also identified the possibility of a supply crunch in 2013, if investments in new extractions do not increase substantially while demand growth continues, in particular from Asian countries like China and India [IEA 2008].



Source: EWG - Energy Watch Group, 2007

Figure 6: Optimistic and pessimistic scenarios of oil production

The iTREN-2030 project expects a plateau (or even a slow decline) of oil production rather than an increase for the next decades. Given the growth in demand, this would lead to a continuous increase of oil prices, as crude oil becomes increasingly scarce due to the widening gap between supply and demand.

In addition, not only the market interactions on the oil market itself affect transport systems, but also the expectations of the trend of crude oil prices. It seems that the high oil prices of 2007/2008 as well as the fast growth of oil prices in 2008 altered the "common wisdom" in a way that the general public, which includes the transport users, expects fuel prices to rise. This then has implications for transport choices, e.g. that fuel efficiency will play a significantly larger role in decisions to purchase new cars than in the past.

To conclude, the probable relative scarcity of fossil fuels as well as the growing expectation and awareness of such scarcity should be treated as one important driver which will change the transport system in the next two decades.

4.1.3 Driver 3: New technologies

For almost the last 100 years, fossil fuel combustion engines have dominated the propulsion of the majority of transport modes. However, fossil fuel combustion engines are in conflict with the two previously described drivers, as they cause greenhouse gas emissions that will have to be reduced and they require fossil fuel resources that are probably declining. In view of these fundamentals, it seems that new transport technologies, in particular low or no-carbon propulsion technologies, will have to emerge in the next decades.

Examples of such technologies are manifold, so that it can be expected that technologies that contribute to solving both problems will be successful, compared with technologies that solve one of the drivers but exacerbate the other (e.g. like substituting crude oil by coal-to-liquid oil, which reduces crude-oil-based fuel demand, but increases greenhouse gas emissions).

Promising new technologies seem to incorporate or at least contribute to two main characteristics: first, the new technologies **increase energy efficiency** and thus reduce absolute energy demand, and second, they **increase** the **climate efficiency** of transport and thus reduce absolute greenhouse gas emissions.

Examples of technologies compatible with climate policy and fossil fuel scarcity include first of all any kind of **electrification** of road transport, be it plug-in hybrid vehicles, battery electric vehicles or hydrogen fuel cell vehicles. In particular, these technologies would be compatible with the two drivers if the electricity required comes from renewable energy sources. When considering national as well as Europe-wide energy scenarios, this expectation could be feasible and foreseeable, as by 2030 renewable electricity can reach market shares in Europe of more than 40%, even 50%, and until 2050 of close to 80% [NITSCH 2008, SCHADE/JOCHEM ET AL. 2009].

The second option might be called **bio-massification** i.e. the increased use of biomass, although this requires that the biomass is grown in a sustainable manner and does not compete with food. Also, it must be ensured that the life cycle assessment of greenhouse gases reveals a reduction of GHGs. Such examples would be 2nd generation bio-fuels (e.g. Fischer-Tropsch fuels from full energy plants or plant residues) or 3rd generation bio-fuels (e.g. algae).

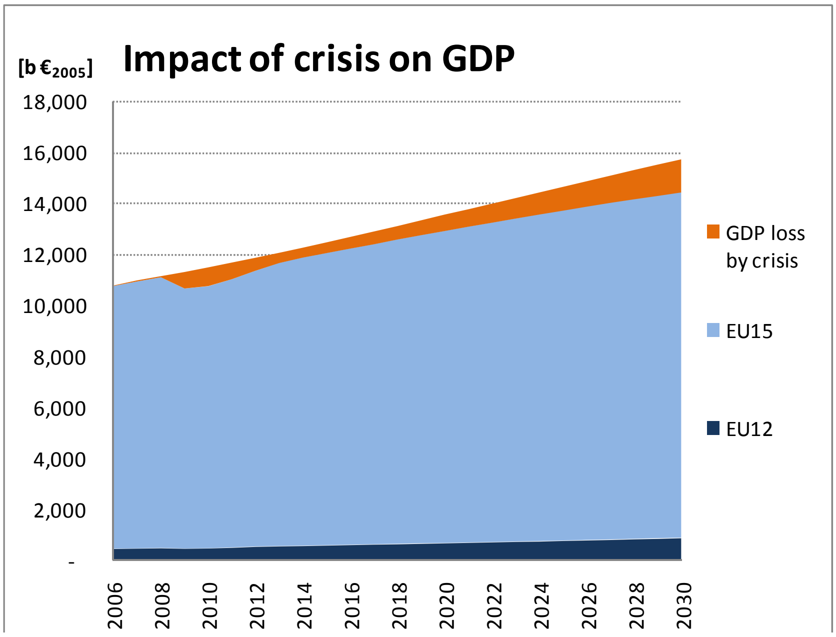
The third technological option could be called the **efficiency revolution**, which would involve light-weight solutions for vehicles and/or down-sizing of vehicles such that "1 or 2 litre cars" like the Loremo prototype become feasible [LOREMO 2009].

Such technology breakthroughs cannot be anticipated analysing fundamentals that are as similarly obvious and predictable as in the first two drivers. However, the emergence of new technologies is the third important driver of the Integrated Scenario of iTREN-2030. From the study of comprehensive publications covering similar long-term transport technology scenarios as iTREN-2030, it transpires they also expect a large variety of new technologies to emerge to reduce energy demand and GHG emissions from transport [e.g. IEA 2009].

4.2 Impact of the economic crisis

The general observation is that the effect of the economic crisis of 2008/2009 is the dominating impact for the economic variables and the economically driven variables, in particular freight transport. However, the picture is different for environmental impacts, as the crisis of course also matters for these impacts, but the impact of policy measures on environmental impacts dominates the impacts of the crisis. This is explained by the following figures in which the uppermost line always represents the Reference Scenario.

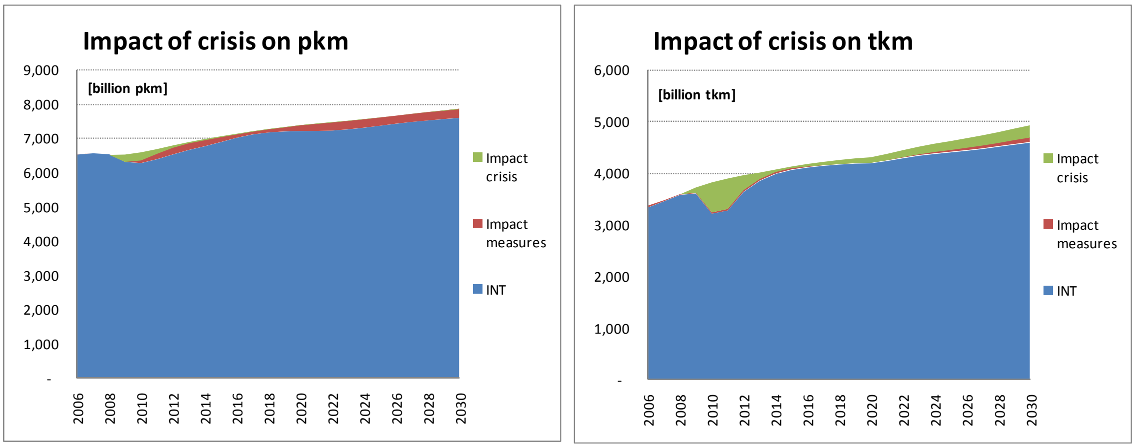
Figure 7 presents the impact of the crisis on GDP development for the EU27. The sharp drop of GDP in 2008/2009 and the catching-up process fostered by the economic stimulus packages can be easily observed in the following years. However, in the long run, GDP development never achieves the level of the Reference Scenario and remains about -8% below the level in the Reference Scenario. Also, the impact of the measures on GDP remains negligible compared with the impacts of the crisis.



Source: iTREN-2030

Figure 7: Impact of economic crisis on GDP

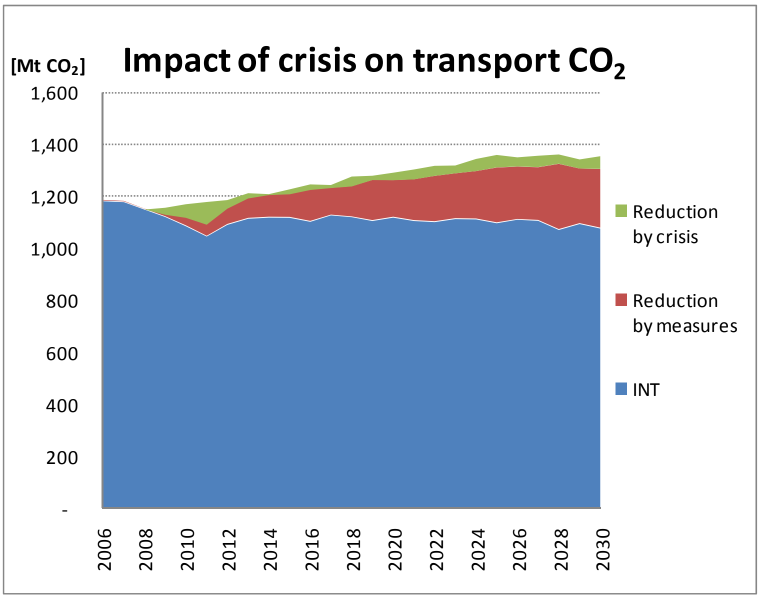
Figure 8 depicts the impact of the crisis on transport performance compared with the impact of the measures. For passenger transport, the crisis only dominates in the first five years, after which the impact of the measures is stronger and leads to a reduction of pkm by about -3% in 2030. For freight transport, the crisis represents the dominating influence over the whole period, though after 2020 the policy measures tend to slightly check freight transport growth. In total, the freight performance in terms of tkm is more than -7% lower than in the Reference Scenario.



Source: iTREN-2030 – ASTRA model

Figure 8: Relationship between impact of economic crisis and of policy measures on transport performance in the EU27

In terms of CO_2 emissions from transport, Figure 9 shows that, in the short run, the crisis exerts the dominating influence, while the policy measures of the INT Scenario lead to significant reductions of emissions in the long run. In 2030, roughly one fifth of reductions can be assigned to the impacts of the crisis, while four fifths are caused by the policy measures. This reveals that the crisis helps to reduce the climate pressure of transport, but that it remains absolutely necessary to implement transport measures to mitigate climate impact.



Source: iTREN-2030 – ASTRA model

Figure 9: Relationship between impact of economic crisis and of policy measures on transport CO_2

4.3 Policies

The policies for the Integrated Scenario were discussed at the 3rd and 4th iTREN-2020 stakeholder workshops. Commencing from the recommendation that the Integrated Scenario should include the **major policies likely to be implemented until 2030,** two criteria were defined to select policies for inclusion in iTREN-2030:

- **relevance** criteria: policies that really make a difference
- **likeliness** criteria: policies that have a high probability of being implemented between now and 2025. The date 2025 was chosen, as the impact of policies often appears only after some time lag, and by commencing at the latest in 2025 all policies should have had some time to take effect until 2030.

This means that the Integrated Scenario is not expected to include all detailed policies that might be decided on and implemented by 2030, but it concentrates on those policies that are identified as being both relevant and likely to be implemented. Of course, both qualifications do not constitute exact criteria and thus the policies for the Integrated Scenario were subject to discussions with the stakeholders, including the European Commission.

Also, the selection of policies was driven by a pragmatic approach, since the models have to be capable of implementing the policies. This becomes even more challenging when a policy has to be implemented in more than one of the models to ensure consistency of the modelling results. In this sense, a further criterion of **model applicability** was also relevant for selecting policies in iTREN-2030.

There are a number of different policy types that could be entered as components in a scenario definition. iTREN-2030 applies a concept of policies in a wide sense, using the following four categories of policies:

- policy (P)
- objective only (O)
- trend adaptation (TA) and
- adaptive policy in Reference Scenario (APRS), e.g. transport infrastructure networks that develop in the same way in Reference Scenario and Integrated Scenario.

Obviously, objectives and trend adaptations do not constitute concrete policies, but are considered as "policies in a wider sense" that may influence the Integrated Scenario. Table 4 summarizes the policies implemented in the Integrated Scenario. Details of the policies are provided in Deliverable D5 [SCHADE et al. 2010]. It should be pointed out that the applied road pricing policies consider rather moderate charges only, so that in some countries the charging levels are even reduced compared with existing charges on long distance networks.

Table 4: List of energy and transport policies of the Integrated Scenario

Measure	Type	Start year	Description
Road user charge trucks	P	2020	Implementation of Greening Transport Package using the cost values identified by the IMPACT Handbook on external cost of transport (about 7 to 10 €ct/vhc-km)
Road user charge cars	P	2025	Implementation of Greening Transport Package transferring the cost values identified by the IMPACT Handbook to car transport (about 2.5 €ct/vhc-km)
City tolls	P	2025	Implementation for metropolitan areas in EU27 only at the level of about 35.7 €ct/vhc-km during peak-period
Fuel tax harmonisation	P	2020	Following EC directive 2003/96/EC tax levels of 35.9 €ct/l gasoline and 41 €ct/l diesel introduced
Air transport into EU-ETS	P	2012	Inclusion of all air transport within or leaving the EU27 into EU-ETS with reduction targets of -3% in 2012 and -5% after 2012 compared to average of 2004 to 2006
Road transport into EU-ETS (upstream)	P	2020	Inclusion of road transport into EU-ETS by upstream approach (CO_2 price in 2020 about 28 $€_{2005}$ per tonne CO_2)
Railway liberalisation	P	2010	Implementation of 3rd railway package reducing passenger rail cost by -2%
CO2 limits cars	P	2015, 2020	Regulation setting CO_2 limits for average new car fleet with a limit value of 130 g CO_2/km in 2015, 105 g CO_2/km in 2020
CO2 limits LDVs	P	2015, 2020	Regulation setting CO2 limits for average new LDV fleet with a limit value of 175 g CO2/km in 2016 and 135 g CO2/km in 2020
Binding use of low resistance tyres HDV	P	2012	The binding use of low resistance tyres for trucks will reduce energy consumption by -3.5%
Battery electric cars	TA	2012	Breakthrough of battery technology and market diffusion of electric city cars after 2012
Battery electric LDVs	TA	2015	Breakthrough of battery technology and market diffusion of electric LDVs for urban deliveries after 2015
Hydrogen fuel cell cars	TA	2025	R&D support and support for market introduction will lead to market diffusion after 2025
Car efficiency labelling	P	2009	Effective labelling of cars according to their energy/CO2 efficiency affecting choices of car buyers to reduce CO2 emissions by -3.5%
Driver education for drivers of HDV	TA	2010	Driver education can reduce energy demand by -20%. It is assumed that due to changing framework conditions -10% is achieved by ambitious education programmes of companies
Increased implementation of CNG fuelling stations	TA	2010	The requirements of climate policy and price differentials increase attractiveness of CNG generating incentives to implement more CNG fuelling stations
GHG reduction target for the EU for 2020	P	2012	Agreement of binding reduction target of GHG emissions of EU27 of -20% until 2020 against 1990. Extension of EU-ETS with certificate price of 28 $€_{2005}$ per tonne of CO2 in 2020
Renewable energy target	O	2008	Harmonized renewable energy support premiums across the EU to reach 20% renewable energy by 2020
Energy efficiency action plan	P	2008	Increase of energy efficiency by 1% annually
Support for CCS	P	2010	Support of R&D and demonstration sites for CCS such that around 2030 first large-scale plants can be built

Source: iTREN-2030. P = policy, O = objective without specifying implementation, TA = trend adaptation

4.4 Results of the Integrated Scenario

The setting of the Integrated Scenario brings us into a world that is different from the past. The scenario includes (i) the economic and financial crisis of 2008/2009 as well as the economic recovery programmes implemented by the EU and the Member States and (ii) ambitious climate, energy and transport policies that are to be implemented between 2009 and 2025. The policies were selected in a stakeholder process in which the yardsticks relevance of policies, likeliness of implementation of policy until 2025 and ability to model the policy by the model system applied in iTREN-2030 were the decisive criteria.

The Integrated Scenario is an output of iTREN-2030 that can stand on its own as an alternative and feasible future scenario considering trend-breaks and plausible policy-making in the next two decades. Taking into account the differences in the scenario framework, it can also be compared with the Reference Scenario, which excludes both the crisis and policies that are passed after 2008.

Economic and financial crisis 2008/2009

The Integrated Scenario incorporates the crisis of 2008/2009. The economic model (ASTRA model) was adapted to reproduce the drop in trade and GDP indicators in 2008/2009 and to incorporate the economic stimulus packages of the EU and the Member States. This generates new trajectories for economic development from 2010 until 2030, which anticipates a growth path with an average annual growth rate of +1.5% that is significantly lower than for earlier studies, but still negates the option of a new economic crisis in the years to come, due to the remaining instability in the financial system and the growing debt of governments as a consequence of the public economic stimulus packages to solve the past crisis.

Energy sector

The rising demand from fast developing world regions and uncertainty about the future availability of cheap resources suggest that crude oil prices will not return to the low levels observed before 2007. It is therefore estimated that crude oil prices will rise from present price levels and remain at levels of around 80 $€_{2005}$/bbl in 2020 and almost 90 $€_{2005}$/bbl in 2030. The prices of CO_2 certificates also moderately increase from today's levels to about 27 $€_{2005}/tCO_2$ in 2020 and about 28 $€_{2005}/tCO_2$ in 2030. This implies that the CO_2 emissions cap follows the target of -20% until 2020 compared with 1990, but this is not made stricter after 2020. For non-ETS sectors it is assumed that a carbon value is applied that follows the CO_2 certificate price.

Major policy strategies in the energy sector in the Integrated Scenario include the application of a certificate trading system for ETS sectors and a carbon value for non-ETS sectors as explained above. Further, feed-in tariffs and other support policies are implemented to enable renewable energies to meet the target of 20% of renewables in energy production until 2020. Finally, the European energy efficiency action plan is implemented, improving energy efficiency by 1% annually. These strategies cause the average annual growth of EU energy consumption to drop from around +0.5% observed between 1996 and 2005 to levels between 0% and -0.2% for the next decades.

A more detailed look at energy demand from transport presented in Table 5 reveals an impressive break-in-trend where energy demand of total transport and all modes increased in the Reference Scenario, while in the Integrated Scenario the growth trend is reversed for total transport, as well as for the major modes passenger car and freight truck and reveals negative average annual changes between 2005 and 2030. For total transport this means a change from average annual growth rates of +0.7% to average annual decline rates of -0.4%.

Table 5: Transport energy demand growth rates by mode between 2005 and 2030 (INT, REF)

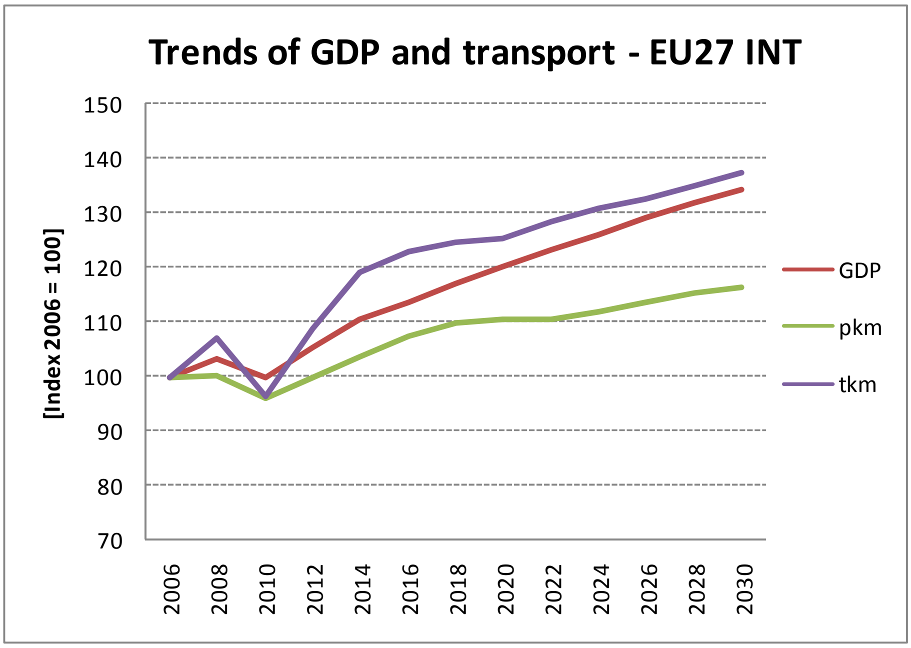
Average annual changes in final energy demand [%]	**Integrated Scenario**	**Reference Scenario**
Transport – all modes	**-0.4**	**0.7**
Road transport cars	-0.6	0.8
Road transport freight	-0.5	0.6
Rail	0.4	1.2
Aviation	0.4	0.8

Source: iTREN-2030

Transport sector

Transport demand indicators and vehicle fleet trends are also shaped by the impacts of the economic and financial crisis. In particular, freight transport responds to the crisis by reducing demand both in the short and in the long term, while passenger transport only responds with reduced demand in the short term, but then returns to the demand levels estimated without the crisis in the medium and long term.

However, the overall growth of freight transport remains much stronger than that of passenger transport, as Figure 10 shows. Until 2030 freight transport increases by +39% compared with 2006 and passenger transport by +16%. This means the growth of freight transport is slightly faster than that of GDP, though comparison of the period 2010 to 2020 and 2020 to 2030 reveals that this only holds for the first decade, while in the second decade economic growth is slightly faster than freight demand growth. This seems to be a first sign of structural change and relative decoupling between freight and the economy. Relative decoupling occurs over the whole period for passenger transport, which is not surprising, as the European population is stagnating and only the eastern European countries continue to increase their motorization significantly.



Source: iTREN-2030

Figure 10: Freight and passenger demand trend in the Integrated Scenario (intra-EU transport demand)

Vehicle fleets

One of the most significant changes compared with the past concerns the structure of the vehicle fleets. The car fleet continues to grow, but at lower rates than in the past, reaching about 280 million cars in the EU27 in 2030, whereas stronger growth occurs in the EU12 countries compared with the EU15 countries. In 2010 more than 95% of the car market is dominated by conventional gasoline and diesel cars. This share is reduced to about 80% by 2030. The strongest alternatives would be small battery electric vehicles which attain a market share of 5% until 2020 and CNG with a share of 3%. Until 2030 the share of battery electric vehicles nearly doubles, while that of the CNG vehicles remains constant. The major reason for the success of electric vehicles is the breakthrough of the battery technology (in particular Lithium-based batteries) strongly increasing energy density. And at the same time, the two drivers fossil fuel price increase and climate policy increase the attractiveness of electric vehicles. Around 2025 it is expected that hydrogen fuel cell vehicles will also start to play a role, since the battery electric vehicles mainly satisfy the needs for clean, short distance urban transport, while hydrogen fuel cell vehicles also provide a potentially non-fossil alternative for longer distances (see Table 6).

Table 6: Share of engine technologies in EU27 in INT scenario

Share of total in [%]	2010	2020	2030
Gasoline	60.7%	52.8%	51.8%
Diesel	34.8%	35.2%	30.2%
CNG	0.8%	3.1%	2.9%
LPG	2.1%	1.0%	1.0%
Hybrid **	1.4%	2.2%	1.2%
Electric	0.2%	5.0%	9.8%
Bioethanol (E85, FFV)	0.1%	0.7%	1.2%

*Source: iTREN-2030, ** = is always reflecting advanced hybrid technology i.e. in 2010 mild hybrid and in 2020 plug-in hybrids, while in 2020 mild hybrids are part of gasoline or diesel.*

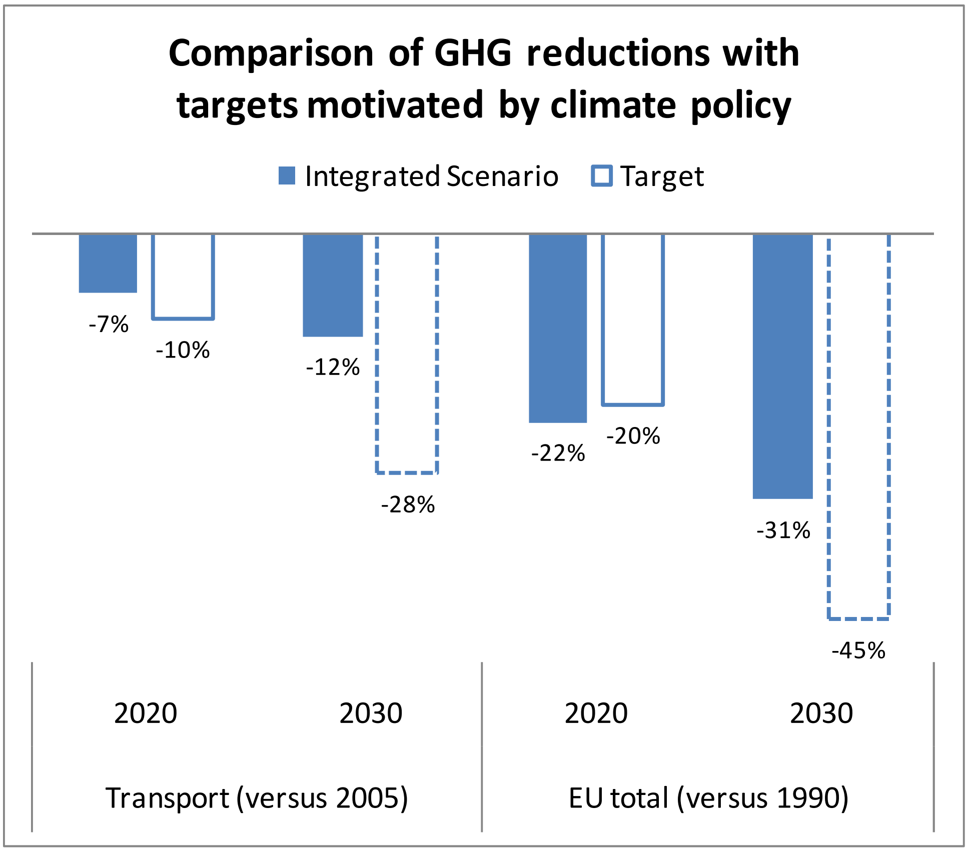
While the level of the car fleet is nearly unchanged by the crisis in the long term, due to the fact that more efficient cars reduce costs and become more attractive in the medium to long run, the same does not hold for the freight fleets. The combined influence of the economic crisis and the policies to mitigate the climate impact of freight transport reduce the fleet of heavy duty trucks by about 800,000 until 2030, compared with the Reference Scenario and of light duty trucks by about 2 million. In growth terms, this means that the HDV fleet nearly stops growing, while the LDV fleet continues to grow at a moderate rate. Battery electric LDVs also start to diffuse into the market after 2015, so that in 2020 about 200,000 electric LDVs and in 2030 more than 1.3 million provide urban delivery services in the EU27.

Greenhouse gas emissions (GHG)

For the first time in the EU27, the development of GHGs shows a negative slope in the Integrated Scenario. This holds for both the aggregate GHGs from all sectors as well as for the GHGs from the transport sector. The trajectories of the Integrated Scenario can be compared with targets for the years 2020 and 2030. For 2020 the EU has defined different targets for the EU in total and the transport sector. The EU total GHG emissions should be reduced by -20% compared with the base year 1990. The EU transport GHG emissions (as transport is a non-ETS sector) should be reduced by -10% compared with 2005, assuming that transport should contribute a share of reductions equal to the other non-ETS sectors. These two targets are fulfilled, or at least are close to being met, in the Integrated Scenario as can be seen in Figure 11. For 2020 the total reduction amounts to -22%, i.e. an over-fulfilment of 2%, though this could be easily ascribed to the economic downturn of 2008/2009. However, transport still underperforms in terms of the reduction target as it achieves only -7% instead of the -10% target. This means that other sectors contribute more drastic reductions.

For 2030 no concrete GHG reduction targets have been defined in official European policy documents, yet. Hence, the objective to limit the global temperature increase by 2100 to 2° Celsius, which was agreed by the EU leaders, has to be considered when arriving at a benchmark for 2030. Such a benchmark can be adopted from the European ADAM project which developed a so-called 2-degree scenario that succeeds in directing Europe onto a pathway towards -80% reduction of GHG emissions until 2050 [SCHADE/JOCHEM ET AL. 2009]. The benchmark of this pathway for 2030 would then mean a reduction of -45% for the EU total GHG emissions and a reduction of -28% for the transport sector. These benchmarks are indicated by dashed rectangles in Figure 11. Obviously, the Integrated Scenario falls short of achieving these benchmarks that would bring Europe onto a long-term path to limit temperature increases to 2° Celsius. This conclusion is not surprising, as major GHG mitigation policies of the Integrated Scenario are only focused on 2020 (e.g. CO_2 emission limits for cars and LDVs, CO_2 emissions cap), but they are not made stricter after 2020 to promote the required reductions.

As a consequence of the Integrated Scenario results, it should be noted that the EU is required to develop and implement policies that become effective between 2020 and 2030 to reduce the GHG emissions of transport by about -30% by 2030. Otherwise it seems that the EU targets for 2050 will not be met, in particular as transport will not contribute sufficient GHG reductions. Since the energy and transport systems also have high inertia, it should be planned to put such policies into place around 2015, so that they can take effect in 2020 and thereafter.



Source: iTREN-2030

Figure 11: Reductions of CO_2 emissions in comparison with reduction targets

The following Table 7 provides a comprehensive overview of major indicators estimated for the Integrated Scenario. Besides the absolute values for the years 2005 (i.e. pre-crisis) and 2030, the average annual change from 2005 until 2030 is shown. Detailed results are presented in the Annex of Deliverable D5 of iTREN-2030 [SCHADE ET AL. 2010].

Table 7: Key indicators for the iTREN-2030 Integrated Scenario (EU27)

Indicator	Absolute values		Aver.% change per year
	2005	2030	
Population total (1,000 persons)	488,594	494,331	0.0%
GDP (billion euros 2005)	10,573	14,445	1.3%
Oil price (euro 2005 per bbl)	44	89	2.9%
Freight transport activity (Intra-EU, billion tkm)	3,430	4,840	1.4%
Road	*1,713*	*2,318*	*1.2%*
Rail	*443*	*618*	*1.3%*
Inland navigation	*192*	*244*	*1.0%*
Maritime (Intra-EU)	*1,083*	*1660*	*1.7%*
Passenger transport activity (Intra-EU, billion pkm)	6,457	7,577	0.6%
Car	*4,665*	*5,493*	*0.7%*
Bus	*615*	*570*	*-0.3%*
Rail	*477*	*645*	*1.2%*
Air (Intra-EU)	*442*	*528*	*0.7%*
Slow	*259*	*341*	*1.1%*
Final Energy Demand (Mtoe per year)	1,821	1,660	-0.4%
Oil	*669*	*465*	*-1.4%*
Gas	*443*	*434*	*-0.1%*
Coal, Nuclear	*583*	*364*	*-1.9%*
Renewables	*126*	*396*	*4.7%*
Share of renewables in final energy demand	8%	24%	4.3%
Share of biofuels in transport energy demand	1%	16%	11.7%
Car fleet size (1,000 vehicles)	211,173	280,279	1.1%
Gasoline	*147,824*	*145,153*	*-0.1%*
Diesel	*57,454*	*84,772*	*1.6%*
LPG/CNG	*4,944*	*10,816*	*3.2%*
Innovative	*951*	*39,538*	*16.1%*
CO_2 Transport emissions (Intra-EU, million tons)	1,044	923	-0.5%

Source: iTREN-2030

5 Assessment approaches using iTREN-2030

The availability and application of the iTREN-2030 model suite enables the quantification of a large variety of indicators in the fields of energy, transport, vehicle fleets, environment and economy. These quantified indicators can be used to provide the input for a variety of assessment schemes. The iTREN-2030 project proposed and applied four different assessment approaches.

- **iTREN-2030 indicator templates**: these templates are provided as an annex to the deliverables describing the Reference Scenario (D4) and the Integrated Scenario (D5) of iTREN-2030. They include the key quantified indicators in the five domains covered by the models: energy, transport, vehicle fleets, environment and the economy. For each domain about 15 to 20 indicators are presented for each Member State and the groupings EU27, EU15 and EU12.
- **TRIAS sustainability impact assessment**: this scheme transfers the quantitative results into a qualitative summary, consisting of coloured up- and downward arrows summarizing the sustainability position of scenarios. Red/yellow/green colours and the direction of the arrows signal if a scenario improves sustainability of the European energy and transport system or not.
- **REFIT composed sustainability indicators**: in this scheme a set of sustainability indicators is proposed, which are either directly derived as an index from the absolute indicator values or are first calculated as composite indicators (e.g. as intensity indicators relating transport performance with GDP, thus revealing decoupling if such an indicator declines), and finally are also transformed into indices. The advantage of the transformation into indices is the resulting comparability of indicators of different domains, which usually apply different units of measurements, etc.
- **ASIF GHG emission calculation formula**: the ASIF formula combines the four technological influencing factors that determine the GHG emissions of transport: activity (pkm, tkm or vkm), modal share, energy intensity and carbon intensity. Despite this high level formulation, of course, detailed information is required to fill the scheme (e.g. on energy/fuel demand by mode or carbon intensity by type of fuel), which can be provided by the iTREN-2030 models.

In general, these approaches could (1) be used to present the results of **one scenario** only, i.e. the development trajectory and the absolute values of the indicators or combinations of separate indicators that create composite indicators, or (2) the approaches can be applied to perform **comparisons** of such indicators **across scenarios**.

6 Stakeholder process

An intensive stakeholder process accompanied the iTREN-2030 project. The original work plan had foreseen two workshops and a final conference. Following the suggestion of the stakeholders, the iTREN-2030 Consortium doubled the number of workshops by organizing two additional workshops at appropriate points in time, thus increasing the involvement of stakeholders. The four workshops and the final conference dealt with the following issues.

- First workshop: user needs and required features from the iTREN-2030 project (November 27th 2007 in Brussels).
- Second workshop: assumptions and key trends for the iTREN-2030 baseline scenario (April 3rd 2008 in Brussels).
- Third workshop: scenarios and policies for the iTREN-2030 baseline: energy, transport, technology and emissions policies (November 19th 2008).
- Fourth workshop: integrated scenario on transport and energy until 2030 and potential impact of the economic crisis on transport (April 22nd 2009 in Brussels).
- Final Conference of iTREN-2030 (October 21st 2009).

The workshops and final conference were attended by participants from the European Commission (in particular DGs TREN, ENV, ECFIN and JRC), national ministries and national agencies of different Member States, representatives of the automotive industry, energy industry, NGOs, banks, research and consultancy organizations. The number of participants grew over time from 45 persons to 70 persons.

Discussions with the stakeholders led to new insights and modified assumptions, mainly related to expected trend breaks and radical changes, such as increasing oil price, ambitious climate policy, introduction of electric vehicles and the economic crisis. Further, the stakeholder process itself was improved by increasing the number of workshops, as explained above, and by putting descriptions of the four models on the website, which increased the transparency of the concept and functioning of the models. The website also enables all deliverables to be downloaded and will be available for at least two years after the end of the project at http://isi.fraunhofer.de/isi/projects/itren-2030/.

Overall, it can be concluded that the stakeholder process stimulated the iTREN-2030 project to make the methodology and results as transparent and consistent as possible and to validate the results against many other sources. This led to an improved understanding of the iTREN-2030 scenarios and models, which is beneficial for the usability and acceptance of the iTREN-2030 project results by a diversity of stakeholders.

7 Conclusions

iTREN-2030 - Integrated TRansport and ENergy baseline until 2030 – was a research project conducted on behalf of the European Commission (EC) DG TREN funded by the EC 6th Research Framework Programme and carried out by a consortium of seven European partners. The objective of iTREN-2030 was to design a powerful toolbox for European transport policy-making, by creating an integrated model system of transport, economics, energy and the environment, which enables responding to the policy issues newly emerging due to the more closely interlinked energy and transport systems. Such a toolbox would allow for coherent scenario and policy analysis to be carried out at the European level for the coming decades.

The iTREN-2030 project created an interlinked, consistent toolbox of the four models TRANSTOOLS, TREMOVE, POLES and ASTRA and applied it to the Reference Scenario. For the Integrated Scenario which took the economic crisis as well as ambitious energy and climate policies into consideration, only the latter three models could be applied due to the limited adaptability of TRANSTOOLS in iTREN-2030.

The Integrated Scenario enabled policy conclusions relevant for energy and transport in the next two decades to be derived, in particular with respect to climate policy. The EU target to reduce total GHG emissions by -20% by 2020 compared with 1990 would be achieved in the Integrated Scenario. However, the reductions in the transport sector fall short of what is proposed, i.e. instead of reducing GHG emissions by -10% by 2020 compared with 2005, the transport sector only achieves -7% reductions, which is still a remarkable result. The gap between reductions and targets for 2030 becomes more substantial, as although studies suggest reduction targets of about -30%, only -12% are achieved. Thus more policies will have to be developed for the period after 2020.

Further research to improve, or in applying, the iTREN-2030 model suite is recommended in the following three directions.

- Thorough realignment of the TRANSTOOLS model so that it can be applied as a strategic model with short response times, enabling the two-way integration of TRANSTOOLS into a wider model system, with energy and economic models.
- Developing further scenarios with the model system, in particular adapting trends for which it was found in iTREN-2030 that either a great range of developments is possible or that the iTREN-2030 scenarios reflect trends that are at the outer ranges of possible developments. One example would be to consider higher growth trends for the oil price.
- Developing and suggesting GHG reduction targets for the transport sector that fit long-term EU reduction targets and underpin them with appropriate policy programmes, to bring energy and transport onto these reduction pathways.

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