

Modelling and strategies for the assessment and **Optimisation**  
of **Energy Usage** aspects of rail innovation

## Deliverable Report

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## The OPEUS project consortium consists of:

No	Name	Short name	Country
1	Newcastle University	UNEW	UK
2	SAFT SAS	SAFT	FR
3	Union Internationale des Chemin de Fer	UIC	FR
4	Union Internationale des Transport Public	UITP	BE
5	Universitaet Rostock	UROS	DE
6	Stadler Rail Valencia SAU	STAV	ES

## List of Abbreviations:

Abbreviation	Definition
AB	Advisory Board
AWP	Annual Work Programme
CA	Consortium Agreement
CCA	Cross Cutting Activities
CFM	Call For Member
COLA	Collaboration Agreement
DoA	Description of Action
EC	European Commission
FINE1	Future Improvement for Energy and Noise
IP	Innovation Programme
OC	Open Call
OPEUS	Modelling and strategies for the assessment and <b>Optimisation</b> of <b>Energy Usage</b> aspects of rail innovation
S2R JU	Shift2Rail Joint Undertaking
WP	Work Package

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## EXECUTIVE SUMMARY

This report forms OPEUS project Deliverable 9.1, providing a summary of the agreed actions to align the *Modelling and strategies for the assessment and **OPT**imisation of **E**nergy **US**age aspects of rail innovation* (OPEUS) project (Grant Agreement 730827) with the wider S2R programme including interaction with FINE 1, the project resulting from call identifier S2R-CFM-CCA-02-2015.

This document complements all other important documents such as the EC Grant Agreement number 730827 and its Annexes, the Collaboration Agreement between OPEUS project and FINE1 project (Grant Agreement 730818) and the various EC guidelines which, in case of conflict or uncertainty, supersede this document.

After introducing the OPEUS project and the objectives of the Deliverable, this report is presented in 3 main sections. The first section explains how the OPEUS aligns with the S2R programme as a whole, including its contribution to the S2R Strategic Master Plan and the Multi Annual Action Plan.

The second section explains the alignment of the OPEUS project with FINE1, the project resulting from the complementary CFM call topic. It elaborates how the two projects, supported by a Collaboration Agreement, work closely together to ensure the most effective, efficient and economical implementation of their work, including liaison over common Deliverables, as well the reciprocal participation to each other's technical management expert groups.

The final section depicts how OPEUS developed its Advisory Board to maximise project impact, bring the influence of industry stakeholders to the project and highlights the involvement of both S2RJU and FINE1 representatives.



## INTRODUCTION

This Deliverable Report aims to provide a summary of the agreed actions to align the *Modelling and strategies for the assessment and **OPT**imisation of **E**nergy **US**age aspects of rail innovation (OPEUS) project (grant agreement number 730827) with the wider S2R programme, including interaction with FINE 1, the project resulting from call identifier S2R-CFM-CCA-02-2015), the importance of which was stated at project proposal stage.*

The six OPEUS consortium partners, from five different European countries, represent an extremely well balanced mix of skills, expertise and stakeholders. Specifically, the consortium is made up of two leading academic partners (Newcastle University and Rostock University), one rail vehicle manufacturer (Stadler Rail Valencia), one leading energy storage systems supplier (SAFT Technologies) and two associations (UITP and UIC) representing a mix of railway undertakings, infrastructure managers, local authorities and public transport operators. This solid mix of universities, leading industrial partners and associations allows the consortium to respond to the challenges posed in the project and to realise the key project results.

OPEUS addresses topic *S2R-OC-CCA-02-2015-Energy usage, generation and saving approaches* (call identifier H2020-S2RJU-2015-01) as part of the Shift2Rail Joint Undertaking (S2R JU) first Open Call issued in December 2015. The topic tackles the specific challenge related to energy consumption aspects within the railway sector and how to at least maintain the environmental advantage that railways have historically enjoyed. The OPEUS project aims to develop a simulation methodology and accompanying modelling tool to evaluate, improve and optimize the energy consumption of rail systems, with a particular focus on in-rail vehicle innovation. The project's duration is 30 Months, commencing on 1<sup>st</sup> November 2016.

As required by the call topic to which it responded, OPEUS builds on an extensive range of knowledge and outcomes generated by a number of key collaborative projects (e.g. CleanER-D, MERLIN, OSIRIS, RailEnergy, ROLL2RAIL) underpinning the research proposed, ALL of which have been led by OPEUS consortium members.



Particularly the tool developed for the CleanER-D project has been used as a starting point. Significant complementary work from the academic community will also be used to enhance the activities of the project. Specifically, these previous projects input will be used to:

- Expand and develop the simulation tool (CleanER-D, MERLIN);
- Complete the operational requirements by enhancing the urban duty cycles (OSIRIS);
- Provide a global vision of energy consumption in railways (CleanER-D, OSIRIS, RailEnergy)

All six consortium participants were involved in these projects, including the production of numerous Deliverables that have a profound effect on the overall OPEUS approach, guaranteeing the continuity of the work and the effectiveness of the concept proposed. The following diagram (Figure 1) provides a timeline of this previous, relevant research:

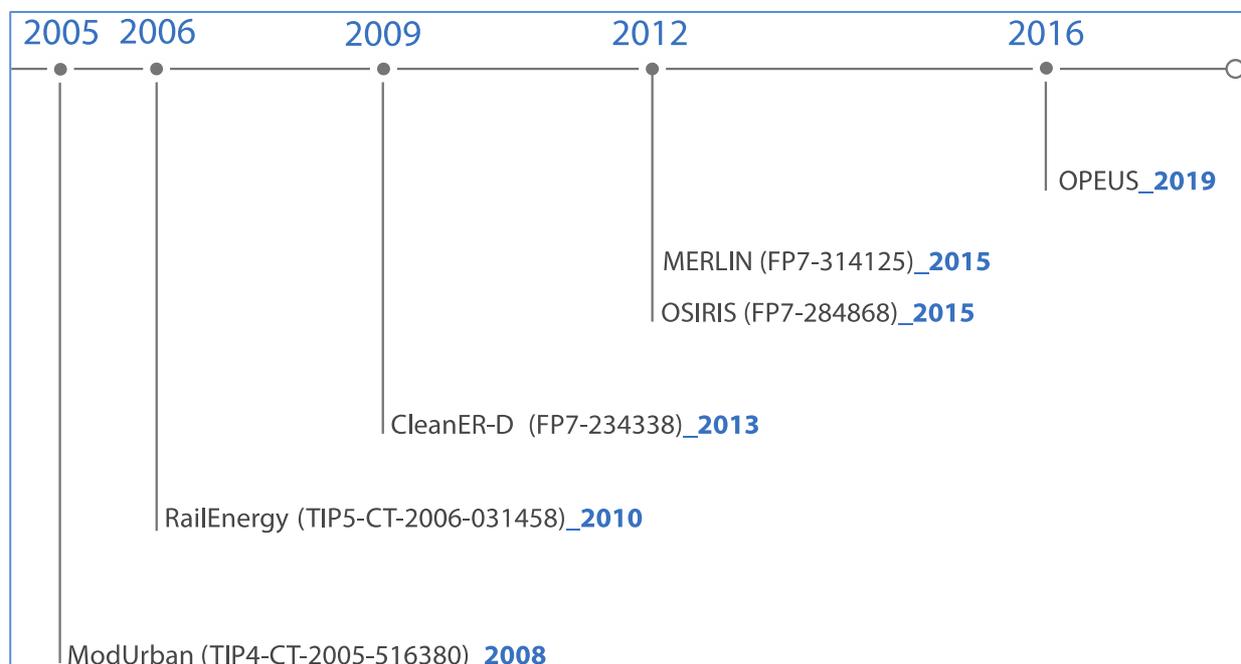


Figure 1 - Timeline of key EC-funded projects relevant to OPEUS

The OPEUS project is divided into 9 Work Packages, as detailed below in Table 1, with a different project partner leading each WP.

Table 1 - Overview of OPEUS WPs

WP No.	WP Title	Lead participant
1	Urban rail systems energy requirements	UITP
2	Simulation model and tool development	UROS
3	Reference scenarios simulation	UNEW
4	DAS study	STAV
5	In-vehicle energy losses study	STAV
6	Advanced ESSs study	SAFT
7	Global vision of energy in railway	UIC
8	Dissemination, exploitation and engagement	UIC
9	Management	UNEW

## OPEUS ALIGNMENT WITH THE SHIFT2RAIL PROGRAMME

The OPEUS proposal addressed topic S2R-OC-CCA-02-2015-Energy usage, generation and saving approaches (call identifier H2020-S2RJU-2015-01) as part of the Shift2Rail Joint Undertaking first Open Call. The topic tackles the specific challenge related to energy consumption aspects within the railway sector and how to at least maintain the environmental advantage that railways have historically enjoyed. Particular emphasis was made in the Call on the need for developing a standardised simulation methodology for estimating energy usage.

The specific ways in which the OPEUS project is addressing the specific elements of the open call topic were detailed at proposal stage and subsequently included to the DoA Annex 1 Part B. They are detailed for context on this report at Annex 1, with Annex 2 presenting an overview of how OPEUS is addressing the topics' expected impacts.

## OPEUS contribution to Shift2Rail Strategic Master Plan and Multi-Annual Action Plan (MAAP)

OPEUS contributes to the Shift2Rail Strategic Master Plan and its executive document, the Multi-Annual Action Plan (MAAP). Specifically, both documents make clear references to the need to address the energy consumption aspects of railways. For instance the traction systems demonstrator (TD1.1), part of IP1 has an extensive number of objectives described as part of the MAAP. These include developing low energy traction systems and innovative components and supporting pre-studies on “energy savings: Hybrid technologies via energy storage, energetic optimisation including, braking energy recovery solutions” (Shift2Rail, 2015). The OPEUS aim and objectives contribute to achieve these key activities of the S2R MAAP by providing a modelling tool that will allow the comprehensive comparison and optimisation of technology propositions developed by the S2R members. OPEUS explicitly plans to use the tool developed to assess selected innovations put forward by the S2R members during the second and third years of the project to demonstrate its applicability and suitability for this task.

Horizon 2020 and Shift2Rail are key instruments to deliver the ultimate goal of a single European rail area (SERA) contained in the Fourth Railway Package. Linked to this goal are the predominant targets of establishing an internal market for rail and of strengthening the competitiveness and attractiveness of the rail sector, while also sustaining the position of the European rail industry (Shift2Rail, 2014). To achieve these, a strong need to materialise innovation is acknowledged, in areas such as business models, services and products, throughout the whole rail value chain.

The Shift2Rail Joint Undertaking (JU)<sup>1</sup> was set up to establish a cooperation platform for the European rail system stakeholders with a view to driving innovation by implementing a far-reaching and co-ordinated research and innovation strategy. Its overall challenge is strengthening the role of rail in the European transport system and the global competitiveness of European industry. Specifically the *S2R Strategic Master Plan* (Shift2Rail, 2014) clearly states this aim by declaring its goal

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<sup>1</sup> Established by Council Regulation (EU) No 642/2014 of 16 June 2014



to contribute to the well-known EC policy objective of increasing the use of energy-efficient transport modes reducing GHG emissions as well as improving the environmental performance of the transport system. To achieve this, key expected outcomes include that:

- *"[...] Introduction of innovative technologies allowing a more efficient use of energy. In particular, energy efficiency is increased thanks to improved traction and braking systems [...] reduction in thermal losses (i.e. doors) and improved driver awareness of energy-saving driving techniques."*
- *"New methodologies and tools to design and validate reliable traction systems and components with [...] improved energy."*
- *"New technologies for energy storage and alternative ways to convey energy to the vehicles should also be examined."*
- *"Safer and better performing brake system with [...] recovery of the braking energy."*
- *"Reduction in the consumption of energy with the introduction of [...] Driver Advisory Systems (DAS) [...] in all rail transport market segments."*
- *"Electrification of rail freight and the development of next generation/hybrid propulsion results in a reduction of air pollution from diesel locomotives [...]."*

In addition the S2R Master Plan includes a dedicated cross-cutting activity dealing for Energy and Sustainability aiming at *"[...] All potential new solutions will have to be monitored and evaluated to achieve optimal energy- efficient technical solutions across all system platform demonstrations (given that urban, regional, high speed and freight segments have different characteristics and constraints that could lead to different technical solutions for energy savings in the different segments) [...]."*

As such OPEUS outcomes are aligned with the H2020 and S2R Strategic Master Plan and MAAP objectives contributing to them by delivering:

- An open source tool that can be used as a key instrument to assess and improve innovation generated by S2R and related to energy consumption which in turn is expected to have a firm impact on competitiveness
- An assessment of the key areas in the traction chain, where losses are occurring, and approaches to minimise these



- A comparison of the key role that driving advisory systems and associated strategies can play in optimising energy consumption on different types of railway operations (e.g. high speed, regional)
- A clear description of the energy requirements and associated influencing factors for urban railways allowing to focus future innovation strategy based on evidence
- A global vision of the way energy is being used by railways and how innovative interventions could shape this to maintain and improve railways' environmental credentials and competitiveness

In order to maximise the expected impact (as described at Annex 2), OPEUS must not only perform at the highest level as a project fulfilling its plans and activities but also engage with actors beyond the project consortium. Key to this success is the establishment of suitable dialog and cooperation with the Shift2Rail JU management and key founding and associate members working towards new innovations relevant to energy optimisation in the different Technology Demonstrators (TDs) as specified in Innovation Programmes (IPs). This includes links with the S2R consortium addressing *S2R-CFM-CCA-02-2015 – Energy and sustainability, including noise and vibrations baseline assessment*, which will be addressed below.

OPEUS links to several of the IPs within the S2R MAAP, but most prolifically:

- IP1 – Cost efficient and reliable trains, through TD 1.1 Traction systems
- IP2 – Advanced Traffic Management and Control Systems, through TD 2.2 ATO
- IP5 – Technologies for sustainable and attractive European rail freight, through TD 5.5, New freight propulsion systems

Participation at the S2R CCA Steering Committee occurs approximately every 5 – 6 weeks, following a standard presentation format as issued by the S2R JU which assists all projects and partners involved to remain up to date with overall progress. OPEUS has identified the key areas of alignment between the project WPs being delivered and fabric of the S2R programme in terms of applicable Work Areas (WA) and the various IP TDs. This is summarized below in Table 2:



Table 2 – OPEUS’s interaction with S2R programme WA and IP specific TDs

OPEUS Work Package	Appropriate to the following CCA Work Area (WA)	Specifically appropriate to the following IP Technology Demonstrators (TD)
1 - Urban rail systems energy requirements	<b>WA5 - Energy and Sustainability:</b>  Specifically, <b>WA5.1 -Energy</b>	
2 - Simulation model and tool development		<b>TD1.1</b> - Traction systems <b>TD2.2</b> - Automated Train Operation <b>TD5.5</b> - New freight propulsion systems
3 - Reference scenarios simulations		<b>TD1.1</b> - Traction systems <b>TD2.2</b> - Automated Train Operation <b>TD5.5</b> - New freight propulsion systems
4 - DAS study		<b>TD2.2</b> - Automated Train Operation
5 - In-vehicle energy losses study		<b>TD1.1</b> - Traction systems <b>TD5.5</b> - New freight propulsion systems
6 - Advanced ESSs study		
7 - Global vision of energy in railways		
8 - Dissemination, exploitation and engagement		

## OPEUS ALIGNMENT WITH FINE1 PROJECT

The S2R research and innovation programme is organised into five Innovation Programmes (IP1-IP5), together with Cross-Cutting Activities (CCA). The calls for proposals to help deliver this programme have been defined as either calls for S2RJU members (CFM) or open calls available to non-members (OC). This method enables the allocation of partnerships, skills and resources to grant activities that will result in best addressing the aims and objectives as set out in the S2R annual work programmes (AWP).

Specific CFMs and OCs have been designated as 'complementary', as they relate to similar topics and/or rely on some of the results of the resulting grant activities. As such, the options regarding 'complementary grants' of the S2R Model Grant Agreement and its provisions, including with regard to additional access rights to background and results for the purposes of the complementary grant(s), have been enabled in the corresponding S2R Grant Agreements.

With regard to the OPEUS project, complementarity is with the S2R member topic S2R-CFM-CCA-02-2015: Energy and sustainability, including noise and vibrations baselines assessment. The project resulting from this topic call is Future Improvement for Energy and Noise (FINE1), involving nine S2RJU Members with Bombardier as the Coordinator, a 36-month project which commenced 1st September 2016 (Grant Agreement 730818).

### **Collaboration with complementary project FINE1 within the S2R Programme**

FINE1 aims to reduce the operational costs of railways by reducing energy use and noise related to rail traffic. As a result, there will be an increase in traffic in Europe and an enhancement the attractiveness of railway in relation to other modes of transport. OPEUS outcomes will impact on FINE1: The relevant expected impact of this complementary topic is related to determining the potential energy improvement of technical innovations in order to support the decision process for choosing the most suitable solution when new assets are purchased. OPEUS will provide a simulation-based approach for the estimation of energy consumption directly contributing to expected impact of this topic as well as supporting the general Shift2Rail objective of simplifying business procedures.

As soon as the grants were awarded, the Coordinators of OPEUS and FINE1 commenced discussion about collaboration between the two projects. A Collaboration Agreement (COLA) was developed and signed by both consortia, to set the conditions under which they now work together to ensure the most effective, efficient and economical implementation of their work. This is in accordance with the obligations under their respective grant agreements, which defines the rights and obligations of the Parties relating to their collaboration under the relevant S2R call and implements the provisions of the respective



Complementary Grant Agreements for OPEUS and FINE1 concerning, amongst other things, Access Rights relating to Results and Background and exploitation potential.

Several of the OPEUS WPs have direct links to those within the FINE1 project, with mutually foreseen activities to be performed, as depicted in Table 3 below (and set out within the COLA).

Table 3 – WP activity links between OPEUS and FINE1

Actions to be performed:	OPEUS (OC) Work Package(s)	FINE1 (CFM) Work Package
<b>Energy simulation methods</b>	<b>2</b> – Simulation model and tool development	<b>3</b> – Energy calculation methodology
<b>Energy calculation methodology, simulation model and tool development</b>	<b>2</b> – Simulation model and tool development	<b>3</b> – Energy calculation methodology
<b>Assessment of energy improvement</b>	<b>2</b> – Simulation model and tool development <b>3</b> - Reference scenarios simulation <b>6</b> – Advanced ESSs study	<b>4</b> – Assessment of energy improvement
<b>Strategic views of energy consumption</b>	<b>7</b> – Global vision of energy in railways	<b>2</b> – CCA energy group
<b>View of future railway system with regards to energy consumption</b>	<b>7</b> - Global vision of energy in railways	<b>3</b> – Energy calculation methodology
<b>Common dissemination strategies</b>	<b>8</b> - Dissemination, exploitation and engagement	<b>10</b> – Dissemination, communication and exploitation

Further, the OPEUS deliverable D3.1 “Scenario set up” and FINE1 deliverables D3.1 “Energy Baseline” and D3.4 “Requirement specification for energy simulation tool” have high degrees of commonality and the projects agreed to, and have been,

working together close on the topic, although separate documents are to be submitted to the EC.

The collaboration between representatives of both projects is well established, with regular common meetings organised where participants of OPEUS consortium and FINE 1 WP2, WP3 and WP4 participate, taking place four times per year via teleconference and at least once per year face-to-face). Most recently, this ongoing dialogue saw the joint development of the simulation reference scenarios which include agreed duty cycles, engine mappings and population of parameter matrix with appropriate values.

Finally, each project also has a 'technical management expert group' consisting of their own WP leads. To further enhance project collaboration;

- One representative of OPEUS attends the Technical Management Meeting of FINE1, and
- One energy representative from FINE1 attends the Steering Board of OPEUS

## IMPLEMENTATION OF AN ADVISORY BOARD

An OPEUS Advisory Board (AB) has been set up as a key instrument to maximise impact. It is composed of industry stakeholders with active interest in the development of energy efficient solutions from a variety of perspectives. The members of the Advisory Board represent a spectrum of bodies including urban and mainline railway operators, equipment manufacturers and international research bodies. They advise, facilitate and improve the work being developed within the project, as well as take the results and disseminate them further within their existing networks. In this way, the OPEUS AB assists the project in achieving its goals and at the same time is supporting the dissemination and exploitation of the project results.

The AB is invited to attend specific full consortium meetings and alongside these there are specific sessions for the OPEUS team to report progress achieved and



discuss the project's next steps with the AB members. Specifically, the role of the AB is:

- To act as a sounding board providing feedback on approach and progress of the project;
- To facilitate and open up paths for engagement, dissemination, exploitation and adoption of the OPEUS results by the wider railway community.

Once all of the key S2R projects were awarded OPEUS specifically awarded one AB seat each to a S2RJU representative and to a representative of the FINE1 consortium.

## CONCLUSIONS

This Deliverable Report aimed to provide a summary of the agreed actions to align OPEUS project with the wider S2R programme, including interaction with complementary project, FINE 1.

Responding to the S2R Open Call topic, the link to the overall S2R programme is clear. Further detail in the report then describes the complementarity of the OPEUS and FINE1 projects, which goes further than simply communicating with each other throughout their lifetimes, but in fact involves the two projects working closely to maximise efficiency of delivery, potential for positive outcome and exploitable results. The sharing of seats on each other's technical management expert groups is one way to reinforce the continued cooperation, as is the involvement of both FINE1 and S2RJU representatives within the OPEUS Advisory Board.



## ANNEXES

### Annex 1: How the OPEUS project is addressing the specific elements of the S2R Open Call topic

S2R-OC-CCA-02-2015 Scope	OPEUS approach
<p><i>The energy requirements for urban rail traffic all over Europe should be analysed resulting from existing specifications, guidelines and best practices, notably from other R&amp;D projects</i></p>	<p>The social, political, economical and operational requirements related to energy usage in urban rail systems are being comprehensively reviewed and updated (through <b>WP01</b>). This work uses existing research results as a basis; particularly the outcomes of relevant activities in the FP7 project OSIRIS which Newcastle University, UITP and SAFT were directly involved with. In addition, H2020's Roll2Rail on-going work in this area is being used where STAV is an active contributor to the project and to its WP8 Energy. Key input from UITP's member base is also being added from existing Metro and energy efficiency working groups.</p>
<p><i>An energy simulation model should be developed and a simulation tool should be provided that allows the evaluation of energy consumption [...] In order to avoid the development of a new tool the provided tool should be based on the existing tools developed within the previous European research projects, where appropriate, e.g. Clean-ER-D [...].</i></p>	<p>OPEUS will expand the functionality and capability of the hybridisation assessment simulation model and tool originally developed by its participants as part of the CleanER-D project. <b>WP02</b> is focussing on this task, which will enhance the original model designed to evaluate energy consumption and vehicle systems architecture for diesel rolling stock to allow OPEUS to also evaluate electric traction. In addition, the project is using other existing knowledge and software implementing an optimisation algorithm, developed as part of the FP7 project MERLIN by Newcastle University allowing the OPEUS tool to evaluate and compare optimised technical solutions.</p>
<p><i>The energy simulation tool should be applied for estimation of the energy consumption for the reference scenarios of the 4 traffic segments (high speed, regional, urban and freight), starting from the state-of-the-art</i></p>	<p>OPEUS is creating four reference scenarios (<b>WP03</b>) as the basis for all simulation and assessment activities. These scenarios will use the existing duty cycles for regional, high speed and freight traffic originally defined by the FP6 project RailEnergy and updated by CleanER-D which are now included in the <i>standard CLC/TS-50591</i></p>

*technology (State 0). Further the energy consumption of state 1 (incl. the S2R innovations) should be estimated twice a year over a period of 3 years.*

(CENELEC, 2013). In addition, OPEUS will enhance the urban duty cycle that the OSIRIS project proposed. Similarly, OPEUS is seeking full engagement and cooperation with the S2R members to ensure relevant innovations can be evaluated swiftly and regularly. The establishment of an Advisory Board will facilitate this process (more about this body, below).

*For the optimisation of driver assistance systems the optimum driver strategies and energy management should be developed for different propulsion systems and traffic segments. Further different driver assistant systems should be compared by means of simulation or "hardware in the loop"*

S-DAS and C-DAS approaches and related strategies are being assessed by simulation (**WP04**). The characteristics and role for potential energy optimisation of these two main types of DAS system are being compared, drawing conclusions in terms of the most promising optimised driver strategies for each of the four reference scenarios. This work is benefitting from experience implementing the technology by OPEUS participant STAV as well as the critical operational feedback provided by UITP and UIC's members, active in OPEUS through these two organisations and the Advisory Board.

*A study should be carried out to analyse the losses of energy within the traction chain including their cooling needs for different traction systems in dependence on the operational states like acceleration, steady state, braking and parking. This should be done by simulation with validated tools. Based on the results, measures for reduction of the losses should be identified*

OPEUS is carrying out an in-vehicle energy losses study (**WP05**) characterising standard vehicle architecture suitable for operation on the four reference scenarios and four operational phases i.e. acceleration, cruising, coasting and braking. This will be then used to analyse the energy losses in the traction chain identifying key areas of improvement. The OPEUS tool will be used to perform this model-based assessment. In addition, the project will also use STAV's own simulation tool to run a complete simulation, providing overall energy consumption for comparison and validation purposes.

*The study should include an analysis of the auxiliary consumers, including at least the heating, venting and air conditioning (HVAC) system, the air compressor and the DC loads*

These aspects form part of the vehicle architecture and as such the in-vehicle energy losses study (**WP05**) is also exploring the characteristics and performance of HVAC and other components. An assessment of DC loads will be carried out. Data provided by OPEUS' vehicle manufacturer partner, STAV, will be used.

*The switching off of propulsion units at low loads should be analysed with respect to energy saving and gear box wear*

Using the four operational phases applied to each of the four reference scenarios as a framework, **WP05** is exploring the merits of introducing a strategy that switches off the

propulsion system at low loads instances (e.g. not during acceleration and braking), investigating its effects and energy usage. It is estimated that this approach would reduce energy losses in motors and converters requiring a low cost intervention in the form of on-board software optimisation (González-Gil *et al.*, 2014b) which will be simulated.

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*Based on the results of the previous EU research projects, e.g. Clean-ER-D, the application of the innovative technologies fuel cells, high performance batteries, super caps and permanent magnet motors for electrical drives should be analysed with respect to energy saving and life cycle costs for different traffic segments.*

The four reference scenarios will be used again to assess the influence of introducing innovative ESSs in energy usage and overall cost (**WP06**). The work is being led by the battery manufacturer SAFT which also led the model-based assessment of such technologies (batteries, double-layer capacitors, hydro-static accumulators) as part of the CleanER-D project. In addition, SAFT contributed to the demonstration of a new concept of onboard energy storage system for trams as part of OSIRIS<sup>2</sup>.

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*A global vision of energy in railways should be developed including smart management of railway networks.*

OPEUS will use the outcomes of its activities to carry out a critique and outlook of rail energy usage leading to a position paper outlining a global vision of energy in railways. This work will summarise energy usage requirements and trends for the four reference scenarios evaluating their significance and influence at system level. Particular relevance will be given to the potential role of introducing smart management of railway networks. This aspect was partially covered in the recent MERLIN project where Newcastle University led the strategic aspects of such networks. OPEUS will advance this by exploring how smart rail networks could be practically implemented. Support from key players such as INFRABEL who is leading work in the field will be essential (see Advisory Board in section 2.2.3).

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<sup>2</sup> [http://www.osirisrail.eu/wp-content/uploads/2015/05/03\\_-\\_New\\_concept\\_of\\_Onboard\\_Energy\\_Storage\\_System\\_for\\_tram\\_tested\\_in\\_Vitoria-Gasteiz.pdf](http://www.osirisrail.eu/wp-content/uploads/2015/05/03_-_New_concept_of_Onboard_Energy_Storage_System_for_tram_tested_in_Vitoria-Gasteiz.pdf)

## Annex 2: An overview of how OPEUS will address the expected impacts of the S2R Open Call topic.

S2R-OC-CCA-02-2015 expected impact	Key relevant OPEUS outputs
<p><i>The expected impact [...] is linked to the determination of the energy improvement of technical innovations in order to decide which innovations should be applied when new trains or infrastructure assets are purchased.</i></p>	<p>Stage 01 is delivering an enhanced simulation methodology and tool (D02.1, D02.2 and D02.3) allowing for the assessment of the potential benefits in terms of energy performance of novel technologies. Then stage 02 will explore the energy improvement that can be derived from applying relevant S2R innovations (D03.3), improved driving strategies (D04.2), advanced ESSs (D06.2) and traction chain improvements (D05.2).</p>
<p><i>The reduced energy consumption should lead to a reduction of the environmental impact and help to increase the competitiveness of rail transport due to reduced energy cost.</i></p>	<p>Stage 03 is providing a critique of the energy usage in both urban (D07.1) and mainline railway systems (D07.2) highlighting areas and solutions of particular interest to improve the environmental performance of rail systems while reducing the costs associated with the energy usage. A detailed description of the energy requirements of urban railways (D01.1) will be also delivered, supporting the outlook assessment.</p>