Findings Report
October 2015

Action WP6 Inv14:
Innovative technologies for light rail and tram-base systems: a European reference resource
Sustainable transport for North-West Europe’s periphery

Sintropher is a five-year €23m transnational cooperation project with the aim of enhancing local and regional transport provision to, from and withing five peripheral regions in North-West Europe.

INTERREG IVB

INTERREG IVB North-West Europe is a financial instrument of the European Union’s Cohesion Policy. It funds projects which support transnational cooperation.
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Introduction

This Findings Report summarises the development of a European reference resource for innovative technologies for light rail and tram-based schemes in cities and regions, with particular reference to lower-cost possibilities and opportunities to maximise use of existing rail infrastructure, whether electrified or non-electrified. The work was undertaken by University College London as part of their contribution to the Sintropher transport project funded by the EU’s North West Europe transnational co-operation Programme under INTERREG IVB.

Sintropher focuses in particular on light rail and tram-based schemes, but the technologies in the reference resource could in some cases be applicable to transport schemes generally, for example bus and heavy rail.

Part 1 provides the background and context to the work, and Part 2 outlines the development of the reference database, and its structure and coverage of topics.

Part 3 sets out the transnational relevance of the resource in relation to knowledge transfer within the Sintropher project partnership, and wider target audiences, and arrangements for open access. The main audiences are governmental authorities and transport agencies at city, regional, national and EU levels; and transport professionals and practitioners who may be involved in initiating and implementing new transport infrastructure links.

Part 4 outlines next steps regarding the hosting, ongoing development, and ongoing open access to the reference database.

Part 5 provides contact details, and Part 6 summarises the overall Sintropher project, of which this work is a part - the overall aims, objectives, partners and partner regions, and activities.
Part 1
Background and objectives

Background

This Findings Report is about one of the Investments undertaken for the Sintropher project funded under the INTERREG IVB North West Europe Programme. It summarises the development of a European reference resource innovative technologies for light rail and tram-based schemes in cities and regions, with particular reference to lower-cost possibilities and opportunities to maximise use of existing rail infrastructure, whether electrified or non-electrified.

The overall aim of Sintropher is to develop sustainable, cost-effective solutions to improve connectivity to, from and within poorly connected regions in North-West Europe - to use innovative transport links to connect peripheral regions of NWE with the core European transport network of high-speed trains, via effective interchange hubs.

There has been a particular focus on tram-train systems which allow local trams to run on to national rail networks, pioneered in Germany, firstly in Karlsruhe and developed in Kassel, which allow urban tram systems to extend over national rail tracks to serve extensive city regions. The project has also looked at other innovative forms of tram systems such as single-track tramways, as well as high-quality transport interchanges that link such systems to major national or transnational rail or air hubs.

The project began in late 2009, with fourteen partner agencies in five EU Member States, and lead partner University College London (UCL): Valenciennes (France); the Fylde Coast (UK); West Flanders (Belgium); North Hesse (Germany); and Arnhem-Nijmegen (Netherlands). Participants included public transport operators, local authorities, regional transport agencies, and universities.

They have worked together on a series of feasibility evaluations, pilot investments and demonstration projects, as well as comparative analyses of EU best practice. The total budget is more than €23m, with funding part-financed by the EU’s INTERREG IVB Programme.

A €1.5m project extension in 2014, covers follow-on work to capitalise on results from the initial project, and added a fifth objective: to test technologies for low cost transport links in different territorial contexts, plus integrated territorial corridor plans that help these links unlock wider economic and regeneration benefits, and better recognise these in business cases. This included two new partners (total now 16) and two extra demonstration regions (total now 7) in West Flanders Brugge-Zeebrugge (Belgium) and Saar-Moselle (a cross-border region France-Germany).

Innovative technologies for light rail and tram - developing opportunities

Previous results from Sintropher show that low-cost systems, such as tram-train, tram-rail, and single-track tram systems, have clear potential but there is no single “best” solution and these opportunities must be assessed and adapted to city/regional circumstances.
Additionally over the 5 years of Sintropher, there have been dramatic developments in relevant transport technologies. The most important are (a) very long-life batteries that allow electric trams and trains to operate over substantial distances “off the wire”; (b) charging devices that boost battery life by recharging at stops en route – e.g. the supercapacitor technology demonstrated at the 2010 Shanghai Expo, or the induction system employed by Bombardier in their Remove trams and buses; (c) discontinuous electrification that allows electric trains and trams to “coast” under bridges and through short tunnels where it would be impossible or prohibitively expensive to install overhead catenary.

A starting-point: UK Network Rail Report

A recent Report by UK Network Rail “Network RUS: Alternative Solutions” (July 2013) - an input to its Route Utilisation Strategy for long-term planning of the national rail network - has reviewed these developments (Figure 1). Although this relates to the context of the UK rail network, the content is highly relevant to other European countries, subject to variations in the national technical and regulatory regime. It offered a useful starting point for Sintropher’s work.

The work by Network Rail followed a remit to think imaginatively about cost effective solutions for accommodating growth in UK passenger demand, and operating services more efficiently. The solutions which are considered in the UK context are generally over and above the conventional solutions such as types of rolling stock and 25kV AC overhead line electrification. It looked at tram-train, tram systems, battery-powered vehicles, hybrid light rail, personal rapid transit, bus rapid transit and guided bus, and electrification solutions for lightly-used routes. Its main focus is on existing rail lines in the UK network, but it can also be used to consider options for new transport corridors in urban areas.

Figure 1
Report by Network Rail on Alternative Solutions (to developing rail infrastructures).
The Report’s overall comment is “Whilst some of the solutions are close to an appropriate stage of development (or adaption) for introduction onto the UK rail network, others will require more attention, for example on battery technology. It is important to be aware that, by definition, a process of innovation is a process of change and that some technologies that are not listed as appropriate at present may become appropriate after further development work. It is possible that over the next 30 years there may be some significant technological developments that could reshape the market for public transport and how it is powered.”

Sintropher: a European reference resource

So within the project’s partner regions, there has been further feasibility work to test these emerging kinds of innovative low-cost solutions in different city/regional contexts, including new developments in technology. Sintropher’s work on a reference resource has three objectives:

- to develop a European database (reference resource) of innovative technologies for light rail and tram-based systems; and exemplar cases of where these approaches have been successfully applied in the real world, to help construct new transport links
- include a review of their potential applicability to rail and light rail systems in other EU Member States
- to promote wide access to this by target audiences, through a web-based resource linked into an appropriate European transport network or platform e.g. ELTIS, POLIS, and EPOMM.

The European reference resource informs project partners’ work, and is also intended to be of relevance to much wider audiences. Particular target audiences are:

- governmental authorities and transport agencies at city, regional, national and EU levels;
- transport professionals and practitioners who may be involved in the initiation and implementation of new transport links

Sintropher focuses in particular on light rail and tram-based schemes, but the technologies in the reference resource could in some cases be applicable to transport schemes generally, for example bus and heavy rail.

The reference resource is a snapshot in time (October 2015) and obviously the field of technologies is developing on an ongoing basis - it is hoped to update the various constituent briefing papers periodically as necessary.
Part 2
Development of the European reference resource

Methodology

The reference resource was developed in stages: (1) specification (2) design (3) software development (4) data input (5) testing and finalisation (6) live operation.

Stage 1

Specification consisted of developing a typology of innovative technologies for light rail and tram-based systems, as a working framework; and then specification of a series of briefing papers (including city/region case examples) to cover the various category of technological solutions.

The typology is shown on Figure 2, and was developed by examining relevant literature (desk exercise) and discussion with experts from the project partners and some external experts. Particular reference was made to the Report by Network Rail mentioned earlier.

Figure 2
Sintropher’s typology of Innovative technologies for light rail and tram-based systems
Stage 2

Design: the briefing papers cover each category (the white boxes on Figure 2) - one paper per category - and content covers:

- context/status of the financing approach
- the mechanism
- advantages
- disadvantages
- track record of implementation
- European case study where implemented/ being implemented
- overall comment/assessment of potential
- future prospects
- transnational relevance
- further information

They are designed to be short and succinct, for busy transport professionals and managers working in government authorities, transport agencies, and consultancies (Figure 3).

Figure 3
Example Sintropher briefing paper
Stage 3

Software development: the reference resource is designed to be web-based and can be easily uploaded on to the Sintropher website for access by any user, by simply going to the home page (news feature or similar) and then navigating to a dedicated section which will include the briefing papers as PDF documents. The website will be operational until at least 2020, beyond the formal end of Sintropher in 2015.

Software development was also influenced by discussions with potential European transport networks/platforms, about potentially hosting the reference resource on their website (to realise the objective to link into an appropriate existing European network or transport platform, in order to enhance dissemination and user access). The simple PDF basis was easily adaptable to such websites, combined with a suitable dedicated web page and feature/tab on the home page, also linked to the website’s keyword search facility if present. Very positive discussions were held with three major networks - ELTIS, POLIS, and UITP.

ELTIS facilitates the exchange of information, knowledge and experiences in the field of sustainable urban mobility in Europe. It is aimed at individuals working in transport as well as in related disciplines, including urban and regional development, health, energy and environmental sciences. Created more than ten years ago, ELTIS is now Europe’s main observatory on urban mobility. It is financed by the European Union under the Intelligent Energy - Europe (IEE) programme.

POLIS is a network of European cities and regions (membership currently 70 organisations). Since 1989, European local and regional authorities have been working together within POLIS to promote sustainable mobility through the deployment of innovative transport solutions. Its aim is to improve local transport through integrated strategies that address the economic, social and environmental dimensions of transport. To this end, POLIS supports the exchange of experiences and the transfer of knowledge between European local and regional authorities. It also facilitates dialogue between local and regional authorities and other actors in the sector such as industry, research centres and universities, and NGOs. In POLIS, decision makers are provided with the necessary information and tools for making sustainable mobility a reality. Within the Political Group of Polis, they also formulate recommendations to the European institutions.

UITP (International Association of Public Transport) is internationally recognised for its work in advancing the development of sustainable urban mobility. UITP has a long history, and is now a worldwide network to bring together all public transport stakeholders and all sustainable transport modes. It promotes innovation and encourages new ways of thinking; provides a platform for sharing insights into the latest mobility trends and hot topics; looks to the future by anticipating mobility needs and inspiring pioneering solutions; and acts as a global centre of knowledge on the sustainable mobility of today and tomorrow; and gathers information, best practices and statistics related to sustainable mobility worldwide.

All three were interested to collaborate with the Sintropher initiative, and the choice of host was difficult given that all three networks have a good reputation in the world of transport, and offer wide access by users. POLIS was chosen to host the European reference resource, based on practical matters - it had a combination of suitable website architecture, open access to users, and ability to act within the timescale of Sintropher which is due to formally finish in October 2015 (a big factor was that Sintropher also developed a European
reference resource on innovative financing for transport infrastructure - which also needed to
be hosted on the same platform (Sintropher Findings Report for Investment 13).

Figure 4
European reference resource hosted by POLIS network

Implementing public transport schemes: approaches to financing and innovative technologies

Sintropher is a transnational INTERREG IVB project, funded by the North-West Europe Programme, and runs from 2009-2015.

The aim of Sintropher has been to look at ways to enhance economic growth through better regional connectivity. It has a particular focus on rail-based modes, which are often neglected in more outlying regions. What are the best ways of implementing such schemes and getting them off the ground?

Two key aspects concern creative approaches to financing and innovative technologies, described in more detail below. Each example given contains two sections: an overview of the approach itself, and a case study of where it has been implemented in practice.

Technology

Classically trains have used electricity as the main means of propulsion, drawing power from overhead wires. In recent years, though, there has been a large increase in the number of alternative modes of propulsion. In the sense that they may make a scheme more potentially viable, it is these technological innovations which we detail here.

1) Ground Level Power Supply

Ground Level Power Supply is a modern innovation in third-rail electrical power transfer for trains.
Even though a choice had to be made, we are pleased to say that ongoing working links are being maintained with all three networks.

Stage 4

Data input: the briefing papers were produced by UCL using desk-based research and in-house expertise, supplemented by information from project partners and external experts:

- desk-based investigation includes reference to the Network Rail Report, and various literature based on a web search

- expert knowledge from project partners include tram-train systems (Kassel University) single-track tram systems (Valenciennes transport authority SITURV) and battery-power systems (Stadsregio Arnhem-Nijmegen and colleague agencies)

- the pool of external experts included Network Rail who are conducting a UK trial of battery-powered trains on a non-electrified line in East Anglia (technical visit by project partner Stadsregio Arnhem-Nijmegen and UCL); UK Dept for Transport (who commissioned a technical trial of tram-trains in Sheffield); and consultancies used by partners in the course of their feasibility investigations.

- other experts spoke at a transnational technical Seminar organised by Landor (a major transport media company) in collaboration with Sintropher in Brussels, February 2014.

- presentation and discussion of the Network Rail Report at a Sintropher Workshop including relevance/applicability to other European countries especially project partners’ own tram/rail regimes (Saarbrucken May 2015) (figure 5).

For the city/region case examples, direct interview with the relevant authorities would have been desirable, but this was not possible due to a demanding timescale and limited resources.

Stage 5

In the testing and finalisation stage, the draft briefing papers were circulated to expert project partners for comment.

Stage 6

The reference resource is going “live” with a news feature and access on the Sintropher website, plus a link to the main material being hosted on the POLIS website (figure 4). A memorandum between UCL (on behalf of Sintropher) and POLIS sets out the operational arrangements, including appropriate acknowledgments to the Sintropher project, NWE Programme and ERDF. It includes provision for future UCL staff and/or POLIS associates, to add new briefing papers or update the existing ones, with appropriate reference to the author, and quality control.
SINTROPHER Plus

GB Network RUS
Alternative Solutions

Saarbrücken Workshop
11th-13th May 2015
Tim Kendell

Network RUS – Strategic Planning Process

- WHAT IS A RUS?
  - Route Utilisation Study
  - Geographical RUS
    - Looks 15 years into the future – assesses needs for the specified route
  - Network RUS
    - Looks up to 30 years into the future at network wide issues
    - Freight RUS
    - Electrification Strategies
    - Stations
    - Passenger Rolling Stock
    - Alternative Solutions

Network RUS – Alternative Solutions

- Reducing Whole Industry Whole Life Costs
  - Tram and Tram Train conversion of heavy rail infrastructure
  - Alternative methods of electrification on lower density lines
  - Community Rail

Tram and Tram Train conversion of heavy rail infrastructure

- Understand what a Tram Train is
  - The difference between a Tram and a Tram Train
- Where is it the appropriate option
- Where it is not an appropriate option
- Understand what changes need to be made to heavy rail infrastructure

Electrification for lightly used routes

- Discontinuous Electrification
  - Unpowered sections under low bridges
  - Conductor wire gapped under low bridges
  - Conductor switched – Paisley Canal option

- Discrete Electrification
  - Long length without electrification
  - Train has energy storage
  - Discrete charging points along or at end of route
  - Trials of Battery train on the Manningtree – Harwich branch
  - Trolley Wire at low voltage
  - Tramway style electrification
  - 750-1500 V DC

Other vehicle options

- Self Powered Vehicles
- Battery Powered Vehicles
- Hybrid Vehicles
- Personal Rapid Transit (PRT)
- Bus Rapid Transit (BRT) or Guided Bus

Community Rail

- Community Rail Partnerships
- Line or Service Designation
- Community and railway companies work together
- Additional freedom for local marketing and ticketing
- Volunteering for non-operational work
- Train operator, Network Rail, Local Authority & Local Community involved
- Added freedom to let station buildings at non-commercial rents for community use
- Outside TEN-T and Interoperability

Network RUS – Alternative Solutions

- Regulated study by Network Rail on behalf of the GB Rail Industry
- Developed in partnership with the GB Rail Industry
- Observers from Government and the Regulator
- Widely Consulted
- Associated Research facilitated by RSSB and Future Rail
- www.rssb.co.uk  http://www.futurerailway.org
- Community Rail Development Strategy
- Association of Community Rail Partnerships ACoRP
- http://www.acorp.uk.com/
Issues arising and how resolved

The main matters were:

- development of a useful typology of innovative technologies for light rail and tram-based systems. As outlined earlier, this was developed by examining relevant literature (desk exercise) and discussion with experts from the project partners and externally.

- selecting good city/region case studies for the various categories of financing approaches - achieved by UCL in-house expertise with advice from project partners and external experts.

- ensuring, in the discussions with potential European networks/platforms, open access to the material by users in accordance with the requirements of the NWE Programme and ERDF funding. Not a problem - users simply go to the home page of POLIS and navigate to the Sintropher page (or use the POLIS search tool to find the light rail/tram technologies topic).

- ensuring the reference resource has a life after Sintropher formally ends in October 2015 - the POLIS website has an ongoing life, and the memorandum with POLIS includes provision to add new briefing papers or update the existing ones, by future UCL staff and/or POLIS associates (with appropriate reference to the author, and quality control).
Part 3
Transnational relevance to Sintropher partners and wider audiences

The reference resource will be utilised both within Sintropher by various project partners, and it also has a much wider transnational relevance to other cities and regions which may be seeking to implement new or extended tram-based links to enhance regional connectivity.

Transnational relevance: Sintropher partners

The reference resource will be utilised by Sintropher partners to follow up their work on technical and economic feasibility assessments for new or extended innovative tram-based systems in their region (“Sintropher Plus”):

- Saar-Moselle: the Sintropher feasibility studies examined options for extending the region’s existing tram-train route to cover (1) a new link Saarbrucken-Forbach (estimated capital cost € 132.7m - € 170.4m) (2) a service connecting Alt-Saarbrucken and the ZF factory, an automobile subcontractor which has almost 10,000 German and French employees (3) extension by creating a small regional loop from Forbach - Völklingen estimated capital cost € 143.8m (4) a large regional loop Forbach -Béning - Freyming-Merlebach, - Creutzwald - Überherrn - Wadgassen - Völklingen - Sarreguemines, estimated capital cost € 292.7m. Tram-train options were compared to bus rapid transit, and the feasibility of using methane gas power from Saar-Moselles’ new state-of-the-art EfW plant (Energy from Waste) is an explicit option.

- Flanders, Brugge-Zeebrugge corridor: De Lijn’s feasibility studies include options for a single-track tram system (as in Valenciennes) a tram-train system (as in Kassel) and various options to extend existing conventional tram.

- Fylde Coast, South Fylde Line: the Sintropher-funded corridor studies examined options to connect the existing Blackpool Tramway on to the SFL, linking to the regional/national rail station hub at Preston by either tram or tram-train.

- Arnhem-Nijmegen: Stadsregio Arnhem-Nijmegen (now Province Gelderland) has assessed the feasibility of operating the region’s existing electric trains (heavy rail) on non-electrified lines on the regional network, using battery power. The same principle could apply to the region’s trams and trolleybus routes.

- Kassel; /Nordhessen: the focus is on further development of the region’s existing innovative tram-train network.

Transnational relevance: Europe-wide

The reference resource should be seen from this perspective, as a means to promote knowledge transfer and learning across different NWE countries and regions.
The technologies and approaches and city/region case examples on the reference resource are context-specific and reflect:

- the geographical context: for example the extent of the urban or regional rail (and/or tram) network and degree of electrification or non-electrification; density of traffic; extent of urban and rural areas; and physical urban conditions such as street width, environmental conditions, historic areas.

- the technical context: the national regime of technical standards for rail or tram infrastructure, rolling-stock vehicles, rail electrification power supply.

- the regulatory context: the national regime for matters especially safety standards, CO2 emissions, environmental impact.

Some of the technical and regulatory matters are EU-wide. A Sintropher Report on the technological and organisational aspects of innovative tram-based systems looks at the desirability of greater harmonisation across Member States where different standards exist (see references).

These potential low-cost solutions now need to be tested in different regional cases in EU Member States. There are some distinct physical differences:

- rail systems in most Member States were built at lower cost than in the UK, with fewer over-bridges and more at-grade road/rail crossings, which may reduce the benefits of some technological alternatives (e.g. discontinuous electrification).

- many areas have historic towns where conservation considerations make overhead catenary undesirable, increasing the advantage of battery-based solutions.

- in many European countries, in contrast to the UK, many urban tram systems have been maintained, or even constructed in the last 20 years, making tram-train solutions more relevant.

Even though the various approaches and case examples are context-specific, their transnational relevance is strong:

- the approaches offer a stimulus and possibilities for wider thinking by cities and regions in other European countries

- some or all of the various approaches might be potentially adaptable within the particular organisational and governance regime of another country, and technical and regulatory regime. For example the Governments’ UK tram-train trial in Sheffield, Network Rail’s UK trial with battery power for trains on a non-electrified heavy rail line in East Anglia, and (in Sintropher) Province Gelderland’s feasibility studies for battery power to enable electric trains to operate on non-electrified routes in their regional network.

The reference resource should be seen from this perspective, as a means to promote knowledge transfer and learning across different NWE countries and regions.
Part 4
Next steps

This covers three dimensions: use of the reference resource by Sintropher project partners; use by wider target audiences; and ongoing availability and development of the resource through time.

Use of the reference resource by Sintropher project partners

The reference resource is available to all partners, to assist with their feasibility work on new or extended tram -based links in their respective regions using integrated corridor studies (see Part 3 of this report). This will include uploading the material on to the Sintropher website.

Dissemination to wider target audiences

The resource will have open access by any user in accordance with NWE Programme requirements and ERDF Regulations. Particular target audiences are governmental authorities and transport agencies at city, regional, national and EU levels; and transport professionals and practitioners who may be involved in the initiation and implementation of new transport links. Access will be by two routes: the Sintropher project website (which has a limited life after Sintropher ends) and the POLIS website (ongoing life).

Dissemination and utilisation will be promoted by a feature on the Sintropher website home page, and a feature on the POLIS website. Plus possible news items in other communication channels such mainstream transport journals.

Ongoing availability and development of the resource in time

As mentioned previously, the material will be available on the POLIS website on an ongoing basis. The memorandum between UCL and POLIS includes provision for future UCL staff and/or POLIS associates, to add new briefing papers or update the existing ones (with appropriate reference to the author, and quality control).
Part 5
References and further information

References

www.networkrail.co.uk

http://www.sintropher.eu/publications


Detailed findings

The European reference resource can be accessed on the following:

Sintropher project website
http://www.sintropher.eu/publications

POLIS website
http://www.polisnetwork.eu/sintropher or http://www.polisnetwork.eu/res/resources

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Responsibility for the report

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Part 6
What is Sintropher?

The Sintropher transport project (Sustainable Integrated Transport Options for Peripheral European Regions) is funded by the EU’s North West Europe transnational cooperation programme under INTERREG IVB.

The overall project aim is to develop sustainable, cost-effective solutions to improve connectivity to, from and within poorly connected regions in North-West Europe. There are four objectives:

• promote possible cost-effective technology-based solutions
• assess the appraisal procedures used by different counties for investment in regional tram systems and improve the development process for a positive business case
• promote high-quality, effective interchange between regional tram systems and regional rail and air hubs
• promote and market the benefits of regional tram-based systems to users and stakeholders

There has been a particular focus on tram-train systems which allow local trams to run on to national rail networks, pioneered in Germany, firstly in Karlsruhe and developed in Kassel, which allow urban tram systems to extend over national rail tracks to serve extensive city regions. The project has also looked at other innovative forms of tram systems such as single-track tramways as well as high-quality transport interchanges that link such systems to major national or transnational rail or air hubs.

The project began in late 2009, with fourteen partner agencies in five EU Member States, and lead partner University College London (UCL): Valenciennes (France); the Fylde Coast (UK); West Flanders (Belgium); North Hesse (Germany); and Arnhem-Nijmegen (Netherlands). Participants include public transport operators, local authorities, regional transport agencies, and universities.

They have worked together on a series of feasibility evaluations, pilot investments and demonstration projects, as well as comparative analyses of EU best practice. The total budget is more than €23m, with funding part-financed by the EU’s INTERREG IVB Programme.

A €1.5m project extension in 2014, covers follow-on work to capitalise on results from the initial project, and added a fifth objective:

• to test technologies for low cost transport links in different territorial contexts, plus integrated territorial corridor plans that help these links unlock wider economic and regeneration benefits; and better recognise these in business cases (this also covered innovative fainting to fund invetswemt cases in such schemes)
This includes two new partners (total now 16) and two extra demonstration regions (total now 7) in West Flanders Brugge-Zeebrugge (Belgium) and Saar-Moselle (a cross-border region France-Germany).

The project officially ends in European funding terms in October 2015 and work will continue by partners beyond this, to capitalise on results and generate impacts in terms of influencing transport and territorial development policies and investment programmes in their regions, and respective national approaches to appraising and deciding investment in such links.

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Sustainable transport for North-West Europe’s periphery

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Partners

Sintropher is coordinated by

In partnership with

Co-funded by the INTERREG IVB programme for North-West Europe