Support to Europe's Rail Joint Undertaking | Framework Contract S2R.19.OP.02 LOT 1 - Strategy Advice

Specific Contract n° 3 – European DAC Investment Plan

Final Report v6 – 16 December 2022

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Executive summary

CONTEXT

In the context of the environmental and macroeconomic challenges facing the EU, rail freight, being the least carbon intensive transport mode, offers the solution to significantly reduce emissions in the transport sector. A single freight train can replace many lorries, which bring the additional benefit of decongesting the road transport. Rail freight plays a key role for the competitiveness of European industries and can take an even more prominent position. On this account, the European Commission has committed to enhance automated mobility and double rail freight traffic by 2050.[1] The European rail sector has committed itself to increasing the modal share of rail freight in the union to 30% by 2030[2].

These objectives are extremely ambitious. In order to reach them, one key technology brick is the deployment of the Digital Automatic Coupling (DAC) in the European rail freight sector.

This report provides an investment plan which would enable the deployment of DAC and thereby revolutionize the European rail freight industry, further strengthening the EU's overall sustainable and digital strategy.

Currently, rail freight operations are still dependent on many manual, cost-intensive and strenuous processes, which are not in line with the EU's overarching vision of digitalisation, low-emission transport nor modern working conditions.[3]

In this respect, one of the key enablers towards full digital train operations is a new DAC technology that has been developed both within Europe's Rail and by different other national programmes. DAC enables an automated coupling and uncoupling of wagons. This increases the capacity of terminals, improves the performance and safety of the railway system, and thus opens the potential for shifts from road to rail transport, reductions in CO_2 emissions and economic growth. Especially, it enables intelligent wagons powering them with energy and digital information that will create new services and opportunities for clients, answering long due demands.

CHALLENGE

The implementation and deployment of this technology risk being hindered by several factors:

- The technological advancement **cannot be made as an interoperable** unit with the old technology. Therefore, the deployment must be simultaneous and adopted by every market player. This complex

[1] As described in the EU SSMS Mobility strategy

[2] https://www.railfreightforward.eu/sites/default/files/usercontent/white_paper-30by2030-150dpi6.pdf

[3] Europe's Rail (2022) Open European DAC Delivery Programme enabled by Europe's Rail [Available at: https://rail-research.europa.eu/european-dac-delivery-programme/]

migration exercise needs to be very rapid yet harmonized. However, the European and national railway systems across Member States are highly fragmented.

- **The distribution of costs and benefits** of DAC across different stakeholders of the liberalised railway system (waggon rental companies, railway infrastructure managers, railway undertakings …) is uneven. Key benefits of DAC will arise in train operations and in infrastructure capacity. However, this business segment is undertaken by a different set of stakeholders than the ownership of wagons which would entail the investment in DAC.

- **The financial landscape** of the rail freight industry in Europe, a sector with high intramodal and high intermodal competition and low margins, makes large capital-heavy investments a significant challenge for market participants, even if there are significant long-term benefits of the investment

► **SOLUTION**

Given these constraints, this report describes the operational framework, the overall financing needs as well as the different financing approaches to deploy this technology.

1. Operational framework:

From an operational perspective, a Europe-wide centralised control booth appears as a fundamental strategic approach for securing a successful DAC deployment in the EU and beyond[4]. This centralised approach would allow to accommodate for the considerable capacity requirements, to set a European standard homologation and to manage incompatible wagons. The DAC migration phase is expected to last 6 years (starting in 2026 and ending in 2031[5]). This centralized approach would be necessary to ensure a harmonized, competitive, and timely DAC production capacity. As 51%[6] of rail freight traffic in the EU is international and has to be interoperable, isolated national solutions would not allow to tackle the problem. Therefore, there is a strong need for intervention by the EU.

2. Funding and financing needs:

From a financial perspective, a model has been designed with the view to preventing public overspending and maintaining viable financial conditions to incentivise market participants. The key inputs have been provided by the DAC Cost Benefit Analysis (CBA) conducted within the framework of Work Package 5 by the European DAC Delivery Programme (EDDP) under the leadership of the European Commission. The structure of the model has been engineered to remain consistent with this CBA data.
The deployment of the DAC requires investments for the purchase and installation of couplers and components, investment in infrastructure and in IT systems. The total investment costs is currently estimated at €10,6 billion (discounted values) in only six years. The societal benefits alone would be estimated at € 12 billion circa over 30 years by 2050 according to EU standards on Cost Benefit Analysis, without considering the economic benefits for

[4] Non-EU members like Switzerland, Norway and Balkan countries are an integral part of the European rail system

[5] These assumptions have been used in the Cost-Benefit-Analysis of this report.

[6] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Railway_freight_transport_statistics#Geographical_location_plays_a_key_role_in_the_share_of_international_transport_performance

the industry stakeholders. There is a need to bridge the gap between massive, short-term investment and long-term benefits of DAC.

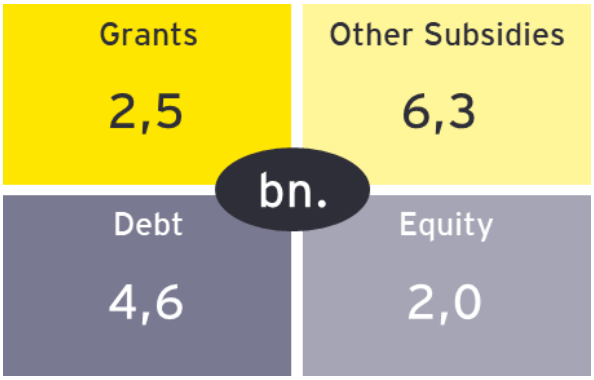
Investment 2026-2031	million €
Total **CAPEX** for DAC migration, during the period 2026-2031[7]	9.034
Additional **OPEX** for DAC extra-maintenance, during the period 2026-2031	1.592
Total	**10.626**

3. Funding and financing options:

Regarding the financing options to support the coordinated deployment of DAC, this report has found that equity would essentially be provided by industry players, though in a moderate form. Financial institutions like the EIB and National Promotional Banks would be keen to engage in large and long-term lending operations for DAC, however grants' quotas and government backed guarantees would be necessary to reduce their significance and cost respectively.
Based on the capacity, form and timing of provision of public support, two scenarios have been modelled for the DAC investment plan:

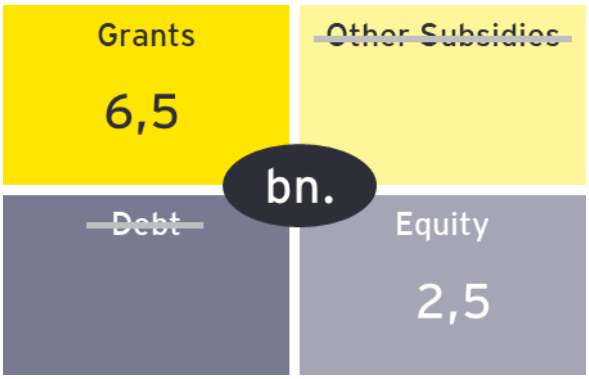
[7] This also includes the one-off costs for the scrapped incompatible wagons (see chapter 4 for detailed information)

Scenario 1: Blended Financing



- The first scenario assumes a moderate level of EU and MS public spending capacity during the period 2026-2031. The deployment would start after 2026, and take the same number of years. In this scenario, equity investments in shares are expected to be limited. This would thus require a significant debt financing need. It envisages favourable and long-term lending conditions by the EIB, National Promotional Banks and other financial institutions and investors, enabled by an EU budget guarantee.
- Special Purpose Vehicles (SPV) will be necessary to get access to and repay the debt on behalf of the community of investing stakeholders
- Under this model, the configuration of (public) funding and (private) financing sources would cover the total CAPEX needs (€9 bn. circa). Associated OPEX and additional costs (€2.5 bn. circa in total) would require additional forms of subsidies during the first years of the DAC operations. The financial model has simulated the minimum amount and duration of additional subsidies necessary to sustain financial viability for all the stakeholders.
- The total public support is expected as €8.8 bn. over 18 years.

Scenario 2: Up-front Funding



- The second scenario assumes that the public grants would be available to cover a large portion of the initial investment cost (CAPEX). This would spare the need for sophisticated financial structures, debt instruments and subsidies to sustain OPEX and other costs. It would also avoid associated transaction costs and risks to complete the DAC migration.
- Under this model, the total EU grant of €6,5 bn. circa, representing 71,5% of the total CAPEX envisaged. The € 6,5 bn of grant represents 1,9% of the grant quota of the RRF (€338 bn.), while it is reasonable to assume that the leftover portion of these funds could be potentially much higher, due to unspent resources.
- The remaining part (€2,5 bn. circa) would be covered by a combination of equity and possible commercial bank loans, depending on convenience and capacity of the individual stakeholders.
- The total public support is expected as €6.5 bn. over 6 years.

CONCLUSION

DAC represents a propitious opportunity to increase the modal share of rail and to decrease the overall energy intensity and carbon emissions of the transport sector while furthering the process of digitalisation of the industry and increasing macroeconomic productivity across borders in the EU. To attain these goals, a Europe-wide implementation, and investments of €10,6 billion would be necessary.

Both the considered scenarios provide positive results in terms of financial viability, presenting a breakeven point by 2035 for all stakeholders. The comparison of the two scenarios produced the following conclusions:

- In terms of funding level, the main difference lies in the public spending capacity and intensity over time. Scenario one foresees more conservative levels of up-front grants available during the period 2026-2031, however, due to necessary, complementary and lasting injections of additional subsidies, it eventually ends up presenting a higher level of total public support (€8.8 bn. over 15 years) compared to the alternative scenario two (€6.5 bn over 6 years).
- In terms of simplicity of the funding mechanism, scenario two would still represent the most feasible option. No sophisticated EU financial instruments would be necessary, as well as any form of subsidy schemes at member state level under scenario two. These avoided complications of the financial structure not only spare the associated transaction costs but more importantly the potential spill outs on the way to a complete and successful DAC migration for the entire EU fleet.

Without prejudice to the financial and political feasibility of the scenarios, scenario two is therefore the recommended way forward to significantly de-risk a complex undertaking per se and to secure the best return for both the private and the public investment.

Taking into consideration the complexity of DAC deployment and the necessary coordination across countries and a variety of stakeholders in the entire European Union and beyond, it is recommended to set up an EU DAC Deployment Manager as a centralized structure to assume critical tasks for the implementation of this strategic European common project. The legal basis for this EU DAC Deployment Manager should be created as soon as possible starting in 2023, to achieve the target of starting the DAC deployment by 2026. The close engagement of the MS will be crucial to a harmonized, coherent hence successful DAC migration in the EU.

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Acronyms and Abbreviations

AC	Automatic Coupling
CBA	Cost-Benefit Analysis
CEF	Connecting Europe Facility
CWS	Core Wagonload System
DAC	Digital Automatic Coupling
EC	European Commission
EDDP	European DAC Delivery Programme
ETCS	European Train Control System
EU	European Union
IPCEI	Important Project of Common European Interest
IM	Infrastructure Manager
LLC	Locomotive Leasing Company
RRF	Recovery and Resilience Facility
RU	Railway Undertaking
SPV	Special Purpose Vehicle
SWL	Single Wagon Load
WLC	Wagon Leasing Company
TSI	Technical Specifications for Interoperability

1 Introduction

This brief introduction will depict two important elements: the notion behind the deployment of Digital Automatic Coupling (DAC) and the purpose of the DAC investment plan laid out in this report.

1.1 Introduction to DAC

European rail freight plays a key role in the competitiveness of European products and industries. An important part of rail freight operations consists of coupling and uncoupling of rail freight wagons, particularly in the Single Wagon Load (SWL) market. The coupling and uncoupling operations are nowadays still performed manually throughout Europe: preparing a train for departure and ensuring all wagons are in place requires several hours and labour lifting a 20kg coupler. Such a strenuous process is not consistent with neither the overarching vision of the EU with regards to digitalisation and low-emission transport nor the digitalisation of the broader industry landscape in Europe[8] and modern working conditions.

DAC is a revolutionary component for the rail freight sector that addresses these issues. DAC enables rail freight operators to automatically couple and decouple the rolling stock in a freight train both physically (the mechanical connection and the air line for braking) as well as digitally (electrical power and data connection)[9]. Moreover, DAC is considered to be a unique opportunity to revolutionize European rail freight transport, as it is the essential element to transform management of railway as a whole through its digital components. DAC will improve the performance of the railway system and bring more capacity and thus will open potential for shifting freight transport to rail, thus providing a foundation for the reduction of emissions, increase in efficiency, and economic growth. As a key enabler for further digitalization and automation of the European rail system, it is a prerequisite to significantly increase rail freight's share of the modal split to 30% by 2030, double rail freight volumes by 2050 and therefore enable reaching of targets laid out by the Green Deal[10].

[8] Europe's Rail (2022) Open European DAC Delivery Programme enabled by Europe's Rail [Available at: https://rail-research.europa.eu/european-dac-delivery-programme/]

[9] Europe's Rail (2021) Digital Automatic Coupling [Available at: https://shift2rail.org/wp-content/uploads/2021/04/DAC-Factsheet_EN.pdf]

[10] Rail Freight Forward (2021) *European Digital Automatic Coupling (DAC)* [Available at: https://www.railfreightforward.eu/node/68]

Figure 1.1 – DAC includes a mechanical connection as well as a digital link between wagons[11]

1.2 The purpose of a comprehensive DAC investment plan

The DAC Investment plan is a key piece of the workstream covering economics of the DAC deployment. As seen in

Figure 1.2, it follows the work of the DAC Cost-Benefit Analysis (CBA) and concludes a series of CBA iterations. It is the final, key building block that will conclude the funding and financing strategy of the DAC roll-out.

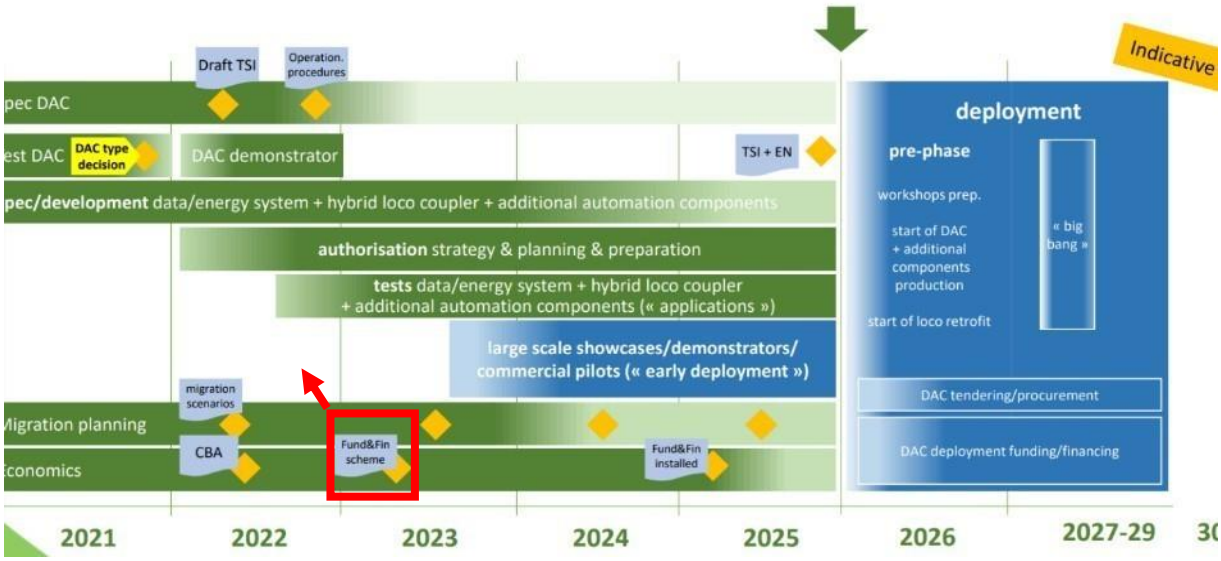


Figure 1.2 – DAC Investment Plan as part of the overarching indicative timeline for European DAC Delivery Programme[12]

A strategic investment plan is a prerequisite for a coordinated European deployment of DAC. While a coordinated European deployment is, in turn, a condition for a successful roll-out. Chapter 3 of this report is dedicated for a more in-depth reasoning for this conditionality, while in this section the key issues that cause this mandate are addressed.

In that regard, there are four key points that emphasize the necessity of a coordinated European deployment and thus a comprehensive investment plan:

1. The **migration** from current mechanical coupling mechanism to DAC is a complex process that involves various stakeholder levels from all member states. The technological advancement from currently used systems is large and thus DAC cannot be made as an interoperable unit with the old technology (e.g. a wagon fully equipped with DAC on both sides cannot be coupled with a wagon equipped with a screw coupler which is most

[11] Europe's Rail (2022) Open European DAC Delivery Programme enabled by Europe's Rail [Available at: https://rail-research.europa.eu/european-dac-delivery-programme/]

[12] EDDP WP3. 2022. Moving European Rail Freight Forward. [Available at:https://rail-research.europa.eu/wp-content/uploads/2022/01/20220111-EDDP-standard-presentation.pdf]

widely used today). This leads to a need for migration to be very rapid yet harmonized across stakeholders and country networks to minimise the operational burden.

2. **The distribution of costs and benefits** across different stakeholders is uneven. Key benefits of DAC will arise in train operations and indirectly also in infrastructure capacity. However, this business segment is undertaken by a different set of stakeholders than the ownership of wagons which entails investment in DAC.

3. **The payback period** for DAC investment, according to the results of the DAC cost-benefit analysis preceding this study, could be seen as challenging in certain scenarios compared to conventional metrics of financial viability from an entrepreneurial perspective. However, on the long-term, beyond conventional metrics, and from a societal perspective, DAC is a revolutionary project that will bring benefits to the European economy and society.

4. Finally, **the financial landscape** of the rail freight industry in Europe, a sector with high intramodal and high intermodal competition and low margins, makes large capital-heavy investments a significant challenge for market participants.

In essence, the highly needed digitalisation of rail freight will not be able to occur using market forces alone. The reasons above show multiple market failures that have prevented the coupling technology to evolve over the past decades and even centuries.

The points above have also been the vital considerations for developing the investment plan, as will be shown in this report.

2 Mandate and approach

The study was conducted using primary data from all key stakeholder groups. As shown in Figure 2.1, stakeholder groups which participated in the study through interviews and/or case studies and/or workshops encompass the industry, financial institutions, member states (largely ministry level) and EU bodies that are relevant to transport, competition, sustainability and regional development matters[13].

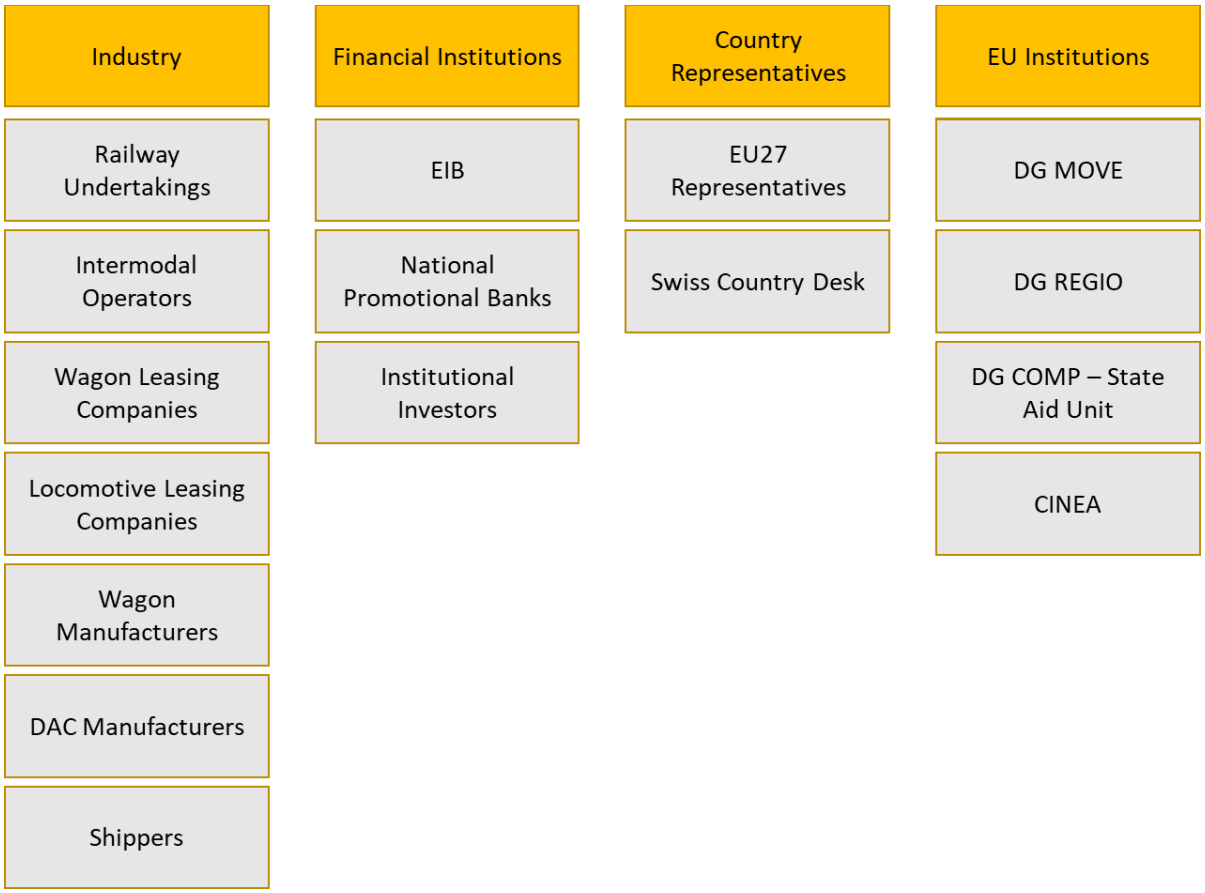


Figure 2.1 - Stakeholder groups consulted as part of the DAC Investment Plan Study

Due to the sizeable nature of the stakeholder network for DAC deployment in general, there is a need for synergetic approach and a coordinating body that would govern the exchange of information, follow up on initiatives and actions This is precisely the purpose that European DAC Delivery Programme (EDDP) has been established with.

[13] In total: 6 case studies, 24 interviews and 4 workshops were held.

2.1 European DAC Delivery programme

European DAC Delivery programme was, as mentioned, formed as a response to the need for an open, cooperation between railway undertakings, infrastructure managers, and wagon leasing companies, as well as the rail supply industry, entities in charge of maintenance, concerned sector organizations, rail research centres, and national and European political institutions. Europe's Rail, through its European DAC Delivery Programme (EDDP), provides a unique European platform for such cooperation and collaboration.

2.2 Technical scope: DAC and additional components

As shown in

Figure 2.2., there are five levels of automatic coupling. The levels differ according to the provided features to the operator. Higher levels represent more features and thus provide more benefits to the operator. The most widely used technology today is screw coupling (shown as SC). Automatic coupling (AC) occurs at levels 1 and 2 while at level 3 and above, a power cable is introduced and thus those levels are considered digital automatic coupling (DAC).

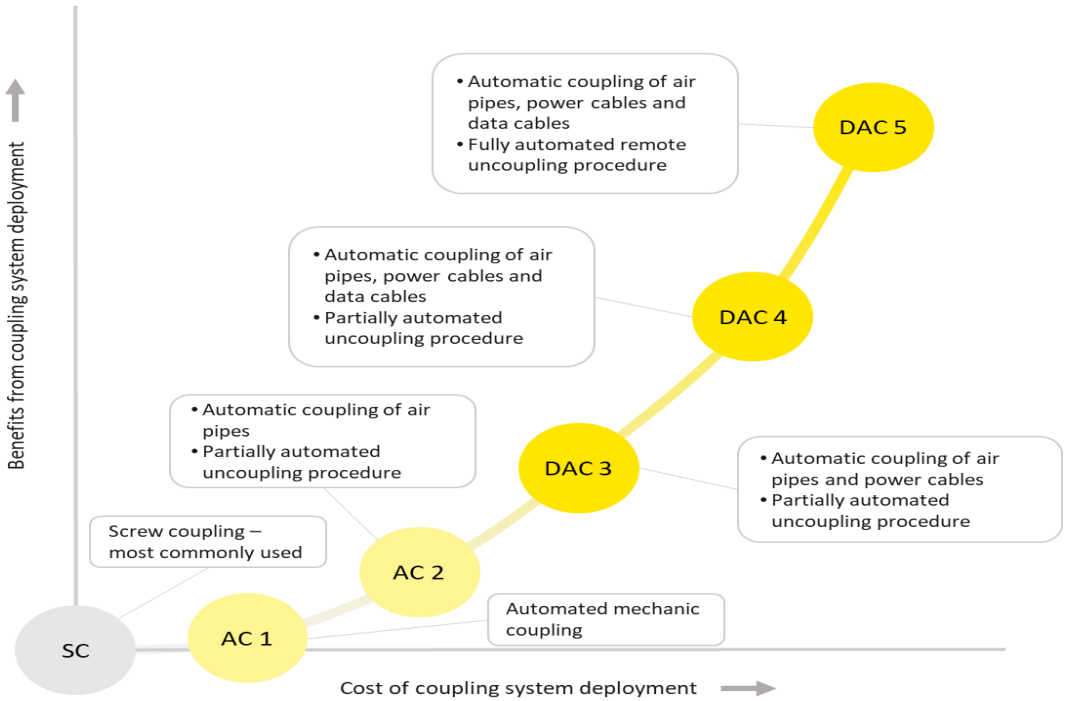


Figure 2.2 – Levels of DAC[14]

[14] Graphics based on: Rail Cargo Group. 2022. *What is Digital Automatic Coupling and what are its levels?* [Available at: https://blog.railcargo.com/en/artikel/dak-faq1]

Scharfenberg latch-type design has been selected by the EDDP in September 2021 as the transnational standard of digital automatic coupling in the EU. Both DAC 4 and DAC 5 are/will be based on this design and will thus be interoperable[15].

As part of the cost-benefit analysis of DAC to which the investment plan strongly links to, different tech packages were determined based on the additional components included together with DAC – and thus different functionalities. These were constructed in order to differentiate modular components that are being installed beyond the DAC 4 – DAC 5 distinction. The matrix of technologies included in each tech package is shown in the figure below.

Tech package	DAC 4	Communi-cation backbone	Train com-position detection	Draining valve for auxiliary air tanks	Automated air valve	Train integrity	DAC 5	Automated brake test	Automated technical wagon inspection
1	X	X	X	X	X	X			
2	X	X	X	X	X	X	X		
3	X	X	X	X	X	X	X	X	
4	X	X	X	X	X	X	X	X	X

Figure 2.3 - Draft Technological Packages[16]

Costs and benefits computed by the CBA refer to the deployment of the tech package 3, which was considered as a fair ambition to target in the short term (3 to 5 years).), communication backbone, train composition detection, draining valve for auxiliary air tanks and automated air valve. The model depicting the investment plan for DAC also includes other packages enabling the agility of the model to adapt to any upcoming decisions by the EDDP.

2.3 Geographical scope

The scope of the DAC Investment Plan covers countries that are set to deploy DAC in the coming years as part of the European DAC Delivery Programme. The programme builds on the system view to ensure a harmonised approach to the evolution of the Single European Rail Area[17]. This includes member states belonging to EU27 plus Switzerland and Norway as per the revised TEN-T regulation – an overarching transport policy by DG MOVE (European Commission). Notably though, once the EU transitions to the fully operational DAC network for freight rail, the relevance of this transition will go beyond.

[15] EDDP WP1. 2022. Open European DAC Delivery Programme enabled by Europe's Rail [Available at: https://rail-research.europa.eu/european-dac-delivery-programme/]

[16] European DAC Delivery Programme WP5. 2022. DAC Cost-Benefit Analysis.

[17] Europe's Rail. 2021. Master Plan. [Available at: https://rail-research.europa.eu/wp-content/uploads/2021/12/20211216-Master-Plan_agreed-in-princ_clean.pdf]

2.4 Sources of information used

The main sources of information used for the study include:

- Literature (see details in section 8 – Bibliography)
- Inputs from EDDP work packages: DAC CBA from WP5, DAC migration plan from WP3, etc. (see details in section 8 – Bibliography)
- Interviews with industry stakeholders, financial institutions, Member States representatives and EU representatives
- case studies, which have been used to test and the feasibility of the different financing options and align on key assumptions (equity/debt ratio, expected return on equity, cost of debt, maturity of debt, etc.).

Interviews and case studies have been identified with the view to maximizing industry and local representativeness:

- Stakeholders group (Wagon Leasing Companies, Loco Leasing Companies, Rail Undertakings, etc.)
- Size of company
- Geographical coverage (see figure 2.4 below.)

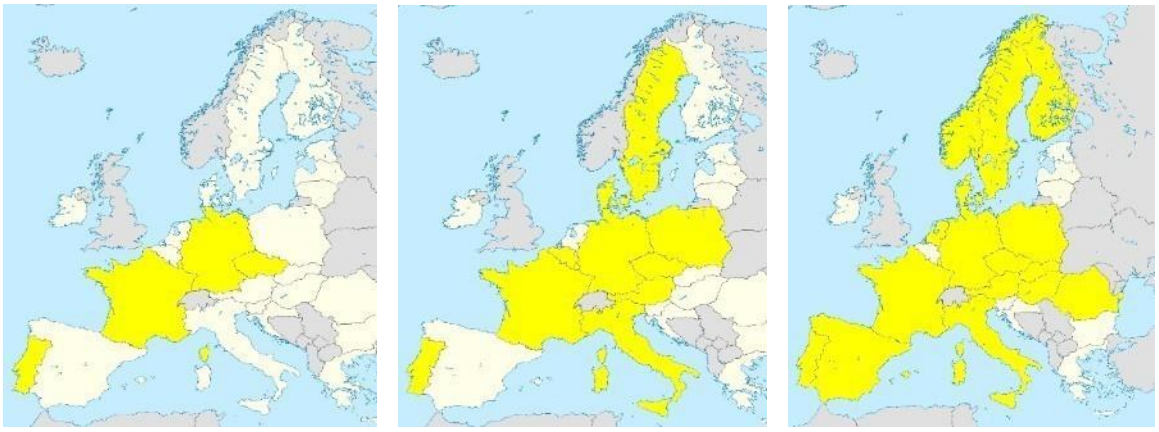


Figure 2.4 – Geographical coverage of case studies (left), interviews with the industry and financial institutions (middle) and member state representatives (right) conducted as part of the DAC Investment Plan[18]

[18] An interview was conducted with a DACcelerate representative for central and south-east Europe which covers member states in this region that are not indicated but from which insights were gathered.

3 Demonstrating the need for a coordinated European deployment

Chapter 1 describes the core challenges and the current lock-in effect faced by the rail freight industry when it comes to coupling technology. This chapter illustrates the nature of these market barriers in more depth and will illustrate how each of the methods of coordinated deployment address these barriers and thus results in a conceivable pathway for all stakeholders.

3.1 Market barriers to DAC deployment

Various factors lead to the European railway freight market not migrating to DAC by itself. The following subsection will address the 5 key issues: interoperability during migration, first-mover disincentive, skewness of costs and benefits, a long payback period and funding & financing capacities in the EU. These represent considerable barriers for migration and for the society to reap the benefits of a fully DAC-equipped EU rail network.

3.1.1 Everybody or nobody: the compatibility and interoperability issue

The developments made in railway technology since the initial deployment of screw couplers (SC) to the launch of DAC and the different design of DAC renders compatibility of the two impossible. Moreover, the production of a hybrid coupler would prove too costly and increase weight, which the hybrid coupler designed for locomotives bears witness to (approx. €100'000 per coupler). This is precisely the reasoning that led the EDDP to choose the Scharfenberg design as the standard for the migration, thus focusing on the long-term benefits of the migration. Hence, being a network industry, the incompatibility between wagons and operators on the network will create operational inefficiencies across Europe during the migration.

The primary result of inefficiencies depicted above is a capacity reduction of the network. It is estimated that mixed coupler operations in the marshalling yards (where most of coupling and uncoupling occurs) will create capacity reductions of 30+%[19]. Moreover, to address lack of interoperability, trainsets would need adapter or buffer wagons, with a DAC in one end and a SC in the other, to be able to run with both DAC and SC equipped wagons. Resulting in trainsets either consisting of one DAC block and a SC block or several DAC and SC blocks together (motley trains). The effects of running these trainsets will vary based on location on the network and the stage in freight train operations. Nevertheless, it is estimated that RUs (the operators) could suffer from a loss of revenue of up to 15% during migration[19]. In addition, a common approach is needed as international traffic is prevalent in the areas of large operations[20] and due to domestic and international traffic being mixed. A situation whereby only some of the European freight consists of DAC-connected wagons is not tenable given that a substantial share of commercial trains already travels across borders. Lastly, a mix of SC and DAC would hinder full digitalisation of the trainsets due to the SCs blocking the flow of data through wagons. This is problematic, since the industry has identified full digitisation as the key lever in delivering all the benefits of DAC[21].

[19] DACcelerate. 2022. Deliverable 4.2: Final report on recommendations including best migration scenario, best point in time for migration in main system, measures needed and minimum requirements/criteria to ensure migration feasibility. [Available at: https://projects.shift2rail.org/s2r_ip5_n.aspx?p=DACCELERATE]

[20] Above 40% of total traffic in main migration area.

[21] European DAC Delivery Programme WP5. 2022. DAC Cost-Benefit Analysis.

3.1.2 First-movers carry the highest cost

The European rail freight markets have undergone liberalisation in the past decades. This resulted in a largely distributed system of independent companies. Each of these companies is, naturally, autonomous and in a competing role with others.

Due to the lack of interoperability, the fleets that will be retrofitted first will bring notable operational constraints to the operators since the rest of the network will still be largely operating with the old technology. This is especially evident with the projection of benefits distribution as shown in *Figure* 3.1. Notably, this projection refers to a coordinated, high-pace migration scenario determined by the EDDP (to be elaborated further in this report). In a hypothetical market-driven migration scenario, the problem of first-movers becomes even more acute due to the longer low-benefit period.

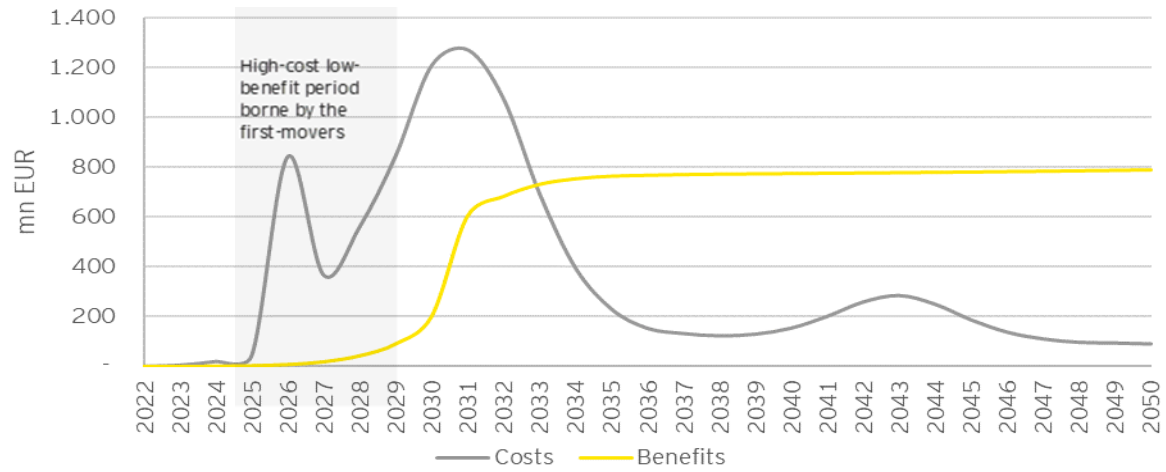


Figure 3.1 – Aggregate annual costs and benefits of DAC on the EU network over the years from the DAC CBA22 show that benefits strongly rise only at the latter stages of the deployment (2030-2031)

Figure 3.1 illustrates how the aggregate costs are projected to have two peaks which reflect the two-step migration process: the preparation phase and the big bang phase (as explained in section 3.2.1 below). The high costs during migration are mainly driven by the initial fixed costs incurred through the deployment of DAC. However, other factors such as operational inefficiency induced by having two different fleets of wagons (one equipped with DAC and the other with SC) further weights on the project. In case buffer wagons are present, the differentiation between fleets is avoided, however wagons become dependable on their orientation (DAC side of one wagon must couple with the DAC side of the other wagon and likewise for SC side of the wagon). This therefore nonetheless results in a notable decrease in operational efficiency, as well as capacity.

The operational burden is borne mainly by the operator (RU) which thus may choose to avoid leasing DAC-equipped wagons if adequate incentive is not provided. In case an RU owns some or most of the wagons it operates, it may choose to delay deployment until their lessor of non-owned wagons (WLC) has done it first to be able to reap the

[22] Data retrieved from: European DAC Delivery Programme WP5. 2022. DAC Cost-Benefit Analysis.

benefits of the new physical capital as quickly as possible. This may result in a deadlock and precisely illustrates the importance of a DAC investment plan as well as the coordinated European approach.

3.1.3 Skewness in distribution of costs and benefits

As denoted in the introductory chapter of this report, one of the crucial features of DAC deployment that has prevented the market to migrate itself (the last tentative was made in the 1960/70s and 1990s with an automatic coupler that did not have digital features, however, Europe could become the first continent in the world with a digital automatic coupling (DAC) system.) is the distribution of costs and benefits across stakeholders that DAC deployment will result in.

The financial benefit/cost ratio will be below one over a ten-year period (expected payback period in the industry). Moreover, although RUs, differently from WLCs and LLCs, are the beneficiaries of DAC's operational efficiency gains, on the other hand they still would be required to cover a significant share of the total investment, since a large percentage of European RUs also owns part of their wagons' and locomotives' fleet. Rail infrastructure managers and terminal infrastructure managers will also significantly benefit from DAC thanks to capacity gains and a better use of existing infrastructure. As this infrastructure is widely paid for by the tax payer, these benefits can be included in the overall societal gains.

The overall benefits are largely incurred by the shippers through significantly improved rail freight services (increased capacity, punctuality and reliability of this mode choice, decrease of transportation price). Moreover, important consideration is the benefits reaped by the society, as DAC will lead to a strong decrease in transport externalities (higher safety, less air pollution, less GHG emissions). This demonstrates the importance of governments involvement and the opportunity that lies in DAC deployment to improve the lives of Europeans on the long-term.

3.1.4 An NPV-negative business case for the rail industry

One of the core focuses of the DAC CBA is demonstrating the presence of costs and benefits through time. The provisional results of the CBA shown in Figure 3.2. illustrate the long duration of costs and net negative cashflow that are required for such a capital-intensive investment, as well as the rather delayed emergence of benefits which combined result in a negative business case for stakeholders. Considering that the CBA was based on a coordinated approach to deployment, it follows that the market-driven approach would result in a more granular deployment and thus even less desirable business cases.

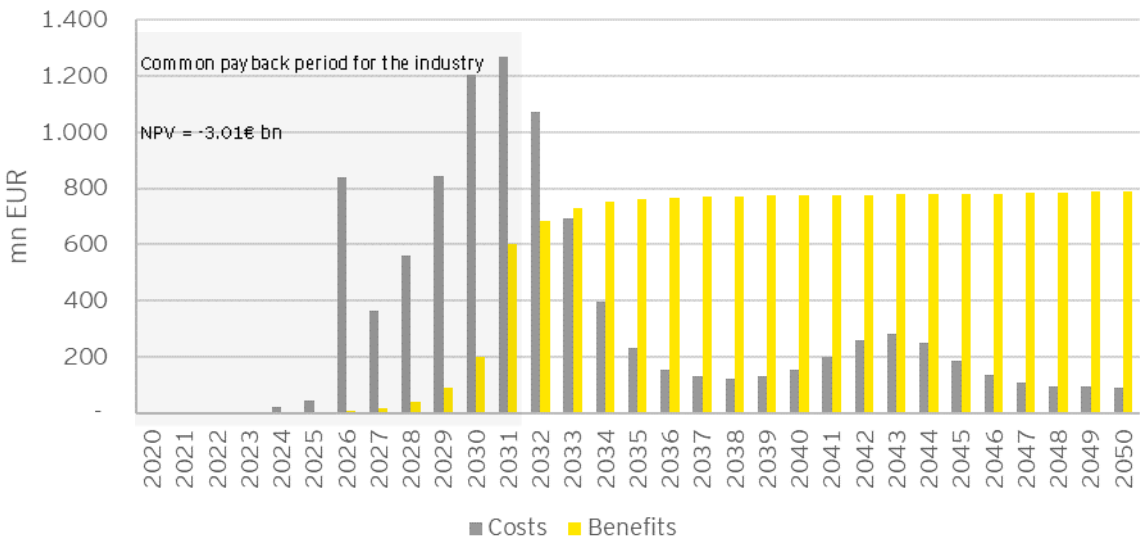


Figure 3.2 – Aggregate costs and benefits arising from DAC[23][24] show that majority of the 30-year benefits are reaped beyond the business case period[25]

Notably, the graph shown in Figure 3.2. also includes costs and benefits that will not flow to or from the industry. In the scenario of applying the current public spending frameworks on rail within member states, the industry would bear a disproportionately higher share of the total costs compared to the share of total benefits that it would reap from the DAC investment, as displayed in Figure 3.3. This emphasises the spillover effect of the benefits of DAC deployment onto the society which could:

1) prevent the industry from reaping all benefits and thus make the financial metrics yet less desirable.
2) present an opportunity for the society to utilise the positive spillover and increase its share of total cost that it bears through public funding and financing.

[23] Data retrieved from: European DAC Delivery Programme WP5. 2022. DAC Cost-Benefit Analysis.

[24] Cashflows are discounted at 4% rate

[25] The payback period indicated has been determined from stakeholder consultation as part of the DAC Investment Plan (the reporting study)

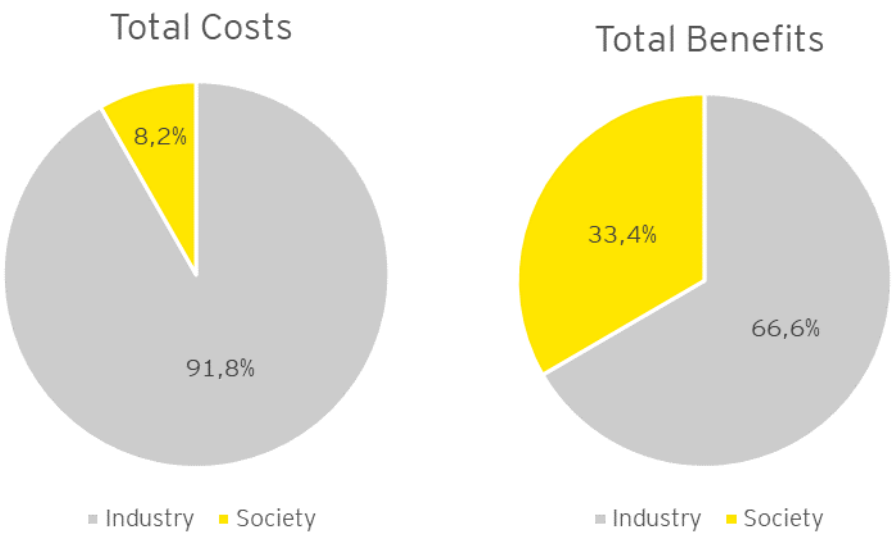


Figure 3.3 – The distribution of total costs and benefits across the industry and society using current flows of public funding and financing[26]

The societal benefits shown in Figure 3.3 arise from two domains: **increased safety** and **lowered externalities**. Safety in this context refers to the reduction of injuries and fatalities related to:

- shunting – many coupling and decoupling operations that are today done manually result in high amount of accidents.
- derailment – due to the poor monitoring ability for the wear & tear of the equipment, derailments today are more frequent and destructive than what they would be with DAC[27].

While the savings from lower externalities result from the modal shift that is, in turn, a consequence of increased competitiveness of rail freight that DAC enables. The net savings materialise since the externality footprint of rail is generally the lowest out of all modes (e.g. climate impact, noise pollution, air pollution etc.)[27]. With regards to climate impact, the EU's transport sector is particularly crucial as it constitutes 25% of overall EU greenhouse gas emissions (in comparison to 15% globally). While freight transport emits about 40% of that (340 Mt CO_2eq)[28]. Rail freight is therefore a major opportunity for decarbonisation as it is vastly less carbon intensive than other commonly used modes, as shown in the figure below.

[26] Data retrieved from: European DAC Delivery Programme WP5. 2022. DAC Cost-Benefit Analysis

[27] European DAC Delivery Programme WP5 & WP7. 2022. It should also be noted that DAC, as an enabler of ERTMS level 3, will also have an impact of the overall safety of the railway system. However, this benefit has not been quantified at this stage.

[28] TDC. 2022. Freight transport and CO_2. [Available at: https://www.tdc-enabel.be/en/2022/02/24/freight-transport-and-co2-a-complex-and-paradoxical-relationship/]

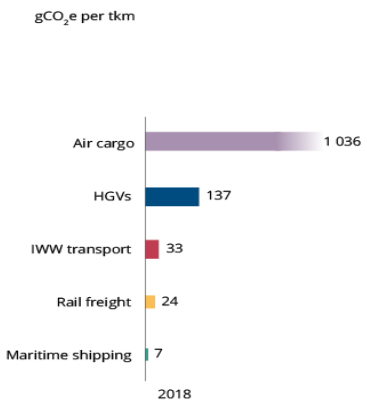


Figure 3.4 - Carbon intensity of rail is vastly lower than most other competing modes[29]

This results in the discounted net societal net benefits reaching 5.6 billion euros by 2060, as shown in Figure 3.5. A remarkable value which cannot be accounted for in the financial statements of the stakeholders and doesn't take material part in their business case. At the same time, the societal benefits measure the business case for government support. The DAC case, therefore, represent a societally profitable destination for public funding in Europe.

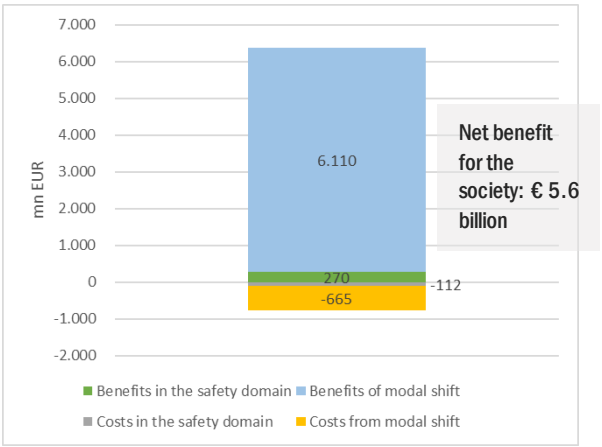


Figure 3.5 - The monetised discounted non-financial benefits of the DAC deployment far outweigh the costs for the society

3.1.5 Funding and financing capacity of the rail industry, member states and the EU

Project such as DAC would need to be financed through regular capital flows for new technologies that applies to the EU member states. This includes equity financing from stakeholders themselves, EU funding as well as funding

[29] EEA. 2021. Rail and waterbone – best for low-carbon motorised transport. [Available at: https://www.eea.europa.eu/publications/rail-and-waterborne-transport]

from member states' budgets. These three segments of project funding and financing will be elaborated further in the following sections.

Equity financing capabilities by the industry

As per the stakeholder consultation during the DAC Investment Plan Study, a primary concern for stakeholders is their own financial capacity to support any larger investment. DAC requires slightly over €10 billion, which compares to annual revenues of around €15 billion for the entire EU rail freight industry and very low profit margins. The margins are also currently negative in certain regions (largely Eastern EU) and market segments such as the Single Wagon Load (SWL). Consultations conducted confirmed this represents a significant challenge for small as well as large market participants.

The steady decline in revenues for SWL over the past years which is shown in Figure 3.6 further contributes to investing capacity and prospects of capacity over the coming years. The decline itself can be largely attributed to costly coupling and uncoupling operations, therefore the crucial need for automation and digitalisation[30] which are precisely the domains that DAC revolutionises. It is crucial to therefore acknowledge the elaborated lock-in effect that prevents the industry from reinventing itself.

It should be noted though that SWL transport requires a much higher number of coupling and uncoupling operations in order to combine different senders and recipient destinations into one train. However, SWL represent an important transport solution, especially for international transport and in some specific market segments, such as steel, chemicals, solid and liquid fuels and transport equipment. Austria, Czech Republic and Germany are the countries with the highest (about 40%) share of the total rail freight market. Therefore a significant number of wagons operating in those countries are used in the SWL services.

[30] European Parliament. 2019. Digitalisation in railway transport. [Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/635528/EPRS_BRI(2019)635528_EN.pdf]

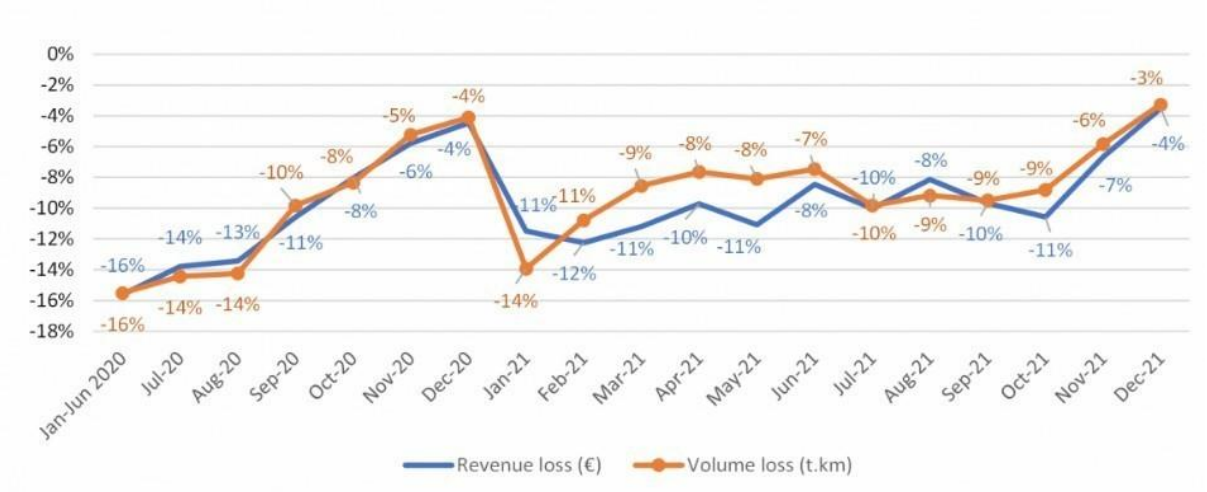


Figure 3.6 - Revenue and volume losses of European rail freight (variation 2020-2021 versus 2019)[31]

Public funding and financing capabilities

The most prominent funding that MS will have access to over the coming years is RRF (Recovery and Resilience Facility). RRF is a part of the multi-annual financial framework for the following 7 years aimed at increasing resilience and sustainability of European economies following the COVID-19 pandemic[32].

The overall allocated budget for RRF is €723.8 billion (in current prices) in loans (€385.8 billion) and grants (€338 billion)[33]. Hence, it is an exceedingly sizeable stimulus for new projects. It has two main targets for investment flows which are: digital transformation and climate mitigation and/or adaptation.

It is important to note that the Commission will make available for allocation 70% of the maximum allocation of the grant quota to the RRF plans, while the remaining 30% will be allocated in 2023. At the same time, article 21 of the RRF Regulation envisages the possibility to amend the existing plans by MS, subject to the Commission positive assessment.

[31] The Community of European Railway and Infrastructure Companies (CER). 2022. Latest CER COVID ImpactTracker: railways lose €50 billion since the start of the pandemic. [Available at: https://www.cer.be/media/press-releases/latest-cer-covid-impact-tracker-railways-lose-%E2%82%AC50-billion-start-pandemic-0]

[32] European Commission. 2022. Recovery and Resilience Facility (RRF). [Available at: https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en]

[33] Idem..

Through national spending as well as planned RRF spending, it is evident that there are disparities between member states' devotion to rail transport. Following is a concise analysis of selected[34] member states to be used as reference. The two investment flows analysed are:

- Public spending on rail from MS budget
- A dedicated RRF funds for rail transport from EU budget (determined also by MS authority)

Czechia

1) In Czechia the public spending is facilitated mainly through the publicly owned infrastructure manager (IM) Správa železnic (SŽ). SŽ has a budget of €2.2 billion in 2022[35]. In 2019 investments from the IM totalled €1.9 billion[36]. Majority of investments are focused on the modernisation of the large legacy infrastructure rather than rolling stock.
2) The RRF of Czechia also prioritises infrastructure projects[38]..

Germany

1) Germany has committed large public spending on railway modernisation. The "largest modernization project ever" in Germany will cost 86 billion euros over the next ten years, according to a deal reached between the country and its major railroad operator, Deutsche Bahn. In order to repair tracks, stations, signalling control, and power supply, it was announced that the federal government will pay 62 billion euros, or an average yearly expenditure of 8.6 billion euros[37].
2) Moreover, Germany has included it's rolling stock in the national Recovery Plan (part of RRF) as an opportunity for modernisation of the fleet[38]. The priority of the modernisation remained on the electrification, however, digitalisation in the context of German's and EU's rail competitiveness was emphasised as an important objective. The first instalment is about €4.5 billion. It contains, in particular, steps for starting various projects, also including the accomplishment of railroad digitalization pilot projects[39] worth € 727 million. It is crucial that this window is utilised for inclusion of DAC into the grant value.

[34] The selection of member states was based on the conducted case studies during the DAC Investment plan development. The studied stakeholders are RUs, WLCs and Intermodal operators within these member states.

[35] Seetao. 2022. Czech Railways announces €2.2 billion railway project plan for 2022. [Available at: https://www.seetao.com/details/138015.html]

[36] Railway Pro. 2019. New investments announced in the Czech Republic. [Available at: https://www.railwaypro.com/wp/new-investments-announced-in-the-czech-republic/]

[37] Reuters. 2020. Germany to invest 86 bln euros to upgrade ageing railway network [Available at: https://www.reuters.com/article/germany-railways-deutsche-bahn-idUSL8N29J40L]

[38] European Parliament. 2022. Transport trends in national recovery and resilience plans [Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698765/EPRS_BRI(2021)698765_EN.pdf]

[39] European Parliament. 2021. Germany's National Recovery and Resilience Plan [Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698849/EPRS_BRI(2021)698849_EN.pdf]

Poland

1) The Polish government has doubled the size of its investment programme for the period 2022-2028 compared to the previous framework for the railway network to 11 billion zloty (€2.38 billion). However, most of the 34 projects selected are within the infrastructure domain[40].
2) Polish recovery plan sets aside 16 billion euros for rail transport.

Portugal

1) Portugal has detailed a €26.3 billion 2030 National Investment Programme, which calls for spending €10.51 billion on 16 rail projects over the following ten years. These 16 projects primarily include high-speed rail development and electrification on lines, however a part of the budget is also secured for new rolling stock[41] which could thus cover the DAC equipped through renewal of rolling stock for the industry.
2) In the National Recovery Plan, Portugal has laid out the objective of modernisation and upgrade of rail infrastructure. The specific projects listed include mainly passenger rail, however not all of the budget has been covered by the listed projects, while the recovery plan itself has the ability to adapt to upcoming technologies over the coming years.

Luxembourg

1) Luxembourg has been a proponent of modernisation of railway in Europe and has led the way in investments in infrastructure improvements and expansion[42]. Luxembourg is planning to invest €3.8 billion over the next 10 years to upgrade its railway network and develop modern transportation terminals.
2) Luxembourg's leading role in transport investments is also evident from the Luxembourg's National RRF plan which allocated as much as a third of the fiscal stimulus to transport.

[40] NFP. 2022. Poland to double budget of rail investment plan [Available at: https://notesfrompoland.com/2022/04/20/poland-to-double-budget-of-rail-investment-plan/]

[41] International Railway Journal. 2020. €10.5bn for rail in Portuguese 10-year investment plan [Available at: https://www.railjournal.com/policy/e10-5bn-for-rail-in-portuguese-10-year-investment-plan/#:~:text=PORTUGAL's%20prime%20minister%2C%20Mr%20Ant%C3%B3nio,a%20renewal%20of%20CP's%20fleet.]

[42] Bausch. 2020. Call for massive investment in the extension of the European rail network. [Available at: https://gouvernement.lu/en/actualites/toutes_actualites/articles/2020/06-juin/30-bausch-letter.html]

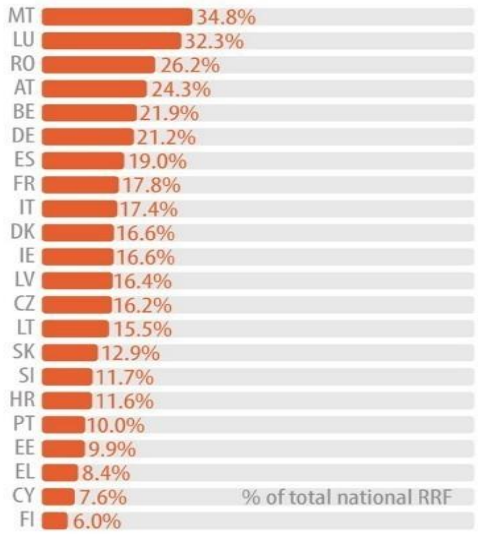


Figure 3.7 - Percentage of funds in the endorsed plans allocated to transport[43]

To conclude the analysis by member states, the public spending is largely focused on infrastructure projects in majority of member states while rolling stock remains underrepresented. Moreover, it is evident that over the previous and planned frameworks there has been a significant difference in spending capacity between MS. The spending also does not necessarily align with the geographic intensity of operation. As shown in Figure 3.8 as well as Figure 3.9, the variation of public spending per tonne-kilometre operated within each member states is varying greatly through geography and time (displayed respectively).

[43] European Parliament. 2022. Transport trends in national recovery and resilience plans [Available at: https://www.europarl.europa.eu/RegData/etudes/BRIE/2021/698765/EPRS_BRI(2021)698765_EN.pdf]

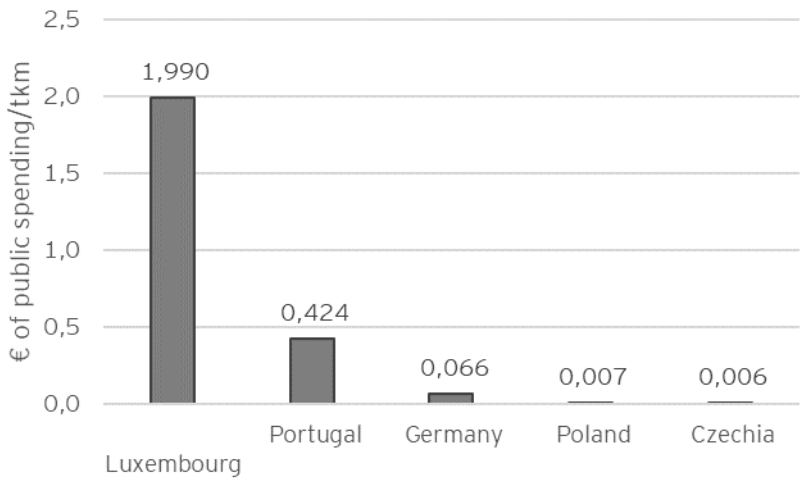


Figure 3.8 – Current annual public spending on rail infrastructure (excluding RRF) of selected MS normalised for rail freight traffic in tkm shows variations of investment sizes across member states[44]

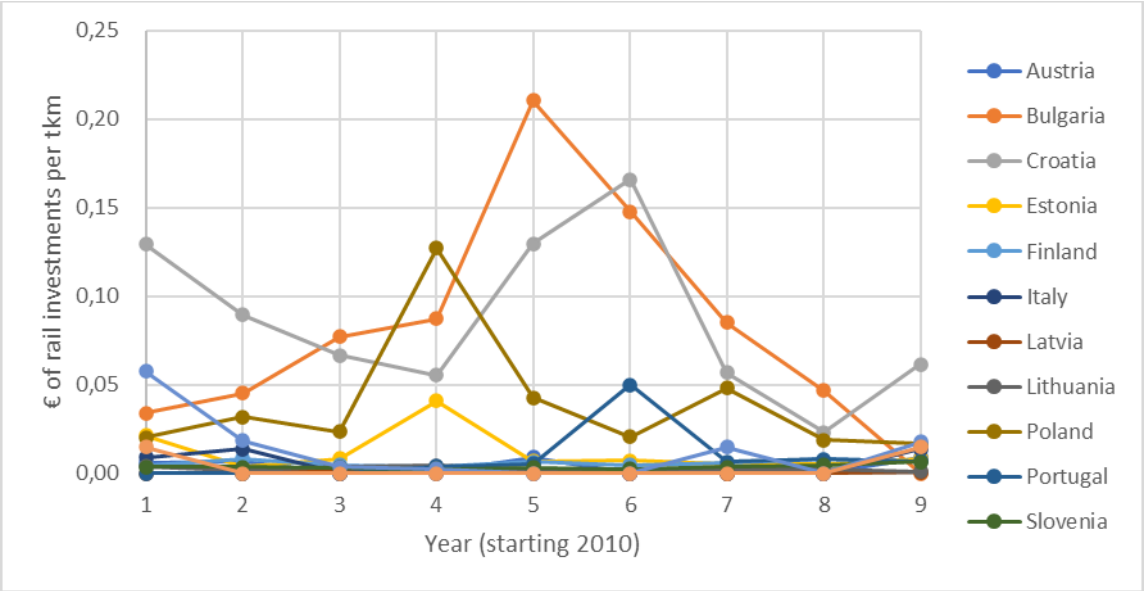


Figure 3.9 – Industry's annual investments in rail rolling stock normalised for freight traffic in tkm for each member state show variations of investment sizes across time[45]

The disparity of MS capacity to fund railway projects is also important to address through other relevant instruments by the EU. Since the reduced public funding capacity seems to be rather correlated with the Gross National Income within EU, it is important to utilise the instrument that addresses this issue, the Cohesion Fund (CF). CF supports investments in the field of environment and trans-European transportation networks. DAC is an opportunity for CF

[44] The spending in Germany appears rather how, however in this analysis the figure is deflated by the exceedig international traffic that operates within German borders and thus increases the denominator (tonne-kilometres of traffic)

[45] IPCEI. 2022. Detailed annual transport statistics. [Available at: https://stats.oecd.org/index.aspx?queryid=79868]

to boost the resilience of targeted MS and to increase the cohesion of the EU freight's cohesion. The CF programmes are a shared responsibility of European Commission and relevant MS, which further emphasizes the rationale behind coordinated European approach to DAC deployment.

3.2 How a coordinated European deployment mitigates these issues

Although in the previous section it is already evident how coordinated European approach is addressing some of the issues, this section will further illustrate the key objective of this approach. It will also serve as a guide for the investment plan to meet these objectives, which will be elaborated in the following chapters.

3.2.1 Solving the compatibility issue: big bang approach

DACcelerate, a project by Europe's Rail has developed the least-cost migration scenario (which also considered the only viable scenario) for all segments of European freight. The migration is nicknamed "big bang" as it involves a rapid migration of the Core Wagonload System (the general interconnected transport system of rail freight which makes around 45% of the EU's wagons). The remaining isolated wagon group networks can be migrated in a case-by-case basis over a 6 year period which was determined as the shortest possible considering manufacturing capacity and other constraints.

The big bang approach prevents the drastic loss of capacity over a long period of time which is the primary concern of DAC migration as mentioned in section 3.1.1. Moreover, this approach to migration reduces the time of interoperability issues and thus all challenges that arise from it become less acute. Even the issue of first-movers being disincentivised becomes less apparent since the migration takes a very short time and thus the low-benefit high-cost period is shorter and thus less impactful.

3.2.2 Redistribution of costs and benefits

The skewness of benefits and costs across stakeholders simply cannot be addressed without the coordinated European approach. To address market failures, certain regulatory forces and financial support must be imposed, thus the governments must be involved. Moreover, to ensure that all stakeholders in Europe are receiving their fair share, fragmented national strategies should be avoided. The regional disparities in wagon operations (e.g. international vs domestic, isolated networks vs core wagonload systems, etc.) are too large for all nations to be able to implement non-cooperative feasible strategies. This is due to the fact that regional disparities result in large geographical skewness of costs and benefits across Europe and thus certain nations may not be willing to participate if the benefits are not placed where the costs are.

Another aspect to consider is the distribution of costs and benefits across stakeholders. External forces are needed for the market failures shown to be mitigated and to relocate the benefits where the costs are. Moreover, certain stakeholders that borne highest costs (e.g. WLCs) are not evenly distributed across Europe. Many member states' RUs are leasing wagons from a few WLCs. This results in a largest cost being borne within member states where WLCs are incorporated. This is another example of the inability of fragmented national strategies to address the distribution of costs and benefits, and it emphasizes the need for a coordinated European approach which would be able to support certain member states more than others.

3.2.3 A positive business case

As was demonstrated in section 3.1.4, the business case for market participants is negative. The primary reason for it is the delayed emergence of benefits from DAC compared to the first capex investment round. This therefore requires a coordinated approach towards providing support from public funds and ensuring a positive business case for all market players. However, as described above, not all member states have the capacity to address the negative business case for DAC. Certain countries will be able to provide more but also require less while others will not be able to provide enough public funds to support the market. This denotes the need for capital flows across EU to ensure that all market players construct a positive business case and thus proceed with the DAC-induced digital transformation.

3.3 Opportunities arising from a coordinated European approach

This section describes some of the key opportunities related to the deployment of DAC following a coordinated European approach. They include the retrofitting capacity for a "big bang", homologation procedure and wagon specificities for retrofitting of DAC.

3.3.1 Retrofitting capacity in a big bang approach

As previously mentioned, the "big bang" approach entails a rapid migration to a DAC-operating CWS in a timespan of up to 2 weeks. More specifically, the "big bang" approach requires adequate preparations in terms of the production of the coupler, infrastructure and personnel availability for the retrofitting and the wagons being "DAC-ready" (by completing DAC parts' pre-installations during regular/planned maintenance stops at workshops).

3.3.1.1 In workshops

The retrofitting of some 350.000 wagons[46] within such a limited time period evidently requires considerable capacity both in terms of personnel and workshops to retrofit the wagons. In terms of personnel, the work carried out by EDDP work package 3 (migration plan) estimates that retrofitting the targeted European fleet of wagons will demand an additional 840-933 workshop staff for retrofitting the wagons to DAC (40% increase). According to the German Association of Freight Wagon Keepers (VPI) there are 188 workshops in Europe working in accordance with their guidelines[47]. If DAC was only to be retrofitted in VPI workshops, every workshop would need to hire 4.5-5 FTEs during the deployment period[48]. Parts of the retrofitting, such as the unmounting of the SC or inserting the DAC coupler head, can be carried out by workers without very particular training requirements[49], nevertheless all inspection and testing must be done by trained wagon fitters and skilled staff. Although, parts of the work can be

[46] There are also 110.000 new wagons which are expected to be put on the market equipped with DAC between 2026 and 2031: 60.000 through natural replacement, and 50.000 to replace the wagons which are going to be scrapped or redirected in isolated operations.

[47] According to "Rail-Assets" there are 694 workshops.

[48] Federal Ministry of Transport and Digital Infrastructure (BMVI) – 2020. "Development of a concept for the EU-wide migration to a digital automatic coupling system (DAC) for rail freight transportation".

[49] DACcelerate report 4.2 DCC-DELS-D-CNC-003-01 - D4.2 FINAL RECOMMENDATIONS.pdf.

carried out by workers without additional training, the current shortage in skilled workers poses a challenge to the deployment. A coordinated European development will help to alleviate these challenges.

Given the international aspect of freight railway transport, the DAC deployment will also have to suit the location of the wagons. As a result, the deployment will need a combination of the workshops identified above and mobile workshops. The mobile workshops will have to be set up temporarily on key parts of the network to address any gaps of where the workshops are located[50]. It would, in addition, also decrease the transport time, and hereby idle time, of the wagons when transported to the workshops.

3.3.1.2 DAC equipment manufacturer

Another challenge that can be facilitated by European coordinated approach relates to the deployment of the DAC manufacturing capacities. With around 350.000 wagons to be retrofitted, there is a need for around twice as many DACs to be produced in addition to the 34.000 hybrid couple for locomotives. It has previously been estimated that approx. 144.000 to 162.000 DACs would have to be produced per year in a 6-year deployment period. This would amount to roughly 40% of the global production and require an expansion in the production capacity. The capability to meet the production capacity has been questioned by some interviewees for this study. Consequently, there would be a need for one of the following solutions:

- Anticipated production of DAC which will then be stored, but that raises the question of pre-financing
- Capacity investments to cover the big bang period and a risk of overcapacity post-big bang
- Outsourcing production outside the EU, but that would mean using part of the tax payers money to buy foreign goods

3.3.2 Homologation and authorization

While the Scharfenberg type DAC has been chosen by the EDDP as the DAC type to be deployed, further work in relation to the homologation and the authorisation need to progress. Notably, a European standard (specifying in detail technical requirements for the manufacturing and the use of the DAC component) still has to be set up. The need for standardisation also applies to any technological connections between the wagons to avoid incompatibility. Furthermore, there is the challenge of either agreeing to a minimum technical level of DAC or ensuring upward/downward compatibility between the DACs. Some stakeholders interviewed for this study have voiced concerns regarding the final technological level of the DAC and has been stressing that type 4-5 has to be deployed for all benefits to be incurred[51]. Moreover, the DAC and its related components should be standardised prior to the deployment commences to avoid any uncertainties for the concerned stakeholders.

3.3.3 DAC-incompatible wagons

A third challenge that can be alleviated through a coordinated European deployment is the number of DAC-incompatible wagons on the market currently. The technical specifications and dimensions of the DAC entails that the wagon itself will become longer than when equipped with a SC. As a result, there needs to be added space on

[50] See P. 55 of the DACcelerate report 4.2 (footnote 40.) for more info on the temporary workshops.

[51] See P.112 of the Federal Ministry of Transport and Digital Infrastructure (BMVI) – 2020. "Development of a concept for the EU-wide migration to a digital automatic coupling system (DAC) for rail freight transportation" for a detailed review of the compatibility demands.

the wagons for the installation of the DACs. This was addressed through an UIC standard 530-1 introduced in 1970, which required space for an automatic coupler (AC, non-digital). However, this requirement was left out of 2006 revision of the TSI-WAG resulting in wagons being produced without required space for AC. According to previous estimations 10-20% of all wagons may not be suitable for DAC installation currently either due to lack of UIC 530-1 space or impossibility to take in the longitudinal pushing forces from DAC[52]. Moreover, a share of the wagon fleet would be close to scrapping age and would thus not be sensible from a cost perspective to retrofit with DAC.

[52] Idem. P.- 39.

4 Financial model to deliver the coordinated deployment of DAC

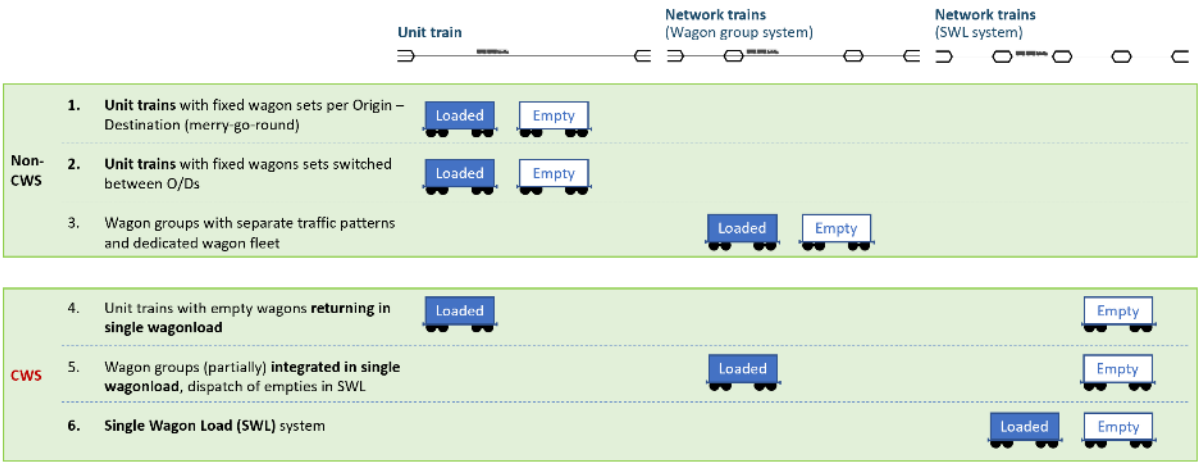
This chapter is describing the main assumptions on costs and benefits which have been used in the financial model. This is based on the DAC cost benefit analysis from September 2022, which has been shared for consultation beginning of October. It is structured in the following way:

- A presentation of the migration scenarios, provided by the EDDP, and adopted in the CBA study carried out by the European Commission as well as in the financial model (§4.1)
- A description of the CAPEX investments required for DAC deployment (§4.2)
- Additional costs considered (recurring OPEX and one-off) related to the DAC roll-out (§4.3)
- A summary of the total investment cost envisioned in the model (§4.4), and
- A description of benefits from the DAC roll-out.

4.1 The expected benefits from DAC roll-out (§5) Migration scenarios

4.1.1 Migration scenarios for wagons

The migration scenarios are a combination of a sequential migration for unit trains and a big bang migration in the Core Wagonload System (CWS). The Core Wagonload System includes all flows using at least one network train in a wagon cycle, as summarized in the figure below:



Source: DAC Programme Board meeting, 29th of April 2022

Figure 4.1 – Scope of Core Wagonload System

The principles of the serial migration and the big bang are illustrated in the figures below:

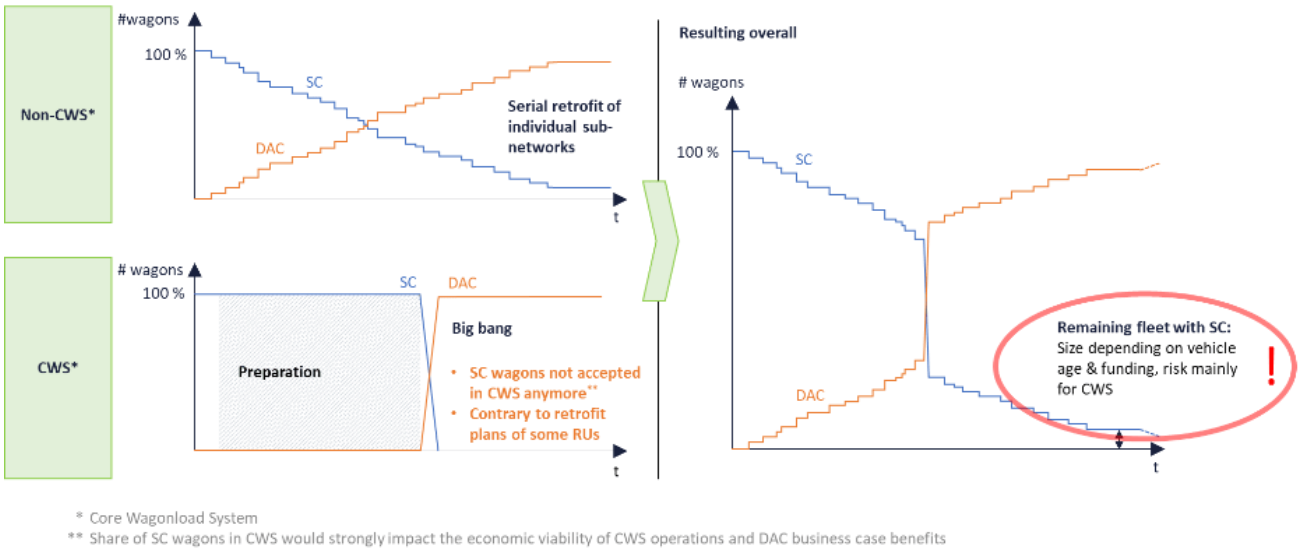


Figure 4.2 – Illustration of the serial migration and the big bang

Based on that, three migration scenarios have been developed by the EDDP:

- A first one over 6 years, which is the preferred option for the sector, but is facing capacity issues from the industry mainly in terms of manufacturing, retrofitting and financing capacity;
- A second one over 12 years, which is the most robust one, but with benefits from the digital functionalities only coming in the long term and;
- An intermediate one over 9 years.

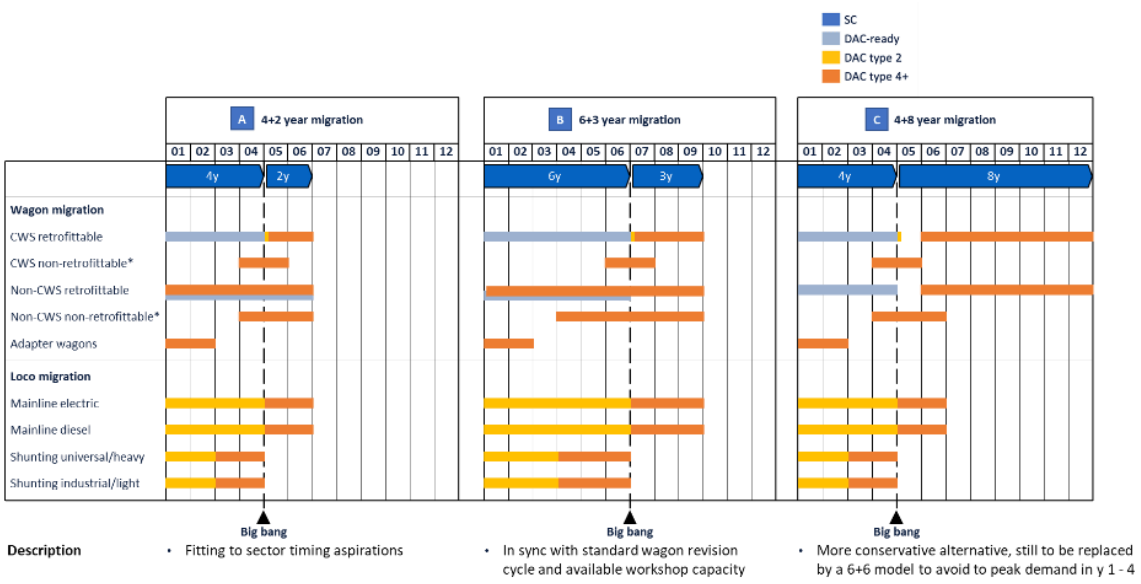


Figure 4.3 - The three migration scenarios

The scenario which has been chosen so far in the CBA and therefore in the financial modelling is the scenario over 6 years (4+2).

The migration scenario is then designed according to:

- The type of wagon (belonging to CWS / not belonging to CWS)
- The starting situation of the wagon: retrofittable / not retrofittable
- Corresponding options: DAC ready and then DAC deployment, possibility to have a special retrofit, to be scrapped, swapped between CWS / non CWS

The migration scenario considered in this study includes:

- The number of preparations on wagons (from screw couplers to DAC ready)
- The number of retrofit to DAC2
- The number of retrofit to DAC 4/5
- The number of new wagons put in operation DAC ready or with DAC 4/5
- The number of wagons redirected (swapped)
- The number of wagons scrapped

Overall, 350.000 wagons are expected to be retrofitted, 60.000 renewed (and equipped with DAC) and 50.000 replaced (wagons scrapped or redirected and replaced with new wagons equipped with DAC).

Those parameters are associated with specific costs, presented in this section, as accounted for in the CBA.

4.1.2 Migration scenarios for locomotives

The migration scenario for locomotives is simpler, with only one scenario, and two categories of operations:

- Basic retrofit (approx. 2000 / year) between 2026 and 2031
- New locomotives (approx. 250 / year)

4.2 Investment needs (CAPEX) & timing

This chapter presents all the investment required to implement the technology and thus reap the expected benefits from DAC. It includes:

- Investment in coupler and the cost of mounting the coupler on the rolling stock
- Investment in additional components according to the different technical packages designed by EDDP, which are connected to different functionalities
- Investment in infrastructure

4.2.1 Investment in IT systems

The distribution of costs over time is based on the migration scenario developed by EDDP and summarized above. Each CAPEX is then allocated to the different categories of stakeholders and split by country (see §2.3 for geographical scope) according to the rules detailed below.

4.2.2 Investment in coupler and cost of mounting the coupler on the rolling stock

The cost of a coupler is estimated at €5'000/unit. This cost includes all the investment required by the suppliers to deliver DAC within the foreseen timeframe. As a reminder, 2 couplers are required per wagon and per locomotive (one on each side).

On top of that, the costs of mounting the coupler have to be considered. However, these costs can vary according to the design of the wagon or the locomotive. Some of them will be easy to retrofit, while others will be more complex. The figure below summarises the assumptions used for the calculation of retrofitting costs for wagons and locomotives:

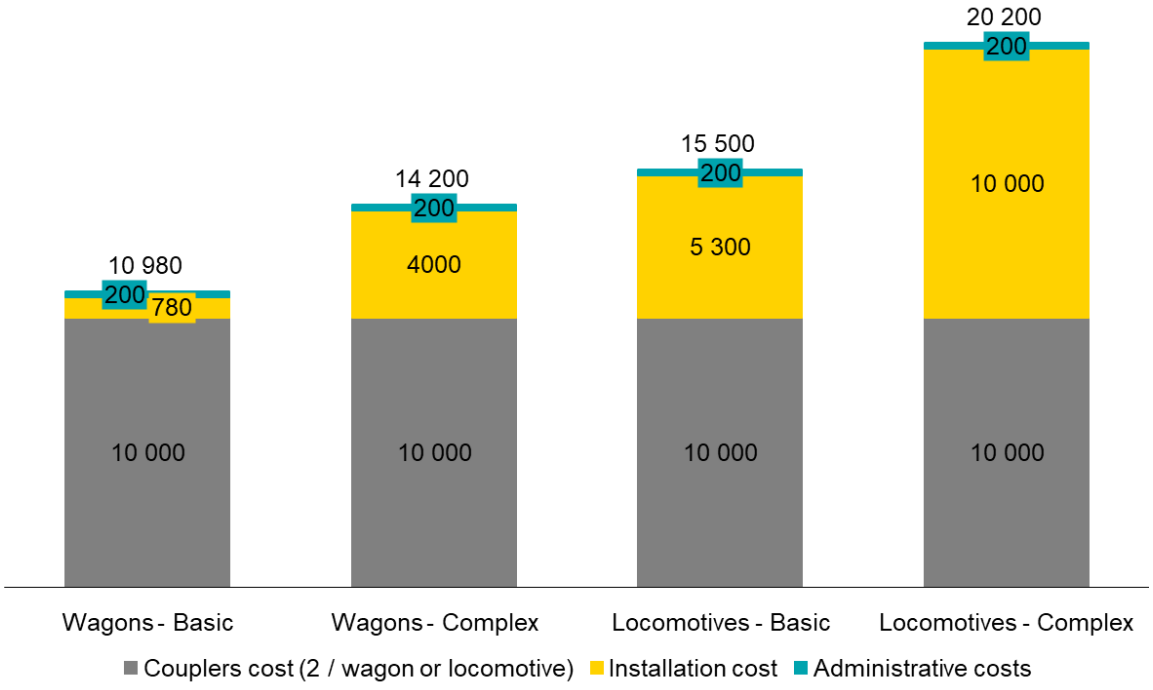


Figure 4.4 – retrofitting costs for wagons and locomotives (in €)

Two other categories of costs have also been considered in the analysis:

- An extra cost for new wagons and locomotives equipped with DAC (compared with the cost of a wagon/locomotive equipped with screw couplers): 3'500 € / wagon and 8'000 €/ locomotive
- And another extra cost of 5'000 €/wagon for wagons which are not going to be equipped with DAC, as there will be some extra cost to keep on operating those wagons:

a. Cost to isolate the screw couplers wagons from the rest of the fleet
b. Transportation costs to bring those wagons in the right location
c. Loss of economic value of wagons due to limited scope of operations

The composition of the total fleet to be equipped is provided by the migration scenario developed by EDDP. The migration scenario selected is detailed in §4.1 above.

4.2.3 Investment in additional components

As outlined in §2.2, DAC is an enabler for new functionalities. Therefore, additional investments have also been considered and bundled in different technical packages for the analysis.

The cost per wagon of each technical package is summarised in the figure below:

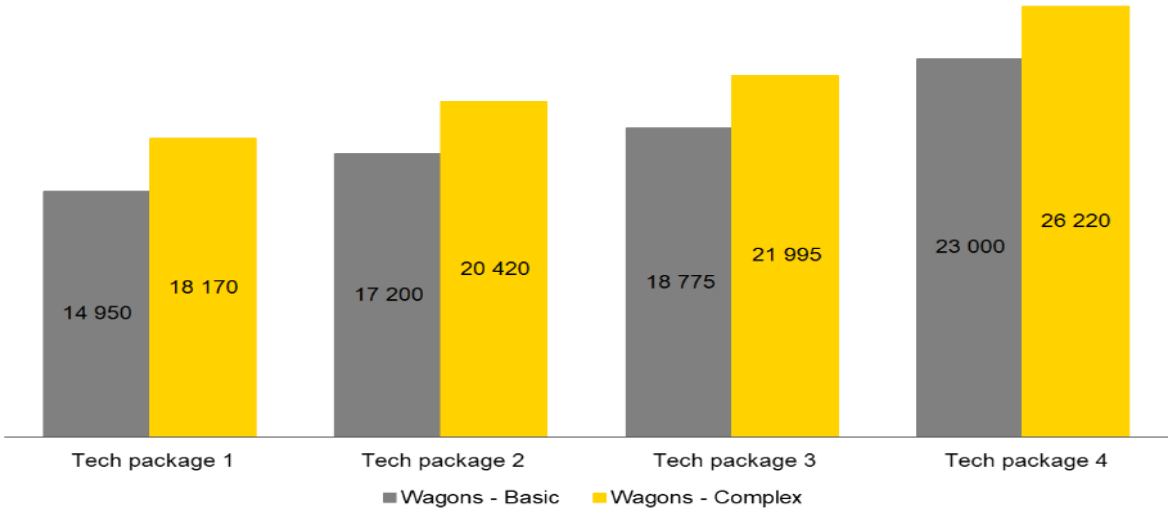


Figure 4.5 – Total cost per wagon for each technical package in € (including cost of the couplers)

4.2.4 Investment in infrastructure

Investments in buffer stops have also been considered in the analysis. A unit cost of €5'000 / bumper has been used. The total number of buffer stops in geographical scope is estimated at ~ 83 000. All the buffers are expected to be replaced in 2026, for a total cost of 417 M€.

4.2.5 Investment in IT systems

An investment for adapting the IT systems of railway undertakings to accommodate the new functionalities enabled by DAC has also been considered in 2026, with a total cost of €600 million.

4.2.6 Allocation of CAPEX per stakeholder

The allocation of CAPEX per stakeholder has been based on data collected from multiple sources:

- BMVI study, which is providing an assessment of the fleet owned by a sample of wagon leasing companies and railway undertakings
- Interviews carried out during the CBA
- Data from UIP

Available statistics present some caveats in terms of ownership allocation amongst some stakeholders' categories (e.g. shippers and wagon leasing companies). Therefore, further to consultation with the industry, the following assumptions, have been made for the study:

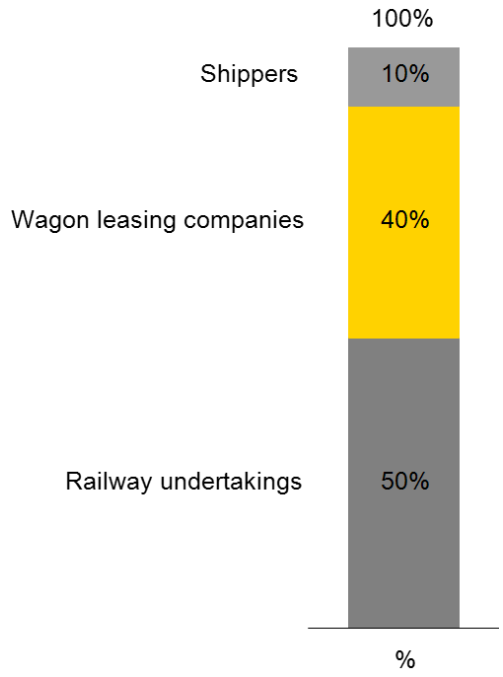


Figure 4.6 – Allocation of costs associated with wagons

With regards to locomotives, the market share of each stakeholder is expected to evolve in the coming years. In 2021, according to a study from Association of European Rail Rolling Stock Lessors (AERRL), the market share of locomotive leasing companies (LLCs) is around 13%. But the market share of LLCs for new locomotives bought between 2016 and 2020 is around 40%. Considering a stable market share of 40% in the future for LLCs, the share of the fleet owned by LLCs is expected to grow progressively and reach 40% in 2050.

4.3 Additional costs related to the DAC roll-out

4.3.1 Recurring costs

Recurring costs correspond to additional OPEX due to extra maintenance costs for DAC, estimated at 300 € / wagon / year and 200 €/ locomotive / year.

4.3.2 Extra operating costs during migration

- The railway system could suffer from extra operating costs during migration, for several reasons: downtime costs of locomotives and wagons during retrofitting
- Additional shunting during migration due to the existence of two systems not interoperable (even during a limited period of time)
- Training of staff with the new system

Even though these potential extra costs have been identified, it has not been possible to provide a robust assessment of them. Indeed, those costs depend on multiple factors:

- For downtime costs, those costs are related to the rental of additional locomotives or wagons to deliver the railway services during migration. But the need to rent additional locomotives or wagons will depend on (i) the impossibility to include the retrofitting within the normal maintenance cycle of the rolling stock; (ii) the absence of spare locomotives or wagons to deliver this traffic; (iii) the availability of the appropriate rolling stock on the market; and (iv) the impossibility to use alternative solutions to deliver the service (for instance subcontracting to road or inland waterway). Therefore, it is very difficult to assess the number of locomotives or wagons which will have to be replaced during retrofitting;
- For additional shunting, it was not possible to collect robust data to support the introduction of an extra cost in the CBA
- Finally, assessing the cost of training staff with the new system is facing another type of difficulty: what will be the future process, and how much training will be required to teach this new process? Moreover, there are already some training done for the staff today: could the training for the new system be done in replacement of older training, which are becoming useless with the new system? Considering all these uncertainties, t was not possible to provide a robust assessment of this cost at this stage.

Additional operating costs during migration are not considered in the calculation today due to a lack of accurate and robust data; those costs will be considered in a future iteration of the CBA.

4.3.3 One-off costs

As detailed in the migration scenario, the whole fleet is not expected to be equipped with DAC, because it would be too complex (and therefore too expensive), or because some wagons or locomotives are too old and their remaining life expectancy does not justify to equip them with DAC. Therefore, those wagons / locomotives will need to be scrapped before the end of their life duration, leading to a write off in the books of the owner of the fleet. The following values have been considered in the CBA, according to current knowledge:

- 25 000 € / wagon
- 50 000 € / locomotive

The number of locomotives to be scrapped has not been assessed yet in the migration scenario, so this value is equal to 0 at this stage. For wagons, total cost is equal to 875 M€, distributed between 2026 and 2029.

4.4 Total investment cost

The total investment envisioned in the model includes the following components:

Investment 2026-2031	million €
Total **CAPEX** for DAC migration, during the period 2026-2031[53]	9.034
Additional **OPEX** for DAC extra-maintenance, during the period 2026-2031	1.592
Total	**10.626**

4.5 Benefits from the DAC roll-out

Benefits include:

- Time savings during operations;
- Longer and heavier trains;
- Increase of capacity in terminals;
- Enabling L3 ERTMS, which in the end will lead to extra capacity on the railway network; and
- Societal benefits, such as increased safety for railway staff and decreased external costs (air pollution, GHG emissions, etc.).

The only benefits considered in the financial analysis are the monetary ones: savings linked with time benefits, longer and heavier trains and increase of capacity in terminals.

4.5.1 Savings linked with time benefits

Benefits linked with time savings have been calculated by the DAC CBA showing a total of more than 18 bn€ over the period 2026-2055.

4.5.2 Savings linked with longer and heavier trains

The savings linked with longer and heavier trains are those of the DAC CBA. They represent a total of almost 800 M€ over the period 2026-2055.

[53] This also includes the one-off costs for the scrapped incompatible wagons (see chapter 4 for detailed information)

4.5.3 Allocation of benefits per stakeholder

A first allocation of the benefits per stakeholder has been developed for this study. This allocation is provisional, as (i) the methodology is currently being fine-tuned in the CBA and (ii) some additional work is still on-going on the CBA itself.

The allocation of the economic surplus has been done in three steps:

1) Allocation between shippers and the railway system (railway undertakings, wagon leasing companies and locomotive leasing companies)
2) Allocation of the railway system economic surplus between railway undertakings and other vehicle owners (wagon leasing companies and locomotive leasing companies)
3) Allocation of the economic surplus between vehicle owners (wagon leasing companies and locomotive leasing companies)

<u>Allocation between shippers and the railway system</u>

The allocation of the costs and benefits has been based on the following economic principles:

- in a competitive environment, the economic surplus is largely passed to the final client (shippers) due to competition between service providers. As railway stakeholders are in competition between themselves but also against other modes of transport, especially road, there will be strong pressure on the railway system to decrease its price if operating costs decrease.
- when a new technology is deployed which leads to a decrease in operating costs, it will take several years to pass a portion of this benefit to the shippers (time for the companies to review their organisation and for the price to adjust).
- a long-term equilibrium can only be reached if the profit margin of service providers is reasonable. For instance, in a capital-intensive industry (such as rail), if the profit margin gets lower than the weighted average cost of capital (WACC), investors would rather prefer better and safer destinations for their money. Crucially, interviews and workshops carried out with representatives from the rail freight industry confirmed that profit margins today is close to 0 or even negative for some specific market segments. Therefore, the rail freight system will certainly retain a portion of the economic surplus generated by DAC.
- Finally, DAC will lead to an overall improvement performance of the railway system, including some additional functionalities, which might allow the railway system to increase its price.

<u>Allocation of the railway system economic surplus between railway undertakings and other vehicle owners</u>

The following rules have been applied to allocate the economic surplus between railway undertakings and vehicle owners:

- In the long term, the economic surplus is split according to the total costs of each group of stakeholders, and
- In the short term, 90% of the economic surplus is allocated to the railway undertakings, as they have to adjust their operating system in order to reap the benefits from DAC. Therefore, they cannot pay more, and have to retain a large portion of the benefits.

Allocation of the economic surplus between wagon leasing companies and LLCs

The economic surplus for vehicle owners is split according to the cost of each stakeholder.

4.5.4 Benefits across all member states

As shown in the previous section, the coordinated European approach is a key condition for a successful DAC deployment. And once critical mass is achieved with deployment, the benefits start materializing across the board. The cumulative discounted benefits are higher than the cumulative discounted costs for 25 (all but Cyprus and Malta) EU member states as well as the other countries belonging to the TEN-T policy (CH, NO, UK). The benefits are proportionate to the amount of rail freight traffic in those countries, but they also depend on the dominating freight segments (block train, single wagon load, or intermodal) and on the number and size of marshalling yards for instance. The cumulative net discounted benefits are positive for all member states, as illustrated in Figure 4.7.

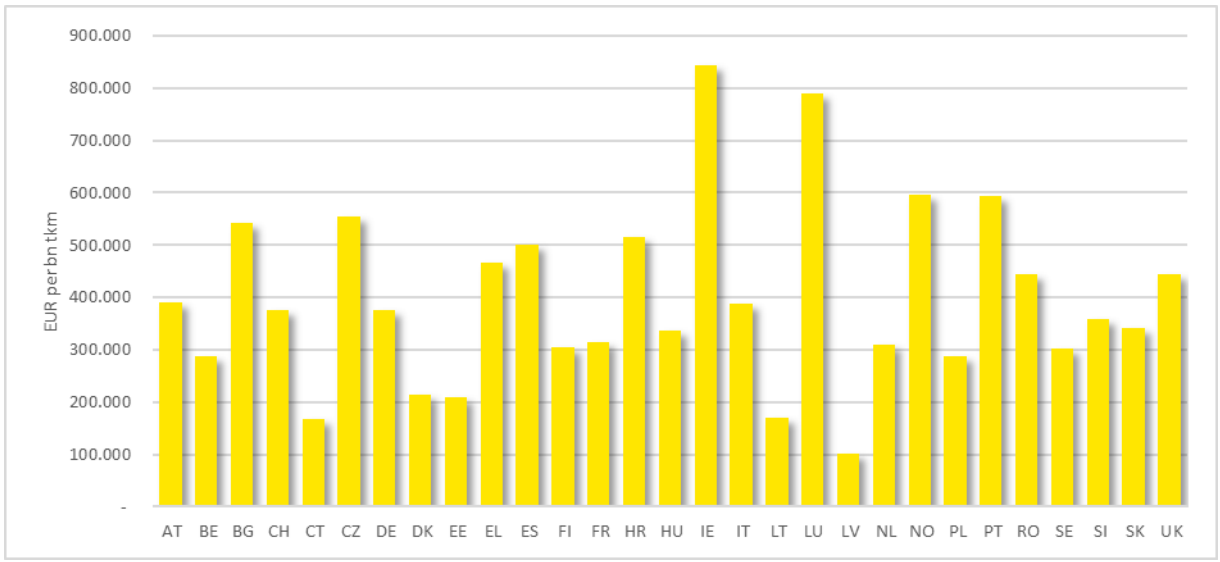


Figure 4.7 - The net financial result of DAC deployment is beneficial for all member states and non-EU TEN-T countries showing a consistent range of benefits when normalised for annual value of tonne-kilometres[54]

[54] Data retrieved from: European DAC Delivery Programme WP5. 2022. DAC Cost-Benefit Analysis

5 Sources of funding and financing to support the coordinated deployment of DAC

The deployment costs of DAC can be covered by four prominent sources of funding and financing:

- Grants: provided by the EU / MS to partially cover the upfront CAPEX investment
- Equity: mainly from railway stakeholders, but potentially also from third party investors like pension funds, insurance companies etc
- Debt: from the European Investment Bank (EIB), National Promotional Banks (NPBs), commercial banks and possibly institutional investors (e.g. pension funds, insurers).
- Additional subsidies: where necessary to further support the business case for investing in DAC.

5.1 Equity

5.1.1 From industry players

For the realisation of the DAC Deployment, key industry stakeholders (wagon leasing companies, locomotive leasing companies, railway undertakings and shippers) will need to provide equity to ensure sufficient capital will be available for the roll-out.

Interviews with key stakeholders in the industry have assessed a varying capacity of equity provision up to a maximum of 30% of CAPEX. The expected return on equity is around 10%.

5.1.2 From other third parties

At this stage of maturity of the DAC deployment program, we have not found any willing third-party investors to commit to an equity investment. Risks are currently too high concerning the technical maturity of the coupler, the political support to implement the project and the business case. Potentially, it is worthwhile investigating this further in the future, when the basis for DAC deployment has been laid.

5.2 Debt

We have performed interviews with key debt providers in the industry, including the European Investment Bank (EIB), National Promotional Banks (NPB's), and pension funds.

We have assessed each of the identified possible debt providers on their willingness to participate, their investment capacity, cost of debt and any other relevant conditions.

5.2.1 EIB

Willingness	From a conceptual point of view, the EIB showed willingness to invest in the DAC roll-out, once the technology proves to be mature and after further investigation

	of the project and the promotor. In principle, freight rail is eligible and prioritised as green mode of transport.
Investment capacity	The EIB can, in turn, finance 50% of the project or up to 70% when combining debt and grants. The latter percentage increases to 90% in case a convergence region is involved.
Cost of debt	Dependent on the credit worthiness of the counterpart. Preference for an SPV scenario as it allows to spread counterparty risk across several companies. In EU guarantee will help to reduce credit risk and therefore the cost of debt for the SPV.
Conditions	A minimum investment of 25 million euro is required in order for the EIB to be able to participate. EIB will not invest in wagons dedicated to the transportation of fossil fuels
Other comments	EIB could foresee a grace period at the start of the DAC implementation period, which will help stakeholders bridge the period in between the initial investment cost and the expected return.

5.2.2 National Promotional Banks

Willingness	Yes, in principle. Green investments are high on the priority list
Investment capacity	Dependent on the NPB, typically between €10m-€800m
Cost of debt	► Dependent on the credit worthiness of the counterpart. Preference for an SPV scenario as it allows to spread counterparty risk across several companies. ► Dependent on guarantees on debt ► Leverage of the project (lower is better). A higher portion of grants or equity will reduce the overall risk of the project for the NPB
Conditions	No investment in wagons dedicated to fossil fuel transportation
Other comments	Question on taking asset security over DAC unit, once it is installed. If a debtor defaults, it is unpractical to recover the asset, as it is installed on a wagon that is not under security with NPB. A solution could be a guarantee on debt by government.

5.2.3 Institutional investors

Willingness	In principle, yes. Given DAC will contribute to e.g. reducing emissions and accidents. Depends on outcome of (i) technical, (ii) environment, (iii) social, (iv) and a cost benefit analysis.

Investment capacity	Investment size must be larger than 25 million euro. Clustering of stakeholders in an SPV would be an excellent way to do this. Leverage of the project should, in theory, not exceed 50%
Cost of debt	Similar to NPBs
Conditions	► Financial viability of the debtor ► Technical due diligence of the project
Other comments	N/A

5.2.4 Pension funds

Willingness	In general, pension funds feel it is too soon for them to consider an investment in DAC. The maturity of the technology is too low, and the deployment phase is far in the future (>=2026)
Investment capacity	Ticket sizes between €100M – €700M
Cost of debt	If the conditions below are met, typically expect: government bonds return + 400-600 basis points
Conditions	ESG positivity, stable cashflows, clear business case, limited counter party risk.
Other comments	N/A

5.2.5 Debt risk & mitigation

Member states and the EU can significantly reduce the counterparty risk for lenders by providing debt guarantees. Such de-risking measure would help reduce the cost of debt significantly.

5.3 Grants and subsidies

5.3.1 At EU level

Several options were considered at the EU level, within the 2027 horizon of the current multi-annual financial framework, to fulfil the grant needs. The most relevant ones include:

CEF	The Connecting Europe Facility (CEF) is a key EU funding instrument to promote growth, jobs and competitiveness through targeted infrastructure investment at European level. It supports the development of high performing, sustainable and efficiently interconnected trans-European networks in the fields of transport,

	energy and digital services. CEF investments fill the missing links in Europe's energy, transport and digital backbone.[55] **Conclusion:** **CEF contains several interesting elements that can support the DAC Deployment, though with limited contribution especially for rolling stock investments so far.**
▶ CEF Transport	It is the funding instrument to realise European transport infrastructure policy. It aims at supporting investments in building new transport infrastructure in Europe or rehabilitating and upgrading the existing one.
▶ CEF financial instruments and EFSI[56]	The EU is providing important support to investments through loans from the European Investment Bank (EIB), where necessary with budget guarantees provided by the Connecting Europe Facility (CEF Debt Instrument) and the European Fund for Strategic Investment (EFSI). The EU has also developed blending instruments combining grants and loans or guarantees. Financial instruments support bankable projects by providing enhanced financing conditions. The CEF financial instruments are used to address specific market needs where there is insufficient private finance to support investment. As with grants, they are oriented to projects which have a clear European added-value, whilst optimising the use of Union funding.
▶ CEF Blending Facility	Blending is a combination of grants with financial instruments. The facility is a cooperation framework coordinated by the Commission, which engages with Implementing Partners such as the EIB, the European Bank for Reconstruction and Development (EBRD) or National Promotional Banks (NPBs) to implement the blending approach. **Conclusion:** **CEF blending is promising setup to combine several financial instruments to finance the DAC Deployment.**
InvestEU	The InvestEU Programme supports sustainable investment, innovation and job creation in Europe. It aims to trigger more than €372 billion in additional investment over the period 2021-27. The InvestEU Programme builds on the successful model of the Investment Plan for Europe, the Juncker Plan. It will bring together, under one roof, the European Fund for Strategic Investments and 13 other EU financial instruments. **Conclusion: the model of InvestEU is an interesting example that can serve as inspiration in the roll-out of DAC in Europe as it combines several financial instruments.**

[55] *Connecting Europe Facility*. (2020, December 15). Innovation and Networks Executive Agency - European Commission. Retrieved September 28, 2022, from https://ec.europa.eu/inea/connecting-europe-facility

[56] European Commission - INEA. (2019, July). *Investing in European networks: The Connecting Europe Facility - Five years supporting European infrastructure*. European Commission. Retrieved September 28, 2022, from https://ec.europa.eu/inea/sites/default/files/cefpub/cef_implementation_brochure_web_final.pdf

ERDF	Provides funding to both private and public bodies in all EU regions. The funding should reduce economic, social and territorial disparities. It supports investments through dedicated national or regional programmes. Enabling Europe to be: (i) more competitive and smarter, (ii) greener, (iii) more connected, (iv) more social), and (v) closer to citizens.[57] **Conclusion:** **As DAC is aligned with many of the objectives of ERDF listed above (more competitive and smarter Europe, greener Europe, more connected Europe), there might be an opportunity to support DAC deployment also through this instrument.**
CF	The Cohesion Fund provides support to Member States with a gross national income (GNI) per capita below 90% EU-27 average to strengthen the economic, social and territorial cohesion of the EU. A share of the Cohesion Fund is assigned to CEF transport, and managed by CINEA. The Cohesion Fund also supports investments in the field of environment and trans-European networks in the area if transport infrastructure (TEN-T). **Conclusion:** **The share of Cohesion Fund managed by CEF Transport could be used to support DAC deployment in cohesion countries. For the rest of the envelope, as Cohesion Fund is mainly focussing on infrastructure projects to reduce economic and social disparities and to promote sustainable development, DAC on-board would probably not be a natural fit for it. But there might be an opportunity to get funding to deploy infrastructure components linked with DAC (like e.g. new buffer stops).**
IPCEI	Important Projects of Common European Interest (IPCEI) are large initiatives directed to enhance the EU competitiveness in EU strategic value chains. They shall provide a very important contribution to economic growth, jobs and competitiveness for the Union industry and economy. IPCEI make it possible to bring together knowledge, expertise, financial resources and economic actors throughout the Union. "…supports investments for R&D&I and first industrial deployment on condition that the projects receiving this funding are highly innovative and do not cover mass production or commercial activities. They also require extensive dissemination and spillover commitments of new knowledge throughout the EU, as well as a detailed competition assessment to minimise any undue distortions in the internal market."[58] **Conclusion:**

[57] *European Regional Development Fund (ERDF)*. (n.d.). European Commission - European Commission. Retrieved September 28, 2022, from https://ec.europa.eu/info/funding-tenders/find-funding/eu-funding-programmes/european-regional-development-fund-erdf_en#:%7E:text=The%20European%20Regional%20Development%20Fund,dedicated%20national%20or%20regional%20programmes.

[58] *Press corner*. (n.d.). European Commission - European Commission. Retrieved September 28, 2022, from https://ec.europa.eu/commission/presscorner/detail/en/IP_22_4544

	Being focused on R&D&I and pre-mass production phases, the DAC Deployment phase would not qualify.

5.3.2 At member state level

As detailed in section 3 above, the Recovery & Resilience Facility (RRF), as centrepiece of NextGenerationEU, is expected to drive the public spending in the member states until 2027, end of the current multiannual financial framework. The RRF does not include digitalisation of rail freight specifically, nor DAC as such. However, DAC features and the expected benefits simply make it a perfect fit for the EU Green Deal and the RRF's key priorities of sustainability and digitalisation. At the same time, due to the incidental continuity of the RRF timeline (ending by 2027) with the envisaged timeline of the DAC migration (starting by 2026), the DAC investment plan could represent a qualifying destination for any leftover from the RRF. This scenario is explored more in detail in the following sections of the report.

Below, an overview of the RRF grant allocations per member state.

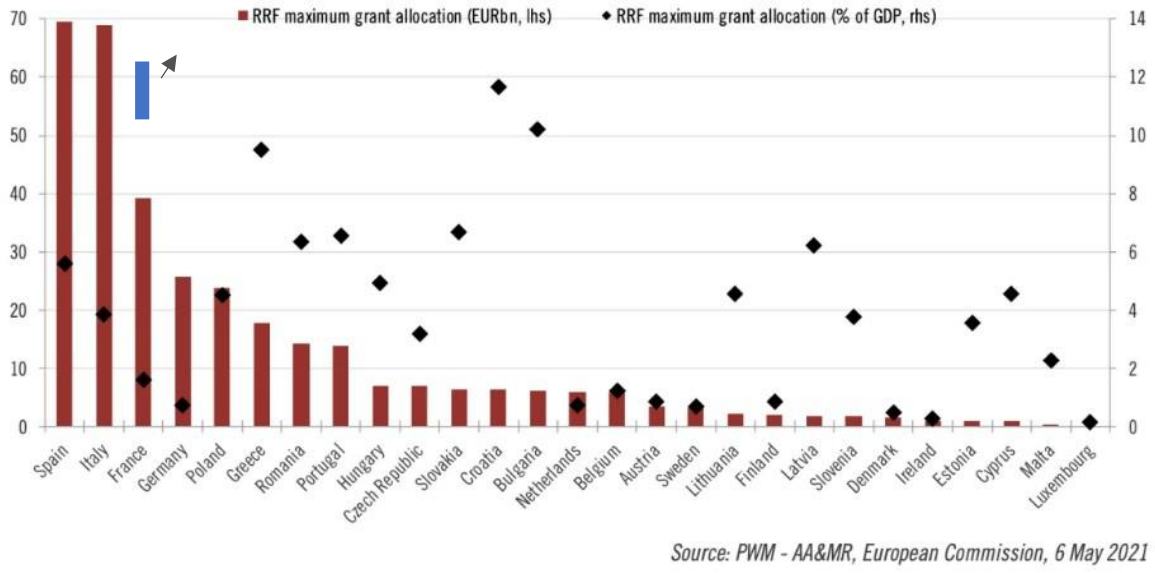


Figure 5.1 - Recovery and Resilience Facility - Grants allocated per member state[59]

The recent experience of the European Structural and Investment Fund (ESIF) throughout the past multi-annual frameworks, has just confirmed a chronic inability of member states to absorb all the planned budget allocations due to the lack of bankable projects in the given time period. With assistance of some extensions for funding

[59] PWM – AA&MR. 2021. The EU's Recovery Fund presents challenges as well as opportunities [Available at https://pictet-wealth-management.prezly.com/qa-next-generation-eu]

deadlines, the ESIF 2014-2020 budget period was spent at a rate of 94%[60]. With this absorption rate the projected unspent of RRF's grant quota (6% of €338 billion) would amount to more than €338 billion, almost the double of the entire DAC investment cost presented in section 4.

5.3.3 Potential new sources of funding

1. The EU Emissions Trading System

The EU Emissions Trading System (ETS)[61] works on the principle of 'cap-and-trade'. It sets an absolute limit or 'cap' on the total amount of certain greenhouse gases that can be emitted each year by the entities covered by the system. This cap is reduced over time so that total emissions fall.

Since the EU ETS was introduced in 2005, emissions have been cut by 42.8% in the main sectors covered: power and heat generation and energy-intensive industrial installations. As a market-based system, the ETS ensures that emission reductions take place where it is cheapest to do so. As a result, most emission reductions until now have taken place in the power sector.

Under the EU ETS, regulated entities buy or receive emissions allowances, which they can trade with one another as needed. At the end of each year, regulated entities must surrender enough allowances to cover all of their emissions. If a regulated entity reduces its emissions, it can keep the "saved" allowances to cover its future needs or sell them to another installation that is short of allowances. A Market Stability Reserve, in place since 2019, stabilises the market by removing surplus allowances from it.

The sectors covered by the existing EU ETS include power and heat generation, energy-intensive industrial sectors and aviation within Europe. Maritime transport and inland transport are excluded from the scope of the system.

In July 2021, the European Commission has presented a legislative proposal to revise the EU ETS in line with the EU's more ambitious target of achieving net emission reductions of at least 55% by 2030, compared to 1990 levels. The Commission is proposing that emissions from the current EU ETS sectors (including the extension to the maritime sector) be reduced by 61% by 2030, compared to 2005 levels. The Commission is also proposing to apply emissions trading in new sectors where sharper reductions are needed to reach the 2030 target. Under the proposal, emissions from maritime transport will be included in the existing EU ETS, while emissions from fuels used in road transport and building will be covered by a new, separate emissions trading system.

Auction revenues from the existing ETS go mainly to Member States' budgets, and are used predominantly to tackle climate change. Under the existing EU ETS, Member States are required to spend at least half of their auction revenues to support greenhouse gas emissions reductions, to deploy renewables and carbon capture and storage, and to improve energy efficiency and district heating. In 2018-2020, revenues amounted to €14-16 billion annually. On average, Member States spent 70% of these revenues for climate- and energy-related purposes.

[60] Funcas. 2021. What the absorption of structural funds says about the EU recovery plan. [Available at: https://www.funcas.es/articulos/what-the-absorption-of-structural-funds-says-about-the-eu-recovery-plan/#:~:text=According%20to%20the%20EU's%20open,funds%20allocated%20had%20been%20spent]

[61] https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_3542

Based on the Commission's proposal, Member States will be required to spend their auction revenues from emissions trading on climate- and energy-related projects, including decarbonisation in the road transport and buildings sectors. This includes investments in zero-emissions vehicles and mobility, energy efficiency improvements and renovations in buildings, as well as financial support in order to address social aspects. Under the existing EU ETS, a portion of allowances is auctioned for the Innovation Fund and the Modernisation Fund, which respectively support breakthrough innovations towards climate neutrality across the EU and power sector modernisation in lower-income Member States. The Commission proposes to increase both funds to help overcome the low-carbon innovation investment gap. The Commission also introduced a proposition of regulation on the 18 May 2022[62], as part of the REPowerEU initiative, which amends the EU ETS Directive and the MSR decision to auction €20 billion worth of allowances from the market stability reserve. The auction revenue would be made available to the Recovery and Resilience Facility (see §2). This new regulation is currently at European Parliament for first reading.

In the European Parliament, the proposal has been referred to the Committee on Environment, Public Health and Food Safety (ENVI). The ENVI Committee adopted its report on 17 May 2022. It was rejected in the June I plenary session, referred back to the Committee, and then adopted in the June II plenary. One of the main modifications is that Parliament wants a share of the ETS auctioning revenue to be used as an own resource for the EU budget and increase the size of the Innovation Fund.

The railway system, including DAC, could benefit from the ETS system, but some additional changes would have to be introduced into the new Directive. This could be done through a modification of the annex 1 on "CATEGORIES OF ACTIVITIES TO WHICH THIS DIRECTIVE APPLIES", with the introduction of railway transport as one of the eligible activities. The opportunity to introduce the railway sector within the ETS scope, like it is envisaged for road, could also be explored. This is still possible today, as the revision of the EU Emissions Trading System is still waiting for the Parliament's position in 1st reading.

2. REPOWER EU

RePowerEU is a legislative proposal on ending the EU's energy dependence on Russia. This is planned to be achieved through various measures such as energy savings and accelerated roll-out of renewable energy. The measures will be financed by the integration of the RePowerEU legislation into the RRF, where the remaining €225 billion in loans will be available. In addition, it will be possible for MS to allocate, voluntarily, roughly € 33 billion from other funds to RePowerEU, while the sale of ETS grants will provide € 20 billion in grants[63][64]. The proposal is currently due to enter into trilogues negotiations (inter-institutional negotiations).

RePowerEU will function as the RRF as the legislation foresees an introduction of a dedicated RePowerEU chapter in the RRF and the national Recovery and Resilience Plans allowing MS to invest in measures which can achieve the RePowerEU objectives. As such it is the MS who will select the investments upon review of the Commission.

[62] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52022PC0231

[63] REPowerEU (europa.eu)

[64] The ETS grants are explained more in-depth above.

DAC could fall under the scope of the RePowerEU proposal under article 21c (1c) "*addressing internal and cross-border energy transmission bottlenecks and supporting zero emission transport and its infrastructure, including railways"*[65]. There is moreover made reference to the upcoming Greening of Freight package scheduled to be published in Q2 2023. Among the three proposals of the package is the "Strengthening cross-border rail for passenger and goods by improving coordination and management". Lastly, the official Commission communication on RePowerEU highlights measures such as "as well as measures for the digitalisation of transport that are in part dedicated to greenhouse gas emission reductions"[66].

The EP adopted its position in 1st reading on November 10. The EP position foresees no budget changes or changes to the inclusion of transport as an objective. Nevertheless, the EP's position includes a 100% co-financing rate for projects supported under the Cohesion Fund, ERDF and ESF+ where they fall under the REPowerEU objectives[67]. The Council adopted their position on October 4. The Council opts for sources of financing coming from the Innovation fund (75%) and frontloading ETS allowances (25%) instead of auctioning from the ETS. The €20 billion remains[68]. Both co-legislators foresee a 15% (Council) and 20% (EP) pre-financing rate of the additional funding.

DAC could hereby fall under the scope of RePowerEU, however, it for the discretion of the MS to invest in DAC and moreover it would be through loans, which have been less attractive to MS[69].

3. Cross mode financing

The principle of cross mode financing is to use money coming from one mode of transport (through tolls, taxes, etc.) to finance the development of another mode. This possibility already exists at Member State level, through the Directive (EU) 2022/362 of the European Parliament and of the Council of 24 February 2022 ("Eurovignette" Directive). This new version of the Directive offers new opportunities to finance DAC deployment in the coming years.

While the current rules cover lorries over 3.5 tonnes, the new Directive extends the scope to all heavy and light vehicles and foresees more proportionate road charges for cars, too. Strengthening the 'user/polluter pays' principle, future charges for lorries and buses will address CO2, as well as pollutant emissions. This translates into a general phase-out of vignettes for trucks on the core TEN-T network over an eight-year period and a shift to distance-based charging. Member States will also be able to set up a combined charging system incorporating distance, time, and CO2 emission criteria. An external cost charge for air pollution will be introduced for heavy goods vehicles after a period of four years following the introduction of the tolls. The revised Directive will also introduce the option to charge for congestion and charge more for travel in sensitive areas, with revenues from those additional charges used for the benefit of sustainable transport[70]. On this latter point, the new Directive

[65] com-2022-231_en.pdf (europa.eu)

[66] Questions and Answers on the REPowerEU Communication (europa.eu)

[67] Texts adopted - REPowerEU chapters in recovery and resilience plans - Thursday, 10 November 2022 (europa.eu)

[68] st12662-re02-en22.pdf (europa.eu)

[69] An ambitious plan without adequate financing? - Institut Jacques Delors (institutdelors.eu)

[70] https://www.europarl.europa.eu/legislative-train/theme-resilient-energy-union-with-a-climate-change-policy/file-jd-eurovignette-directive-revision

specifies that *"Revenues generated from congestion charges, or the equivalent in financial value of those revenues, shall be used to address the problem of congestion, or to develop sustainable transport and mobility in general."*

So there is an opportunity within existing legal framework for Member States to find additional sources of funding to finance investments in new technologies (such as DAC) for alternative modes of transport.

5.4 Legal framework for State aid

In identifying suitable member states' funding solutions for DAC, State aid matters must be considered. Under the EU Treaty (Article 107 of TFEU), State aid that threatens to distort competition in unlawful. If State aid exists, a conformity assessment must be undertaken based on various regulations. Further to consultations with DG COMP, it was concluded that any support from member states for the DAC deployment must comply with the Guidelines on State aid for Railway Undertakings[71]. However, this document is currently being revised as per the communication by the European Commission[72]. The revised document will likely extend onto other market players, not just the Railway Undertakings as per the stakeholder consultation. Being the revision still in progress, no confirmation on the changes could be acquired. The revised guidelines will inevitably be in force by the time DAC deployment begins, hence it will be important follow to the revision closely.

At the same time, provided all eligible beneficiaries can apply, there is no market distortion at EU level and, on the contrary, clear EU socio-economic benefits are at stake, for the same principle applied for the IPCEI, member states would be rather encouraged to support projects that make a clear contribution to the EU strategic objectives[73]. In such circumstances, this can be achieved by loosening the relevant state aid guidelines into a separate lawful clause that allows for more competition distortion (and thus strategic cooperation).

As elaborated above, through the consultation with DG COMP, it was found that IPCEI framework cannot be applied to DAC deployment as such due to the main scope of IPCEI being large research and innovation consortia of multiple companies. For this purpose, IPCEI could therefore apply to further research and innovation efforts with regards to DAC.

[71] EUR-Lex. 2008. Communication from the Commission — Community guidelines on State aid for railway undertakings. [Available at: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52008XC0722(04)]

[72] European Commission. 2022. State aid: Commission invites comments on proposed revision of Guidelines on State aid for railway companies. [Available at: https://ec.europa.eu/commission/presscorner/detail/en/ip_21_7049]

[73] European Commission. 2022. IPCEI. [Available at: https://ec.europa.eu/commission/presscorner/detail/en/IP_21_689]

6 Possible scenarios and implementation approaches

6.1 Scenario zero: the current situation

The current scenario presents important pre-conditions already met and a promising march towards full investment maturity.

Significant progress has been made in developing the technological blueprint for DAC and it is estimated that the Technical Specifications for Interoperability (TSI) and the DAC industrialization process can be ready by 2025.

A migration strategy has been designed with the view to optimizing costs, minimizing risks and maximizing return at the EU network operation level. Convergence among operators started taking pace and growing.

The migration plan has been assessed in terms of costs and benefits and results clearly show a positive case, though long-term, for all stakeholders together, public and private. The late recognition of benefits compared to the capital investment time and extra-maintenance costs during the DAC migration phase remain crucial challenges to address.

Therefore, the success of the DAC deployment will depend on the identification of a viable mix of funding and financing resources which can help cover the financial gap, in terms of initial capital investment (see 4.2) as well as the additional costs during the migration phase (see 4.3) until benefits' recognition will steadily improve the cash position of the investing stakeholders.

It should be noted that the recognition of benefits will crucially depend on the level of deployment achieved and its timely synchronization across the rail freight operation network in the EU. Therefore, even in possible few front-runner countries where resources could be available to sustain the initial investment, stakeholders may experience a very disappointing return in case of insufficient followers and scale effects.

Moving forward

Taking into consideration the strategic interests at stake and the complexity of a synchronized DAC migration plan involving a significant number of the EU stakeholders, a central and single control booth appears as a fundamental strategic approach for securing success. Drawing inspiration from the aviation modernization programme for Europe's air traffic management (SESAR), the establishment of a dedicated Deployment Management for DAC could be a very appropriate and most probably easy to replicate solution.

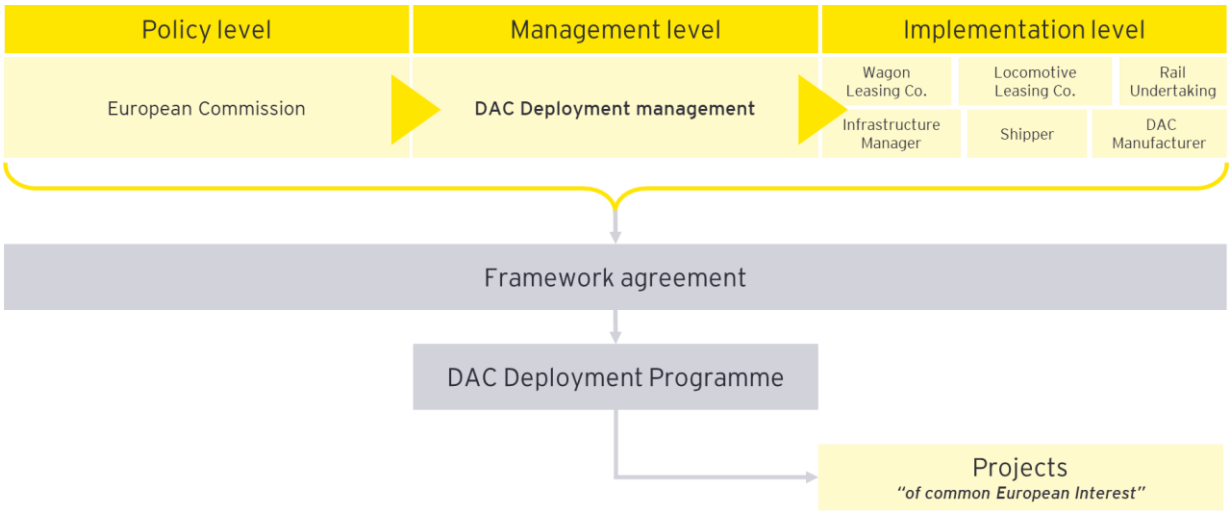


Figure 6.1 – DAC Deployment Management Framework

The operational responsibilities of the DAC Deployment management include the articulation of the EU DAC migration plan into coordinated implementation plans at local/stakeholder level, more specifically it implies:

- Coordinating with manufacturers to make sure the production capacity is aligned with the migration plan;
- Driving and coordinating the demand of stakeholders / individual projects;
- Allocating funds (pre-defined unit contributions) to approved projects on the basis of specified eligibility criteria;
- Coordinating stakeholders for a synchronized implementation of their respective projects until close out; and
- Acting as a centralized procurement unit, on behalf of the programme, ensuring an economically viable and interoperable evolution of the system

The establishment of an appropriate EU body for the management of the DAC deployment in the EU would therefore stand for a fundamental pre-condition for a successful DAC migration and will increase confidence by investors.

Benefits	**Drawbacks**

► Harmonized and coherent DAC roll-out across member states ► Improved risk management, savings on engineering costs, centralized expertise ► Increased implementation speed ► Reduced operational implementation effort on the side of stakeholders (WLC, LLC,…) ► Formalization of project of common European interest, supported by implementing EU Regulations	► Additional political support needed ► Timely and compliant engagement of all MS on EU Regulations ► Overhead cost related to the DAC Deployment Management

On this basis, two alternative scenarios have been envisioned for the DAC investment plan:

- Scenario one: structured blended finance
- Scenario two: simple, upfront public funding

6.2 Scenario one: Blended Financing

It is characterized by a moderate level of public spending capacity at EU and MS level at the start of the DAC migration. This condition, combined with constraints in equity provision declared by the investing stakeholders, determines the need of a significant quota of debt. The scenario, similarly to the InvestEU Fund, envisages favourable and long-term lending conditions by the EIB, National Promotional Banks and other financial institutions and investors, enabled by an EU budget guarantee.

Two relevant approaches have been assessed for the implementation of the DAC investment in scenario one:

- A Connecting Europe Facility (CEF) lending facility for DAC, and
- A dedicated Special Purpose Vehicle (SPV), a legal entity created for the financing of the DAC retrofitting.

Both these two approaches have shown interesting aspects (see Appendix 8.2 and 8.3 for more details) and have eventually pointed towards a combination of their respective most suitable practices for the implementation of the DAC investment.

The most inspiring aspects followed include:

1. Determination of unit contributions for:
    a) upfront grant support, as a percentage of the initial investment (CAPEX), and
    b) additional subsidies, as percentage of the overall deployment and operation cost of stakeholders.
2. Financial aggregation of stakeholders into a SPV, to raise and administer funding and financing that a large part of stakeholders would not afford individually

EU grants, within specified maximum unit contribution, would be managed by the DAC Deployment Management (DM) that will coordinate and ensure a desired deployment intensity over the DAC implementation period. These upfront unit contributions could be modulated to possibly consider higher thresholds for recipient assets in cohesion countries.

The provision of the EU guarantee shall also enable senior debt conditions from the EIB and other possible financial institutions and investors.

One or more SPV(s) (see appendix 9.3 for further details) will:

- Act as an aggregator of debt demand and secure same debt conditions to all stakeholders (big and small ones) taking part in the SPV
- Collect grants, debt and equity provisions from the investing stakeholders (LLCs, WLCs and Rus)
- Pay the acquisition, installation and maintenance costs of the DAC
- Charge a leasing fee to stakeholders to repay the debt and its running cost

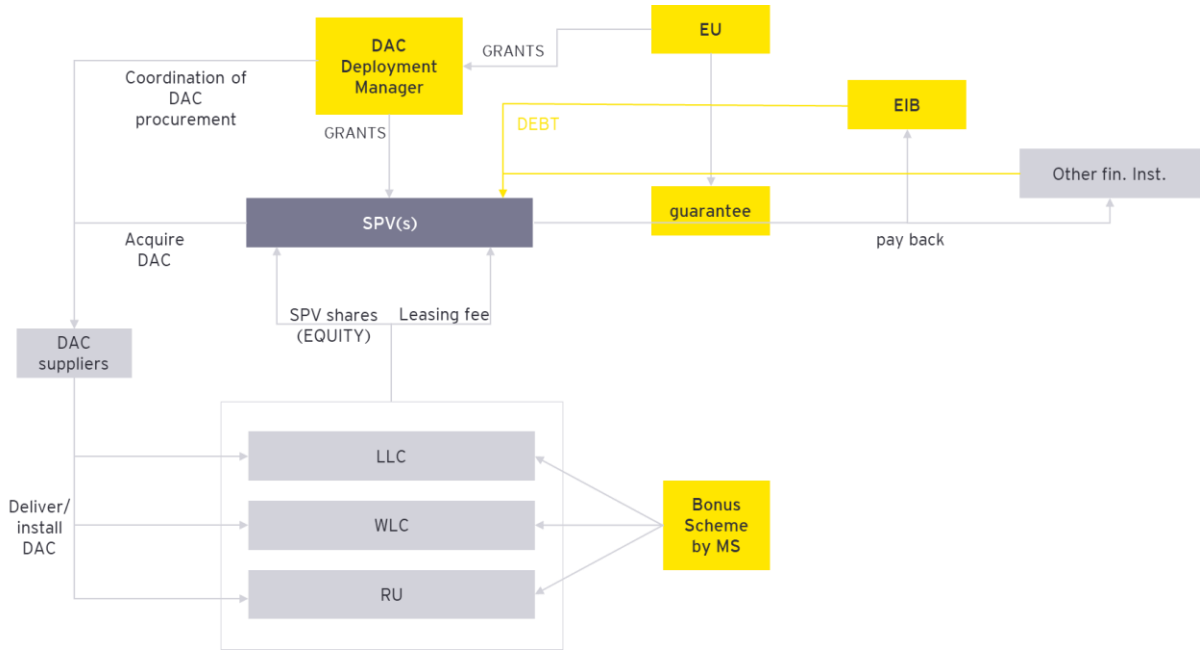


Figure 6.2 – funding and financing scheme – scenario one

This configuration of (public) funding and (private) financing sources shall be able to cover the total CAPEX (€9 bn. circa), however will not provide sustainability for the future of the investment. The financial impact of the associated OPEX and additional costs (€2.5 bn. circa in total) would not be affordable for the industry without additional forms of subsidies during the first years of the DAC operations. In the proposed model this additional subsidy is provided by Member States in the form of a bonus scheme. Cash flow positions of stakeholders will be significantly stressed otherwise, while they will need to recover and ensure a sustainable financial path until benefits will start materializing.

Additional subsidies could come following different schemes already adopted in the rail transport sector:

- 'Availability payment', often used in presence of Public Service Obligations (PSO), whereby the provision of assets/services, responding to defined quality standards, is automatically compensated by the public contracting authority with regular so-called 'availability payments'. The availability payment is applied as a de-risking mechanism as it is either independent from the actual level of use of the asset or in case the actual level of asset utilization is below certain specified minimum thresholds. It has to be noted that this option is

normally utilized to guarantee the minimum intended provision of the passenger transportation services rather than the freight ones, as the latter do not refer to a PSO scheme.

- Bonus scheme based on actual asset utilization. This other option has been already introduced in the rail freight transportation sector with the DTAC (Differentiated Track Access Charging) Regulation for silent trains. The DTAC scheme has been implemented in different MS and in different forms (bonus / bonus-malus) and outcomes in terms of transparency and efficiency of the subsidy distribution amongst stakeholders. The most critical aspect of this scheme has proved to be the 'indirect' subsidization of some stakeholders, such as LLCs and WLCs, who would receive the bonus through the RU, as single recipient of the track access charge.

The most appropriate bonus scheme for DAC could still be based on actual asset utilization, though operated directly by each of the DAC assets' owner (RUs as well as LCCs and WKLs). New asset management systems enabled by DAC and GIS data would easily provide detailed reports with actual assets utilization in the network (which DAC wagon/loco and for how many km travelled in a specific period). These data could then be validated by the local authority (with respect to conformity of assets running) and the Infrastructure Manager (with respect to the actual km travelled in the network in the period).

It should be noted that, in case of higher upfront grant contribution for asset registered in cohesion countries, the additional subsidy required in those countries, during the initial operation phase, will be lower. It is in any case to envisage a different level of subsidization through the bonus scheme in the EU member states. This could require regulated mutual agreements in terms of domestic and interoperable bonuses. These bonus schemes can be established in a way to make them automatically granted if certain criteria, either mandatory or voluntary, are met.

When providing subsidies by public authorities, the so-called 'Market Economy Investor Principle' ("MEIP") will have to be considered. Under this principle, investments in an undertaking by public authorities is not considered state aid in case it invests together and on equal terms with private investors or when an *ex-ante* study is carried out that demonstrates that investments are likely to generate sufficiently high returns. A sufficiently high rate of return is that which would satisfy the expectations of a private investor. The essence of the MEIP is that when a public authority invests in an enterprise on terms and conditions which would be acceptable to a private investor operating under normal market conditions, the public investment is not considered as state aid. More details on state aid are provided in Appendix 9.4

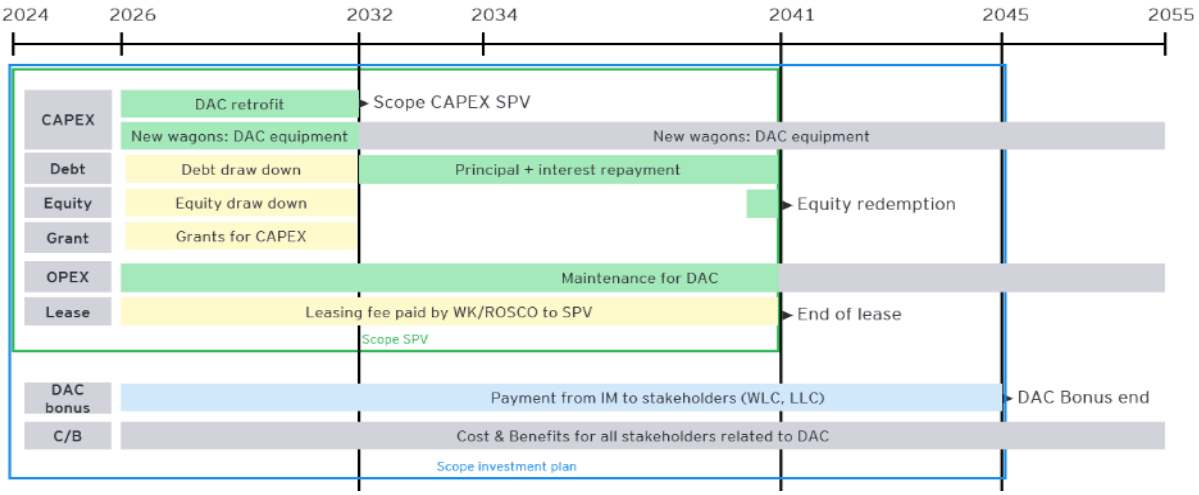


Figure 6.3 – funding and financing scheme – scenario one timeline

6.3 Scenario two: Up-front Public Funding

Historically, and as mentioned in section 5.3.2, a sizeable percentage of funds allocated by the EU ends up being unutilised. The most recent case is that of the ESIF, where only 94% of allocated EU expenditure ended up being utilised (absorption rate) at EU level. This set of circumstances becomes unique in the history of the EU's public spending when combined with the exceptional budget allocated by the EU to the Recovery & Resilience Facility (RRF)[74]. Such possible and sizeable left over of the EU budget would eventually materialize by the end of the current multi-annual financial framework (2027) and will become increasingly assessable during the course of the next years (e.g. with the mid-term evaluation envisaged by 2024 – see 6.4. for more details) and could therefore be reallocated right at the start of the DAC investment. This unique opportunity would make the scenario two plausible.

Furthermore, it assumed that any leftover from closing funds and facilities would in any case be additional to, not substitute for a normal, yet moderate availability of public resources (same as scenario 1), which should therefore be considered as the baseline for scenario two.

The investing stakeholder (WLC, LLC, RU) will enter into a grant agreement and will engage in terms of own financial contribution plus demonstration of debt capacity as necessary.

Scenario two would present a much easier funding and financing set-up (see fig. 6.4).

[74] €723.8 billion

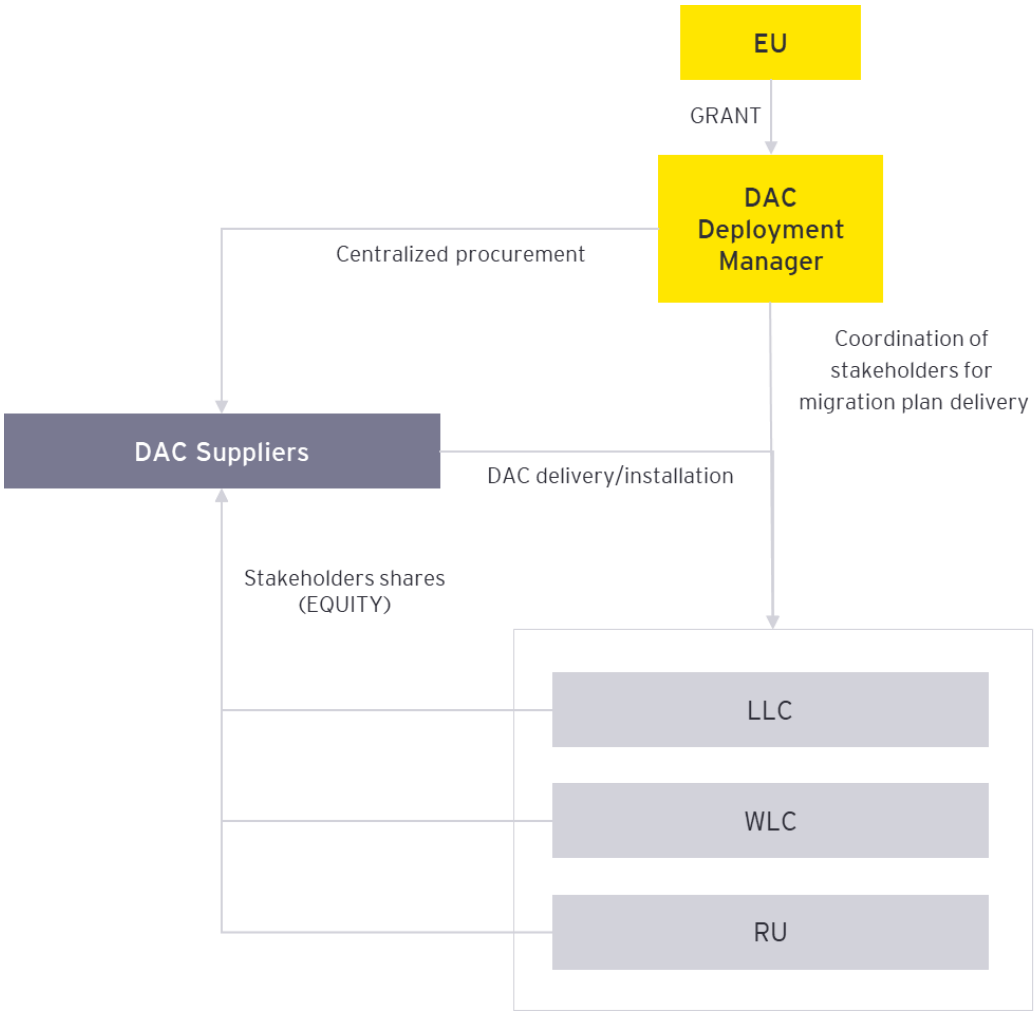


Figure 6.4 – funding and financing scheme – scenario two

7 Results and Conclusion

This chapter illustrates the results of the financial model developed for the two scenarios, as described in section 6, and provides conclusions and recommendations for a sustainable investment by all stakeholders.

7.1 Scenario one: Blended Financing

It is characterised by a narrower share of grants, therefore the model contemplates a more complex mix of financial instruments, as described in section 6 above.

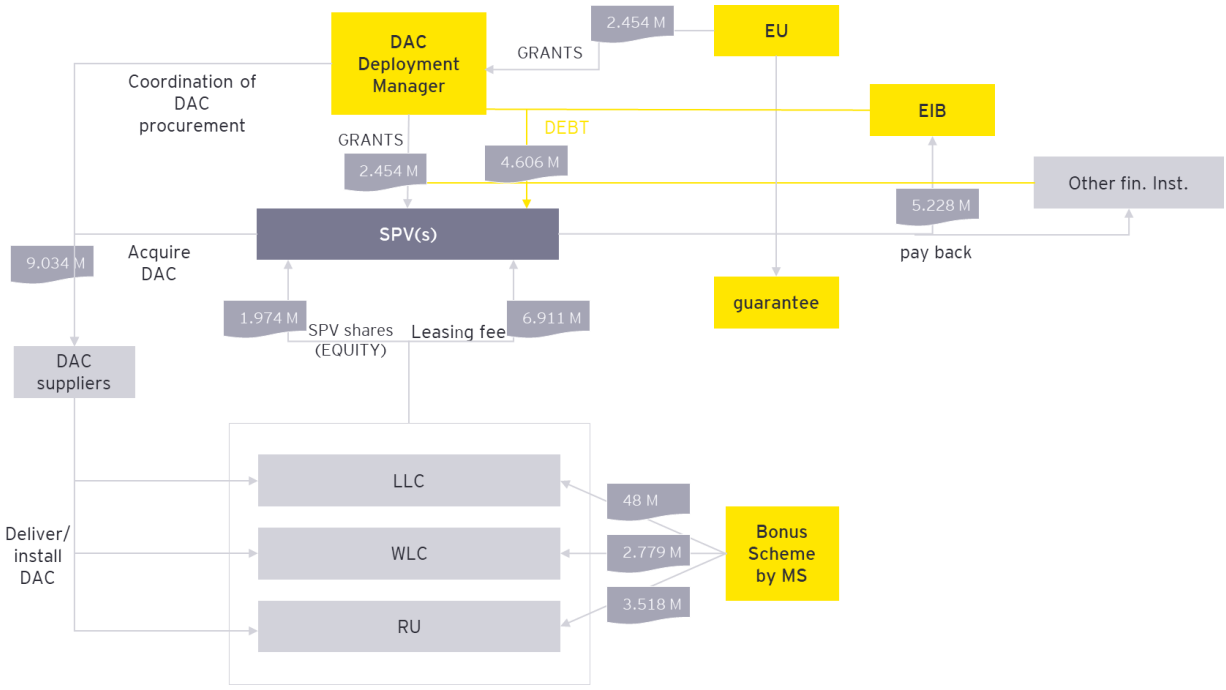
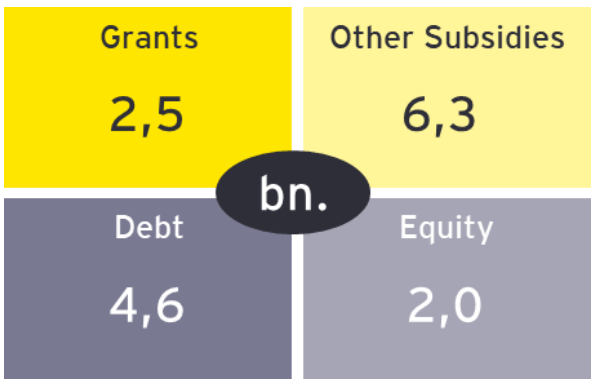


Figure 7.1 – overall results –scenario one

The total CAPEX considered (€9'034 million) has been covered by the sources' mix (grant, debt and equity) illustrated in the figure above. The 27% EU grant quota (€2'454 million) includes a differentiated contribution to the DAC unit cost: 20% to be applied in non-cohesion countries and 40% in case of cohesion countries.



This CAPEX coverage configuration is alone insufficient, due to all the OPEX and additional costs specified in section 4, to make the DAC investment viable. On the basis of estimated cost of capital (debt and equity), the model has calculated the minimum amount and duration of additional subsidies necessary to sustain financial viability for all the stakeholders during the first years of DAC operations. As described in section 6, the additional subsidies were assumed to be covered by MS.

The yellow portion of the bar charts below represents the calculated additional subsidies necessary to provide sustainable cashflow projections for stakeholders.

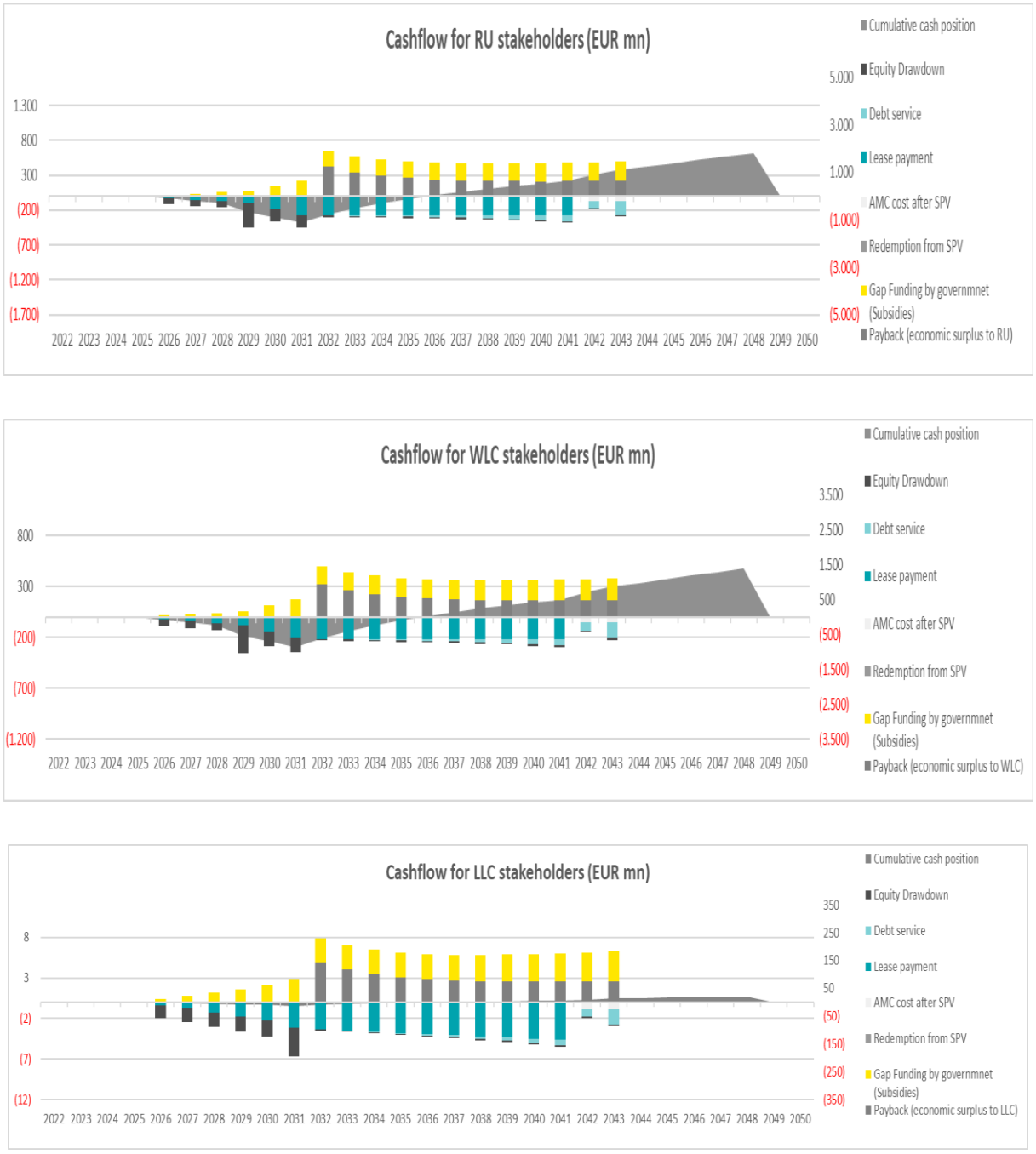


Figure 7.2 – cashflow per stakeholder – scenario one

The assumed regular injection of subsidies to stakeholders, over a period covering the entire SPV duration plus additional two years, would suffice to hold up their respective cashflows until the benefit recognition time.

The total amount of additional subsidies to cover the gap has been calculated in €6'345 million (48 m to LLCs, 2.779 m to WLCs and 3.518 m to RUs), equivalent to an average of €373 million per year, which could be modulated over the period.

It is worth nothing the predicted distribution of the overall amount of subsidies among member states, according to their respective level of rail freight traffic. The top five countries alone (Germany, Poland, France, Sweden, and Austria) would cover more than circa 57% of the total amount of DAC subsidies and grants (circa 8,8 billion euros). Interestingly, the benefits of the same countries would also represent circa 57% of the total benefits (circa 12 billion euros). The total spending would thus be proportionate to the benefits acquired in this model.

The SPV cashflow below illustrates sources of funding and financing providing coverage for:

- DAC acquisition,
- Installation and maintenance costs, and
- Debt repayment over its 21-years lifetime.

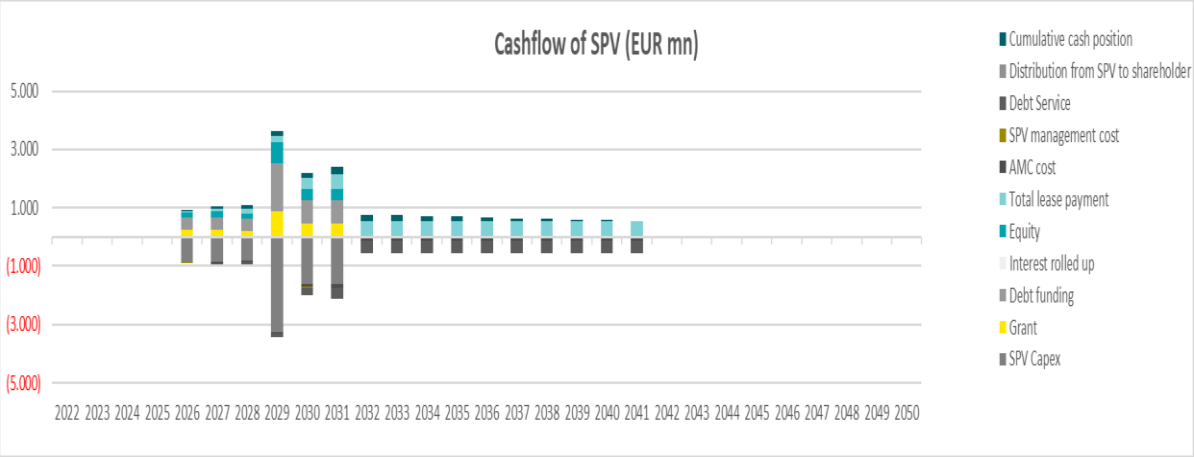


Figure 7.3 – SPV cashflow – scenario one

From a public investment perspective, it is interesting to note that the total public funds disbursed over 18 years and amounting to € 8.8 billion circa, will generate € 12 billion circa by 2050, as shown in the figure below.

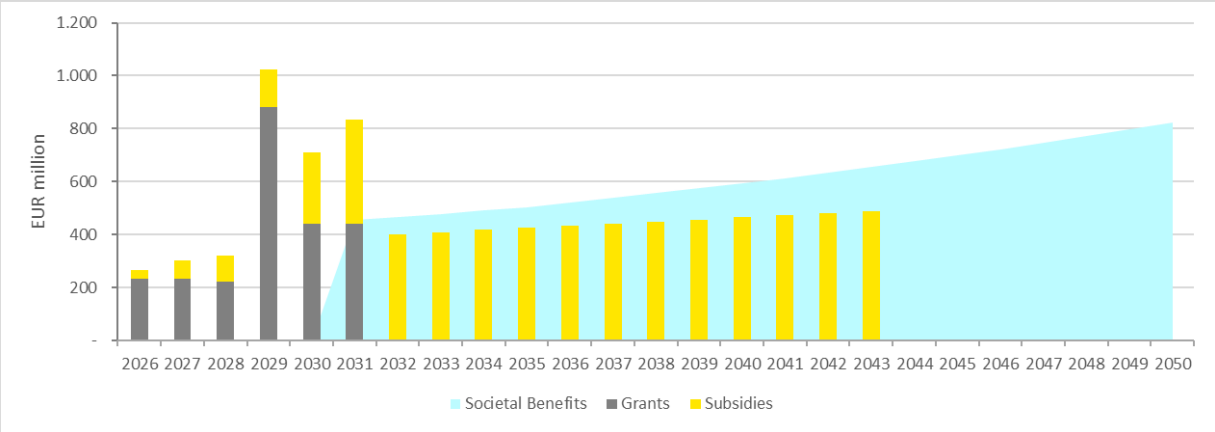


Figure 7.4 –Public sector funding and societal benefits generated – scenario one

7.2 Scenario two: Up-front Public Funding

In this scenario, given the large availability of EU and MS funding, the model has calculated the minimum amount of EU grant necessary to address the market failure and create a business case for the stakeholders (as described in section 6). The results show a total EU grant of €6'458 million, representing 71,5% of the total CAPEX envisaged (€9'034 million).

The remaining part (€2'576 million, 28,5% of the CAPEX) shall be covered by a combination of equity and commercial bank loans, depending on convenience and capacity of the individual stakeholders.

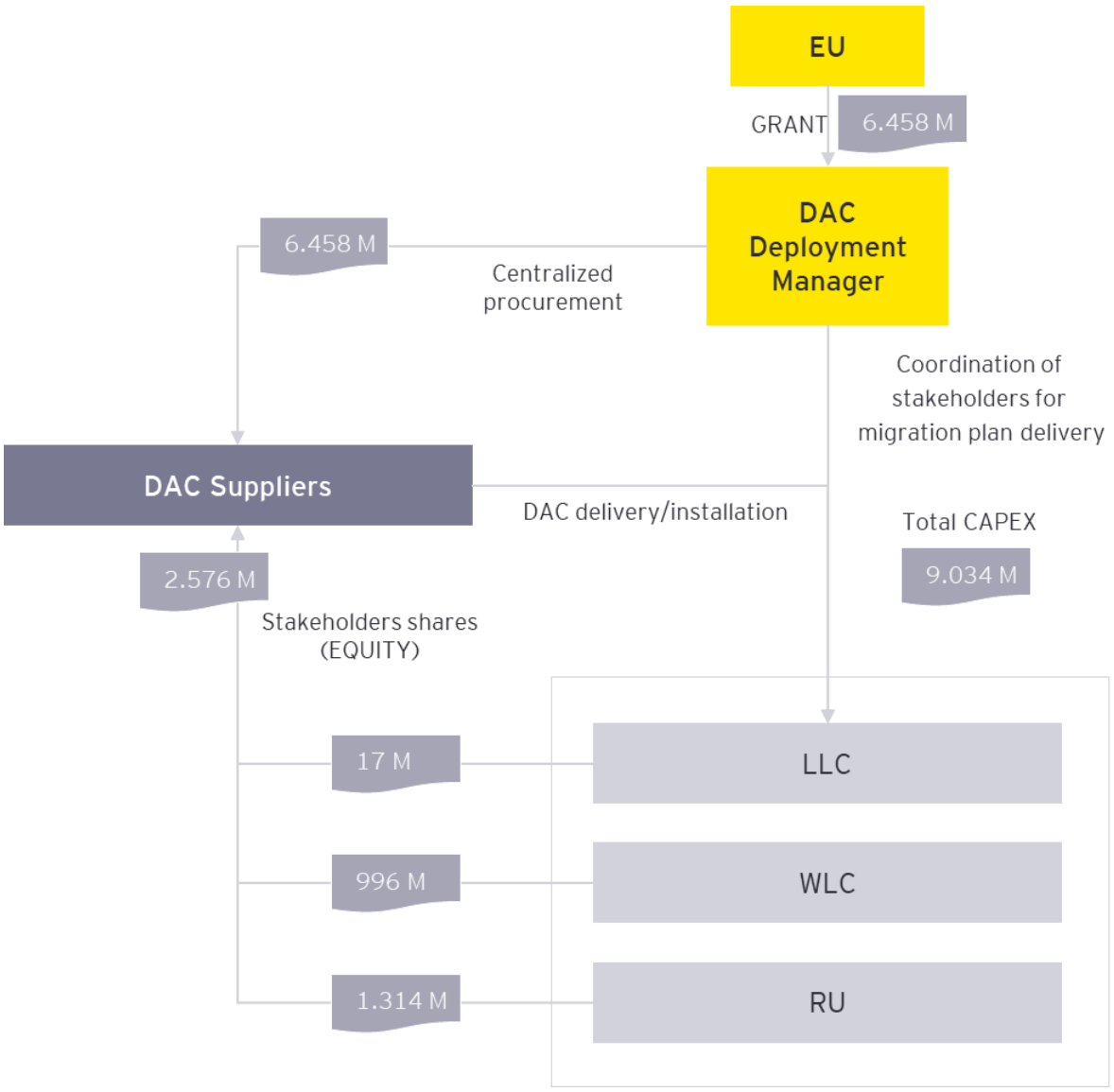
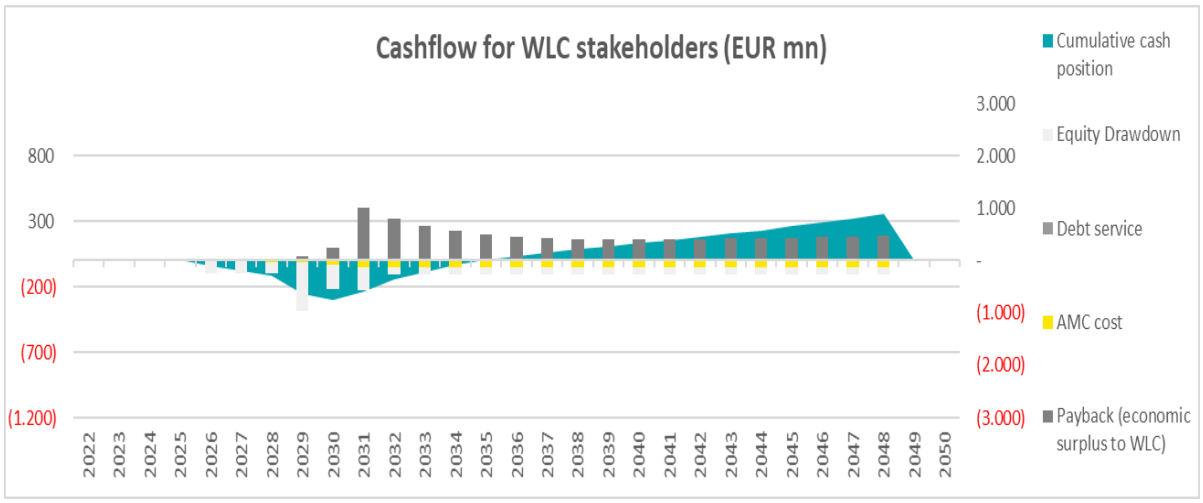
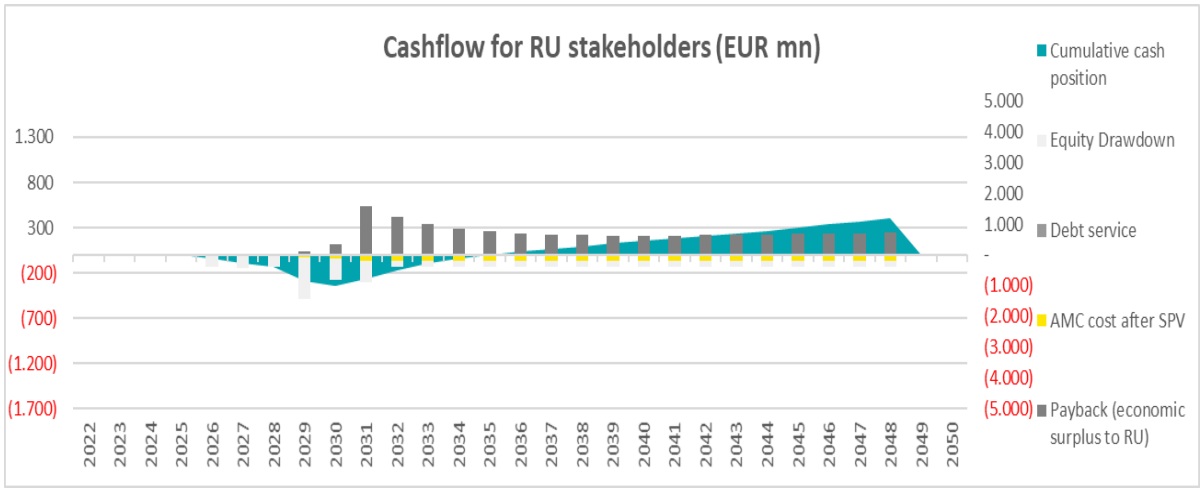


Figure 7.5 – overall results – scenario two

The model results show a breakeven point reached in 10 years and a healthy cashflow position in the longer term for all stakeholders (see figure 7.2)





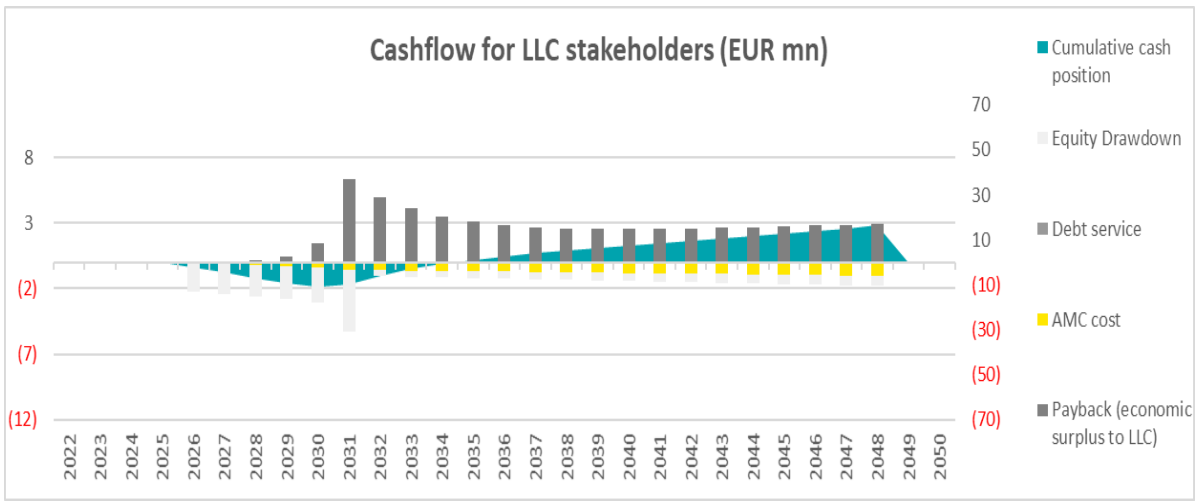


Figure 7.6 – cashflow per stakeholder – scenario two

From a public investment perspective, compared to scenario one, scenario two is expected to produce the same level of societal benefits (€ 12 billion circa by 2050), but with only € 6.5 billion of public funds (instead of € 8.8 billion), though disbursed over 6 years, instead of 18 years as in scenario one.

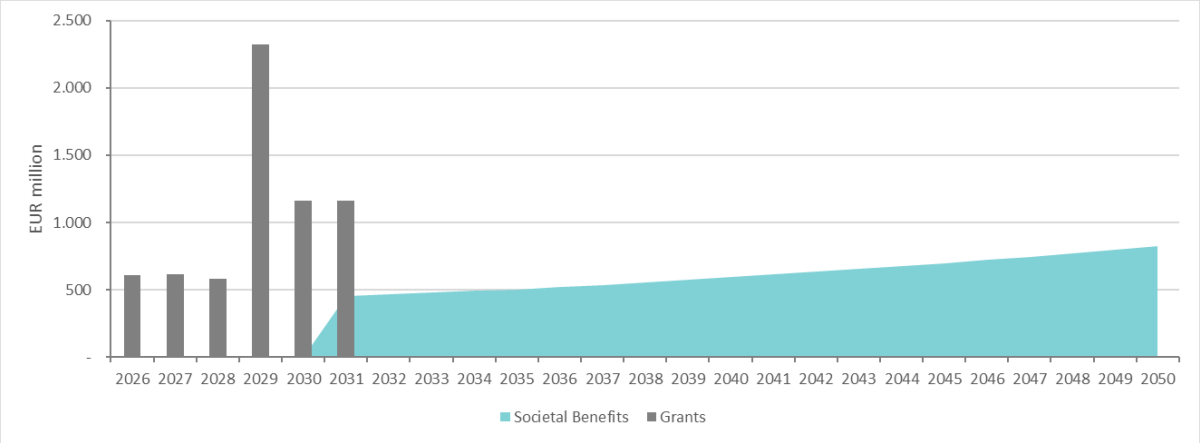


Figure 7.7 – Public sector funding and societal benefits generated – scenario two

7.3 Conclusions

Both scenarios have been modelled to calculate the minimum level of public spending necessary to correct market failure for the DAC investment. Both the simulations provide positive results in terms of financial viability, presenting a breakeven point by 2035 for all stakeholders, almost 10 years after the start of the investment. As a side remark it is worth noting that a key assumption effecting the return of the industry stakeholders is the future pricing of DAC assets' service. The study has considered a moderate price increase for DAC freight rail services, since it is acknowledged that price competitiveness compared to other transport modes will be a key driver to realize the shift-to-rail ambition for freight traffic.

In terms of funding level, the main difference lies in the public spending capacity and intensity over time. Scenario one foresees more conservative levels of up-front grants available during the period 2026-2031, however it eventually ends up presenting a higher level of total public support (€8.8 bn. over 15 years) compared to scenario two (€6.5 bn over 6 years). It should be noted that this doesn't even account for the cost of the EU guarantee envisaged to provide senior debt conditions, which could go up to 30% of the debt raised and expose an additional equivalent of €1 bn circa of public resources.

In terms of simplicity of the funding mechanism, scenario two would still represent the most feasible option. No sophisticated EU financial instruments would be necessary, as well as any form of subsidy schemes at member state level under scenario two. These avoided complications of the financial structure not only spare the associated transaction costs but more importantly the potential spill outs on the way to a complete and successful DAC migration for the entire EU fleet.

As emphasized in the previous sections, the rationale for the scenario two is based on two main observations: the historical trend confirming a minimum physiological level of unspent resources for closed EU funds/facilities and absorption capacity by member states, on the other hand the exceptionally large allocation made on the ongoing RRF. The € 6.5 billion of grant necessary for the DAC migration plan represent only the 1,9% of the grant quota of the RRF (€338 billion), while it is reasonable to assume that the leftover portion of these funds could be potentially much higher.

DAC would stand out as a major opportunity to reallocate these funds given both its environmental and digital features. Indeed, the DAC would, in one single initiative, check most all the criteria set out by the EC in its Green Deal.

For this reason, it would be advisable to start positioning the DAC investment plan with the appropriate EU Institutions, and the Parliament in particular, as a possible reserve destination for unspent RRF resources. This could generate an enormous trust and engagement by all stakeholders in the entire value chain.

Meanwhile the possible structure of the EU DAC Deployment Management should be further assessed and established, taking into account the differences in number, size and complexity of the rail industry compared to the aviation one, which represents a convenient and easy to replicate precedent implemented by the EU in the transport sector. Other suitable options could also be explored to set up the necessary organisation, capabilities and resources to manage the DAC funds, including their allocation, coordination and disbursement.

The following section provides a roadmap and a set of recommendations in terms of possible next steps for the most timely and appropriate follow up on the DAC investment plan.

8 Roadmap

This chapter will present a roadmap for the coming years to obtain funding for DAC and the key steps to be taken to setup a DAC Deployment Manager. The chapter is divided into three sections:

- Possible immediate actions under the current legislative framework;
- Future actions for influencing the future revisions of legislation related to EU funding; and
- Stages to establish a DAC Deployment Manager.

8.1 Funding and financing

Two different kinds of actions have been considered for the roadmap:

- Actions which can be taken within the existing regulatory framework
- Actions leading to a change in the regulatory framework to facilitate and accelerate DAC deployment from a financial perspective

Actions which can be taken within the existing regulatory framework

The figure**Error! Reference source not found.** below illustrates the key periods related to acquiring funding under the current legislative framework. The points in the figure are explained in greater details in the table below the figure. The years indicated in the illustration below denotes the window of opportunity. Thereby, the action should start in the first year indicated in the time period.

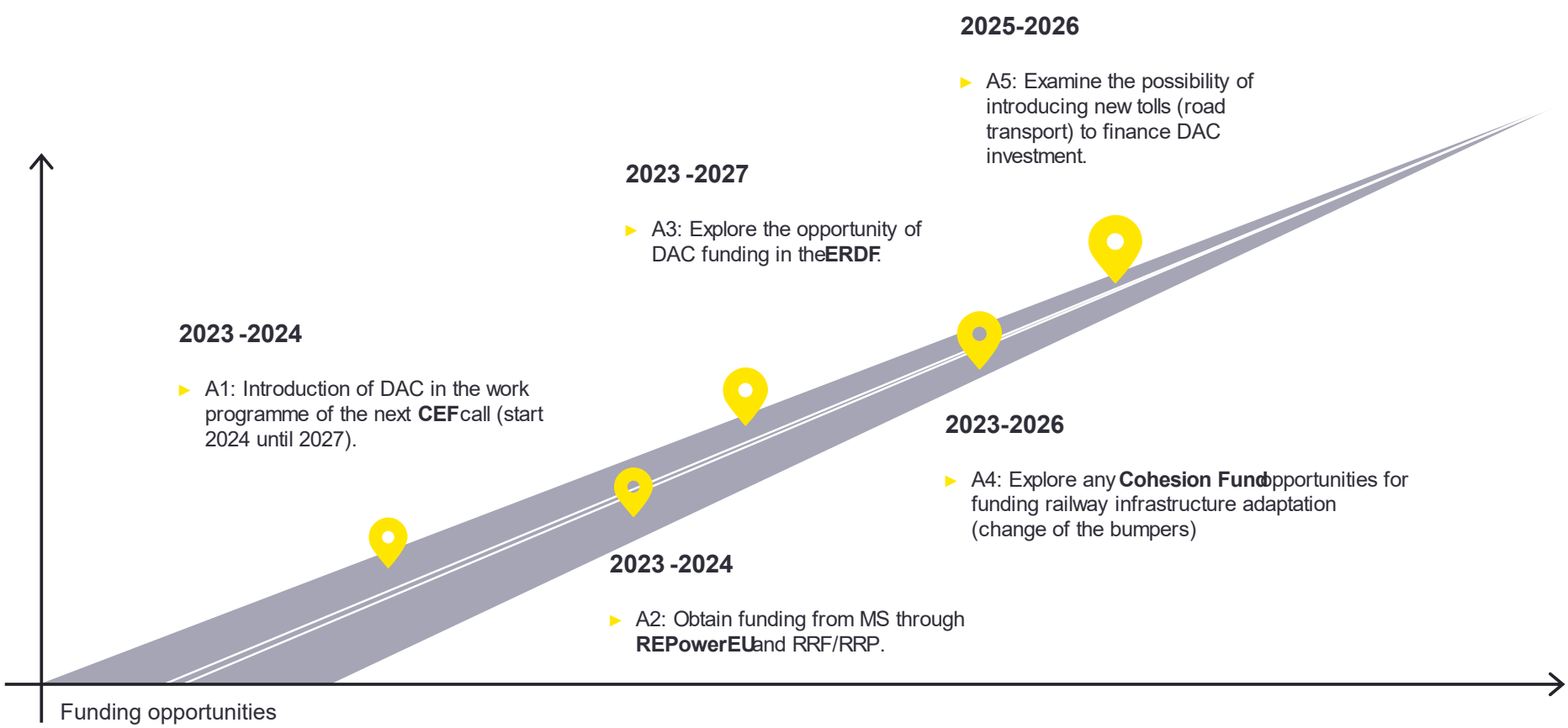


Figure 8.1 : Roadmap - Funding opportunities under the current legislative framework

Priority	Action #	Legal document / facility	Stakeholder	Description of the action
Immediate actions	A1	CEF 2021-2027	European Commission	Explore the possibility to introduce DAC in the work programme of next CEF call, once the product is approved. This action has to be anticipated as much as possible. If approved by for funding, the remaining CEF budget (€ 7,8 bn of which 15% possibly could go to DAC[75]) could be used for smaller deployment projects. The risk for DAC would be that it is not yet mature.
Immediate actions	A2	REPOWER EU	European Commission and MS	DAC would be eligible for financing under the RepowerEU chapter introduction in the RRF and RRPs. The financing would go through the MSs in their RRPs. A risk for DAC receiving funding under the RePowerEU would be MS not using the tool since it's heavily based on loans which have been less attractive than grants (see section 5.3.3.2 for more information).
Short term actions (2025-2027)	A3	European Regional Development Fund (ERDF)	Regions	As DAC is aligned with many of the objectives of ERDF, there might be an opportunity to support DAC deployment also through this instrument. But the capacity to use resources from ERDF within this financing period will also depend on the maturity of DAC products.

[75] c20215763-cef-financing-annex.pdf (europa.eu)

Priority	Action #	Legal document / facility	Stakeholder	Description of the action
Short term actions (2025-2027)	A4	Cohesion Fund (CF, not channelled through CEF)	Member States	Explore the possibility to use CF to finance the adaptation of the railway infrastructure (change of the bumpers). But the capacity to use resources from CF within this financing period will also depend on the maturity of DAC products.
Short term actions (2025-2027)	A5	Directive (EU) 2022/362 ("Eurovignette")	Member States	Explore the possibility to implement new tolls or taxes on road transport to finance investment in the railway sector, including DAC.
Short term actions (2025-2027)	A6	Green Rail Investment Platform	EIB	Future SPV to apply to this lending facility.

Actions leading to a change in the regulatory framework

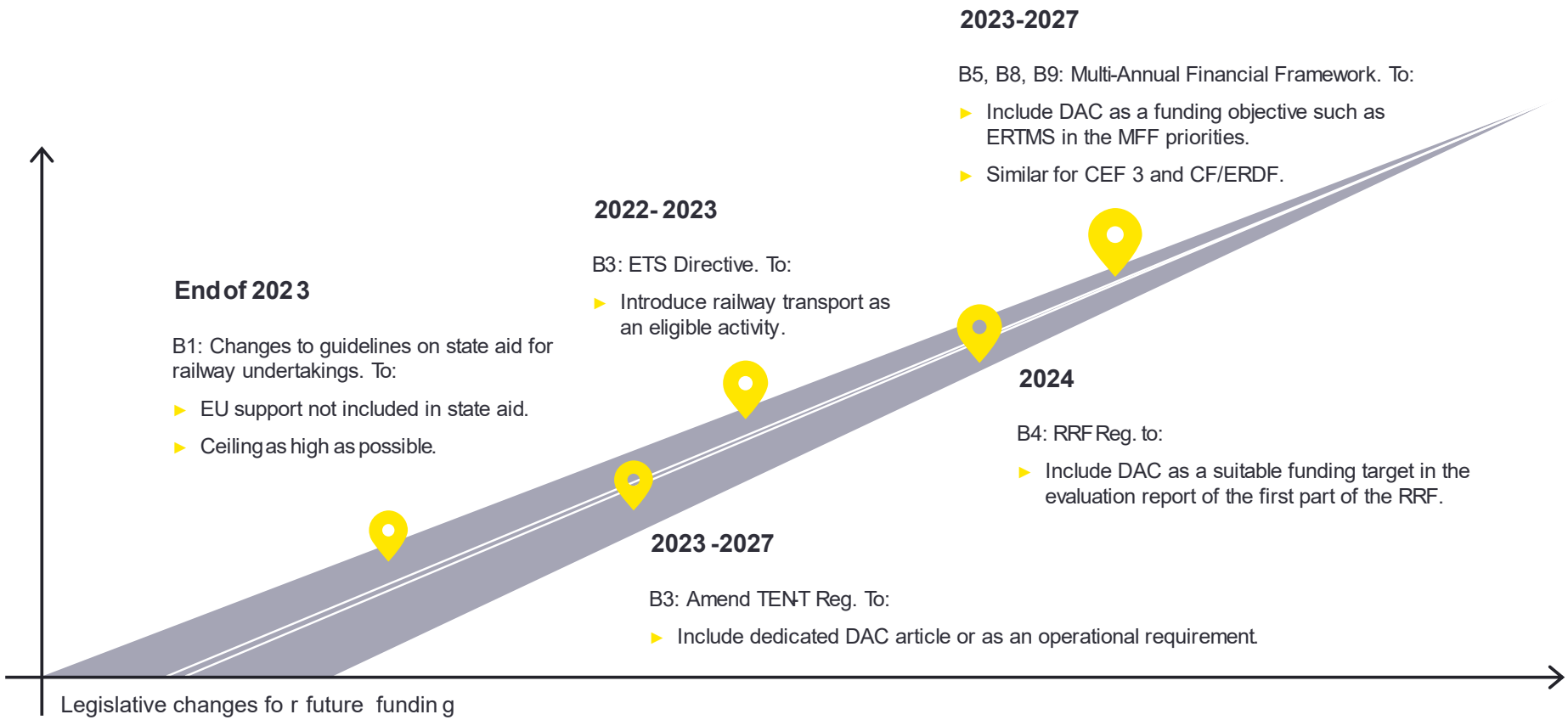


Figure 8.2 : Roadmap - Actions related to future legislation

Priority	Action #	Legal document	Calendar for revision	Description of the action
Immediate actions	B1	Guidelines on State aid for railway undertakings	End of 2023	It is very important to make sure that DAC is considered in the new guidelines. Moreover, it should be clearly specified that EU support would not count in the ceiling of state aid, and to push the ceiling as high as possible. It should also be clear that these guidelines are applicable to all vehicle owners, not only railway undertakings.
Immediate actions	B2	TEN-T regulation Regulation (EU) No 1315/2013	On-going	Obtain a dedicated article on DAC, such as Art. 19 (h).
Immediate actions	B3	ETS - Directive 2003/87/EC	On-going	Introduce railway transport as one of the activities eligible.
Immediate actions	B4	RRF - Regulation (EU) 2021/241	2024	An evaluation of the Facility shall be provided by the Commission by 20 February 2024. The evaluation report shall be accompanied by a proposal for amendments to the Regulation. In case of unspent budget from RRF by then, this evaluation report could be a key opportunity for the DAC funding.

Priority	Action #	Legal document	Calendar for revision	Description of the action
Short term actions (2024-2027)	B5	CEF Regulation (EU)	2024-2027	DAC to be quoted, like ERTMS, RIS, ITS, VTMIS or SESAR in "Article 9 – Eligible actions" in the 2nd work programme (2024-2027). Work related to this shall be coupled with efforts for the next MFF.
Short term actions (2025-2027)	B6	Charging of infrastructure Directive 2012/34/EU	Depending on final financing scheme	Introduce DAC as a case to differentiate Track Access Charges.
Short term actions (2024-2027)	B7	ERDF/Cohesion Fund (2028-2034)	2024-2027	Similar to CEF in Action B5.
Long term actions (2023-2027)	B8	Multi-Annual Financial Framework (2028-2034)	2023-2027	Influence the EC, Council, MS and the EP for green freight transport to have a larger role in the next MFF. Explicitly referring to DAC as an eligible action and lever to deliver green freight transport. The MFF is the deciding factor in the budget allocation for the sectorial funds (ERDF, CEF etc.), thus it remains key for potential DAC financing. The steps taken towards the adoption of the MFF are listed below (as based on the negotiations for the current MFF): Now-2024: ► MS leaders will informally discuss the priority areas for the next MFF. In parallel the EP will start discussing it as well. 2024/25: ► The EC will work and adopt a reflection paper/position paper on the next MFF. Setting out possible priorities etc. The budget committee in the EP will in return adopt their position.

Priority	Action #	Legal document	Calendar for revision	Description of the action
				► The EP may adopt a position paper on the next budget stating their wishes. ► The EC will draft their MFF proposal, which includes a public consultation. Roughly half a year after the start of the drafting the proposal will be published. In the proposal the budget allocations are fleshed out in detail. The EP and the Council will analyse the proposal in depth. ► The European Council (MS heads of state and government) will publish their priorities. The MFF will continue to be theme of discussion on European Council meetings. 2026: ► Council will discuss and adopt a negotiation box. ► Council discusses sectorial policies. ► EP discussions in parallel with the Council and the European Council. 2027: ► Final agreement in Council and consent by the EP. 2028: ► Start of the MFF.
Short term action (2024-)	B9	Future TEN-T Guidelines revision	2024-	The TEN-T Regulation sets out the objectives of the EU in relation to a completion of the European transport network. It moreover sets out the measures which can obtain the objectives. Importantly for DAC, it serves as reference for the funding priorities of CEF and ERDF. Hereby, an explicit inclusion of DAC as a TEN-T priority is important for securing funding.

8.2 Roadmap for the establishment of a DAC deployment manager

The deployment of DAC will, as described in detail above, require considerable efforts and coordination in order to achieve a timely, coordinated and cost-efficient European deployment of this revolutionary technology. This section will describe a possible administrative setup of a DAC deployment manager. It is based on the example SESAR Deployment Manager (SDM) from the European air traffic sector. The section will briefly describe the SDM and then present the necessary steps to setup a DAC Deployment Manager. The SDM was replaced by the SESAR Deployment and Infrastructure Partnership (SDIP) in 2022 continuing the duties of the SDM.

SESAR Deployment Manager

Description: The SDM is the body responsible for the deployment of the SESAR technologies/solutions, denoted as Common Projects. It was foreseen established in 2004 when SESAR was launched, as part of the SESAR deployment phase which was scheduled to take place from 2014-2020. Roughly +30 staff work as part of the SDM.

Legal basis: It was established in 2014 and based on Art. 9 of Commission Implementing Regulation (EU) n.409/2013[76]. The Implementing Regulation of the SDM is based on article 15a of Regulation (EC) No 550/2004 of the European Parliament and of the Council of 10 March 2004 on the provision of air navigation services in the single European sky, which sets out common objectives for safe and efficient provision of air navigation services in the EU. Article 15a of that Regulation, conveys implementing powers to the Commission for the implementation of common projects related to the Air Traffic Management Master Plan[77].

Organizational setup: The SDM is set up as a framework partnership between the European Commission and the aviation industry stakeholders. The members were selected upon a call for proposal for members and each member shall carry out or be part of at least one implementation project. The SDM is set up on based on art. 178 of Commission Delegated Regulation (EU) No 1268/2012 of 29 October 2012 on the rules of application of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council on the financial rules applicable to the general budget of the Union[78]. Members include the EC, airlines, airports, air navigation service providers and the network manager (Eurocontrol).

The SDM has 3 layers consisting of a policy, management and implementation layer. The EC is responsible for the policy layer, while the implementing partners (aviation industry stakeholders) are responsible for the management and implementation. The relationship between the parties is governed through 3 agreements: the Framework Partnership Agreement (governing the 3-layer governance), and Internal Cooperation Agreement (governs relationship between the implementing partners) and a Specific Grant Agreement (governs the budget of the SDM and the technical description of the action)[79].

[76] EUR-Lex - 02013R0409-20210222 - EN - EUR-Lex (europa.eu)

[77] EUR-Lex - 02004R0550-20091204 - EN - EUR-Lex (europa.eu)

[78] EUR-Lex - 02012R1268-20180802 - EN - EUR-Lex (europa.eu)

[79] EUR-Lex - 02013R0409-20210222 - EN - EUR-Lex (europa.eu) & Sneak-Preview-29-10-2015.pdf (ctfassets.net)

Budget: The SDIP benefitted from a €10 m grant from CEF for the period 2022-2024[80]. Implementing partners also transfer a fee to the SDM. Moreover, the SDM is responsible for finding additional funding mechanisms for the implementation of the technologies.

Time period: The establishment of the SDM was foreseen when the SESAR project was created. In line with the commencement of the deployment phase, the work of adopting the implementing regulations started roughly a year out from the entry into force.

Application to a DAC Deployment Manager

Taking the details of the SDM into account this section will establish the steps needed to setup a DAC deployment manager.

Description: A DAC Deployment Manager (DM) should have as its main objective the uniform and efficient deployment of DAC across the EU, hereby coordinating with the various railway industry stakeholders, the EC and the EU-Rail JU. In addition, it should be the intermediary link between the EC and the funding recipients for the deployment of the DAC. As a result, the DM should be established as a natural extension of the EDDP benefitting from the knowledge acquired in the preparation phase of the DAC specification and deployment. The time period should indicatively be of similar length as the deployment period foreseen in this report. With deployment starting in 2026, the DM should start its work in 2024 allowing for time to coordinate the deployment. The DM should continue in a reduced format for the following years to ensure a continued uniform deployment.

As compared to the SDM above, the DAC DM would have a different scope of tasks. The difference being that the DAC DM would deploy one technology in a plethora of different situations and with different stakeholders involved. The SDM on the other hand manages the deployment of several technologies in similar settings. This difference increases the coordination costs considerably of the DAC DM as compared to the SDM. This in turn provides for higher demands for the DAC DM. Moreover, the risks related to errors in deployment calls for a higher capacity DAC DM than is the case for the SDM.

Legal basis: A possible DAC DM could have a similar legal structure as the SDM through a Commission Implementing Regulation. However, this would entail a specific legislative reference conveying implementing powers to the EC for the establishment of the DM. Currently, no direct reference is made conveying powers to the EC to adopt implementing regulation with a view to implement and deploy DAC. Clauses would be art. 97 of Council Regulation (EU) 2021/2085 which sets out the objectives of the EU-Rail JU[81]. Art. 97 foresees a Deployment Group, which has the responsibility of advising the governing board on market uptake of technologies developed by the JU. Nevertheless, it would likely have insufficient capacity to manage the full deployment of DAC, specially considered that it still is responsible for advising the JU on the deployment of other technologies.

[80] CFP SDM 2021 Call document final.pdf

[81] EUR-Lex - 32021R2085 - EN - EUR-Lex (europa.eu)

As a result, a legal basis should be made by a revision of a current EU legislation (SERA, TEN-T or similar) setting out the definitions and specifications related to DAC and hereby providing a legal basis for the establishment of a DAC DM. Moreover, a reference to a DAC DM should be made in Regulation (EU) 2021/2085 in similar fashion to the SESAR JU.

Organizational setup: Similarly to the SDM, the DAC DM should gather the European Commission and stakeholders from the railway industry, e.g. the WLCs, LLCs, RUs and IMs. A core team should be dedicated full time to the project. This core team could include:

- Dedicated staff directly hired by the DAC DM
- Staff provided by the railway industry and allocated to this project for a limited period of time
- Staff from engineering and consulting companies

Budget: indicatively the budget should be higher than for the SDM, due to higher degree of complexity of the rail sector structure which imply more coordination of DAC projects and stakeholders, and therefore an increased need for resources. The budget could be sourced through CEF and the railway industry in similar fashion to the SDM.

Timeline: To be ready for deployment start in 2026, a revision of a current EU legislation should start as soon as possible. The revision could potentially last minimum a year, whereafter an implementing Regulation should be adopted. This could have the DAC DM ready for deployment in 2026, although under tight time pressure. It will, however, be critical to have all stakeholders aligned by then in order not to jeopardise the deployment of DAC. The timeline is illustrated **Error! Reference source not found.** below.

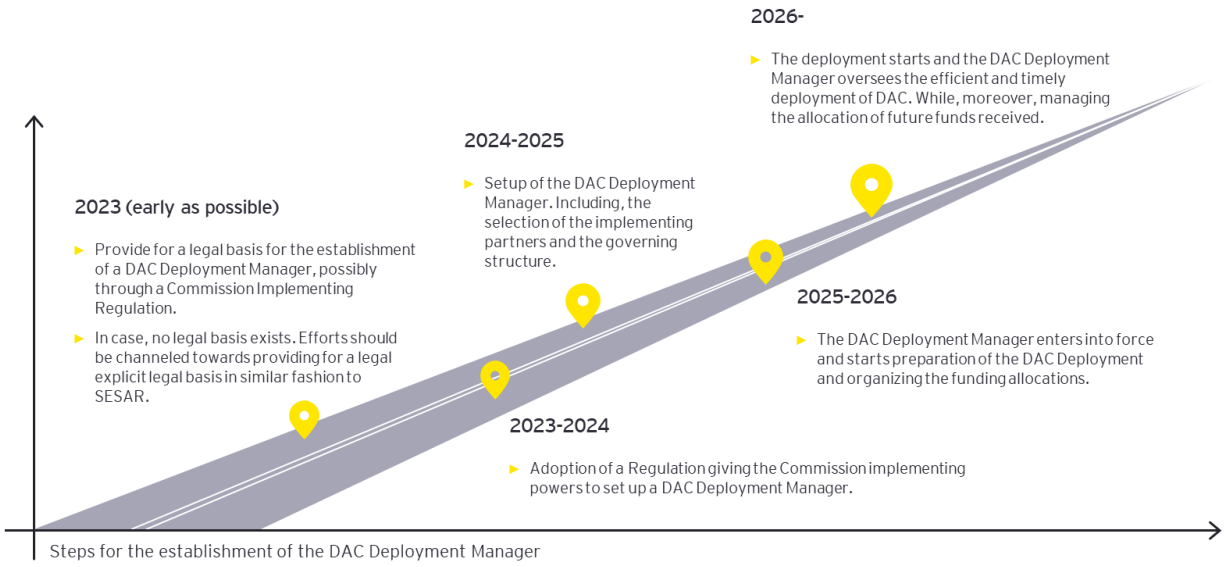


Figure 8.3 : Roadmap - Establishment of a DAC Deployment Manager

9 Appendices

9.1 Details on CEF applicability

Eligibility of DAC to CEF 2021-2027

Article 9 of Regulation (EU) 2021/1153 specifies the actions eligible for funding:

- *actions relating to efficient, interconnected, interoperable and multimodal networks for the development of railway, road, inland waterway and maritime infrastructure*
- ***actions relating to smart, interoperable, sustainable, multimodal, inclusive, accessible, safe and secure mobility***
- *[…]*

For actions relating to smart, interoperable, sustainable, multimodal, inclusive, accessible, safe and secure mobility, article 9 is quoting:

- *actions supporting sustainable freight transport services in accordance with **Article 32** of Regulation (EU) No 1315/2013 and actions to reduce rail freight noise;*
- *actions supporting new technologies and innovation, including automation, enhanced transport services, modal integration and alternative fuels infrastructure for all modes of transport in accordance with **Article 33** of Regulation (EU) No 1315/2013;*

There might be an opportunity to connect DAC either to Article 32 or Article 33 (or both), according to the extracts in **bold** below.

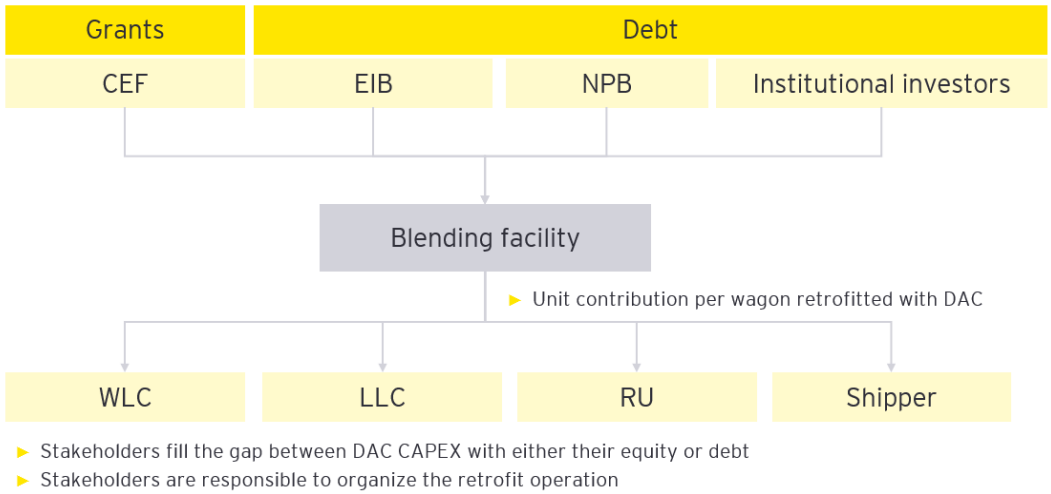
Article 32 of Regulation (EU) 1315/2013, "Sustainable freight transport services":
*Member States shall pay particular attention to projects of common interest which both provide efficient freight transport services that use the infrastructure of the comprehensive network and contribute to **reducing carbon dioxide emissions and other negative environmental impacts**, and which aim to:*
improve sustainable use of transport infrastructure, including its efficient management;
*promote the deployment of **innovative transport services**, including through motorways of the sea, **telematic applications** and the development of the ancillary infrastructure necessary to achieve mainly environmental and safety-related goals of those services, as well as the establishment of relevant governance structures;*
***facilitate multimodal transport service operations**, including the necessary accompanying information flows, and improve cooperation between transport service providers;*
[…]

Article 33 of Regulation (EU) 1315/2013, "New technologies and innovation ":
In order for the comprehensive network to keep up with inno-vative technological developments and deployments, the aim shall be in particular to:
support and promote the decarbonisation of transport through transition to innovative and sustainable transport technologies;
[…]
***improve the operation**, management, accessibility, interoper-ability, multimodality and efficiency of the network, including through multimodal ticketing and coordination of travel timetables;*

9.2 Details on a possible CEF blending facility for DAC

The CEF Blending Facility has implemented an innovative approach to attract participation of private sector investors and financial institutions in CEF projects, therefore contributing to growth, jobs and competitiveness through targeted investment at European level. This principle has been applied for infrastructure and on-board investments, like in the case of the ERTMS.

Another element of novelty has been the active participation of debt providers (EIB and other implementing partners) in the necessary due diligence before getting access to the EU grants and the blending scheme.

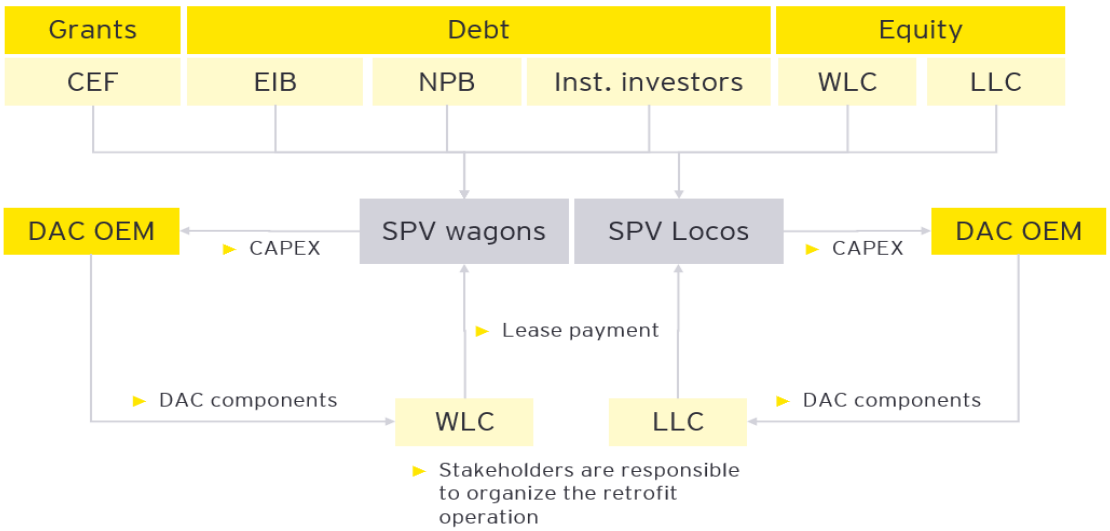


Benefits	Drawbacks
► Rolling call system: meaning no strict deadline for applicants and possibility to cover a sequency of same investments over a few years ► Certainty of grant receivable for investors and certainty of actual number of units invested in for the funding government ► Possible combination with CEF DI for risk sharing, credit enhancement / senior debt conditions	► Administrative burden for every individual stakeholder ► Lack of coordination of individual stakeholders' plans, ► Financial, organisational and migration preparedness inequality among stakeholders

9.3 Details on a possible SPV for DAC

One or more SPVs could be created. One can envision a case for two: one SPV for DAC wagon components, and one for DAC locomotive components, so as to aggregate similar stakeholders needs and retrofitting supply chain and

cost differences. The SPVs would be in charge of acquiring the DAC assets and leasing (operational lease) them out to LLC's and wagon owners. Debt, grants and equity contribution are made directly to the SPV's. Wagon owners become shareholder of the SPV for the wagon equipment. LLCs become shareholders of the SPV for locomotive DAC equipment. Maintenance costs of DAC equipment ('OPEX') would be invoiced to the SPV



Benefits	Drawbacks
► Improved debt-financing capacity of the SPV compared to individual wagon owners or LLC's (risk spread) ► Equality between stakeholders in terms of access to financing and funding ► Increased purchasing power of grouped wagon owners and LLC's	► Overhead cost related to managing the SPV and a fairly complex shareholder structure (many shareholders spread in different countries) ► Stakeholders need to organize the retrofit operation themselves ► According to recent accounting rules (IFRS 16) lessees will no longer be able to have DAC assets accounted off balance sheet

9.4 Details on state aid

The first criterion for public investments not to be considered state aid is that they should be pari passu with private investments and meet the following conditions:

- The amounts are similar and on similar terms.
- The private investment is not nominal/marginal.
- The investments take place at the same time.
- The private investors derive no extra advantage [an advantage outside the framework of the investment].
- The private investors do not have other exposure/liability in the company in which they invest.

For the second criterion (i.e. the investment generates market rates of return) a specific valuation, based on realistic assumptions related to the underlying market and financial conditions, will need to demonstrate comparable levels of return achieved by similar companies in similar sectors.

It should be noted that there is also a specific communication of the European Commission setting out the guidelines on state aid for railway undertakings. It sets out the principles that must be respected for investment by public authorities in RUs not to be considered as state aid. It contains detailed rules under which aid by public authorities is not considered state aid. Providing subsidies for investments that relate to RUs will have to comply with the principles set out in this communication. These guidelines are under revision currently.

There is also the consolidated text of the Commission Regulation N° 651/2014 that declare certain categories of aid compatible with the internal market rules. This regulation provides in some specific rules under which aid by public authorities are not considered state aid and thus acceptable within the applicable EU rules.

When establishing the SPV it must also be considered that as the shareholders will in principle be the national RUs that in most cases qualify as contracting authorities and thus fall under the scope of the Directive 2014/24/EU on public procurement or the Directive 2014/25/EU on procurement by entities operating in the water, energy, transport and postal services sectors depending on how the activities are exactly to be qualified. This means that the decision of such RU's to participate in the SPV may be subject to the public procurement rules of the said directives. This also implies that the SPV could potentially qualify itself as a contracting authority having to respect the rules of these directives and the public procurement rules of the MS of its incorporation. This would mean that it will have to comply with these rules for the acquisition of goods, services or works. In case the DTAC falls within the rules set out in the applicable directives and regulations, the competent agencies of the MS should in principle also accept it.

The obligation to comply with the applicable procurement rules and procedures must assure that the conditions of the contracts such as the price, warranties, limitation of liability, etc. are all at arm's length.

The public tender rules apply to "public contracts", which have to be for pecuniary interests and in writing between a public body and a provider and relate to the execution of works, the supply of products or the provision of services. Certain financial thresholds must also be met depending on the classification of the procurement. The value of a contract for the purpose of the thresholds is its estimated value taking into account the total expected costs. The threshold (for 2022) for the supply of products in the utilities sector, for example, is 431,000 EUR while these of works is 5,382,000 EUR.

The value is in principle confined to the value of each single procurement. However, the EU directives provide in a "splitting" prohibition, which requires the aggregation of the value of a number of similar procurements in certain circumstances. This must prevent artificial splitting up of procurements into lower value procurements that would fall outside the scope of public procurement directives. This implies that in case more than one procurement is awarded for a single overall project (for example, a phased construction project), the value of these procurements must be added together. The aggregate value will then determine whether the relevant thresholds are met or not.

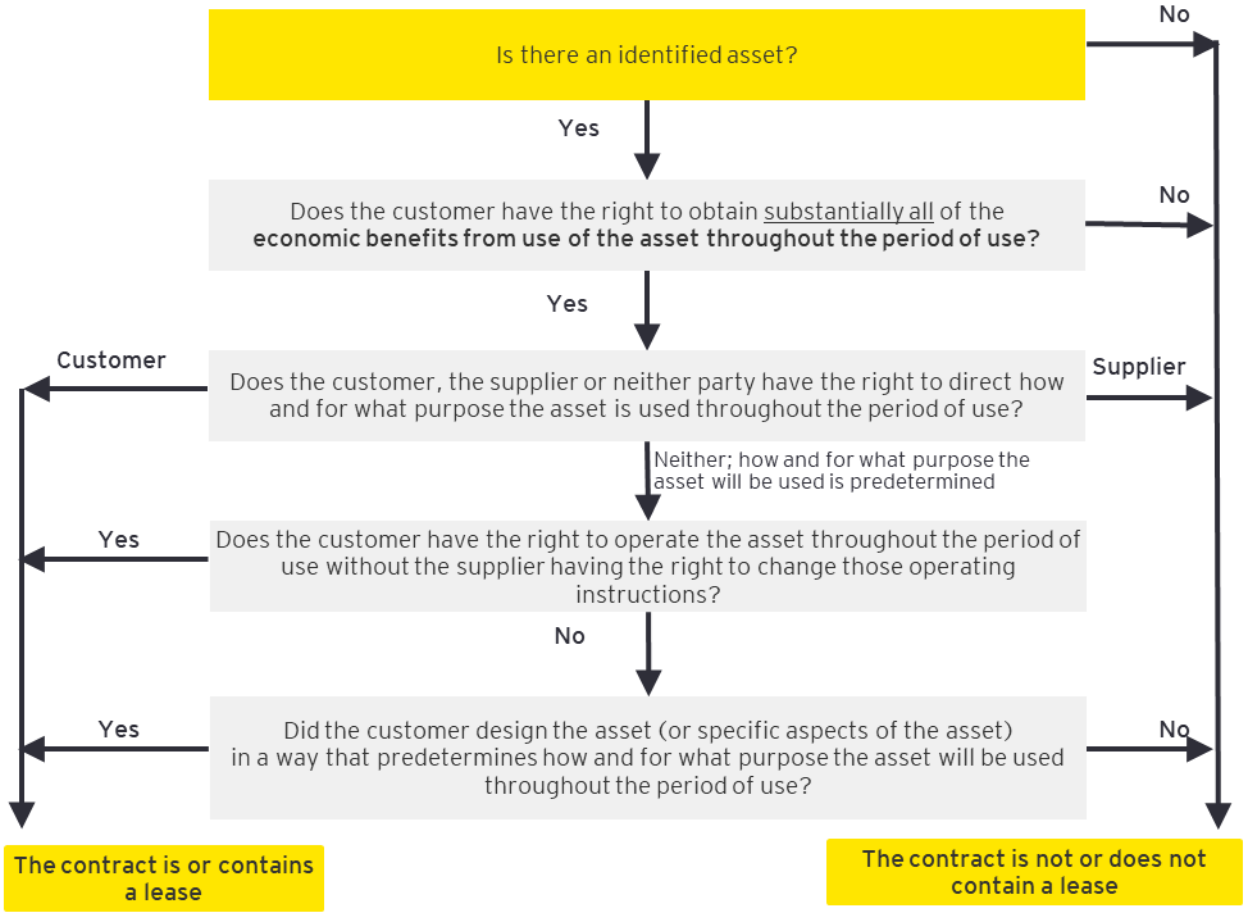
It must be noted that lower value contracts that fall outside the scope of the 2014 directives, might still fall under the general principles derived from the Treaty on the Functioning of the European Union that provides in specific public procurement rules. These must also ensure an equal access for all operators to procurement opportunities in MS, as well as fair competition for public contracts.

To initiate a public tender at EU level a contract notice must be published in the Official Journal of the EU in standard form at the beginning of the process. There is an exception to this obligation in the event there is only one possible provider, for instance,

9.5 Details on IFRS16 accounting rules for leasing contracts

Under IFRS 16, the lessee (WLC, LLC and RU) will likely have to activate the DAC assets on its balance sheet, as shown in the overview below:

IFRS 16 has a new definition of a lease: A contract is, or contains, a lease if the contract conveys the right to control the use of an identified asset for a period of time in exchange for consideration. Below you find the criteria to be met:



First, for an arrangement to be a lease, there must be an identified asset in the arrangement.

- Explicitly or implicitly identified in the contract (An asset may be implicitly specified, for example, if the supplier has only one suitable asset.)
- Physically distinct
- No substantive substitution rights

Second, the customer must have the right to obtain substantially all (>95%) the economic benefits from the use of the identified asset.

Third, the customer must have the right to direct the use of the identified asset:

Customer has right to direct how and for what purpose the asset is used – decision making rights:

- Rights to change type of output;
- Rights to change when;
- Rights to change where;
- Rights to change whether the output is produced + quantity

Relevant decisions about how and for what purpose the asset is used are predetermined:

- Customer must have the right to operate without supplier changing operating instructions;
- Customer designed the asset in a way that predetermines the use.

There are some exemptions, in which case IFRS16 does not classify a contract as a lease:

- **Short-term leases**: for leases with a lease term of 12 months or less, lessees can make an accounting policy election, by class of underlying asset, to not recognise lease assets or liabilities on the balance sheet (A lease that contains a purchase option does not qualify). Lease contract cannot have an extension option.

- **Low value assets**: Lessees can make an accounting policy election, on a lease-by-lease basis, to use the low-value assets exemption based on the value of the asset when it is new, regardless of the age of the asset being leased. Asset value < 5.000 USD.

<u>Accounting impact of lease under IFRS 16</u>

For the lessee, the following overview shows that any contract classified as a lease under IFRS16 will need to be present on the balance sheet as an asset

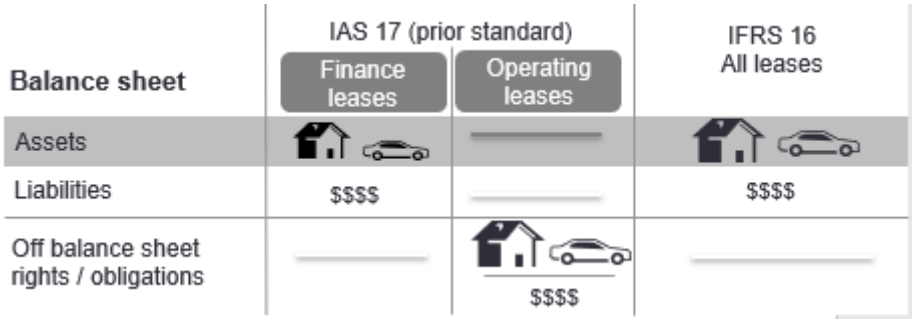


Figure 9.1 Lessee accounting, Balance sheet

For the lessee, in the P&L, there will be two components under IFRS16: the depreciation of the asset and the interest cost related to the leasing contract. This holds for all leases, both operational and financial. The biggest change compared to IAS17 is found for operational leases, as a lease contained a single operational expense on the P&L under the prior standard.

For the lessor, the accounting impact depends on whether it concerns a financial or an operational lease. For a financial lease, the contract is booked on the balance sheet as a receivable at an amount equal to the net

investment in the lease. In the P&L, the capital repayments received will reduce the receivable and the interest income will be accounted for as finance income.

For an operational lease, it will be accounted under Property, Plant & Equipment (PPE). In the P&L, the asset will be depreciated and the lease payments from operating leases are recognized as income on either a straight-line basis or another systematic basis.