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Hydrogen buses for sustainable mobility: the role of the Taxonomy as a key driver towards the green transition

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Summary

INTRODUCTION

The effects of the pandemic on public transport have been overwhelming. First the lockdown, then the implementation of public health rules related to social distancing, the use of facial masks, and sanitation have created a context of fear and reluctance in all those who daily moved by public transport.

In addition, the need for comfort, respect for the environment and safety are increasingly evaluated as critical for consumers: these factors will, ultimately, be decisive for the emerging modes of transport, new and old, from electric vehicles to scooters. Users are no longer forced to choose between an efficient vehicle and an ecological vehicle.

In this context, e-mobility is the future: the synergy of the development of all branches of electromobility is fundamental to guarantee an efficient decarbonisation of transport. Therefore, not only electric vehicles, but also hydrogen vehicles will play a key role in achieving climate-neutral mobility.

According to their technical characteristics, hydrogen-powered vehicles are best suited for journeys that run long-rage routes, transport heavier loads and require fast fuelling. What is central is the great need for flexibility that hydrogen buses are able to satisfy.

When it comes to the "why" question, the main advantages of a hydrogen drive are represented by its environmental performance. Indeed, this type of technology – when it is based on green hydrogen[1] - allows for completely emission-free driving, it is extremely quiet and it does not generate vibration. Hydrogen fuel cell guarantees reduction of carbon emissions and the only by-product of the chemical reaction is water.

On the other hand, being hydrogen an innovative technology, it is challenged by different barriers, mainly represented by high upfront costs, limited hydrogen resources and technological barriers.

For all these reasons, state intervention is of paramount importance in helping industries develop and implement this new form of green mobility, first of all by re-directing capital flows towards sustainable investments. This is why the Taxonomy application - the strategy for achieving a common understanding of what constitutes sustainable activities across the EU- can be an answer to the question "how to do it".

The problem, however, is related to its recent enactment and its degree of complexity. In fact, now that we finally have a gold standard classification system to follow, we need to see how it can be applied correctly.

[1] The only 100% sustainable hydrogen that is obtained is obtained through the electrolysis of water in special electrochemical cells powered by electricity produced from renewable sources. Enel. *Green hydrogen, a new ally for decarbonization*. https://www.enel.com/company/stories/green-hydrogen-opportunities accessed on 20/05/2022.

The purpose of this research project is precisely to answer the question: *how Taxonomy can impact the adoption of sustainable activities, starting by applying it to hydrogen vehicles for the public mobility sector?*

In order to address this issue, qualitative research methods were implemented with the aim of developing a structured methodology, applying it to the case study in question and verifying the results. In addition to that, semi-structured interviews and secondary data analysis were carried out to collect all the relevant data needed to conduct the research.

The purpose of analyzing Taxonomy application to public hydrogen mobility requires a prior analysis of the general applicability of the Taxonomy by reference to: (a) the development of a scalable and transferable methodology; and (b) the analysis of the results obtained by applying the methodology to our case study. These are the starting assumptions analyzed in the paper.

With regards to the choice of the case study, it falls on the company Ratp Dev, in collaboration with which a business plan has been defined for the purchase of a new fleet of hydrogen buses. Ratp Dev is a French company, operating in the public mobility sector across 14 countries. It offers various mobility services, from the bus to the metro and it has been committed for years to adopting increasingly sustainable technologies, with the aim of reducing the environmental impacts of its operations. And in fact, the decision to draw up an investment plan for the purchase of hydrogen buses moves in the same direction.

To achieve the objectives pursued, the dissertation focuses in the first chapter on the literature review part, in order to frame the theoretical background and contextualize the problem, while in the second chapter the analysis moves mainly on the development of the methodology and its application to the case study, with consequent analysis and discussion of the results. In this part, the methods of data acquisition are first explained as regards the definition of the methodology and as regards the choice of the case study and in the next phase, the methodology developed for the research case is tested. Finally, the last chapter takes into consideration the Social Taxonomy, as a fundamental part of the context of analysis, the adoption of which has not, however, been formalized yet. The purpose of the last chapter is to analyze how much this new Regulation will bring about changes to the context of reference and to highlight the possibilities under the Social Taxonomy for what concerns our case study.

Eventually, in the Conclusion paragraph, the main concluding remarks are discussed.

CHAPTER I – ENABLING THE TRANSITION

1. The Taxonomy Regulation

Hydrogen mobility can make a major contribution to achieve the EU's climate and energy goals for 2030 and meeting the goals of the European Green Deal. Investments towards sustainable projects and activities, such as green mobility plans, are essential but in order to facilitate their delivery, a common language and a clear definition of what is 'sustainable' is needed. With the adoption of the EU Taxonomy Regulation, this issue is expected to be solved, as well as to reduce the phenomenon of "greenwashing".

The background of the EU Taxonomy can be identified in the Action Plan on Sustainable Finance[2], the European Commission's proposal to address the issues of greenwashing, the lack of a clear definition of sustainable investment, and the lack of sustainability considerations in investment decisions. Ten measures were included in the proposal, divided into three main categories: redirecting capital flows towards sustainable activities, sustainability as a part of risk assessment, and sustainability included in company reporting. As part of its efforts to shift financial flows toward sustainable activities, the European Commission created in 2020 a common classification system for sustainable economic activities, that is the EU Taxonomy Regulation 2020/852.

Basically, at the moment, it establishes a list of environmentally sustainable economic activities for investment purposes and it lays out six environmental objectives as listed below (however, for the sake of completeness, it is right to say that the EU Taxonomy is not simply limited to these goals, as evidenced by the European Commission's decision to mandate the Platform on Sustainable Finance to work on the extension of the EU Taxonomy to social objectives. This topic will be analysed in the last chapter):

1. Climate change mitigation
2. Climate change adaptation
3. The sustainable use and protection of water and marine resources
4. The transition to a circular economy
5. Pollution prevention and control
6. The protection and restoration of biodiversity and ecosystems

The EU Taxonomy classifies as "environmentally sustainable" economic activities that substantially contribute to at least one of the above-mentioned environmental objectives, while at the same time not significantly harming any of these objectives and meeting minimum social safeguards. Finally, in addition to these criteria, an activity that wants to be 'taxonomy-aligned' must comply with the technical screening

[2] European Commission. (2020). *Renewed sustainable finance strategy and implementation of the action plan on financing sustainable growth* https://ec.europa.eu/info/publications/sustainable-finance-renewed-strategy_en

criteria contained in the Delegated Acts and developed by the EU Technical Expert Group [3], which will be replaced by the Platform on Sustainable Finance (PSF).

According to the Regulation, the technical screening criteria (TSC) have to respect different requisites, namely, the TSC have to be science-based, they have to build on the existing practices and take into account life cycle impacts. Moreover, where possible, they have to contain threshold to enhance their consistency. These conditions are designed to ensure that the Taxonomy operates according to best practices, avoiding inconsistencies and ensuring a high degree of credibility.

At the time of writing, the European Commission published two delegated acts.

The first Delegated Act (Climate Delegated Act), adopted in June 2021, defines clear criteria for activities for climate change adaptation and climate change mitigation objectives (two of the six environmental goals – for the remaining ones, another delegated act will be adopted by the end of 2022)[4].

The second Delegated Act, supplementing art. 8 of the Taxonomy Regulation (the so-called disclosure delegated act), published in December 2021, clarifies the content and methodology of information that financial and non-financial actors have to disclose about the percentage of sustainable economic activities in their businesses. About that, the Regulation does not apply to every single undertaking (at least for the moment), but specific requirements are envisaged. Indeed, the recipients of the Taxonomy Regulation are identified in financial market participants offering financial products, financial and non-financial firms within the meaning of Directive 2014/95 / EU (the Non-Financial Information Disclosure Directive - "NFRD"), Member States and "the EU in the context of introducing national and EU-level requirements regarding financial market participants or to issuers for the purpose of labelling financial products or corporate bonds that are marketed as environmentally sustainable". [5]

As regards the actors not subject to the NFRD, such as small and medium-sized enterprises, the Regulation provides for the possibility of disclosing their KPIs on a voluntary basis as a tool for obtaining funding. However, it is expected that the Taxonomy will also be applied to small and medium-sized enterprises in the medium term.

[3] The Technical Expert Group on Sustainable Finance is a group of 35 members from civil society, academia, business and the finance sector, set up by the EC to advise on the implementation of the Action Plan on Financing Sustainable Growth.

[4] For what concerns the other four environmental objectives, the PSF provided the first recommendations to the European Commission in March 2022, which will then have to follow the entire feedback and consultation process before being adopted.

[5] Taxonomy Regulation Delegated Act 2021/4987 (p.1)

To identify the economic activities eligible to be taxonomy-aligned and to ensure a wide range of coverage, the PSF used the NACE industrial classification system[6], fundamental also for determining the technical screening criteria. In cases where the current level of granularity within NACE was not considered sufficient, the NACE sectors were supplemented by additional categories. This is due to the fact that the last revision of the NACE classification system dates back to 2008 and as such is not up to date with all the most recent production methods.

In order to assess the priority areas for the environmental objectives, the TEG's methodology relies on two factors: the priority macro-sectors were chosen based on their total GHG emissions (using Eurostat 2016 data), given the fact that the GHG emissions are a reflection of the impact of those macro-sectors on the goal of climate change mitigation and that a single indicator is sufficient to asses them; secondly, relying on expert recommendations, 'mitigation opportunities' were identified (what is considered is the "improvement potential").

Life cycle considerations are also relevant. The TEG has tried to take into account the effects on the entire life cycle of economic activities, wanting to ensure that future Taxonomy technical screening criteria will incorporate life-cycle considerations. Indeed, such considerations are deeply assessed for individual activities in the TSC.

As it immediately becomes clear, the European Taxonomy is a transparency tool for companies, investors, policymakers and financial institutions with the aim of helping firms on their path towards ecological transition and at the same time providing clear elements for investors who want to promote sustainable investments.

Indeed, on the companies' side, the EU Taxonomy can be seen as an instrument to organize their climate transition and collect finance for it, whereas on the side of the investors, this classification system provides clear information on what investors are betting on. Investors can use the EU Taxonomy criteria to filter and discover sustainable investment possibilities with a positive environmental impact.

The EU Taxonomy is not, however, a required list of economic activities that investors must finance. It also has no mandated environmental performance standards for businesses or financial goods. Investors have

[6] The Statistical classification of economic activities in the European Community, abbreviated as NACE, is the classification of economic activities in the European Union. Eurostat. (2016) *Glossary:Statistical classification of economic activities in the European Community (NACE).* *https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Statistical_classification_of_economic_activities_in_the_European_Community_(NACE)#:~:text=NACE%20is%20a%20four%2Ddigit,developed%20within%20the%20European%20statistical*

complete control over their investments. However, it is predicted that the EU Taxonomy will become a change enabler and stimulate a move to sustainability over time.

Likewise, the EU Taxonomy is not an exhaustive list of activities that can positively contribute to the environment. The Delegated Acts must be seen as tools that are constantly updated, with the aim of covering as many activities as possible. Indeed, the rationale behind the Taxonomy is that it will reflect technological and policy developments and for this task, a specific body has been envisaged, that is the Platform on Sustainable Finance.

The fact that the EU Taxonomy relies on the existing market practice makes it easier to understand and use it on one hand, and on the other hand, it also serves as a way to ensure that the EU Taxonomy is aligned with the current frameworks.

1.1 The first delegated act for climate change adaptation and mitigation objectives

The adoption of the first delegated act meant a lot, not only for its legal value but also for its symbolic worth. With the first Delegated Act, in fact, the basis for other important legislative initiatives in the EU's renewed sustainable finance strategy is provided, starting from the ones linked to sustainability reporting and arriving at the issues of labelling and standards for sustainability-themed financial products.

Through it, the EU Taxonomy covers the activities of approximately 40% of companies in sectors that are responsible for almost 80% of direct greenhouse gas emissions in Europe[7]. Essentially, it establishes the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation and for assessing whether that economic activity causes no significant harm to any of the other environmental objectives.

In this context, the EU Taxonomy identifies three different types of substantial contributions: (i) economic activities that make a substantial contribution based on their own performance, (ii) enabling activities which are economic activities that, by provision of their products or services, enable a substantial contribution to be made in other activities and (iii) transition activities, for which there are no low- or zero-carbon technological alternatives, but which support the transition to a climate-neutral economy[8].

With regard to the thresholds for the screening criteria for the climate-change mitigation objective, the TEG takes as a reference two objectives: net-zero emissions by 2050 and a 50-55% reduction by 2030. To meet

[7] European Commission. (2021) *Sustainable Finance and EU Taxonomy: Commission takes further steps to channel money towards sustainable activities.* https://ec.europa.eu/commission/presscorner/detail/en/ip_21_1804
[8] EU Technical Expert Group on Sustainable Finance. (2020). *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance.*

these targets, the TEG recognizes that sectors with near-zero carbon emissions must be enlarged, while strongly polluting sectors must decarbonize quickly. To be recognized as significantly contributing to climate change mitigation, an economic activity must demonstrate compatibility with medium- and long-term climate goals. For heavily emitting sectors, for which low-carbon solutions are not yet in place, two conditions are relevant in order to define their pathways towards transition: 1. ensuring no lock-in of assets inconsistent with these goals, and 2. environmental performance well above the sector average.

For the purpose of climate change mitigation objective, on the other hand, the importance of safeguards is highlighted with regard to solutions implemented to adapt economic activities, ensuring that they do not increase the risk of a detrimental impact on other people, nature, or assets. This protection is in addition to the previously established safeguards against economic activity-related harm. When it comes to adaptation, the TEG believes that an activity can be regarded to have a positive environmental impact if it fits both the substantial contribution and DNSH requirements for other environmental objectives.

Given the complexity of the process to be made, the EU Commission has produced the EU Taxonomy Compass, which provides a visual depiction of the contents of the EU Taxonomy, beginning with the Delegated Act on the climate objectives (climate change mitigation (Annex I) and climate change adaptation (Annex II), which became effective on January 1, 2022. Users can use the Taxonomy Compass to see which activities are included in the EU Taxonomy (taxonomy-eligible activities), which aims they contribute significantly to, and which criteria they must meet.

By using this instrument, it is possible to see the “activity by sector” tab, where you can check which economic activities for a given sector are considered taxonomy-relevant and view the technical screening criteria applicable to them. It will be particularly useful to assess the eligibility of our case study, as we will later in the following sections.

1.2 The second delegated act: disclosure obligations

The second reference for what concerns the application of the Taxonomy is the Delegated Act supplementing art. 8 of the Regulation. The objective of the Act is to specify the disclosure requirements for financial and non-financial undertakings as provided by art. 8 of the Regulation. The Delegated Act's rules allow businesses to convert the technical screening criteria of the Climate Delegated Act (and the future Environmental Delegated Act) into quantitative economic performance indicators (KPIs) that will be publicly disclosed.

Indeed, by giving information to investors about the environmental performance of assets and economic activities of financial and non-financial undertakings, Article 8 of the Taxonomy Regulation intends to

promote market transparency and assist prevent greenwashing. This clause also attempts to expand the field for green finance by making information about corporations' environmental performance more transparent.

Any financial or non-financial undertaking in the scope of the NFRD (Non-Financial Reporting Directive) is required to report the extent to which its activities are associated with economic activities that qualify as environmentally sustainable under the Taxonomy Regulation, according to Article 8(1).

Thus, the central elements of the sustainability reporting regime that underpins the EU's sustainable finance strategy are represented by the NRFD, as reviewed by the CSDR[9], the Regulation on sustainability-related disclosures in the financial services sector (SFDR) and the disclosure required under the Taxonomy Regulation.

As explained below, for the purpose of our research it is useful to focus attention on the obligations of non-financial companies. According to the Regulation, they must disclose the proportion of environmentally sustainable economic activities that comply with the EU Taxonomy criteria. Through the translation of environmental performance into financial variables (turnover, CapEx and OpEx KPIs), investors and financial institutions can use clear and comparative data to help them make investment and financing decisions.

The main KPIs for non-financial companies include:

- The turnover KPI, that represents the proportion of the net turnover derived from products or services that are taxonomy-aligned. The Turnover KPI gives a static view of the companies' contribution to environmental goals (Euorpean Commission 2021).
- The CapEx KPI, that represents the proportion of the capital expenditure of an activity that is either already taxonomy-aligned or is part of a credible plan to extend or reach taxonomy alignment. CapEx provides a dynamic and forward-looking view of companies' plans to transform their business activities. (Euorpean Commission 2021).
- The OpEx KPI, that represents the proportion of the operating expenditure associated with taxonomy-aligned activities or to the CapEx plan. The operating expenditure covers direct non-capitalised costs relating to research and development, renovation measures, short-term lease, maintenance and other direct expenditures relating to the day-to-day servicing of assets of property,

[9] The Corporate Social Responsibility Directive whose aim is to widen the scope of the NFRD to all large companies registered in the financial markets. https://ec.europa.eu/info/business-economy-euro/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en

plant and equipment that are necessary to ensure the continued and effective use of such assets (Euorpean Commission 2021). [10].

According to TEG recommendations, companies should fulfil the Taxonomy calculation separately for climate change adaptation and for climate change mitigation objectives. In this way, greater transparency is provided about which environmental objectives are pursued. At the same time, a breakdown of the KPIs according to the economic activity should be provided, involving transitional and enabling activities and the achieved objective.

We will analyse more depth the technical aspects in the paragraph of the methodology, but for the moment it is necessary to highlight the main benefits that companies that comply with the disclosure requirements can enjoy. Indeed, in addition to the transparency improvements already considered, this Delegated Act will improve the credibility of non-financial corporations in terms of the information issued. As a matter of fact, relying on the data provided by the KPIs, companies will be able to demonstrate their environmental performance (in terms of economic activities and assets) to investors, institutions and all stakeholders involved. In addition, it will be easier for companies to identify and communicate their strategy of environmental objectives in the medium and long term, which is concretely tangible.

As a result, a considerable increase in investment in sustainable economic activities is expected, helping to achieve the EU's climate goals.

2. Why hydrogen? Policy issues

As demonstrated by the steps taken by the European Union, the problem of climate change is widely recognized as one of the most important obstacles to overcome in our times. Like any challenge, this also comes with a possibility. The possibility of reviewing and adapting our social, economic and environmental system, also considering the economic and social upheaval caused by the COVID-19.

The EU taxonomy classification system represents one of the fundamental building blocks adopted at the European level in order to support this transformational change. The Regulation contributes to the achievement of the objectives as set by the European Green Deal, which can be defined as the European Union's response to these crises, intended as a blueprint for coordinating and organizing the efforts needed to make Europe more resilient, more effective and more sustainable.

Adopted in 2019, the European Green Deal has three macro-objectives:

[10] European Commission. (2021). *FAQ: What is the EU Taxonomy Article 8 delegated act and how will it work in practice?"* (para. 6) https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/sustainable-finance-taxonomy-article-8-faq_en.pdf

- no net emissions of greenhouse gases by 2050;
- economic growth decoupled from resource use;
- no person and no place left behind.

It is structured around eight policy areas[11], among which there is the sustainable mobility one. The fact that the Green Deal identifies these area as those where more interventions are needed is linked to their environmental impact in terms of GHG emissions. In fact, the Technical Expert Group findings demonstrate how 93,5% of GHG emissions are produced by just seven macro-sectors, including Transport[12].

In this context, the growing consensus around zero-carbon hydrogen as a key element for decarbonising transport and more generally for Europe's energy future is demonstrated by the solutions implemented by the EU Commission to promote its application and implementation to the entire continent.

From a policy perspective at the European level, the Hydrogen Strategy[13] must certainly be mentioned, as a development plan for the hydrogen supply chain, which can be used as an energy vector, fuel or storage. This legislative package is divided into three implementing parts, the last of which foresees, starting from 2030 and ending in 2050, to secure H2 technologies for the production and use of clean hydrogen to be mature and to be effective also for the hard-to-abate sectors such as maritime transport, aviation and industrial buildings.

At the Italian level, on the other hand, the main regulatory reference is represented by the National Strategy for Hydrogen**.** In the preliminary guidelines issued in 2020[14], it is stated that the objective of the National Hydrogen Strategy is to foresee its application:

- in long-haul transport;
- in the railways;
- in heavy industry (eg chemical and oil refining);
- as a blending of hydrogen into the gas network.

The guidelines of the National Hydrogen Strategy move on two-time horizons with different objectives: a first phase foresees in the short term, by 2030, to make hydrogen "progressively competitive in selected

[11] They are: biodiversity, sustainable food systems, sustainable agriculture, clean energy, sustainable industry, building and renovating, sustainable mobility, eliminating pollution and climate action.
[12] M. Hessenius, P. Sweatman. (2020). *Applying the EU Taxonomy: Lessons from the frontline*, Climate & Strategy, Climate Company. https://www.euractiv.com/wp-content/uploads/sites/2/2020/10/Applying-EU-Taxonomy-lessons-from-the-front-line-FINAL.pdf
[13] European Commission. Hydrogen. https://energy.ec.europa.eu/topics/energy-system-integration/hydrogen_en#:~:text=EU%20hydrogen%20strategy,-Hydrogen%20is%20an&text=The%20dedicated%20strategy%20on%20hydrogen,infrastructure%20to%20an%20international%20dimension.
[14] Ministero dello sviluppo economico. (2020) *Strategia Nazionale Idrogeno Linee Guida Preliminari.* https://www.mise.gov.it/images/stories/documenti/Strategia_Nazionale_Idrogeno_Linee_guida_preliminari_nov20.pdf

applications". While in the long term, by 2050, hydrogen is seen as a key vector for decarbonising the "hard-to-abbot" sectors, that is, energy-intensive heavy industry and aviation.

Clearly, the regulatory framework does not stop there and is much more complex, but these two examples give us a further idea of what is the path outlined for the future in terms of hydrogen and its application to sustainable mobility and the reason why public service providers are looking at it as a valid alternative for their fleets.

In line with what has been said so far, a policy document "Decarbonizzare i trasporti: evidenze scientifiche e proposte di policy"[15] drafted by the experts of the Ecological Transition Structure of Mobility and Infrastructures (STEMI) of the Ministry of Sustainable Infrastructures and Mobility (MIMS) has been published in April 2022. The document addresses the central theme of choosing the best transport technologies for decarbonisation, with the aim of outlining the steps that will lead, in the coming years, to the reduction of polluting emissions in the sector. In fact, in Italy, the transport sector is directly responsible for 25.2% of greenhouse gas emissions and 30.7% of CO2 emissions, to which are added emissions in the aviation sector and international shipping[16].

Almost 93% of the national emissions of the whole sector is attributable to road transport of passengers and goods, a sector for which there is an increase of 3.2% in emissions between 1990 and 2019, in contrast to the decrease in the 19% of total emissions during the same period[17].

In order to reach the targets of 55% reduction of greenhouse gas emissions by 2030 and their zeroing by 2050, it is necessary to accelerate the decarbonisation process, starting from the mobility sector. This need is even more urgent considering the consequences of the international crisis triggered by the invasion of Ukraine, which has brought the geopolitical aspects of energy to the center of attention, highlighting how it is necessary to unbundle Europe from its dependence on fossil fuel supplies, especially when this dependence is subordinated to undemocratic countries. According to the European Commission's communications with the RePowerEU project[18], there is a need to speed up the decarbonization process envisioned by the European Green Deal, not only to address the climate emergency but also to achieve greater independence and energy security.

The main evidence of the MIMS' report suggests that "electrification is in general terms the most promising technological option for several sectors, although not all". In fact, if for passenger transport on the road

[15] Ministero delle Infrastrutture e della mobilità sostenibili. (2022). *Decarbonizzare i transporti: evidenze scientifiche e proposte di policy.*
[16] *Ibidem.*
[17] *Ibidem.*
[18] the new EU energy plan (with a budget of 300 billion euros) to reduce dependence on Russia and accelerate the green transition. https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131

(private cars, taxis, local buses) electricity provides greater advantages, as regards long-distance routes, even green hydrogen could represent an opportunity, in particular in the so-called hydrogen valleys, that are, districts in which the production, the infrastructures and the use of hydrogen are put in a single place. They can be defined as an incubator to boost hydrogen and related technologies.

As for the other potential applications of hydrogen in the transport sector, the Document underlines how it will be fundamental for all those sectors where electrification is not possible or too expensive, i.e. sectors that are difficult to decarbonize, such as aviation and maritime transport. However, it is widely recognized that today the main problem is represented by the scarce production of hydrogen in our country, a problem strictly linked to that of high costs. In this regard, as argued by Minister Giovannini[19], it is essential to invest in electricity generation systems from renewable sources and strengthen the recharging network, in order to continue experimenting with alternative solutions to fossil fuels.

Clearly, hydrogen is going to play a key role in the future years, considering also Italy's potential for the hydrogen market, as demonstrated by economic feasibility analyses provided by Confindustria (2020)[20] and by Associazione Italiana Idrogeno e Celle Combustibili (2021)[21]. According to these sources, the national territory has some key characteristics that allow it to apply as an enabler of a European strategy on hydrogen.

First of all, thanks to the position of a capillary network for the transport and distribution of gas and the strategic political position in the Mediterranean, through a series of targeted interventions, the Country can contain the basis for receiving greater percentages of hydrogen for internal uses and for export to northern Europe.

Secondly, it is the second country in Europe for added value of the manufacturing sector and is the first for the number of small and medium manufacturing enterprises, an economic-industrial fabric that contains some of the distinctive skills in the production of technologies applied along the supply chain. Although there are technological and production areas in which it is still necessary to strengthen its positioning, Italy can also count on large national research and energy players able to position themselves as leaders in major processes of innovation and technology transfer.

Ultimately, Italy can exploit its ability to integrate hydrogen into the energy system, thanks to its distinctive characteristics. The country's predisposition for the use of gas and the availability of dedicated infrastructures resulting from it, can act as facilitators for the transition to hydrogen in the country.

[19] Minister of Infrastructure and Transport.

[20] Confindustria. (2020) *Piano d'azione per l'idrogeno.* https://www.confindustria.it/wcm/connect/552759de-3bb8-472f-a20b-07ab2aa5f21f/Position+Paper_Piano+d%27azione+per+l%27idrogeno_ott+2020_Confindustria.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE-552759de-3bb8-472f-a20b-07ab2aa5f21f-nuhfm09

[21] Associazione Italiana Idrogeno e Celle combustibile. (2020) *Priorità per lo sviluppo della filiera idrogeno in Italia*. https://www.h2it.it/wp-content/uploads/2021/01/H2IT_REPORT_19gen21.pdf

Furthermore, as regards the production of green hydrogen, Italy can count not only on a positioning that places it among the most virtuous countries in Europe for the share of renewables in the production of electricity (17.8%), but also on high skills in the production of biogas and biomethane (4th producer in the world of biogas and 2nd in Europe).

Besides policy interventions, there is a wide range of private and public-private initiatives whose aim is to boost the deployment of hydrogen vehicles and specifically, hydrogen buses.

Among these, considerable results have been achieved by the Joint Initiative for hydrogen Vehicles across Europe (JIVE- 2017/2022 and JIVE 2 – 2018-2023). The JIVE project, with a budget of 113. 6 million euros under the European Union Horizon 2020 framework program for research and innovation, started in 2017 with the aim of promoting the deployment of hydrogen buses at large scale. Together with the JIVE 2 – started in 2018 as the successor of JIVE 1, with a budget of 224.5 million euros -, they will deploy over 300 zero-emission fuel cell buses and accompanying infrastructure in 16 European cities and regions, making it the largest deployment in Europe to date.

The overall goal of the JIVE initiatives is to accelerate the commercialization of fuel cell buses through the large-scale deployment of vehicles and infrastructure, with the goal of making fuel cell buses commercially viable for bus operators and empowering local governments to regulate these news form of public mobility.

In order to reach these objectives, specific targets have been set up. They are:

- Achieve 30% cost reduction versus state of the art;
- Operate 50% of the vehicles for at least 36 months;
- Deploy the largest capacity hydrogen refueling stations (HRS) in Europe and achieve near 100% reliability:
- Demonstrate technological readiness of FC buses and HRS and encourage further uptake[22].

These initiatives aim to eliminate the obstacles to the spread of hydrogen buses and represent an important source of data, in order to collect possible critical issues and at the same time disseminate the positive impacts of hydrogen mobility.

As a matter of fact, the number of countries having policies that actively encourage investment in hydrogen technology, as well as the sectors they target, is growing. There are now over 50 targets, requirements, and policy incentives in place to boost hydrogen, the bulk of which are focused on transportation. National

[22] Fuel Cell Electric Buses. *JIVE*. https://www.fuelcellbuses.eu/projects/jive

governments have increased their spending on hydrogen energy research, development, and demonstration in recent years[23].

Thanks to its intrinsic characteristic and to its different potential uses, hydrogen is today enjoying unprecedented momentum.

Considering the background, this paper wants to contribute to the existing literature, by analyzing how Taxonomy can impact the adoption of hydrogen-vehicle buses, as an additional instrument to support its implementation.

CHAPTER II – TAXONOMY APPLICATION TO HYDROGEN PUBLIC MOBILITY

1. The methodology

Considering the complexity of the process outlined by the Taxonomy and by the Delegated Acts, this research project aims to outline an effective methodology, following which non-financial companies that want to demonstrate their alignment with Taxonomy are clear about the main steps to be followed.

In fact, given that the Taxonomy Regulation has been published quite recently, there is a very little literature review. What is needed is to fill the gap in terms of applicability, and according to our hypothesis, this can be achieved by developing a clear and specific methodology capable of identifying the path to follow in accordance with the provisions of the Regulation to assess any impacts.

1.2 Data collection

In order to develop, test and validate the methodology, a step-wise approach was applied, using different methodological strategies.

The (1) initial review of the background literature on key concepts and required compliance obligations led to an initial conceptualization of a framework for the methodology. In the next phase, in order to enrich the data, (2) workshops and webinars with academic experts were followed[24]. Next, we aimed at evaluating the effectiveness of the methodology through (3) expert semi-structured interviews. Finally, through (4) the application of the methodology to our case study, the effectiveness of the tool was assessed.

[23] IEA. (2019) The future of Hydrogen: seizing today's opportunities. https://iea.blob.core.windows.net/assets/9e3a3493-b9a6-4b7d-b499-7ca48e357561/The_Future_of_Hydrogen.pdf

[24] Series of webinars on the EU taxonomy – Discussion on future developments with the Platform on Sustainable Finance (02/2021) & EU Platform on Sustainable Finance presents: Social Taxonomy (02/2022)

Alongside the data collection necessary for the processing of our tool, it was necessary to collect the data relating to our case study, which qualify for the most part as secondary data (company reports) and partly as primary data, obtained through an interview with company's representatives.

1.3 Building the methodology

As part of this study, a literature review was conducted to identify the key issues to be addressed as required by the Taxonomy Regulation.

This part was developed mainly through web searches, and consulting the official pages of the European Commission. Alongside this, the final reports prepared by the TEG Group represented another decisive source of research, as well as the academic papers issued by industry associations.

Participation in the webinars dedicated to the topic then allowed to enrich the collected database, allowing to take into consideration also the critical points as declared by the experts.

After these two phases, the methodology was developed and in order to assess its correctness, a direct interview was carried out with sector expert from Greenomy[25] - a financial consultancy institute operating in the Taxonomy sector and subsequently, another interview was held with a practitioner from Envoria – financial software architects' company[26].

2. The outlined technology

In order to reduce the complexity of the process, the outlined methodology is divided into four phases[27]:

First phase – Eligibility assessment

The first stage is to determine whether a company's activity -or activities- are eligible, namely covered by the Taxonomy. As already said, the European industrial classification system (NACE) is used to classify economic activity. In this phase, the use of the Taxonomy Compass is particularly useful, as it allows users to perform eligibility checks. Once the eligibility is assessed, the activity has to pass a criteria-compliance check.

Second phase – Technical screening phase

At this step, non-financial company needs to assess if the activity fits the established TSC, which shows substantial contribution to climate change mitigation and/or climate change adaptation objective.

[25] Recorded interview, carried out on 23/05/2022.
[26] Recorded interview, carried out on 02/06/2022.
[27] It is assumed that non-financial companies that intend to align themselves with the Taxonomy are among those subject to Article 8 of the Regulation.

As previously explained, for each environmental objective, the Taxonomy Regulation recognises three distinct types of substantial contribution that can be considered taxonomy-aligned:

1. Economic activities;

2. Enabling activities;

3. Transition activities;

The Taxonomy Regulation identifies three conditions for an activity to be included as a transitional activity: that it (i) has greenhouse gas emission levels that correspond to the best performance in the sector or industry; (ii) does not hamper the development and deployment of low-carbon alternatives; and (iii) does not lead to a lock-in of carbon-intensive assets, considering the economic lifetime of those assets[28].

In addition to that, among the requirements for the TSC set out by art.19 of the Regulation, they shall "take into account the life cycle, including evidence from existing life-cycle assessments, by considering both the environmental impact of the economic activity itself and the environmental impact of the products and services provided by that economic activity, in particular by considering the production, use and end of life of those products and services".

Third phase – DNSH compliance

Once the substantial contribution to one or more environmental objectives is verified, we need to assess whether the "Do No Significant Harm" criteria are met with regard to the other objectives, where relevant. What the Taxonomy asks is only the evaluation of the activity in question (and not of the whole company) respecting the DNSH criteria both as regards its production process, its use phase and its end-of-life treatment.

It is important to highlight that not all economic activities have a specific DNSH criteria for the goal to which they contributed, or for all other environmental goals: in some circumstances, they may have a minor influence on one or more goals, or the targets are irrelevant to them, making DNSH criteria superfluous.

Fourth phase– Minimum Social Safeguards check

This step concerns the social dimension of the Taxonomy assessment. Indeed, what is required by the Regulation is the respect of specific guidelines as provided by the OECD guidelines, the UN Guiding Principles on Business and Human Rights conventions and the ILO conventions. The Taxonomy requires actors to adopt specific human rights and anti-corruption policies within their organizations in compliance with international standards. Code of ethics, risk management plans, anti-bribery strategies and similar are

[28] European Commission. (2021). *Questions and Answers: Taxonomy Climate Delegated Act and Amendments to Delegated Acts on fiduciary duties, investment and insurance advice.* https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_1805

the typical tools put in place by companies in order to demonstrate their commitment to respect the minimum safeguards.

Fifth phase – Disclosure requirements

The last step is related to the disclosure of the KPI indicators, as required by the Delegated Act. This step will vary according to the type of environmental objective pursued. Indeed, different indicators are considered when it comes to climate change adaptation or climate change mitigation, as illustrated below:

Tab 2.1: Differences in calculation approaches for company climate change mitigation and adaptation.

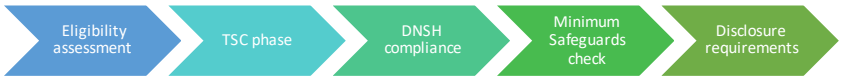
Financial metric	Climate change mitigation	Climate change adaptation
Turnover	Can be counted where economic activity meets Taxonomy technical screening criteria for substantial contribution to climate change mitigation and relevant DNSH criteria.	Turnover can be recognised only for activities enabling adaptation. Turnover cannot be recognised for adapted activities at this stage.
Capex & opex	Can be counted where costs incurred (capex and, if relevant, opex) are part of a plan to meet Taxonomy technical screening criteria for substantial contribution to climate change mitigation and relevant DNSH criteria.	Can be counted where costs incurred (capex and, if relevant, opex) are part of a plan to meet Taxonomy technical screening criteria for substantial contribution to climate change adaptation and relevant DNSH criteria.

Source*: Taxonomy: Final report of the Technical Expert Group on Sustainable Finance* (March 2021)

Once this five-step process has been completed, the Taxonomy alignment is concluded and the company is able to show its results and attract new investors. The following tab is a visual representation of the envisaged process, whose aim is to outline a usable methodology for all the actors (of non-financial undertakings) who intend to follow the compliance procedure with what is outlined in the Taxonomy Regulation. This means that the steps outlined in the methodology can also be applied to case studies other than the one addressed in the thesis, thus ensuring a high degree of technology transfer. The fact that the methodology is transferable to other realities is an element that allows its improvement and scalability in order to make the compliance process simpler and more effective.

From a medium-term perspective, the developed methodology could also be implemented through the use of online software, capable of generating what is required by the Regulation, simply by asking companies to enter the necessary data on the platform. Subsequently, one could also consider protecting this know-how through IP rights or similar tools, so that it would be possible to minimize the risk of disruption and apply back new learnings to the core business, in addition to predictable revenue growth as a consequence of the IP protection.

Tab 2.1.2: The outlined methodology



Source: author's own elaboration.

3. Case study selection

As previously explained, to collect the data about the company, both primary and secondary data were used.

The data needed in order to develop the KPIs were extracted from secondary resources, such as the business plan developed for assessing the economic feasibility of the project and the company balance sheet.

Subsequently, an interview with the representatives of the company was carried out in order to collect qualitative information concerning the company's position in terms of project risk execution, strategic vision regarding the project, relationships with stakeholders and ESG policies already in place that could create synergy with alignment with Taxonomy.

By analysing the secondary data of the company, we can classify the actor involved as a non-financial undertaking operating in the public transport mobility services, recipient of the NFDR Directive. It should be noted in this phase that such company is not responsible for constructing and delivering the buses, but it manages and provides public transport services.

Secondly, there is the identification of the activity for which taxonomy alignment is required. About that, the company in question wants to renew its fleet of buses with ten hydrogen buses to cover the suburban routes, characterized by those properties which we talked about in the introduction, that is long-haul routes with fast refueling times that require great flexibility.

Then, there is the analysis of the interview carried out with the company representatives regarding the execution of the project and the reason behind the company's desire to change its operating model and acquire a new fleet.

What emerged is first of all the desire to adhere to a more sustainable business model from an environmental point of view, in fact, as we said previously, hydrogen vehicles eliminate greenhouse gas emissions, bringing

a positive impact in environmental terms. In addition to this, there are also considerations relating to the alternative represented by electric buses, of which the critical aspects linked to vehicle autonomy and the disposal of exhausted batteries are of concern.

Secondly, an additional reason for investing in hydrogen-powered buses is related to the economic bankability of this project. Not only does the National Recovery and Resilience Plan provide specific funds for hydrogen mobility, but also the Complementary Fund reconfirms its importance by providing additional financial contributions for the realization of sustainable projects in the field of mobility, as we will see later.

Clearly, in this context, Taxonomy will also have its contribution, being a useful tool for companies wishing to demonstrate their environmental commitment by aligning with the provisions of the Regulation and benefiting from the consequences, in terms of accessing environmentally sustainable finance or as a part of their overall business strategy based on environmental sustainability.

However, despite the great potential recognized in Italy, the company complains about the lack of operational experience of sufficient scope in terms of size and duration such as to provide reliable feedback on maintenance costs, plant components, trend in hydrogen purchase costs and supplies.

What emerges from the analysis of the data collected from the interview, in terms of criticalities and main issues related to the development of a service based on hydrogen supply, reflects what was elaborated by the report of the European Investment Bank "Unlocking the Hydrogen economy - stimulating investments along the hydrogen value chain "published in May 2022[29].

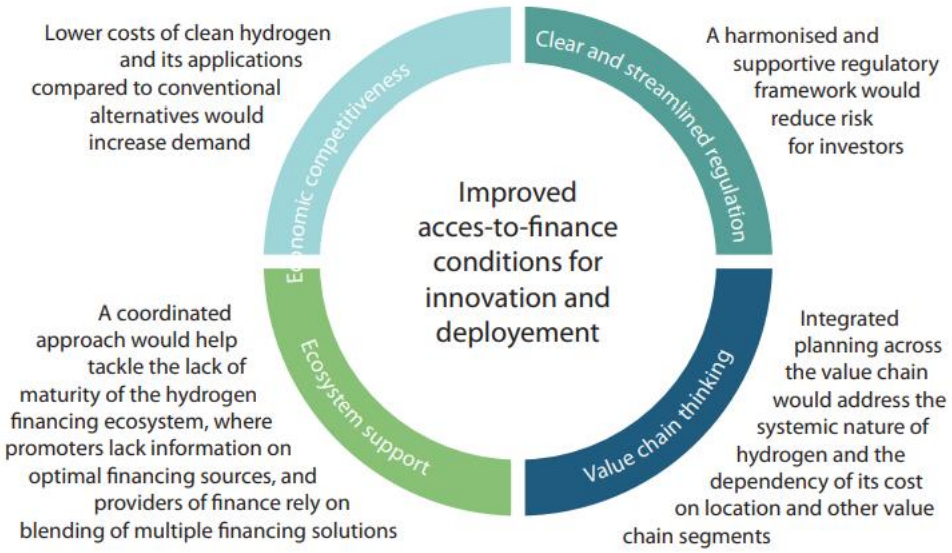
The study summarizes the important points of a 46-market participant investor consultation aimed at better understanding their investment plans, perceived challenges and limits, and perspectives on how to unlock hydrogen development as a large-scale option in order to cut down on greenhouse gas emissions.

Basically, the main challenges can be grouped into 3 main areas of intervention: market and regulatory conditions, conditions of access to finance and integration of the value chain and ecosystem development.

To these problems, the Report provides potential solutions to be implemented, in order to achieve the objectives set by the European Union, as illustrated below:

[29] EIB (2022) *Unlocking the hydrogen economy —stimulating investment across the hydrogen value chain. Investor perspectives on risks, challenges and the role of the public sector.*
https://www.eib.org/attachments/publications/unlocking_the_hydrogen_economy_en.pdf

Figure 5: Key forces required to increase investor funding for hydrogen innovation and projects



Source: EIB (2022) *Unlocking the hydrogen economy—stimulating investment across the hydrogen value chain. Investor perspectives on risks, challenges and the role of the public sector.*

As demonstrated, there are still many steps to be taken in order to make the hydrogen market competitive, and this is the reason why public intervention is considered fundamental, as a driving force not only from an economic point of view but also as an actor involved in the development of these projects.

4. Results

Once the case study has been explained and the methodology has been set up, we can apply it to the relevant case study. In the following paragraphs, we are going to apply the methodology for the climate change mitigation objective and later for the climate change adaptation goal.

It should be noted that, considering the methodological nature of this thesis, the methodology has been applied and evaluated for points A, B, D, while for points C and E, the research is limited to outlining the steps to be followed, without proceeding with the implementation of what is required.

4.1 Climate change mitigation objective

A) Eligibility assessment

According to the outlined methodology, the first thing to verify is if the activity that we have to analyse is covered by the Taxonomy. By using the Taxonomy Compass, it is possible to see that the activity is

taxonomy-eligible in the sector of transport, specifically named "Urban and suburban road passengers transport" as it is fit the NACE codes.

Through an analysis of the information provided, we know that the activity under study could be associated with several NACE codes, in particular, H49.31 *(purchase, financing, leasing, rental and operation of urban and suburban transport vehicles for passengers and road passenger transport)*, H49.3.9, N77.39, and N77.11 in accordance with the statistical classification of economic activities established by Regulation (EC) No 1893/2006.

B) TSC phase

The second step refers to the compliance with the specific screening criteria developed by the Taxonomy for the climate mitigation environmental objective.

The first criterion refers to the substantial contribution analysis. As defined by the Technical Annex to TEG Final Report, an economic activity substantially contributes to climate change mitigation if such activity contributes *substantially to the stabilization of greenhouse gas concentrations in the atmosphere to a level that prevents dangerous anthropogenic interference with the climate system, avoiding or reducing emissions of greenhouse gases or by increasing the greenhouse effect absorption of gases*[30]. For the latter, a list of different means is identified, but for the purpose of our research is significant to report only the one that is applicable to our case study, that is, increasing clean or climate-neutral mobility.

The substantial contribution criterion is assessed if the activity complies with one of the following criteria:

- the activity provides urban or suburban passenger transport and its direct (tailpipe) CO2 emissions are zero;
- until 31 December 2025, the activity provides interurban passenger road transport using vehicles designated as categories M2 and M3 that have a type of bodywork classified as 'CA' (single-deck vehicle), 'CB' (double-deck vehicle), 'CC' (single-deck articulated vehicle) or 'CD' (double-deck articulated vehicle), and comply with the latest EURO VI standard, i.e. both with the requirements of Regulation (EC) No 595/2009 and, from the time of the entry into force of amendments to that Regulation, in those amending acts, even before they become applicable, and with the latest step of the Euro VI standard set out in Table 1 of Appendix 9 to Annex I to Regulation (EU) No 582/2011 - with respect to emissions from heavy-duty vehicles (Euro VI) - where the provisions governing that step have entered into force but have not yet become applicable for this type of vehicle. Where such standard is not available, the direct CO2 emissions of the vehicles are zero.

[30] EU Technical Expert Group on Sustainable Finance. (2020). *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance.*

Considering the fact that in our case study, the public transport company wants to adopt buses powered by green hydrogen (generated from renewable sources through electrolysis) which therefore have zero CO2 emissions, and that the envisaged vehicle falls into the single-bodied M3 [31]category, both the criteria are met.

When it comes to Life-Cycle-Assessment considerations[32], embedded in the development of the technical screening criteria to the extent feasible, to understand the full environmental impact of the deployment of fuel cell buses, what should be considered are all the phases of their life cycle. Basically, they are: (a) raw material extraction; (b) material production; (c) manufacturing; (d) operation and maintenance; (e) end-of-life; (f) disposal.

Considering the fact that in our case study, the company is expected to enter this chain once the buses have been manufactured, the company will be responsible for the assessment of the last three steps. About this, the treatment of the buses' steel and metal parts will be performed considering the relevant legislation for end-of-life vehicles in the EU[33], according to which there should be 95% of reuse and/or recycling and 5% landfilling. For all the remaining vehicle components (electrical system, tyres, wood) the envisaged process will follow the standard practice, according to which will be implemented an open-loop recycling for glass, incineration of tyres and plastic mixtures, and landflling treatment for all other parts. As regards the recycling of spent lithium-ion battery and the treatment of exhausted fuell cell stacks, it will comprise a hydrometallurgical process to extract metals (platinum and metals).

Besides this, in order to complete the vehicle's LCA a second cycle has to be considered, namely the fuel life cycle that involves all processes from harnessing a primary energy flow or stock to different forms of conversion, distribution, storage and use in the vehicle[34].

It is worth saying that according to the scientific research carried out so far by experts and researchers on hydrogen buses powered by green hydrogen, at least 80% of the energy consumption in the hydrogen life

[31] M3: vehicles of category M, having more than eight seats in addition to the driver's seat and with a maximum mass exceeding 5 t. Vehicles of category M3 may have space for standing passengers.
[32] The considered LCA is performed according to ISO 14040:2006 guidelines for Environmental management—life cycle assessment—principles and framework and ISO 14044:2006 Environmental management—life cycle assessment—requirements and guidelines.
[33] EU (2000) Directive 2000/53/EC of the European Parliament
and of the Council of 18 September 2000 on end-of life vehicles - Commission Statements. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32000L0053
[34] The considered LCA is performed according to ISO 14040:2006 guidelines for Environmental management—life cycle assessment—principles and framework and ISO 14044:2006 Environmental management—life cycle assessment—requirements and guidelines.

cycle is due to the hydrogen production phase[35]. Furthermore, bus production accounts for the majority of total emissions, while the bus life cycle accounts for nearly 65% of the total impact of climate change[36].

That is to say that if on the one hand hydrogen buses are able to guarantee a net reduction of greenhouse gas emissions throughout their life cycle (85% reduction in GHG emissions compared to diesel buses)[37], other vehicle impacts, related to buses production and to the energy-intensive process for green hydrogen production, still raise challenges on how to further enhance the environmental benefits of fuel cells vehicles.

C) DNSH compliance

At this stage, what must be checked is compliance with the Do No Significant Harm principle. Its application to the Taxonomy is quite relevant, given the fact that it allows taking into account life-cycle considerations. According to the Regulation, the economic activities that substantially contribute to climate change mitigation or adaptation have the duty, at the same time, to do no harm to any other of the four environmental objectives. This constraint serves to ensure consistency between the various objectives and to avoid that an economic activity that contributes to one of the objectives on one hand, harms one or more of the other goals on the other hand. Let's see its application to the other environmental objectives.

- Climate change adaptation: As reported by art. 12 of the Taxonomy regulation, an economic activity is considered as significantly harming climate change adaptation "where that activity leads to an increased adverse impact of the current and expected climate, on itself or for other people, nature and assets"[38]. All material risks to the economic activity itself should be reduced to the extent possible and on a best-effort basis in order to ensure that the services that economic activities/vulnerable populations/vulnerable ecosystems rely on are resilient to climate change and that those services are not delivered in a way that negatively affects the adaptation efforts of others. These considerations have been translated into two specific criteria that have to be respected: (i) Reducing material physical climate risks; (ii) Supporting system adaptation. What is required is a robust and climate risk and vulnerability assessment, whose steps are defined in Appendix A of the Technical Annex[39].

[35] L. Iannuzzi, J.A. Hilbert, E.E. Silva Lora (2021) *Life Cycle Assessment (LCA) for use on renewable sourced hydrogen fuel cell buses vs diesel engines buses in the city of Rosario, Argentina.* https://www.sciencedirect.com/science/article/pii/S0360319921001312

[36] Pederzoli, D.W., Carnevali, C., Genova, R. *et al.* (2022) *Life cycle assessment of hydrogen-powered city buses in the High V.LO-City project: integrating vehicle operation and refuelling infrastructure*. https://link.springer.com/article/10.1007/s42452-021-04933-6#citeas

[37] *Ibidem.*

[38] EU Technical Expert Group on Sustainable Finance. (2020). *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance.*

[39] Appendix A - Generic criteria for DNSH to climate change adaptation: https://ec.europa.eu/sustainable-finance-taxonomy/documents/CCM%20Appendix%20A.pdf

- Circular economy: Procedures are in place to manage waste, both during the use (maintenance) phase and at the end of the life cycle of the fleet, including the reuse and recycling of batteries and electronics.
- Pollution prevention: For road vehicles of categories M, tyres comply with external rolling noise requirements in the highest populated class and with Rolling Resistance Coefficient (influencing the vehicle energy efficiency) in the two highest populated classes as set out in Regulation (EU) 2020/740 of the European Parliament and of the Council and as can be verified from the European Product Registry for Energy Labelling (EPREL). Where applicable, vehicles comply with the requirements of the most recent applicable stage of the Euro VI heavy-duty emission type-approval set out in accordance with Regulation (EC) No 595/2009[40].

D) Minimum safeguards check

This stage concerns the compliance with the Minimum Social Safeguards. Companies must evaluate this compliance as indicated in the international conventions taken as reference by the Taxonomy, i.e. the OECD Guidelines on Multinational Enterprises (MNEs) and the UN Guiding Principles on Business and Human Rights, with specific reference to the ILO Core Labor Conventions.

Through this obligation, the Regulation wants to ensure that companies, in carrying out their business, do not act illegally against workers in terms of labour and human rights. To this end, specific plans must be put in place, through policies and management systems able to identify and prevent adverse impacts.

Specifically, as reported by the Taxonomy Compass, the requirements concerning the Minimum Safeguards establish that:

1. The minimum safeguards referred to in point (c) of Article 3 shall be procedures implemented by an undertaking that is carrying out an economic activity to ensure the alignment with the OECD Guidelines for Multinational Enterprises and the UN Guiding Principles on Business and Human Rights, including the principles and rights set out in the eight fundamental conventions identified in the Declaration of the International Labour Organisation on Fundamental Principles and Rights at Work and the International Bill of Human Rights.
2. When implementing the procedures referred to in paragraph 1 of this Article, undertakings shall adhere to the principle of 'do no significant harm' referred to in point (17) of Article 2 of Regulation (EU) 2019/2088. [41]

[40] *Ibidem.*
[41] European Commission. (2022). *Taxonomy Compass, Urban and suburban transport, road passenger transport.* https://ec.europa.eu/sustainable-finance-taxonomy/activities/activity_en.htm?reference=6.3

As for the company in our case study, compliance with minimum social protection is at the heart of the company's core business, Ratp Dev. Since 2011, the Company has adopted a Code of Ethics based on four guiding principles: a. respect for people, b. legal compliance, c. customer service, d. consideration of stakeholders[42].

Its goal is to establish a standard of behavior to be followed in everyday environments. In this way, employees should be able to resolve problems or ethical issues that arise during the performance of their official functions, ensuring a working environment in which respect for the ethical dimension is ensured.

In addition to this, the Company is also committed to the prevention of corruption, with its Code of Business Conduct and Prevention Corruption[43], which illustrates the different types of behaviour to be prohibited, that may be deemed to be corrupt, influence peddling or anti-competitive practices.

Finally, the Company also undertakes to publish the Corporate Social Responsibility Report[44], in which all the policies, practices and behaviors adopted by the company in favor of the community in which it operates are declared. Its ultimate goal is to demonstrate how the company harmonises economic objectives with social and environmental ones, with a view to sustainability.

As a matter of fact, the Company's strategy is fully aligned with the relevant international conventions on respect for human rights.

E) Disclosure requirements

Given the fact that our activity contributes also to climate change adaptation objective, this assessment will be explained below.

For explanatory purposes, a summary table of what has been said so far -with regard to the TSC -is present in Annex II of this paper.

4.2 Climate change adaptation objective

[42] Ratp Group. (2019). *The Ratp Group Code of Ethics*. https://www.ratp.fr/sites/default/files/inline-files/CODE%20ETHIQUE_UK.pdf
[43] Ratp Group. (2021). *Code of Business Conduct and Prevention of Corruption*. https://www.ratp.fr/sites/default/files/inline-files/CODE%20DE%20CONDUITE_UK.pdf
[44] Ratp Dev. (2022). *CSR Report, Statement of extra-financial performance as of December 31,2021* https://www.ratpdev.com/sites/default/files/annexes/communiques/Statement%20of%20extra-financial%20performance%202021_RATP%20Dev.pdf

Considering that the macro-sector "Public Transport" is identified by the Taxonomy as one of those having an impact on different climate objectives, we have to apply the very same process with respect to the second environmental objective, which is climate-change adaptation[45].

A.1) Eligibility assessment

As for climate change mitigation objective, the activity is covered by the same NACE codes (H49.31, H49.3.9 etc) regarding the "Purchase, financing, leasing, rental and operation of urban and suburban transport vehicles for passengers and road passenger transport".

B.1) TSC phase

Article 11 of the Taxonomy in identifying when an economic activity shall be considered to substantially contribute to climate change adaptation, states that such activity should "substantially reduce or prevent the adverse impact of the present on future climate, or the risks of such adverse impact on the activity itself, or on people, nature or assets" (EC, 2021). [46]

Considering the definition provided by the Technical Annex, according to which "the material physical climate risk is the risk of (financial and non-financial) losses occurring due to performance failures, performance delays or incomplete performance of an economic activity resulting from climate-related hazards", two different types of substantial contributions can be identified:

1. "Adapted activities: an economic activity is adapted to all material physical climate risks identified for the economic activity to the extent possible and on a best effort basis; and/or

2. Activities enabling adaptation of an economic activity: the activity reduces material physical climate risk in other economic activities and/or addresses systemic barriers to adaptation, and is itself also adapted to physical climate risks"[47].

Given that depending on the type of activity, the Taxonomy provides for different TSC, it is important to define which category the activity of our case study falls into. This choice is left to the user as what is determined is the primary objective of the actor concerned (there is no a priori definition). In this regard,

[45] Also in this case, the methodology is applied and assessed only for points A and D. For the others, there is the outline of what should be done.
[46] EPRS. (2022) EU taxonomy: Delegated acts on climate, and nuclear and gas. https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/698935/EPRS_BRI(2022)698935_EN.pdf
[47] EU Technical Expert Group on Sustainable Finance. (2020). *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance.*

assuming that our main objective is climate change mitigation, we can categorize our activity as 'adapted activity'.

Before getting to the analysis of the technical criteria it is important to make some considerations first.

For the goal of adaptation to climate change, the Taxonomy has adopted an approach based on principles and qualitative technical criteria, considering the fact that it is recognized that climate change will affect all sectors of the economy and therefore everyone will have to adapt.

According to the TEG, what emerges is the context-specific nature of adaptation which precludes the possibility of producing an exhaustive list of activities that contribute to the adaptation. For this reason, a list of guiding principles was found to be more useful and effective in verifying whether an activity has the potential to contribute to the climate change objective. They are the following:

Principle 1: The economic activity reduces all material physical climate risks to the extent possible and on a best effort basis.

Principle 2: The economic activity does not adversely affect adaptation efforts by others.

Principle 3: The economic activity has adaptation-related outcomes that can be defined and measured using adequate indicators.

Having defined the conceptual framework in which the case study is located, we can now analyze specifically the TSC elaborated by the TEG for adapted activities that want to contribute to the second environmental objective of the Taxonomy. We have three main criteria:

- Reducing material physical climate risks: The economic activity integrates physical and non-physical measures aimed at reducing - to the extent possible and on a best effort basis - all material physical climate risks to that activity, which have been identified through a risk assessment.
- Supporting system adaptation: The economic activity and its adaptation measures do not adversely affect the adaptation efforts of other people, nature and assets.
- Monitoring adaptation results: Adaptation results can be monitored and measured against defined indicators. Recognising that risk evolves over time, updated assessments of physical climate risks should be undertaken at the appropriate frequency where possible.[48]

C.1) DNSH compliance

[48] *Ibidem.*

As regards the criterion of Do No Significant Harm, the same conditions are established as for the first environmental objective in terms of Circular economy and Pollution prevention (no indicators are provided for the climate change mitigation, water and biodiversity objectives)

D.1) Minimum safeguards check

Again, the Minimum safeguards must be considered in the same terms as the climate change mitigation objective.

As for the former, the summary of the TSCs concerning the climate change adaptation criteria is contained in Annex II of this paper.

E) Disclosure requirements: calculate the alignment of the investment with the Taxonomy

Finally, once all these steps are completed, the calculation of the investment alignment should be developed. The Taxonomy establishes well-defined financial metrics to be considered and their disclosure is strictly related to the disclosure obligations under the Taxonomy.

Company disclosure

In order to comply with the disclosure obligations under the Taxonomy, our company has to:

A. Disclose the proportion of the turnover aligned with the Taxonomy – for the climate mitigation objective
B. Disclose the capex and if relevant the opex – both for the climate mitigation and climate adaptation objectives.[49]

The Delegated Act specifies how these obligations should be applied in practice. Indeed, the Act requires non-financial undertakings to present the information by using the templates provided by Annex II[50] to the above-mentioned regulation and it requires that the information disclosed cover the annual reporting period from the previous calendar year of the date of disclosure.

In order to analyse these financial metrics, we take as a reference the business plan in which there is the calculation of capital and operational expenditure related to the investment and then consider the estimated turnover associated with such activity[51].

The CapEX

[49] In order to avoid double counting -as required by the Taxonomy -, for the climate change adaptation objective we cannot count turnover.
[50] Delegated Regulation Article 8 and its annexes: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R2178&from=FR
[51] It is specified that for confidentiality reasons, it is not possible to share data relating to the construction of the business plan.

As regards the CapEX, the reference formula as reported by the ANNEX 1 to the Delegated Act states as follows:

- $Taxonomy\ aligned\ CapEX\ \div$
  $Additions\ to\ assets\ during\ the\ FY\ before\ deprecition, amortisation\ and\ remasurements$

The OpEX

The operational expenditure related to the delivery and continuation of the activity encompasses very different factors. To assess its value, we have to run the following calculations:

- $Taxonomy\ aglined\ Opex\ \div Dircet\ non\ capitalised\ costs*$

*Meaning: RnD, renovations, short-erm leases, maintenance and repair

The turnover

To calculate the KPI related to the turnover, we have to consider two elements, as follows:

- $Turnover = Net\ Turnover\ aligned \div Net\ Turnover$

It should be noted that for all three formulas, what is calculated is essentially the division between Capex, Opex and Turnover aligned with the requirements of the Taxonomy, and their relative total. Therefore, the calculation refers to the division between aligned Capex-Opex-Turnover (we can define them as a subset of the denominator items that respect certain characteristics) and their gross total.

According to our methodology, this is the final phase of the alignment. In fact, once the KPIs have been calculated, they are ready to be reported and published as required by the Taxonomy.

5. Financing opportunities

At the beginning of the discussion of the paper, we underlined that one of the main objectives of the Taxonomy is to direct investments toward sustainable projects. This willingness stems from the huge need for funds that these projects require.

The purchase of hydrogen buses is one of these, presenting very high production costs, and consequently purchase costs. And it is precisely at this point that the importance of aligning our business with the Taxonomy comes into play: by demonstrating its compliance with the provisions of the Regulation, our investment qualifies as truly "sustainable", becoming able to attract the attention of all those stakeholders who want to invest in activities that contribute to the fight against climate change.

Alongside the interest of private investors, alignment with Taxonomy should also provide an advantage for access to the so-called Green Bond Standard. Given their potential and the close link that the legislator

wanted to foresee with Taxonomy, it is necessary to go deeper into the subject, also in order to answer our research question, i.e. how Taxonomy can impact sustainable public mobility.

5.1 The possibilities under the Taxonomy: EU Green Bonds

The first green bond was issued in 2007 by the European Investment Bank: it was created to fund projects that have positive environmental and/or climate benefits and since that moment, its growth was exponential. Basically, green bonds are financial instruments that finance green projects and provide investors with regular or fixed-income payments. Over the last 14 years, green bonds have become a valuable tool to address the impacts of climate change. They enjoyed a 49% growth rate in the five years before 2021, according to Climate Bonds, whose analysis suggests the green bond market annual issuance could exceed the $1 trillion mark by 2023. The success of green bonds has inspired the European Commission's proposal of an EU Green Bond Standards[52].

Indeed, even if according to statistics, an average annual growth rate of 95% can be attributed to green bonds market[53], there is no uniform green bond standard within the EU. The EC proposal's purpose is to fill this gap and finally provide investors and market actors with a sort of "gold standard" for how companies and public authorities can use green bonds to raise funds on capital markets to finance investments while meeting sustainability requirements and protecting investors from greenwashing.

5.2. The EU Green Bond Standard

In such a context, the legislative proposal of the European Commission has been launched in September 2020 as a key pillar of the broader Sustainable Finance Action plan – the EC plan which aims to promote sustainable investing across the European Union.

According to the proposal, the European Green Bond Standard will be strictly connected to the Taxonomy, given the fact that issuers of green bonds will have a robust tool at their disposal to show they are funding green projects aligned with the EU Taxonomy. Indeed, there are four key requirements under the proposed framework:

1. The funds raised by the bond should be allocated fully to projects aligned with the EU Taxonomy;

[52] L. Jones (2021) *Green Forecast Updated to Half a Trillion – Latest H1 Figures Signal New Surge in Global Green, Social & Sustainability Investment.* Climate Bonds Initiative. https://www.climatebonds.net/2021/08/climate-bonds-updates-2021-green-forecast-half-trillion-latest-h1-figures-signal-new-surge#:~:text=Green%20bonds%20have%20been%20soaring,a%20more%20modest%20growth%20rate.

[53] Climate Bonds Initiative. *Explaining Green Bonds*. https://www.climatebonds.net/market/explaining-green-bonds accessed on 15/05/2022.

2. There must be full transparency on how bond proceeds are allocated through detailed reporting requirements;
3. All EU green bonds must be checked by an external reviewer to ensure compliance with the Regulation and that funded projects are aligned with the Taxonomy. Specific, limited flexibility is foreseen here for sovereign issuers;
4. External reviewers providing services to issuers of EU green bonds must be registered with and supervised by the European Securities Markets Authority. This will ensure the quality and reliability of their services and reviews to protect investors and ensure market integrity. Specific, limited flexibility is foreseen here for sovereign issuers.[54]

Nevertheless, given the fact that, at the time of writing, the proposal has not entered into force, we cannot determine to which extent and through what modalities the final draft will be equal to the initial proposal. However, the green bond market still represents a valid source of financing that deserve to be taken into account given its specific requirements with which our proposal comply with.

5.3 Financing opportunities under the NRRP

If at the European level Green Bonds represent a valid financing instrument for our project, at the national level this role is represented by the Recovery and Resilience Plan.

With a budget of 248 billion euros, the Plan is divided into objectives and missions. The formers are divided into 3 points: Digitalization and Innovation, Ecological Transition and Social Inclusion. As part of the second objective, we find Mission number 2 "Green Revolution and Ecological Transition" with a budget of 68.6 billion euros. For the purposes of our research, it is within this mission that funds are earmarked for public hydrogen mobility. More specifically, there are 5 investment plans, active from 2022, which provide for:

1) Hydrogen experimentation for road transport;

2) Renewal of bus fleets, green trains;

3) A large industrial plant for the creation of tools necessary for the production and use of hydrogen;

4) Research and development on hydrogen;

[54] EU Technical Expert Group on Sustainable Finance. (2019). *Report on EU Green Bond Standard.* https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/190618-sustainable-finance-teg-report-green-bond-standard_en.pdf

5) Production in abandoned industrial areas, to be used for local transport and industry;

Besides this instrument, the Italian government has implemented the so-called "Complementary Fund to NRRP" with the objective of providing an additional booster for the achievement of specific objectives, among which there is also the renewal of buses fleet powered by renewable energies (point 2 of the above list) with a contribution of 600 million euros to those already provided by the NRRP (3.63 billion of euros).

To access these funds, the legislator has envisaged a sort of indirect link to the Taxonomy, as the actors who want to take advantage of these opportunities must, among others, demonstrate compliance with the DNSH principle, as outlined in the Taxonomy.

6.Discussion

The concept of the Taxonomy is recognized as an important enabler for companies and investors moving toward sustainable activities. However, demonstrating and implementing the guidelines of the Regulation leads to new requirements for the actors involved. Existing regulations and directives do not provide for a rigorous classification system and related procedures to be followed as it happens with the Taxonomy, thus not responding to the new standards compliance. This paper contributes to filling this gap by developing a methodology, scalable and transferable. It offers a standardised procedure describing the steps to be considered for the alignment with the Taxonomy.

The tool has the ability to help the application of the Taxonomy to the real economic setting, according to rounds of literature analysis, webinars, specialized interviews with feedback from practitioners and research specialists and finally by applying it to our specific field of research.

The pilot case study on the Ratp Dev company showed that, for companies wishing to align their investments with the Taxonomy, the tool can respond to the need for a clear procedure to follow. First, the methodology helps identify which alignment interventions are needed and which are not.

This could facilitate the compliance process and enhance its dissemination by increasing best practices. Secondly, the tool could be useful to analyze if what the company has done in terms of environmental impact and ESG performance are configured to effectively support the company in the alignment process. Thirdly, the tool could always be improved, in terms of specificity, by being applied to other sectors of the economy, in which different actors with different characteristics are involved, in order to increase the transferability of the methodology.

The objectives pursued have both been achieved. As regards the objective of contributing to bridging the gap in terms of Taxonomy applicability, a methodology was developed and the results of its application were

analyzed. On the other hand, from the point of view of the specific case study, by applying the methodology outlined, it was possible to demonstrate the alignment of the investment for hydrogen buses with Taxonomy.

The consequences of this alignment are analyzed in the context of funding opportunities, in which two cases have been highlighted: that of Green Bonds, an instrument directly linked to alignment with Taxonomy and that envisaged by the NRRP in the field of hydrogen buses, whose access, although not strictly linked to alignment with the Taxonomy, is subject to compliance with the DNSH principle[55], which in our case is verified as it has already been analyzed in the alignment phase with the Regulation.

Considering the high complexity of the process necessary to assess compliance with the DNSH principle, the fact that compliance with it has already been verified in our investment plan represents a facilitator for all actors who, like in the proposed case study, intend to access tenders in the scope of the NRRP.

However, despite the rigor with which the methodology was developed, there are still limitations. Indeed, firstly, the fact that the Regulation is enforceable only from 2022, entails that there is limited proof of its effectiveness in terms of pursued goals. And this, clearly, has an impact also on the soundness of the proposed methodology.

Even if the process that led to the adoption of the Taxonomy lasted 3 years, and involved different stakeholders, its final text is not without criticism from those who see taxonomy as an ineffective, politicized and even counterproductive tool for achieving the objectives of the European Green Deal, such as Sebastien Godinot, economist and director of WWF Europe[56].

The breaking point is due to the choice to include gas and nuclear energy in the upcoming developments of Taxonomy as sustainable activities. The argument, which sees several stakeholders at stake, has caused great stir and disappointment for those who see this choice as a kind of legitimacy for the greenwash.

In any case, for the purposes of this research, we wanted to point out these statements to also report other points of view. Like any decision with a great potential impact on the economy, the Taxonomy has its opponents.

Another element that could reduce the robustness of the methodology is linked to the intrinsic characteristics of Taxonomy, explicitly defined by the TEG as a living document, capable of reflecting the economic changes of the real world. While this choice serves to ensure its efficiency, on the other hand it increases its mutability. Possible changes could be made to the requirements now envisaged.

[55] Italiadomani. (2022*). Il principio DNSH (Do No Significant Harm) nel PNRR.* https://italiadomani.gov.it/it/Interventi/dnsh.html
[56] D. Passeri. (2021). *The fossil fuel lobby has found its way into Europe's 'Green New Deal'.* https://global.ilmanifesto.it/the-fossil-fuel-lobby-has-found-its-way-into-europes-green-new-deal/

With regard to this last point, actually, the proposed methodology stands as a flexible tool, able to accept and adapt to possible changes (we talked about it in reference to technology transfer).

However, in the coming years, we will have sufficient data to assess whether or not the Regulation has achieved its objectives, but it is at least necessary to try to contribute to its development through academic research, also for detecting possible critical issues, if any.

The last element to take into consideration concerns the novelty of the methodology. It should be recognized, in fact, that although specific interviews have been carried out to validate its effectiveness and different qualitative methods have been implemented, in order to improve its quality, it will be necessary to test it and apply it in other areas and also to reach as many feedbacks as possible. These are the next steps foreseen.

CHAPTER III – Looking forward with the Social Taxonomy

1. The Social Taxonomy

In the EU's sustainable finance strategy, alongside the importance of environmental aspects, there are also the considerations of social ones. Indeed, in order to achieve the UN goals (SDGs) is of paramount importance to take into account social investments.

In this context, it is no coincidence that there is a growing trend in the demand for social bonds (in 2021 there was a 376% increase in global issuance of social bonds compared to the same period in 2020)[57]. This trend demonstrates how social activities are able to attract the attention of investors increasingly interested in the issuance of social bonds, also because they are aware that not taking social aspects into account when managing a company or investing in certain business, could be a particularly risky choice in terms of revenues and reputation.

In addition to a private focus on social aspects, EU legislation is rich in reference sources in which the importance of a social taxonomy is recognized: from EU treaties to those to which the EU has decided to accede, it can be deduced that attention to the environment and social well-being are two key aspects of the European strategy. The main references are represented by the European pillar of social rights, the European Social Charter, the EU Charter on fundamental rights, and the European Convention on Human Rights.

[57] ACGF (2021) *Green, Sustainability and Social Bonds for COVID-19 Recovery* https://www.adb.org/sites/default/files/publication/678191/green-sustainability-social-bonds-covid-19-recovery.pdf

However, despite the recognition of the role of social aspects, a real turning point for the European Union frameworks has been represented by the approval of the EU Green Deal, with its ambitious objectives in terms of environmental and social sustainability.

The third goal of the Deal (leave no person and no place behind) is the one more clearly referred to social actions. However, as it happens for environmental objectives, there is a huge need for investments for the achievement of the European goals (that are, the UN's SDGs). Indeed, according to the UN's sources, a financing gap of $ 2.5-3 trillion a year can be estimated for developing countries in the achievement of SDGs goals[58].

The solution promoted by the EU legislation to accumulate more funds for environmentally sustainable activities has been the development of the European environmental Taxonomy, thanks to which a sort of capital guidance to market participants is provided.

As we have analyzed, in the Taxonomy there is the consideration of social impacts, by expressly requiring the respect of minimum social safeguards in order to consider an activity taxonomy-aligned, as established by art. 18 of the Regulation.

However, the focus of the EU Taxonomy is on the environmental aspects and the social considerations must be seen more as a reference or a feature, rather than the real focal point.

Against this background, the European Commission decided to asked to the Platform on Sustainable Finance to work on this topic and develop an extending report concerning the Social Taxonomy, by creating a sub-group dedicated to this objective.

1.1 Final Report on Social Taxonomy

Following the EC's mandate, the Platform on Sustainable Finance released its first report in July 2021 (until September 2021), in order to receive feedback from the interested audience.

According to the report, there were more than 250 responses concerning social taxonomy, demonstrating a powerful interest and related concerns around the topic. Indeed, the most frequent claim was about the possible administrative burden upon entities and financial actors caused by a social taxonomy non-aligned with the already existing environmental one. As a consequence, the efforts of the PSF have been focused on the alignment, as far as possible, of the social taxonomy structure to the environmental one.

[58] United Nations. (2022). *Sustainable Development Goals*. https://www.un.org/sustainabledevelopment/sg-finance-strategy/

The result is the creation of a single structure dimension in which three main objectives are contained: decent work including value-chain workers, adequate living standards and wellbeing for end-users, and inclusive and sustainable communities and societies.

That said, the Social Taxonomy will belong to the regulatory landscape that considers not only the Taxonomy, but also the proposed Corporate Sustainability Reporting Directive (CSRD) – which will replace the already mentioned NFRD, the Sustainable Finance Disclosure Regulation (SFDR), and the Sustainable Corporate Governance (SCG) initiative.

For what concerns the CSRD and the SFDR, both are tools aiming at improving the disclosure and transparency of companies' businesses and financial participants, whereas the SCG's focus is more on governance matters: specifically, this initiative is focused on the due-diligence duties of a company and its impact on: (i) human rights including workers' rights; (ii) health; (iii) the climate; and (iv) the environment. It aims to prevent, mitigate and account for potentially adverse sustainability impacts based on the UNGPs and the OECD guidelines[59].

Clearly, such directives and regulations framed the background and legal references in which the Social Taxonomy will be applicable and they must be taken into account when procedures will be set up, in order to create a coherent context in which possible overlaps will be solved effectively, both from the side of the regulators that on side of the recipients.

With this purpose in mind, we can start analyzing the possible structure of the Social Taxonomy, as proposed by the TEG report. Given the fact that the reference model is represented by the environmental Taxonomy, we know that the Social one has to set the objectives, then set the impacts that can achieve these objectives (substantial contribution), and finally designate criteria in which the principle of DNSH is applied.

1.2 The objectives

In order to define the goals, the TEG proposed a stakeholder-centric approach in which the objectives can be defined according to their belonging group. We can identify three main types of stakeholders: the own workforce of the activity, end-users, and affected communities. Basing the allocation of topics to these stakeholders, the following objectives are designed:

1.Decent work (including value-chain workers);

2.Adequate living-standards and well-being for end-users; and

[59] European Commission. *Sustainable corporate governance*. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12548-Sustainable-corporate-governance_en accessed on 20/05/2022.

3.Inclusive and sustainable communities and societies.

Clearly, these objectives cover a wide range of topics and for this reason they need: *(i) different approaches for prioritising sectors; (ii) different substantial contributions; and (iii) different DNSH criteria*[60]. That is, they need sub-objectives. So, for example, the first objective includes measures promoting equality and non-discrimination at work, the second refers to ensuring healthy and safe products and services and protection of personal data and privacy, and the third objective on the other hand takes into account the supporting of sustainable livelihoods and land rights and so on and so forth. What will be important is the definition of well-defined and mission-oriented sub-objectives so that in case of a simultaneous contribution of one activity to more than one sub-objectives, bundle criteria can be applied.

The TEG recommendations identified three types of substantial contributions:

1.Avoiding and addressing negative impacts;

2.Enhancing the inherent of positive impacts of: (i) social goods and services; and (ii) basic economic infrastructure; and

3.Enabling activities.

For what concerns "avoiding and addressing negative impacts" contribution a differentiation must be made: with regards to activities that are typically part of minimum standards, they should be excluded in order to avoid any kind of risk-mitigation measures being considered a substantial contribution. This differentiation is needed to ensure that substantial-contribution criteria are credible and actually able to improve the outcomes.

Enhancing the positive impacts contribution is applied for two objectives: "adequate living standards and wellbeing for end-users" and "inclusive and sustainable communities and societies".

Finally, there are the enabling activities contribution criteria in which is clear the reference to the model of the environmental Taxonomy: indeed, as for the first regulation, also in this case we can identify activities that are able to improve social performances of other activities and that, for such reason, must be considered.

1.3 Different DNSH criteria

[60] Platform on Sustainable Finance. (2022) *Final Report on Social Taxonomy*. https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/280222-sustainable-finance-platform-finance-report-social-taxonomy.pdf

With regards to the DNSH criterion, its meaningfulness is assessed also in the environmental Taxonomy and here it wants to pursue the same goal: the regulators want to avoid that while an activity can contribute to one sub-objective, it is harming another one at the same time.

However, the definition of DNSH criteria is quite problematic in the Social Taxonomy given the fact that it would be difficult to prioritize sectors or because it would not be possible to link CapEx or turnover to these activities. The TEG recognises how challenging could be the drawing up of DNSH criteria and in the meantime, other details are being designed, it suggests that when a specific DNSH is available, it has to be enforced.

As regards the relevant sectors, they are extracted by the NACE industrial classification system which covers 21 economic sectors and is sub-divided into 4 levels of subcodes. For the application of the Social Taxonomy, it might be useful to implement some additional specifications, but the reference to the NACE codes remains still the most effective way to see the real economy landscape.

It will be important to select the relevant sectors according to pre-established methodology (by way of example, the TEG presents a focus on high-risk NACE sectors for 'addressing negative impacts' substantial contribution). Of course, a lot of work and assessments have to take place but, guidelines can still be provided in order to see how the Social Taxonomy will work.

The report continues its analysis by providing some examples and by analyzing the governance 'G' issue but for the purpose of our research, it is useful to focus the attention on this part and see how the Social Taxonomy could be applied to our case study.

2.The Social Taxonomy in the context of public transport

After having applied the outlined methodology to our case study, we can also develop an application of the Social Taxonomy to it.

As we know, the activity that we are analyzing belongs to the basic services that should be provided to the community. Given the suggest stakeholder-centric approach of the social taxonomy, our activity will interest all three categories: own-work force, end-users and affected communities.

Before elaborating a possible example of the application of the Social Taxonomy to our case, it is useful to take a step back and consider the social benefits of public transport more broadly.

Much literature has been developed in this regard and although the conclusions may seem obvious, actually, it is necessary to report the advantages - with a focus on the social side - of public transport in a global context in which there seem to be more cars than human beings.

The benefits of public transport can be analyzed following a triple-bottom line in which the economic, the environmental and the social impacts are considered. Clearly, the argument would deserve a long debate and discussion, but for the purpose of our case study, we can summarize some key points. Putting aside the economic and environmental benefits, we can focus on the strictly social ones.

First of all, an efficient public transport service is able to facilitate workforce mobility and knowledge. From a social perspective, this means that social mobility can be achieved in an easier way thanks to the possibility of accessing more job opportunities[61].

This aspect is strictly related to the second benefit that is, social inclusion. Indeed, transport is a key tool to ensure that an individual is able to get access to employment, health services, education, and recreational activities. Similarly, transport services are very important for the most disadvantaged: low-income workers, the elderly and people with disabilities are particularly at risk of social isolation and this factor has been exacerbated by the COVID-19 pandemic. It is not a case that several non-profit organizations have mobilised their resources in order to help these categories during the pandemic so that they could have access to the basic services (such as supermarkets, post offices, pharmacies etc.).

The third aspect is represented by health. According to some research, each additional hour spent behind the wheel increases the likelihood of obesity by 6%[62]. This first insight wants to underline how using public transport services encourages an active lifestyle and improves personal fitness. On the other hand, alongside physical health, there is also mental health. As demonstrated by different studies, the possibility to walk on a street and benefit from the green areas, are two elements that favor healthy mental status. Removing cars from the streets, and consequently, removing car parks dedicated to them could allow the re-allocation of such spaces to green areas or pedestrian paths.

Finally, there is the issue of the ageing population and this is particularly true in Italy where, following a decreasing trend that has now been recorded for at least 15 years, in 2020 the births of the resident population were 404,892, about 15 thousand less than in 2019 (-3.6%) [ISTAT][63]. The fact is that public transport usually represents the main way of access to vital services for the elderly and as it is happening for health and social welfare policies, this demographic shift should be taken into account also by the transport sector.

[61] TTF Australia, Tourism and Transport Forum. (2010) *The Benefits of Public Transport*. Microsoft Word - Benefits of PT FINAL 2.doc (ttf.org.au)

[62] *Ibidem.*

[63] ISTAT (2021*) Natalità e fecondità della popolazione residente | anno 2020*. https://www.istat.it/it/files/2021/12/REPORT-NATALITA-2020.pdf

Considering all these characteristics, an engagement strategy could be created with interested communities in order to advertise the benefits of a hydrogen-powered public service.

Taking for example some strategies already implemented by other players in the sector[64], running hydrogen tours at the hydrogen fuelling stations and co-ordinating hydrogen school challenges seem to be two effective engagement strategies able to ensure a greater understanding and acceptance of hydrogen technologies.

These types of initiatives benefit also from a high-degree potential of transferability, being applicable elsewhere to show the power of information distribution at all levels of society. The challenges developed for pupils (such as playing with LEGO to build a fuel-cell bus) can be used in different contexts, where hydrogen applications are already in use. The workshops can be customized to include location-specific information, informing students about current projects and inspiring the next generation about the relevance of green technologies.

After having framed the background, we can prototype an example of how our activity could contribute to social objectives. As we have seen, the benefits for the end-users are quite relevant and for this reason, the example – whose structure follows the one provided by the PSF - will be referred to them even if the social benefits of public transport services can be referred also to the workforce (the drivers).

2.1 Objective: Adequate living standards and well-being for end-users, sub-objective: access to bus transport

	Rationale for selecting sectors
Selection of sectors	Sectors that contribute to reductions in the number of people without adequate, safe, and affordable public transport services. Transport and storage; NACE CODE H49.3.1. Urban and suburban passenger land transport (public transport).
Types of substantial contributions	**Enhancing positive impact inherent in economic activity**
Substantial contribution	Improving the availability of hydrogen bus units. Improving accessibility.

[64] Interreg Europe. (2022). *Population Engagement with Hydrogen Technology in Aberdeen.* https://www.interregeurope.eu/good-practices/population-engagement-with-hydrogen-technology-in-aberdeen

	Adequate living standards and well-being for end-users	**Decent work**	**Inclusive and sustainable societies and communities**
DNSH	Guarantee acceptability Hydrogen buses units must follow the environmental taxonomy for protection of ecosystems. Guarantee quality Hydrogen buses units must respect DNSH criteria set for the sector under the environmental taxonomy. There must be security of tenure for vulnerable groups. On process-related criteria, human rights and labour rights must be respected.	ILO core labour standards must be met. There must be adequate OHS. The minimum wage must be paid to workers.	No pollution of air when hydrogen buses are circulating, no emission of noise.

Source: author's own elaboration.

2.2 Concluding remarks

Demonstrating the alignment of our activity with the Social Taxonomy is expected to produce results not only from a social perspective but also considering the economic benefits.

Indeed, the fact that the activity under study would -according to the published draft- respect the requirements under the Social Regulation would mean that our investment would constitute a social investment, contributing substantially to achieve social goals.

It would be clear to private investors and public institutions that the company's activity boosts the respect for human rights and better working conditions, enabling them to make more conscious decisions.

All these factors should generate a positive impact on the company's reputation. In addition to opening the spectrum of financing opportunities, thanks to the easy access to social bonds and the attention of all those investors who see the social side as a fundamental aspect in the management of their activities, the alignment could improve perceptions by the community in which the company operates, in the sense that its presence in the area would be seen as an added value, not only for the conditions in which its employees work but also for the respect that the company shows towards all stakeholders.

Growth opportunities would unlock, giving the possibility of expanding activities aligned with Social Taxonomy and contributing to the achievement of European objectives, taking into account the concept of 'Just Transition'[65] , for a more inclusive Europe.

CONCLUSIONS

In this thesis, we address the research question: *how Taxonomy can impact the adoption of sustainable activities, starting by applying it to the case of hydrogen vehicles for the public mobility sector?*

The objectives pursued have moved in one direction but at two different levels of granularity. With regard to the first objective, the more contextual one, we wanted to demonstrate how to proceed with the alignment to the Taxonomy of the case study's activity, that is the renewal of the bus fleet for extra-urban transport with hydrogen buses. This was possible thanks to the developed methodology. In a subsequent phase, we moved on to the analysis of the results of the alignment with the Taxonomy, with particular regard to financing opportunities.

Through this procedure it has been shown that: (a)it is possible to test the alignment by applying the proposed methodology and that (b)this alignment has an impact on the financing possibilities of our business.

In fact, as emerged from the analysis, the activities aligned with the Taxonomy enjoy advantages in terms of access to Green Bond funds and at the same time benefit from this alignment in terms of procedures to be performed to access funding under the NRRP.

The point (a) is then very well linked to the second objective of the thesis, the more general one: to contribute to bridging the gap in terms of Taxonomy applicability, thanks to the development of the methodology and the analysis of the results of our case study.

[65] e.g. where employees and communities who are disproportionately impacted by the transition away from a fossil-fuel-based economy are not unfairly disadvantaged or "left behind."

Secondly, in this context of analysis, we wanted to deepen the research topic also taking into consideration the provisions on the Social Taxonomy, as a (future) relevant part for what concerns the objectives and obligations of the actors concerned.

In fact, in the third chapter, the analysis focuses on what has been proposed so far in terms of social objectives and their potential impacts, with a particular focus on our research field. In this way, we wanted to research the potential alignment of the activity under study and the possible consequences, in terms of opportunities. In this regard, it has been shown that the analyzed activity can contribute to the objectives of Social Taxonomy, thus increasing funding opportunities on the one hand and its reputation on the other.

The fact that the aspect of Social Taxonomy has been taken into consideration, even if its regulation has not yet entered into force, is the result of the desire to create a framework as complete as possible, being aware that this part of the legislation could have a significant impact on our business, and beyond.

The following research project thus broadens the literature review on Taxonomy, Social Taxonomy and related growth opportunities for hydrogen mobility in public transport, with the aim of highlighting how the impacts of such Regulations can be generated and exploited, in order to contribute to the European goal of being the first climate-neutral and socially responsible continent.

ANNEX I – Interviews with experts

A) Questions for Ratp - Hydrogen buses for sustainable mobility

1. What were the reasons that prompted you to look for an alternative solution in hydrogen for your fleet of passenger buses?
    - Mainly the critical aspects related to electricity in terms of autonomy of vehicles, disposal of exhausted batteries, overall environmental impact of the power supply system in terms of emissions, also considering the production processes of electricity and hydrogen.
2. Following the research carried out for the realization of the business plan for hydrogen buses, what are the major risks associated with the execution of a similar project, from the point of view of the purchaser (Cilia) of these vehicles?
    - Lack of sufficiently extensive experience in terms of size and duration to provide reliable feedback on: maintenance costs, component wear, fuel system reliability, trend in hydrogen purchase and supply costs.
3. In particular, to what extent does your project leverage the availability of hydrogen 24/7 along the route of buses with refueling stations and how have you assessed the risks associated with supply and storage? Will you only use green hydrogen or also gray hydrogen? What kind of interaction has there been with the hydrogen producers and with the manufacturer? Can you be particularly specific in this regard by also indicating the particular focus of these interactions (eg procurement, storage in your parking lots and storage conditions, design and risks related to the safety of the tanks)?
    - As mentioned in the previous point, procurement is one of the critical issues in the planning and implementation of the project. To date, there are very few production plants and even fewer distribution points. To hypothesize to carry out a hydrogen-powered tpl service, it is essential to provide a production / storage point on site available 24/7 and with a minimum storage able to guarantee at least 3 days of service. Given the construction costs of the plants and the current contribution margin of the TPL service in the Lazio region, it is currently impossible, in the absence of major public investments, to guarantee the economic sustainability of the construction of production and storage plants consistent with the aforementioned dimensional specifications. .
4. Have you considered the typical 10-15 year replacement cycle for diesel buses as a business case time horizon? Assuming that the business case covered capital expenditures (CAPEX) and operating expenses (OPEX), how did you consider an increase in operating expenses (OPEX) related to the production and storage of hydrogen [and the costs of fuel cells]?
    - If I understand the question correctly, ask me if we used the useful life of diesel vehicles for the hydrogen business case? Obviously, in the case of hydrogen cars, the duration of the car

and the storage and maintenance costs must also be checked in the light of what has been said in points 2. and 3. above.

5. Have you developed opportunities to create synergies with local / regional / interregional industry (producers, suppliers of gas, H2 by-product of chemical plants, etc.)?
   - No.
6. For the elaboration of my thesis, I am working on the taxonomy-alignment of the hydrogen bus project. Have you checked the eligibility of the project under the According to the European Taxonomy, verifying, first of all, the classification of the project according to the NACE and product code?
   - No, at the moment we are evaluating macro technical and operational aspects related to a first feasibility study
7. Assuming that the purchase of the buses will be financed in whole or in part by the PNRR, have you made a DNSH analysis of the individual buses and of the project as required by the European PNRR regulation? To this end, how does your decision tree actually work to evaluate DNSH under the PNRR?
   - See previous point
8. Pursuant to the Taxonomy Regulation, in fact, it will be possible to identify, according to a series of established requirements and criteria, which investments are truly green and sustainable and consequently "aligned with the taxonomy". This tool aims to increase the level of transparency of companies and financial actors working in sustainable projects on the one hand, and on the other hand it allows potential investors to better understand which companies to invest in according to their degree of sustainability.

   In this regard, the financial metrics required for the alignment calculation refer to 3 specific indicators: Capex, Opex and company turnover. Would it be possible to compare these data with those I have (deriving from the business plan)?
   - See previous point
9. Have you made an evaluation of the project involving the stakeholders and have you somehow expressed their requests to hydrogen producers and constructors? To what extent have you integrated the requests of your stakeholders in the execution of the project?
   - No, at the moment we are evaluating macro technical and operational aspects related to a first feasibility study
10. Do you have an engagement policy with stakeholders and an ESG strategy? If so, how are they structured and what role does the project play in this strategy? //
11. To date, to what extent do you think it is feasible to build a hydrogen bus line, specifically taking into account the technical-economic feasibility?

- The solution appears feasible without prejudice to what was previously explained in points 2. and 3.

B) Interview with Greenomy – carried out on 23/05/2022

Expert interviewed: Laura Lopez, Sustainability Analyst at Greenomy

J.1: I briefly present why I asked for this call. Basically, I am writing my final thesis on Taxonomy and its application to hydrogen mobility for public transport. The choice to focus on this field is also due to the internship carried out at Ratp, a company that operates in the public transport sector, in which we worked on defining a business plan for the purchase of hydrogen buses. In this context, with my thesis I want to demonstrate that by applying the methodology I developed, the company in question is able to demonstrate its alignment with Taxonomy. And a second objective is to also ensure the transferability of the methodology. In this regard, I would like to have some advice from you on how I set it up.

L.1: Yes, of course.

J.2 This is the visual representation of my methodology. I developed 5 stages that are related to the steps that the case study Company should follow to demonstrate the alignment of its activity. The first is about the Eligibility assessment, the second is about TSC screening criteria phase, followed by the DNSH compliance. The fourth step is represented by the respect of Minimum Social Safeguards and finally there is the Disclosure requirements stage. Actually, about this, I have some doubts. I don't know if it is correct to include it as a part of the methodology.

L.2: I think that you have the main points. I'm not entirely sure if the Disclosure requirement part would be better at early stage, or if it fits well at the very end. Anyway, it is correct to include it. And it would be better to specify that in the Eligibility step what you are assessing is the economic activity coverage.

C) Interview with Envoria – carried out on 02/06/2022

Expert interviewed: Nicolas Petherson, International Sales Manager at Envoria

M.1: I briefly present why I asked for this call. Basically, I am writing my final thesis on Taxonomy and its application to hydrogen mobility for public transport. The choice to focus on this field is also due to the internship carried out at Ratp, a company that operates in the public transport sector, in which we worked on defining a business plan for the purchase of hydrogen buses. In this context, with my thesis I want to demonstrate that by applying the methodology I developed, the company in question is able to demonstrate its alignment with Taxonomy. And a second objective is to also ensure the transferability of the methodology. In this regard, I would like to have some advice from you on how I set it up.

N.1: Yes sure. What exactly are the business activities? Public transportation? And where is it located?

M.1: It is referred to public transport services with hydrogen buses and it is located in Italy.

N.2: Ok, first of all, let me see how you imagined your process, even with a graphic support if possible. Show me exactly what you've done so far.

M.2: Ok, this is the visual representation of my methodology. For what concern the calculation of the KPIs, it is still ongoing. So, this is the process that I suggest essentially by starting to eligibility assessment, then the TSC phase take off in terms of substantial contribution assessment. Following, there is the DNSH compliance in terms of criteria established by the Regulation for the specific activity and Minimum Safeguards check in terms of policies implemented by the company in order to prevent risks and ensure the respect of workers' human rights. And finally, the disclosure requirements with regard to the KPIs. I essentially applied these steps to my case study to demonstrate its alignment, but with regard to the DNSH compliance, I simply outlined the process to be followed without apply it to the case study for operational reasons.

N.2: Ok, I want to show you something as Envoria has just published a guide on the EU Taxonomy, but it is not yet opened to the public. It is a company documentation, so it is your lucky day. Essentially, I think you got the point on how the process works. Your process is exactly similar to the guidelines that we developed. As you may see from the doc, at the second page, I have a very similar way in which we developed our process. But, let me ask you something. How do you explain to me the Technical Screening Criteria and how it is different from the DNSH and compliance Safeguards?

M.2: Ok, with the TSC phase I refer to the substantial contribution assessment to one of the environmental objectives, whereas in the DNSH I refer to the impact of the activity to the other 5 environmental objectives.

N.3: Well, so ok, we are on the same layer [then, He explained the process envisaged by Envoria]. So, I think that your methodology is well-structured and of course scalable to other activities, not just that of your case study.

ANNEX II – TSC summaries

A) Climate change mitigation – Source: EU Technical Expert Group on Sustainable Finance. (2020). *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance*.

6.3 Public transport

Sector classification and activity	
Macro-Sector	H - Transport and storage
NACE Level	4
Code	H49.3.1
Description	**Urban and suburban passenger land transport (public transport)**
Mitigation criteria	
Principle	Demonstrate substantial GHG emission reduction by: - Increasing the number of low- and zero emission fleets, and improving fleet efficiency - Improving efficiency of the overall transport/mobility system
Criteria	CO_2e emissions per passenger- kilometre (gCO_2e/pkm). • Zero direct emissions land transport activities (e.g. light rail transit, metro, tram, trolleybus, bus and rail) are eligible. • Other fleets are eligible if direct emissions are below 50 gCO_2e/pkm until 2025 (non-eligible thereafter) **Brief rationale**: Zero direct emissions public transport (e.g. electric, hydrogen) is eligible because: • With the present energy mix, the overall emissions associated with zero direct emissions public transport (i.e. electric or hydrogen) are among the lowest compared with other transport modes. • The generation of the energy carriers used by zero direct emissions transport is assumed to become low or zero carbon in the near future The threshold of 50 gCO_2e/pkm until 2025 ensures that the carbon intensity remains similar to criteria for eligible road vehicles with low occupation factor (50 gCO_2/vkm) and significantly lower than emissions for an average car.
Rationale	
The threshold of 50 gCO_2e/pkm until 2025 ensures that the carbon intensity remains similar to criteria for eligible road vehicles with low occupation factor (50 gCO_2/vkm) and significantly lower than the average car (290 gCO_2 /vkm[343]). The criteria is based on actual ridership (passenger-km) and not capacity offered (seat-km or places-km). This should be justified through real monitoring data from operations or ex-ante demand assessments. The current average emissions intensity for	

a bus in the EU is 70-90 g CO_2 e/pkm[344] with load factors of around 10 passengers per bus, with the variation dependent on a number of considerations such as public service obligations, type of service, etc. As per current average technology, a hybrid bus would require at least 16 passenger average occupation factor, and diesel more than 20 passengers to be eligible. This threshold is therefore stringent while it provides some flexibility to recognize highly efficient systems and advanced hybrid technology. Diesel and petrol cars still represent the immense majority of the road fleet in all countries and the penetration of electric vehicles will materialize at a yet unknown pace. In the meanwhile, a lack of investment in public transport fleet renewal can lead to behavioural changes, such as modal shift to private car that would be significantly more difficult to revert in the future[345].	
Do no significant harm assessment	
The main potential significant harm to other environmental objectives from the operation of urban and suburban passenger land transport (public transport) are summarised as follows: • Direct emissions to air[346] from the exhaust gases of internal combustion engine: nitrogen oxides (NOx), total hydrocarbon (THC), non-methane hydrocarbons (NMHC), carbon monoxide (CO), particulate matter (PM) and particle number, and from tyre abrasion and brakes friction and noise emissions[347]; • Waste generation (hazardous and non-hazardous) during maintenance and end-of-life of the vehicle or rolling stock.	
(2) Adaptation	• Refer to the screening criteria for DNSH to climate change adaptation.
(3) Water	
(4) Circular Economy	• Regarding both maintenance and end-of-life management of vehicles or rolling stock, compliance with EU and national legislation on hazardous waste generation, management and treatment.

	• Compliance with Directive 2000/53/EC ("End-of-life of vehicles Directive") only for vehicle types M1 and N1 (busses are out of scope of the Directive)
(5) Pollution	• Buses must comply with the current Euro VID and from 2022, the Euro VIE stage. Railcars, locomotives must comply with latest applicable standards (currently stage 5) of Non-Road Mobile Machinery Regulation[348]. • Where applicable, tyres must comply with the (revised) Tyre labelling regulation[349]. It includes noise labelling requirements but not requirements on tyre abrasion. However, the proposal of revision envisages a test method to be developed: A suitable testing method to measure tyre abrasion is not currently available. Therefore, the Commission should mandate the development of such a method, taking into full consideration of all state-of-the-art internationally developed or proposed standards or regulations, with a view to establishing a suitable testing method as soon as possible. • Where applicable, tyres must comply with the noise requirements set by Regulation (EC) No 661/2009 on type-approval requirements for the general safety of motor vehicles[350]. • Vehicles must comply with Regulation (EU) No 540/2014[351] on the sound level of motor vehicles and of replacement silencing systems. • Minimise noise and vibrations of rolling stock by applying thresholds on pass-by noise in dB in line with Regulation 1304/2014 Noise TSI[352]: o Electric locomotives <84dB at 80km/h & <99 at 250 km/h; o Diesel locomotives <85 at 80km/h; o Electric multiple units <80dB at 80km/h & <95 at 250 km/h; o Diesel Multiple Units <81dB at 80km/h & <96 at 250 km/h; o Coaches <79dB at 80km/h; o Wagons <83dB at 80km/h
(6) Ecosystems	

B) Climate change adaptation – Source: EU Technical Expert Group on Sustainable Finance. (2020). *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance*.

6.3 Public transport

Sector classification and activity	
Macro-Sector	H - Transport and storage
NACE Level	4
Code	H49.3.1
Description	**Urban and suburban passenger land transport (public transport)**

Adaptation criteria
Depending on the primary objective of the activity, refer to: • Screening criteria for adapted activities • Screening criteria for an activity enabling adaptation Users of the Taxonomy should identify and explain which criteria they are responding to.

Do no significant harm assessment	
The main potential significant harm to other environmental objectives from the operation of urban and suburban passenger land transport (public transport) are summarised as follows: • Direct emissions to air[555] from the exhaust gases of internal combustion engine: nitrogen oxides (NOx), total hydrocarbon (THC), non-methane hydrocarbons (NMHC), carbon monoxide (CO), particulate matter (PM) and particle number, and from tyre abrasion and brakes friction and noise emissions[556]; • Waste generation (hazardous and non-hazardous) during maintenance and end-of-life of the vehicle or rolling stock.	
(1) Mitigation	Emissions performance threshold of 95g CO_2 e /pkm should not be exceeded.
(3) Water	
(4) Circular Economy	• Regarding both maintenance and end-of-life management of vehicles or rolling stock, compliance with EU and national legislation on hazardous waste generation, management and treatment. • Compliance with Directive 2000/53/EC ("End-of-life of vehicles Directive") only for vehicle types M1 and N1 (busses are out of scope of the Directive)
(5) Pollution	• Buses must comply with the current Euro VID and from 2022, the Euro VIE stage. Railcars, locomotives must comply with latest applicable standards (currently stage 5) of Non-Road Mobile Machinery Regulation[557]. • Where applicable, tyres must comply with the (revised) Tyre labelling regulation[558]. It includes noise labelling requirements but not requirements on tyre abrasion. However, the proposal of revision envisages a test method to be developed: A suitable testing method to measure tyre abrasion is not currently available. Therefore, the Commission should mandate the development of such a method, taking into full consideration of all state-of-the-art internationally developed or proposed standards or regulations, with a view to establishing a suitable testing method as soon as possible. • Where applicable, tyres must comply with the noise requirements set by Regulation (EC) No 661/2009 on type-approval requirements for the general safety of motor vehicles[559]. • Vehicles must comply with Regulation (EU) No 540/2014[560] on the sound level of motor vehicles and of replacement silencing systems. • Minimise noise and vibrations of rolling stock by applying thresholds on pass-by noise in dB in line with Regulation 1304/2014 Noise TSI[561]: o Electric locomotives <84dB at 80km/h & <99 at 250 km/h; o Diesel locomotives <85 at 80km/h; o Electric multiple units <80dB at 80km/h & <95 at 250 km/h; o Diesel Multiple Units <81dB at 80km/h & <96 at 250 km/h; o Coaches <79dB at 80km/h; o Wagons <83dB at 80km/h
(6) Ecosystems	

B.1) Screening criteria for adapted activities – Source: EU Technical Expert Group on Sustainable Finance. (2020). *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance*.

Criterion	Description
A1: Reducing material physical climate risks	The economic activity must reduce all material physical climate risks to that activity to the extent possible and on a best effort basis.
A1.1	The economic activity integrates physical and non-physical measures aimed at reducing - to the extent possible and on a best effort basis - all material physical climate risks to that activity, which have been identified through a risk assessment.
A1.2	The above-mentioned assessment has the following characteristics: • considers both current weather variability and future climate change, including uncertainty; • is based on robust analysis of available climate data and projections across a range of future scenarios; • is consistent with the expected lifetime of the activity.
A2: Supporting system adaptation	The economic activity and its adaptation measures do not adversely affect the adaptation efforts of other people, nature and assets.
A2.1	The economic activity and its adaptation measures do not increase the risks of an adverse climate impact on other people, nature and assets, or hamper adaptation elsewhere. Consideration should be given to the viability of 'green' or 'nature-based-solutions' over 'grey' measures to address adaptation.
A2.3	The economic activity and its adaptation measures are consistent with sectoral, regional, and/or national adaptation efforts.
A3: Monitoring adaptation results	The reduction of physical climate risks can be measured.
A3.1	Adaptation results can be monitored and measured against defined indicators. Recognising that risk evolves over time, updated assessments of physical climate risks should be undertaken at the appropriate frequency where possible.

BIBLIOGRAPHY AND SITOGRAPHY

- ACGF (2021) *Green, Sustainability and Social Bonds for COVID-19 Recovery* https://www.adb.org/sites/default/files/publication/678191/green-sustainability-social-bonds-covid-19-recovery.pdf
- Appendix A - Generic criteria for DNSH to climate change adaptation: https://ec.europa.eu/sustainable-finance-taxonomy/documents/CCM%20Appendix%20A.pdf
- Associazione Italiana Idrogeno e Celle combustibile. (2020) *Priorità per lo sviluppo della filiera idrogeno in Italia*. https://www.h2it.it/wp-content/uploads/2021/01/H2IT_REPORT_19gen21.pdf
- Climate Bonds Initiative. *Explaining Green Bonds*. https://www.climatebonds.net/market/explaining-green-bonds accessed on 15/05/2022.

- Confindustria. (2020) *Piano d'azione per l'idrogeno.* https://www.confindustria.it/wcm/connect/552759de-3bb8-472f-a20b-07ab2aa5f21f/Position+Paper_Piano+d%27azione+per+l%27idrogeno_ott+2020_Confindustria.pdf?MOD=AJPERES&CONVERT_TO=url&CACHEID=ROOTWORKSPACE-552759de-3bb8-472f-a20b-07ab2aa5f21f-nuhfm09
- Passeri. (2021). *The fossil fuel lobby has found its way into Europe's 'Green New Deal'.* https://global.ilmanifesto.it/the-fossil-fuel-lobby-has-found-its-way-into-europes-green-new-deal/
- Delegated Regulation Article 8 and its annexes: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R2178&from=FR
- EIB (2022) *Unlocking the hydrogen economy —stimulating investment across the hydrogen value chain. Investor perspectives on risks, challenges and the role of the public sector.* https://www.eib.org/attachments/publications/unlocking_the_hydrogen_economy_en.pdf
- Enel. *Green hydrogen, a new ally for decarbonization*. https://www.enel.com/company/stories/green-hydrogen-opportunities accessed on 20/05/2022.
- EPRS. (2022) *EU taxonomy: Delegated acts on climate, and nuclear and gas*. https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/698935/EPRS_BRI(2022)698935_EN.pdf
- EU (2000) Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles - Commission Statements. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32000L0053
- EU Technical Expert Group on Sustainable Finance. (2019). *Report on EU Green Bond Standard. https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/190618-sustainable-finance-teg-report-green-bond-standard_en.pdf*
- EU Technical Expert Group on Sustainable Finance. (2020). *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance*.
- European Commission (2022*). REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition.* https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131
- European Commission. (2019). *Questions and Answers: political agreement on an EU-wide classification system for sustainable investments (Taxonomy)* https://ec.europa.eu/commission/presscorner/detail/it/qanda_19_6804

- European Commission. (2020). *Renewed sustainable finance strategy and implementation of the action plan on financing sustainable growth* https://ec.europa.eu/info/publications/sustainable-finance-renewed-strategy_en
- European Commission. (2021) *Sustainable Finance and EU Taxonomy: Commission takes further steps to channel money towards sustainable activities. https://ec.europa.eu/commission/presscorner/detail/en/ip_21_1804*
- European Commission. (2021). *FAQ: What is the EU Taxonomy Article 8 delegated act and how will it work in practice?"* (para. 6) https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/sustainable-finance-taxonomy-article-8-faq_en.pdf
- European Commission. (2021). *Questions and Answers: Taxonomy Climate Delegated Act and Amendments to Delegated Acts on fiduciary duties, investment and insurance advice.* https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_1805
- European Commission. (2022). *Taxonomy Compass, Urban and suburban transport, road passenger transport.* https://ec.europa.eu/sustainable-finance-taxonomy/activities/activity_en.htm?reference=6.3
- European Commission. Hydrogen. https://energy.ec.europa.eu/topics/energy-system-integration/hydrogen_en#:~:text=EU%20hydrogen%20strategy,-Hydrogen%20is%20an&text=The%20dedicated%20strategy%20on%20hydrogen,infrastructure%20to%20an%20international%20dimension.
- European Commission. *Sustainable corporate governance*. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12548-Sustainable-corporate-governance_en accessed on 22/05/2022.
- Eurostat. (2016) *Glossary:Statistical classification of economic activities in the European Community (NACE). https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Statistical_classification_of_economic_activities_in_the_European_Community_(NACE)#:~:text=NACE%20is%20a%20four%2Ddigit,developed%20within%20the%20European%20statistical*
- Fuel Cell Electric Buses. *JIVE.* https://www.fuelcellbuses.eu/projects/jive
- IEA. (2019) The future of Hydrogen: seizing today's opportunities. https://iea.blob.core.windows.net/assets/9e3a3493-b9a6-4b7d-b499-7ca48e357561/The_Future_of_Hydrogen.pdf

- Interreg Europe. (2022). *Population Engagement with Hydrogen Technology in Aberdeen*. https://www.interregeurope.eu/good-practices/population-engagement-with-hydrogen-technology-in-aberdeen
- Italiadomani. (2022*). Il principio DNSH (Do No Significant Harm) nel PNRR.* https://italiadomani.gov.it/it/Interventi/dnsh.html
- ISTAT (2021) Natalità e fecondità della popolazione residente | anno 2020. https://www.istat.it/it/files/2021/12/REPORT-NATALITA-2020.pdf
- L. Iannuzzi, J.A. Hilbert, E.E. Silva Lora (2021) *Life Cycle Assessment (LCA) for use on renewable sourced hydrogen fuel cell buses vs diesel engines buses in the city of Rosario, Argentina.* https://www.sciencedirect.com/science/article/pii/S0360319921001312
- L. Jones (2021) Green Forecast Updated to Half a Trillion – Latest H1 Figures Signal New Surge in Global Green, Social & Sustainability Investment. Climate Bonds Initiative. https://www.climatebonds.net/2021/08/climate-bonds-updates-2021-green-forecast-half-trillion-latest-h1-figures-signal-new-surge#:~:text=Green%20bonds%20have%20been%20soaring,a%20more%20modest%20growth%20rate.
- M. Hessenius, P. Sweatman. (2020). *Applying the EU Taxonomy: Lessons from the frontline*, Climate & Strategy, Climate Company. https://www.euractiv.com/wp-content/uploads/sites/2/2020/10/Applying-EU-Taxonomy-lessons-from-the-front-line-FINAL.pdf
- Ministero delle Infrastrutture e della mobilità sostenibili. (2022). *Decarbonizzare i transporti: evidenze scientifiche e proposte di policy*.
- Ministero dello sviluppo economico. (2020) *Strategia Nazionale Idrogeno Linee Guida Preliminari.* https://www.mise.gov.it/images/stories/documenti/Strategia_Nazionale_Idrogeno_Linee_guida_preliminari_nov20.pdf
- Pederzoli, D.W., Carnevali, C., Genova, R. *et al.* (2022) *Life cycle assessment of hydrogen-powered city buses in the High V.LO-City project: integrating vehicle operation and refuelling infrastructure*. https://link.springer.com/article/10.1007/s42452-021-04933-6#citeas
- Platform on Sustainable Finance. (2022) *Final Report on Social Taxonomy*. https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/280222-sustainable-finance-platform-finance-report-social-taxonomy.pdf
- Ratp Dev. (2022). *CSR Report, Statement of extra-financial performance as of December 31,2021* https://www.ratpdev.com/sites/default/files/annexes/communiques/Statement%20of%20extra-financial%20performance%202021_RATP%20Dev.pdf

- Ratp Group. (2019). *The Ratp Group Code of Ethics*. https://www.ratp.fr/sites/default/files/inline-files/CODE%20ETHIQUE_UK.pdf

- Ratp Group. (2021). *Code of Business Conduct and Prevention of Corruption*. https://www.ratp.fr/sites/default/files/inline-files/CODE%20DE%20CONDUITE_UK.pdf
- Taxonomy Regulation Delegated Act 2021/4987 (pp.1)
- The Corporate Social Responsibility Directive whose aim is to widen the scope of the NFRD to all large companies registered in the financial markets. https://ec.europa.eu/info/business-economy-euro/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en
- TTF Australia, Tourism and Transport Forum. (2010) *The Benefits of Public Transport.* Microsoft Word - Benefits of PT FINAL 2.doc (ttf.org.au)
- United Nations. (2022). *Sustainable Development Goals.* https://www.un.org/sustainabledevelopment/sg-finance-strategy/

LUISS

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Course of Green and Sustainable Finance

Hydrogen buses for sustainable mobility: the role of the Taxonomy as a key driver towards the green transition

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Summary

INTRODUCTION

The effects of the pandemic on public transport have been overwhelming. First the lockdown, then the implementation of public health rules related to social distancing, the use of facial masks, and sanitation have created a context of fear and reluctance in all those who daily moved by public transport.

In addition, the need for comfort, respect for the environment and safety are increasingly evaluated as critical for consumers: these factors will, ultimately, be decisive for the emerging modes of transport, new and old, from electric vehicles to scooters. Users are no longer forced to choose between an efficient vehicle and an ecological vehicle.

In this context, e-mobility is the future: the synergy of the development of all branches of electromobility is fundamental to guarantee an efficient decarbonisation of transport. Therefore, not only electric vehicles, but also hydrogen vehicles will play a key role in achieving climate-neutral mobility.

According to their technical characteristics, hydrogen-powered vehicles are best suited for journeys that run long-rage routes, transport heavier loads and require fast fuelling. What is central is the great need for flexibility that hydrogen buses are able to satisfy.

When it comes to the "why" question, the main advantages of a hydrogen drive are represented by its environmental performance. Indeed, this type of technology – when it is based on green hydrogen[1] - allows for completely emission-free driving, it is extremely quiet and it does not generate vibration. Hydrogen fuel cell guarantees reduction of carbon emissions and the only by-product of the chemical reaction is water.

On the other hand, being hydrogen an innovative technology, it is challenged by different barriers, mainly represented by high upfront costs, limited hydrogen resources and technological barriers.

For all these reasons, state intervention is of paramount importance in helping industries develop and implement this new form of green mobility, first of all by re-directing capital flows towards sustainable investments. This is why the Taxonomy application - the strategy for achieving a common understanding of what constitutes sustainable activities across the EU- can be an answer to the question "how to do it".

The problem, however, is related to its recent enactment and its degree of complexity. In fact, now that we finally have a gold standard classification system to follow, we need to see how it can be applied correctly. The purpose of this research project is precisely to answer the question: *how Taxonomy can impact the adoption of sustainable activities, starting by applying it to hydrogen vehicles for the public mobility sector?*

In order to address this issue, qualitative research methods were implemented with the aim of developing a structured methodology, applying it to the case study in question and verifying the results. In addition to

[1] The only 100% sustainable hydrogen that is obtained is obtained through the electrolysis of water in special electrochemical cells powered by electricity produced from renewable sources. Enel. *Green hydrogen, a new ally for decarbonization*. https://www.enel.com/company/stories/green-hydrogen-opportunities accessed on 20/05/2022.

that, semi-structured interviews and secondary data analysis were carried out to collect all the relevant data needed to conduct the research.

The purpose of analyzing Taxonomy application to public hydrogen mobility requires a prior analysis of the general applicability of the Taxonomy by reference to: (a) the development of a scalable and transferable methodology; and (b) the analysis of the results obtained by applying the methodology to our case study. These are the starting assumptions analyzed in the paper.

With regards to the choice of the case study, it falls on the company Ratp Dev, in collaboration with which a business plan has been defined for the purchase of a new fleet of hydrogen buses. Ratp Dev is a French company, operating in the public mobility sector across 14 countries. It offers various mobility services, from the bus to the metro and it has been committed for years to adopting increasingly sustainable technologies, with the aim of reducing the environmental impacts of its operations. And in fact, the decision to draw up an investment plan for the purchase of hydrogen buses moves in the same direction.

To achieve the objectives pursued, the dissertation focuses in the first chapter on the literature review part, in order to frame the theoretical background and contextualize the problem, while in the second chapter the analysis moves mainly on the development of the methodology and its application to the case study, with consequent analysis and discussion of the results. In this part, the methods of data acquisition are first explained as regards the definition of the methodology and as regards the choice of the case study and in the next phase, the methodology developed for the research case is tested. Finally, the last chapter takes into consideration the Social Taxonomy, as a fundamental part of the context of analysis, the adoption of which has not, however, been formalized yet. The purpose of the last chapter is to analyze how much this new Regulation will bring about changes to the context of reference and to highlight the possibilities under the Social Taxonomy for what concerns our case study.

Eventually, in the Conclusion paragraph, the main concluding remarks are discussed.

CHAPTER I – ENABLING THE TRANSITION

Hydrogen mobility can make a major contribution to achieve the EU's climate and energy goals for 2030 and meeting the goals of the European Green Deal. Investments towards sustainable projects and activities, such as green mobility plans, are essential but in order to facilitate their delivery, a common language and a clear definition of what is ‘sustainable’ is needed. With the adoption of the EU Taxonomy Regulation, this issue is expected to be solved, as well as to reduce the phenomenon of "greenwashing".

As part of its efforts to shift financial flows toward sustainable activities, the European Commission established in 2020 the creation of a common classification system for sustainable economic activities, that is the EU Taxonomy Regulation 2020/852.

Basically, at the moment, it establishes a list of environmentally sustainable economic activities for investment purposes and it lays out six environmental objectives as listed below (however, for the sake of completeness, it is right to say that the EU Taxonomy is not simply limited to these goals, as evidenced by the European Commission's decision to mandate the Platform on Sustainable Finance to work on the extension of the EU Taxonomy to social objectives. This topic will be analysed in the last chapter):

1. Climate change mitigation
2. Climate change adaptation
3. The sustainable use and protection of water and marine resources
4. The transition to a circular economy
5. Pollution prevention and control
6. The protection and restoration of biodiversity and ecosystems

The EU Taxonomy classifies as "environmentally sustainable" economic activities that substantially contribute to at least one of the above-mentioned environmental objectives, while at the same time not significantly harming any of these objectives and meeting minimum social safeguards. Finally, in addition to these criteria, an activity that wants to be 'taxonomy-aligned' must comply with the technical screening criteria contained in the Delegated Acts and developed by the EU Technical Expert Group [2], which will be replaced by the Platform on Sustainable Finance (PSF).

At the time of writing, the European Commission published two delegated acts.

The first Delegated Act (Climate Delegated Act), adopted in June 2021, defines clear criteria for activities for climate change adaptation and climate change mitigation objectives (two of the six environmental goals – for the remaining ones, another delegated act will be adopted by the end of 2022)[3].

The second Delegated Act, supplementing art. 8 of the Taxonomy Regulation (the so-called disclosure delegated act), published in December 2021, clarifies the content and methodology of information that financial and non-financial actors have to disclose about the percentage of sustainable economic activities in their businesses.

[2] The Technical Expert Group on Sustainable Finance is a group of 35 members from civil society, academia, business and the finance sector, set up by the EC to advise on the implementation of the Action Plan on Financing Sustainable Growth.

[3] For what concerns the other four environmental objectives, the PSF provided the first recommendations to the European Commission in March 2022, which will then have to follow the entire feedback and consultation process before being adopted.

As it immediately becomes clear, the European Taxonomy is a transparency tool for companies, investors, policymakers and financial institutions with the aim of helping firms on their path towards ecological transition and at the same time providing clear elements for investors who want to promote sustainable investments.

Indeed, on the companies' side, the Taxonomy can be seen as an instrument to organize their climate transition and collect finance for it, whereas on the side of the investors, this classification system provides clear information on what investors are betting on. Investors can use the EU Taxonomy criteria to filter and discover sustainable investment possibilities with a positive environmental impact.

Why hydrogen? Policy issues

After having explained the main features of the Taxonomy, in the second paragraph, the problem is put in the context of the research field, that is hydrogen public mobility. The aim is to assess the relevance of the hydrogen value chain by providing an overview of policy initiatives and public and private partnerships, whose aim is to boost the deployment of such technology.

At the European level, the EU Green Deal and the Hydrogen Strategy are seen as two building blocks that define the hydrogen supply chain development plan. In addition to this, public-private initiatives are considered within the JIVE project (Joint Initiative for Hydrogen Vehicles across Europe) whose goal is to implement the largest fleet of hydrogen buses in Europe, in order to facilitate their commercialization.

At the national level, on the other hand, the National Hydrogen Strategy is analyzed, as well as the most recent reports released by industrial associations (such as Confindustria) and government bodies (such as the Ministry of Infrastructures and Transport) in which are defined the strategies for promoting the hydrogen supply chain as well as the potential of hydrogen for the decarbonisation of the transport system.

CHAPTER II – TAXONOMY APPLICATION TO HYDROGEN PUBLIC MOBILITY

Considering the complexity of the process outlined by the EU Taxonomy and by the Delegated Acts, this research project aims to outline an effective methodology, following which non-financial companies that want to demonstrate their alignment with Taxonomy are clear about the main steps to be followed.

In fact, given that the EU Taxonomy Regulation has been enacte quite recently, there is a very little literature review. What is needed is to fill the gap in terms of applicability, and according to our hypothesis, this can be achieved by developing a clear and specific methodology capable of identifying the path to follow in accordance with the provisions of the Regulation to assess any impacts.

The outlined methodology is divided into four phases[4]:

First phase – Eligibility assessment

The first stage is to determine whether a company's activity -or activities- are eligible, namely covered by the Taxonomy. The European industrial classification system (NACE) is used to classify economic activity. In this phase, the use of the Taxonomy Compass is particularly useful, as it allows users to perform eligibility checks. Once the eligibility is assessed, the activity has to pass a criteria-compliance check.

Second phase – Technical screening phase

At this step, non-financial company needs to assess if the activity fits the established TSC, which show substantial contribution to climate change mitigation and/or climate change adaptation objective.

As previously explained, for each environmental objective, the Taxonomy Regulation recognises three distinct types of substantial contribution that can be considered taxonomy-aligned:

1. Economic activities that make a substantial contribution based on their own performance;

2. Enabling activities which are economic activities that, by provision of their products or services, enable a substantial contribution to be made in other activities;

3. Transition activities for which there are no low- or zero-carbon technological alternatives, but which support the transition to a climate-neutral economy.

Third phase – DNSH compliance

Once the substantial contribution to one or more environmental objectives is verified, we need to assess whether the "Do No Significant Harm" criteria are met with regard to the other objectives, where relevant. What the Taxonomy asks is only the evaluation of the activity in question (and not of the whole company) respecting the DNSH criteria both as regards its production process, its use phase and its end-of-life treatment.

Fourth phase– Minimum Social Safeguards check

This step concerns the social dimension of the Taxonomy assessment. Indeed, what is required by the Regulation is the respect of specific guidelines as provided by the OECD guidelines, the UN Guiding Principles on Business and Human Rights conventions and the ILO conventions. The Taxonomy requires actors to adopt specific human rights and anti-corruption policies within their organizations in compliance with international standards. Code of ethics, risk management plans, anti-bribery strategies and similar are

[4] It is assumed that non-financial companies that intend to align themselves with the Taxonomy are among those subject to Article 8 of the Regulation.

the typical tools put in place by companies in order to demonstrate their commitment to respect the minimum safeguards.

Fifth phase – Disclosure requirements

The last step is related to the disclosure of the KPI indicators, as required by the Delegated Act. This step will vary according to the type of environmental objective pursued. Indeed, different indicators are considered when it comes to climate change adaptation or climate change mitigation, based on the primary objective of the activity.

However, as a general rule, the main KPIs for non-financial companies include:

- The turnover KPI, that represents the proportion of the net turnover derived from products or services that are taxonomy-aligned. (European Commission 2021)

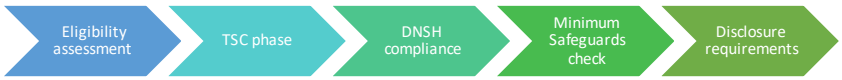
- The CapEx KPI, that represents the proportion of the capital expenditure of an activity that is either already taxonomy-aligned or is part of a credible plan to extend or reach taxonomy alignment. (European Commission 2021)

- The OpEx KPI, that represents the proportion of the operating expenditure associated with taxonomy-aligned activities or to the CapEx plan. (European Commission 2021)[5]

Once this five-step process has been completed, the Taxonomy alignment is concluded and the company is able to show its results and attract new investors. The following tab is a visual representation of the envisaged process, whose aim is to outline a usable methodology for all the actors (of non-financial undertakings) who intend to follow the compliance procedure with what is outlined in the Taxonomy Regulation. This means that the steps outlined in the methodology can also be applied to case studies other than those addressed in the thesis, thus ensuring a high degree of technology transfer. The fact that the methodology is transferable to other realities is an element that allows its improvement and scalability in order to make the compliance process simpler and more effective.

[5] European Commission. (2021). *FAQ: What is the EU Taxonomy Article 8 delegated act and how will it work in practice?"* (para. 6) https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/sustainable-finance-taxonomy-article-8-faq_en.pdf

Tab 2.1.2: The outlined methodology



Source: author's own elaboration.

Results

Once the case study has been explained and the methodology has been set up, we can apply it to the relevant case study. In the following paragraphs, we are going to apply the methodology for the climate change mitigation objective and later for the climate change adaptation goal.

It should be noted that, considering the methodological nature of this thesis, the methodology has been applied and evaluated for points A, B, D, while for points C and E, the research is limited to outlining the steps to be followed, without proceeding with the implementation of what is required.

Climate change mitigation objective

A) Eligibility assessment

According to the outlined methodology, the first thing to verify is if the activity that we have to analyse is covered by the Taxonomy. By using the Taxonomy Compass, it is possible to see that the activity is taxonomy-eligible in the sector of transport, specifically named "Urban and suburban road passengers transport" as it is fit the NACE codes.

Through an analysis of the information provided, we know that the activity under study could be associated with several NACE codes, in particular, H49.31 *(purchase, financing, leasing, rental and operation of urban and suburban transport vehicles for passengers and road passenger transport)*, H49.3.9, N77.39, and N77.11 in accordance with the statistical classification of economic activities established by Regulation (EC) No 1893/2006.

B) TSC phase

The second step refers to the compliance with the specific screening criteria developed by the Taxonomy for the climate mitigation environmental objective.

The substantial contribution criterion is assessed if the activity complies with one of the following criteria:

- the activity provides urban or suburban passenger transport and its direct (tailpipe) CO2 emissions are zero;
- until 31 December 2025, the activity provides interurban passenger road transport using vehicles designated as categories M2 and M3 that have a type of bodywork classified as 'CA' (single-deck vehicle), 'CB' (double-deck vehicle), 'CC' (single-deck articulated vehicle) or 'CD' (double-deck articulated vehicle), and comply with the latest EURO VI standard, i.e. both with the requirements of Regulation (EC) No 595/2009 and, from the time of the entry into force of amendments to that Regulation, in those amending acts, even before they become applicable, and with the latest step of the Euro VI standard set out in Table 1 of Appendix 9 to Annex I to Regulation (EU) No 582/2011 - with respect to emissions from heavy-duty vehicles (Euro VI) - where the provisions governing that step have entered into force but have not yet become applicable for this type of vehicle. Where such standard is not available, the direct CO2 emissions of the vehicles are zero.

Considering the fact that in our case study, the public transport company wants to adopt buses powered by green hydrogen (generated from renewable sources through electrolysis) which therefore have zero CO2 emissions and that the envisaged vehicle falls into the single-bodied M3 [6]category, both the criteria are met.

When it comes to Life-Cycle-Assessment considerations, embedded in the development of the technical screening criteria to the extent feasible, to understand the full environmental impact of the deployment of fuel cell buses, what should be considered are all the phases of their life cycle. Basically, they are: (a) raw material extraction; (b) material production; (c) manufacturing; (d) operation and maintenance; (e) end-of-life; (f) disposal.

Besides this, in order to complete the vehicle's LCA a second cycle has to be considered, namely the fuel life cycle that involves all processes from harnessing a primary energy flow or stock to different forms of conversion, distribution, storage and use in the vehicle.

C) DNSH compliance

At this stage, what must be checked is compliance with the Do No Significant Harm principle. Its application to the Taxonomy is quite relevant, given the fact that it allows taking into account life-cycle considerations. According to the Regulation, the economic activities that substantially contribute to climate change mitigation or adaptation have the duty, at the same time, to do no harm to any other of the four environmental objectives. Let's see now its application to the other environmental objectives.

- Climate change adaptation: As reported by art. 12 of the Taxonomy regulation, an economic activity is considered as significantly harming climate change adaptation "where that activity leads to an

[6] M3: vehicles of category M, having more than eight seats in addition to the driver's seat and with a maximum mass exceeding 5 t. Vehicles of category M3 may have space for standing passengers.

increased adverse impact of the current and expected climate, on itself or for other people, nature and assets". These considerations have been translated into two specific criteria that have to be respected: (i) Reducing material physical climate risks; (ii) Supporting system adaptation. What is required is a robust and climate risk and vulnerability assessment.

- Circular economy: Procedures are in place to manage waste, both during the use (maintenance) phase and at the end of the life cycle of the fleet, including the reuse and recycling of batteries and electronics.
- Pollution prevention: For road vehicles of categories M, tyres comply with external rolling noise requirements in the highest populated class as set out in Regulation (EU) 2020/740 of the European Parliament and of the Council and as can be verified from the European Product Registry for Energy Labelling (EPREL). Where applicable, vehicles comply with the requirements of the most recent applicable stage of the Euro VI heavy-duty emission type-approval set out in accordance with Regulation (EC) No 595/2009.

D) Minimum safeguards check

The final stage, before beginning the disclosure requirements' part, is the one concerned with the compliance with the Minimum Safeguards.

As for the company in our case study, compliance with minimum social protection is at the heart of the company's core business, Ratp Dev. Since 2011, the Company has adopted a Code of Ethics based on four guiding principles: a. respect for people, b. legal compliance, c. customer service, d. consideration of stakeholders[7].

Its goal is to establish a standard of behavior to be followed in everyday environments. In this way, employees should be able to resolve problems or ethical issues that arise during the performance of their official functions, ensuring a working environment in which respect for the ethical dimension is ensured.

In addition to this, the Company is also committed to the prevention of corruption, with its Code of Business Conduct and Prevention Corruption[8], which illustrates the different types of behaviour to be prohibited, that may be deemed to be corrupt, influence peddling or anti-competitive practices.

Finally, the Company also undertakes to publish the Corporate Social Responsibility Report[9], in which all the policies, practices and behaviors adopted by the company in favor of the community in which it operates

[7] Ratp Group. (2019). *The Ratp Group Code of Ethics*. https://www.ratp.fr/sites/default/files/inline-files/CODE%20ETHIQUE_UK.pdf
[8] Ratp Group. (2021). *Code of Business Conduct and Prevention of Corruption*. https://www.ratp.fr/sites/default/files/inline-files/CODE%20DE%20CONDUITE_UK.pdf
[9] Ratp Dev. (2022). *CSR Report, Statement of extra-financial performance as of December 31,2021* https://www.ratpdev.com/sites/default/files/annexes/communiques/Statement%20of%20extra-financial%20performance%202021_RATP%20Dev.pdf

are declared. Its ultimate goal is to demonstrate how the company harmonises economic objectives with social and environmental ones, with a view to sustainability.

As a matter of fact, the Company's strategy is fully aligned with the relevant international conventions on respect for human rights.

E) Disclosure requirements: calculate the alignment of the investment with the Taxonomy

Finally, once all these steps are completed, the calculation of the investment alignment should be developed.

Company disclosure

In order to comply with the disclosure obligations under the Taxonomy, our company has to:

A. Disclose the proportion of the turnover aligned with the Taxonomy – for the climate mitigation objective
B. Disclose the capex and if relevant the opex – both for the climate mitigation and climate adaptation objectives.

The CapEX

As regards the CapEX, the reference formula as reported by the ANNEX 1 to the Delegated Act states as follow:

- $Taxonomy\ aligned\ CapEX\ \div$
  $Additions\ to\ assets\ during\ the\ FY\ before\ deprecition, amortisation\ and\ remasurements$

The OpEX

The operational expenditure related to the delivery and continuation of the activity encompasses very different factors. To assess its value, we have to run the following calculations:

- $Taxonomy\ aglined\ Opex\ \div Dircet\ non\ capitalised\ costs$*

*Meaning: RnD, renovations, short-erm leases, maintenance and repair

The turnover

To calculate the KPI related to the turnover, we have to consider two elements, as follow:

- $Turnover = Net\ Turnover\ aligned \div Net\ Turnover$

It should be noted that for all three formulas, what is calculated is essentially the division between Capex, Opex and Turnover aligned with the requirements of the Taxonomy, and their relative total. Therefore, the

calculation refers to the division between aligned Capex-Opex-Turnover (we can define them as a subset of the denominator items that respect certain characteristics) and their gross total.

Then, the very same process is applied to climate change adaptation objective.

Financing opportunities

Once the alignment has been demonstrated, it is useful to analyse funding opportunities under the current framework. On one hand, we have the Green Bonds (financial instruments that finance green projects and provide investors with regular or fixed income payments) and the EC proposal to provide a uniform Green Bond Standard within the EU with the aim of providing investors and market actors with a sort of "gold standard" for how companies and public authorities can use green bonds to raise funds on capital markets to finance investments while meeting sustainability requirements and protecting investors from greenwashing.

According to the proposal, the European Green Bond Standard will be strictly connected to the Taxonomy, given the fact that "the funds raised by the bond should be allocated fully to projects aligned with the EU Taxonomy".[10]

If at the European level Green Bonds represent a valid financing instrument for our project, at the national level this role is represented by the Recovery and Resilience Plan.

With a budget of 248 billion euros, the Plan is divided into objectives and missions. The formers are divided into 3 points: Digitalization and Innovation, Ecological Transition and Social Inclusion. As part of the second objective, we find Mission number 2 "Green Revolution and Ecological Transition" with a budget of 68.6 billion euros. For the purposes of our research, it is within this mission that funds are earmarked for public hydrogen mobility. More specifically, there are 5 investment plans, active from 2022.

Beside this instrument, the Italian government has implemented the so-called "Complementary Fund to NRRP" with the objective of providing an additional booster for the achievement of specific objectives, among which there is also the renewal of buses fleet powered by renewable energies (1 of the 5 investment plans) with a contribution of 600 million of euros to those already provided by the NRRP (3.63 billion of euros).

To access these funds, the legislator has envisaged a sort of indirect link to the Taxonomy, as the actors who want to take advantage of these opportunities must, among others, demonstrate compliance with the DNSH principle, as outlined in the Taxonomy.

[10] EU Technical Expert Group on Sustainable Finance. (2019). *Report on EU Green Bond Standard*. https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/190618-sustainable-finance-teg-report-green-bond-standard_en.pdf

Discussion

The concept of the Taxonomy is recognized as an important enabler for companies and investors moving toward sustainable activities. However, demonstrating and implementing the guidelines of the Regulation leads to new requirements for the actors involved. This paper contributes to filling this gap by developing a methodology, scalable and transferable. It offers a standardised procedure describing the steps to be considered for the alignment with the Taxonomy for non-financial undertakings.

The pilot case study on the Ratp Dev company showed that, for companies wishing to align their investments with the Taxonomy, the tool can respond to the need for a clear procedure to follow.

The objectives pursued have both been achieved. As regards the objective of contributing to bridging the gap in terms of Taxonomy applicability, a methodology was developed and the results of its application were analyzed. On the other hand, from the point of view of the specific case study, by applying the methodology outlined, it was possible to demonstrate the alignment of the investment for hydrogen buses with Taxonomy.

The consequences of this alignment are analyzed in the context of funding opportunities, in which two cases have been highlighted: that of Green Bonds, an instrument directly linked to alignment with Taxonomy and that envisaged by the NRRP in the field of hydrogen buses, whose access, although not strictly linked to alignment with the Taxonomy, is subject to compliance with the DNSH principle[11], which in our case is verified as it has already been analyzed in the alignment phase with the Regulation.

Considering the high complexity of the process necessary to assess compliance with the DNSH principle, the fact that compliance with it has already been verified in our investment plan represents a facilitator for all actors who, like in the proposed case study, intend to access tenders in the scope of the NRRP.

However, despite the rigor with which the methodology was developed, there are still limitations. Indeed, firstly, the fact that the Regulation is enforceable only from this year, entails that there is limited proof of its effectiveness in terms of pursued goals. And this, clearly, has an impact also on the soundness of the proposed methodology.

Another element that could reduce the robustness of the methodology is linked to the intrinsic characteristics of Taxonomy, explicitly defined by the TEG as a living document, capable of reflecting the economic changes of the real world. While this choice serves to ensure its efficiency, on the other hand it increases its mutability. Possible changes could be made to the requirements now envisaged.

With regard to this last point, actually, the proposed methodology stands as a flexible tool, able to accept and adapt to possible changes (we talked about it in reference to technology transfer).

[11] Italiadomani. (2022*). Il principio DNSH (Do No Significant Harm) nel PNRR.* https://italiadomani.gov.it/it/Interventi/dnsh.html

The last element to take into consideration concerns the novelty of the methodology. It should be recognized, in fact, that although specific interviews have been carried out to validate its effectiveness and different qualitative methods have been implemented as previously explained, in order to improve its quality, it will be necessary to test it and apply it in other areas and also to reach as many feedbacks possible. These are the next steps foreseen.

CHAPTER III – Looking forward wit the Social Taxonomy

To conclude the dissertation, there is the final chapter concerning the Social Taxonomy. The choice to also include Social Taxonomy as an object of analysis is due to the desire to present a picture as complete as possible, considering that the aforementioned regulation has not yet entered into force.

It was considered relevant to analyze the Social Taxonomy, as it is expected that its adoption will also have an impact on what has been said so far in terms of Environmental Taxonomy. In this context, then, we wanted to assess the opportunities under the Social Taxonomy for our case study.

Demonstrating the alignment of our activity with the Social Taxonomy is expected to produce results not only from a social perspective, but also considering the economic benefits.

Indeed, the fact that the activity under study would -according to the published draft- respect the requirements under the Social Regulation would mean that our investment would constitute a social investment, contributing substantially to achieve social goals.

It would be clear to private investors and public institutions that the company's activity boosts the respect for human rights and better working conditions, enabling them to make more conscious decisions.

All these factors should generate a positive impact on the company's reputation. In addition to opening the spectrum of financing opportunities, thanks to the easy access to social bonds and the attention of all those investors who see the social side as a fundamental aspect in the management of their activities, the alignment could improve perceptions by the community in which the company operates, in the sense that its presence in the area would be seen as an added value, not only for the conditions in which its employees work but also for the respect that the company shows towards all stakeholders.

Growth opportunities would unlock, giving the possibility of expanding activities aligned with Social Taxonomy and contributing to the achievement of European objectives, taking into account the concept of 'Just Transition'[12] , for a more inclusive Europe.

CONCLUSIONS

[12] e.g. where employees and communities who are disproportionately impacted by the transition away from a fossil-fuel-based economy are not unfairly disadvantaged or "left behind."

In this thesis, we address the research question: *how Taxonomy can impact the adoption of sustainable activities, starting by applying it to the case of hydrogen vehicles for the public mobility sector?*

The objectives pursued have moved in one direction but at two different levels of granularity. With regard to the first objective, the more contextual one, we wanted to demonstrate how to proceed with the alignment to the Taxonomy of the case study's activity, that is the renewal of the bus fleet for extra-urban transport with hydrogen buses. This was possible thanks to the developed methodology. In a subsequent phase, we moved on to the analysis of the results of the alignment with the Taxonomy, with particular regard to financing opportunities.

Through this procedure it has been shown that: (a)it is possible to test the alignment by applying the proposed methodology and that (b)this alignment has an impact on the financing possibilities of our business.

In fact, as emerged from the analysis, the activities aligned with the Taxonomy enjoy advantages in terms of access to Green Bond funds and at the same time benefit from this alignment in terms of procedures to be performed to access funding under the NRRP.

The point (a) is then very well linked to the second objective of the thesis, the more general one: to contribute to bridging the gap in terms of Taxonomy applicability, thanks to the development of the methodology and the analysis of the results of our case study.

Secondly, in this context of analysis we wanted to deepen the research topic also taking into consideration the provisions on the Social Taxonomy, as a (future) relevant part for what concerns the objectives and obligations of the actors concerned.

In fact, in the third chapter, the analysis focuses on what has been proposed so far in terms of social objectives and their potential impacts, with a particular focus on our research field. In this way, we wanted to research the potential alignment of the activity under study and the possible consequences, in terms of opportunities. In this regard, it has been shown that the analyzed activity can contribute to the objectives of Social Taxonomy, thus increasing funding opportunities on the one hand, and its reputation on the other.

The fact that the aspect of Social Taxonomy has been taken into consideration, even if its regulation has not yet entered into force, is the result of the desire to create a framework as complete as possible, being aware that this part of the legislation could have a significant impact on our business, and beyond.

The following research project thus broadens the literature review on Taxonomy, Social Taxonomy and related growth opportunities for hydrogen mobility in public transport, with the aim of highlighting how the impacts of such Regulations can be generated and exploited, in order to contribute to the European goal of being the first climate-neutral and socially responsible continent.