STUDY ON ENVIRONMENTAL IMPACT OF CONNECTIONS BETWEEN PUGLIA AND MOLISE

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1. INTRODUCTION

The present study is part of the SOLAR ("Sustainable reduction Of carbon footprint Level in program AiRports") project of the Interreg IPA CBC Italy-Albania-Montenegro 2014-2020 Programme.

This activity aims to evaluate environmental impacts of the activity realized in another project the ON CLOUD NINE, funded within INTERREG IPA CBC Italy-Albania-Montenegro 2014-2020, referring to the integration of Bari Airport with Molise. ON CLOUD NINE aimed to improve the integration of Bari airport with Molise Region, with the implementation of public transport direct connections. Starting from this experience, the study has to analyze the connections between Puglia and Molise from an environmental point of view in terms of reduction of polluting emissions. Specifically, the evaluation is based on the services implemented within ON CLOUD NINE project but also studying how optimizing the connections between Molise and the Puglia airports (Bari in particular) considering also the need to reduce polluting emissions.

The environmental impacts as reduction of polluting emissions, taking into account the specific topic of the SOLAR project, is evaluated by measuring the CO2 emissions as carbon footprint. It consists of a measure that expresses in CO2 equivalent the total greenhouse gas (GHG) emissions directly or indirectly associated with a product or a service. This method therefore permits to assess the environmental impact in terms of global warming.

CO2 emissions in many countries are due to the energy and transport sectors. About this, about 25% comes from the transport sector in which civil aviation is an important part. Therefore, many airports are taking actions to mitigate CO2 emissions and adapt to the changing climate by enhancing the resilience of their infrastructure and operations. It is important to observe, as clearly shown by the analysis carried out in the WP T1.1 of the SOLAR project (Carbon footprint report) in Albania and Montenegro, that carbon emissions from aviation movements and land side access phases of workers and passengers (the main part of Scope 3 sources) represents the large majority of emissions. In the case of Tirana International Airport and the Podgorica airport, Scope 3 CO2 emissions are more than 90% of the total emissions. Similar contributions are recorded in many other airports all over the world. Airport management can only partially influence these activities producing Scope 3 emissions but actions for ensuring better connections to reach airports can improve in a relevant way the sustainable environment of airports.







2. INTRODUCTION ABOUT MOLISE REGION

The Molise Region is one of the smallest region of Italy with a population of about 290,000 inhabitants in an area of 4,433 kmq. The Molise Region is composed for 55% of its area by mountain and for 44% by hill; specifically, the region covers the areas between the Appennini mountain range and the Adriatic sea, bordering with Abruzzo and the Adriatic Sea to the north, Latium to the west, Campania to the south and Apulia to the east. The population shows a decrease in the last 20 years of about 30,000 people and the old-age index is about 239 elderly people for every 100 young people with people older than 65 years that represents the 26% of the population. The main towns are Campobasso with a population equal to about 48.000 inhabitants, Isernia with 21.000 inhabitants and Termoli with about 32.000 inhabitants. A specific characteristic of the region is also related to the location of the main part of the urban settlements: 123 of its 136 municipalities are located in mountainous areas and only 1 is situated on the coastline.

By the economic point of view, the Molise region is less developed than other Italian regions for many reasons as the morphology of the territory and the infrastructural deficiencies. The primary sector is still one of the main sectors of activity in Molise. The sector had shown an expansion, favored by the development of the cereal supply chain and the capacity of exports of local businesses in foreign markets. These trends are accompanied by a modest increase in the average size of processing enterprises, which however remained lower than the national ones. The secondary sector is mainly based on small and medium enterprises, operating especially in the food, clothing, engineering and construction sectors. The industrial development is concentrated in the Termoli area with the presence of an important plant of the Stellantis group for the engine production. Other industrial areas are in the surrounding of Campobasso and in the area between Isernia and Venafro. The tertiary sector is the main developed sector in the Molise region and one of the most important activity is the tourism. In the last years, this activity show a positive trend, especially due to the coastal tourism during the summer that represents the largest part of this market. The Istat statistics reports a total number of about 448.000 overnight stays of which 76% made by no local tourists (from other Italian regions and from other countries).

This short description about Molise region socio-economic characteristics permits to identify specific issues related to the connection from Molise to airports. First, there is a clear requirement of implementing this kind of services for the population needs, for the business trips and for supporting the tourism development. Second, these services have to be created and developed in a particular context with a distributed and quite low level of demand of transport.

With regard to the transport infrastructures, the Molise region is characterized by the presence of an extensive road network (about 3,300 km) and by a limited development of the railway network. In the region there is not an airport open to public aviation services. The road supply has a composition similar to the national typological articulation, but the freeways have a lower incidence (in the case of Molise only about 1%). The main road







infrastructures are reduced to few connections along the East-West direction crossing the region and along the North-South direction on the coastline strip, representing the main access corridors for interregional traffic. Specifically, the skeleton of the road network is composed from the corridor from San Vittore, on A1 freeway between Rome and Naples, to Termoli on the Adriatic sea reaching the A14 freeway. This corridor crosses all the regional territory passing for Isernia and Campobasso. The project of upgrading this corridor as a freeway, managed by the public company Autostrade del Molise spa, is still at the level of preliminary design. The remaining road network has the function of connecting the built up areas each other, mainly crossing mountain areas with the relative problematic development in terms of horizontal and vertical alignment.

With regard to the railway network, this consists of lines managed exclusively by the Ferrovie Dello Stato group (RFI for the infrastructures management and Trenitalia as operator), for a total development of about 265 km, of which only 60 km on electrified line and 23 km with a double track line. The electrification is almost exclusively on the Adriatic coastline (Pescara - Termoli - Foggia lines), which deals with national and interregional traffic. Two lines compose the backbone of the internal Molise railway network: 1) Campobasso - Termoli; 2) Campobasso – Isernia – Venafro. Venafro represents the western connection point with the national network with two different stretches: one to Naples and another one to Cassino-Frosinone-Rome line. Moreover there are 2 secondary deviations: one is directed to south to Benevento, while the other is directed to north to Sulmona. The PNRR-PNC funding is also related to the improvement of the railway network in Molise. Specifically, the line Roccaravindola-Isernia-Campobasso will be electrified and sped up. In the first part of the line, the works are in progress while for the second part the project is still at the level of preliminary design.

The main important services are related to the connections, passing from Isernia, between Campobasso and Rome (Venafro-Cassino way) and Campobasso and Naples (Vairano-Venafro way). The performance of these services appears to be rather inefficient for the scheduling (few runs during the day) and for the long travel time due to the characteristics of the lines.

The supply of public transport services is also composed by bus services connecting all the municipalities with the main towns in the region. The bus network produce a total amount of annual services of about 16.5 million km, operating by private and public companies with about 400 buses. There are also some services connecting Campobasso and Isernia with other Italian cities like Naples, Rome, Pescara and Bari.







3. CONNECTIONS AMONG MOLISE REGION AND AIRPORTS

As previously shown, there is the need of connections among the Molise region and the airports located close to the region under investigation. The present section describes the current condition about connections between Molise region and the five nearest cities with an airport infrastructure: Rome, Naples, Pescara, Foggia and Bari. For ease of reading, the analysis is carried out using Campobasso as the city representing the Molise region.

The airport of Rome Fiumicino is an intercontinental airport with services for all continents and a very large number of possible destinations for Italy and Europe, including also low cost airlines. The railway directly reaches the airport. The Airport of Naples Capodichino is largely growing in the last years because it becomes an operational base for some low-cost airlines. The traffic of the airport is mainly associated to national trips. The airport of Pescara is a secondary airport with about 15 possible destinations in Italy and in Europe. The services are involving low-cost airlines and Lufthansa connections with hubs in Germany. The railway directly reaches the airport but the runs per day are very limited. The airport in Foggia starts public aviation services in November 2022 and today it works with direct flights for 4 Italian cities (Milan, Turin, Catania and Verona). Finally, the Bari airport is a strategic airport in the Italian airport system with more than 5 millions of passengers every year and a large supply of flights with destination in Italy and many other countries in Europe. The low-cost airlines represents about 75% of the traffic. The airport is used mainly for national trip but it is constantly increasing also the international traffic. The railway directly reaches the airport.

According to this short review about the characteristics of the airports located close to the Molise region, it could be possible to underline that Bari airport and in perspective, the Foggia airport represent important nodes of the transport network for travelling in Molise. Fiumicino airport is obviously the only hub clos to Molise region and one of the more frequent node of passing for intercontinental connection. Naples and Bari airport, instead, represents the closest point for accessing a large set of flights with national and international destinations among European countries. Pescara is the less interesting airport for the small number of flights at disposal and, by this point of view, it has not to be considered in competition with Bari or Foggia. This last new airport could increase the importance for the Molise region but it is still a small regional airport.

The next table shows the existing land connections among Campobasso and the five selected airports. The table reports the following data collected for transport alternatives existing in the months of January and February of year 2023:

- the distance (in km) from Campobasso and every airport computed on the road network taking into consideration the quickest option;
- the travel times by car from Campobasso and every airport computed on the road network taking into consideration the quickest option and regular traffic condition;







- the travel times by train from Campobasso and every airport computed taking into consideration the quickest option using regional and intercity services (no high speed train). The information refers to the airport station if existing otherwise it is referred to the main station of the city with airport;
- the travel times by bus from Campobasso and every airport computed taking into consideration the quickest option using intercity or regional services. The information refers to the arrival at the airport if possible otherwise it is referred to the arrival at the city with airport.

AIRPORT	DISTANCE (KM)	ACCESS MAIN CHARACTERISTICS	TRAVEL TIME BY CAR	TRAVEL TIME BY TRAIN	TRAVEL TIME BY BUS
Rome - Fiumicino	245	Train station at the airport No direct buses from Molise	2 h and 45 min	4 h 2 transfers 8 runs per day	3 h and 30 min 1 transfer
Naples - Capodichino	150	No direct buses from Molise	2 h	3h and 20 min 1 transfers 5 runs per day	2 h and 45 min 6 runs per day
Pescara - D'Abruzzo	165	Train station at the airport No direct buses from Molise	2 h	4 h and 30 min 2 transfers 3 runs per day	2 h and 45 min 1 run per day for 4 days a week
Foggia – Gino Lisa	95	No direct buses from Molise	1 h and 15 min	3 h and 30 min 1 transfers 5 runs per day	1 h and 40 min 2 run per day (regional services) 1 h and 20 min (Flixbus) 1 run per day 5 runs per week
Bari — Karol Wojtyla	215	Train station at the airport No direct buses from Molise	2 h and 30 min	About 5 h 2 transfers 5 runs per day (need of using High Speed services from Termoli or Benevento to Bari)	3 h 1 run per day for 5 days a week







The results of the data collection permits to identify clearly that the travel by car is always the best solution by the point of view of travel times without any issue related to the schedule as happens for public transport services. By the environmental point of view is, of course, the worst solution but the alternatives today are really not effective by many points of view. The comparison of the data for the two solutions analyzed for the public transport permits to observe that existing connections are, in both cases, unsatisfying for the large travel times, for the need for at least one transfer and for the limited number of services per day at disposal. The connections by bus provide, for all the airports a better solution, with the exception of Fiumicino airport with a travel times larger than by car but quite competitive taking into account the different costs of the travel options. The main issue is related to the schedule of the service and the lack of direct connections with the airports. The railway options is constrained by the low quality of the services especially in Molise region with low operating speed and very few runs per day.

4. CARBON FOOTPRINT CALCULATION METHODOLOGY

In this section is described the methodology used for the computation of the carbon footprint. The methodology used is that one used in the Airport Carbon Accreditation scheme (hereinafter ACA). ACA is a program developed in Europe by the Airports Council International (ACI) Europe in 2009 for encouraging and facilitating the adoption of good CO2 emissions management practices by airports. Today ACA reached a diffusion all over the world also because ACA accreditation provides an opportunity for airports to gain public recognition for their achievements, promotes energy efficiency improvements, encourages knowledge transfer, raises the profile and credibility of an airport, encourages standardization and increases awareness of all stakeholders towards these issues.

ACA focuses on CO2 emissions because they represent the vast majority of airport GHG emissions. The details of the methodology are reported in the ACA Scheme Documentation and Guidance (Issue November 2020) and in the Report Project 492-2022-2 - Methodology for Carbon Footprint Calculation for Airports (Rev 1 November 2022). The computation is carried out by using the worksheets provided by the Green House Gas (GHG) protocol at http://www.ghgprotocol.org/calculation-tools/ including the emission factors as well as the calculation tool with Emission Factors from ACERT_tool V6 (year 2021).

About the carbon footprint of an airport, three different categories of emissions can be computed:

• "Scope 1" emissions: these are defined as direct emissions of "GHG" deriving from sources owned or controlled directly by the airport management company. These emissions derive from activities over which the company can have a direct influence through its actions. In particular, the emissions of airports included in this category concern: the use of natural gas, the use of fuel for vehicles owned by the company, the use









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of fuel for business trips, the use of refrigerant gas, use of wooden pallets and "diesel" type fuel for fire training, propane and kerosene burning;

- "Scope 2" emissions: these are associated with the use of electricity imported from the grid or from a thirdparty energy supplier in the form of heat or electricity. These indirect "GHG" emissions are due to emissions upstream of the production and delivery of fuel to power plants. The airport can influence the amount of electricity it uses for its operations;
- "Scope 3" emissions: these represent the emissions deriving from many activities related with the airport but for which the airport management company is without their control The airport has only some influence on "Scope 3" emissions. Sources included in this category include aircraft movement, i.e. all aircraft movements up to a height of 1,000 meters above airport level, employees moving through the airport, passenger surface access phase in airport, third party "Air-side" vehicle activity, waste disposal, water usage (supply and treatment), airport business trips and engine testing.

The category of Scope 3 includes the emissions due to the passengers phase of access to the airport. The computation in this case is carried out with the following formula:

CO2 emissions [kg CO2] = Total distance travelled by vehicle type [vehicle-km or passenger-km] * vehicle specific emission factor [kg CO2 /vehicle-km or kg CO2 /passenger-km]

The total distance travelled by vehicle type is computed for the following categories: a) buses; b) train; c) passenger cars, using in this case data representative of the fuel mix used by cars in the study area.

Specifically, taking into account the objective of evaluating the environmental impact of the connections between Molise and airports, the data are used only for computing the total mass of emissions with a perimeter related only to the access phase referring only to a one-way trip. The final choice is about the accuracy, without specific additional data, to use the simplest approach aggregating the total emissions from the total number of vehicle-kilometres travelled on the total length of all roads within a defined study area using a national fleet vehicle mix, base year and average annual mileage by vehicle type.

5. ON CLOUD NINE PROJECT ENVIRONMENTAL ANALYSIS

The ON CLOUD NINE ("cONnecting CLOse and Unexplored Destinations with New INter-Adriatic transport sErvices") is another project of the Interreg IPA CBC Italy-Albania-Montenegro 2014-2020 Programme. As planned by WP T.2. "Interregional and multimodal connections" project activity, the Molise Region first carried out a feasibility study on the existing connections between the Bari airport and the city of Campobasso, and then implemented the actual pilot action, i.e. implementing a multimodal road connection from the regional capital to the Bari airport, complementary to the air connection with Albania. In addition, to support the pilot action and to







provide the highest visibility of the new multimodal connection, the partner Regione Molise, in accordance with the project activity WP T.3.2 "Marketing and promotional actions" operated promotional activities of the pilot action through billboards, advertisements in online newspapers, posters and press releases.

The preliminary study pointed out that the inland areas suffer from an obsolete and tortuous infrastructure network, both the railway and the road one, especially due to the territory's morphology and the small level of population. Taking into account that on the Adriatic side there is already a connection between Molise and Puglia, well established for several infrastructures (A14 and the Adriatic railway) of National and EU relevance. Therefore, the preliminary study considered that any connecting section between Molise and Puglia on the Adriatic ridge could only duplicate existing ones. For this reason, the study worked for creating a service between Campobasso and the Apulian airports using the Campobasso - Foggia – Bari roadway connection. Pilot action was carried out by the Molise Tour company, from August 9 to September 9 of year 2022. The services was structured with two weekly runs on Tuesdays and Fridays, scheduled for ensuring a temporal coordination with the Bari - Tirana A/R flights.

As follows there is the detail of the timetable of the service carried out, taken from the poster placed at the stop:

Campobasso - Foggia - Bari

AIRPORT	Tuesday	Friday
CAMPOBASSO - Terminal Bus	7:00	13:45
FOGGIA - Stazione FS	8:30	15:15
BARI - Aeroporto	10:00	16:45
BARI - Aeroporto	12:30	17:30
FOGGIA - Stazione FS	14:00	19:00
CAMPOBASSO - Terminal Bus	15:30	20:30







The pilot action permits to propose a total number of runs equal to 20 in 10 days. The ridership during the short experience is only 6 passengers out of 20 runs carried out. Only 1 passengers used the Bari-Campobasso services while the other 5 passengers travelled on the section Foggia-Bari. These data are shown as follows:

N°	Data	Route	Final destination	Reason for travel	Gender	Age
1	09/08/2022	Foggia - Bari	Bari	Work	М	30
2	12/08/2022	Foggia – Bari	Milano	Holiday	М	54
3	12/08/2022	Foggia – Bari	Milano	Holiday	М	60
4	02/09/2022	Bari - Campobasso	Campobasso	Work	М	32
5	06/09/2022	Bari - Foggia	Foggia	Work	М	44
6	06/09/2022	Bari - Foggia	Foggia	Work	М	48

The report describing the pilot action in the ON CLOUD NINE proposes an analysis about the reasons of the low number of passengers recorded. Such phenomenon can be attributed to several factors including longer travel times due to road works on the Campobasso-Foggia section, the shorter time needed to reach the airports of Naples and Pescara, people's habit of using private cars and late promotional actions carried out in July and August, too late because after the usual travel and vacation booking period. Moreover, the pilot action, on the other hand, permitted to discover the need of connections between Foggia and Bari airport in which there are 5 of the 6 passengers travelling. This is an important observation considering that this travel is already covered by additional and frequent connections by railway and buses services. In this case, there is also a direct connection between the city of Foggia and the Bari airport (the "Pugliairbus" service).

The latter datum, however, is useful for the Apulia region as an element of evaluation in the grouping of the distribution of Local Public Transport (LPT) services. After the execution of the pilot action, it is possible to draw the conclusion that a direct multimodal connection from Campobasso to Bari, in view of the travel times and the presence of multiple daily connections of the Foggia-Bari route guaranteed by the Apulian LPT service, isn't an effective and efficient strategic choice.

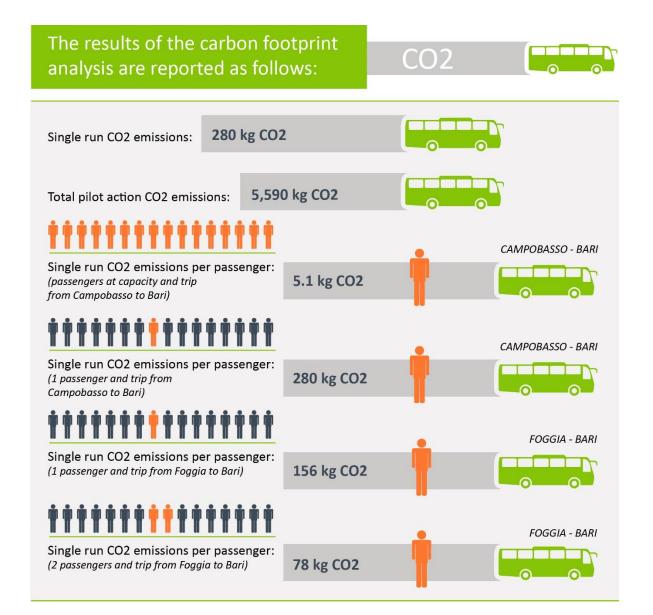
Starting from this data, it was possible to identify the carbon footprint of the pilot action of the ON CLOUD NINE project. For the environmental analysis, as previously written, it is considered only the CO2 emissions. The computation is carried out by using the following data:

- 20 runs of the service between Campobasso and Bari airport for a length of a single run of about 215 km;
- service operated with a touristic bus with a capacity of about 55 passengers;

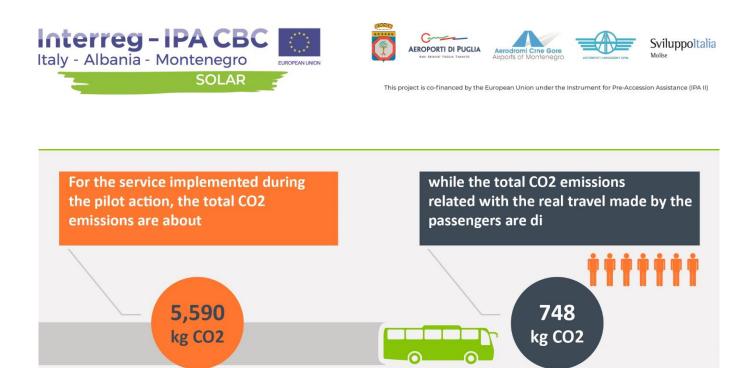




- service operated with a first section of about 95 km from Campobasso to Foggia and a second section from Foggia to the final destination of the Bari airport of about 120 km;
- the total number of passengers is equal to 6 where 5 are related to the second section and only 1 to the first and second section from Bari airport to Campobasso;
- passengers, according to data at disposal, moved with a travel companion (2 persons together) for two times (4 passengers) and alone in other two times (2 passengers).







The analysis of the ON CLOUD NINE project data and the environmental analysis of the pilot action carried out in year 2022 permits to make some interesting considerations.

First, it is possible to underline that the coordination of the service schedule with the flights for Tirana represents an interesting proposals for passengers with Albania as destination but this is a relevant limit of the proposal. In fact, the main issue is the low number of flights option at disposal with this bus services schedule without taking into account the specific destination.

Second, by the environmental point of view, the few passengers transported represent an important barrier for the sustainability of this kind of services not only by the financial point of view but also for the CO2 emissions. Public transport services are convenient solution by the environmental point of view, also without using electric or other low emission vehicles, if the load factor is at least equal to half of the capacity.







6. MOLISE PUGLIA CONNECTIONS ENVIRONMENTAL ANALYSIS

In this section, starting from the analysis previously reported, the environmental analysis is completed by introducing an additional computation of CO2 emissions taking into account also the transport alternatives to bus connections. In this way, it is possible to identify in a clear way the set of possible solution for the access phase by the carbon footprint point of view.

For the environmental analysis, as previously written, it is considered only the CO2 emissions. The computation is carried out by using the data collected in the other sections of this document. The main data used is listed as follows:

- connection between Campobasso and Bari airport with a length of about 215 km for car and buses and about 270 km for the train option;
- bus service operated with a touristic bus with a capacity of about 55 passengers;
- train service operated with a regional/intercity train;
- emission factor for passenger car is an average value representative of the fuel mix used by cars in Italy.

The computation is carried out first by analyzing the three alternative without considering the number of passengers and then by analyzing the impact of the number of passengers travelling on the specific public transport services or in the cars. For this case, the computation is made for 1 single person or two persons travelling together.

The results of this carbon footprint analysis are reported as follows:

First analysis:

CO2 emissions for a single travel by car:	34,4 kg CO2	
CO2 emissions for a single travel by train:	7.9 kg CO2	
CO2 emissions for a single travel by bus:	280 kg CO2	









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Second analysis involving passengers

CO2 emissions for passenger by car	34.4 kg CO2	1	
(1 person travelling):		•••	
CO2 emissions for passenger by car	17.2 kg CO2		
(2 person travelling):			
CO2 emissions for passenger by train:	7.9 kg CO2	•	
		•	
CO2 emissions for passenger by bus	55.9 kg CO2	5	
(5 persons travelling):		•	
CO2 emissions for passenger by bus	27.9 kg CO2	10	
(10 persons travelling):			
CO2 emissions for passenger by bus	14.0 kg CO2	20	
(20 persons travelling):			
CO2 emissions for passenger by bus	9.3 kg CO2	30	
(30 persons travelling):			
CO2 emissions for passenger by bus	5,6 kg CO2	50	
(50 persons travelling):			







The calculation of the impact of passengers on train services is not possible for the lack of data at disposal. As clearly shown by the results, the car is the less sustainable solutions while the bus, for this specific travel, represent an optimal solution with increasing environmental efficiency with the growth of the number of passengers transported. The railway solution is not so effective for the lack of direct lines and services, requiring longer distance of travel. Of course, this is a normal condition for the transport system when it is considered an area of few and dispersed population as the Molise region.

7. CONCLUSIONS

The environmental analysis of land connections between Molise region and the Apulian airports permits to underline some important aspects related to the airport decarbonization process. Frist of all, the Scope 3 emissions are very large respect to the other two categories (Scope 1 and Scope 2) and the airport management company has to work, in coordination with local and national administration, to increase the sustainability of these activities. These efforts could also increase the attractiveness of airports and related surrounding areas for potential passengers. In this case, the quantity and the quality of public transport options at disposal represent an important element in planning travels for not opnly for business but also for holiday reasons.

Second, the connections proposed for the Bari airport has to be considered useful for the Molise region but it has to be designed by a) identifying potential demand with overlapping destination (for instance, Foggia airport or the port of Bari for cruise and other passengers services, etc.) for creating the condition of increase the number of passenger transported; b) proposing an attractive schedule in coordination with the flights in arrival and departure from the airport. These requirements permit to create sustainable transport solution for the access phase also by the environmental point of view.

Finally, it is important to say that the results of this study can be used for disseminating knowledge on possible actions to reduce the environmental impact of access activities and stimulating open and multi-focused dialogue among stakeholders of airport systems about these issues.







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