GEF City Cluster Eco-transport Project


Final Report

General Report

Energy and Environment Development Research Center

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# CONTENT

1 PROJECT INTRODUCTION .............................................................................1
   1.1 BACKGROUND ..................................................................................1
   1.2 OBJECTIVE ....................................................................................3
   1.3 TASKS ..............................................................................................4
   1.4 TECHNICAL APPROACH ...................................................................5

2 PROJECT PROGRESS ..................................................................................1
   2.1 PROJECT INCEPTION PHASE ............................................................1
   2.2 PROJECT MID-TERM PHASE ..............................................................4
   2.3 PROJECT FINAL PHASE ....................................................................5

3 INTRODUCTION FOR INTEGRATED TRANSPORT HUB PILOTS ..........7
   3.1 LIITUO INTEGRATED TRANSPORT HUB ..........................................7
      3.1.1 Engineering Briefing .................................................................7
      3.1.2 Layout Briefing .........................................................................10
   3.2 XIANGJIANG INTEGRATED TRANSPORT HUB ................................10
      3.2.1 Engineering Briefing .................................................................11
      3.2.2 Layout Briefing .........................................................................13

4 EE&ER EVALUATION METHODOLOGY FOR HUBS .........................17
   4.1 PRINCIPLE AND APPROACH ........................................................17
   4.2 EMISSION REDUCTION MODE .......................................................17
   4.3 EMISSION REDUCTION CALCULATION ........................................18
   4.4 EVALUATION STEPS ....................................................................20
   4.5 SURVEY PROPOSAL ......................................................................20
      4.5.1 Principle ..................................................................................20
      4.5.2 Data Selection ..........................................................................21
      4.5.3 Required Data Table .................................................................21
      4.5.4 Survey Method ........................................................................22
      4.5.5 Survey Schedule ......................................................................23
      4.5.6 Training Arrangement ..............................................................23
      4.5.7 Questionnaire Design ..............................................................23
      4.5.8 Sample Volume ........................................................................27

5 ANNUAL EE&ER EVALUATION REPORT FOR HUBS ......................28
   5.1 REPORT DEVELOPMENT AND DRAFTING ....................................28
   5.2 EE&ER EVALUATION FOR LIITUO HUBS ....................................28
   5.3 EE&ER EVALUATION FOR XIANGJIANG HUBS ............................32
   5.4 ANALYSIS AND IMPACT OF EE&ER FOR HUBS .......................34
      5.4.1 Impact on Passenger Volume ....................................................34
      5.4.2 Impact on Transport Share .......................................................35
      5.4.3 EE&ER Evaluation Report for Hubs ..........................................35

6 RECOMMENDATIONS ON EE&ER FOR HUB ......................................37
   6.1 APPLY BUILDING ENERGY-SAVING TECHNOLOGIES ..................37
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.2</td>
<td>OPTIMIZE OPERATION STRUCTURE</td>
<td>37</td>
</tr>
<tr>
<td>6.3</td>
<td>PROMOTE TOD MODE</td>
<td>37</td>
</tr>
<tr>
<td>6.4</td>
<td>IMPROVE INFRASTRUCTURE CONSTRUCTION</td>
<td>38</td>
</tr>
<tr>
<td>6.5</td>
<td>ENHANCE TRANSFER SMOOTH LEVEL WITHIN HUB</td>
<td>39</td>
</tr>
<tr>
<td>6.6</td>
<td>STRENGTHEN OPERATIONAL MANAGEMENT LEVEL</td>
<td>39</td>
</tr>
<tr>
<td>6.7</td>
<td>INCREASE PASSENGER TRANSFER EFFICIENCY</td>
<td>39</td>
</tr>
<tr>
<td>7</td>
<td>INSPIRATION AND VISION FOR EE&amp;ER EVALUATION</td>
<td>40</td>
</tr>
<tr>
<td>7.1</td>
<td>OBJECTIVE LIMITATION FOR EVALUATION</td>
<td>40</td>
</tr>
<tr>
<td>7.2</td>
<td>INSPIRATION AND VISION FOR NEST-STEP STUDY</td>
<td>41</td>
</tr>
</tbody>
</table>
1 Project Introduction

1.1 Background

City is a regional center and emergence of city clusters is a historical process, with the rapid development of city clusters through the polarization effect of a large number of industries and population. With the expansion of the scale and strength, the city generates radiation driven effect on the surrounding area, resulting in the formation of a city circle or metropolitan Area. As the traffic conditions improved by expansion of city scale and intercity, especially with the appearance of expressway, adjacent urban radiation region becomes close and part of overlapping. Economic links between cities are closer, as well as influence each other more and more high, with formation of urban agglomeration development state. Due to the inconsistency between the cities of city clusters, urban and urban and rural comprehensive coordination, management mode, policies and regulations, system of urban comprehensive traffic development problem has not been solved, which restricts the urban agglomeration overall performance of the play, city clusters are in urgent need of construction safety and unimpeded, convenient, green comprehensive transportation system.

China's Ministry of Transport (MOT) has become conscious of the complexity and potential of city clusters transportation, and plans to promote the development of comprehensive transportation through strategy formulation, policy frameworks formulation, capacity building, institutional innovation and urban group case pilot demonstration method. In 2009, Hunan Province People's Government and MOT signed Memorandum on Department of transportation, Hunan Province People's Government to accelerate Hunan resource saving and environmental friendly transportation development minutes of talks. According to the memorandum, Hunan Province will meet the Changsha-Zhuzhou-Xiangtan (CZT) city cluster traffic capacity, improve the efficiency of resource use and reduce traffic energy consumption and greenhouse gas emissions. The successful experience of the project will provide important reference for other developing countries.

Under the above background, China City Cluster Eco-Transport Development Project funded by GEF has been approved. MOT will be the Executive Agency (EA) of the Project. A Project Management Office (hereinafter referred to "PMO") under the project is established. The World Bank will serve as the Implementing Agency (IA) for the Project.

This project focuses on the research of China’s city clusters comprehensive transportation to carry out strategic planning, policy, environment, management, technology and other aspects of the system. What's more, it proposes suitable strategy and related policies for China’s economic and social development and the national goal of energy conservation and emission reduction of urban comprehensive transportation group development, based on two pilot projects of CZT and Changsha Lituo, Xiangjiang River area integrated transport hub. Content of the project mainly includes Chinese city group ecological
comprehensive transportation development planning guide and comprehensive passenger hub technical guidelines, the pilot project of the comprehensive passenger transportation hub effect of energy saving and emission reduction tracking assessment, optimization of CTZ comprehensive traffic integration implementation plan (including strategic environmental assessment (SEA), put forward advice on CTZ integrated transport hub design, the development of passenger demand model, and through capacity building and experience to promote, promote the effective integration of urban agglomerations in China of various modes of transportation, improve transport efficiency, reduce the energy consumption and greenhouse gas emissions. The project consists of four parts below:

(1) **China City Cluster Eco-Transport Development Strategic Planning**

This component will support consultant services to help MOT analyze the emerging transport patterns and issues of city clusters, propose multi-modal integrated transport strategies, policies, regulations, institutional framework and coordination mechanism, and develop technical guidelines for city cluster integrated transport planning and multi-modal passenger terminal design. The component will be based on the in-depth analytical works on CZT and other selected city clusters in China. It is envisaged that three consultancies are required:

1) Provision of technical assistance for policy analysis of emerging issues in transport development of city clusters and for developing integrated transport development strategies for city clusters;

2) Provision of technical assistance for developing technical guidelines for city cluster integrated transport planning and multi-modal passenger terminal design, including guidelines for Strategic Environment Assessment (SEA);

3) Provision of technical advisory services for the establishment of a monitoring and evaluation system to measure and monitor transport energy consumption and CO$_2$ emissions in city clusters.

(2) **Pilot Demonstration in CZT City Cluster**

This component will support the following activities, which will be carried out in parallel and in coordination with the implementation of Component 1:

1) Provision of technical assistance for transport integration planning and implementation plan in CZT City Cluster, including the SEA at the planning level;

2) Provision of technical assistance for (i) design of integrated multi-modal transport terminals in CZT City Cluster, including two to be constructed under Component 3(c) of the Project below, and (ii) design and supervision of customer satisfaction survey; and construction of two multi-modal passenger terminals and installation of Smart Transport Management System and electric bus charging facilities for pilot demonstration, including: (i) Lituo Terminal, to become an integral part of the Southern Changsha High Speed Rail Line Station cum Bus and Urban Rail Terminal Complex located at Lituo; and (ii) the Western Changsha Terminal.
(3) Capacity Building *(To carry out research, inspection, training, forums and Application and promotion of achievements, etc.)*

This component supports the following training and capacity building activities.

1) Develop a website for dissemination of Project design and implementation experience;

2) Provide technical advisory services for passenger demand model development and dissemination;

3) Carry out of workshops for knowledge and idea exchange and CZT City Cluster experience dissemination on the topics;

4) Organize international training on the following special topics: (i) multi-modal integrated transport planning; (ii) planning and design of integrated multi-modal passenger terminals; (iii) institutional development for integrated transport management; and (iv) intelligent transport systems for multi-modal passenger terminals.

(4) Project Management

This component provides support to PMO to implement, supervise and manage the different parts of the project. It includes: (i) set up a PMO (ii) make working plan, capacity building task outline, financial management manual and project procurement plan. (iii) Organize relevant meetings and (vi) coordinate, monitor and follow up the progress of the project, etc.

*The pilot project of the comprehensive passenger transportation hub effect of energy saving and emission reduction tracking assessment* is one of the tasks and research topics under the project.

1.2 Objective

The objective of this consulting project is to estimate the carbon dioxide (CO\textsubscript{2}) actual emission reductions on two pilot comprehensive passenger hub under operation and draw up the first three-year monitoring and evaluation report under operation, through the establishment of energy-saving emission reduction monitoring framework. In addition, according to the report, it aims to further improve the energy-saving emission reduction effect monitoring framework, for other similar traffic patterns to copy. The project will improve Xiangjiang new district and Lituo bus hub station design of Changsha city and reduce greenhouse gas emissions in two dimensions, by the introduction of efficient integrated transport hub.

(1) Local level:

The passengers arriving/departing the two integrated transport hub of Changsha will take public transport, reducing private car and taxi travel mode.

(2) Regional level

The passengers in Changsha city of Hunan province (including CTZ City Cluster) returning other cities will be based on long-distance bus to reduce private car travel. It
makes the traffic CO₂ emissions of CTZ reduce 10% than that of the usual scenario (the project evaluation report), and achieves the effect of energy saving and emission reduction.

1.3 Tasks

In order to achieve the objectives of the project, the following four tasks will be carried out.

Task 1: To set up monitoring framework

To evaluate energy saving and emission reduction facilities and hub

Design for the integrated transport hub

To sum up the energy saving and emission reduction measures of the international integrated transport hub, focusing on those with the lowest cost and the best effect. To evaluate the traffic flow data obtained in the preliminary design of the integrated transport hub.

To establish a framework and evaluation method of carbon emissions for the integrated transport hub

To establish the effect analysis evaluation framework and methods of carbon emissions, through research on all traffic hub carbon emissions assessment methods and factors of literature, establishing a sustainable carbon emission effect analysis method. To get the carbon footprint index and the index of carbon emission reduction, by synthesizing of these methods and the evaluation of factors, application in the project assessment report, feasibility studies and other information in the data extraction process.

Establish a calculation index system and monitoring method

To investigate the traffic flow, based on the evaluation method mentioned above, and record the number of motor vehicles in and out of the comprehensive passenger terminal.

Task 2: To optimize the planning and design of the integrated transport hub and put forward the suggestion of energy saving and emission reduction

To review and evaluate the planning and design of the pilot project of the two integrated transport hub, and put forward the suggestion of optimizing the planning and design of the integrated transport hub and the energy saving and emission reduction. To analyze the successful case of energy saving and emission reduction in integrated transport hub at home and abroad, providing reference for future comprehensive passenger hub planning and design. According to the national energy saving and emission reduction requirements, this project will put forward the key points of energy saving and emission reduction in the planning and design of integrated transport hub.

Task 3: To finish the three year annual monitoring and evaluation report

To collect data and check records based on the monitoring framework

To evaluate the carbon emission of the integrated transport hub based on the
investigation data obtained by the actual operation. To compare with a large number of data in the early phase of design by using of electronic watches and computer programs, to calculate the reference line. Constantly improve the analysis methods, to improve the design of comprehensive passenger terminal and the benchmark program

**Data Research**

**Calculate and complete the annual monitoring report**

To recommend energy-saving emission reduction monitoring procedures and calculation standards, in order to reduce the loss in the transportation system in the process of transfer and increase passenger transportation volume. This standard will be calculated into low carbon or carbon emission reduction index of indicators of achievement.

To survey and record all traffic models of traffic, in order to start with the end of the study before and after the reduction of the calculation and evaluation; to review the transportation planning and design of the integrated transport hub, and put forward the improvement suggestions to the design and benchmark of the comprehensive passenger terminal, and improve the energy saving and emission reduction ability of the integrated transport hub;

At the beginning of the comprehensive passenger terminal project, carry out a period of three years of annual research work, and submit and update the analysis of monitoring report in two months after the end of the investigation.

**Task 4: Training**

**Provide the international experience and attain the assessment and monitoring program**

**Carry out training on monitoring framework**

To provide PMO with the Best Practices on energy-saving emission reduction assessment and monitoring procedures, serving as technology transfer outcome, and prepare the relevant training courseware.

**1.4 Technical Approach**

Technical roadmap is shown as figure 1.1.
**Phase one: Inception and Plan**

- **Inception**
  - Project plan
  - Documents review
  - Field investigation
  - Discussion

**Phase two: Project implementation**

**Task 1 Establish monitoring scheme**
- Review facilities and design
- Establish carbon emission evaluation scheme and method
- Establish indicators system & monitoring method

**Task 2 Optimization of planning and design**
- Review and evaluate pilot project, proposal for design and emission reduction
- Analyse international and domestic cases
- Propose key point of emission reduction for plan and design

**Task 3 Prepare annual monitoring and evaluation report**
- Collect data related to emission reduction and check records
- Data investigation
- Calculate and prepare annual monitoring report

**Task 4 Conduct monitoring training**
- Provide international experiences and procedures for evaluation and monitoring
- Conduct training for monitoring scheme

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**Figure 1.4-1 Technical Roadmap**
2 Project Progress

In 10 June, 2016, Contract package of GEF China City Cluster Eco-Transport Development Project, the pilot project of the comprehensive passenger transportation hub effect of energy saving and emission reduction tracking assessment, was signed in MOT. Yu Sheng-ying, deputy director of comprehensive planning department of MOT, and Dr. Liu Xin from EED formally signed the project consulting service contract, with relevant personnel witness from GEF PMO, comprehensive planning department of MOT, EED and media reporter. Since the start of the project, the main experience is as follows.

2.1 Project Inception Phase

In the phase of inception, EED signed contract with Department of Regulations of MOT, organized twice of working conference, conducted prophase investigation, collected and analyzed data, participated in report-back meeting held by WB and finished some related research.

Specific progress includes:

(1) Mobilization meeting & the first working conference.

In order to start the consultation service project of Monitoring and Evaluation of the Achievements of Energy Saving and Emission Reduction of kick-off meeting namely the first working conference was held in conference hall of EED in June 15, 2014. Mr Kang Yanbing, the team leader, Mr. Zhu Yuezhong, national energy conservation and emissions reduction experts, Dr. Lv Bin, the national development and reform commission energy research institute, Mr.Liu Xin and the related staff from EED such as Ms.Hong Zhifang, and WangMin, Mr. Zhang Xiaodan and Dong Rui were invited to attend the conference. Main reference of the meeting as below:

The project managemen staff introduced the TOR and work plan, pinpointed the overall work plan and recent task.

Discussed the possible issues by analysis of existed information and data.

Dwelt on the key output of the project, plan, investigation and the related content to report to mission.

Outcome of the meeting as below:

The expert team further understood the requirements of TOR, more defined the expert responsibilities and tasks for implementation ensure responsibility arrives person

Discussed those key and difficult points that is to finish establishment of monitoring framework and the first annual monitoring report. Within four and a half months after contract signing.

The next task has been confirmed during the meetings, which are to prepare project site
investigation and report to the mission, and make plans to put forward the issue such as whether the first annual monitoring report can be finished on time.

(2) Data collection and preliminary analysis

EED organized experts to carry out research on the data, collecting the information about methods and techniques used to evaluate energy conservation and emissions reduction of ecological transport hub design at home and abroad. Data collected including:

Traffic emission reduction status at home and abroad;

Present situation integrated transportation planning in Changzhutan;

Calculation method of carbon reduction in the field of traffic at home and abroad

The primary outcomes of data collection and analysis include:

Identifying the difficulties and key points of the work through data analysis and survey, which are baseline data and annual monitoring data acquisition.

Establishing preliminary framework and research scope of carbon emission reduction monitoring of the passenger transport hubs in Changzhutan.

(3) Field survey

The experts of EED proposed to survey for data collection, according to preliminary monitoring framework approach, and have an informal discussion with RTA of Changsha City and both clients of the hub project to understand the project implementation and operation on Jul 1st-3rd, 2014.

Data collected including: Background information of both integrated transport hub projects; Project feasibility study reports about both integrated transport hub projects; Technical measures and direction of Xiangjiang new district transport hub; Regular operation of Xiangjiang new district transport hub before construction; General layout scheme of Xiangjiang new district transport hub; Design scheme of Tuoli super-speed bus-station.

Based on the discussion, the important data sheet involving passenger flow volume, mean travel distance, travel modes and their corresponding level of energy efficiency indicator have been sent to the clients for data collection.

(4) Reporting to the mission

The experts reported to the mission from WB in the debriefing organized by PMO in Hunan Province DOT on Jul4, 2014. The subject involving CP3 covered:

Mr. Liu Xin, the director manager of EED, reported the issue in the course of contract signing, data research, expert meeting, and field investigation and introduced the progress of the project.

Mr. Kan Yanbing, the leader of the experts’ team, introduced the emission reduction evaluation strategy of the two hubs and reported the difficulties and key.

The difficulties and key of the project operation were discussed among the experts, PMO,
WB and the clients.

Consensus:

It is expected that Xiangjiang new district integrated transport hub will work formally in May, 2015, whose monitoring report will start from 2015 till two years of successional emission reduction monitoring report has achieved. Lituo integrated transport hub has been working in Apr of this year, as well its monitoring record is going on.

The project team reached an agreement on the next meeting with the mission from WB after this briefing, which will discuss the detailed methods of the monitoring framework.

(5) The second working conference

Monitoring framework exchange was held in the World Bank on Jul 9, 2014, which invited the project staff Mr. Kang Yanbing, Mr. Lvbin, Ms. Wang Min, and Mr. Zhang Xiaodan as well Ms. Yang Yi and Mr. Ren Shuai, transport analysts from WB. The staff of project listened to the introduction of valuation framework given by Ms. Yang Yi and discussed the detailed method and technique of the monitoring framework.

The second working meeting was held in the next day. Mr. Kang yanbing, the leader of the experts’ team, Mr. Zhu Yuezhong, the national energy saving and emission reduction expert, and Dr. Lv Bin, from Energy research Institution, NDRC were invited to participate. Mr. Liu Xin and Zhang Xiaodan, Ms. Hong Zhifang and Wang Min from EED also attended to discuss.

The meeting discussed the frame of the thesis proposal and transport emission reduction monitoring framework, and determine the direction of the modification.

(6) Opening report review meeting

Under the contract, the project opening report held a review meeting in Beijing Tonglian Building on August 5, 2014. The attendees include DOR of MOT, PMO of GEF, WB, group of experts and relevant personnel, evaluation experts, a total of about 35 people.

Project team conducted a project preparatory work report, project specialists and delegates reviewed the opening report and discuss future work focus and difficulty. Ms. Xia hong, director of PMO of GEF, chaired the meeting. Mr. Liu Dong from DOR of MOT and Mr. Zhou Weimin, transportation experts of WB make speech.

The project team presented the project findings, experts carefully reviewed the opening report, the main review comments include:

"Opening report" and "Inception Report" in the report of the purpose, content, and other aspects of the role is completely different. This report is the project opening report, should be unified using the "opening report" to avoid confusion.

Under clear modeling scenarios, systematic consideration of the transportation system of Changsha, and due consideration to bring the project leaked, so that the result is more scientific.
Need to fully consider the project baseline assessment of technical difficulty, because Changsha Xiangjiang new district Transport Hub is in the construction period. At the same time, inadequate Passengers flow problem should be fully predict in a few years after the Transport Hub opened. Based on actual monitoring and calculation to estimate regular Passengers flow.

Need to take full account of the Seasonal operating characteristics of Transport Hub. Select the monitoring period should be consistent with the traffic flow and migration law of Changsha-Zhuzhou-Xiangtan areas, at the same time, should consider the emission reduction of diminishing marginal when more than transport capacity.

2.2 Project Mid-term Phase

(1) Determine Investigation plan. According to the general idea of the assessment methodology, and comprehensive experts, WB, PMO and other various views, PMO developed a research program of ecological data transportation projects, determine the research content, including data requirements, research methods, research schedule, research training arrangements, and developed a questionnaire survey form. After several discussions and modifications with the WB, finally, determine a formal project research program.

(2) Opening report revised. According to expert opinions, the project team has revised and improved the opening report, and joined identified research programs. Project team submitted the revised and improved opening report on September 3, 2014, and received PMO and WB’s approval.

(3) Monitoring framework and data research training. Data collection experts, Wang Min, went to Changsha to train the staffs of Lituo integrated passenger terminal in terms of monitoring framework and data research from August 27, 2014 to August 29, 2014. Each questionnaire (total three) was issued 2,000 copies.

(4) First time data research. Because Xiangjiang new district junction station has not opened as at September 2014, so the project team conducted a questionnaire survey for Lituo passenger terminal. Hunan longxiang Group has accepted the project team commission for Lituo integrated passenger terminal passengers out of the station for a period of seven days of the questionnaire survey, from September 1, 2014 to September 7, 2014. Project team issued and recovered effective survey questionnaire 2,000 copies which investigated the mode of transportation, trip distance, etc. of passengers, and received preliminary findings in September 8.

(5) Interim Report and associated outputs ready. The project team and experts conducted a statistical for the first findings (see Report II: Detection and Assessment Report) in September 2014. October, the group discussed the overall situation of the project and get a preliminary manuscript: Discussed and preliminary confirmed the report one: evaluation framework and assessment report. Analyzed the report tow: Survey and Assessment Report for the status and progress of transport hubs, and listed the Index of baseline emission, at the same time, analyzed monitoring results. Analyzes the necessity
of Energy Saving and Emission Reduction Review of report three, and calculate greenhouse gas emissions and analyzed energy saving effect. Combined with domestic and international excellent planning and design experience, the experts of the project team optimized two integrated transport hub.

The project team conducted a meta-analysis of four reports, complete interim report of Monitoring and Evaluation of the Achievements of Energy Saving and Emission Reduction of Pilot Project- Integrated transport hubs.

(6) **Interim meeting of the project feedback.** On April 15th 2015, the PMO of GEF in Beijing hosted the mid-term review of the effect of the integrated transport hub of pilot projects for energy conservation and emissions reduction monitoring and assessment project. Attend the meeting with the global environment facility "urban ecological comprehensive traffic development in China" project experts, as well as from Changsha comprehensive transportation hub construction investment co, LTD., the represent of the longxiang Group. The expert which attend the meeting, give briefly suggestion of the mid-term report, in accordance with the agreement of the report.

**2.3 Project Final Phase**

(1) **Data research in the second year.** The Hunan longxiang Group has taken the responsible for issuing the questionnaire, they had taken the action from Feb 24, 2015 to Mar 2, 2015 and the Mai 30, 2015 to Jun 5, 2015 and the Sep 1,2015 to Sep 7, 2015. Every time issue the station passenger questionnaire survey for seven days, the city level travel passengers 2800 questionnaires and regional travel passengers 2702 questionnaires survey, such as transportation, travel distance of passengers choose were investigated. On February 2015, the city level passenger research recycling effective questionnaire 1300, regional research recycling effective questionnaire 1062. On June 2015, the city level passenger research recycling effective questionnaire 1223, regional research recycling effective questionnaire 1873. On September 2015, the city level passenger research recycling effective questionnaire 1947, regional research recycling effective questionnaire 1814. The number of the issuing questionnaire can satisfy the requirements of sample size.

(2) **Finish the finally draft report.** On September 2015, the project expert Xiaohui BAI and lina HUANG who had analyze the data (the specific data will be shown in the sub-report 5). On October, the expert group which discussed the result and come to the end conclusion: the description of the situation of the integrated transport hub station construction progress is analyzed, and lists the emissions baseline factors, at the same time, analyses the monitoring result; On energy conservation and emission reduction evaluation report necessity analysis evaluation, accounting the energy saving and emission reduction of greenhouse gas emission, monitoring and evaluate the effect of energy conservation and emissions reduction.

(3) **Data research in the third year.** The Hunan longxiang Group had taken the responsibility of the project experts; they take the survey from the November 12, 2015 to November 18, 2015 and the February 17 2016 and February 25, 2016. Every time they
issued 2800 questionnaires to the city level and 2702 to the regional level in the aspect of the transport method and travel distance. On November 2015, the city level received 1129 questionnaires, and respectively for regional level of 1556. While for the Xiangjiang new district, they had received 2279 for city level and 1939 for regional level. On February 2016, the Lituo city level has received 1708 and 1932 for regional level with the relatively, Xiangjiang new district has taken 1977 for city level and 1110 for regional level.

(4) The final report. On February 2016, the expert group Xiaohui BAI and Lina HUANG had been discussed the total situation of the group and finally finished the final report. In October the expert group discussed the overall situation of the project, and got the preliminary results; after the analysis of the emission baseline and the monitoring result, we had taken the necessity analyze of the emission reduction and the accounting of the GHGs, doing the research of the energy saving and emission reduction, adsorption the draft of the finally report finally got the final report.

(5) Project final report review and training on capacity building. On March 2016, according to the TOR's requirement, the project group holds the training meet in the Guizhou mansion, Beijing, China. Through the training course and the proving the experience of the example of evaluation of energy-saving and monitoring process to the local Department of transportation and the PMO. Meanwhile, the EED also hold the project review meeting in the Tonglian Mansion.
3 Introduction for Integrated Transport Hub Pilots

Changsha city located in the middle of China, which has the specific location. The Changsha city general planning 2003-2020 pointed out the goal of the transportation planning is to build the national level integrated city, to form the moderned international civilized airport, the xianing port, express high way. Which to build the Changsha as the center cover "3 + 5" urban agglomeration of 90 minutes of traffic circle, push the "3 + 5" urban agglomeration regional integration.

The research center is to evaluate the emission reduction of Changsha Lituo and Xiangjiang new district new district integrated transport hub center.

3.1 Lituo Integrated Transport Hub

3.1.1 Engineering Briefing

Lituo passenger terminal, with an occupation of 12,000 m², total construction area of 31,485 m² and total investment of CNY 340 million, is located to the south of western square of Changsha South Railway Station and designed to daily passenger volume of 27,225, and is one of four national-level integrated highway transportation hubs newly built in Changsha during 12th 5-Year Plan.
Figure 3.1.1-1 The transport passenger junction planning of Changsha city
Lituo passenger terminal is integrated infrastructure of public transportation and urban railway hub matched Changsha South High-Speed Railway Station, belonging to Changsha South High-Speed Railway Station, and had been built two years ago and has been put into (trail) operation. The underground part of the integrated building (high-speed railway and public transit hub) has been completed, part of which will serves as parking garage of public transit hub. A transfer station of urban railways will be inclusion of the underground part with a 3-floor building above for passenger service and hub management.

Lituo passenger terminal is designed to be a passenger hub combining railway-intercity railway-bus measures.
3.1.2 Layout Briefing

Lituo station inside the Wu Guangxi square is an important part of traffic zero distance transfer. However, due to space constraints, some preparation classes zone service functions are considered set in different places, contents of this design is Lituo bus station master station room, with a total construction area of 26,299.7 square meters, the entire bus station is divided into two parts: the total area of the underground part of which is the departure zone of 11,799.4 square meters, it has been implemented and completed in advance, aboveground construction area of 14,500.3 square meters of waiting, ticketing and station master function room.

Aboveground is mainly the station room, ticket office and other functional rooms, the design elevation is The Yellow Sea elevation 38 meters.

Underground part is long distance inbound and parking. The design elevation is 32 meters, with a total construction area of 11,799.4 square meters.

The entire underground layout is arranged around a national railway station square, both inside and outside organize streamline relation with the three-dimensional model, and traffic flow does not interfere with no cross.

Figure 3.1.2-1 Design sketch of Lituo integrated transport hub

3.2 Xiangjiang new district Integrated Transport Hub

The original Changsha west bus station built in January 6, 1995, with occupation area of 92.8 mus; locate in the Xiangjiang new district pilot core area of “resource-economical and environment-friendly society”. In recent years, the rapid development of highways and inner city ring road run through, with the West Bus Station as the dot, has gradually formed a densely woven as convenient traffic network, Which composed by Changzhang Highway, Jingzhu Highway, Shangrui Highway, Hengzao Highway, Changtan Highway, State Road 319, Ring Road, and another 11 bus lines is the gateway to the city of Changsha.
The West Bus Station undertakes 40% of Passenger Traffic Volume between Changsha and outside, and the main passenger lines sent to the west area of Changsha. The West Bus Station send 1850 flights daily, the highest peak 2800 trips, and send visitors 28,000 passengers daily, the highest peak 90,000 people, and operate 1000 vehicles daily. Buses originating line 11, 343 vehicles, and sending frequencies 1800 times daily.

### 3.2.1 Engineering Briefing

Changsha Xiangjiang new district junction station, with occupation area of 240 mu, total construction area of 310,000 m² and total investment of CNY 3.2 billion (CNY 1.56 billion in traffic function), integrates functions of traffic transferring, innovation and career center, shopping, entertainment, information processing center, intelligent transportation demonstration center.

**The main design features of Xiangjiang new district junction station include:**

The Xiangjiang new district traffic hub, as an internal and external transportation distributing center and an important component of compound national highway transportation hub, is expected to be a sustainable hub with largest transfer volume, the concentrated transportation of a majority of bus routes, the key station of Metro Line 2, and a joint of other traffic measures. The Xiangjiang new district traffic junction, designed as a trial and demonstrative traffic junction with advanced traffic science and technology, shortens the transfer time by 5 min and distance of that by 60 m or less by integrating MRT, BRT and urban buses (including buses with clean power); achieves rapid transportation in and out of province by connecting Changsha-Yiyang-Changde LRT and Hunan-Sichuan High-Speed Railway in the planning; ensures passengers obtain tickets on time, even quick air tickets, security check and boarding procedures in the hub by cellphones, the internet and the information service platform through application of ITS, 3G communication technology, Internet of Things technology, and achieves information processing and sharing among passengers, buses, the station and roads. The project also includes landmark building construction to develop an innovation and career incubation center as a platform with business creation, promotion and enjoyment for business travelers and elites, as well as a large shopping mall for residents nearby and business travelers for one-stop consumption.

Xiangjiang new district station as a transfer center of long- and short-distance passenger cars, urban public transportation and intercity railways. Xiangjiang new district station present as an important joint to energy-conserving and environment-friendly integrated transportation system and compound hub in pilot area; and supports integrated transportation system in Changzhutan. The station, designed as a trial and demonstrative traffic junction with advanced traffic science and technology, serves as an integrated hub combining many traffic measures, and an important component and active business center in Pioneer Zone.
Changsha Xiangjiang new district traffic hub integrates inter-city trains, buses, etc. with existing station, is designed as a structure capable of disassembly and transformation for junction of short- and long-distance passenger transportation, bus transportation, and urban railway transportation. By the analysis of traffic demand, daily transfer volume will exceed 250,000; passenger capacity will reach 80,000 by the year of 2021.
3.2.2 Layout Briefing

The overall scheme optimized for integrated transport hub was integrated design, and considering the commercial development within the scope of land, and due to space constraints, the overall program is two-story three-dimensional layout.

On the basis of meeting the traffic function, the right turn ramps which belong to the southwest quadrant of the West Second Ring Road and Fenglin Road overpass, is the directional into the stations stereo layout ramp, the northeast quadrant is left turn ramp from south to west.

Replanting the layout of the original west Bus Station, the west and northwest corner land in the north of the Garden Road, is as the comprehensive development of land, the east and the northeast corner land in the north of the Garden Road, is as the transfer building land, and in the middle encircled area, plans to build a six-building Vehicle safeguarding and preparation.
Figure 3.2.2-1 the plane figure of Xiangjiang new district integrated passenger junction engineering

(1) The overall layout of the elevated system

1) Supporting on-site elevated layout

Integrated transport hub viaduct respective shunt out a ramp from the Fenglin Road Viaduct and the West Second Ring Road Viaduct, connected to transfer building. Supporting elevated section width is 20m, with 3 Lane set, the inside lane is a long-distance passenger Lane, and the outside lane for traffic lanes and the overtaking lane, also set the 7.8m wide passenger platform in the station side, which is connected with the ground layer by stairs, elevators and escalators.

According to the supporting on-site elevated ramp length, set up 13 parking spaces for Passengers getting off. After the passengers getting off, the vehicle southbound to the gas station, vehicle testing and maintenance buildings, detour to the west side of the bus stop protection building into the vehicle preparation building.

Supporting on-site elevated and long-distance truck parking and departure area connected at the upper of East Garden, while connected to the bus stop protection building. The overhead outbound lane from the south of bus stop protection building to the east across the West Second Ring Road and to the north connects the West Second Ring Road Viaduct.

2) Passengers distribution facilities

On the inside of the passenger drop-off area of the viaduct, set passenger distribution platform, width 7.8m and length 186m, and connected with the ground floor by the
escalator, stairs, vertical lift of garden road, the escalator openings were connected with rail station entrances, waiting hall and bus first and last stop.

In view of the height difference of viaduct and the ground is about 7.2m, can set the escalators and stairs in the southern end of the transfer building and the north side of bus stop security building, to shunt the passenger of overhead distribution platform, thus forming an integrated three-dimensional public switched platform.

3) Vehicle safeguarding and preparation building

Vehicle safeguarding and preparation building were designed into six layers, and steed upper and lower ramp on the west side, with 4 lanes, meet passenger vehicle requirements. In the scheme are large cars as the standard to design. In the 2-6 layers, set 311 short haul vehicle parking spaces.

(2) The overall layout of the ground floor

1) Regular public transport

On the scale of conventional buses, in addition to meeting the daily needs of planning, it should also be surplus to deal with the holiday passenger peak demand.

On the south side of the bus location, set 19 bus lines, using harbor layout, achieve complete separation of people and vehicles. Conventional bus arrival and departure are on the ground floor. At the same time, set the bus stop in Fenglin Road and South Second Ring side roads to meet the requirements of the transit bus docking. Construct bus repair, maintenance, washing and refueling facilities on the south side of the bus stop protect buildings.

2) Rail Station Passageway

Combined with Metro Line 2, the station entrances are provided at Voeux Road of West Second Ring Road, Both sides of the East Garden Road and Yulan road, and respectively connected with the basement of the building transfer area and commercial area to meet passenger transfer demand with highway passenger station and conventional public transit, and passenger demand of Yulan Road commercial exploitation.

3) Taxis

Drop off area of taxi and social vehicles were set in the negative layer, and entrances were set in the west side of West Second Ring side roads and in the southeast of Garden Road. Negative layer boarding areas set up a total four lanes, which can stop 60 cars at the same time, and meet the needs of eight taxis' boarding. The taxi service areas were located in the east side of the bus stop protect building to provide temporary resting place for taxi drivers within the region, and set up a total 20 parking spaces, and a few taxi service position. The scale of boarding area's passenger demand is surplus than planning, can cope with the peak of the holiday passenger.

4) Social vehicles

According to the result of demand forecasting, public parking need 1000-1100 in high
strength synthetic development of the comprehensive transportation hub. Social vehicles are divided into North and south two parking area:

In the south block of the west of stop protect buildings provided about 320-360 underground parking. The car park entrance of the west side is arranged in the Yulan Road, and the east’s is on the eastern side of security to stop building.

In the North block of land provided 1393 parking spaces, entrance using a decentralized setting, and the public car park entrance which is set on the Fenglin Road, the East of highway passenger station, southeast corner, and Garden Road, and Yulan Road, have a total of six.
4 EE&ER Evaluation Methodology for Hubs

4.1 Principle and Approach

The main energy saving principle of the project is: the passengers were attracted by the convince of the passenger junction hub which lead to they choose the public transportation way to get to the destination. In this kind of the way, they had reduced the emission of the energy comparing to using vehicles. Of which lead to the effect of the energy saving.

Figure 4.1-1 the main mechanism of the energy saving and emission reduction

There are 2 levels to achieve the goal of the energy saving in this project:

City level: there will be more passengers using public transportation to get to the destination to Changsha city, which will decrease the utilization of the automobile and increase the number of passenger who using the public transportation. In the same way, there will be more passengers to get to their destination from Changsha city.

The regional level: the passengers from Changsha city to other cities and the opposite direction passengers will take more methods of the long-short bus, to reduce the use of the automobile.

4.2 Emission Reduction Mode

The basic travel mode （take the example of the passengers leave the Changsha city, the opposite direction is the passengers from other city to get to Changsha city）

1) Baseline mode

Urban level: passengers to other place/suburban county, by taxi, private cars, the subway, bus, and other travel way, arrived in the Xiangjiang new district bus terminal, then take leave long-short passenger transportation.

Regional level: some passengers to other place/suburban county, by private car or taxi directly from the city arrived at the destination.
2) The emission reduction mode

Urban level: because of the convince of the hub station, there are parts of passengers who travel by taxis and private cars arrive before bus passengers will be replaced by bus or subway transportation to reaches the Xiangjiang new district integrated transport hub station. Then take leave passenger transportation by long-short transportation.

Regional level: parts of the passengers will directly change the travel mode by long short transportation through Xiangjiang new district passenger transport junction hub.

4.3 Emission Reduction Calculation

According to the discuss the calculate formula will be as follows:

The main emission reduction result = the city level reduction + regional level reduction

**The city level reduce result**

=(the emission reduction of the unit of the passengers person kilometer before the construction of the hub—the emission reduction of unit of the passengers person kilometer after ) × the numbers of the passenger × average travel distance

**The regional level reduction result**

=the emission before the construction of the hub— after the construction situation

We mainly considerate the passenger transport hub suffered much by the season, weather and the holidays took the years as the unit to set the reducing periodic.

The emission index calculate are based on the different kinds of the fuel and the average velocity is 22 kilometer/hour. The CDM shows the useful data, but not for the government climate change panel committee .the emission index which as follows:
Table 4.3-1 Index of baseline emission

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Velocity</th>
<th>Fuel type</th>
<th>Fuel efficiency</th>
<th>CO₂ emission factor/l fuel</th>
<th>CO₂ emission factor/km</th>
<th>Mean CO₂ /km</th>
<th>Mean share</th>
<th>Mean CO₂ /capita km</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>km/h</td>
<td>%</td>
<td>km/l</td>
<td>kgCO₂ /l</td>
<td>kgCO₂ /l</td>
<td>kgCO₂ km</td>
<td></td>
<td>kgCO₂ /km</td>
</tr>
<tr>
<td>Petrol</td>
<td>Diesel</td>
<td>Petrol</td>
<td>Diesel</td>
<td>Petrol</td>
<td>Diesel</td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>Cars</td>
<td>22</td>
<td>95%</td>
<td>5%</td>
<td>100%</td>
<td>9</td>
<td>11</td>
<td>2.75424</td>
<td>2.94348</td>
</tr>
<tr>
<td>Taxi</td>
<td>22</td>
<td>30%</td>
<td>70%</td>
<td>100%</td>
<td>8</td>
<td>11</td>
<td>2.75424</td>
<td>2.94348</td>
</tr>
<tr>
<td>Bus</td>
<td>22</td>
<td>100%</td>
<td>100%</td>
<td>1.8</td>
<td>2.2</td>
<td>2.75424</td>
<td>2.94348</td>
<td>1.5301333</td>
</tr>
</tbody>
</table>

Source: GEF grant project appraisal documents

* Gasoline/diesel ratio of transport will be adjusted according to the ratio of the actual research
4.4 Evaluation Steps

According to the evaluation methodology and mechanism, there will be five processes by evaluating the performance of the energy saving and emission reduction, the index are as follows:

(1) Determined the baseline

The mainly baseline must be determined, the index which be included: the number of the passenger volume before and after, the traffic share ratio and kinds of energy and energy consumption level, moreover, the situation of the long short passenger line of the 200KM, from the base date we can determined the carbon emission of the passenger transport person kilometer. The baseline information can adopt the feasibility research data.

(2) The data collection, clear up monitoring and tracing

After the project investigation and survey, the project owner and local management department cannot offer the total basic data, for example the transportation share ratio and after the discuss of the project group, expert, PMO, the world bank, preimary determined the access of the core date.

A. the city level data acquirement method:

We can determine the transportation diversity ratio through the questionnaire, according to the investigation result and the statistic ration; we finally determined the transportation volume and the traffic diversity ratio.

B. the regional level data acquires method:

We do the questionnaire to determine the passenger ratio from vehicles to bus of the passenger transportation line within 200 kilometers.

In general, some of the data can be accessed by the mainly department of the management and the statistic. Because the period of the calculate is long, we still need to monitor and follow the sub-data.

Pre-assessment

Give the pre-assessment to the performance of the emission reduction base on the benchmark data and the accrual operates data.

(3) Perfect the evaluation and the model

According to the pre-evaluation, we perfected and adjuster the evaluate method and the model, make the result of the evaluate to be more objective.

4.5 Survey Proposal

4.5.1 Principle

The Integrated transport hub of survey data, the investigation object technology complex, involving multiple disciplines (urban traffic planning science, applied statistics, computer
science, etc.), and the problems existing in the practice is also very complicated and varied. But from the perspective of different subject areas:

As the specific application of the sample survey, the most important question is the survey methods and the sample ratio, the total performance and the adjustment to the error as the transportation specific research, the mainly problem is too familiar with the knowledge and the mastery of the sampling respondent.

As a large scale of data and complex structure of the database construction and application practice, the main problem existed in establishing a database system, the corresponding application design.

In this project, we use a scale of integrated transport hub passenger flow measurement methods, namely the situation of passenger flow through a period of time the artificial sampling survey, and based on the concept of data fusion to overall expansion of the number of bus travel general data sample.

The general characteristics of hub station passenger flow will also present week, day and time-varying characteristics because of the passenger periodic travel change. After we had investigate the local hub, and we found that the situation of passenger flow always shows the similar time-change characteristics. According to this relatively stable characteristic, we can analyses the classification and the process of analyzing the characteristic of the passenger flow according to time sequence in statistical sample is classified as orderly clustering problem.

### 4.5.2 Data Selection

We mainly focus on the index of the cost and accurate of the sampling survey. Thus, it's very important to maintain the accurate data and reduce the cost. If we don't considerate the non-sample error, the survey accurate and the sample has positive correction. When the sample after more than a certain number, the unit increase of sample size for accuracy enhancement effect is not obvious. At the same time, the investigation cost and the sample size is linear positive correlation basically. There should be a proper sampling rate, to achieve optimal equilibrium precision and survey costs.

Additional, the supply of the chosen survey date is very important, at present, the usually way is to base on the experience. We use the supplement survey data in this report. We strictly considerate the passenger flow situation and the influence of the weather, we choose the specific day to do the questionnaire which could mostly represent the passenger flow situation. The first investigation is the spring vacation or the summer vacation, totally represent the requirement of the passenger, in considering the different of the week-end and the usual time there is un different, we finally survey 7 days, thus we could count the total sample space.

### 4.5.3 Required Data Table

According to the overall thought of the methodology of the energy saving and emission reduction of the integrated transport hub, we mainly use two different aspect of the optimize the emission potency:
A. The go and return hub level: because the convince of the transportation, the more passenger choose the public transport way to replace the vehicle transport.

B. Regional level: because of the convince of the transportation, the passenger hub will attire more people choose the bus to replace the vehicle to the destination under the situation of the acceptable time and distance.

4.5.4 Survey Method

According to the research, some data can be static acquire and others need to be investigate, and other key index need to be determined by the questionnaire.

Combining the characteristic of the two hubs, the access date by the inquire questionnaire can be seen from the 4.5.4-1. Between the two hubs, the Xiangjiang new district includes the shopping and office equipment, which cannot be easily get through number of the passengers or the transportation numbers ,in order to promote the reasonable and the acuity of the data, we use the method of questionnaire and the statistique date to re-confirm the number of the transport passenger.

After received the questionnaire, firstly we has logical verifying the truth of the questionnaire, and doing the primary number of the questionnaire. The data will be process by the excel database. Data analysis using the weighted average method, calculates the different percentage composition and average travel distance transportation.

Table 4.5.4-1 Data from questionnaire

<table>
<thead>
<tr>
<th></th>
<th>Lituo</th>
<th>Xiangjiang new district</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passengers flow</td>
<td>Passengers flow</td>
<td>Xiangjiang new district includes facilities for shopping and office</td>
<td></td>
</tr>
<tr>
<td>Ratio of traffic modes sharing rate</td>
<td>Ratio of traffic modes sharing rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regional level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio of passengers shift from private cars to buses</td>
<td>Ratio of passengers shift from private cars to buses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Data investigation
Though inquiry, site visit.
(2) Questionnaire
The main contents of the questionnaire is shown as in 4.4.5.
4.5.5 Survey Schedule

To ensure the integrity of research, the traffic affected by season, holidays, etc. will be taken into consideration. Investigation will be conducted in summer, the Spring Festival period of, as well as in peacetime. Details are shown in table 4.5.4-1:

**Figure 4.5.5-1 The schedule**

<table>
<thead>
<tr>
<th>Hub</th>
<th>Time</th>
<th>Period</th>
<th>The report</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1/9/2014-7/9/2014</td>
<td>Summer</td>
<td>2014</td>
</tr>
<tr>
<td></td>
<td>24/2/2015-2/3/2015</td>
<td>Spring festival</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30/5/2015-5/6/2015</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/9/2015-7/9/2015</td>
<td>Summer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12/11/2015-18/11/2015</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17/2/2016-25/2/2016</td>
<td>Spring festival</td>
<td>2016</td>
</tr>
<tr>
<td></td>
<td>17/2/2016-25/2/2016</td>
<td>Spring festival</td>
<td>2016</td>
</tr>
</tbody>
</table>

*Xiangjiang new district was operated on October 2015*

4.5.6 Training Arrangement

Data acquisition expert min .WANG, Xiaohui BAI, Lina HUANG of the project team will conduct on-site training for staff of Lituo hub, Hunan Longxiang Group, including time, location, number of copies, content of the questionnaires, as well as a one-day on-site demonstration. A sample survey questionnaire will be obtained, questionnaires will be modified accordingly. After that, each questionnaire (a total of three) will be distributed as 2000 copies will be arranged.

4.5.7 Questionnaire Design

There are three questionnaires for departing passengers, arriving passengers and inter-regional bus travelers:
Questionnaire: the city level passenger

Time  weather  investigator

1. By which kind of the method you had been arrival here?
   (1) Taxi ☐ (2) vehicle ☐ (3) BUS ☐ (4) subway ☐ (5) walk ☐ (6) others ☐

2. The start pot _____ distance from here.

3. Which kind of the traffic method do you use to get here before the hub was built?
   1) Taxi ☐ (2) vehicle ☐ (3) BUS ☐ (4) subway ☐ (5) walk ☐ (6) others ☐

How old are you?

(1) Under18 ☐ (2) 18~45 ☐ (3) 45~60 ☐ (4) over 60 ☐

4. Your income?
   (1) 2000 ☐ (2) 2000~4000 ☐
   (3) 4000~6000 ☐ (4) 6000 ☐

5. Your purpose?
   (1) Work ☐ (2) go to school ☐
   (3) Go home ☐ (4) shopping ☐
   (5) Travelling ☐ (6) others ☐

Thanks for your understood.

\[ 200 \times 7 \text{ jour} = 1400 \]
Questionnaire2: in facing the city level passenger

6. By which kind of the method you had been arrival here?
   (1) Taxi □ (2) vehicle □ (3) BUS □ (4) subway □ (5) walk □ (6) others □

7. The start pot [ ] distance from here.

8. Which kind of the traffic method do you use to get here before the hub was built?
   1) Taxi □ (2) vehicle □ (3) BUS □ (4) subway □ (5) walk □ (6) others □

How old are you?
   (1) Under18 □ (2) 18~45 □ (3) 45~60 □ (4) over 60 □

9. Your income?
   (1) 2000 □ (2) 2000~4000 □
   (3) 4000~6000 □ (4) 6000 □

10. Your purpose?
   (1) Work □ (2) go to school □
   (3) Go home □ (4) shopping □
   (5) Travelling □ (6) others □

Thanks for your understood.

3Questionnaire: for the local bus passenger

Time investigator weather

________________________

2note: 200*7=1400

3Note: the place where had been issue: 400*7=2800
1. The start pot__, distance from here.

2. By which kind of the method you had been arrival here?
   (1) Taxi □ (2) vehicle □ (3) BUS □ (4) subway □ (5) walk □ (6) others□

3. What's your age?
   (1) 18 □ (2) 18~45 □ (3) 45~60 □ (4) 60 □

4. Your monthly income?
   (1) 2000 □ (2) 2000-4000 □
   (3) 4000-6000 □ (4) 6000 □

5. Your purpose?
   (1) Work □ (2) go to school □
   (3) Go home □ (4) shopping □
   (5) Travelling □ (6) others □

Thanks
4.5.8 Sample Volume

For the survey we had considerate the situation of the traffic both in local and the regional level. For the city level we had designed the depart passenger and the arrival passenger, thus we had designed the three different kind of questionnaire. The number of the questionnaire we used the simple random sample method to determine the sample number.

Figure 4.5.8-1 The total number and the number of the sample

<table>
<thead>
<tr>
<th>Total</th>
<th>The sample number</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>44</td>
</tr>
<tr>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>500</td>
<td>222</td>
</tr>
<tr>
<td>1000</td>
<td>286</td>
</tr>
<tr>
<td>5000</td>
<td>370</td>
</tr>
<tr>
<td>10000</td>
<td>398</td>
</tr>
<tr>
<td>100000</td>
<td>400</td>
</tr>
<tr>
<td>1000000</td>
<td>400</td>
</tr>
</tbody>
</table>

\[ y = 72.907 \ln(x) - 243.08 \]

\[ R^2 = 0.9946 \]

Chart is required under the confidence level of 95%, the error limit of 0.05, with simple random sampling to estimate P, corresponding to the overall size of the required sample size. To meet the requirements of precision level, with the increase of the overall size, the ratio of sample size increases gradually reduced to zero.
5 Annual EE&ER Evaluation Report for Hubs

5.1 Report Development and Drafting

The project group doing the investigate survey and monitor work in order to evaluate the performance of the integrated transport hub from June 2014 to March 2016, and finally get the 2014,2015,2016 three annual monitoring and evaluating report.

5.2 EE&ER Evaluation for Lituo Hubs

The Lituo of the passenger number as follows:

Table 5.2-1 the number of the passenger of Lituo integrated transport hub

<table>
<thead>
<tr>
<th>Content</th>
<th>Program</th>
<th>The number of the baseline</th>
<th>2014 summer vacation average</th>
<th>2015 Spring festival average</th>
<th>2015 May to June</th>
<th>2015 Summer</th>
<th>2015 11-12</th>
<th>2016 Spring Festival</th>
<th>2016 Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of the passenger (people/day)</td>
<td>the passenger number of the Changsha south railway station</td>
<td>48000</td>
<td>57000</td>
<td>117500</td>
<td>60000</td>
<td>100000</td>
<td>70000</td>
<td>85000</td>
<td>110000</td>
</tr>
<tr>
<td></td>
<td>the day number of the passenger in Lituo bus station</td>
<td>7900</td>
<td>9000</td>
<td>6400</td>
<td>4800</td>
<td>5600</td>
<td>4000</td>
<td>6600</td>
<td>6000</td>
</tr>
</tbody>
</table>
The passenger who take the Lituo long distance bus terminal

<table>
<thead>
<tr>
<th></th>
<th>5056</th>
<th>5593</th>
<th>3200</th>
<th>2400</th>
<th>2800</th>
<th>2000</th>
<th>3300</th>
<th>3000</th>
</tr>
</thead>
</table>

(The resource come from the feasible research report and the statistic data of the Hunan longxiang transport development group.)
The transport sharing rate of the three years in Lituo passenger transport station:

**Table 5.2-2 the transport sharing ratio of the Lituo passenger transport hub**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>City level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the ratio of the transport</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sharing (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subw</td>
<td>20%</td>
<td>21.60</td>
<td>22.50</td>
<td>24.70</td>
<td>26.50</td>
<td>27.20</td>
<td>29.10</td>
<td></td>
</tr>
<tr>
<td>bus</td>
<td>16%</td>
<td>23.30</td>
<td>27.50</td>
<td>30.50</td>
<td>36.40</td>
<td>45.20</td>
<td>49%</td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>34%</td>
<td>25.50</td>
<td>20%</td>
<td>17%</td>
<td>13%</td>
<td>11%</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>vehicl</td>
<td>30%</td>
<td>24.50</td>
<td>23%</td>
<td>20%</td>
<td>16.60</td>
<td>14%</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>walk</td>
<td>0%</td>
<td>5%</td>
<td>7%</td>
<td>7%</td>
<td>2.00%</td>
<td>2%</td>
<td>4.80%</td>
<td></td>
</tr>
<tr>
<td>others</td>
<td>0%</td>
<td>0.10%</td>
<td>0.40%</td>
<td>0.40%</td>
<td>5%</td>
<td>0.10%</td>
<td>0.10%</td>
<td></td>
</tr>
<tr>
<td>Regional</td>
<td></td>
<td>5056</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>the main travel mode before</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bus</td>
<td></td>
<td>91.89</td>
<td>90.60</td>
<td>89.00</td>
<td>91.00</td>
<td>90%</td>
<td>89.00</td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td></td>
<td>2.58%</td>
<td>2.60%</td>
<td>2.60%</td>
<td>2.80%</td>
<td>3%</td>
<td>3.30%</td>
<td></td>
</tr>
<tr>
<td>Vehicl</td>
<td></td>
<td>3.73%</td>
<td>3.80%</td>
<td>3.90%</td>
<td>4.20%</td>
<td>4%</td>
<td>4.60%</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>1.80%</td>
<td>3.00%</td>
<td>4.50%</td>
<td>2.00%</td>
<td>2.80%</td>
<td>3.10%</td>
<td></td>
</tr>
</tbody>
</table>

The ratio of the transport sharing in the city level of Lituo integrated traffic passenger hub.

**Figure 5.2-1 The traffic sharing ratio of the Lituo passenger transport hub**
Please see the change of the distance of the Lituo passenger transport hub in table 5.2-3, graph 5.2-2.

**Table 5.2-3 The distance change of the Lituo integrated passenger hub**

<table>
<thead>
<tr>
<th>content</th>
<th>Distance (km)</th>
<th>2014</th>
<th>2015 1st time</th>
<th>2015 2nd time</th>
<th>2015 3rd time</th>
<th>2015 4th time</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>City level</td>
<td>12</td>
<td>13.40</td>
<td>16</td>
<td>16.00</td>
<td>16.00</td>
<td>19.96</td>
<td>20.00</td>
</tr>
<tr>
<td>Regional level</td>
<td>200</td>
<td>118.05</td>
<td>156</td>
<td>155.98</td>
<td>176.00</td>
<td>197.48</td>
<td>183.33</td>
</tr>
</tbody>
</table>

**Figure 5.2-2 the change of the distance of the Lituo integrated transport hub center**

According to the survey data and the statistic data, we calculate the carbon emission reduction through the energy saving and emission reduction method, the first year of the Lituo passenger transport hub is 5.995 thousand ton CO\textsubscript{2}, the second year is 29.245 thousand ton CO\textsubscript{2}, the third years is 40.019 thousand ton CO\textsubscript{2}, which can be seen from the graph 5.2-3.
The three years change map of the carbon emission reduction of Lituo integrated passenger hub

5.3 EE&ER Evaluation for Xiangjiang Hubs

The number of the day passenger flow during the survey time:

Table 5.3-1 The day number of the passenger in transport center hub

<table>
<thead>
<tr>
<th>Content</th>
<th>Project</th>
<th>The number of the passenger in baseline scenario</th>
<th>2015 November-December</th>
<th>2016 Spring festival</th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of the passenger number of the passenger (people/day)</td>
<td>the day passenger number flow of the Xiangjiang new district</td>
<td>50640</td>
<td>48000</td>
<td>54000</td>
</tr>
<tr>
<td></td>
<td>the transmit number of the passenger number of Xiangjiang new district</td>
<td>25320</td>
<td>24000</td>
<td>27000</td>
</tr>
</tbody>
</table>

(The resource come from the feasible study report and the statistic data of the Hunan longxiang transport development group.)

The ratio of the transport sharing of the Xiangjiang new district passenger transport hub center:
Table 5.3-2 The traffic sharing ratio of the Xiangjiang news district passenger transport hub

<table>
<thead>
<tr>
<th>Content</th>
<th>Project</th>
<th>The baseline</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>City level</td>
<td>The sharing ratio of transport (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>metro</td>
<td>50%</td>
<td>50%</td>
<td>51%</td>
<td></td>
</tr>
<tr>
<td>bus</td>
<td>30%</td>
<td>31%</td>
<td>34%</td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>12%</td>
<td>10%</td>
<td>8%</td>
<td></td>
</tr>
<tr>
<td>Vehicle</td>
<td>8%</td>
<td>7%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>walk</td>
<td>0</td>
<td>2%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>others</td>
<td>0</td>
<td>0</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Regional level</td>
<td>the mainly traffic method before the hub was made (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>90%</td>
<td>89.05%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taxi</td>
<td>3%</td>
<td>3.60%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vehicle</td>
<td>6%</td>
<td>6.35%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>others</td>
<td>1%</td>
<td>1.00%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5.3-2 The traffic sharing ratio of the Xiangjiang new integrated transport hub center

Table 5.3-3 The distance change of the distance of Xiangjiang new district

<table>
<thead>
<tr>
<th>Content</th>
<th>The distance of the baseline (km)</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>City level</td>
<td>12</td>
<td>20.00</td>
<td>20</td>
</tr>
<tr>
<td>Regional level</td>
<td>200</td>
<td>218.31</td>
<td>246.97</td>
</tr>
</tbody>
</table>

According to the survey data, we use the method of the energy saving and the emission reduction to calculate the carbon emission volume. The Xiangjiang new district carbon
emission is 38.775 thousand ton CO\textsubscript{2} and 53.097 thousand ton CO\textsubscript{2} in 2016.

5.4 Analysis and Impact of EE&ER for Hubs

5.4.1 Impact on Passenger Volume

Figure 5.4.1-1 The forecast of the passenger number of the two integrate passenger transport hub

The number of the Lituo passenger hub passenger flow volume had been increased from the 48 thousand in baseline scenario to 110 thousand in 2016, comparing to the Xiangjiang new district hub in 54 thousand.

The Lituo integrated passenger hub center had been operated in 2014; the convince of the passenger hub center had been appeared for now. Along with the development of the city, the passenger flow number will be continuous grow. While the Xiangjiang new district had been opened lately , the number of the passenger had been had suffered lot of the development of the commercial and the complement of the transport function.but as we conformed, with the development of the passenger transport hub ,the travel number will has reached significantly development.

Figure 5.4.1-2 The distance change of the two integrated transport hub

The passenger number of the two transport hub had been linearly increased by the augment of the city people and the convince of the hub, the distance per person had
changed with decompiles of the passenger hub. From the graph 5.4.1-2 we can see that the distance of the two passenger transport hub had been increased from 12km to 20 km. While for the regional level is no much change. The Xiangjiang new district belongs to one of the main long distance bus terminal passenger transport hub, there exist more passenger and the distance reach up to 246.97km.

5.4.2 Impact on Transport Share

![Diagram showing traffic sharing ratio](image1)

Figure 5.4.2-1 Compilation of the traffic sharing ratio the two different passenger hub

The passenger of the both transport hub has more people who take the public transport method yearly. Among which, the ratio of the subway had been increased up to 30%, the utilization ratio of the taxi and the vehicle had been significantly decreased. The number of the ratio had been reduced by 25%.

For the Xiangjiang new district passenger transport hub, the subway travel mode had been taken up to 50%, there are more people will take the bus to travel with the passage of the time. The ratio had been increased up to 34% comparing to the vehicle, the number had decreased by 4%. With the promotion of the public transport mode and the convince of the transfer mode in the hub and the increase of the green travel consciousness, there will be more people choose the public transport way.

5.4.3 EE&ER Evaluation Report for Hubs
According to the survey result of the 2014, 2015, 2016, the emission reduction has been increased year by year. The energy saving and the emission reduction volume will be increased yearly by the increase of the passenger number, the travel distance and the ratio of the public transport. We can predict the number will reach up to 73.64 thousand ton CO2 by 2018.

The Xiangjiang new district integrated transport hub has been recently operated, we don’t have much date for reference and we do not correctly forecast the number of the energy saving and emission reduction. However at the first year the number had been reached up to 40.345 thousand ton CO2, and after 5 years, the number will be 96 thousand ton CO2. along with the time goes on, we predicted both integrated traffic passenger hub will take more effective performance in the energy saving and emission reduction.

Figure 5.4.3-1 The energy saving and the emission reduction of the two hub
6 Recommendations on EE&ER for Hub

6.1 Apply Building Energy-saving Technologies

At present, passengers require higher comfort travelling environment. Considering complex function and huge volume of ITHs, low-carbon technologies are preferred to be applied, such as green energy-saving and intelligent building technologies, in specific:

- Install large-capacity photovoltaic devices on floor or roof;
- Apply new glass curtain wall system. The application of new glass curtain wall can improve building vision and comfort passengers, including smart glass walls and photovoltaic glass curtain wall system;
- Apply CCHP and solar power technology to achieve efficient energy utilization and recycling;
- Apply intelligent lighting systems, such LED, control sensors, etc.;
- Apply low-flow water device that can significantly reduce water use;
- Apply water and rainwater recycling system;
- Apply garbage storage;
- Apply recycling of construction waste;
- Select building materials produced at local to reduce fossil fuels in the transport process.

6.2 Optimize Operation Structure

It is advised to improve vehicle structure to improve management structure at ITHs, such as update current vehicles, phase out energy-consuming, old and un-safety vehicles. It is also advised to prohibit vehicles engaged in operation if they cannot meet emission and pollutant standard. Meanwhile, it is important to promote energy-saving and environmental-friendly vehicles to improve the overall transport efficiency.

6.3 Promote TOD mode

ITHs are usually emerged in cities with rapid economic development. This is a great opportunity to conduct TOD project with high potential benefit. With solid design and proper comprehensive development within and around station, space of commercial,
travelling, living and transport shall be developed to create huge value. For 2 cases mentioned in this book, Liguo and Xiangiang hubs will be developed as social and economic center Chang-Zhu-Tan city cluster, and TOD mode will help make contribution.

Based on lesson learnt from international and national best practices, urban public transport system and land use integration are two key factors to improve vehicle structure. To achieve sustainable development of ITHs, it is advised to:

First, it is proposed to advocate green traffic specification guideline and establish urban intelligent transportation systems and model with support of pilot projects for BRT, road and subway, including BRT planning and implementation, road application of green lighting, rainwater collection, water reuse, metro planning and implementation, etc. In specific:

- Establish green traffic specification guidelines and standard;
- Establish hub intelligent transportation system and corresponding model;
- Conduct demonstration projects;

Secondly, it is proposed to adopt compact and mixed building style for buildings and streets, to further encourage passenger to use public transport. TOD elements are strongly recommended to be involved into design and planning. Therefore, mixed function of living zone will be formed, including work, shopping, culture, education, living and transport. Under such design, passengers would prefer bicycle, walk, and public transport instead of using private car or taxies.

Thirdly, it is proposed to develop sustainable financing plan. Land premium collection income will ensure smooth project progress. To apply TOD development, it is essential to ensure high passenger volume with support of culturing land developing demand.

Last, it is important to combine TOD and Transport Demand Management (TDM), especially on congestion charging, parking management and car-sharing. Based on international experience of developing TOD and TDM, it has been approved to be an efficient approach to EE&ER for ITHs.

6.4 Improve Infrastructure Construction

Currently, many ITHs face the problem of lacking of counterpart infrastructure, such as un-accomplished road around by hub, un-finished expansion of main road, poor road condition, un-operating subways, etc. Once ITHs have been established, passenger volume will be increased dramatically. However, poor counterpart transport system around would be a great challenge for sustainable development of ITHs.

Enhancing capacity of counterpart transport system and facilities, would not only increase
the ITH stability, but also enhance traffic convenience, improve travel convenience and increase transport efficiency, thus to achieve emission reduction target.

6.5 Enhance Transfer Smooth Level within Hub

One of important function of ITHs is to promote integrated development at regional level, such as city cluster. A huge ITH would involve passengers from railway, air, road and tram. To enhance transfer efficiency and saving passengers’ time, it is important to enhance transfer smooth level within hub. The objective of zero transfer shall be considered as future development direction.

6.6 Strengthen Operational Management Level

The construction and development of ITHs include hardware and software contribution. Both aspects shall be considered and applied in proper manner to achieve ultimate objective. It is proposed to establish integrated passenger transport hub management organizations, develop mature transport system, achieved high level of coordination during transferring, develop all-pass ticket system, build operating information systems, etc.

6.7 Increase Passenger Transfer Efficiency

Efficiently organizing passenger flow line would facilitate passengers traveling and transferring. Based on survey and study on Liguo and Xiangjiang hubs, it is proposed to optimize hub design and facilities as followings:

- Improve passenger flow line structure, including improving continuity and smooth level in transfer process to ensure compact and smooth transferring;

- Design transfer channel rationally to shorten distance and time during transferring. Unreasonable passenger flow line would cause congestion at some point and lower transfer efficiency.

- Design proper passenger flow guidance to avoid mixed flow. A single-way and organized flow would increase transfer efficiency, and would also shorten transfer distance among taxi, public bus, subway and railway stations, thus contribute to EE&ER of ITHs.
7 Inspiration and Vision for EE&ER Evaluation

This project, based on international best practice and survey findings of Lituo and Xiangjiang hubs, focuses on principle, technical framework and methodology of EE&ER evaluation of two hubs, and concludes the EE&ER evaluation results. The output of this study contributes to improvement and optimization of ITHs design and operation. It is advised to continue conduct monitoring at regular time for hubs and come to evaluation conclusion. However, due to objective limitations, some information would influence the accuracy of evaluation result. The future inspiration and vision are also proposed as follows.

7.1 Objective Limitation for Evaluation

This project is the first project focusing on EE&ER evaluation for ITHs. Due to limited time and tasks, the following objective limitations shall be mentioned:

• Limitation of data source

Data applied in this report is mainly referenced from Statics Year Book and official website, and some data are provided by local government and authorities. It is difficult to ensure the accuracy of data source since a fusion data set is applied. Therefore, the evaluation result concluded may not reflect the accurate fact in Lituo and Xiangjiang hubs.

The time period of study cannot cover the whole construction and early-operation period of hubs, which leads to a result of insufficient data collection that causes influence to study conclusion.

Generally speaking, passenger volume or related number needs a certain period to become available and stable, e.g. ten years or longer. The period applied in this study is relative short and it will cause unstable result.

• Limitation of EE&ER Calculating Model and Methodology

Based on transport share and other data derived, the EE&ER evaluation result has limitation for less parameter. And besides, the method of prediction of passenger volume per year based on volume per day, will cause deviation between calculation and actual data.

• Limitation of study capacity

Due to limited study capacity of expert team, this project conduct analysis and evaluation based on current data prediction and available methodology. The evaluation result concluded is lack of further proven by existed other case. The conclusion, therefore, may
contain biased information or partially inaccurate data.

The expert team is relatively young with less experience, and the case is the first evaluation project on carbon emission reduction with no successful prior experience.

Based on limitations above, the research conclusion and result still need to be further improved.

7.2 Inspiration and Vision for Nest-step Study

ITH is a complex and huge system, so that many factors would influence passengers’ intention to travel. It is proposed to focus on the following area for further study:

• Study on successful experience of developed countries, including model of influence by integrated transport hub to passengers, principle and methodology of EE&ER evaluation on hubs, especially on fine analysis of passenger travelling factors;

• Conduct data collection research, including data type, quality control on reliability, comparability, factor coverage and accessibility;

• Conduct parameter study under China’s certain condition, including carbon emission factors for each type of vehicle, in order to obtain proper data that suits China’s actual situation.