

2.1.2 Selected Technology

With the above background, together with extensive stakeholder discussions, in Part I of the TNA report, 11 technologies for climate change mitigation in Bhutan were shortlisted for the transport sector. Out of these, 3 technologies were selected through an extensive multi-criteria decision analysis (MCDA) that was used to prioritize technologies through a process that was country-driven, participatory and involved a number of stakeholders. A three day workshop for criteria weighting and technology prioritization was held at Paro, Bhutan.

Intelligent Transport System, Non-Motorized Transport and Mass Transit are the prioritized technologies for transport sub-sector. Further information on these technologies is contained in the TNA report.

Out of these three technologies, Intelligent Transport System was the technology finalized by the TNA Task Force for the preparation of barrier analysis, enabling framework and technology action plan. This is also the top technology as per the results of technology prioritization. Moreover, this technology is included in the Surface Transport Master Plan of Bhutan, 2007 and is in line with Bhutan's Transport Policy that envisages safe, reliable, affordable, convenient, environment-friendly, responsible and high quality surface transport system in the country by minimizing constraints to the mobility of people, goods and services.

The other two prioritized technologies were not finalized since these are being considered under separate plans and programmes in Bhutan. Promotion of non-motorized transport is being considered (particularly for Thimphu) by the Thimphu Thromde. Further, mass transit, specifically bus rapid transit is being considered under the Bhutan Urban Transport Systems project.

2.2 Action Plan for Intelligent Transport System

2.2.1 About Intelligent Transport System

Intelligent Transport System (ITS) basically refers to the application of information and communication technologies (ICT) to vehicles and to transport infrastructure. It is primarily an ICT based system designed to improve operational and managerial efficiency of transport system in general and public transport in particular. An increase in the efficiency of the public transport system also leads to reduction in associated GHG emissions. The components of ITS systems generally includes

- Data Acquisition Systems
- Data Communication Systems
- Data Management Systems
- Display Systems

Data Acquisition Systems: This includes sensors, automatic vehicle identifiers (AVI) and GPS. Sensors are used to obtain traffic parameters such as vehicles count, occupancy and speed. AVI systems are used to specifically identify a vehicle and its speed on road. GPS systems are used to identify the vehicle location and velocity in real time. Travel time, speed, distance and delay are estimated with help of GPS systems.

Data Communication Systems: Data captured using data acquisition systems needs to be effectively communicated to its intended users such as control centres and public display systems. Wireless technology is normally used for data communication systems.

Data Management Systems: for generating short and long term trends, data gathered through acquisition systems must be clean and removed from garbage values. Once the data is clean, data can be aggregated or disaggregated and subsequent analysis is done to generate effective traffic management policies and forecast traffic status. Based on forecast status real time decisions could be taken to prevent congestion etc.

Display Systems: These display systems are used to convey information to travellers using Message Signs, Radio, SMS, etc. ITS can provide information on travel times, travel speed, delay or accidents etc.

Intelligent Transport System could be applied to various areas as highlighted below:

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- 1) **Advanced traffic management systems:** These systems integrate various sub components such as CCTV, sensors for vehicle detection, communication and messaging into a single system for real time traffic monitoring so that traffic management is efficient, real time information to users about traffic conditions, incident detection, signal control, predict traffic trends in real time to avoid congestion.
- 2) **Advanced traveller information systems:** It provides travel related information to users such as estimated travel times of buses on bus stops, route selection, parking availability, so that users can take intelligent decisions as per their convenience.
- 3) **Advanced public transport systems** – It includes passing of real time information of public transport to passengers such as real time passenger information systems, prioritization of public transport, estimated time for bus arrival at bus stops, transit priority of public transport etc.
- 4) **Advanced Rural Transport Systems** – These systems provide information about remote road and weather conditions. This type of systems can be valuable for implementation in rural areas of the country to provide information for users travelling in those areas.
- 5) **Advanced Vehicle Control systems** – These systems enhances the driver control on the vehicles by alerting the driver of possible collision due to vehicle speed or location.
- 6) **Commercial Vehicles Operations** – These systems are implemented to track commercial vehicles such as trucks and taxis for enhanced safety and traceability³.

³ For further details on the technology please refer to the technology factsheet of the, 'Technology Needs Assessment and Technology Action Plans for Climate Change Mitigation', National Environment Commission, Royal Government of Bhutan, 2012

2.2.2 Target for technology transfer and diffusion

The overall target for diffusion of this technology has been based on the existing national and sectoral plans, programs and policies. These include the Transport Policy of Bhutan, the Surface Transport Master Plan of Bhutan, 2007⁴ and the 11th Five Year Plan targets of the country.

The following specific targets have been set by TNA task force members and the Road Safety and Transport Authority (RSTA) for the period 2013-2018.

- Implement ITS technologies in the existing Regional Transport Offices (RTOs) in Thimphu, Phuentsholing, Gelephu and Samdrup Jongkhar and the proposed RTO of Mongar. The key components would include:
 - Install GPS based automatic vehicle tracking system
 - Establish a centralized traffic control centre to handle the operational requirements of traffic
- Set up LED display boards at all the bus-stops and terminals in the cities as well as districts across the country to provide real time information about bus operations
- Install Public Information System inside the buses plying on cities as well as inter district routes
- Introduce E-ticketing and smart card facilities for inter district passenger transport
- Provide information services for passengers through SMS
- Set up Automatic Vehicle Fitness and Emission Testing Centres in the existing RTOs in Thimphu, Phuentsholing, Gelephu and Samdrup Jongkhar and the proposed RTO of Mongar.

2.2.3 Barriers to the technology's diffusion

Given the current situation in Bhutan with regard to Intelligent Transport Systems, in the course of TNA process several barriers have been identified. These barriers are both economic and non-financial barriers. Among the economic and financial barriers, as with other technologies ITS also requires high capital investments which is a major constraint to introducing this technology. The non-financial barriers are mostly those associated with the limitations of the knowledge about the technology, capacity in existing institutional structure and the current policy and regulatory framework. Based on these identified barriers, suitable enabling measures which will assist the country in overcoming these barriers have also been identified. A brief summary of these barriers and enabling measures is presented here below. These enabling measures have further been defined and elaborated on with concrete action for each in the next section of this report.

2.2.3.1 Economic and financial barriers

The main economic barrier for transport management systems is the huge investments required to set up the system in the country. Investments would be needed in setting up the infrastructure such as for traffic detectors, road-side information displays, IT-based communication systems, GPS systems etc. Subsequent investment would also be needed to continuously upgrade the systems and also for effectively operating and maintaining the systems.

For instance, the Surface Transport Master Plan of Bhutan (2007) identifies installation of communication systems integrated with tracking components for public transport as an important measure for managing the transport systems in the country. Such a system would play an important role in improved traveller advisory services, schedule adherence and could be archived to support future planning efforts that minimize GHG emissions. For such a system, the communication network available in Bhutan would have to be considerably upgraded to ensure coverage of all areas on the road corridor. It is estimated that the cost of setting up the infrastructure would be to the tune of Nu. 20 million (USD 0.36 million). The GPS unit mounted on each vehicle

⁴ Surface Transport Master Plan of Bhutan, 2007

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would cost approximately Nu. 25,000 (USD 450). Bringing in such huge investments for transport management system is a significant barrier, hindering its implementation.

These high costs are in turn due to factors such as difficulty in acquiring the needed land, limited number of passengers and limited investment capacity of the private players.

In Bhutan, acquisition of land is an impending issue, which leads to high land price. This is particularly true while planning for terminals. With land cost being one of the primary costs associated with development of ITS, costly land makes the entire process particularly investment heavy.

Due to low population and thereby limited number of passengers, the economies of scale are not reached for ITS measures making it further cost intensive.

Private players in Bhutan have low investment capacity which makes them unable to invest in such high cost intensive propositions as ITS. High subsidy requirements in turn further jeopardizes the sustainability of the program.

All these factors together contribute to economic and financial barriers to development of ITS in Bhutan.

2.2.3.2 Non financial barriers

- a) **Policy, legal and regulatory:** In Bhutan, the transport policies and regulations are mostly outdated having being developed in 1999. Thereby these do not reflect the needs of the current time, and require updating and revisions.

In addition, in the current policy there is no focus particularly on development of sustainable transport systems, such as in the Transport Policy 2006. The policies need to be amended to include specific portions on mass transit and ITS.

- b) **Institutional:** Currently, in Bhutan the transport sector is governed by different Ministries looking into varying mandates of transport. The Ministry of Information and Communication with its Policy and Planning division currently looks into overall policy and planning related aspects of the sector. Ministry of Home and Cultural Affairs is responsible for looking after the Dzonkhags and traffic police whereas Ministry of Works and Human Settlements for Thromdes. There is an ensuing proposal for re-structuring of the institutional structure, with a probability of creation of a separate ministry of transportation.

Though under the current institutional structure there are different departments looking in different aspects of transportation, there is still serious issue of limited human resources which restricts the development and adoption of ITS in the country. There are few technical transport experts and professionals in RSTA at present (2-3 experts). Overall there is limited institutional capacity to plan, implement and operate new technologies. Even there is no dedicated traffic police in remote areas and traffic ends up being managed by non-transport professionals

Poor coordination between planning and implementing agencies with overlapping mandates between RSTA and City Planners poses a significant institutional barrier. In addition implementation of PPP model faces concerns regarding coordination with transport authorities and less willingness of private players in being part of such partnerships.

- c) **Technical:** No specific ITS related impact assessment studies are available in order to assess the needs and benefits of such a system. Though an IFC funded study for implementation of Bus Rapid Transit System (BRTS) has been conducted for the city of Thimphu which has come components of ITS, no such studies exists for other cities. In absence of these, the knowledge about the application and operation and management of the technology in the transport departments both at central as well as local level is very limited.

In addition, limited infrastructure and enforcement measures such as weigh bridges often act as a hindrance in planning of ITS in Bhutan as well as difficult terrain and topography hinders the uptake of many new technologies

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- d) **Information and awareness:** There is a lot which needs to be done in terms of raising awareness of using mass transit systems and building the related knowledge. Currently, the benefits and impacts of ITS is not known to local transport experts and general public at large.

2.2.4 Enabling measures

Based on intensive discussions with experts and extensive secondary research, following measures for building an enabling environment for development and diffusion of the technology have been identified:

2.2.4.1 Economic and financial measures

The constraint of huge capital costs for transport management systems and ITS could be overcome by availing international financing options in low carbon and sustainable transport. These financing opportunities can be in form of Grants, Loans and Technical Assistance. The country can utilize these opportunities in areas of creation of concepts and plans, setting of infrastructure, operations management, technology transfer and capacity building. In order to facilitate this, it is imperative to develop a detailed project implementation plan.

2.2.4.2 Non financial measures

Various measures that could be implemented in Bhutan to overcome some of the impending non-financial measures are:

- a) **Overcoming technical barriers:** In wake of lack of any impact assessment studies of ITS in Bhutan, it is imperative to first conduct these studies. It is important to study the areas of implementation of ITS and potential impact on traffic, congestion, safety and environment. These could be conducted particularly for the towns of Phuentsholing, Gelephu, Samdrup Jongkhar, Mongar, Paro, Bumthang, Khuruthang (Punakha), Bajo (Wangdue), and Haa.
- b) **Building institutional support:** In order to strengthen the institutional structure for development and implementation of ITS, it emerged that setting up Automated Vehicle Fitness and Emission Testing Centres across the towns/cities of Thimphu, Phuentsholing, Gelephu, Samdrup Jongkhar and Mongar is needed.

In addition, to overcome overlapping mandates and tasks of different organizations looking into aspects of transport in Bhutan, specific and independent mandates to different departments and ministries with regard to ITS should be assigned. What is also required is restructuring of the organizations currently looking into transport sector.

- c) **Regulatory and policy support:** It is important for policies, regulations and acts to reflect the needed importance for developing ITS in the country and providing the required support. It is important to revise the current Bhutan's Transport policy, Act and regulations to include implementation of ITS in country.
- d) **Information and awareness:** Awareness campaigns regarding the benefits of ITS measures in reducing congestion, reducing pollution and improving productivity to current engineers, operators, traffic police and potential engineers are required to be undertaken. Awareness campaigns for general public towards using ITS and its benefits should also be conducted.

2.2.5 Proposed Action Plan for Intelligent Transport System

In order to develop a most relevant action plan for development and diffusion of ITS in the country, focused sector specific roundtable discussions were held in Thimphu, Bhutan at NEC. The roundtable participants consisted of sectoral experts and representatives from Ministry of Information and Communications. Through a technology specific presentation, the roundtable had intensive discussions, which focused on following aspects:

- *Overview of the transport sector* - discussions were held on relevant institutions, stakeholder networks, policies, acts and regulations governing the sector and likely to facilitate deployment and diffusion of ITS

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- *General sector barriers and measures*- this brought forward discussions on general profile of barriers faced in the transport sector and the kind of measures that are needed to overcome them.
- *Defining the technology domain*: special focus was given to discussion in terms of defining the technology in a most relevant way, given the national circumstances of Bhutan
- *Targets for technology development and diffusion*- specific targets were identified for ITS. These were based on government plans and documents, particularly the 11th FYP and any on-going or planned government programme for diffusion of the technology.
- *Barriers to diffusion of ITS*- barriers as identified in Part II of the TNA report, were again revisited along with specific enabling measures to overcome them.
- *Proposed Action Plan Framework for Technology development and diffusion*- a draft action plan framework was presented and discussed in detail to aggregate and rationalize the measures identified to develop national capacities for acceleration of technology deployment and transfer. The discussion also prioritized and characterized measures for technology acceleration for a national action plan along with estimates of possible technology investment costs.

Based on discussions held at the roundtable, a revised national strategy/action plan was prepared and sent to roundtable participants, especially to Ministry of Information and Communications for review and comments. Based on which a final prioritized action plan along with national strategy was prepared.

The section brings together the Action Plan which is reflective of the national priorities as those highlighted in the Government of Bhutan Plans, such as the 11th FYP as well as those felt most urgent by TNA Taskforce members and Bhutanese experts.

The Action Plan and thereby the national strategy formulation for deployment and diffusion of is reflective of national priorities. The budgets of each of these action points are those provided by the Ministry of Information and Communications

a) Aggregation and rationalization of measures identified for technology acceleration

The list of measures identified for formulation of a national strategy to accelerate the development and transfer of technologies can be seen in Table 6 below.

Table 6: Measures for strategy formulation for ITS

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Economic and Financial Measure			
Potential assessment of ITS implementation in the country, to approach bilateral and multilateral funding agencies		X	X
Non Financial Measures			
Institutional			
Setting up Automated Vehicle Fitness and Emission Testing Centres	X	X	
Assignment of specific targets to different departments and re-structuring the transport sector	X	X	X

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Policy, Legal and regulatory

Revise the current Transport policy, Act and regulations	X	X	X
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Technical

Prepare detailed technology report for ITS implementation for 5 cities		XX	XX
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Awareness generation and information

Training and awareness campaigns for system engineers, operators and general public on ITS		X	X
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* Note: This table illustrates for a strategy of acceleration measures according to letters of each square, using the timescale for completion of an action, where:

- Letter "X" refers to measures which need to be started in the short term and carried out within the next five years;
- Letter "XX" refers to measures which can be completed in up to 10 years;
- Letter "XXX" refers to measures longer-term measures which can be planned for completion within 15 years from the current date and also will be used for other technologies below.

b) Prioritization and characterization of technology acceleration measures for a national plan

Based on the barriers and the enabling measures required for deployment and diffusion of ITS in Bhutan, the key action points that are essential and immediate are described in Table 7. These action points are organized in priority, in order to convey the importance of action required.

The proposed measures are aligned with the 11th Five Year Plan of Royal Government of Bhutan to ensure that these measures receive required policy and funding support of the Government. For implementation of these measures, RSTA along with MoIC will be the lead agencies ensuring action against each of these. Since implementation of ITS is a large scale project it is crucial to develop funding proposals and access international low carbon transportation funds based on assessment of potential of ITS implementation and its benefit in terms of GHG reduction and co-benefits in Bhutan. This has been proposed to be the most important action for implementing ITS in the country.

While key components of ITS as identified in the technology description section can be implemented based on the feasibility study, there is a clear need of the Department of Transport to set up emission testing centres for vehicles and provide necessary technical assistance to these centres. In line with this, it is proposed to set up Automated Vehicle Fitness and Emission Testing Centres across the towns/cities of Thimphu, Phuentsholing, Gelephu, Samdrup Jongkhar and Mongar. In order to implement project of this stature in the country it is essential that the policies and regulations are in support of such action. Thereby it is proposed to revise the current Transport Policy, Act and regulations to include implementation of ITS in country.

For these measures to lead to actual benefit it is important for all stakeholders to understand its benefits. Awareness campaigns regarding the benefits of ITS measures in reducing congestion, reducing pollution and improving productivity to current engineers, operators, traffic police and potential engineers along with general public have been proposed.

And finally, for actual implementation of all the above measures preparation of detailed technology report for ITS implementation is essential. Utilizing the funds allocated under Bhutan's 11th Five Year Plan; Technical assistance fund and debt fund support from ADB, World Bank and KfW for preparation of detailed technology report and all of above measures will be required. It is proposed the project designing could focus first on cities/towns of Thimphu, Phuentsholing, Gelephu, Samdrup Jongkhar and Mongar. .

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The importance of each action point along with the timelines and activities, agencies responsible, potential costs along with indicators of success are defined in Table 7 below.

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Table 7: Technology Action Plan based on measures identified for technology acceleration (in priority) for ITS

S. No	Measure	Why is it important?	Who should do it?	How should they do it?	Time-scale	Monitoring, reporting and verification for measure	Indicators of Success	Estimated (*1000 USD)	costs	Potential Risks	Potential Funding sources
1	Economic and financial measure: Develop funding proposals and access public and international low carbon transportation funds based on assessment of potential of ITS implementation and its benefit in terms of GHG reduction and co-benefits in Bhutan.	The cost of implementation of ITS system is high. However, financial assistance (technical support, grants, low rate financing) to sustainable transport measures is available through various unilateral and multilateral agencies. To avail these benefits, the project must demonstrate that it leads to less GHG	RSTA, MoIC along with transport / ITS experts	<ul style="list-style-type: none"> - Identify the components of ITS for implementation and how it will integrate with upcoming public sector transport systems such as BRT. - Identify total cost of implementation of ITS. - Estimate GHG emissions reduction due to implementation of ITS in the country - Estimate other benefits such as reduction in air pollution, safety improvement 	2013-2014	RSTA, MoIC	<ul style="list-style-type: none"> - A published report on feasibility of ITS in Bhutan providing necessary information to stakeholders - Funding sources shortlisted - Funding provided by international agencies. 	100		- The impact of funds in terms of GHG reduction per passenger may not be high as compared to other LDCs having higher population density. Thus it may jeopardize international fund flow.	Green Climate Fund, Least Developed Country Fund (GEF); World Bank Clean Technology Fund; UNDP MDG Carbon Facility; ADB Climate Change Fund; International Climate Initiative; Co-financing by funds allocated by Government of Bhutan under its 11 th Five

for the transport sector in Bhutan. These NAMAs can then attract domestic (unilateral), bilateral and carbon finance based funding (Credited NAMAs). Other funding sources as mentioned in previous measures also possible.

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4	<p>Capacity building and awareness generation measures:</p> <p>Awareness campaigns regarding the benefits of ITS measures in reducing congestion, reducing pollution and improving productivity to current engineers, operators, traffic police and potential engineers</p> <p>Undertake awareness campaigns for general public towards using ITS and its benefits</p>	<p>The measure is crucial to raise awareness of using mass transit systems and building the related knowledge. Currently, the benefits and impacts of ITS is not known to local transport experts and general public at large. In order to ensure, effective implementation of these systems, and ensure economies of scale are achieved, it is important to build confidence of general public, and increasing their comfort of depending on these systems.</p>	<p>MoIC and RSTA</p>	<ul style="list-style-type: none"> - Design a national level awareness and capacity building program consisting of: <ul style="list-style-type: none"> - Conference, study visits and training of transport department personnel for the selected cities - Workshops, street plays, advertisements (through print and audio/visuals) for general public for selected cities 	<p>2013-2018</p>	<p>MoIC RSTA</p>	<p>and</p>	<ul style="list-style-type: none"> - Awareness campaign conducted for general public - Training conducted for engineers, operators and traffic police. - Workshops and exposure visits for transport department personnel 	<p>150</p>	<p>No perceived risks</p>	<p>Funds allocated under Bhutan's 11th Five Year Plan; Technical assistance fund and debt fund support from ADB, World Bank and KfW.</p>
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5	<p>Technical and market enabling measure: Prepare detailed project report for ITS implementation Focus on cities/towns of Thimphu, Phuentsholing, Gelephu, Samdrup Jongkhar and Mongar Set up pilot project in Thimphu for demonstration of ITS.</p>	<p>It is important to prepare such detailed reports to arrive at estimates for equipment required for e.g. for setting up Automated Vehicle Fitness and Emission Testing Centres etc. and also to assign responsibilities across organizations within Bhutan.</p>	<p>MoIC and RSTA</p>	<p>- MoIC and RSTA to coordinate with city authorities for preparation of such project design. - Assign guidelines to city authorities for designing such a programme.</p>	<p>2013-2018</p>	<p>MoIC RSTA</p>	<p>and</p>	<p>- Reports prepared for all five cities.</p>	<p>400 (Detailed Project Reports) 2000 (pilot project)</p>	<p>No perceived risk apart from availing the required funding support for the measure.</p>	<p>Funds allocated under Bhutan's 11th Five Year Plan; Technical assistance fund and debt fund support from ADB, World Bank and KfW.</p>
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c) Finalizing national strategy

Based on priority technology action plans in the sub-sectors, a national strategy and action plan for the ITS implementation targets are presented in Table 8.

Table 8: National Strategy (technology transfer and deployment) for ITS

	0-5 years	5-10 years	10-15 years
Large-scale, short to medium term technology			
<i>Intelligent Transport Systems</i>			
Potential assessment of ITS implementation in the country, to approach bilateral and multilateral funding agencies	X		
Setting up Automated Vehicle Fitness and Emission Testing Centres across the towns/cities of Thimphu, Phuentsholing, Gelephu, Samdrup Jongkhar and Mongar	X		
Revise the current Transport policy, Act and regulations to include implementation of ITS in country	X	X	
Assigning specific independent mandates to different departments and ministries with regard to ITS	X		
Awareness campaigns and training programs for engineers, operators, traffic police, potential engineers and general public at large	X	X	
Prepare detailed technology report for ITS implementation to start with 5 cities and set up pilot projects	X		