

1.2 Action Plan for Composting

1.2.1 About Composting

The term composting is defined as biological degradation of waste under controlled aerobic conditions. The waste is decomposed into CO₂, water and the soil amendment or mulch. In addition, some carbon storage also occurs in the residual compost.

Three composting techniques that are available to compost bio solids are windrow, aerated static pile, and in-vessel composting (ClimateTechWiki)¹. Each technique varies in procedures and equipment needs. Other variations between the technologies are issues such as air supply, temperature control, mixing, and the time required for composting.

Windrow composting is the production of compost by piling organic matter or biodegradable waste, such as animal manure and crop residues, in long rows (windrows). This method is suited to producing large volumes of compost. These rows are generally turned to improve porosity and oxygen content, mix in or remove moisture, and redistribute cooler and hotter portions of the pile. Windrow composting is a commonly used farm scale composting method.

Aerated Static Pile composting, refers to any of a number of systems used to biodegrade organic material without physical manipulation during primary composting. The blended admixture is usually placed on perforated piping, providing air circulation for controlled aeration. Keeping in mind the complexity and cost, aerated systems are most commonly used by larger, professionally managed composting facilities, although the technique may range from very small, simple systems to very large, capital intensive, industrial installations. Aerated static piles offer process control for rapid biodegradation, and work well for facilities processing wet materials and large volumes of feedstock. ASP facilities can be under roof or outdoor windrow composting operations, or totally enclosed in-vessel composting, sometimes referred to tunnel composting.

In-vessel composting is an industrial form of composting biodegradable waste that occurs in enclosed reactors. These generally consist of metal tanks or concrete bunkers in which air flow and temperature can be controlled, using the principles of a "bioreactor". Generally the air circulation is metered in via buried tubes that allow fresh air to be injected under pressure, with the exhaust being extracted through a biofilter, with temperature and moisture conditions monitored using probes in the mass to allow maintenance of optimum aerobic decomposition conditions. This technique is generally used for municipal scale organic waste processing, including final treatment of sewage biosolids, to a safe stable state for reclamation as a soil amendment. In-vessel composting can also refer to aerated static pile composting with the addition of removable covers that enclose the piles. There have been other techniques and methodologies also small scale aerobic composting such as

Further details on the technology are provided in the technology factsheet of the TNA Report.

1.2.2 Target for technology transfer and diffusion

The overall target to develop this technology has been based on the national and sectoral strategies, plans and programs such as the Waste Prevention and Management Act 2009 of Bhutan and plans of various city authorities. As per the Waste Prevention and Management Regulations, each Thromde (third level administrative division in Bhutan) is required to create an enabling environment for waste recycling to create a viable business opportunity to the private sector by providing technical support, leasing of land, government subsidy and through initiation of collaborative waste recycling projects with the private sector when deemed feasible. It also specifies that composting either on commercial scale or on a community level shall be the preferred method for organic waste management. Thromdes on their own or through arrangements with the private sector should provide such facilities.

As per discussions held during TNA workshop involving the NEC and City Municipalities, the preliminary target for setting up commercial scale composting systems at prominent urban centres such as Thimphu,

¹ <http://climatetechwiki.org/technology/jiqweb-abt-0>

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Phuentsholing, Samtse, Gelephu, Samdrupjongkhar, Deothang, Trashigang, Rangjung, Yangtse, Mongar, Chamkhar, Trongsa, Bajo, Khuruthang, Paro and Haa are being set. In terms of timelines, as per the existing government plan the city of Thimphu targets to have a commercial composting system by the end of 2013 and other major cities by 2015. Currently, NEC is in the process of developing a National Strategy on Integrated Waste Management for Bhutan. It is expected to be finalized in the year 2013. In 11th Five Year Plan as well, it is expected that some budget allocations will be provided for waste management.

1.2.3 Barriers to the technology's diffusion

Given the current situation in Bhutan with regard to development and diffusion of composting as a technology for waste disposal, in the course of TNA process several barriers have been identified. These barriers have been categorized as economic barriers and non-financial barriers. While economic barriers primarily include high cost and low scale of composting plants, the non-financial barriers are mostly those associated with the limitations of the current institutional structure, the current policy and regulatory framework and those associated with information and awareness with regard to composting. 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.

1.2.3.1 Economic and financial barriers

The key financial barrier for the creation of commercial level composting plants is the lack of financing mechanisms for such projects. Also, lack of incentives generally serves as a hindrance for private players to set up such plants.

The high cost of setting these plants is often associated with high land costs due to unavailability of land. Also, due to less population, a comparatively lesser proportion of compost is generated, economies of scale are not reached, and making these plants unattractive to investors.

1.2.3.2 Non financial barriers

- a) **Technical barriers:** There is lack of latest feasibility studies to identify and prioritize potential sites for setting up composting plants as well as the financial requirements of setting up the technology. In wake of lack of such studies no comprehensive strategy for implementation of composting has been established.

Also, there is lack of technical know-how on technology domestically thus posing issues with regard to setting up and operation of the plants. There is also lack of infrastructure at the municipal level for collection and segregation of waste. This poor collection and segregation of waste leads to less generation of raw material, in terms of compostable waste required for successful running of composting plants.

Not only sufficient availability of compostable waste is an issue but also unavailability of viable sites for setting up commercial composting plants, restricts setting up of such plants. This is particularly true for urban centres, where most spaces are available on the outskirts, and issues related to transportation of the compost then arise, often increasing costs. The other key issue is the unwillingness of people to accept composting plants around their place of stay or work which makes it even more difficult to obtain viable sites.

- b) **Information and awareness:** There is also limited societal awareness in terms of benefits of waste management (health benefits) (financial benefits) and practice on waste segregation at source is one of the key barriers in the country. This also leads to the problem of unavailability of proper compostable raw (waste) material to operate the plant effectively. There have been no awareness or capacity building programs conducted so far in order to improve the awareness and sensitivity levels of the people towards proper waste management.
- c) **Lack of well-defined institutional structure:** Currently, National Environment Commission is the overall coordinating agency also looking at regulatory aspects of waste management in the country. In terms of implementing agencies, there is yet no formal structure in place, it is currently informally

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undertaken by city corporations. There is thereby a need to develop formal institutional structure for waste management also looking at composting for the country.

1.2.4 Enabling measures

Based on intensive discussions with experts, extensive secondary research as well as international experience, measures for building an enabling environment for development and diffusion of the technology in a way to overcome the above barriers have been identified. These measures include:

Economic and financial measures

In order to overcome high financial costs associated with setting up composting plants, it is recommended to establishing clear procedures for providing incentives or subsidies for encouraging private participation in composting ventures to facilitate the availability of necessary finance. This could potentially be done by using domestic and international funding sources to provide incentives for promoting public private partnerships in setting up composting plants. These funding sources could be used to provide incentives such as tax rebates, custom duty exemptions on import of related equipment. Such incentives are already mentioned in the Economic Development Policy and Waste Prevention and Management Act. The same could be promoted using domestic and international funding sources.

Also, since low scale is a major economic barrier, it has been identified that de-centralized composting units could be alternative option to a large scale commercial composting plant. These units can be managed through a programmatic approach in Dzonkhags and Thromdes.

Non financial measures

- a. **Overcoming technical issues:** As a first step it is crucial to undertake feasibility studies to identify and prioritize potential sites for composting as well as the financial requirements of setting up the technology. This is important to showcase to the policy developers, municipalities, financial institutions, technology suppliers and other market players regarding the market potential of composting technique in Bhutan for waste management. It will help overcome current unavailability of viable composting sites. This will also help assess the overall waste management potential of the technology and possible estimate of finances required and cost recovery period.

In addition to carrying out such studies it is also important to provide the needed support infrastructure for waste management through composting. Currently municipalities face constraints for waste collection and segregation due to lack proper facilitating infrastructure for this. In order to ensure a proper functioning and supply of compost to composting plants it is essential to develop this support infrastructure.

- b. **Designing a formal institutional structure for waste management:** in wake of lack of any formal structure for waste management and also facilitate setting up of composting plants, it is important to design a formal institutional structure for management of waste in the country. It is crucial to have a formal system of waste management in the country with specific institutions looking into waste management aspects with clearly defined responsibilities.

In addition, it is important to build capacity of these institutions to carry out effective waste management and also facilitate implementation of composting plants in the country.

- c. **Awareness campaigns and information generation:** In order to build awareness regarding composting, it is important to disseminate information and awareness through campaigns on the technology and its benefits at both municipal and household level. These campaigns are essential to create awareness and inculcate practice of segregation of waste at source, and help accept people to have composting plants around their place of stay and work.

1.2.5 Proposed Action Plan for Composting

In order to develop a most relevant action plan for deployment and diffusion of composting technology focused sector specific roundtable discussions were held in Thimphu, Bhutan at NEC. The roundtable participants consisted of sectoral experts and representatives from National Environment Commission and Thimphu, Thromde. Through a technology specific presentation, the roundtable had intensive discussions, which focused on following aspects:

- *Overview of waste generation* - discussions were held on relevant institutions, stakeholder networks, policies, acts and regulations governing the sector and likely to facilitate deployment and diffusion of composting
- *General sector barriers and measures*- this brought forward discussions on general profile of barriers faced in the waste management 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 transfer and diffusion*- specific targets were identified for composting technology. These were based 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 composting*- 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 deployment 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 National Environment Commission for review and comments. Based on this, 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 technology is reflective of national priorities. The budgets of each of these action points are those provided by the National Environment Commission.

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 2 below.

Table 2: Measures for strategy formulation for composting

Strategic measure	Accelerating innovation RD&D	Accelerating deployment	Accelerating diffusion
Economic and Financial Measure			
Establishing clear procedures for providing incentives or subsidies for encouraging private participation in composting ventures	X	X	X
Non Financial Measures			
Institutional			
Designing of a formal institutional structure for waste management and setting up and management of composting projects		X	X
Build capacity of institutions for setting up and effective management of composting projects		X	X
Technical			
Feasibility studies to assess different composting techniques and financing models for promoting composting at decentralized and centralized level		X	X
Establishing support infrastructure for setting up and managing composting projects		XX	XX
Information and awareness			
Dissemination of information and awareness campaigns on the composting as a technology for waste management and its benefits at both municipal and household level		X	X

* 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.

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

Based on the barriers and the enabling measures required for development and diffusion of composting technology in Bhutan, the key action points that are essential and immediate are described in Table 3. 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 a national level waste management strategy a robust institutional structure is essential; thereby the National Environment Commission will be the lead agency to drive all the measures and will work closely with Ministry of Works and Human Settlement and City Authorities to ensure required planning and implementation support. In this context, strengthening of these institutions in terms of required human resources and technical expertise through proper budget allocation and capacity building and training programs have been proposed.

It is also essential to undertake an assessment of different composting techniques applicable at both decentralized and centralized levels. This will help built an understanding of different techniques available and most suitable for Bhutan. What is also required is to assess different financing models for implementing these different techniques. Along with this proper support infrastructure is essential to support the composting projects including centralized composting plants. In this context, setting up the support infrastructure in terms of transportation facilities, proper waste collection and segregation units or facilities have been proposed to be constructed.

Development of composting units in the country will require significant capital support to ongoing waste management programs. This will require sourcing from both Government budget and co-funding using international technical assistance grants and loans. The funds could be utilized to provide incentives such as tax rebates, custom duty exemptions on import of related equipment, and potentially help in promoting public private partnerships in setting up composting projects. Finally, dissemination of information and awareness campaigns on the composting as a technology for waste management and its benefits at both municipal and household level is needed and has been proposed.

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 3 below.

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Table 3: Technology Action Plan based on measures identified for technology acceleration (in priority) for Composting

S.No	Measures	Why is it important? (Priority)	Who should do it?	How should they do it?	Time-scale	Indicators of Success	Estimated costs (000 USD)	Potential risks	Potential Funding sources
1.	Designing of a formal institutional structure for waste management and setting up and management of composting projects	To have a formal system of waste management in the country with specific institutions looking into waste management aspects with clearly defined responsibilities. This will greatly facilitate setting up and running of composting projects.	NEC and MoWHS	<ul style="list-style-type: none"> - Identify specific organizations looking into following specific aspects: <ul style="list-style-type: none"> - Policy, Regulation and M&E aspects of waste management (with composting being one of them) as per the Waste Prevention and Management Act - Undertaking planning and technical support - Providing financial support - Implementing agencies <p>A possible institutional structure could consist of following bodies in hierarchy:</p> <ul style="list-style-type: none"> - For policy and regulation aspects- NEC - Planning and technical aspects- MoWHS (possible have a specific division looking into waste management issues) - Financial aspects- Ministry of External Affairs and Ministry 	2013-2015	<ul style="list-style-type: none"> - A well-defined institutional structure established by 2015 - A possible strengthening of the institutional structure in the Waste Prevention and Management Act by 2018 	50	New institutional structures may require changes and amendment in Acts and regulations which may be difficult. A series of approvals may be required in finalization of an institutional structure which may entail time.	Government budget appropriated for waste management sector in Bhutan

2.	Build capacity of institutions for setting up and effective management of composting projects	<p>To build capacity of NEC, MoWHS and Municipalities for effective waste management and composting</p> <p>Currently, NEC's Capacity is limited in terms of technical human resources and it requires experts in technology evaluation and its monitoring</p> <p>The understanding and management potential of the municipalities is also very limited for managing</p>	NEC and MoWHS	<p>of Finance</p> <ul style="list-style-type: none"> • Implementing Agencies- Thromdes, Dzongkhags, Municipalities/Gewog/Villages - Design and undertake intensive training programmes focusing for: <ul style="list-style-type: none"> • Municipality: on approaches, concepts, planning and budgeting for setting up and managing composting plants specifically - MoWHS to potentially have a separate dedicated division looking at integrated solid waste management (incl. composting) for planning, budgeting and hardware execution 	2013-2018	<ul style="list-style-type: none"> - A number of training programmes conducted by 2018 - A separate division and created and operational under MoWHS for waste management 	150	<p>Availability of required trainers and experts for conducting training programme may be difficult.</p>	<p>Green Climate Fund; GEF's Least Developed Countries Fund; Carbon Funds of ADB and World Bank; Clean technology Fund;</p> <p>NAMA for waste management in Bhutan can be prepared in which composting could be one of the low carbon technology options. In Bhutan's context, supported NAMAs could be developed and funding could be</p>
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3.	<p>Feasibility studies to assess composting techniques and financing models for promoting composting at decentralized and centralized level</p>	<p>To showcase to policy developers, municipalities, financial institutions, technology suppliers and other market players regarding the market potential of composting technique in Bhutan for waste management. It will help overcome current unavailability of viable composting sites.</p>	<p>Ministry of Works and Human Settlement and City Councils,</p>	<ul style="list-style-type: none"> - Identify organization to undertake such a study either domestically or hire external consultants - Prepare a list of possible composting technologies and implementation models (e.g. decentralized, centralized, hybrid). With particular focus on techniques applicable at household level. - Undertake a cost benefit analysis of each technology/model - Describe implementation mechanism for each technique, identifying roles of involved agencies. - Analyze possible financing models for different techniques of composting. Explore potential of PPP models, incentive schemes from municipalities for households to promote household level composting etc. - Document the results of such a study in form of Guidebook, to be made 	<p>6 months</p>	<p>A publicly available report on Composting potential in Bhutanese cities to manage waste.</p> <p>A list of finalized technologies for application in the country.</p> <p>A list of possible financing models for promotion of different techniques of composting.</p>	<p>50</p>	<p>No risk perceived. Except availability of necessary funding.</p>	<p>obtained accordingly from developed countries.</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> <p>For funding policy measures and other measures Nationally Appropriate Mitigation Actions (NAMAs) can be developed</p>
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technology and possible estimate of finances required and cost recovery period.

publically available.

for the transport sector in Bhutan. These NAMAs can then attract domestic (unilateral), bilateral and carbon finance based funding (Credited NAMAs)

Green Climate Fund, Least Developed Country Fund (GEF); World Bank Clean Technology Fund; UNDP MDG Carbon Facility; ADB Climate Change Fund; International Climate

<p>4.</p>	<p>Establishing support infrastructure for setting up and managing composting projects</p>	<p>Currently municipalities face constraints for waste collection and segregation due to lack of proper facilitating infrastructure for this. In order to ensure a proper functioning and supply of compost to</p>	<p>NEC and City Councils</p>	<p>Study successful case examples from other countries on models of support infrastructure applied.</p>	<p>2013-2015</p>	<ul style="list-style-type: none"> - Infrastructure support set up at specific sites by 2015 - Proper transportation facilities in place for transfer of compost to composting plants 	<p>200</p>	<p>Getting the right manpower for undertaking the necessary work can prove to be a challenge. Along with necessary funding.</p>	<p>Government budget and co-funding by international funds as mentioned earlier.</p>
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composting plants it is essential to develop this support infrastructure

5.	Establishing clear procedures for providing incentives or subsidies for encouraging private participation in composting ventures	To encourage active private participation in setting up of composting plants.	NEC	Use of domestic and international funding sources to provide incentives for promoting public private partnerships in setting up composting plants. These funding sources could be used to provide incentives such as tax rebates, custom duty exemptions on import of related equipment. Such incentives are already mentioned in the Economic Development Policy and Waste Prevention and Management Act. The same could be promoted using domestic and international funding sources.	2013-2015	- A number of incentives provided to equipment suppliers, plant implementers by 2015	200	Delay in getting access to funds from domestic and international sources	Government budget and co-funding using international technical assistance grants and loans.
6.	Dissemination of information and awareness campaigns on the composting as a technology for waste	To create awareness and inculcate practice of segregation of waste at source, and help accept people to have composting	NEC, MoWHS and NGOs	<ul style="list-style-type: none"> - Develop content of such campaigns - Develop campaign material, in form of brochures, pamphlets etc. - Door-step communication on segregation and storage - Occasional clean-up campaigns on littering 	2013-2018	<ul style="list-style-type: none"> - A number of campaigns designed and conducted during the period 2013-2018 - Advertisements made and aired on radio, 	100	Mindsets and breaking into old habits of households may prove to be challenging to overcome through	GEF Least Developed Countries Fund; Small Grant Program; Government Budget; Other

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management projects around
and its their place of
benefits at stay and work
both
municipal and
household
level

and indiscriminate
disposal

Use of print and
electronic media, flyers,
movies, etc.

television etc.
during 2013-
2018

awareness
campaigns

international
grants by UN
and other
multilateral
and bilateral
funding
agencies.

c) Finalizing the national strategy

Based on priority technology action plans in the sub-sectors, a national strategy and action plan for the composting targets are presented in Table 4.

Table 4: National Strategy (technology transfer and deployment) for composting

	0-5 years	5-10 years	10-15 years
Large-scale, short to medium-term technology			
<i>Composting for Solid Waste Management</i>			
Designing of a formal institutional structure for waste management and setting up and management of composting projects	X		
Built capacity of institutions for setting up and effective management of composting projects	X		
Feasibility studies to assess composting techniques and financing models for promoting composting at decentralized and centralized level	X		
Establishing support infrastructure for setting up and managing composting projects	X		
Establishing clear procedures for providing incentives or subsidies for encouraging private participation in composting ventures	X	X	
Dissemination of information and awareness campaigns on the composting as a technology for waste management and its benefits at both municipal and household level	X	X	