External Review of

The TERI-SDC Biomass Project

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Report Prepared For

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Summary and Key Recommendations

In principle and structurally the TSBP program is meaningful and should be continued but needs re-alignment.

The evaluation team is presenting this report based on the project documentation received before the mission, the findings and observations made during the mission and the discussions with SDC and the Swiss project consultant after the mission. The evaluation team is not able to comment on project achievements and situations, which were not visited during the mission.

The TORs for the evaluation team are stipulating that the review shall provide strategic inputs into the future direction of SDC/GPCC India's engagement in biomass energy and renewable energy technology and that TERI will use the results of the review to strengthen, expand and improve the quality of its services in the remaining duration of the project. Following the scope outset by the ToRs, it's in the nature of the evaluation, that critical aspects with a potential for improvement are more dominantly highlighted and explored in detail than achieved positive results. This focus does not imply a view of the authors that would limit or diminsh the scope and quality of the positive work that has been carried out by all involved parties to the project.

Biomass:

- The renewability and sustainability of biomass currently being used should be analyzed based on CDM methodologies. The biomass used should be "renewable biomass" and should be from sustainable sources.
- Green house gas reduction as a sign of the benefit of the program should be monitored following CDM methodologies.
- Research and tests of non-woody biomass should be in the focus and should be accelerated.
- The findings of the surplus biomass assessment study should be translated to an actionable sustainable biomass supply chain.
- Thermal gasifiers seen by the evaluation team are fired with medium sized cut wood and are operating well. The size of wood is not critical for thermal gasifiers. The two stage gasifier seen at the TERI lab in Delhi, with a mechanical forwarding system (screw) for the wood in the precombustion part of the plant, must be feeded with small sized (closecut) wood. For the evaluation team it's questionable, whether in rural areas a permanent high quality of the wood sizing with the given equipment is possible.
- We recommend that the project should become active in supporting sustainable biomass supply chains

Thermal gasifier:

- TERI shall support the licensees in getting official MNRE approval. Only with official MNRE approval and recognition the financing of plant installations can be supported by governmental subsidies.
- Financial schemes which are in place shall be made available to potential project owners. Additional financial support from SDC for implementation at gasifier level is not required.
- Knowledge sharing between licensees and TERI and among licensees shall be institutionalized. The licensing agreement must balance sometime competing aims: incentivize quality products,

incentivize competitive pricing, incentivize innovation and customization, incentivize exchange among licensees, assure financial contribution sufficient for product development and marketing. The current set-up is not conducive to knowledge sharing among licensees.

- Performance of gasifiers with respect to air pollution should be monitored and shared with Pollution Control Boards.
- The evaluation team has only seen one thermal gasifier operating on constant temperature level (Ceramic Industry in Ahmedabad). According to the respective licensee, this operation mode was reached through his own invention. Other licensees claim missing automation and through that limited access to new markets. This observation and comment of the respective licensee is contradicting to the "07. TSBP-OpRep4 2014.pdf" wich states on page 3 (6) "Output 1.4: Thermal gasifier automation with burner control field tested. Activity 1.4.1: Field-testing at Belgaum / Ahmedabad along with licensee manufacturers". The evaluation team was not able, basing on the thermal gasifiers seen, to prove what was written in the 07. TSBP-OpRep4 2014.pdf.
- Allthough work safety is mostly in the responsibility of the operators of the plants, accidents on the plants could cause negative reputation of the plants. Therefore it's recommended that TERI is supporting and motivating the licensees to take care for good work safety as far as possible.
- Work safety has two components: adequate technologies and adequate operation practices. The basic design of the gasifier seems to be compatible with work safety requirement. Issues observed during the field visit relate to operation practices (e.g. producer gas and heat exposure during fuel loading and flame extinction) and the integration of the equipment with existing production equipment (e.g. no safe platform for worker to stand while doing fuel loading). Reputational risk for SDC and TERI arises from accidents that can happen due to not sufficient work safety at gasifier locations. The project cannot reasonably assume responsibility for verfying each individual installation. An example of a possible way to mitigate this risk is that 1) Teri updates the gasifier manual to include details on safe installation and safe operation practices 2) includes in its licensing agreements that licensees must translate the manual into local language and deliver at least 3(?) copies along with every gasifier installation. It's the opinion of the evaluation team, that in case of possible accidents with gasifiers, allthough if the accident is not caused by the gasifier itself, the reputational risk for SDC and TERI remains.

Two stage gasifier for electricity production

- The available study on the first pilot project in rural areas should be revised carefully and availability of renewable biomass must be properly ascertained.
- According to the information received from the Swiss project consultant, it would be possible by adapting the screw-based biomass moving system, to feed the gasifier with different type of locally available agri-waste. This possibility should be further elaborated and implemented. SDC should allocate budgets and milestones to be reached by TERI.
- Again according the information received from the Swiss project consultant, a breakthrough can be expected short term (some months) on the radar glow-bed control. This would be an important step towards a steady producer-gas and finally electricity production. If this breakthrough cannot be achieved within reasonable time, SDC and TERI should consider stopping the development of the two stage gasifier.
- A detailed survey of the actual international state of R&D and market introduction of small scale biomass gasifiers for electricity production shall be made. Basing on the outcome, a decision on the further support and development of the TSBP (two stage gasifier) shall be made.

- For the implementation, a robust business plan with financial solution should be elaborated, the results shown in the study for the first application in a rural area are questioned and must be revised.
- Co-operation with 3rd party financing institutions for the implementation and broader expansion of the two stage gasifier could be considered.

South-south co-operation

- Under the condition that renewable and sustainable biomass supply is available and financing mechanisms are implemented, the thermal gasifer is ready for export to developing countries.
- The SDC / TERI strategy not to consider the 2 stage gasifier under south-south co-operation is justified and the review supports this strategic orientation.
- South-south cooperation for thermal gasifiers should be a long term strategy and not a high priority at this moment, as the evaluation team expects TERI experts to be very much engaged in different tasks in India (see comments above).

Project steering

- More and stronger local supervision, support and control is needed, by whom should be discussed, e.g.:
    - supporting licensees to get MNRE listed
    - supporting development of financing schemes and access to subsidies
    - supporting knowledge sharing between TERI and licensees and licensees and licensees
    - assessing pollution control
    - supervising biomass sourcing and assessing level of renewablity and sustainability of sourcing
- Cooperation with other development institutions should be discussed, e.g. GIZ would be interested in a cooperation, such as “cooperation in the field of up-scaling of the program”, PPP model development for private enterprises, etc..
- Possible reputational risk are given due to issues related to work safety, working environment, pollution, non-sustainable biomass supply and child labour (e.g. in ceramic cluster). Allthough this issues are not under the control of TERI and often also not of the licences, it must be expected, that a dark shadow may always remain on the SDC supported technology if e.g. accidents are happening while filling wood into the thermal gasifier and during operations of the gasifier (exposure to heated lines carrying gas to the dryers). Please see also last bullet point above under “Thermal gasifier”.

- The credit proposal has not been translated fully into the LFA and areas like establishment of sustainable biomass supply chain in pilot basis and more equity to women is not included in LFA.[1]
- The technical and economical results of the TERI activities shall be reviewed in more detail and a Quality Assurance (QA) procedures shall be implemented. One possibility would be to adapt the TORs of the Swiss consultant (and DTU) accordingly.

[1] Ref; Document 1 " credit proposal . pdf" page 5 of 18, " the project will develop a method to analyze the supply chain of biomass in two districts of India and ***to establish a sustainable biomass supply on a pilot basis*** to ***bring in more equity to the poor and the women*** who are the ones involved in the collection and gathering."

Page 5 of 18 , table for „outcomes and outputs" , point 2.3 " ***sustainable biomass supply chain established*** in select target areas "

Pg 6 of 18 , point 3.III) under " demystify the biomass supply chain" " ***the result of the study will be used to establish sustainable biomass supply system on pilot basis***"

Ref document 3" TSBP Prodoc.pdf" page 18/40 under point 6.0 " expected results', sub point "Outcome 2" 2nd bullet point " ***Viability of biomass supply is assessed in 2 clusters and solutions to ensure viability are availability***"

Outcome 2 of logframe: Output 2.1: Methodology for assessing viability of biomass supply chain. Output 2.2: Viability of biomass supply is assessed in 2 clusters and solutions to ensure viability are available.

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Abbreviation:

BTG	Boiler Turbine Generator
CDM	Clean Development Mechanism
CHP	Combined Heat and Power
DIC	District Inspector council
DTU	Danmarks Tekniske Universitet
EE	Energy Efficiency
GHG	Green House Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit,
GPCC	Global Programme Climate Change
JV	Joint Venture
LFA	Log Frame Agreement
LSP	Local Service Provider
MEDA	Maharashtra Energy Development Agency
MNRE	Ministry of New and Renewable Energy
MSME	Micro Small and Medium Enterprise
NTPC	National Thermal Power Corporation
PPP	Public-Private Partnership
QA	Quality Assurance
ROI	Return on Investment
SDC	Swiss Development Agency
SIDBI	Small Industries Development Bank of India
TERI	The Energy Research Institute
TOR	Terms of Reference
TSBP	TERI SDC Biomass Project

1 TOR and Methodology Applied

The objective of the external review was to assess the overall performance of the TSBP project, including the impact, outcomes, outputs, partnerships, processes and opportunities for potential scaling-up and to make recommendations for a potential next phase. The review is providing a critical external view on how the SDC funded Biomass Energy program is being implemented in the ongoing phase as well as the achievements of the previous phases of the project and scope for improving the project strategy in the remaining duration of the project and beyond.

The evaluation team is presenting this report, basing on the project documentation received before the mission, the findings and observations made during the mission and the discussions with SDC and the Swiss project consultant after the mission. The evaluation team is not able to comment on project achievements and situations, which were not visited during the mission.

As the TORs for the evaluation team are stipulating that the review shall provide strategic inputs into the future direction of SDC/GPCC India's engagement in biomass energy and renewable energy technology and that TERI will use the results of the review to strengthen, expand and improve the quality of its services in the remaining duration of the project, it's in the nature of the evaluation, that critical aspects with a potential for improvement are more dominant highlighted than all positive aspects. This does absolutly not mean, that a lot of very positive and well functioning work was done by all involved parties, it only wants to show – according to the TORs – where the potential for improvement is.

The review is based on the set of criteria given through the TORs: impact, relevance, effectiveness, efficiency and sustainability. The review followed the key points/questions given in the TORs and tried to provide answers to all of them.

The review team first studied the documentations handed over in advance and in a second phase, during various meetings and field visits in India, completed their picture and impressions of the state of the project.

Most planned contacts and visits could be made and thereby the most important questions could be discussed and analysed. Visits at sites, were two stage gasifiers are or will be installed, were not possible, as the two stage gasifier is only operated in the TERI lab until today. Regarding the topic South-South cooperation, the comments made below are only based on the documentation provided and some short comments made by TERI during meetings.

The review team was composed out of 2 Consultants from Verde International AG (a Swiss and an Indian Expert) and a representative of SDC Switzerland, not being involved in the program to date.

2 Biomass

2.1 Site Observations:

Figure 1: Sized Wood supplied for use in gasifier

Figure 2: wood collected at plant site for sizing and use in gasifier

2.1.1 In field:

The 2 stage gasifier for power generation as well the thermal gasifiers using TERI design standards can actually only be feeded with wood sized to specific dimensions, suitable for these installations. No other biomass material in the form of agro waste or wood waste, like fine saw dust, or any other biomass residue was being tried out in any these places. The majority of the wood stock seen was being supplied by the TERI licenscees. Most of the operators of the gasifiers have arrangemets with the licensees for supply of the sized biomass material. An exeption is the licenscee in Ahmedhabad, he does not supply biomass. It was noted that the biomass feedstock is required to be sized into specific sizes which could then be fed to the gasifiers. All biomass waste had to be sized in order to be used in the gasifier. The job of sizing of biomass material required a degree of competency and reliability to deliver a permanent quality in order to be able to deliver biomass stock of accepable quality.

The thermal gasifier – as there is no mechanical forwarding system for the wood – is less critical with regard to a constant wood size, certain deviations are possible and could also be observed during the site visits.

The two stage gasifier is including in its first stage a screw moving the wood, therefore the quality requirements for a uniform size of the wood / biomass is much higher. The evaluation team is questioning, whether this quality demand can be reached in rural areas. This could be a hurdle in dissemination and long term sustainable application of this technology in rural areas.

Additionally it is to mention, that an important share of the equipment seen and used for wood sizing is highly unsafe and the danger of working accidents is high. Free running sawing blades, as seen by the evaluation team in the TERI lab installation in Delhi (see also Figure 2 above, in the background: wood sizing equipment (free running sawing blades) at pre-military training school in the surroundings of Kolhapur), are dangerous and an improvement is needed.

Most of the wood being used in the gasifier was supposed to be either

- Industry waste material, like rejects from saw mill and packaging industry or
- Hard wood bought from forest waste, auctioned from govt / non-govt agencies.

Renewability of hard wood, used in abundance in the areas visited, was identified as a major issue. In line with definition of "renewable Biomass" as per CDM methodology[2], Biomass which are originating from land areas which are forests can be classifed as Renewable only if,

- The land areas remain a forest and
- Sustainable management practices are undertaken on these land areas to ensure, in particular, that the level of carbon stocks on these land areas does not systemically decrease over time and
- National and regional forestry and nature conservation regulations are complied with.

Efforts must be made to ascertain that the above conditions are complied with in establishement of biomass supply chain involving woody biomass for the projects.

It was acknowledged by both the end users as well as the TERI licensses that secured supply of woody biomass is key to the success of the project. In order to solve the issue of secured supply of biomass most of the inteviewed TERI licensses were setting up their own biomass supply network so that enough amount of biomass is available to the end users.

The cost of biomass as evidenced from site is given in Table 1.

Sl. No.	**Area**	**Raw woody Biomass (INR / Kg)**	**Sized woody Biomass (INR / Kg)**
1	Ahmedabad	-	5 (waste from industries, sized)
2	Kolhapur	2.5	6~6.5
3	Belgaum	2.0	6.5~7.0
4	Bangalore	2.5	6~7

Table 1: Cost of Biomass in different areas.

The project acknowledges that availability of biomass in proper quantity and steady supply of biomass is central to the success of the project. The project thus included surplus availability study of biomass in 2 districts and to map the entire supply chain network therein. The biomass supply chain needs to be understood for accelerating usage of biomass based clean energy systems for power and thermal applications. Rapid and sustained uptake of biomass gasifier-based systems depends vitally on ensuring the organized collection of biomass and un-inturupted supply of biomass material to these gasifier systems.

A study was conducted at Belgaum to find out the surplus amont of biomass and to understand the supply chain network in the region. One of the objectives of the study was also to study of women in the biomass supply chain and to setup one sustainable biomass supply chain on a trial basis. As per the credit proposal for the project one of the objective of this study for demystifying biomass supply chain was also to understand the roles and capabilities of women as service providers in

[2] Refer EB 23, Annex 18 of UNFCCC CDM executive board meetings records.

these supply chain. The trial biomass supply chain was to include the option of strenthening the role of women in the supply chain.

The report " TERI SDC BIOMASS PROJECT DEMYSTIFICATION OF BIOMASS ASSESSMENT AND SUPPLY CHAIN, BELGAUM DISTRICT, KARNATAKA." evaluated the amount of biomass which is available in surplus in the region using a methodology which is more reliable and robust in nature. But the LFA as well as the project report does not identify means of enhancing the role of women in the biomass supply chain network. Neither does it help in setting up a supply chain in the Belgaun region as a test case.

The TSBP Project Document (03. TSBP Prodoc.pdf) identified on page 19 under 7.0 Activities; Thrust Area -1: Biomass Energy Technology Development; "The major activities include:", bullet number 7: "Development of gasifier for loose biomass (suitable for sectors like jaggery and milk processing etc. which show good potential for adopting gasifier based solutions)". The review did not find evidence during the visit, during the interaction with the local licensses, nor during the interaction with TERI of such technological developments or efforts.

2.2 Links of gasifier promotion with GPCC's focus on forest context

GPCC's mission is to foster climate-compatible development over the long term. Within these efforts, GPCC focuses on the importance of forests for sustainable development and local livelihoods. Forest affect the environement by providing ecosystem services which include watershed services as well as carbon sink services. Beyond the environmental services, local community can generate income from forest related acitivities which include sustainable harevesting of forest products. Managing forests and forest landscapes sustainably is of great relevance in strategies addressing both Climate Change and mitigation and adaptation. Deforestation and forest and land degradation combined are responsible for more than 20% of global GHG emissions. Forests protect ecosystems and social systems from extreme events and help them adapt to changing environmental conditions. Forests and trees also play a critical role in sequestering carbon dioxide and stocking carbon. Forests protect soil, water and biodiversity and provide an ever increasing number of woody fibers and other products that remain critical for sustainable development (source: Strategic Framework 2014–2017). Through the promotion of gasifiers that use woody biomass, TSBP is intrinsically linked with the wood suply chain. A increased focus on sustainble wood supply chains would strengthen the projects link to GPCC goals of sustianble forest management.

2.3 Information received from Swiss Project Consultant

After the mission to India, the PM of the evaluation team had the opportunity for a meeting with the Swiss project consultant. This meeting gave good insight in the actually planed and performed development work at TERI on the two stage gasifier. An important point of discussion was the possibility of the use of non-woody-biomass.

The main unsolved and open technical issue on the two stager is the control of the hight-level of the glow bed. The consultant discovered just recently a provider of low cost radar systems for such control and will iniciate a test installation on the plant in the TERI lab in Delhi. If this will lead to success within some months, a breakthrough towards steady producer-gas production and - as a consequence - also to a constant frequency of the power production will be reached.

After this issue will be solved, the consultant and TERI will also be able to start testing the use of agriwaste as fuel for the two stage gasifier. The feeding system (screw) has to further be adapted and developed towards the use of non-woody-biomass. It shall be possible, according to the information received, to reach results in 6 to 12 months.

2.4 National and Regional Policy

2.4.1 National Indian policy on Biomass based power generation

Strategic Plan for New and Renewable Energy sector for the Period 2011~2017:

In April 2002, renewable energy based power generation installed capacity was 3475 MW which was 2% of the total installed capacity in the country. As on 31.12.2010, it has reached 18,655 MW, which is about 11% of the total installed capacity.

(Source: http://mnre.gov.in/file-manager/UserFiles/strategic_plan_mnre_2011_17.pdf)

Technology / year	***Biomass / Agri Waste***	***Bagasse cogen***	***U&I Energy***	***SHP***	***Solar***	***Wind***	***Total targets***
Cummulative (anticipated upto 31.03.2011)	1025	1616	84	3040	35	13900	19683
2011~12	100	250	20	350	300	2400	3420
2012~13	80	300	25	300	800	2200	3705
2013~14	80	300	35	300	400	2200	3315
2014~15	80	250	45	300	400	2200	3275
2015~16	80	250	55	350	1000	2200	3935
2016~17	80	250	60	360	1100	2200	4050
Total for 6 years	**500**	**1600**	**240**	**1960**	**4000**	**13400**	**21700**
Cumulative total target	**1525**	**3216**	**324**	**5000**	**4035**	**27300**	**41400 (app.)**

Table 2: Year wise targets for grid interactive RE power for the period (2011~2017) (all figures in MW

Giving the following observation

- In grid connected power generation systems Biomass / Agro waste based power generation potential is targeted to amount to be around 3.6% of the total capacity which is insignificant.

2.4.2 National or Regional forestry and nature conservation regulation and Central policy on biomass gasification and National Bio-energy mission.

The state policies with respect to utilization of forest waste varies from state to state. The summary of the policies is provided in the annexure.

The govt. policy on biomass gassification is detailed under the Ministry of New and Renewable energy (http://mnre.gov.in/schemes/offgrid/biomass/) and it states that

"The Ministry is promoting multifaceted biomass gasifier based power plants for producing electricity using locally available biomass resources such as wood chips, rice husk, arhar stalks, cotton stalks and other agro-residues in rural areas. The main components of the biomass gasifier programmes are:

i. Distributed / Off-grid power for Rural Areas
ii. Captive power generation applications in Rice Mills and other industries.
iii. Tail end grid connected power projects up to 2 MW capacities.

3. The focus of the biomass gasifier program is to meet captive electrical and thermal needs of rice mills and other industries which in turn help in replacing / saving of conventional fuels such as coal, diesel, furnace oil etc. In addition, to provide unmet demand of electricity for villages for lighting, water pumping and micro-enterprises. Emphasis is also given for setting up of small biomass gasifier based power plants up to 2 MW capacities connected at the tail end of grid as it provides multiple benefits such as reducing T&D losses, ensuring sustainable supply of biomass, access to electricity in villages etc. "

The government policy thus encourages use of wood chips as well as biomass residues which are locally available sucah rice husk, arhar stalks, cotton stalks etc. These biomass feedstocks are envisioned to not only provide power but also thermal energy to industries.

The biomass used in the project activity if origninating from the forests would need to comply with the CDM requirements for demonstrating that it is renewable in nature.

The goverment has planned to launch a National Bio Energy Mission, as biomass based rural off grid energy genration model has shown huge replication potential. Under the proposed National Bio Energy mission , detailed under the 12th Planning commission[3], the objective is to create a policy framework for attracting investments and to facilitate rapid development of commercial biomass energy market based on utilization of surplus agro-residue and development of energy plantations.

Thus future outlook for biomass based systems is on Agro Residue and Energy plantation based system.

The Planning Commission of India has developed an energy scenario building tool, the India Energy Security Scenarios 2047, which explores a range of potential future energy scenarios for India, for diverse energy demand and supply sectors leading upto 2047[4].

For the Bio- Energy sector under the section "Biomass residue production and End-usage" it is detailed that bioenergy production in india are made up of agricultural residue, forest residue, sugarcane molasses based bioethanol, jatropha biodiesel and Biogas.

[3] http://planningcommission.gov.in/plans/planrel/12thplan/pdf/12fyp_vol2.pdf
[4] http://indiaenergy.gov.in/index.php

The future outlook presents the Bio-energy sector as below :

"Bioenergy production is already estimated to be about 1842 TWhr/year (25% of the total energy consumption of India. The biomass residues are mainly used for cooking. Part of agri-residue (about 15 million tons) is used for power generation (2.5 GW). The agri-residue that accounts for bioenergy is 67% of the residue that is not used as animal fodder (287 million tons (dry)). This split is maintained in future for all the four levels, leaving the other 33% constant for other uses. The agri-residue productivity is projected to increase from 0 to 1% (annual) across the four levels. As for forestry residue, 160-180 million tons/year (dry) is rated to be the sustainable limit for recovery from forests and it is extended across the four levels accordingly.Presently most of the agri-residue used for bioenergy is used as solid fuel for cooking (62% out of 67%). The remaining fraction is used for power generation (5% out of 67%). The forestry residue is entirely used for cooking. The biomass residue used for cooking is used inefficiently in traditional cookstoves. Improved-efficiency cookstoves are expected to be used in future. The proportion of agri-residue is projected to increase for power generation applications in future (10-30% out of 67% across the four levels). Agri-residue is also expected to be converted to liquid transportation fuels in future (4-30% out of 67% across the four levels) as the conversion technologies mature. Transportation fuels have a critical implication on the nation's economy given the huge strain placed by the crude oil import bill (6,000 billion rupees). The split that is used for cooking as solid fuel is projected to decrease from the present 62% (out of 67%) to 53-11% across the four levels. The forestry biomass is modeled to be used only for cooking as solid fuel across all the four levels[5]".

The future energy modelling as given in the vision document for "India energy scenario 2047" is more electricity generation centric but carrys an element that cautions that forestry biomass should be used only for cooking purpose under all the 4 scenarios.

The evaluation team observed, basing mostly on verbal coments made by licensees or even by clients of the licensees, that there may be differences or inconsistencies in policy or legal regulations between different states and between national and state levels.

2.5 Interaction with Central and State agencies

2.5.1 Ministry of New and Renewable Energy (MNRE)

The review team met with the Director of MNRE, Dr. V K Jain and the Director of Biomass based power generation, Mr. Khare. During the interaction with MNRE the following observations were made

- The government of India does not encourage the use of woody biomass for energy generation , focus is on utilizing locally available biomass residue rather than woody biomass.
- A lot of policies have been put in place to encourage electricity generation from biomass stocks for rural electrification these include capital susidies, preferential tariffs, tax benefits and excise benefits etc. Policy support for thermal systems is only in the form of capital subsidy for thermal installations .

[5] http://indiaenergy.gov.in/bioenergy.php

- MNRE does not encourage biomass collection from discreet locations, but on the contrary encourage utilizing biomass residue at source to generate energy. This would help in lowering cost of biomass if used locally as it would avoiding transportation related cost.
- MNRE in prinicple also does not encourage energy plantation as it has other related environmental impacts on land change and change in land utilization patterns.
- For MNRE utilization of wood industry residues is acceptable, e.g. saw dust and waste wood from plywood industry.
- The evaluation team found, that there could be some contradictions between the "spoken and the written" word, e.g. policy documents.

2.5.2 Interaction with Maharashtra Energy Development Agency (MEDA)

The review team met with the Manager of bio-energy and of energy conservation at MEDA office at Pune and made the following observations.

- MEDA has no program at this point in time for promotion of biomass gasifiers for thermal applications.
- As per MEDA they can only provide assitance to entities who are registrered with MNRE as service providers in specific technology segments like biomass gasifiers in this case, as the local licensses are not enlisted / do not appear on MNRE website they would not be able to get the full asisstance of MEDA.
- Focus is on rural electrification and on MW scale power generation units using either the Boiler Turbing based Generation (BTG) route or gasification route.
- MEDA feels that there could be good potential for use of gasifier technology in MSME, but they are not aware of the technological developement and the success of this technology in MSME segment.

2.6 Assessment with respect to TOR criteria for Biomass

TOR	Questions / Criteria	assessment / opinion of the review team
1.	Discuss Context and Relevance	

	Relevance of biomass energy technologies in India's Energy mix and renewable energy sector	Biomass based energy systems is one of the areas under development amongst the renewable energy options in India. A total of around 550 Million tons of agro waste is generated out of which around 150~200 million tons are utilized, thus leaving a surplus agro residue of around 300 Million tons. Focus should be on utilizing agro waste at the source/point of generation. Wood from forests should only be used if its waste. Biomass based gassfiication systems are encouraged under govt. policies for both thermal and electrical ouputs, the power generation systems are envisioned to be connected to the tail end of the grid and this would result in a lot of associated benefits including social and economical benefits.
	Relevance of biomass energy technologies in meeting energy needs of India's MSME sector.	Biomass based energy systems are relevant for certain MSME sectors and are also recognized as EE measures under schemes by financial institutions like SIDBI. All biomass based technologies should comply with pollution guidelines and the biomass sourcing should be according to the government policy (see above) . In our visits we have seen that biomass based thermal systems are more acceptable in larger units with respect to ROI. For micro enterprises upfront investment is a barrier, which could be overcome by capital incentives.
2	Discuss Impacts	
	Has the project adapted adequately during the 1994-2013 as per the changing external energy sector policy and regulatory environment?	We have not found instances where the strategy deviated from governmental policies. Sustainability and renewability of biomass being used in the project needs to be further analysed to keep the program in line with GHG reduction requirement. Agro waste should have been taken into account during implementation.
3	Discuss Effectiveness and Efficiency of Strategy	
	Are the project outcomes and outputs of the 3 yrs phase in alignment with the originally defined objectives.	See A2 for details.
4	Sustainability	

	Should the project consolidate its activities in the present sectors/clusters or expand to new sectors/clusters? Which are the other sectors/clusters where the project should expand?	Automation and use of other biomass type (agro residue) will be accelerated in the program through further developments (radar control and feeding system, see 2.2). Use of sustianble sourced wood fuels should be complemented by utilizing agro-residue.
	Should the project focus on technology development or on up-scaling? What strategies project needs to adapt for accelerating the diffusion of thermal gasifiers for MSMEs and for off-grid/grid-connected rural electrification?	Technology development must be re-focused on utilizing agri waste. Rural Electrification should be in line with govt policies and should be continued but with checks and balances and definitive milestones.
	How can the project engage more closely with the government (national and state)?	Information dissemination and regular updates / newsletters must be shared with DIC's and state level authorities. Success stories must be showcased to the authorities. TERI needs to work more closely with industries and government on introducing automation controls and systems in the product design.
	What would be the role of other stakeholders like academic/research institutions that can complement project efforts	Re-alignment of the program with respect to agro waste is needed, if TERI is unable to take up the same new stakeholders must be brought into the program.

Table 3: Assessment with respect to TOR criteria for Biomass

3 Thermal Gasifier

3.1 Site Observations

Figure 3: Thermal Gasifier for sand drying

Figure 4: Thermal gasifier for food prep.

In field:

TERI design for gasifiers for thermal application are being promoted among MSME segments through the local licensees and they are responsible for the marketing, installation and upkeeping of the installations.

Around 54 gasifiers have been installed during the last 2 years (2013-14) covering new application areas across the country. The relatively new applications areas have been developed over the years by the Local Service Providers and Licensees.

Some concerns related to work safety were observed during site visit, they include:

- Non availability of proper charging platform for wood resulting in people standing atop the gasifier which is highly unsafe.
- Leakage from flanges and ducts carrying the gas was observed and this may pose fire hazards.
- Lack of insulation on the hot line carrying gas to burner is a safety hazard. Accident was reported at one installation due to the same.
- Flame out during grating movement was observed and the mechanism for burner lighting was found to be crude and not safe.

During the site visit it was reiterated by the state agencies as well by the DIC that the gasifiers must be able to fulfill the pollution norms of the state agencies. The financial agencies like SIDBI also emphasised that all such programs must be able to demonstrate that they, when functional, fullfill environmental norms. One entity during the site visit complained of severe dusting and fume generation during the wood recharging stage resulting in pollution as well as health hazards to the operating personnel.

According to the evaluation team's findings, TERI did not yet analyse the environmental impacts of the thermal gasifiers which are being installed as part of the program and thus adherance to pollution norms could not be adjudged during the evaluation.

Monitoring of the installed gasifiers as part of the program was found to be severly lacking in the program. Although the licensees share the information of number of new installations which have

happened during the year, no information is available on the status of the gasifiers which have been already installed as part of the program. So at any point in time it is not known as to how many of the gasifiers are functional under the program. Licensees informed that although the co-ordination with TERI till the implementation stage is good, but after installation there is no monitoring that happens on the ground. Any distruption or bottleneck at the site are not analysed for rectification and the knowledge is also not dessiminated across licensees so that potential repetition of the problem could be avoided.

Automation for promotion of thermal gasifiers in new applications was a thrust area during the current phase of the TSBP program. Although the prototype installation was done at TERI Gwal Pahari installation and one TERI Licencee was brought down to demonstrate the same, licensees reported that no such functioning system was available from TERI. Supporting the importance stated in project documents of the output "automation system for thermal gasifier developped" the elvaluation team felt the need for automation during the site visits and several new application areas of thermal gasifiers would need to have automation built into the design.

New application areas like bangle manufacturing and jaggary manufacturing were identified by some licensees as new areas which needed modification of the gasifier to be able to use other biomass feedstock. This part of the development work was not completed during this period and some work on utilization of pine needle was found to have carried out by TERI, but was not successful. As jaggery making is a short duration activity and unit owners may be not keen on acquiring technology, this was not a focus area in the past.

The promotion of thermal gasifiers in MSME segment required that the licensees are well trained in the technology being offered by TERI and is provided with adequate training material and tools for dissimination of knowledge to the client. Although the licensees were found to be aware of the TERI technology but the training material were found to be lacking at the companies using the gasifiers and this could lead to significant impact on the running of the project. They include

- Update of the training material to include the latest changes in the gasifier offerings, the training material available at Kolhapur was of 2009 and one at Belgaum was of 2007.
- The training material has to be translated into local language so that the worksmen who operate the gasfiers at the installation sites can use them and keep themselves abreast on the technical aspects.
- The training material has to include instruction on safety related matters and do/donts on safety related matter.
- The training material was found lacking with respect to maintenance checklists and periodical check points which needs to be adhered to for a trouble free gasifier operation.

Of the 54 numbers of gasifiers which were installed during the last 2.5 years the distribution of the gasifiers among the MSME segment is as follows:

Sector	No. of Installations	%age
Micro	15	28%
Small	39	72%
Medium	0	0%

Table 4: Distribution of gasifiers among the MSME segment

Thus penetration in the micro scale category of entities has been limited and the primary barrier to this promotion is upfront investment cost. Although the payback of these installations are only in

months, in some cases days, micro scale organisations have problems in arranging for funds for these project. Governmental incentives in the form of capital incentives would help in further penertration of this technology among the micro scale category projects.

3.2 Assessment with respect to TOR criteria for thermal gasifiers

TOR	Questions / Criteria	assessment / opinion of the review team
1.	**Discuss Context and Relevance**	
	Relevance of the strategy and approach followed under the project	Strategy and approach as per the project outline are relevant. Alternative to wood fuel, the usability of agricultural waste should and will be developed. Relevant considerations for the thermal gasifier, like GHG accounting, pollution control, non-woody-biomass supply were not in focus in project implementation.
	Contribution to GPCC goals and objectives	Relevant GPCC goals and objectives are: innovative projects, Swissness component, mitigate risks of CC, preserve natural resource, The program to bring gasifiers to MSME sectors is innovative as well as the tar free electrical energy generation program. The Swissness component is missing. The mitigation of CC risk and preservation of natural resource depends on the type and renewability of biomass being used in the project. The evaluation team, based on its observations and interactions during the field visit, had some questions about the sustainability of the sourced wood for the gasifiers. In the case that wood should not be sourced from sustainable sources, there would be a possible conflict between SDC's programs regarding de-forestation and the technology promoted and existing wood supply chains used.
2	**Discuss Impacts**	
	What have been the pioneering contribution of the TSBP and the biomass components of the TSBP in the field of biomass energy, clean energy technol-	The use of biomass energy in certain MSME clusters (e.g. foundry, ceramic) has been pioneering. But introduction of other biomass feed stock for

	ogy diffusion and mitigation?	gasifier, use of biomass gasification in by different licensees identified new sectors are missing.
	Was the project engaged with the right mix of stakeholders.	Yes, but roles of State Pollution Control Board, MNRE, Ministry of Forestry (wood utilisation policy) and Financial institutions have not been evidenced in the project. Rural communities and livelihood clusters at sites with available agro waste should be selected, once the technology is available.
	What are the innovations in low emissions development, which was effectively addressed under the project and with what results?	GHG emission reduction has been effective in case of use of renewable biomass but the quantification methodology is not in place, emissions of pollutants (beyond tar) have not been measured.
	What have been the impacts in terms of technology transfer in thermal and rural electricity generation systems.	Impacts of thermal applications: • generation of biomass based energy systems resulting in savings in MSME segments, we observed that mainly larger units are using the systems • the biomass supply chain established and new market mechanism evolved for biomass supply, • awareness created among MSME clusters in biomass based energy system tech transfer. District Industrial Centres / State agencies are not fully aware of the progress of the program and benefits that has happened due to the installations.
	What was the impact and learning of the knowledge management effort including sharing of technology designs for thermal gasifiers with the licensees?	The core design is transferred from TERI to the licensees but all improvement and adaptations to applications areas are made by licensees and not shared fully with TERI and not at all with other licensees due to market competition among licensees. Reason for lack of knowledge sharing among licensees is the non-exclusive contracts (with respect to Clusters as well as geography) between TERI and licensees.
3	Discuss Effectiveness and Efficiency of Strategy	

	Is the choice of focus sectors/clusters suitable?	Sectors / clusters taken up under the program are okay.
	How effective has the project been in linking implementation actions with policies.	Listing of licensees with MNRE for being authorised for subsidies application could increase the number of implementations. Communication with state agencies on project development not proper and they not aware on the success of program as reported by MEDA/ DIC's of Chennai and Bangalore.
	Was the approach and the up-scaling strategy followed by the project adequate?	Up-scaling done through new licensees and market support by TERI. Licensees upscale based on economics and their market outreach. Up-scaling strategies as outlined by TOR, eg. automation, use of other biomass feedstock and establishment of sustainable biomass supply chain not found.
	What are the impacts and learning from the project in terms of capacity development of TERI and other partners, especially the licensees?	Impacts: Licensees have learned about the technology and how they can be adapted to specific application, they learned that secured biomass supply was key to success and they established mechanisms. Some licensees changed their market approach to reach businesses. But the training material for licensees needs to be updated with inclusion of local language, standard operating procedures and proper maintenance checkpoints.
	Are the project outcomes and outputs of the 3 yrs phase in alignment with the originally defined objectives.	See A2 for details.
	How effective are the monitoring instruments used at different levels for project implementation.	Data for evaluating effectiveness not available. Reporting could also be a transparency problem (taxes).
	Was the project efficient and effective related to use of SDC funds (cost effectiveness and financial sustainability)	We are not aware of how much was spent in total. See above.
4	Sustainability	

	Should the project consolidate its activities in the present sectors/clusters or expand to new sectors/clusters? Which are the other sectors/clusters where the project should expand?	Automation and access to subsidy and other biomass type (agro residue) should be accelerated in the program. SDC / Consultant must monitor the project progress from close range and monitor the program at licensees's levels. Replication of technology in sectors across the geography must be done. The problem of licensing and knowledge sharing must be taken care of. Focus should be on utilizing agro-residue and not wood waste under the program
	Should the project focus on technology development or on up-scaling? What strategies project needs to adapt for accelerating the diffusion of thermal gasifiers for MSMEs and for off-grid/grid-connected rural electrification?	Further technology development shall be focused on utilizing agri waste. The project must keep up-scaling the thermal gasifiers using automation and new designs for new sectors.
	How can the project engage more closely with the government (national and state)?	Information dissemination and regular updates / newsletters must be shared with DIC's and state level authorities. Success stories must be showcased to the authorities. Several licensees want to be assisted in getting listed on MNRE website and SIDBI website, they expect that implemetations will then get better access to subsidies.
	What would be the role of other stakeholders like academic/research institutions that can complement project efforts	Re-alignment of the program with respect to agro waste is needed, if TERI is unable to take up the same new stakeholders must be brought into the program.

Table 5: Assessment with respect to TOR criteria for thermal gasifiers

4 Two Stage Gasifier for Electricity Generation

4.1 Site Observations:

Figure: Prototype 2 stage gassifier at Gwal Pahari

Figure: Fabrication of a two-stage gasifier at Kolhapur.

B: 2 STAGE GASIFIER (PROTOTYPE) AT TERI GWAL PAHARI

The two stage gasifier is still limited to the prototype which has been installed at TERI Gwal Pahari and has run on an avearge of 4~5 hrs per day. The feedstock used in the prototype is wood sized to around 2 Inch size, only wook stock is used in the prototype unit.

Technological advancement in form of introduction of automation has been made in the prototype and of all the modifications the bed control of the biomass material is found to be one of the critical of all the modificaitons done. Due to the expensive nature of this bed control mechanism efforts are „on“ to make the automation afforable and locally avialble. Work on the same is still in progress and has not been completed.

The project eonomics of generating power from a two Stage gasifier system does not work out favourably unless additional benefits in form of central subsistence and preferential tariffs are provided to the project. Capital incentives during setting up of project would not be able to make the project economically viable unless generation based incentives are provided on an ongoing basis. Even at the best fuel to energy ratio for the two stage gassfier , i.e. 1 kg/KWh of energy generation, the cost of generation works out to be higher than grid power due to the high cost of sized wood[6]. The projects can only be financially viable if they replace highly costly High Speed Diesel based energy systems which are used by commercial setups in areas where grid power is not available.

[6] Based on the observed cost of 5~6 INR / kg of sized wood used in the gasifiers.

During the site selection phase Sites were selected based on[7] :

- Status of electrification – Sites which had grid setup but did not have consistant power supply were taken up.
- Income generation acivity – sites which has micro-enterprises which would benefit from the project were selected.
- Institutional suitability and stability-
- Villagers willingess to participate
- Spread of the village and
- Avaialibility of biomass.

Economics viability of the 2 Stage gasifier system for electricity generation for areas where grid setup did not exist and where no commercial load exists needs to be assessed and mechanism to bridge the viabality gap needs to be found.

NTPC was one of the stakeholders in the program and the first 2 sites were supposed to be identified and offered by NTPC for deployment of this technology. Policy change at NTPC corporate resulted in NTPC dropping out of the project and TERI had to look out for partners who would be able to finance the project.

At present 2 different sites have been identified. One at Koraput and another at Rayagada have been indentified based on the study carried by TERI. The two stage gasifier is being fabricated at Chandrapur Works for deployment at the 2 sites. SDC has decided to fund two of four projects to be taken up under the program.

As the technology has not been deployed at site, the team could not assess the following crucial aspects of the project.

- Specific fuel consumption per tonne of power generated
- Ability to provide un-interupted power to the livelihood clusters in the region under field conditions
- Performance of the unit with respect to other type of biomass material
- Performance of the unit with respect to tar formation and removal as part of the design at an actual site of installation.
- Operability and maintainability of the unit.
- Ability of the local rural population to be able to operate and maintain the system.

As mentions also in chapter 2.2. of this report, after the mission to India, the PM of the evaluation team had to opportunity for a meeting with the Swiss project consultant. This meeting gave good insight in the actually planed and performed development work at TERI on the two stage gasifier.

The main unsolved and open technical issue on the two stager is the control of the hight-level of the glow bed. The consultant discovered just recently a provider of low cost radar systems for such control and will iniciate a test installation on the plant in the TERI lab in Delhi. If this will lead to success within some months, a breakthrough towards steady producer-gas production and - as a consequence - also to a constant frequency of the power production will be reached.

[7] TERI presentation at Guwalpahari – TSBP_external review outcome1-NOV2014 – sunil 2 page ref.pptx.

The feeding system (screw) has to further be adapted and developed towards the use of non-woody-biomass. It shall be possible, according to the information received, to reach results in 6 to 12 months.

The evaluation team is therefore recommending to observe the further technical development of the two stage gasifier closely. The Swiss project consultant is convinced to be able to present soon next encouraging results.

4.2 Review of project documentation

Economics of Village Gassifier Rayagada: TERI has carried out the economic analysis of the two stage gasifier system for village electrification and supply to Nutrimix plant at Odisha. Following are the observations on the The economic model as worked out by TERI:

- Specific fuel consumption rate is taken as 1 kg/unit of power which is the best performing point of the gasifiers. For conservative estimation the worst case scenario should have been taken.
- Cost of biomass at local markets is taken @ 2.1 INR/kg where as during the field visits the minimum price encountered for sized woody biomass at industrial sites was @ 5~5.5 INR/kg.
- No justification has been provided for the tariff structure (used by the distribution utility) used for lighting load and productive load in the economic model. Thus the assumptions used in the economic model could not be validated.
- No price / cost has been allocated for the land on which the unit would be setup. It is planned that the land would be leased out for the power generation unit and thus a lease amount should be allocated for economic model.
- The electrical output from the plant has captive load (industrial + household) for only 13 hrs per day, it is not understood if the plant would be shutdown for the rest of the period. If so, then it would entain starting up the plant afresh everyday and thus limiting the lifetime of the unit.
- The cost of biomass has been taken on the net load delivered by the plant and not on the gross power that would have to be generated to meet the net output. 10% auxilliary consumption has not been accounted for in the economic model.
- No maintenance cost is allocated for the gassifier over the 15 years lifetime as used in the economic model.
- The Economic model does not include senstitivity analysis of the key parameters like change in domestic and industrial load, change in cost of biomass etc and thus it is not possible to evaluate the robustness of the economic model. Initial estimates indicate that the economics of the proposal is dependent on the amount of power delivered to the Nutrimix unit and the collection from these units. A change in load pattern by around 15% renders the economic model unviable. The economic model also does not include any working capital and assumptions of deferred payment which are normal for Indian power setups. Thus the model would need to be re-worked to check the economic viability of the setup.

Detailed project report for provision of basic electricity for lighting and power for productive needs of micro-enterprises in Rayagada, Odisha:

The report evaluates the site conditions and viability of setting up a electricity generation system at Rayagada district of Odisha. The values and facts as given in the above mentioned reports do not match with the economic model for the project.

The following are the major observations on the contents of the report.

- In the economic model the domestic load is assumed to be for 5 hours but the report details the changeover from 5PM to 9PM which is a period of 4 hours only.
- Under section 2.1.2 it is stated that potential "unelectrified Villages" were mapped in the districts identfied in consultation with the state agencies. The statistics of the selected site states that 83% of the households have access to electricity and there is an electrical grid existing in the village.
- Although the study report under section 3.3 states, that on an average 3 hours of electricity at the villages from the grid, but there are long periods of outage during the monsoon seasons. It is not evident, as to how this 3 hours of electricity has been factored in the economic model. In the model it is assumed, that the productive load which is required for 8 hrs and the domestic load which is required for 5 hours will be met from the proposed gassifier based electricity generation unit.
- The economic model is based on annual generation of 55920 Kwh of power but the biomass availability study assumes 117000 Kwh of annual power generation. The study shows that there would not be enough woody biomass for use in the project.
- Under section 3.7.1 the report states that "*During the village level discussions, it was revealed that no surplus wood could be collected from these plantation areas. The constitutional 73rd amendments in Panchayatraj Act have allowed control of Gram Panchayat over these resources. The woods collected from dead/matured trees of these plantations are auctioned by the Panchayats. Villagers in need of wood for domestic consumption are provided with the same on payment of cost. The villagers only have free access to these areas for collection of falling leaves. Hence only dry leaves have been considered as the available biomass from these plantations.*". As per the biomass survey only 7 Tonnes of woody biomass in the form of twigs and branches is available at site. It is not understandable as to how the requirement of 56 tonnes of biomass would be met for the plant as the plant design is only for woody biomass of specific sizing and not for dry leaves and other stock.
- Section 3.7.4 states that as against a annual surplus availability of 184.6 tonnes of biomass from the region as found during the surplus biomass availability study there is further scope of woody biomass collection of around 75 tonnes per month which amounts to around 900 tonnes of woody biomass per year and the statement is not qualified with proof of from where the biomass would be available and how such huge amount of biomass is available when as per law no wood is available for commercial use in the region.

Thus the facts and figures as given in the detailed project report is not alligned to that of the economic model and there are issues with respect to availability of biomass and economic viability of the project in itself.

4.3 Interaction with Central and State agencies

4.3.1 Ministry of New and Renewable Energy (MNRE)

The review team met with the Director of MNRE, Dr. V K Jain and the Director of Biomass based power generation, Mr. Khare. During the interaction with MNRE the following observations were made

The government of India does not encourage the use of woody biomass for energy generation, focus is on utilizing biomass residue rather than woody biomass.

Small (kW sized) distributed power generation systems based on locally available biomass is in line with governments policy on biomass gasification based electrical and thermal systems. Thurst is on usage of renewable and sustainable biomass material in such installations.

For MNRE utilization of wood industry residues is acceptable, e.g. saw dust and waste wood from plywood industry.

4.3.2 Interaction with Maharastra Energy Development Agency (MEDA)

The review team met with the Manager of bio-energy and of energy conservation at MEDA office at Pune and following are the observations.

Focus is on rural electrification and on MW scale power generation units using either the Boiler Trubine Generator (BTG) route or gasification route.

There are several pockets in the rural sector where this technology could be used for distributed power generation

4.4 Assessment with respect to TOR criteria for two stage gasifiers

TOR	Questions / Criteria	assessment / opinion of the review team
1.	Discuss Context and Relevance	
	Relevance of the strategy and approach followed under the project	Strategy and approach as per the project outline are relevant. Alternative to wood fuel, the usability of agricultural waste should and will be developed.
	Contribution to GPCC goals and objectives	Relevant GPCC goals and objectives are: innovative projects, Swissness component, mitigate risks of CC, preserve natural resource. The program to develop the tar free electrical energy generation program is innovative. It is innovative, that the unit will use the local grid to power the households by isolating the grid from the regional network, this removes the requirement for grid synchonization setup which is costly as well as a problem for so small producers.

		The Swissness component is missing. The mitigation of CC risk and preservation of natural resource depends on the type and renewability of biomass being used in the project.
2	Discuss Impacts	
	Assessment of the overall achievements (accountability) of the project in terms of outreach, viability and sustainability of the outcomes and impact, at the level of project stakeholders.	Not discussed as two stage gasifier has not been deployed at the time of the evaluation.
	Was the project engaged with the right mix of stakeholders.	Due to change in internal policy, NTPC was no longer a proper partner to engage in this project. Post setting up the pilot projects during the process of commercial deployment of this technology other relevent stakeholders like State pollution control boards (SPCB), financial institutions should be engaged.
	What are the innovations in low emissions development, which was effectively addressed under the project and with what results?	GHG emission reduction has been effective in case of use of renewable biomass but the quantification methodology has a lot of assumption which would result in over estimation of ER's associated with the project. Aspects like renewability of biomass and project emissions associated with transportation and preparing of biomass feedstock has not been factored in the methodology, emissions of pollutants (beyond tar) have not been measured. Emissions from 2 stage electrical system will be known after field trials.
	What has been the impacts in terms of technology transfer in thermal and rural electricity generation systems.	Impacts associated with rural electiricy generation systems cannot be assessed as they are not installed and commissioned on the field.
3	Discuss Effectiveness and Efficiency of Strategy	
	Is the choice of focus sectors/clusters suitable?	Please refer remark on selection of sites with available agro waste residues.
	How effective has the project been in linking implementation actions with policies.	The project with respect to electricity generation from tar free gasification route has not been implemented till now

	Was the approach and the up-scaling strategy followed by the project adequate?	Development of a tar free model for electrical system is an innovation but it has not progressed to the extent it should have in the project. While the approach is okay it has not translated to real action.
	Are the project outcomes and outputs of the 3 yrs phase in alignment with the originally defined objectives.	See A2 for details.
	How effective are the monitoring instruments used at different levels for project implementation.	Data for evaluating effectiveness not available. Reporting of producition figures could also be a transparency problem (taxes) towards state authorities.
	Was the project efficient and effective related to use of SDC funds (cost effectiveness and financial sustainability)	We are not aware of how much was spent in total. See above.
4	Sustainability	
	Should the project focus on technology development or on up-scaling? What strategies project needs to adapt for accelerating the diffusion of thermal gasifiers for MSMEs and for off-grid/grid-connected rural electrification?	Technology development must be re-focused on utilizing agri waste. The project for the 2 stage gasifier system the program may be continued with clear timeline and deliverables at definitive time intervals.
	What would be the role of other stakeholders like academic/research institutions that can complement project efforts	Re-alignment of the program with respect to agro waste is needed, if TERI is unable to take up the same new stakeholders must be brought into the program.

Table 6: Assessment with respect to TOR criteria for two stage gasifiers

5 Overview of the Current Situation on R&D and on Markets

Additionally to the TORs, the consultants would like to give a brief overview of the current situation on international market and in research in the field of small systems (around 20kW).

5.1 State of research and development

Several organisations are currently engaged in research in the field of biomass gasification. Below is a brief overview of the current situation.

btg - biomass technology group has developed a two-stage process, which is produceing a clean synthesis gas. This gas is suitable for powering a engine to generate electricity, as well as for direct thermal use.
A fast pyrolyses takes place in the first stage (around 500°C). The resulting organic vapor is subsequently converted, with the use of catalysts, in the second stage in a clean synthesis gas. No thermal energy has to be supplied from outside for this autothermal process.
This system is still in the testing phase and is not yet ready for the market. The headquartered of btg - biomass technology group is in Enschede, Netherlands.
http://www.btgworld.com/en/rtd/technologies/gasification

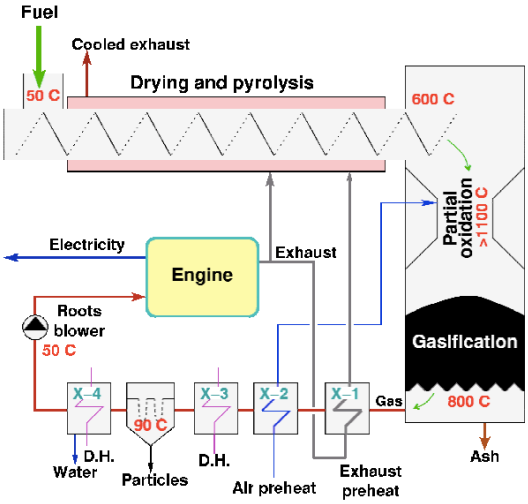

Figure 5: Schema of a two stage gasifier, such as the "Viking".

The **Biomass Gasification Group, MEK, DTU** has conducted in the year 2003 a long-term test with a two-stage gasifier, called "Viking". This CHP-System generates a thermal output of 75kW. “Viking” produces an low-tar gas, which is suitable for powering a engine to produce electricity. During the trial periode in 2003, the plant was operated for 435 hours , therefrom 190 hours without interruption.
As it is usual for two-stage systems, in the first stage the pyrolysis at relatively low temperatures occurs. The resulting vapor is subsequently oxidized in the second stage with pre-heated air to producergas. This gasifier achieves an efficiency of 25%.
As feed material wood chips were used during nearly the complete test periode.
http://gekgasifier.pbworks.com/f/Viking_Gasifier-designcontructiontesting.pdf

The **IEA Bioenergy Task 33** creates an overview of the current state of research, existing and projected systems. This forum allows an exchange of knowledge in the field of biomass gasification.
http://www.ieatask33.org

5.2 Producers

The following manufacturers offer biomass gasifiers producing synthesis gas for direct use. Some of them offer combined solutions with a generater directly build in.

Black Mountain Woodfuels and Ankur Scientific:
The companies together have designed an tar free model of gasifiers for use in power generation. The company has successfully developed and commercialized a wide range of biomass gasifiers ranging in size from as small as 5 kWe output to 2200 kWe output. A number of field installations both in industrial applications and in applications like rural electrification are a testimony not only to the long-term reliability of the gasifiers, but also of the growing acceptance of the technology developed by the company. The company now has installations in Sri Lanka, Uganda, Cambodia, Italy, U.S.A, Colombia, Australia etc. Many of these clients chose Ankur’s technology after a highly rigorous technical evaluation effectively proving Ankur’s technical prowess and developmental skills.
Ankur Scientific is a TUV certified ISO 9000, ISO 14000 and OHSAS 18000 company. The Company’s products are CE certified. This certificate by a stringent third party auditor not only certifies the functionality of the product but also the safety and emission norms met by the same.

Chogan Powers Private Limited:
The company has supposidly developed the World's first very high temperature tar free biomass gasifier in combination mode of updraft and downdraft and uses multi fuel biomass at extreme conditions i.e. upto 35% moisture content and high ash content. The technology has been commercialised and is avialable for the market.

GB Consulting s.r.o. together with IE India Pvt. Ltd.
These companies who are famous leader in conversion of biomass into electrical and thermal energy and biomass technologies in global market. As a technology focused company has IE India Pvt. Ltd. two decades of experience in solutions using biomass for energy production.
In 2012 the company IE India Pvt. Ltd. signed a technological partnership with GB Gasifired Europe to improve biomass gasification technology. GB Gasifired Europe provides development and research gasification technology, the manufacturing and sale of technology for the European and American market.
Over the years, the company IE India Pvt. Ltd. has established good name in the uses of biomass and designed and developed its own original variety of systems for biomass gasification, pyrolysis of biomass, biomass briquetting and drying of biomass.
They have developed Gasification units based on the principle of flow drift and able to transform any biomass to Syn-Gas of high quality and with an insignificant proportion of tar. The only limitation of the gasification unit is the size of fuel < 3 mm. Universal gasification units are unique in their ability to gasify even a low quality fuels, such as soy beans, cereal straw and rapeseed, mustard stalks, sunflower hulls, oily skin, etc., containing a high proportion of ash and low quality flow.
Technology and unique design of the reactor and effective drying system are the result of more than fifteen years of continuous development.

Btek Renewable Energy Products
The companie offers a viarity of different gasifiers, producing between 10m^3 and 20m^3 of gas per hour. For a small gasifier, which is cabale of transforming 8-14kg of biomass into 10-15m^3 gas per hour, the charge about $ 1'999.- (exkl. costs for taxes and shipping). The combined system with a electricity output of 20kWe costs installed $ 40'000.-.
Those gasifiers are able to handle a variety of different types of biomass, such as wood chips, hay, grass or corn cobs. The synthetic gas has a caloric value of 4600–5200 kJ/m^3 and is low on tar.
Such a gasifier can run about 5-8 hours without interruption, afterwards it has to be cleaned.
To collect the gas for later use, btek offers some kind of biobags with a volume of 10m^3 to 100m^3.
The headquartered of Btek Renewable Energy Products is in Newmarket, Ontario in Canada.

The Reviewers were not able to visit any of these competitions instllations in order to assess the claims on development of a tar free model for biomass based energy generation system. But the question must be discussed, whether a further SDC support for the two stage gasifier development at TERI is – in view of the competitors positions – meaningful.

6 South – South Cooperation

The South – South cooperation until today did not result in practical results. Some preparation works were made, such as

- Country evaluation for potential cooperation. Thailand and Ethiopia were identified, Thailand later on again excluded, due to high political risks.
- partner identifications,

- conferences in Ethiopia for dissimination of information on the system.

For the evaluation team it's too early to assess in detail the impacts and learnings from the South-South cooperation and to discuss the further enhancing of that cooperation. Nevertheless some comments are made:

- the concept to transfer knowledge and technology developed and tested in the TSBP program in Inida to developing countries is very good and shall be implemented.
- Technologies and concepts for implementation must be ready for the Third World markets, meaning that it must be field tested and operational under situations similar to the target markets. If the technology would be transferred, but not being able to operate as expected, a damage of the positive image of the technology and the cooperation could occur.
- The **thermal Gasifier** for applications with no need for steady temperature levels is ready for such technology transfer, under the condition that renewable biomass supply is available and financing mechanisms are implemented.
- The SDC / TERI strategy not to consider the **two Stage Gasifier** and the **automated version of the thermal Gasifier** at the present state of technical development under south-south co-operation shall be supported. Before exporting this technologies, long term experiences in India, under permanent supervision of the R&D team of TERI, should be collected and used for the systems improvement.
- South-south cooperation should be a long term strategy and not a priority at this moment. The main available manpower at TERI shall be used with high priority for the open issues to be solved in the field of Biomass, automation and steady production of tar-free producer gas for power production.
- Thailand: the decission not to work with Thailand under the given political situation is not evident to the evaluation team, as many other public and private entities from outside are doing good developments there. But this comment can not be proven further, as the evaluation team did not go into more details on that topic.

7 Project Steering

A general observation made by the evaluation team is, that within TERI the TSBP program is quite well managed and controlled. However, the implementation at licensee level would need more and stronger local supervision, support and control:

- supporting licensees to get MNRE listed would lead to broader acceptance, access to state subsidies and therefore increased sales and implementations
- supporting development of financing schemes and access to subsidies at licensee level would create stronger sales and better access to clusters not open for gasifier
- supporting knowledge sharing between TERI and licensees and licensees and licensees would help to increase quality, improve technical development and better acceptance in the market
- measurements of air pollution and assessing pollution control would increase acceptance of the technology at official bodies and potential clients
- supervising biomass sourcing and assessing level of renewable sourcing would help to prove the sustainability the operation of the implemented gasifiers.

The evaluation team got the feeling, that probably the target to develop the two stage gasifier to a marketable degree of maturity is an not reachable expectation within the TSBP program. This feeling was re-adjusted through the explanations on the technical development state of the Swiss project consultant. The evaluation team is recommending SDC, to allow the room for further developments, but to observe and control it closely.

A cooperation with other development institutions could be considered. The meeting with GIZ has shown, that GIZ would be interested in a cooperation, such as “cooperation in the field of up-scaling of the program”, PPP model development for private enterprises, etc..

A detailed survey of the actual international state of R&D and market introduction of small scale biomass gasifiers should be made. The decision on the further support and development of the TSBP (two stage gasifier) should be made basing also on the results of this survey.

The technical and economical results of the TERI activities should be reviewed in more detail and a QA institution should be implemented. One possibility would be to adapt the TORs of the Swiss consultant accordingly.

Possible reputational risk are given due to issues related to work safety, working environment, pollution, non-sustainable biomass supply and child labour (e.g. in ceramic cluster). Periodic control and observations of implemeted gasifier would help to increase quality of mostly operational aspects and therefore also reduce risks for SDC to be involved in reputational problems.

8 Summarizing Recommendations for Future Orientation

The following recommendations are elaborated basing on the comments presented above and are summarizing briefly what was said in this report:

1. Continue to support the establishment and the certification of sustainable renewable[8] biomass suppy chains in project areas.
2. TERI shall further concentrate it's R&D work on the applicability of non-woody biomass for both, the thermal gasifier and the two stage gasifier.
3. The implementation of thermal gasifiers shall be supported through stronger coordination between TERI and licenscees and support in getting acknowledgement from official bodies.
4. It's to be expected, that the R&D work on the two stage gasifier will lead to success in 6 to 12 months time. Otherwise stopping the program shall be considered. Success means steady power production under rural areas conditions and for competitive full cost calculation.
5. South-South cooperation on the thermal gasiifer technology under sustainable local conditions shall be continued and strengthened.

[8] refer to the UNFCCC criteria for demonstration of renewable biomass – EB 23 Annex 18

A1 Visit schedule and references of persons visited during the tour

Meeting in Delhi			
Date	**Meetings**		**Stakeholders / Attendees**
10.11.2014	09:00 am – Kick-off meeting with SDC 10:30 am – Transfer to TERI Gwal Pahari 11:30 am – Presentation by TERI, visit to Two-stage gasifier, thermal gasifier and earlier versions of gasifier systems		Shirish Sinha (SDC) Daniel Ziegerer (SDC) J Murali (TERI) N K Ram (TERI) Amit Kumar (TERI) Sunil Dhingra (TERI) Albert Trevor K. Minu Barkha Tanvir
11.11.2014	**Team 1: Transit from Delhi to Ahmedabad** Visit to Thermal Gasifier installed in Ceramic unit and meeting with Industry Association Meeting with Dr S N Mishra, Central Glass and Foundry Research Institute (CGCRI) Meeting with MSME- DI	**Team 2: Trasit from Delhi to Pune** Meeting with, Maharashtra Energy Development Agency (MEDA) Meeting with Dr V V N Kishore – Pune Transfer from Pune to Kolhapur	**Team 1:** Kamal Dudani (TERI licensee) DR. S N Mishra (CGCRI) **Team 2:** Dr. V V N Kishore (EX. TERI) Hemant H Patil (MEDA) S A Patil (MEDA) P V Tayde (MEDA) Mr. M Kulkarni (TERI Licensee)
12.11.2014	**Team 1: Visit and Meetings in Ahmedabad** Visit to Thermal Gasifier installed in Puffed Rice units. Meeting with Mr Hardik Shah/his team members, Gujarat Pollution Control Board – 2 pm (Gandhinagar)	**Team 2 : Field Visit in Kolhapur** Meeting with TERI Licensee Visit to Licensee manufacturing facility (also see fabrication of two-stage biomass gasifier) Visit to Thermal	**Team 1:** Kamal Dudani (TERI licensee) **Team 2:** Mohan Kulkerni (2 M industies , Licensee) Mr. M N Khatib (Foundry

	Meeting with Mr Bharat Shah, Gujarat Cleaner Production Centre *Meeting with Gujarat Energy Development Agency (Gandhinagar)*	*gasifiers installed by Licensee* *Meeting with foundry cluster association.* *Meeting with District Industried center*	
13.11.2014	**Field visit in Belgaum cluster (Alexander Luchinger, Reto Thonen and Shubendu Biswas)** Meeting with TERI Licensee Visit to Licensee's manufacturing facility Visit to Thermal gasifiers installed by Licensee		Mr. Ram Bhandare (Cluster foundation) M S Shanmugasundaram (Ashok Iron works) Mr. Narendra P Burli (Ashok Iron works) Mr. Sameer (TERI Licensee)
14.11.2014	**Field visit in Belgaum cluster** Visit to Thermal gasifiers installed by Licensee Meeting with DIC *Meeting with Industry Association*		Mr. Praveen Ramadurg (DIC, Belgaum) Mr. Sameer (TERI Licensee)
15.11.2014	**Meetings in Bengaluru** Meeting with TERI Licensees at TERI Southern Regional Centre, Domlur *Meeting with MSME DI*		V B Kulkerni (TERI) Ravi Kumar N (Harith Avani technologies, Teri Licensee) S N Rao (Teri Licensee) S N Rangaprasad (MSME-Development Institute) Kamal Dudani (OM Energy) Vineesh V (NExtgen)
17.11.2014	**Meetings with TERI, Ministry, SIDBI and GIZ** Meeting with TERI, India Habitat Centre Meeting with MNRE Meeting with Mr Rajiv Kumar, SIDBI, *Meeting with GIZ*		Amit Kumar, Albert Trevor, N K Ram , K. Minu , Barkha Tanvir Dr. V K Jain (MNRE) Dr. Khadre (MNRE) RajiV Kumar (SIDBI)

18.11.2014	Meeting with Dr S N Srinivas, UNDP, 55 Lodi Estate, New Delhi Debriefing Meeting with SDC Wrap, closure and next steps	S N Srinivas

A2 LFA Assessment and observations during field visit

TSBP: Logical Framework Analysis (LFA)		
Strategy of Intervention:	**Key Indicators** **(incl. target values and baseline)**	**Assessment / observations after file visits**
Impact : **Rural communities and small enterprises save on energy cost and reduce GHG emission based on biomass clean energy**	GHG emissions reduction is expected to be in the range of 85,000 tons of CO2 over a period of fifteen years	No GHG calculations based on recognized methodology available
Outcome 1. Affordable gasifier technology systems that work reliably under field conditions are available on the market, both for: a) rural electricity production and b) commercial thermal gasifier applications	1.1 Communities in four villages have daily supply of 6-8 hours of electricity from advanced gasifier technology in compliance with Rural Electricity Policy 2006	Technology not deployed on site It's to be expected, that the R&D work on the two stage gasifier will lead to success in 6 to 12 months time.
	1.2 40 MSME operate thermal gasifiers on economically viable conditions	Over 40 gasifiers installed, exact number not monitored by TERI.
Outputs 1.1 Second generation two stage gasifier system developed and tested for NTPC Badarpur site	1.1.1 20 kWe two stage gasifier system for decentralized applications developed	Data from field trial not available.
1.2 Technology package of the two stage gasifier developed for village level installation	1.2.1 NTPC accepts and/adopts the technology package	NTPC dropped out as a stakeholder from the project.
1.3 Village level mechanisms for distribution of electricity services established	1.3.1 Village based Management models such as Village Electricity Committee (VEC) established and capacitated to manage the two stage gasifier system	Village level consultation for site selection done but must be realigned with new biomass type(agri waste)
	1.3.2 At least 2 operators in each village trained on operation and maintenance of the two stage gasifier system	Technology not deployed
1.4 Automation system for thermal gasifier developed	2.1.1 Gasifier control system for intermediate heating applications adopted	One automation at licensee level observed (Ceramic industry)

1.5 New target end users of thermal gasifiers are capacitated for operation of gasifier	2.2.1 40 end-users (installations) trained on Operation and Maintenance aspects of biomass gasifier based thermal system	Training provided but training material to be updated and changed.
1.6 Partnerships established with dealers and Local Service Providers	2.4.1 At least four dealers appointed through TERI's Joint Venture Company	1 JV and 9 licensees in place in total, 3 new licensees during this period
	2.4.2 At least three new LSP set up in target areas (thermal gasifier)	As above
1.7 GHG emission reduction quantified	1.4.1 Method for GHG reduction is established	Not in place, draft methodology available in place but uncertainty of accounting very high due to several assumptions, no actual accounting in place

Outcome 2 (framework related & policy-related) Policy implementation informed by ground realities enhances sustainability of biomass resource management.	Recommendations taken up by division/district/State Sustainable biomass supply mechanism established for biomass based clean energy solutions for rural electrification and MSME	Not yet
Output 2.1 Methodology for assessing viability of biomass supply chain	2.1 (output itself is an indicator) Methodology takes account of: 1) Vulnerability of the poor 2) Role of men and women 3) Food security	1 biomass assessment study done till date. Study in 4 industrial clusters is ongoing.

Output 2.2. Viability of biomass supply is assessed in 2 clusters and solutions to ensure viability are available.	2.2. (output itself is an indicator) Actor mapping in biomass supply chain including role of men and women in biomass supply chain	As above,
Outcome 3. Partners in two other developing countries adopt biomass based clean energy solutions	TERI's joint venture company enters into Technology transfer agreement with project developers in two developing countries	Seminars held in one country (Ethiopia) under this cooperation.
3.1 Stakeholder platform is established for knowledge exchange on biomass based clean energy systems	3.1.1 One international conference conducted on biomass based decentralized clean energy solutions in one of the identified developing countries	Not yet
3.2 Technology transfer mechanisms established in two developing countries	3.2.1 Technology transfer agreement (licensees or JV) signed with project developers in at least two countries	Not yet

A3 Summary of Provisions for regulating felling of trees and transit in various States

This Annex is added in the sense of a supporting document, not dealing directly with the result of the review.

A3.1 Andhra Pradesh

- The Andhra Pradesh Forest Produce Transit Rules, 1970 is applicable.
- AP Private Forest Rules in Agency area, 1977. The Andhra Pradesh Preservation of Private Forest Rules,1978
- The Andhra Pradesh (Protection of Trees and Timber in Public Premises) Rules,1989
- WALTA, 2000 provides for water land and tree
- TP required for felled timber.
- In tribal area no felling can be done without permission of the collector.
- In Govt. land nobody can cut tree without permission of forest department.
- Exempted species are categorized district wise.
- The Andhra Pradesh Forest Produce Transit Rules,1970 is not applicable to Red sanders and Sandal wood, Orange, Tati, Casuarina, Guava, Seemathoma, Sapota, Coconut, Cashew, Eucalyptus, Neelagiri Jamaoil, Subabul, Seema Chinta, Ber, Rain tree nidraganneru, Juamun,
- Nallatumma, Mango, Panasa jack fruit, Bamboo, Myrobalam, Wood apple.

A3.2 Assam

- Transit of timber under Assam Forest Regulation, 1891.
- Assam (Control of felling and removal of Trees from Non Forest land) Rules, 2002 vide Notification No. FRM-88/2001/77 dated 7th May, 2002 regulates felling permission and transit of timber derived from non forest areas.
- 48 tree spp. have been declared Reserve- Champ (sopa), Chaulmugra, Nahar, Sia, Gugra, Kurail, Hollong , Sal, Mekai, Semal, Rata, Amari rata, Kolia, Poma, Sissoo, Ping, Khair, Moj, Kathal, Indian Rubber, Dudh Champa, Jinari, Chhamolia, Kuhir, Agar, Gamari, Bonsum, Sida, Bogi Jamuk, Hollock, etc.
- Provision for registration of Tree plantation with DFO.
- Permission for felling of trees for self consumption and registered plantations is to be granted within 30 days from the date of receipt of application. In such cases no transit pass is required.
- Provision for penalty in the form of confiscation of felled trees when in violation of rules/ guidelines.
- Permission for extraction of rubber trees shall be given by authorized officer for extraction of 30 trees at a time after ascertaining the status of land etc. verification/demarcation by Range Officer.

- Seizure & confiscation of felled trees in violation of rules, which may be released on payment of penalty (50% of Govt. royalty on timber)
- Trees not requiring felling permission like: Aam, Jamun, Kathal, Eucalyptus, Poplar, home grown Bamboo, Leteku, Paniol, Madhuriam need not be registered.
- Provision for Service Charges to be realized by the Forest Department for services rendered.
- Permission is granted to only the landowner of tree plantations.
- Felling permission and transit permit are given by DFO as per provisions prescribed by PCCF Assam.

A3.3 Bihar

- Bihar Kashth & other Forest Produce Transit Regulations Rules, 1973.
- People have right to cut and transport trees grown on their land in line with regulations as mentioned in Annexure-I
- Permit from DFO or Authorized Officer is necessary.
- 10 Species have been exempted from the purview of Transit Rule vide Notification No. Van Vikraya.38-2000-456 dated 27.02.2009
- The exempted spp. are: Poplar, Eucalyptus, Kadamb, Gumhar, Mango, Lichi, Tar, Khajoor, Semal and Bamboo except Dendrocalamus strictus.
- Registration of Property Mark is necessary for export or removal of timber. Registration fee is required for property mark.
- Preferred species planted are Kadam, Semal, Teak, Gamar are preferred along with horticulture spp. like Mango & Litchi. Poplar is also getting acceptance. Due to root fungal disease, Shisham is not preferred.
- Panchayat has been empowered through Bihar Panchayat Raj Adhiniyam, 1993 vide Notification No. Van Vikray/ 2000-2117 dated 01.07.2002 for delegation of powers for transit within the District by Head of Gram Panchayat
- For transit outside District boundaries permit from DFO is required.

A3.4 Chhattisgarh

- The Chhattisgarh Govt. Revenue Department Land Revenue Code and letter dated F.8-31/ Revenue/2003 dated 22.07.2003 & No. F.8-31/ Revenue 2006 dated 27/02/2006 govern tree felling on non forestry land.
- Chhattisgarh Transit (Forest produce) Rule, 2001, Gazette Notification dated 25. 08.2011 & 27.10.2004 regulate transit of Forest produce.
- Chhattisgarh Adim Janjati Ka Sarankshan (Vrikshon Me Hit) Adhinium , 1999 & Rule, 2000.
- Permission for tree felling is required in respect of restricted lands.
- No permission required for cutting of trees for commercial purposes from private land.
- In respect of the above NOC is to be issued by the Tehsildar/ Naib Tehsildar for species other than 9 restricted spp. Forest department will issue transit pass on receipt of NOC within 15 days.

- Following Species exempted from transit regulations, Casuarinas, Subabul, Poplar, Israeli Babul (Acacia tortilis), Vilayati Babul (Prosopis juliflroa), Manzium Acasia manzium, Acacia nilotica.
- Power to issue transit pass for Siris, Neem, Ber, Palas, Jamun, Reunjha (Acacia leucophloea), Nilgiri Eucalyptus obtained from plantation older than 10 years given to Gram Panchayat for transit within district.
- Transit pass for Species other than mentioned above will be issued by a forest officer on the recommendation of Panchayat level committee.
- Restriction on felling of specified species standing on the holding of the Bhumi Swami belonging to aboriginal tribe.
- Permission of Collector is required, who may obtain report from SDM (Revenue) & DFO before grant of permission.
- Permission will be restricted to such number of trees to fetch the BhumiSwami an amount not exceeding Rs. 50,000/= in a year to meet the specified purpose.
- The Collector will endorse a copy of the permission to DFO, who will be responsible for cutting, stacking, sale of timber and remit the sale proceeds into the joint account of Bhumi swami & the Collector in the prescribed manner.
- List of specified Tree pp. are Sagwan, Buham, Shisham, Sal, Tinsa, Saja, Mahua, Bhirra, Karanj, Tendu, Lendia, Dhawra, Khair, Khamar, Chandan, Haldu, Aam, Jamun, Imli, Arjun.
- The Collector shall register the application submitted by Bhumiswami to cut the trees and send one copy of application to SDO (Revenue). In the case where the khasra No. is adjoining reserve or protected forests or village forest, it shall be mandatory for the SDO to make local enquiries after spot inspection and to ensure that the government or village forest has not been included in the demarcation.

A3.5 Dadra & Nagar Haveli

- Ministry of Home Affairs' Notification No. 277(E) dated 21.04.1999 extends to the Union territory of Dadra and Nagar Haveli, the Goa, Daman and Diu Preservation of Trees Act, 1984 (Act No. 6 of 1984). The Goa, Daman and Diu preservation of Trees Act, 1984 extends to the Union Territory of Dadra and Nagar Haveli (An act No. 6 of 1984).
- No tree species are exempted under timber transit rules or similar rules
- Every person who is granted permission under this Act to fell or dispose of any tree is bound to plant such number and kind of trees in the area from which the tree is felled or disposed by him.
- The preferred tree species by farmers/ land owners for planting on private land are Teak, Babool, Casuarina, Eucalyptus, Amla, Sitafal, Jackfruit, Sebabul, Amli etc.

A3.6 Delhi

- Delhi Tree Preservation Act, 1994 is in force.
- No transit Rules have been framed. Permission granted for felling / pruning of trees is usually supporting document for transit of such timber.
- Compensatory tree plantation in lieu of tree felled.

A3.7 Goa Daman & Diu

- Goa, Daman & Diu Preservation of Tree Act,1984

- Establishment of tree Authority & Tree Officer
- Duty of Tree authority include tree census, planting and transplanting, preservation and conservation
- No felling of trees without permission from tree officer
- Obligation to plant trees in lieu of tree being felled
- Penalties for violating the procedure.

A3.8 Gujarat

- Permission to cut trees regulated by Saurashtra Felling of Trees (Infliction of Punishment) Act, 1951. Rules framed under the Act in 1961.
- Permission required from cutting trees by Revenue Office as empowered by the Act not below the rank of Tehsildar. Revenue officer can inflict fine for violation.
- Permission is required for felling of Teak, Black wood, Sandal wood Khair, Mahuda, Timru, Simla, Sadad, Kanaj, Kanaji, Seven, Bio, Rohan, Ebony, Kadao, Kalam, Baldervo, Harde, Dhavada, Mango, Palmyra palm, Date tree and Jamun.
- The State has relaxed felling of some species Neem, Kasia, Kanji, Khijdo, Mango and Amla under the Act.

A3.9 Haryana

- Punjab land preservation Act, 1900 is applicable in Aravalli and Shivalik.
- No transit rules for agro forestry spp. in remaining area
- Tree felling is banned without permission from Forest Department.
- Spp. exempted eucalyptus and Poplar, Ailanthus, Melia azadirach and M. composata, bamboo and mulberry Saw Milling Rules as per direction of Hon'ble Supreme Court applicable since, 2006.
- No TP required for Eucalyptus, Poplar, Mango etc.
- Forest Corporation revises rates every six months for minimum support price. Market rates are better for farmers.
- No registration of tree plantations of farmers is required.

A3.10 Himachal Pradesh

- HP Land Preservation Act, 1978 governs felling of trees on private land.
- HP timber transit rules govern movement of all timber and forest produce.
- On private land having forests with 16 nationalized spp. (conifers and oaks) only Forest Corporation can fell, convert and sell timber as per felling cycle (usually of 10 years.)
- spp. namely Eucalyptus, Poplar, Albizzia, Bauhunia, Mulberry, Salix etc. have been exempted from the LPA and also from the Transit rules.

- 3 plants are to be planted with respect to the number of trees felled.
- For bonafide consumption, 5 trees can be felled with the permission of Range Officer.

Jharkhand

- Jharkhand Timber and Other Forest Produce (Transit and Regulation)
- Rules, 2004. New amendments proposed in 2010.
- Gram Sabha to give certificate of ownership of trees on private land
- No transit permission required for transport within village limits for bonafide use.
- Bambusa bamboo, Bambusa tulda, B. vulgaris, B. balcoa & canes proposed to be exempted from transit rules. Also Sabai Grass, Gum, Ral, Seeds & fruits are proposed for exemption from transit.
- Sal, Sagwan, Bija Sal, karam, Asan, Khair, rosewood, salai to be removed after obtaining permission from DFO or authorized ACF. Permission is also required for Aam, Mahua, Gamar, Shisham, Kathal, Jamun etc.
- Removal of roots of Ashwagandha from the definition of roots
- Removal on transit of babul and subabul for promoting their plantation under agro-forestry.
- Penalty for violation of the regulation specified.

A3.11 Karnataka

- Karnataka Preservation of Tree Act, 1976 and Karnataka Preservation of Tree Rules, 1977.
- Establishment of Tree authority and Appointment of Tree Officer,
- Restriction of felling of trees
- Provision for compulsory planting trees in place of tree felled.
- Exemption for 11 spp. from transit rules- Eucalyptus Casuarina, Subabul, Rubber, Coconut, Arecanut, orange, Erythrina, Glaricidia, Sesbania, Silver oak.

A3.12 Kerala

- The Kerala Private Forests (Vesting and Assignment) Act,1971
- The Kerala Preservation of Trees Act 1986 is applicable to private forest.
- The Kerala Promotion of Tree Growth in Non Forest Areas (Amendment) Act, 2007.
- Every owner of non-forest land in a non-notified area shall have Right to cut and transport any tree except sandal wood tree standing on his land
- No tree standing in any area of non forest land specified in the notification shall be cut.

A3.13 Madhya Pradesh

- Vide Gazette Notification No. F.30-40-95-X.3 dated 13.12.2000 the Madhya Pradesh Transit (Forest Produce) Rules, 2000
- The transit pass will be issued by the Panchayat on the recommendations of the Panchayat Level Committee for the species Babool, Siris, Neem, Ber, Palas, Jamun, Reunjha, Bamboo

(except in the districts of Khandwa, Betul, Hoshangabad, Harda, Chhindwara, Seoni, Balaghat, Jabalpur, Katni, Mandla, Dindori, Shahdol).

- Transit pass for the species other than those mentioned above is to be issued by Forest Officer on recommendations of Panchayat Level Committee.
- Transport of privately owned timber under the Lok Vaniki Mission requires the procedures mentioned above.
- Registration in the office of DFO is required for the forest produce is to be transported.
- Gram Panchayat will issue the transit pass for transporting the forest produce within district and the adjoining districts and for the other destination the transit pass is required to be issued by a Forest Officer.
- The tree species exempted from transit pass for transport are Neelgiri, Casuarina, Subabul, Poplar, Israili Babul, Vilayati Babul.
- No transit pass shall be required for the removal of any forest produce for bonafide domestic consumption by any person and such forest produce which is exempted by the State Government from the operation of these Rules.
- No transit pass is required for removal of mineral from forest for which transit pass is not compulsory under these Rules.

A3.14 Maharashtra

- Felling of trees in private lands is regulated by following three Acts:
- Maharashtra Felling of Tree (Act 1964)
- Maharashtra (Urban Areas) Preservation of Trees Act, 1975
- The Maharashtra Land Revenue Code, 1966
- Permission for transportation of forest produce, so obtained after receipt of felling permission from the Tree Officer, is generally given by the concerned Dy. Conservator of Forests under the provisions of the Indian Forest Act.1927 and the rules made there under namely the Bombay Forest Rules, 1942.
- Presently 16 species are included in the Schedule which are:

    1. Hirda (Termanalia chebula)
    2. Teak (Tectona grandis)
    3. Mahuwa (Madhuca latifolia)
    4. Tamarind (Tamarindus indica)
    5. Mango (Mangifera indica)
    6. Jack (Artocerpus integrifolia)
    7. Khair (Acacia catechu)
    8. Sandal (Santalum albam)
    9. Bija (Pterocarpus marsupium)
    10. Haldu (Adina cardofolia)
    11. Tiwas (Ougelnia dulbergoidies)

12. Ain (Terminalia tomentosa)
13. Kinjal or Kindal (Terminalia paniculata)
14. Anjan (Harduchia binata)
15. Jambhul (Syzigium cumini)
16. Mangrove

- Within the district of Sindhudurg only

17. Shisam (Dalbergia latifolia)
18. Shivan (Gmelina arboria)
19. Nana (Lagrstroemia lanceolata)
20. Behala (Terminalia belerica)
21. Kazra (Strychnes nux-vomica)
22. Bhedus (Euginia zeylanica)
23. Pandhra ain (Terminalia arjuna)
24. Kajoo (Anacardium occidentale)

- Exempted species under timber transit rules: Babhul, Subabhul, Prosopis, Eucalyptus, Ashok, Moringa, Phoenix, Chiku, Bhendi, Acacia and Poplar.
- The Maharashtra (Urban Areas) Preservation of Trees Act, 1975 is for regulating felling of any tree in Urban Area. Felling permission is granted by the "Tree Officer" appointed by the Tree Authority. This being the local area, provisions of Bombay Forest Rules, 1942 regarding transportation of forest produce are not applicable, hence no transit pass is required for local limits.
- The Maharashtra Land Revenue Code, 1966 regulates the felling in thenon-forest areas other than Urban Areas and for the species which are not included in the Schedule attached with above mentioned Act of 1964. Permission for felling of trees is granted by the Revenue Officer i.e. Sub Divisional Officer (Dy. Collector). So far as transportation of forest produce is concerned it is regulated by Forest Officers under Bombay Forest Rules 1942 in respect of timber and other forest produce.

A3.15 Manipur

- Guidelines for the felling of tree in non forest areas under the direction of Supreme Court notified in 2003.
- Felling and transportation of bamboo shall be as per provisions of Manipur Forest Rules, 1971.
- Plantation raised on non-forest area by an individual / NGO shall be registered with DFO.
- No felling permission is required for Yongchak (Parkia roxburghii) and Theibong (Artocarpus integrifolia).
- Permission for felling of trees for non commercial purposes in respect of registered plantations to be with DFO. DFO may accord permission within 60 days from the date of receipt for felling of trees and in respect of plantation registered for more than 3 years the felling permission will be given within 30 days.

- Permission for felling of trees for commercial purposes from non-forest area in respect of registered plantations shall be made by the person to DFO.
- Transit permit required for removal of felt trees. Provision for confiscation of material felled in violation of these guidelines.

A3.16 Meghalaya

- The Meghalaya Forest (Removal of Timber (Regulation) Acts and Rules 1981 and 1982
- United Khasi & Jaintia Hills Autonomous District Amendment & control (Forest) Act, 1958
- The Meghalaya Forest (Removal of Timber (Regulation) Acts & Rules 1981 & 1982
- The Meghalaya Tree (Preservation) Act, 1976
- The Meghalaya Tree Felling (Non Forest Areas) Rules Acts & Rules.
- As per Meghalaya Tree Felling (Non-Forest Areas) Rules, 2006
- Felled trees are allowed to be transported on transit passes after realization of forest royalty and tax as applicable.
- Registration of tree plantations with DFO is required.
- Government approval is required for working scheme.
- Procedure for permission of felling of trees prescribed.
- Special authorized officer in the Autonomous Hill Council areas.
- Tree spp. not requiring felling permission: all horticulture tree spp. excluding Aam & Wild apple. Guava, jackfruit, Carambula, Plum, Peach, pear, Coconut, Arecanut, litchi, Cashewnut, Citrus spp do not require felling permission.
- Permission not to be granted when trees are less than 5 years old.

A3.17 Mizoram

- In compliance of Supreme Court's order dated 12.05.2001in W.P. No. 202/1995 the Government of Mizoram has framed the guidelines for felling of trees from non-forest areas.
- Application for permission for felling of trees for non-commercial purposes including registered plantations shall be made to the DFO.
- Request for permission for felling of trees from non-forest area for commercial purposes other than in respect of registered plantations to be made to the DFO.
- Trees species not requiring felling permissions from non-forest areas are Aam, Jamun, Kothal and all species of bamboo, Leteku, Paniol and Madhuriam.
- The transit of timber from the non-forest land shall be regulated as per provisions of relevant Acts/Rules/regulations/guidelines regarding movement of timber or timber products.

A3.18 Nagaland

- Felling of trees from privately owned forests as per approved working schemes
- Felling of isolated trees and plantations carried out as per the provisions of Nagaland Tree Felling regulations 2002 amended in 2006.

- Transit pass required for removal of felled trees.
- Provision for seizure and penalty for violation.

A3.19 Odisha/Orissa

- Orissa Timber and other Transit Rules 1980.
- Village Forest Rules,1985
- Orissa Timber & other Forest Produce Transit Amendment Rules, 2006:
- Exempted spp under Orissa Timber transit Rules,1980 Notification No.2013 dated 8.2.99.
- Permit to be taken from the committee for felling of trees and transit.
- Management of village forest by drawing of management plans.
- Transit permit shall be issued free of cost by DFO for all forest produce in transit by land, rail or water.
- No transit permit for transport of minor forest produce within district except lac, tassar, myrabolans, gums and resin, root or Patalagaruda, Sal seed, tamarind and hill broom.
- Species to which provisions regarding farm forestry and forestry farming or the rural poor plantation are not applicable are kurum, panas, kasi, sissoo, gamhar, amba, champa, sal, teak, asan.
- Species exempted Bambusa nutan (Sundarkanai), Bambusa vulgaris (Badi baunsa), Bambusa tulda (bolangi Baunsa), Samania saman, eucalyptus Hybrid (Nilgiri/ palas), Acacia auriculiformis, Cassia siamea, Casuarina equisetifolia, Silver oak,
- No transit permit for timbers grown outside India.

A3.20 Puducherry/ Pondicherry

- Pondicherry Timber Transit Rules, 1983
- Issue of permit for the transportation of timber and registration is to DFO.
- Teak, Rosewood, Sandalwood and Red Sanders are protected wood and such species cannot kept be in possession or transported by any individual/farm without special permit.

A3.21 Punjab

- Punjab Land Preservation Act, 1900 applicable.
- Agro forestry/ farm forestry crops have no requirement for transit pass like Poplar, Eucalyptus and Melia composita.
- Transit Rules applicable in 5 Districts covering the area closed under Punjab Land Preservation Act, 1900 in Ropar, Mohali, Hoshiarpur, Pathankot and Nawashahar (Shaheed Bhagat Singh Nagar. In closed are which cover private forests closed under Section-4 & 5 of PLPA, management is done by Forest Department and 100% revenue is given to Farmers. Marking Fee is charged by the Dept. plantation is also done by Forest Department and normally Khair, Amla and bamboo is planted. TP is required in such cases as felling permit. Initially 10 year cycle has now reduced to 5 year cycle to increase people's participation and management plans is prepared.

- In 2000, Tree Apportionment Rules, 2000 were framed a Govt. Notification sharing revenue with farmers for raising roadside trees on Govt. land covering road side trees like NH and State Highways and Link Road.

A3.22 Rajasthan

- Rajasthan Forest Produce Transit Rules, 1957
- Transit Pass mandatory for movement of forest produce.

A3.23 Tamil Nadu

- Tamil Nadu Preservation of Private Forest Act,1949.
- The rules not to be applied for the cutting of sandal wood trees or thinning of private plantation to teak, Casuarinas and eucalyptus manifested for the silvicultural improvement of the crop and the cutting and removal of fuel small timber reeds and green manure leaf for bonafide agricultural or domestic purposes.
- The cutting of sandalwood trees in a forest and their transport outside are to be governed by the Madras Forest Act, 1882.
- In granting permission for the cutting of trees by the selection method in case of private forest, the minimum girth height has been specified for the trees like Casuarinas, Eucalyptus, Wattle, Silver oak, Pines, etc.
- Trees shall be permitted to cut only in one coupe in each block during a specified year.

A3.24 Tripura

- Procedure for extraction of trees for non forest area revised & notified in 2010.
- Special provision for extractions of Rubber trees.
- Registration of trees standing on non forest land to be done with authorized Officers with prescribed registration fee. Only owner can submit application for registration.
- The Range Officer forwards application to authorized officer who in turn after satisfying that application meets necessary requirements send application to SDM for joint verification and demarcation of land with revenue officials. The authorized officer will issue Tree Registration Certificate (TRC) based upon joint verification report usually within 45 days. Validity of TRC is 7 years or the date of removal of trees whichever is earlier.
- For obtaining felling permission the tree owner is required to submitregistration certificate, details of species, no & measurement of trees to be felled. Maximum trees permitted for felling not to exceed 30. Time limit of operation of permit for tree felling is 90 days. No fresh permit is given until the trees permitted to be felled and removed against earlier permission.
- Registration Certificate and extraction permission not required for Mango, Lichi, Moringa, and Guava. Prescription of manner in which violation is guidelines are to be dealt with.
- Transit Pass required for movement of extracted material.
- Fallen trees due to natural causes can be removed; owner can remove after intimating authorized officer.
- One time permission for felling of 5 trees for domestic use from non forest land not contiguous to forest land is given in 20 days.

A3.25 Uttar Pradesh

- Uttar Pradesh timber and other forest produce transit rules, 1976.
- Total 20 spp. are exempted from transit pass like eucalyptus, poplar in various district state
- District wise spp. are exempted from transit where reserve forest or etc.
- Farmers are encouraged to plant exempted spp.
- Private forests are also governed by these rules. The department can assist in preparation of management plans of private forests.
- Forest department facilitates individual farmers in growing private agroforestry/ farm forestry by taking up plantation activities at their cost. Promotion of Kisan nurseries in western UP.
- UP Govt. has suggested that exotic species grown by farmers on large scale should be fully exempted from regulatory regime of felling permits and timer transit in States such as Poplars, Eucalyptus, Subabul(Leucaena sp.), Casuarinas, Ailanthus sp; Gmelina sp; Silver oak (Grevillea robusta) Mulberry (Morus alba), Kadam (Anthocephalus cadamba) Melia sp; Acacia arabica, Acacia auriculiformis, Acacia mangium; Acacia lenticularis, Albizza sp, Azadirachta india, Borassus flabeliformis, Hovea brasiliensis, Prosopis spp; Butea monosperma, Cedrela toona, Tamarindus india, Grewia opositifolia, etc.

A3.26 West Bengal

- WB Private Forest Act, 1948 is in force which regulates permission for felling and transit of trees grown on private lands.
- WB Forest Produce Transit Rules, 1959.
- WB Trees (Protection and Conservation in Non Forest Areas) Act, 2006.
- The West Bengal Trees (Protection and Conservation in Non Forest Areas) act, 2006.
- Provision for Tree Card for individual farmers.
- Provision for penalty and confiscation of materials felled and transported in violation of such rules.
- No tree exempted.
- No tree can be felled in non forest areas except with the procedure laid out for obtaining permission for felling of trees with obligation to plant trees in lieu of trees felled.
- Compulsory tree plantation in certain areas including high rise multi unitbuildings for residential, commercial, industrial or institutional use.
- No owner of a private forest in a notified area or other person shall fell or remove tree from such forests until the working plan in respect of such forest has been approved.
- Permission mandatory for 11 spp.:- Khair, Semal, Sissoo, Tendu, Gamar, Mahua, Champ, Sal, Mahogani Teak and Mangroves. Remaining exempted.
- Permission for felling of a tree outside forest areas is required from competent authority with obligation to plant trees as prescribed. Compulsory plantation of trees in respect of development works.