

PROJECT COMPLETION REPORT

DST Sanction Order No.: NRDMS/11/1319/2007 Date: 11-04-2008

Project title

**Agro-climatic Zone Based Mapping of
Renewable Energy Resources in Assam**

Sponsored by

**Natural Resources Data Management System
Department of Science and Technology
Govt. of India, New Delhi**

Conducted by



**Prof. D C Baruah (PI)
Department of Energy
Tezpur University
Tezpur 784028
Assam, India**

PROJECT COMPLETION REPORT

- Notes:**
1. 10 copies of the Project Completion Report (PCR) should be sent within one month of the completion or termination of the project.
 2. The PCR should be in bound form.
 3. Cover page should include the title of the project, file number, names and addresses of the investigation.

1. **Title of the project** **Agroclimatic Zone Based Mapping of Renewable Energy Resources in Assam**
2. **Principal Investigator** Prof. Debendra Chandra Baruah, Department of Energy, Tezpur University, Napaam, Tezpur, Assam, 784028
Co-Investigator None
3. **Implementing Institution** Tezpur University, Napaam, Tezpur, Assam, 784028
Collaborating Institution None
4. **Date of commencement** 03-06-2008
5. **Planned date of completion** 03-06-2008
6. **Actual date of completion** 26-12-2011
7. **Objectives as stated in the project proposal:**
 - (i). To identify stakeholders/users and ascertain their requirements (need assessment) with respect to spatial and temporal availability of energy resources in Assam
 - (ii). To assess spatial and temporal availability of four major renewable energy resources viz., biomass, solar radiation, wind and hydro power based on survey and experiments conducted in a selective agro-climatic zone in Assam
 - (iii). To assess existing energy demand in the selected agro-climatic zone through energy modeling
 - (iv). To forecast future energy demand based on energy modeling
 - (v). To generate maps of renewable energy resources and energy demands
 - (vi). To take appropriate steps for capacity building for target group
8. **Deviation made from original objectives if any, while implementing the project and reasons thereof:**

No deviation is made from the original objectives of the research project.

9. **Experimental work giving full details of experimental set up, methods adopted, data collected supported by necessary table, charts, diagrams & photographs:**

Automatic Weather Station (AWS) data, NASA's solar radiation data, Satellite images, topographical maps, field survey data and other ancillary data are integrated in GIS environment to assess renewable energy resources availability in the study area. The experimental works including the methodologies are elaborately described in the Final Technical Report related to the research project.

10. **Detailed analysis of results indicating contributions made towards increasing the state of knowledge in the subject:**

Renewable energy resources mapping have been done at various spatial scale. For example, biomass energy potential in the study region is assessed at three levels *viz.* district, development block and village. Similarly, solar energy potential is mapped at district level for each of the five districts of NBPZ. Detail discussions regarding the findings of the research work are presented in the Final Technical Report.

11. **Conclusions summarising the achievements and indication of scope for future work:**

(i) Rice dominated agriculture characterized by single cropping prevails in this region. Major chunk of crop residue remains unutilized or underutilized. The village level mapping of the crop residue biomass resources can be considered as the unique output of this project. The information available in these maps of the entire NBPZ could be useful for decentralized renewable energy planning. Considering the deficient and inadequate supply of grid-electricity, the power generation through any of the proven routes could be feasible. Industrial thermal load for tea processing could be another use of the surplus crop residue.

(ii) The natural spatial and temporal variations of solar insolation prevail within the locations of NBPZ. The availability of solar insolation ($\text{kWh/m}^2/\text{day}$) is higher During February to June, as compared to other months of the year. The solar radiation data measured with the AWS at Tezpur indicates that on an average about five (5) hours per day solar radiation above 350 W/m^2 are available

(iii) The wind data recorded by AWS at Tezpur for a limited period indicates weaker strength of wind energy resources. As the data period is shorter, the usefulness of the results will be limited and this could be considered as indicator only. Wind speed of Tezpur lies between 1 and 2 m.s^{-1} for maximum number of hours in a year. February, March and April are seen to have higher wind speed compared to the remaining months.

(iv) A large number of tributaries are mapped. However, the power potential has

not been assessed. In major portions of their flow through the NBPZ, the slopes of these tributaries are flat as known from the toposheet. However, favourable rainfall data indicates the need of further investigation for hydropower potential in some of the tributaries.

(v) Data concerning domestic (cooking, transport, lighting, comfort, and entertainment), service sector (educational institute, health center, post office), industry and market sectors are collected through standard procedure to assess the energy consumption pattern. The outputs of this analysis are expected to be useful for all the agencies working for developmental project concerning this section of population.

A detail discussion regarding conclusions, achievements and future scope are presented in the Final Technical Report.

12. **S&T benefits accrued:**

1. A GIS integrated spatial model is developed for renewable energy resources assessment. The model can handle number of input parameters (satellite image, toposheet, field data, road network data, land use land cover data, crop data, energy related data etc.). The developed methodology is expected to be useful for mapping of renewable energy resources particularly biomass resources in other regions also.
2. Renewable energy resources strength in NBPZ has been precisely estimated through this research project. The generated information will be useful for renewable energy planning in this region.
3. Information generated related to energy consumption pattern in the region would be useful to develop scientific tool for energy conservation in domestic sector.

i. List of Research publications

ii.

S No	Authors	Title of paper	Name of the Journal	Vol.	Pages	Year
01	M Hiloidhari, D C Baruah	Rice straw residue biomass potential for decentralized electricity generation: a GIS based study in Lakhimpur district of Assam, India	Energy for Sustainable Development	15	214-222	2011
02	M Hiloidhari, D C Baruah	Crop residue biomass for decentralized electrical power generation in rural areas (part 1): Investigation of spatial availability	Renewable and Sustainable Energy Reviews	15	1885-1892	2011

03	D C Baruah, Moonmoon Hiloidhari	Adequacy of crop residue biomass as renewable energy for tea drying in Assam: A spatial assessment	Journal of Agricultural Engineering	46	43-50	2009
04	M Hiloidhari, D C Baruah, S Hazarika	Decentralized biomass based power plant planning using remote sensing data and GIS	In: International conference "Geospatial World Forum" at Hyderabad			18-21 Jan 2011
05	M Hiloidhari, D C Baruah	Biomass energy resources assessment in north bank plain zone of Assam, India using geospatial tools	In: International conference "Geospatial World Forum" at Hyderabad			18-21 Jan 2011
06	M Hiloidhari, D Baruah, D C Baruah	Spatial assessment of rice residue biomass for electricity generation in Sonitpur district of Assam, India	In: National conference on renewable energy for development of under-developed areas with particular reference to North-East India at Tezpur University			23-25 March, 2010
07	S R Chetia, M Hiloidhari, D C Baruah	Energy conservation opportunities in rural households	In: National conference on renewable energy for development of under-developed areas with particular reference to North-East India at Tezpur University			23-25 March, 2010
08	S R Chetia, M Hiloidhari, D C Baruah	Assessment of energy consumption pattern in rural system: a case study in selected villages of Sonitpur district of Assam, India	In: National seminar on climate change and sustainable development with reference to India at Tezpur University			2-4 April, 2010
09	Baruah D C, M Hiloidhari	Fossil fuel substitution in tea processing through biomass energy: A study in Sonitpur district of Assam	In: All India seminar on bioenergy and biodiversity initiative at Assam State Centre of the Institution of Engineers (India), Assam			28-29 August, 2009
10	D C Baruah, M Hiloidhari, B Singha	Some agro-technological issues with reference to spatial availability of crop residue biomass in NE states of India	In: 96 th Indian Science Congress at North Eastern Hills University, Meghalaya			3-7 Jan, 2009
11	D C Baruah, M Hiloidhari, B Singha	A spatial assessment of crop residue biomass as alternate source of thermal energy in tea processing in Assam	In: National seminar on Global Warming and its mitigation at Nazira College, Sivasagar, Assam			3-4 October, 2008
12	D C Baruah, B Singha, M	Agricultural development of North-	In: Proceedings of the conference on			2008

Hiloidhari	Eastern region through renewable energy intervention: An analysis	agricultural engineering inputs for the development of the NE region at Assam University, Assam			
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(Another four numbers of manuscript sent for publication in peer-reviewed international journals are currently under review)

iii. Manpower trained on the project

a) Research Scientists or Research Associates

Seven (07) M. Tech in Energy Technology students and two (02) M.Sc. in Environmental Science students of Tezpur University are trained through this research project. The list is given below:

1. Mr. Sanjib Hazarika, Department of Energy, Tezpur University, 2009
2. Mr. Dipal Baruah, Department of Energy, Tezpur University, 2009
3. Mr. Rupam Konwar, Department of Energy, Tezpur University, 2009
4. Mr. Haradip Mahilary, Department of Energy, Tezpur University, 2009
5. Ms. Smriti Rekha Chetia, Department of Energy, Tezpur University, 2009
6. Mr. Bhaskar Jyoti Dutta, Department of Energy, Tezpur University, 2010
7. Mr. Deborshi Baruah, Department of Energy, Tezpur University, 2010
8. Ms. Oli Talukdar, Department of Environmental Science, Tezpur University, 2009
9. Ms. Priyam Lakshmi Borgohain, Department of Environmental Science, Tezpur University, 2009

b) No. of Ph.D. produced: One (continuing)

c) Other Technical Personnel trained:

Three (03) Technical Assistants engaged for three months duration are trained through the research project. The list is given below

1. Mr. Moni Saikia, Sootea, Sonitpur District
2. Mr. Abhijeet Baruah, Jamuguri, Sonitpur District
3. Mr. Diganta Hazarika, Gorumoria Village, Lakhimpur District

iv. Patents taken, if any: No

4. Financial Position:

No	Financial Position/ Budget Head	Funds Sanctioned	Expenditure	% of Total cost
I	Salaries/ Manpower costs	518800.00	563563.00	31.55
II	Equipment	679300.00	673733.00	37.72
III	Supplies & Materials (i.e. consumable)	75000.00	66132.00	3.70
IV	Contingencies	30000.00	28057.00	1.57
V	Travel	97900.00	65970.00	3.69
VI	Overhead Expenses	185000.00	185000.00	10.36
VII	Others, if any (includes expenditure for pre-project & post-project workshops and procurement of satellite images)	200000.00	203545.00	11.40
	Total	1786000.00	1786000.00	100%

5. Procurement/ Usage of Equipment

a)

Sl No	Name of Equipment	Make/Model	Cost (FE/ Rs)	Date of Installation	Utilization Rate (%)	Remarks regarding maintenance/ breakdown
01	GIS Software (ArcView)	Model: ArcGIS 9.2, ArcView 9.2 Make: ESRI, USA	3,48,400.00 (Three Lakhs Forty Eight Thousand Four Hundred) Only	29-07-08	100%	It is single licensed software with limited functionality. Multi-licensed software with added extension is required.
02	Automatic Weather Station Including data logger	Model: iMETOS SD Make: Pessl instrument, Austria	2,70,514.00 (Two Lakhs Seventy Thousand Five Hundred Fourteen) only	18-07-08	100%	Technical problems occurred in 2010 with the data logger, wind and solar data receptors. It was rectified later.

b) Plans for utilising the equipment facilities in future

- The GIS software is being used by the students of M. Tech (Energy Technology) and PhD (Energy) programmes of the Department of Energy, Tezpur University for research activities.
- The climatic data available from the Automatic Weather Station (AWS) installed inside the University campus will be used for future research activities. The data have been also using by other organizations.

Name and Signature with Date


23-02-12

(D C Baruah, PI)

Principal Investigator
DST (Govt. of India) funded research project on
"Agro-climatic Zone Based Mapping of
Renewable Energy Resources in Assam"
Department of Energy, Tezpur University
Tezpur, Assam, India- 784 028

STATEMENT OF EXPENDITURE

1. Sanction Letter/ Order No and date of sanctioning the project: **No. NRDMS/11/1319/2007** Date: **11-04-2008**

2. Total Project Cost: **Rs. 17, 88,100/- (Rupees Seventeen Lakhs Eighty Eight Thousand One Hundred) only**
(Sanctioned/ Revised Project Cost, if applicable)

2. Date of Commencement of Project: **03-06-2008**

3. Date of Completion of Project: **26-12-2011**

4. Grant received in each year (financial year):
 - a. 1st Year: **Rs. 11, 00,000/- (Rupees Eleven Lakhs) only**
 - b. 2nd Year: **Rs. 3, 06,000/- (Rupees Three Lakhs Six Thousand) only**
 - c. 3rd Year: **Rs. 3, 00, 000/- (Rupees Three Lakhs) only**
 - d. 4th Year: **Rs. 80,000/- (Rupees Eighty Thousand) only**
 - e. Interest, if any: **N/A**
 - f. Total (a+b+c+d+e): **Rs. 17, 86,000/- (Rupees Seventeen Lakhs Eighty Six Thousand) only**

Statement of Expenditure

(to be submitted financial yearwise i.e. DOS* to 31st March of that financial year say 20XX, 01-04-20XX till 31.03.20XX+1 year and so on)

Sl no	Sanctioned Heads	Funds received (Rs.) (FY 2008-09, 2009-10, 2010-11, 2011-12) (Sanctioned)	Expenditure Incurred (Rs.)				Total (Rs.) (IV+V+VI)	Balance, if any (Rs.)	Remarks
			1 st Year (3 rd June 2008 to 31 st March 2009)	2 nd Year (1 st April 2009 to 31 st March 2010)	3 rd Year (1 st April 2010 to 31 st March 2011)	4 th Year (1 st April 2011 to till project completion)			
(I)	(II)	(III)	(IV)	(V)	(VI)				
1.	Manpower costs	518800.00	120597.00	174700.00	162216.00	106050.00	563563.00	-44763.00 (over expense)	The balance amounts in the consumables, travel, contingencies, post project workshop and equipment heads are adjusted for manpower, maps & satellite imagery heads of the project.
2.	Consumables	75000.00	12949.00	32404.00	13188.00	7591.00	66132.00	8868.00	
3.	Travel	97900.00	5140.00	33026.00	21696.00	6108.00	65970.00	31930.00	
4.	Contingencies	30000.00	10000.00	2330.00	15727.00	00	28057.00	1943.00	
5.	Others, if any								
(i)	Pre project workshop	50000.00	50000.00	00	00	00	50000.00	00	
(ii)	Post project workshop	50000.00	00	00	00	45008.00	45008.00	4992.00	
(iii)	Maps & Satellite imagery	100000.00	75961.00	32576.00			108537.00	- 8537.00 (over expense)	
6.	Equipment	679300.00	379808.00	293925.00			673733.00	5567.00	
7.	Overhead expenses	185000.00	75000.00	00	110000.00		185000.00	00	
8.	Total	1786000.00	729455.00	568961.00	322827.00	164757.00	1786000.00	00	

Amount to be refunded/ reimbursed (whichever is appropriate): NIL

Name and Signature of Principal Investigator: Dr. D C Baruah

Date: 06-02-2012



Signature of Competent financial/ audit authority (with seal):

Date: 
Finance Officer
TEZPUR UNIVERSITY

* DOS: Date of Start of Project
Principal Investigator
of India funded research project on
"Agro-climatic Zone Based Mapping of
Renewable Energy Resources in Assam"
Department of Energy, Tezpur University
Tezpur, Assam, India- 784 028