ASSESSMENT OF SURPLUS CROP RESIDUE BIOMASS ENERGY SECTOR: INDIA

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Abstract: *This paper deals with three issues related to surplus residues biomass energy: 1. the concept of surplus crop residues biomass energy, 2. institutional setup for residues biomass energy policy & planning, and 3. Its achievement at the national level. The choice of surplus crop residues biomass energy is dependent on the institutional framework that shaped its existence in the renewable energy sector. The current study is shaped by various alternative learning-based approaches used by academics and practitioners in the field of renewable energy. The approaches show similarities with Clean Development Management (CDM) goals and reflect the alternative and sustainable development context within which they were framed toward ecological-based energy capacity building. The institutional framework can encourage surplus crop residual biomass energy, and it is one of the few alternative energy resources in which individuals appear eager to invest. However, the surplus crop residues biomass energy initiative is slowly spreading across the country, wait and watch if the surplus crop residues biomass energy approach can prove its merits.*

Key words: Residues-Energy, Energy Policy and Planning, Gasification, Biomass cogeneration

Introduction

Why is surplus residues biomass energy an important contribution to renewable energy? There is a growing demand for energy across the nations of the world. The development of any region depends on energy availability. However, the non-renewable energy resources are depleting fast, making it imperative to understand and develop renewable energy sources from the ecological system. Biomass has the potential to be an alternate energy source as fossil fuels, although to be used carefully with the preservation of land and water resources simultaneously (Datye, 1997). It is essential because many countries' energy agencies consider agricultural residues a potential renewable energy resource.

There are many biomasses renewable energy sources, and agriculture residue is one of them. The term 'biomass' covers the remaining solid part from all (biological) plant and animal matter on the Earth's surface. Wood has been the popular biomass fuel used. However, the importance of agricultural crop residue is clearly understood and is fast replacing the use of wood. Any energy resources such as heat and electricity generated from these remaining agricultural residues are called 'Residues-Energy', particularly for the Biomass Power plant. There are wide varieties of agricultural residues biomass. Residues-Energy is one of the most promising renewable energy sources globally due to its geographical availability and ability to generate heat and power on various scales. (MNRE, 2010; Datye, 1997). The International Energy Agency aggressively pursues all developed and developing nations to use alternative and renewable energy resources under the 'Bioenergy Task 29 project'. Indian government initiated a project to use residues biomass energy with international collaboration with the Governments of Austria, Canada, Ireland, Japan, Norway, Sweden, United Kingdom and the Republic of Croatia of Europe titled "New and Renewable Energy Resources". The "Economic Drivers in Implementing Bioenergy Projects" spanned three years (2003-05). Another project, "Residues Aspects of Energy", was initiated to identify substantiated net regional gains and benefits in the use of residues energy so that it may be promoted in areas where the gains can be maximised most widely handled (MNRE, 2008; Administrative Staff Colleges of Hyderabad, 2005).

The Expert Committee on Integrated Energy Policy set up by the Planning Commission examined that India has one of the world's lowest per capita energy consumption rates. On the other side, decreasing the energy intensity¹ in GDP to increase energy efficiency is critical for India to satisfy its energy requirements. Rural energy demand is also included, which can be achieved through crop residue usage (Planning Commission, 2006). Developing uses of residues in an organised manner can also spin off substantial socio-economic benefits because residues sources are naturally produced in a decentralised pattern (rural areas). The residues are the primary energy source for rural people in general and poor people in particular. Additionally, it provides a source of income for landless agricultural labourers and a supplement to revenue for small and marginal subsistence farmers (Administrative Staff Colleges of Hyderabad, 2005). Given this dispersed nature, it is essential to research and evaluate residues' use and production's exact nature and status.

Study Region

The primary survey was conducted in *Patna* and *Rohtas* districts. Geographically, both the districts fall under the Northern and Southern parts of the *Son Watershed* region of Bihar State. It is noteworthy that many districts of Bihar, other than Patna and Rohtas, are also part of the *Son River Watershed*. These two districts were selected due to two reasons. First, both have flat alluvial lands and fertile soil. Secondly, both are known for their agricultural activity. The climate here is sub-

¹ Energy intensity measures a country's economic efficiency in terms of energy use. It is expressed in terms of energy units per unit of GDP.

Tropical, like the northern plains. The area receives monsoonal rainfall up to 150 centimetres during peak season. Agriculture is the primary activity of people in both districts. Here, crops such as Paddy, Wheat, Gram and Pulses are cultivated extensively. In addition, food grains, vegetables, and fruits are also cultivated in the *Watershed Command Region*. Five villages in the Patna district were chosen for the study: Anandpur, Lodipur, Darweshpur-Uparwar, Sadikpur and Katesar. Administratively, these villages are divided into two blocks: 1. Maner Block includes the villages of Lodipur, Sadikpur, and Darweshpur-Uparwar; and 2. Bihta Block, which includes the villages of Anandpur and Katesar. Five villages in the Rohtas district were chosen for the survey. Mahadewa, Pokharaha Jamalpura, Chainpur, Berkap, and Hurka are among them. These villages are administratively divided into two blocks: 1. Dehri Block, which encompasses Chainpur, Berkap, and Hurka. 2. Nasriganj Block encompasses Mahadewa and Pokharaha Jamalpur villages.

Figure 01: Map of Survey Area

Objective

1. Defining the surplus crop residues biomass concept.
2. Exploring the Institutional Setting for residues biomass energy policy and planning.
3. Assessing the surplus residues biomass energy production pattern.

Research Methodology and Sources

The first step in the study has to define surplus crop residues for energy purposes through the help of the primary survey. Quantitative and qualitative methods were introduced during primary and secondary data collection. After that study process through the secondary data for a broad overview of discourses and content analysis about the institutional setup for policy & planning and its achievement at the national levels.

Primary Data

A primary survey was carried out to verify the existence of surplus crop residues. The method of defining surplus crop residues adopted from the MNRE study "*25 Years of Renewable Energy in India, 2008*". The Son watershed in Bihar's Patna and Rohtas districts was the field area from 2012 to 2013 that looked at 200 households primarily engaged in agricultural farmland activities. A questionnaire was prepared, and respondents were selected with a random sampling method for an interview concerning residue utilisation. Gathering data on the use of agricultural residues in various stakeholders and their corresponding quantities. The categories were classified according to utilisation patterns that appeared during the survey, such as feed for cattle, a hut for keeping and storing domestic animals, use for domestic fuel, being used as a small-scale industry fuel source, raw materials for paper production, a lack of productive use disposal is a concern, used as a source of energy in the brick making industry, use in the cottage and food industry and last burned in the fields. (See table no. 1). The category of a lack of productive use disposal is a concern, and burned in the fields have been defined as surplus crop residues biomass amount according to MNRE's norms, because it is not disturbing share of traditional uses so that it can become a resource for power/energy use.

Secondary Data

The only Ministry of New and Renewable Energy provides secondary data on institutional setup for policy & planning purposes and its achievement in the country, so the present study utilised these data for full fill their objectives.

Result and Discussion

There are many common uses of agricultural residues. However, the category of a lack of productive use disposal is a concern and burned in the fields defined as surplus crop residues biomass, so it becomes a source of power/energy production resources without interfering with traditional uses. The administrative structure is the most important issue in developing the crop residues sector. The entire structure created three levels. The MNRE has implemented inclusive programmes to develop and utilise various agricultural residues biomass power technologies in the country. As a result, technological devices have been developed, such as biomass gasification, bagasse cogeneration and biomass cogeneration. As an outcome, the total amount of biomass energy generated in 2018 was 4502 MW.

Defining Surplus Crop Residue Biomass

Surplus means what remains after a portion of something has been removed, but in the case of surplus crop residues biomass, this does not apply. The study uses the following table to define surplus crop residue biomass. The data in this table was gathered from surveyed villages between 2012 and 2013. The analyses have included all major areas where crop residues have a traditional utilisation pattern. There are many common uses of residues, but, the category of a lack of productive use disposal is a concern and burned in the fields defined as surplus crop residues biomass amount, it becomes a source of power/energy production because it does not interfere with traditional uses

**Table 01: Bihar's Ten Villages in Patna and Rohtas Districts Share Different Shareholders'
Crop Residue Biomass: 2012 and 2013. (in Quintal)**

Typical uses of Residues (Quintals)	Rice (Straw)	Rice (Husk)	Wheat (Straw)	Gram (Straw)	Arhar (Straw)	Arhar (Husk)	Maise (Straw)	Total
Feed for cattle	201.00	39.00	2230.00	110.00	0.00	12.35.00	0.00	2592.35
A hut for keeping and storing domestic animals	132.00	120.00	0.00	45.00	50.00	0.00	0.00	347.00
Use for domestic- fuel	203.00	21.00	430.00	10.00	0.00	0.00	0.00	664.00
Being used as a small-scale industry fuel source	105.00	120.00	260.00	0.00	0.00	0.00	0.00	485.00
Raw materials for paper production	230.00	0.00	234.00	0.00	0.00	0.00	0.00	464.00
A lack of productive use disposal is a concern	1405.00	0.00	0.00	300.00	0.00	0.00	90.00	1795.00
Used as a source of energy in the Brick making industry	234.00	320.00	0.00	68.00	0.00	0.00	0.00	622.00
Use in the cottage and food industry	1465.00	606.00	32.00	0.00	28.00	0.00	0.00	2131.00
Burned in the fields	500.00	69.53	890.00	0.00	0.00	0.00	0.00	1459.53
Total	4475.00	1295.53	4076.00	533	78.00	12.35	90.00	10559.88

Institutional Background for Surplus Crop Residue Biomass Energy

MNRE is the nodal institution for implementing various renewable energy programmes, and the surplus agricultural residues biomass program is one of them. The Ministry supervises one of the world's most extensive agricultural residues biomass energy programmes, covering the full range of renewable energy technologies, including grid-connected and off-grid systems. (MNRE, 2006-07). MNRE has developed a substantial industrial base in innovation, allowing it to export technology and knowledge to other nations (Reddy & Balachandra, 2002). Biomass energy promotion is a key component of the country's strategy for sustainable energy growth.

India has a concise history related to developing residues biomass energy. The Commission for Additional Sources of Energy (CASE) was founded in 1981 to research and promote alternative energy sources. The sector has evolved through numerous phases of growth since its beginnings. In 1982, the Department of Non-Conventional Energy Sources (DNES) was founded; in 1992, it was renamed the Ministry of Non-Conventional Energy Sources (MNES). CASE has been absorbed into MNES. CASE's primary objective was to foster the country's expansion and promotion of new renewable energy sources (NRSE) by formulating policies and programmes. Moreover, it served as the program's coordinator and had an important role in intensifying research and development activities to ensure the effective implementation of the relevant government policies. CASE bridges the gap between research and production by promoting the acquisition of both financial and technical resources necessary for the rapid commercialisation of NRSE technologies. Furthermore, it was required to survey, plan, approve, and implement programmes in the public, private, and small-scale sectors to produce all necessary materials and components for commercialising the area's technical know-how. CASE was also tasked with recommending promotional measures to encourage industry adoption of NRSE technologies to the government. The Planning Commission directs all national policies and efforts at the planning level and approves all central government and state government programmes. A distinct division within the Planning Commission is responsible for managing and coordinating all NRSE proposals and projects submitted by the central and state governments (MNRE, 2002-03; MNRE, 2003-04; MNRE, 2004-05; MNRE, 2005-06).

On the financing front, the Indian Renewable Energy Development Agency (IREDA) was established in 1987 to alleviate the burden of renewable energy technologies' high initial costs and perceived high financing risk. IREDA was a public sector enterprise tasked with financing renewable energy projects. IREDA provided low-interest loans for such projects. As a result, REDA's interest rates are competitive with market rates (MNRE, 2008). Following this, the MNES

developed broad policy guidelines for promoting agricultural biomass energy generation in 1993. This included guidelines and a framework for biomass energy pricing (Rathore, Mathur, & Solanki, 1993). Numerous policies and initiatives were implemented in 1993 to promote the commercialisation of biomass energy (MNRE, 2008). In October 2006, the Ministry of Non-Conventional Energy Sources had renamed the Ministry of New and Renewable Energy. The Ministry then began to support implementing an extensive, broad-spectrum programme that would cover an array of new and renewable energy sources, including solar, wind, bio, hydro, and waste energy. The MNRE determined that it was necessary to establish three levels of authorities/institutions to carry out its functions. (MNRE: Government of India, 2015): These functions are divided into the following categories:

Central level: The central government has the authority to take whatever steps necessary to develop and deploy agro biomass energy/power, that is MNRE.

1. Initiate, monitor, and review the implementation of a national biomass power policy and plan.
2. Plan and implement nation wide programmes to increase the use of biomass fuels for electricity generation.
3. Establish laboratories, testing centres, and research institutes to research and develop biomass power technologies.
4. Manage and keep track of the funds earmarked for developing renewable energy sources, such as the biomass power fund.
5. Standards and norms for resource assessment (of various biomass power resources), technologies, and products should be developed and coordinated.
6. By providing adequate funds for coordination, meetings and research; access to MNRE data and resources; and salaries for permanent staff, the policies aim to support the biomass power committee and any other body or agency established under the provisions of the policies.
7. State-level renewable energy policies and state-level biomass power plans should be developed following guidelines issued by the central government and supported by the state governments.

State Level: Biomass energy policy and plan at the state level.

1. The state government is responsible for periodically developing, monitoring, and implementing a state-level biomass power policy and plan.
2. 2) While making this decision, the state government must consider the current national biomass energy policy and plan and any relevant guidelines issued by the state government.
3. The state governments could also establish a green state fund for biomass power.
4. State-level biomass power policies and plans were developed according to the current status. The state government must consult the designated state nodal agency.

Districts to Village Level: There are a variety of topics on which the state government can develop policies or plans through their district's office to block-level officers, including village panchayat.

1. Establishing biomass power goals
2. Incremental cost-sharing
3. Facilitating the deployment framework
4. Biomass power park development
5. Building a system for transporting power
6. State green funds should be established and utilised
7. Data management for biomass power
8. Resources evaluation
9. An inclusive approach to land use for biomass power plant development

Surplus Crop Residue Biomass Energy Achievements

The MNRE has undertaken comprehensive programmes to promote the development and use of diverse biomass energy technologies. As a result, several technologies such as biomass gasification, biomass cogeneration, and bagasse cogeneration have been developed. Although bagasse cogeneration has been running since 1950, its quantity was very small. After energy reforms in 1990, biomass gasification and biomass cogeneration emerged as potentially important sectors for long-term development. The surplus generated electricity has been supplied to the main grid. However, the cogeneration path has been chiefly followed for rural and small industrial purposes. Crop residues biomass power have three branches presented following table with their achievement:

Table 02: Biomass Power Plant Development Bases of Production and Cumulative Installed Capacity/ MW

Year	Biomass power in MW	Bagasse cogeneration in MW	Biomass gasification in MW eq.
1950	---	40.00	----
1960	---	65.00	----
1970	---	103.00	-----
1980	---	113.00	-----
1990	50.00	152.00	36.00
2000	70.00	250.00	45.00
2001	80.00	278.00	42.80
2002	103.00	365.00	53.00
2003	130.00	483.00	58.00
2004	115.00	612.00	62.00
2005	376.53	491.00	71.00
2006	466.50	571.83	75.85
2007	605.80	719.83	86.53
2008	702.62	605.60	110.20
2009	1048.20	703.30	242.90
2010	980.00	829.50	109.62
2011	795.00	1272.00	128.00
2012	1142.60	1952.53	148.26
2013	1263.00	2300.00	156.89
2014	1365.00	2648.40	164.70
2015	1365.20	2800.35	171.63
2016	1502.40	2554.00	178.52
2017	1540.10	2666.70	190.42
2018	1603.30	2689.20	210.32

Sources: Compile from Different MNRE Reports

The table summarises the development and achievement of surplus residues biomass energy. In the year 2018 total biomass power capacity was 4502 MW. The technology is popular amongst users as it is convenient for the rice and sugar industries. From 1990 to 2000 growth took a remarkable turn after an initial period. From 2000 to 2010, growth was rapid. There are many reasons, but the development of new technology and government subsidy played a major part. From 2010 to 2018, the growth rate and increased power generation capacity were maintained. Implementing biomass technology has been supervised centrally by MNRE, but actual dissemination has devolved by state governments.

Conclusion

The study verifies the surplus crop residues biomass for energy utilisation following MNRE, and It becomes a source of energy production that does not obstruct conventional uses.

Biomass has the potential to be used in place of fossil fuels. The institutional framework for policy and planning has recognised biomass residues as energy resources. As a result, three institutional levels were established: central, state, and district to the village. MNRES' policy shift toward hierarchical organisation and institutional support has yielded a positive outcome. According to the MNRE, India has a comprehensive strategy for harnessing energy from surplus crop residues biomass. The planning and policy strategy has now integrated various biomass energy options on a megawatt scale into the grid. Nearly 4502 MW biomass power capacity has been commissioned since 2018.

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