

## Biomass resource availability in Kerala

In Kerala, the state level biomass resource assessment study was carried out at the time of development of Biomass Resource Atlas of India (2002-04). According to Biomass Resource Atlas of India, biomass power generation potential in Kerala is around 500 MW. No separate state level assessment has been done for assessing the biomass potential for the state; however, The Kerala Energy Report 2011 projects the potential biomass availability up to year 2050. The information presented here is taken from the Kerala Energy Report 2011.

### Agro-residue production from agricultural crops

The main agricultural crops in Kerala are paddy, coconut, rubber, arecanut, and tapioca. Presently, most of the agricultural residues generated in the fields are either used as fodder, thatching material or burnt to prepare the soil for the next cropping season or it is left on the farm to mulch and improve soil's nutrition level. Therefore, considering the variety of alternative uses for crop residues, the study considered a standard availability of 10 per cent of biomass resource for energy generation. However, changing consumption trends and improved collection efficiency in the future could make a larger resource base available for generation of energy. Table below gives the crop, residues and crop to residue ratio considered in the study for estimation of agro-residue potential in Kerala state.

Crop	Residue	Residue generation (kg)
Paddy	Husk (per kg of crop)	0.20
	Straw(per kg of crop)	1.50
Coconut	Husk & Pith (per kg of crop)	0.53
	Shells (per kg of crop)	0.22
	Fronnd ( Tonnes/hectare)	4.00
Rubber	Primary wood (Tonnes/hectare)	3.00
	Secondary wood (Tonnes/hectare)	2.00
Arecanut	Husk (per kg of crop)	0.80
	Fronnds (Tonnes/hectare)	3.00
Tapioca	Stalks (per kg of crop)	0.75

### *Paddy*

Paddy is sown across all the three seasons in Kerala. The state grows nearly 600 different varieties of paddy across 14 districts. However, in recent years the changing land use pattern in Kerala has reduced the paddy cultivation by 70 percent. In 1961-62, there were about 7,53,000 hectares (ha) of land under paddy cultivation. As against it, in 2010-11, the cultivated land for paddy was only 2,13,000 ha, which generated about 5,22,000 metric tonnes (MT) of rice.

The main residue from paddy crop is straw and husk. Paddy straw in Kerala is usually either left over farms to be mulched or is burnt so that the soil can be prepared for the next crop cycle. Most of the husk is either utilized as energy source for running shelling operations or for preparation of parboiled rice. Due to the predominance of small and fragmented land parcels, lack of mechanization and high labour costs make collection of rice

straws difficult and as a result, the collection of straw is negligible. Thus, the collection efficiency of 10 percent is considered for calculating the available paddy straw. Based on factors, the annual availability of paddy straw and husk is calculated as 78,300 MT and 10,400 MT respectively.

Crop	Crop production (metric tonnes (MT))	Type of residue	Crop to residue ratio	Residue production (MT/Yr)	Collection efficiency (%)	Available residue (MT/Yr)
<b>Rice</b>	5,22,000	Straw	1.5	7,83,000	10	78,300
	5,22,000	Husk	0.2	1,04,400	10	10,440

### *Coconut*

The total area under coconut cultivation was 7,70,000 ha in 2010-11, which is 40% of the State's net cropped area. Coconut plantations generate husk, shells and fronds. Shells have alternative non-energy uses for charcoal or activated carbon in some international markets. A part of the coconut fronds is utilized for manufacturing temporary thatching materials and roofing arrangements, but rest may be available for the energy generation. Coconut husk is procured directly by the coir industries but almost all the husk generated is utilized by the coir industry for manufacturing different items. Leaving aside the husk and shell, fronds can be potentially converted for energy generation.

Crop	Area under coconut cultivation (ha)	Type of residue	Crop to residue ratio (MT/ha)	Total residue generation (MT/Yr)	Collection efficiency (%)	Available residue (MT/Yr)
<b>Coconut</b>	7,70,000	Fronds	4	3,080,000	10	3,08,000

### *Rubber*

Kerala accounts for more than 90 per cent of the natural rubber produced in the country. The area recorded under rubber cultivation in the year 1965-66 was 1,21,009 ha, which has increased to 5,34,230 ha in the year 2010-11. The changing land use pattern in Kerala indicates the increasing cultivation of Kerala in coming years due to government incentivizes for domestic rubber production, more mechanization, etc. However, here only net wood availability is mentioned based on the assumption of 10 per cent residue availability.

Crop	Area under coconut cultivation (ha)	Type of residue	Crop to residue ratio (MT/ha)	Total residue generation (MT/Yr)	Collection efficiency (%)	Available residue (MT/Yr)
<b>Rubber</b>	5,34,230	Primary wood	3	16,02,690	10	1,60,269

### *Arecanut*

Arecanut is another crop, residues of which can be used for energy generation. The major residues from Arecanut plantations are fronds and husk. Fronds are mainly consumed by elephants as their staple diet, and as such are not available for the energy generation. Arecanut husk on the other hand does not have any significant alternate use and could be utilized for the generation of power. The area under Arecanut cultivation was about 99,834 MT in 2010-11. The ratio of Arecanut husk to the cop is about 0.8. Thus at a collection efficiency of 10 percent, the available Arecanut husk is 7,993 MT per year.

Crop	Area under coconut cultivation (ha)	Type of residue	Crop to residue ratio	Total residue generation (MT/Yr)	Collection efficiency (%)	Available residue (MT/Yr)
<b>Arecanut</b>	5,34,230	Husk	0.8	79,927	10	7,993

### *Tapioca*

The cropping pattern of last 15 years indicates that major portion of land under tapioca cultivation has shifted to rubber plantation. During 1995-96, the crop area under tapioca cultivation was 1,13,601 ha, which declined to just 72,284 ha by 2010-11. The major residue obtained from tapioca is stalk. Nearly 0.75 kg of stalks is obtained per kilogram of crop harvest. This does not have any alternate use and can be utilized for the purpose of energy generation.

Crop	Crop production (metric tonnes)	Type of residue	Crop to residue ratio	Residue production (metric tonnes/year)	Collection efficiency (%)	Available residue (metric tonnes/year)
<b>Tapioca</b>	23,60,081	Stalks	0.75	17,70,061	10	1,77,006

### Agro-Based Wood-Processing Industries

The plantation based wood-processing industries generate a significant amount of saw-dust and bark as by-products. The major plantations in Kerala are rubber, coconut and arecanut. All these three varieties have a useful life-cycle of 25-30 years after which they need to be cut and replanted. Thus, the availability of such tree logs is maintained through out the year on a consistent basis for the purpose of timber as well as fuel.

Considering a useful life cycle of 30 years for coconut, arecanut as well as rubber plantations, nearly 2.59 tonnes of wood would be generated per hectare annually from each of the crops. Further to this, the wood collection efficiency of 60 per cent and the residue generation of 50 per cent have been assumed as the rest is utilized for other purposes. The total wood generation from rubber, arecanut and coconut trees is presented in table.

Type of Tree	Area (hectares)	Total wood (MT/Yr)	Collection Efficiency (%)	Alternative uses (%)	Available wood (MT/Yr)
Rubber	5,34,230	13,83,656	60	50	4,15,097
Arecanut	99,834	2,58,570	60	50	77,571
Coconut	7,70,000	19,94,300	60	50	5,98,290
<b>Total</b>					<b>10,90,958</b>

Table below presents the total available agro and forest residue potential in the state of Kerala. Approximately 17 lakh metric tonnes of biomass resource is available that can potential convert to produce more than 250 MW of power.

Type of residue	Available residue generation (metric tonnes/year)
Paddy straw	78,300
Paddy husk	10,440
Coconut fronds	3,08,000
Rubber wood	1,60,269
Arecanut husk	7,993
Tapioca stalks	1,77,006
Agro based wood processing	10,90,958
<b>Total</b>	<b>18,32,966</b>