ENERGY SCENARIO IN THE STATE OF JAMMU AND KASHMIR

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INTRODUCTION

Energy resources hold the key to the economic development of any region. Their availability accelerates growth and development and their non-availability retards development. This paper attempts to present a brief status report on the availability of energy resources and their existing and projected consumption patterns in the region of Ladakh, Jammu, and Kashmir. The non-availability of reliable time series data offers a serious constraint in presenting a realistic picture of the energy scenario in the state. Nonetheless, an attempt has been made to present a realistic picture of the energy resources of the state and the problems concerning their developent.

Physiography and Geology

The development of energy resources cannot be perceived correctly unless viewed in the context of physiography and geology. Jammu and Kashmir lies between 32°15'N to 37°5'N latitude and 72°35'E to 80°20'E longitude. It has a total area of about 222,000km^2. Its population, according to the census of 1981, was 5.95 million (Census of India 1981). Nearly 80 percent of the total population is rural and depends largely on primary economic activities--agriculture and forestry.

Geologically, the state has rock formations from the Archaen to the Cainozoic Eras (Wadia 1981). The geological structures are not favorable for fossil fuels. However, in the rocks of the Carboniferous Age, coal seams yielding brown coal and lignite have been found in Kalakot (Jammu Region), and Pulwama and Baramulla (Kashmir Region). Peat also occurs in patches in the alluvium of Jhelum and in the swampy ground of the upper reaches of the Kashmir Valley. Dried peat bricks are used as fuel. Peat is also applied in the fields as manure.

Physiographically, three distinct regions of the state can be identified: Jammu, Kashmir, and Ladakh. These are also distinct cultural regions. The Jammu region, comprised of southern alluvial plains, constitutes part of the Great Plains of India and resembles the landscape of Punjab. To the north of the plains lies the Kandi (undulating) tract, the ranges of the Siwaliks, and the Pir-Panjal Range. The Siwaliks of Jammu have an average altitude of 600 meters, while the Pir-Panjal which makes a water divide between Tawi and Chenab Rivers has an average elevation of 2500 meters above sea level (Raza et al 1978). The Chenab River, generally running along the strike between Pir-Panjal and Zanskar mountains, cuts a deep gorge through the northern parts of the Jammu region.

The Kashmir Valley of Kashmir is of

recent geological origin. It is a synclinal basin with the character of an enclosed vale, being surrounded by an unbroken ring of young folded mountain ranges with Pir-Panjal in the south and the Zanskar range in the north. Having been the scene of simultaneous operation of the complementary processes of deposition and sub-areal denudation, the surface features of the valley show the inextricable juxtaposition of both (Raza et al 1978). The Pir-Panjal forms a formidable barrier on the south and southwest, separating it from the Jammu region; the Great Himalaya and the Zanskar ranges shut it off from the frostbitten plateau desert of Ladakh and Baltistan. The region is drained by innumerable streams and rivers but mainly by Jhelum (Vitasta), Sindh (a tributary of Jhelum), Rembiara, Lidder, Dudganga and Harwan.

Ladakh constitutes the northernmost physiographic cultural and administrative region of the state. It includes Kargil, Zanskar, Rupshu, Nubra, Aksai-Chin and Leh. Ladakh is a vast arid tableland located at an average height of 4000 meters above sea level. It is mostly formed of mechanically weathered rocks and granite dust and is completely bereft of forests and pastures.

Climatic Conditions

The state of Jammu and Kashmir is situated in sub-tropical latitudes, but owing to high altitudes and snowclad peaks, the predominant climate has strong mountainous and continental characteristics of the temperate latitudes.

The southern part of Jammu region, being for the most part continuous with the plains of Punjab, is marked for its monsoonal climate. It is very hot during summer and equally cold in winter. The severity of winter is accentuated in areas of high altitudes because of heavy and frequent snowfall. The rainy season in Jammu region lasts from mid-June to September. Nearly 80 percent of the region's average annual rainfall is recorded during this season.

The Valley of Kashmir has a temperate continental climate, characterized by marked seasonality. In fact, the genesis of Kashmir weather is intrinsically linked with the mechanism of weather in the Indian subcontinent in general. Nevertheless, the Valley, being surrounded on all sides by the Himalaya ranges, has a modified sub-tropical climate. It has a fairly long spring stretching from March to the middle of May. Springs are fairly cold and wet, the mean monthly temperature in April being only about 16°C. The summer season, locally called *grishm*, lasts from June to August (Raina 1971). The region experiences a high degree of insolation in this season because of the rarified atmosphere at high altitudes, which leads to the steady melting of glacier ice. This improves the discharge of rivers and the consequent efficiency in the generation of hydel power. It is during this period that the peak generation of hydel power is recorded and load shedding is minimum. September and October are the months of autumn, locally know as *harud*. These months record the maximum range of temperature. Although the cold season or *wand* and *shesur* lasts from mid-October to February, its intensity is experienced from mid-December to the end of January which is locally termed as *chilla-kalan*. Heavy snows fall in the mountains during this season and occasionally in the Valley also. The mean minimum temperature in January remains below -3°C, often reaching as low as -10°C. During this period the Kashmir Valley receives rains from the western disturbances (Temperate Cyclones). Winter rains are, however, associated with snow in January, February, and early March.

The Valley received an unprecendented heavy snowfall of over 200 mm in 24 hours on 25-26 December, 1985. For nearly three weeks both the maximum and the minimum temperatures remained below the freezing point. During this period, the need for power is greatest but the supply is minimum because of the sharp decline in the flow of water. Since coal as a source of energy is not available locally, the axe falls on fuelwood which is extensively used, consequently leading to deforestation as will be observed later.

The climate of Ladakh and Zanskar is very dry and cold. In winter, the rivers freeze and the temperature often goes below freezing point, the mean minimum reading as low as -10°C at Leh and -40°C in Dras. The skies are generally clear and insolation intense. Winds, however, blow with steady speed and are a potential source for generating wind energy. Day temperatures in summer rise to 40°C which becomes unbearable. The Indus, Shyok, and other valley regions are extremely warm in summer. The atmosphere of the Leh Valley is remarkably transparent and the heat of the sun, which can be harnessed for the generation of solar energy, is intense.

Floristically, the state is divided into three regions: alpine desert flora of Ladakh, predominantly temperate flora of Kashmir, and sub-tropical flora of Jammu (Kachroo 1985). Ladakh hardly receives precipitation except in the form of snow and frost and is characterized by xerophytic vegetation. Scrubby bushes constitute the major vegetational component of Ladakh, except in the more humid regions of Nubra Valley. The Kashmir region has distinct vegetation zones because of altitudinal change from 1350 meters to 400 meters above sea level: mixed vegetation of broad-leaved deciduous trees and conifers; conifer forest; white juniper, birch, and stunted birch; and alpine flora zones. The willow trees *conium maculatum* and *senecio vulgaris*, which are found extensively in Srinagar and among river and canal banks up to a height of 2600 meters are a recent introduction in the Valley. The sub-tropical belt of the Jammu region is dominated by broad-leaved forests, both deciduous and evergreen. Oak (deodar) and pine trees are found occasionally on the inter-Pir-Pinjal ranges. The foothills are dominated by *dodonaea* scrub and *sissoo*.

Demographic Characteristics

The population of Jammu and Kashmir, according to the census of 1981, was 5,954,009, which is slightly less than the population of the Union Territory of Delhi. During 1971-81, it registered an anual growth rate of 28.95 percent, which is much above the national average growth rate of 20 percent. Table 1 presents a synoptic view of some of the basic demographic characteristics of the state and its three regions

Table 1: Jammu & Kashmir State: Some Basic Population Characteristics - 1981

State/ Region	Total Population	% of total	Decadel growth rate 1971-81	Urban Total	Pop %	No. of towns	Rural Total
J & K	5954009	100	28.95	127877	21.47	56	4675238
Kashmir Div.	3134904	52.6	26.42	828009	26.41	23	2306895
Jammu Div	2717069	45.8	25.92	420579	15.47	31	2296410
Ladakh Div.	620953	1.6	24.85	30613	4.93	2	590340

Table 1: (Contd.)

State Region	Popula-tion %	Density of popu-lation	Total Working Population	Percent of Working Population		
				Primary	Secondary	Tertiary
J & K	78.53	59	30.08	62	6	32
Kashmir Div.	73.59	196	31.56	77	6	17
Jammu Div.	84.53	103	28.73	81	7	12
Ladakh Div.	95.07	5	44.78	73	5	22

Source: Census of India 1981

regions. The Kashmir Valley stands out as the demographic node of the state, containing 52 percent of its total population. Of the three regions, the Valley has the highest population growth rate, claims the highest gross density of population (which speaks for its land-carrying capacity), and contains over 60 percent of the state's total urban population. The state, however, has a weak economic base which is substantiated by the dominance of primary and tertiary sectors in its occupational structure.

ENERGY RESOURCES OF THE STATE: DEVELOPMENT AND CONSUMPTION PATTERNS

The resource base and socioeconomic structure reveal that the state is well-endowed with fuelwood and water resources; however, it is deficient in coal, petroleum, and natural gas. Of the energy resources used in the state, hydroelectricity, fuelwood, and kerosene are by far the most important. Together, they constitute 95 percent of the total energy consumed in the state. Presently 80 percent of the energy consumed in the state is obtained from fuelwood trees raised on farm embankments and from culturable wasteland. The consumption of electricity, kerosene, and LPG predominates in urban areas whereas rural areas depend largely on fuelwood. In the villages of Kandi or undulating hill areas, fuelwood constitutes up to 98 percent of the total energy consumed for cooking, heating, and lighting (Husain 1986). Although largely confined to the urban centers, electricity is the prime source of energy, particularly in Srinagar and Jammu--the summer and winter capitals of the state--where commercial and industrial activities are concentrated.

Fuelwood

The state has a wide variety of temperate and sub-tropical trees in its extensive forested areas, which cover nearly 30 percent of the total area. Most of these are used as fuelwood, but the principal among them are conifers and willows (Table 2). Twigs and branches constitute a very important source of energy, particularly in the rural areas of Jammu region. In four of the six districts of this region, twigs and branches are the dominant source of domestic energy and are acquired free of cost. Conifers (blue-pine and silver-pine) are the predominant source of fuelwood in the Kashmir region and in districts of Jammu region which have extensive use of fuelwood. In Srinagar district, twigs and branches, conifers, and willows are consumed in almost equal proportion. In the tropical parts of Jammu region, tropical trees like *banmusroo* and *kail* are also used as fuelwood.

Of the conifers used for fuelwood, silver-pine is most common. The blue-pine is valued more for its fine quality of charcoal. Because of its oil-bearing quality, it is also used as a source of domestic lighting in rural areas, particularly during winter.

It has been estimated, based on a pilot study, that the average annual consumption of fuelwood in the state amounts to approximately 26 million quintals. This pilot study covered 416 rural and 293 urban households from the Jammu and Kashmir regions, and was

Table 2: Spatial Consumption of Fuelwood in Jammu and Kashmir Divisions

District	Twigs branches	Conifer	Willow	Kikar	Hatab	Walnut	Poplas
Anantnag	36	40	21.2	0.4	0.3	-	-
Badgam	40	39.1	12.6	6.3	-	-	-
Baramulla	29.4	30.1	17.7	11.6	-	0.5	4.0
Kupwara	41.2	58.8	-	-	-	-	-
Pulwama	24.8	52.1	14.0	2.7	-	-	-
Srinagar	22.0	39.5	33.1	2.1	-	-	-
Doda	15.3	57.4	-	-	-	-	-
Poonch	77.0	23.0	-	-	-	-	-
Jammu	64.4	1.4	-	8.8	-	-	-
Kathua	73.8	10.2	-	-	-	-	-
Rajouri	44.2	50.2	-	-	-	-	-
Udhampur	69.3	16.9	-	-	-	-	-

Table 2: (Contd.)

District	Zangloo	Fruit trees	Banjm-naroo	Tali	Derek	Eucalyp-tus	Others	Total
Anantnag	-	-	-	-	-	-	1.0	100
Badgam	-	1.3	-	-	-	-	-	-
Baramulla	1.3	5.4	-	-	-	-	-	100
Kupwara	-	-	-	-	-	-	-	100
Pulwama	-	-	-	-	-	-	-	100
Srinagar	-	3.3	-	-	-	-	-	100
Doda	-	0.2	19.3	-	-	-	9.8	100
Poonch	-	-	-	-	-	-	-	100
Jammu	0.2	-	-	23.1	1.7	0.4	-	100
Kathua	-	1.9	2.0	3.1	-	-	9.0	100
Rajouri	-	-	-	0.8	-	-	4.8	100
Udhampur	1.3	-12.5	-	-	-	-	1.0	100

conducted in 1983. The study shows that in addition to firewood, which constitutes the single most important fuel for domestic consumption, cowdung, sawdust, dry-leaves, charcoal, soft coal, kerosene, and cooking gas are also used as domestic fuels. Of these, the consumption of kerosene and gas is confined primarily to urban areas. In the rural areas where firewood and its byproducts are the principal sources of domestic fuels, one or two members of each household spend a part of his/her working hours collecting dry firewood twigs, branches, dry leaves, and dungcake from forests, arable lands, wastelands, and pastures. No studies, however, are available to indicate the manhours rural households spend collecting fuelwood for domestic consumption.

It has been estimated in the same study that the per head consumption of firewood in the state is 3.8 quintals per annum with twigs and branches accounting for 1.6 quintals or 42 percent of this consumption. The per capita consumption of firewood in rural areas is 4.4 quintals per head per annum compared to 2.5 quntals per capita in urban areas. Twigs and branches constitute 2.1 quintals per capita per annum in rural areas and 0.4 quintals in urban areas.

Table 3 also highlights the fact that of the three regions, Kashmir has the highest fuelwood consumption, but its per capital consumption is lower than that of Jammu region, presumably because of its higher proportion of urban population. Of the total fuelwood consumed in the state, 42 percent (10.94 million quintals) is contributed by twigs and branches, and the balance of 15.10 million quintals is obtained in the form of wood from forests. Nearly one million quintals of dry leaves are also annually consumed as fuel in the rural areas of the state (Table 4). It is obvious that deciduous trees such as *chinar* (Nepal) and poplar, which shed their leaves in autumn, also play a role in the supply of fuel to the people of the state. The consumption of firewood and its byproducts as fuel by regions and districts is given in Table 4.

The combined per capita consumption of firewood in both urban and rural areas varies from a minimum of 0.8 quintal in Jammu to a maximum of 4.3 qunitals in Doda. In the rural areas, consumption ranges from 0.7 (Jammu) to 4.7 (Srinagar). The highest (5.5) and the lowest (0.1) per capita consumption of firewood in both urban and rural areas is higher in the Kashmir region. In the Jammu region the consumption of twigs and branches is more prominent. Table 4 further reveals that the consumption of dry leaves, charcoal, and sawdust as fuels is confined to the Kashmir region. About 80 percent of the charcoal is prepared from superior timber trees (deodar (oak), *badul* (silver-pine), spruce, and pines). Charcoal is used in *samewars* for preparing tea or heating water, and in *kangris* (portable earthen heaters). The urban poor also use sawdust for cooking and heating.

It is evident that at present, fuelwood is the most important source of domestic energy in the state. Massive use of fuelwood has led to excessive deforestation and consequent widespread encroachment on forest and pasture lands especially in the Narang Catchment, Daksum Valley, Gurez Valley, and the slopes of the Pir-Panjal.

Table 3: Jammu and Kashmir State — Rural Urban Fuelwood Consumption Regionwise — 1983

Figures in thousand quintals

Region	Rural Population	Fuelwood consumption	Urban Population	Fuelwood consumption	Total Population	Fuelwood consumption	Share of each region to total %
Jammu	2297010	10101 90.59%	420059	1050 9.41%	2717069	11157	42.8
Kashmir	2306265	10146 83.06%	828099	2070 16.94%	3134364	12216	46.9
Ladakh	590340	2597 97.14%	30613	76.5 2.86%	620953	2673	10.3
Total	5193615	22850	1378771	3196.5	7472386	26046	100.00

Source: Census of India 1981, and field work by the authors.

This encroachment has accentuated the process of soil erosion. Although detailed investigations about the spread of eroded areas have yet to be made, it is so widespread and of such serious proportion that even a layman cannot fail to notice it. Under the increasing population pressure, farmers are extending cultivation even on vulnerable steep slopes, thereby making the ecosystem more fragile.

Forests which have been indiscriminately felled for fuel and timber are vital for the maintenance of ecological diversity, preservation of watersheds, prevention of soil erosion, moderation of climate, and provision of areas of aesthetic value for recreation. In brief, deforestation accelerates erosion and makes run-off more erratic, reducing availability of water and resulting in water pollution. This process may become irreversible, altering the environment so drastically that the ecosystem may loose its balance and resilience, making afforestation impossible, and reducing the scenic beauty and economic productivity of the areas until they become ecological slums. In this context, power development should be carefully assessed. If ecological balance is to be preserved and environmental degradation to be halted, then the use of forest as fuelwood has to be minimized and the development of other conventional and nonconventional resources of energy, such as hydel, thermal, nuclear, wind, solar, and biogas, should be accelerated.

Kerosene, Coal, Cooking Gas, and Cowdung Fuels

In addition to firewood and its byproducts, the state also consumes

Table 4: Per Capita per Annum Consumption of Wood and Its Byproducts as Fuel in Rural and Urban Areas (1983)

District	Firewood			Twigs & Branches			Dry leaves		
	R	U	T	R	U	T	R	U	T
Kashmir Region									
Anantnag	2.3	4.0	2.6	1.5	1.3	1.5	0.3	0.2	0.3
Badgam	1.3	4.5	1.9	1.6	0.6	1.4	0.3	0.8	0.4
Baramulla	2.8	4.8	3.2	1.6	-	1.3	0.3	Neg	0.2
Kupwara	3.4	5.0	3.6	3.0	-	2.6	1.6	Neg	1.3
Pulwama	3.1	2.8	31	1.1	0.3	1.0	0.1	0.1	0.2
Srinagar	4.7	2.3	1.9	2.0	0.2	0.6	0.1	Neg	Neg
Jammu Region									
Doda	4.3	4.6	4.3	0.9	-	0.8	0.1	-	Neg
Poonch	2.0	5.5	2.9	4.5	-	3.3	0.4	-	0.3
Jammu	0.7	0.1	0.8	1.3	0.1	1.4	Neg	-	Neg
Kathua	1.0	0.6	0.9	3.0	1.4	2.6	-	-	-
Rajouri	3.1	4.4	3.2	3.1	-	2.6	0.4	-	Neg
Udhampur	1.2	0.3	1.1	2.5	2.3	2.4	0.1	-	Neg

District	Charcoal			Sawdust		
	R	U	T	R	U	T
Kashmir Region						
Anantnag	0.3	0.1	0.3	0.4	1.7	0.6
Badgam	0.4	0.2	0.4	Neg	0.2	0.2
Baramulla	0.3	0.1	0.3	0.3	3.3	-
Kupwara	0.3	0.1	0.3	-	-	-
Pulwama	0.1	0.2	Neg	Neg	0.1	Neg
Srinagar	0.3	0.3	0.3	-	0.1	Neg
Jammu Region						
Doda	Neg	-	Neg	-	-	-
Poonch	-	0.2	0.1	-	-	-
Jammu	-	Neg	Neg	Neg	Neg	Neg
Kathua	-	-	-	-	-	0.2
Rajouri	-	-	-	-	-	-
Udhampur	-	-	-	-	-	-

Source: Directorate of Economics & Statistics, Planning & Development Department, Govt. of J & K, Pilot Survey, 1983 kerosene, coal, cooking gas, and cowdung as domestic fuels. Barring cowdung, which is consumed primarily in rural areas, the other three sources are used mainly in urban centers.

Kerosene is an important source of fuel, especially for cooking, but its consumption is strongly urban-centered. In the Kashmir region, Srinagar, which has over 19 percent of the state's total population, consumes over 67 percent of total kerosene supplied to the region (Zutshi et al 1985). The districts which are away from the capital cities of Srinagar and Jammu (Doda and Kupwara) have significant levels of kerosene consumption. On average, it has been estimated that the per head per annum consumption of kerosene in the city of Srinagar is about 19.8 liters, which is much higher than in the rural areas and more than double the consumption (8.7 liters) in the state.

Coal is not locally available and has to be transported by truck to the Valley from the Bihar coal mines. Consequently, due to its high cost, coal is used as fuel, particularly during winter by institutions such as army camps, factories, and educational institutions, and by the urban rich. Reliable figures are not available for the annual consumption of coal. In the University of Kashmir, 1200 quintals of coal are used in winter for *bukharis*--an indigenous device for heating rooms.

Cooking gas was introduced in the state in the late sixties. Its use, however, is limited to the principal cities. For example, in the Kashmir region, about 82 percent of gas consumer-connections are in Srinagar Municipality, while Jammu Municipality accounts for 79 percent of gas because of high capital costs of installation, confined to the upper strata (Alam et al 1985). Occasional breakdown of the transport system, particularly during the winter season, adversely affects the supply of gas in the Valley.

Seasonal Variations in Fuel Consumption

Seasonal variations in temperature lead to wide fluctuations in the consumption of domestic fuels. The consumption of fuel during winter is appreciably high, especially in the Valley of Kashmir and in the Kandi areas of the Jammu, Kashmir, and Ladakh regions. The impact of seasonality on the consumption of fuel is highlighted in Table 5.

The consumption of practically all the fuels almost doubles during winter. In the absence of an assured supply, which frequently happens particularly with LPG, kerosene, and coal, the people are subjected to severe hardship; during winter, the generation of power at the state hydel stations is also at its lowest.

Power Development, Consumption, and Potential

As pointed out earlier, power is the key to a high level of economic development. Its level of consumption in any country is a significant indicator of development. For instance, the U.S.A. claims a per capita consumption of 8,487 units per day. In sharp contrast, the Indian average per capita consumption is 133 units. In Jammu and Kashmir, it is only 93 units per capita per day. This is among the most backward states of India and will continue to stay as such unless adequate and early steps are taken to improve its power situation. The state has hardly any coal, and because of unfavorable geological conditions, the prospects of striking gas and petroleum are not promising. It has however, tremendous potential for hydel generation which has been inadequately tapped. By considering the status of water power development in the state, projected demand for power, as well as development potential for power, may be analyzed.

Table 5. Consumption Per Capita Per Annum

	Rural		Urban			Total	
	Summer	Winter	Summer	Winter		Summer	Winter
Firewood	1.6	2.8	0.8	1.7	1.4	2.4	3.8
Dry leaves	-	0.2	-	-	-	0.2	0.2
Charcoal	0.1	0.1	-	0.1	0.1	0.1	0.2
Sawdust	-	0.1	0.1	0.3	0.1	0.1	0.2
Kerosene (ltr)	1.6	2.4	9.5	10.3	3.9	4.8	8.7
L.P. Gas (kg)	-	-	2.3	4.6	0.7	1.3	2.0
Cowdung	0.4	0.9	0.1	0.2	0.3	0.7	1.0

Source: Survey of Renewable Energy Resources and Requirements in J & K, University of Kashmir

The three perennial rivers--Indus, Jhelum, and Chenab--and their tributaries which drain the state, open immense opportunities for the generation of hydroelectricity. It has been estimated that these rivers provide theoretically a potential of 13,000 MW of hydel generation. Because of faulty planning and priorities, only a fraction of this potential has so far been utilized which can be observed in Table 6. The importance of hydroelectricity is highlighted by the fact that 270 MW of hydel power at 6 percent load factor for one year is equivalent to 340 tons of diesel oil (Kumar 1985). On this basis, the above theoretical energy will be equivalent to 20 MT of diesel oil.

The total generation of hydel power in the state amounts to 168 MW in the summer season, which drops to 121 MW in the winter season. In addition, the state gets 60 MW from the northern grid which, with the help of capacitors, is raised to 75 MW. These sources of power together supply on average 956 MU of power per year which is almost half the actual demand for power in the state. It can be observed from the following figures that during a short spell of three years the gap between demand and supply has increased manifold from 19 MW in 1981 to 187 MW in 1984.

Lack of adequate power supply has retarded the growth of industrial, commercial, and agricultural development in the state. Power supply is rationed throughout the year and particularly during the winter season,

Table 6: Jammu and Kashmir State: Generation of Hydel Power (1984-85)

Division	Installed	Effective Capacity MW		Summer Winter
		Summer	Winter	Difference
A - Jammu				
(1) Chenei HEP	25	20	12	8.0
(2) Kalakot Thermal	21.4	4	4	-
(3) Other Small Stations	3.0	2	1	1.0
Total - A	49.9	26	17	5.0
B - Kashmir				
(1) L. Jhelum J. P.	105	105	65	40.0
(2) U. Jhelum Stage I	22.62	22	17	5.0
(3) Canderbal	15.0	12	10.5	1.5
(4) Morhra	9.0	7	7	-
(5) Bemina & others	6.0	-	4.5	-
Total - B	157.6	146.0	104.0	-
Total A + B	208.1	168.0	121.0	47.0
C - Imports				
State share from B.B.N.M.	-	27.0	27.0	-
Total A + B + C	208.1	195.0	148.0	47.0

Source: Digest of Statistics, Jammu & Kashmir State, 1983 - 84

when in Srinagar no part of the city gets more than 8 hours of power supply in 24 hours. On account of this restricted supply of power in the state, and especially in the Valley, no major industry except Hindustan Machine Tool could so far be attracted despite packages of incentives, such as tax concessions and rent-free land, which the state government has offered to provide. If this gap in demand and power supply is allowed to grow, the state will perpetually remain one of the least developed states of India (Mujoo 1985). It is expected that the state may begin to receive over 150 MW of power from Salal early in 1987. If this happens, the power situation in the state will be relieved to a certain extent. The Dulhasti project has not gone beyond the investigation stage, and is not likely to be completed before the end of the century. The state government is also contemplating installation of a standby diesel power generating sets of 100 MW in the Srinagar region, to overcome the

Table 7: Electricity Demand and Supply by Seasons

	SUMMER			WINTER		
	DEMAND (MW)	SUPPLY (+)	DIFF. (-)	DEMAND (MW)	SUPPLY (+)	DIFF. (-)
1980-81			- 24			- 19
1983-84	271	168	- 308	107	121	- 187

acute scarcity of power during the winter season in the Valley.

Hydel Power Projects Under Investigation and Execution

Although theoretically the potential for power development seems to be colossal, a realistic estimate of the potential for power development reveals that in the next 14 to 15 years, if financial resources are made available, 3208.64 of hydel power MW can be installed in the regions of the state as shown in Table 8 and detailed in Table 9.

Table 8: Regions Expected Installed Capacity

Regions	Expected Installed Capacity
State	3208.64 MW
Kashmir	259.80 MW
Jammu	291.00 MW
Ladakh	39.56 MW

It may be noticed that most of the projects which have been taken up for investigation and execution in the Ladakh and Kashmir regions are either medium- or mini-order projects which can be implemented within the stipulated period of time if funds are made available. In contradiction, most of the projects in Jammu are large-sized and highlycapital-intensive. The power development programs in the early stages of the Plan periods were installed because of the emphasis of state planners on major hydel projects, such as Salal and Dulhasti, which if completed would have yielded over 500 MW of power. The Planning Commission could not allocate requisite resources for these projects.

In order to reduce backwardness and accelerate economic development, resources must be found to implement these power projects which are either in advanced stages of investigation or execution.

Power Supply and Demand Projections

The state of Jammu and Kashmir has a weak statistical base. Time series data are not available for scientific projection of power demands for the next 15 to 20 years by the various sectors of the economy. Even the present consumption figures for the various sectors are not available and have been disaggregated in accordance with the growth estimate of power

Table 9: Hydel Projects Under Investigation

Region	Installed Capacity	Energy Million Units
A - Ladakh Region		
1. Iqbal Rridge Hydel P.	3.75MW	under execution
2. Igo-Phey	5.60MW	38.65
3. Nattayan	0.45MW	0.25
4. Shakerchiktan	0.26MW	1.56
5. Timbis Kunur	0.20MW	1.20
6. Haftal	1.00MW	2.17
7. Kumdock	0.10MW	0.60
8. Dum Khar (micro)	2.00MW	2.20
9. Tungate	.10MW	0.60
10. Bung-Dong	.20MW	1.20
11. Thusgam barso	.20MW	1.20
12. Marpocho	.20MW	1.20
13. Hanu	.75MW	1.50
	11.06MW	48.65
Medium Hydel Projects		
1. Panikher Parkchak	9.5MW	21.19
2. Chotak Project	9.5MW	21.19
3. Dumkhar	9.5MW	21.19
Total	28.5MW	63.57
Grand Total	39.56MW	111.71

B - Kashmir Region	River Stream	Installed Capacity
1. Upper Sindh Hydel Project Stage II	Sindh	10.5 MW
2. Nunwan-Batkote	Lidder	22.6 MW
3. Shitkari-Kulan	Sindh	84.0 MW
4. Boniyar	Boniyar	4.8 MW
5. Hirpora	Rambiara	9.0 MW
6. Athwatoo	Madhumati	7.5 MW
7. Barenwar	Doodganga	2.0 MW
8. Tangmarg	Ferozpur Nallah	2.6 MW
9. Mutchill		
10. Asthan	Gurez Nallah	1.0 MW
11. Keran	Keran Nallah	0.6 MW

B - Kashmir Region (Contd.)	River Stream	Installed Capacity
12. Wangat	Wangat	1.5 MW
13. Ardow Stage I	Lidder	7.5 MW
14. Ardow Stage II	Lidder	3.0 MW
15. Laripora	Lidder	2.5 MW
16. Erin	Erin	3.0 MW
17. Pahalgam	Lidder	3.0 MW
Total		239.8 MW

C - Jammu Region	Installed Capacity	Location/Investigation Agencies
1. Gyspa	222 MW	NP/HP
2. Bardung	54 MW	NP/HP
3. Seli	87 MW	NP/HP
4. Roli	295 MW	NP/HP
5. Kirtha Naunatoo	750 MW	J&K/J&K
6. Naunatoo-naigad	400 MW	J&K/J&K
7. Dul-Hasti	390 MW	J&K/CWC
8. Ratlee	170 MW	J&K/CWC
9. Bagliar	220 MW	J&K/CWC
10. Sawel Kot	400 MW	J&K/CWC
11. Bursar	275 MW	J&K/CWC
12. Pukhul	325 MW	J&K/CWC
13. Salal	354 MW	J&K/CWC under execution

demand projected by the state government. These points may be borne in mind while reading Table 10, giving existing and projected power consumption in the state by 2000 A.D.

The energy planners of the state have projected a fivefold increase in the consumption of power, excluding domestic consumption, from 956 MU in 1984 to nearly 5000 MU in 2000 A.D. The highest rise in demand has been projected in the industrial sector on the assumption that a high rate of industrial growth is inevitable to cope with rising unemployment. Industrial growth will be dependent on the availability of power. The domestic sector is also likely to register phenomenal growth if other sectors develop along the lines projected above. These projection figures make it clear that economic well-being and future prosperity are inextricably tied with massive power development.

Nonconventional Sources of Energy

The use of nonconventional sources of energy such as solar energy, biogas, wind energy, and geothermal energy is still in experimental stages. It may be noticed from Table 11 that in the

Seventh Plan, allocation for the development of nonconventional sources of energy is meagre.

Solar energy. Solar energy is perennial, available free, and convertible to most other forms of energy. It is free of load shedding and climatic discomfort. It has the further merit of being a dispersed energy source which every household and every village can use, especially in Ladakh where it holds distinct promise because of high insolation. A recent study reveals that even if the solar photovoltaic (PV) array and acessories are supplied free of cost, the cost of batteries alone would make the cost of energy not less than Rs. 2.18 per kWh (Mujoo 1985).

In Jammu and Kashmir, the Department of Nonconventional Energy Sources (DNES), Government of India has agreed to electrify a village each in Zanskar and Bani (Ladakh), both situated in the far-flung areas of the state, by providing solar PV arrays with batteries of 12 kW and 1 kW respectively (National Paper India 1981). If this project succeeds, and if in view of worldwide declining prices of solar PV cells the Department of Nonconventional Energy Sources agrees to assist and give further subsidies, the state of Jammu and Kashmir should be able to have a generating capacity of almost 150 kW of solar electricity by 1990.

Wind energy. The wind speed data published by the Indian Meteorological Department and analyzed at the National Aeronautical Laboratory, indicates that in Ladakh and parts of Jammu and Kashmir Divisions, the average wind energy density is more than 3 kWh/m^2 on an annual basis. Thus, conditions are conducive to the development of windmills and systematic efforts are underway for their development (Kumar 1985). Under the National Project for demonstration, 25 wind-operated water lifting pumps for irrigation and other uses were allotted to this state. These pumps are designed to operate at cut velocity of 2.5 N/sec and give a discharge of about 20,000 liters/hour. In all, 16 wind pumps were received from the manufacturers, but only one could be installed in Tikri (Udhampur) for providing water to a forest nursery.

Biogas. Biogas produced mainly from cowdung, night soil, and poultry droppings can be utilized as a fuel for cooking, lighting, running diesel engines and for generating electricity. One well-known advantage of this technology is that cowdung and other wastes are converted into enriched manure in the digester after the generation of gas. The use of biogas in the villages also helps in improving sanitary conditions and checks environmental pollution, besides reducing drudgery and improving health conditions of rural people.

In Jammu and Kashmir, family-size biogas units are being popularized by the Agriculture Production Department. The costs of these units are fully covered through DNES subsidies and bank loans. The Department of Power is now focusing on the commissioning of large-sized community/institutional biogas plants (Kumar 1985). A few of them are likely to be installed during the course of the Seventh Plan Period.

In Srinagar, a weed gassification project is also under consideration. This is an

Table 10: Present and Projected Consumption of Power by Sector—1984 - 88, 1989-90, 1990 - 95, and 1995 - 2000 A. D.

Million Units

Sectors	Power Consumption 1984-85	Projected Consumption 1989-90	Power increase 1990-95	1995-2000	Projected Rate in 2000 AD over 1984 - 5 level of Consumption	Growth in Percent
Total	956.0 MU				4834.14	
Agriculture	122.0	172.5	266.4	436.0	134.0	10-15
Industry	250.0	502.8	1015.6	2392.8	2142.8	12-20
Commerce	80.0	150.6	379.3	770.2	690.2	10-11
Sevage'Public Water Supply & Municipal Corporation	90.0	137.5	242.3	478.3	388.3	12
Public Lighting	12.0	23.49	41.98	89.04	72.04	12
Bulk Consumers						
Commercial	180.0	262.0	421.90	745.50	665.50	10
Non-Commercial						
Transport	-	61.03	235.30	57.32	571.32	-
Domestic	734.0					
Estimates	222.0					

offshoot of a Lake Conservation and Beautification Project of the Urban Developmental Engineering Department. It is expected to extract up to 3 tons/day of weed from Dal Lake. If gassified and supplied to adjacent hotels for cooking purposes, a savings of about 35,000 liters of kerosene is expected.

Geothermal energy. The Geological Survey of India has identified the hot springs of Puga Valley (Ladakh) as a potential source of geothermal energy. Boring to a level of 224.30 meters has

Table 11: Five Year Plan 1985-90 and Annual Plan 1985 - 86—Jammu and Kashmir State

Rs. In Lakhs

Name of the Scheme	Allocation Centre 1984-85	Actual Expenditure 1984-85	7th Plan 1985 - 90 Outlay State	Outlay Centre Expected	Annual Plan 1985 - 86 Outlay State	Outlay Centre Expected
1. Solar Electrification	Nil	0.023	15.0	100.00	3.00	13.00
2. Solar Cookers	6.00	-	2.50	5.00	0:50	1.00
3. Solar Air Heating	1.5	Nil	2.50	10.00	0.50	1.50
4. Solar Water Heating	6.50	Nil	2.50	10.00	0.50	1.00
5. Solar Timber Kiln	1.00	Nil	5.00	5.00	1.00	1.00
6. Solar Driers	0.50	Nil	2.50	5.00	0.50	1.00
7. Solar Architecture	Nil	Nil	5.00	10.00	1.00	1.00
8. Solar Stills	Nil	Nil	3.75	5.00	0.75	1.00
9. Wind Pumps	Nil	Nil	2.50	5.00	0.50	Nil
10. Aero-generators	Nil	Nil	15.00	100.00	3.00	10.00
11. Bio-gas (Community/Inst.)	Nil	Nil	100.00	2.00		
12. Sewage Gas	Nil	Nil	5.00	100.00	1.00	10.00
13. Weed Gasifications	Nil	Nil	10.00	40.00	2.00	8.00
14. Wood Gasifications	Nil	Nil	17.50	50.00	3.50	5.00
15. Briquetting/Pelletisation	Nil	Nil	7.50	15.00	1.50	3.00
16. Energy Plantation	Nil	Nil	0.50	2.50	0.10	0.50

Source: The New and Renewable Energy Thrust of the J & K Govt. A Factual Report by Arun Kumar, IAS Additional Secretary, Govt. of J & K, Power Development Department, Srinagar.

been done and a temperature of 123.4°C has been obtained. In the current year the ONGC hopes to drill up to 500 meters and is likely to hit a temperature of 200°C.

Alternate sources of energy in the coming years will play a vital role in the socioeconomic tranformation of the state, but success will depend largely on the extent to which solutions to various technical, economic, social, and organizational problems can be found (Dayal 1984).

CONCLUSIONS

It should be clear from the information presented in this paper that, barring hydel and fuelwood, Jammu and Kashmir lack natural resources, such as coal, petroleum, gas, and geothermal, for power generation. They have not been able to utilize adequately their full hydel power potential. The slackness in hydel development has been largely because, in the early phase of planning for power development, energy planners stressed the development and completion of the major hydel projects such as Salal and Uri. These have not materialized. Consequently, Jammu and Kashmir are plagued by a chronic power shortage, so that during winter, when hydel power generation is significantly reduced due to adverse climatic conditions, electricity in the entire region and particularly in the Valley is strictly rationed and is not available for more than 8 hours in a 24-hour period.

Inordinate delays in the execution of major hydel projects and the consequent acute scarcity of power has forced state energy planners to shift their emphasis to the development of micro and mini hydel plants. They have now identified the development of 726 MW, 301 MW, and 54 MW minor and micro hydel power in the Valley, Jammu, and Leh Kargil regions. Of this, they have been able to develop and utilize only 93 MW in the Valley and 60 MW in Jammu. In addition, nearly 60 MW are obtained through the northern grid. These are being raised to 75 MW through the use of capacitors. This is totally insufficient to meet the peak demand, which far exceeds the supply of 956 million units in 1984-85. Furthermore, the supply is drastically curtailed during the winter season.

Rural-urban competition for power supply is equally acute. Both in the Valley and the Jammu regions, the capital cities of Srinagar and Jammu are the largest consumers of power and their capacity to consume power is insatiable. At the moment, these two cities together account for about 50 percent of the total power units sold in the state. Their industrial development has been retarded for want of power. If power is made available, industrial, commercial, and domestic consumption of power will increase by geometrical proportions in these two cities. This will retard rural electrification and use of power for agriculture.

Another disturbing ecological problem in the development of power is the desire to preserve mountain ecology which militates against the compelling need to use firewood as a source of fuel both in urban and rural areas. In urban areas, firewood is a rationed commodity. The annual approximate consumption of 26 million quintals of firewood in the state has led to massive deforestation; consequent soil erosion has adversely affected mountain ecology. It has been estimated by the Advisory Board on Energy in India that this state would need by 2004/05 A.D. 3 million tons of fuelwood: 2.4 and 0.6 million tons respectively for rural and urban areas. In order to prevent this phenomenon from assuming catastrophic proportions, the state needs accelerated programs of: energy plantation; extension of electricity network to rural areas for domestic consumption with assured supply of power; and diversification of power resources in the state by tapping nonconventional sources of power; and establishment of thermal power stations.

1. The state has a World Bank-aided social forestry program which has so far covered the 86,000 and 332,000 hectares of wasteland in the Valley and the Jammu regions respectively. Technology is now available to use fuelwood for power generation. For instance, bagasse is being used for the generation of power in sugar factories. In Gujarat, an experimental fuelwood-based pilot power generating station has been set up.

2. A direct relationship between the rise in per capita income and power consumption has been established by numerous studies. In a recent study on fuelwood consumption in Hyderabad, income-power consumption elasticity has been well demonstrated (Alam et al 1985). The per capita income in the state has been rising both in the urban and rural sectors. It is therefore obvious that power consumption will also rise in proportion to the growth of income. Hence, in order to meet rising energy demands of the various sectors in the state, hydel power generation has to be accelerated.

3. There is little development of nonconventional sources of energy; although some schemes were drawn up during the Sixth Plan Period, none were implemented. In the Seventh Plan, these schemes have been transferred to the State Department of Power for implementation. The inadequacy of development of nonconventional sources of energy is highlighted in Table 11.

4. In order to overcome the acute and chronic scarcity of power in thestate, the establishment of a major thermal power station is a vital necessity to ensure rapid and sustained economic development. This was also recommended by a national seminar on energy in Jammu and Kashmir.

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