FIELD TESTING OF AN INDUCTION GENERATOR LOAD CONTROLLER FOR MICRO HYDEL STATION USING PUMP AS TURBINE AND INDUCTION MOTOR AS GENERATOR

Closure Report

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Sponsored by:

KRPLLD of the Centre for Development Studies

Thriruvanathapuram

ACKNOWLEDGEMENT

An unfinished project will have just as many benefactors as a finished project, possibly even more! This project is rather unusual in the sense that it involved the co-operation and understanding of personnel from quite a few institutions: IIT Delhi, Kirloskar Brothers Pune, Kirloskar Electric Company Mysore, Fluid Control Research Institute Kanjikkode, besides IRTC, Mundur. The Grama Panchayaths of Karimba and Malampuzha, the District Collector of Palakkad, various officials of the Kerala Forest Department, the Late Sri.K.Madhavan (former Member of Central Water Commission) and various peoples' representatives and the residents of Attila and Kavarakkundu have all extended their wholehearted support and good will for the project, and most of them are just as disappointed as we are, that this project has not taken off.

Our colleagues at IRTC, especially the Civil Engineering Team, have spared no efforts to see this through. Their enthusiasm and commitment did not vane even in the face of repeated set backs and even physical assault.

To all these individuals and institutions, we owe a debt of gratitude.

Finally, we thank the KRPLLD and Dr. K.N.Nair, particularly, for the understanding and indulgence they have displayed, in the face of the vicissitudes and setbacks, which were beyond our control.

31.03.2004.1.1 Director

Mundur IRTC

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I. BACKGROUND OF THE PROJECT

IRTC has conducted extensive studies on the feasibility of small, mini and micro hydel stations in Kerala and prepared a few Detailed Project Reports also. One problem remaining to be tackled was that of governance and control, for units of small size. Of course, sophisticated control systems are available for bigger generators used in power applications. But they are much too expensive and inappropriate for micro hydel (less than 100 KW) units. One solution concept which is widely adopted is the Load Controller, originally popularized by the ITDG, London. Some imported units have been installed in the Pookkot and Sugandhagiri micro hydel stations in Wyanad district, under the auspices of ANERT, Government of Kerala, under a DST Govt. of India, project. However this technology is yet to be indigenised and the equipment is yet to be made readily available to the users. So a suggestion was made to develop a similar control system for Induction Motors, used As Generators (IMAG). A similar situation existed with the use of Pumps As Turbines (PAT) also. It is well known that centrifugal Pumps can be used as Turbines for medium head applications. Of course, there is a price to pay in the form of decrease in efficiency, but there may be several situations where this price is acceptable. While a properly designed turbine for a particular head and flow rate is an expensive, one of a kind, piece of equipment, the centrifugal pumps of most working ranges, is a ubiquitous machine, which one can buy, off the shelf. So it has become a common practice to use a Centrifugal Pump of roughly comparable head and flow rate as exist at the site, in place of a 'designer turbine', in order to save cost. However, the methodology for choosing the correct specifications for the most suitable machine is not clearly established. Nor is the loss in performance properly evaluated under field conditions.

So this project was originally proposed with the twin objectives of: -

a. Developing and field testing a Load Controller for Induction Motor to be used as Generator, and
b. Evolving a methodology for choosing the specifications of a Centrifugal Pump to be used as Turbine.

However, while the project proposal was being scrutinized by KRPLLD, it became known that IIT Delhi had nearly completed the indigenous development of a Load Controller for Induction Motor As Generator. So we were advised that it is unnecessary to duplicate this effort. Instead it was suggested that we could collaborate with them in this venture. Prof. S.S. Murthy, Head, Electrical Engineering Department, IIT Delhi was contacted., and it was learned that they had almost completed the development of a prototype under a DST project. But this remained to be field-tested and they were on the look out for some partners in this effort (Appendix-1) This opportunity was welcomed by us and the proposal was accordingly modified as 'Field Testing of an Induction Motor Load Controller for Micro Hydel station using Pump As Turbine and an Induction Motor As Generator'.

This was in January 1998.

II. TECHNICAL ASPECTS

Grid independent stand alone microhydel system to feed the local area must be simple, maintenance free and user friendly. The system consists of hydro turbine, generator, electrical loading network, control mechanism to effect instantaneous power balance between the input hydel power and out put electrical power.

Induction generator with its many advantages like ruggedness, easy off the shelf availability, less maintenance requirements, absence of de excitation inherent short circuit protection, provides an attractive replacement to synchronous generator, especially for stand alone power generation. But a self excited grid independent induction generator (SEIG) exhibits poor voltage regulation. For micro-hydel application, since the mechanical input remains nearly constant, single point power operation of SEIG is made use of. The capacitor excitation of SEIG is fixed such that it gives rated output at rated speed and the load connected is controlled such that the SEIG always sees a constant load at its terminals.

Basic Scheme

The basic scheme consists of a capacitor self excited induction generator driven by a micro-hydel turbine (or a pump used as a turbine) with head and discharge nearly constant. Generator feeds the variable consumer loads. The differential power between input power and customer power is fed to a dump load using a load controller. A variable VAR system may be integrated with the controller to augment reactive power of the load.

Self Excited Induction Generator (SEIG)

An ordinary 3 phase induction motor with sufficient capacitors connected across each of its terminals works as a Self Excited Induction Generator (SEIG). Self excitation of the generator begins by the action of either a residual magnetism of the iron core or charge in the excitation capacitors. When the induction machine is driven by a prime mover, the residual magnetism of the iron core induces voltages in the stator windings at a frequency proportional to the rotor speed. With sufficient capacitor excitation and a minimum load impedance, the process continues leading to increase in induced stator voltage until it settles to a steady state operating point determined by the airgap

flux linkage-saturation. The machine now operates as a Self Excited Induction Generator (SEIG) and can feed a load, at a voltage and frequency dictated by the value of the capacitor, speed of the prime mover, parameters of the machine and the load

Conventional single phase induction motors can be directly employed as self excited single phase induction generators. The concept of the three phase SEIG for single phase load was investigated in view of using three phase standard induction motors to feed single phase load due to their wide availability. For operation as a single phase generator, with minimum unbalance in winding currents the maximum power can be taken out by connecting particular value of capacitors in the ratio 1:2 across any of the two windings. There is no need to connect capacitor across the third winding. In such a configuration it was found the machine can supply upto 80% of its three phase output without exceeding the rated winding currents of the stator.

Specially designed two winding single phase induction motor with capacitor excitation across the auxiliary winding and load connected across the main winding can also work as a single phase SEIG.

Both the single phase and three phase SEIGs exhibit inherently poor voltage regulation when loaded. For micro-hydel application, since the mechanical input remains more or less constant, single point operation of SEIG is made use of corresponding to the operating power input. The capacitor excitation of SEIG is fixed such that it gives rated output at rated speed and the load connected is controlled such that the SEIG always faces a constant power load at its terminals.

Load Controller

The operating point of the SEIG is fixed such that it gives rated output at the rated conditions of voltage, current and speed. Now the variation in the consumer load connected is neutralised by the load diverting the extra power to a dump load.

The load controller developed under this project consists of a diode rectifier and a series chopper. The duty cycle of the chopper switch is controlled to vary the dump load. SEIG terminal voltage is used as feedback signal to a PI controller, the output of

which is given to a PWM controller. The PWM signal after proper isolation and amplification drives the chopper switch. Since the speed and hence frequency are constant, output power remains constant when the voltage is maintained constant.

Laboratory model of the complete system for stand alone power generation was designed, fabricated and tested successfully. The electrical load controller was fabricated at Kirloskar Electric Co. Mysore. The load controller is inter phased between the generator and the DC dump load. Variable customer load is connected across the generator terminal in parallel with the load controller. The uncontrolled turbine was simulated using a DC motor controlled by a DC thyristor rectifier drive which runs the motor at constant speed and constant torque. A 7.5kW, 415V/ 1500rpm. 3 phase Induction motor with 3phase capacitor connected across the terminals serves as 3 phase SEIG.

VAR Compensator

In a stand alone SEIG based micro-hydel system the capacitors connected across the SEIG terminals can supply the reactive power requirement of the load only to a limited extent. As the demand for reactive power by the load on the machine goes up the terminal voltage goes down drastically. In order to compensate for this drop in terminal voltage some external means of VAR compensation has to be done. Switching on additional capacitors across the machine terminals is one of the cheapest and effective ways of compensating for the drop in terminal voltage due to inductive loading.

The VAR compensator was designed and developed by a three step switching scheme using binary weighted capacitors C and 2C. The VAR requirement is sensed in every cycle and compensation is provided if required. Thyristors were used to switch on capacitors and switching is done on Zero crossing instant of the voltage. Laboratory model for switching capacitor scheme was designed and implemented.

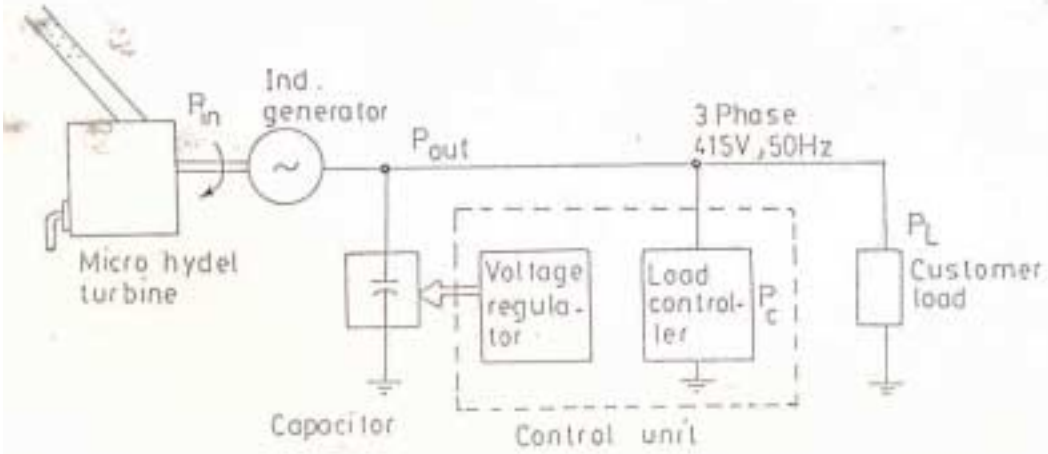

Fig. 1 Schematic of the proposed unit

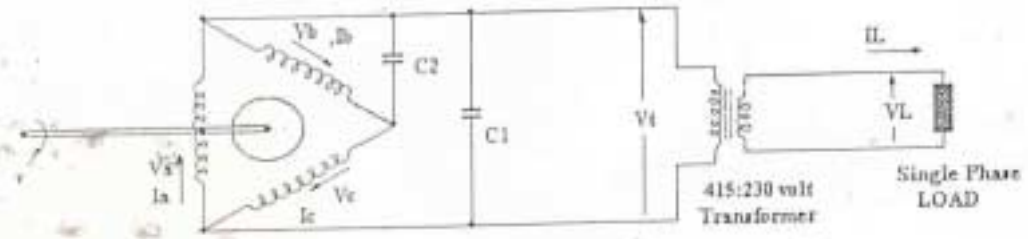

Fig.3 Scheme of 3-phase SEIG feeding single phase load (C-2C Connection)

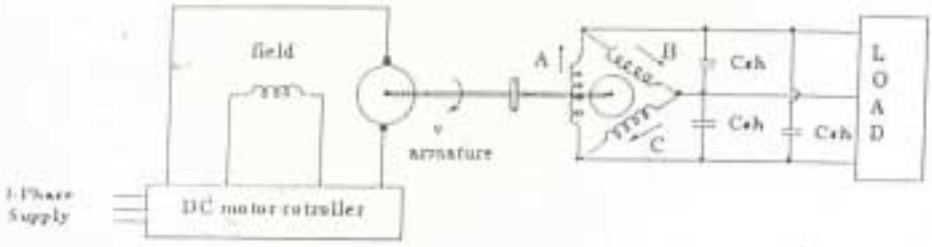

Fig.4 Three phase SEIG feeding balanced three phase load

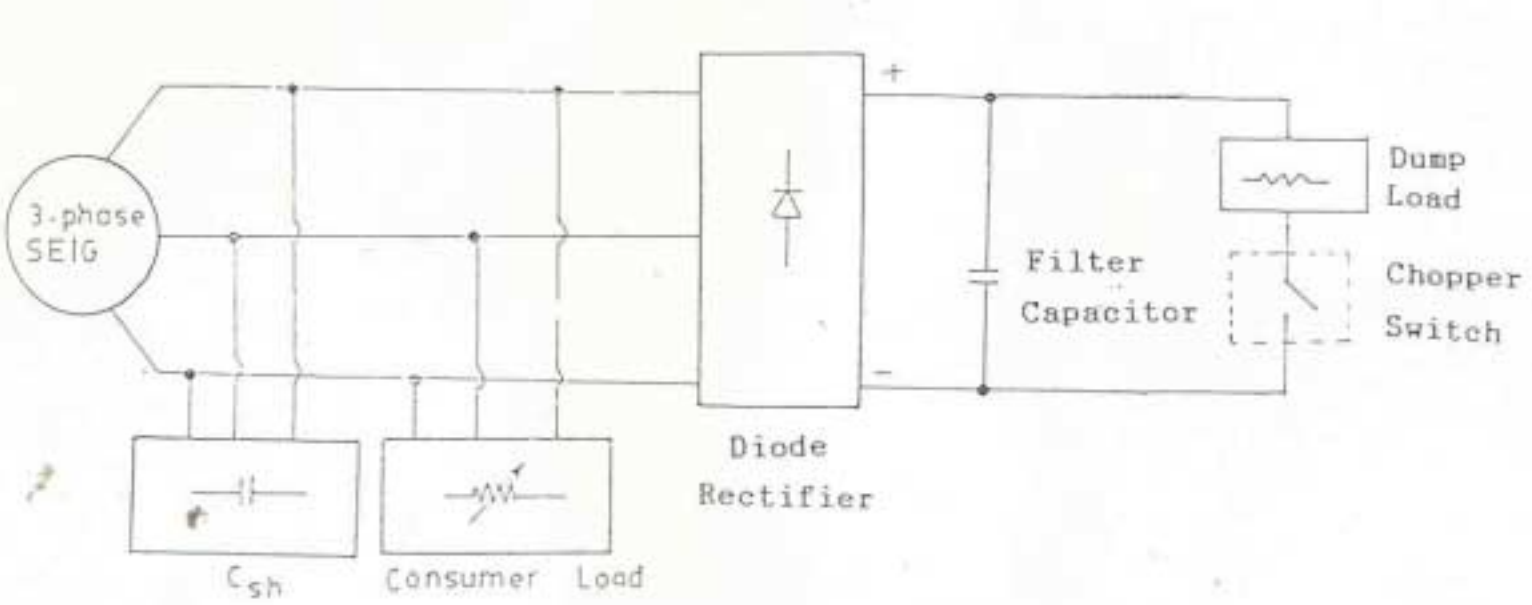

Fig.6 Three phase SEIG with load controller

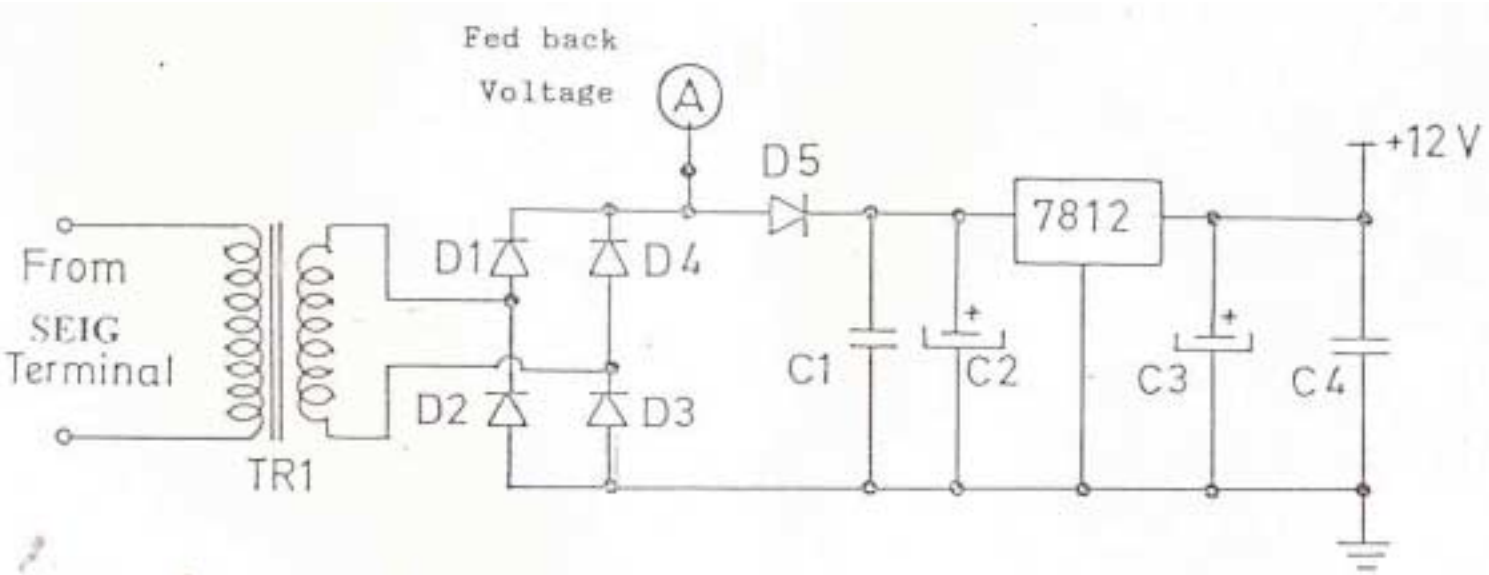

Fig.8 Control Circuit Power supply & Voltage Sensing

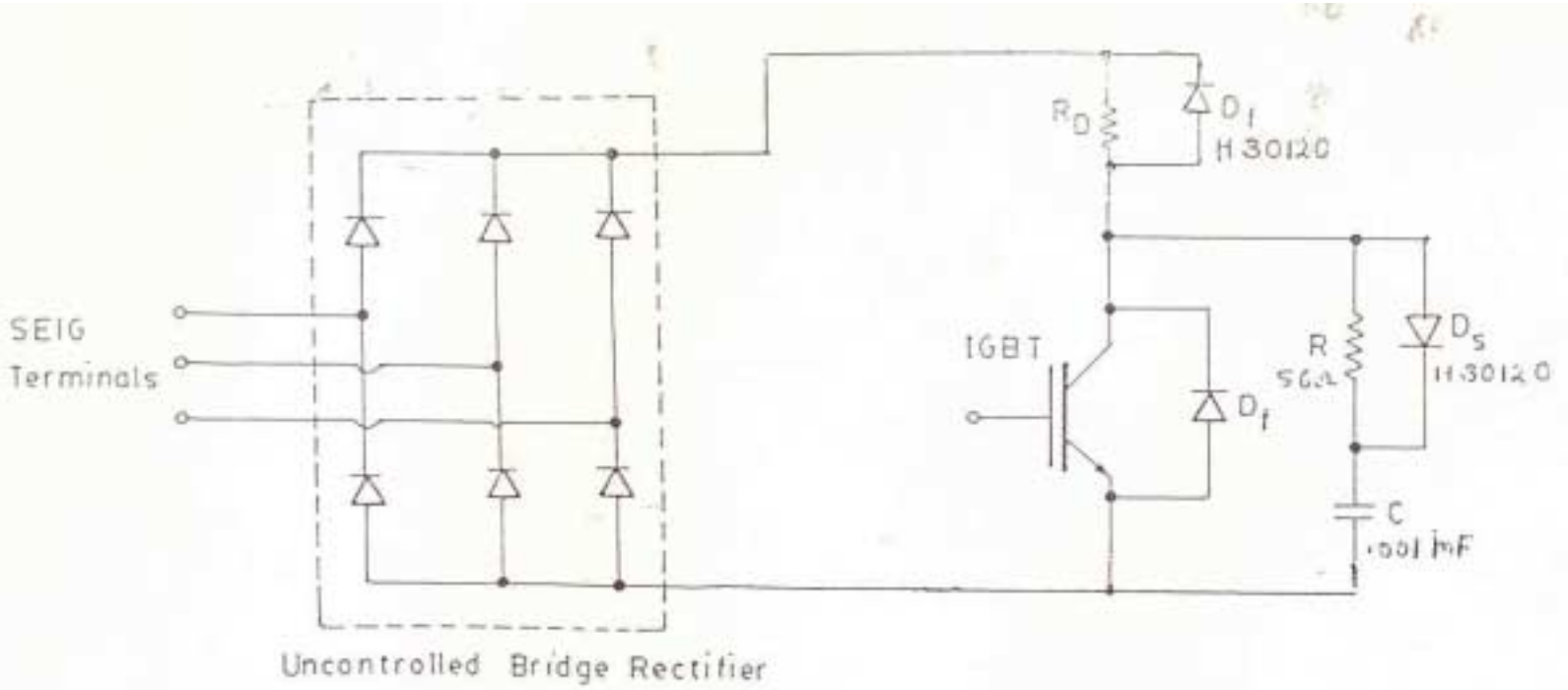

Fig.10 Power circuit (IGBT Chopper)

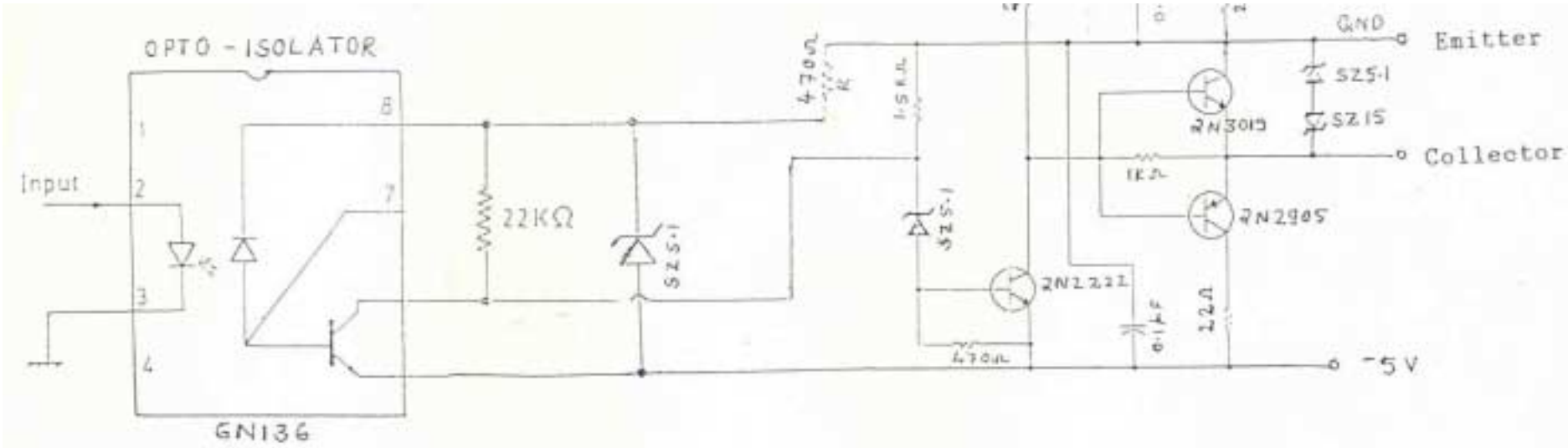

Fig.11 Gate Driver Circuit for IGBT

III. PROGRESS ACHIEVED

Mr. Jayaprakash, P, the Principal Investigator of the project, visited IIT Delhi, had discussions with Prof. S.S. Murthy, and went through a familiarization programme to study and absorb the new technology of the Electronic Load Controller. Subsequently there was a meeting of the various institutions collaborating in this venture: viz., IIT Delhi (who would develop and supply the Load Controller), M/S Kirloskar Electrical Company, Mysore (who would fabricate it), M/S Kirloskar Brothers Limited, Pune (who would supply the Pump), and IRTC who would arrange for the field testing. The services of the Fluid Control Research Institute (Palakkad) were also enlisted for the testing of the Pumps.

A site at Attila, in Karimba Panchayath, Palakkad district, was identified as suitable for this field-testing. (Appendix-2). A detailed project Report (DPR) was prepared for this site by the project team. A Socio economic survey was conducted at the nearby habitat, where 30 families live. Their power needs were ascertained. A meeting was conducted at the locality with the involvement of the Grama Panchayath President, ward member, and locally influential persons. The local inhabitants were told about the possibility of utilizing the energy of the nearby waterfall for meeting their electricity requirements.

Everybody was enthusiastic and promised full co-operation and support, so that this could be taken up as a community effort. They formed a society to undertake this work. (Appendix 3) Since the site was located in private land, no forest clearance was required. This was perceived as a positive feature. The landowner was approached through his local agent. (The real owner was residing in a distant town, and a care taker was looking after the property. The landowner also agreed to give permission for setting up the PAT installation on the stream bank, on his soil. (Appendix-4)

In the mean time the Principal Investigator again visited IIT Delhi where the development of the Load Controller was progressing. He had discussions with Dr. S.S. Murthy. He witnessed the laboratory testing of the equipment. Consultations were in progress with the Kirloskars also, regarding the specifications of the

appropriate pump for this site, which had a head of 40m and discharge of about 40 LPS during the lean season.

IV. THE FIRST SET BACK

The first set back for the project occurred when the owner of the plot where the PAT installation was to be located, went back on his word (and written assurance) and refused permission to use his property for this purpose. We had several interviews with him but he was adamant. Our enquiries into the reasons for this volte face brought out certain interesting aspects of rural life. As mentioned earlier, he is an absentee land lord and it is his local agent (or Karyasthan) who looks after the estate and feeds him on local news. It seems that some local youths, who are among the supposed beneficiaries of this project, had offended him by their boorish behaviour. They, reportedly, made light of his 'generous' offer to lend the use of his land for this project and said that even without his consent, the project would take off. He took this up as a challenge and flatly refused to allow such people any access to his land. Our offer to keep such persons out and to let him have complete control over the land was not enough to propitiate him. Even the intervention of persons of standing, in the neighbourhood, was of no use.

So we had no option but to abandon this site and to look for an alternative location

V. THE KAVARAKKUND SITE

Kavarakkund waterfalls, located in the Malampuzha Panchayath of Palakkad District, is an ideal site for a micro hydel project. It was originally envisaged as a drinking water project for the nearby hamlet.

In view of the difficulties experienced at the Attila site, it was decided to shift the field test location of the Load Controller to the Kavarakkundu site. Permission was sought and obtained from the KRPLLD authorities, for this change of site. The Delhi IIT team was also informed of the circumstances which compelled us to make this change.

Accordingly detailed field investigations were conducted at the Kavarakkundu site and a DPR was prepared. (Appendix-5)

VI. TESTING OF THE PUMP UNIT

The shifting of site necessitated a fresh look at the specifications of the pump, suitable for this new location. After a perusal of the various available options, a ‘Suguna 6”x6” pump’ was selected. Since the performance curves supplied by the manufacturers were found to be not too reliable, fresh tests were conducted with the help of FCRI Palakkad, the foremost testing center in India. (Appendix 6). From these results, the Best operating points for this pump, in operation as Turbine were determined, in accordance with the available flow and head at this site.

VII. PREPARATIONS AT THE NEW SITE

The Kavarakkundu site had been originally identified under the initiative of the Forest Department Personnel located at the Vettiel Estate, located nearby. Initially it was suggested that if it is presented mainly as a Drinking Water Project for the nearby tribal families, the Forest Department itself might be willing to support it. Later it transpired that the river banks fall technically under the category of Vested Forest, and the project would need clearance from the MOEF, Government of India. MOEF has the same procedure for any project involving any forestlands, whether it is micro, mini, small or big. So, elaborate forms had to be filled up, maps made and everything was duely forwarded through the local DFO, Conservator of Forests, and the Nodal Officer at Office of the Principal Chief Conservator of Forests, Trivandrum. Several queries had to be answered and clarifications given, including site inspection by a Conservator of Forests from Bangalore. And finally sanction was given by the MOEF, Govt. of India in 2.3.2001.

We had made elaborate preparations at the grass root level to create awareness and enthusiasm for this project, especially in view of our reverse at Attila. Several meetings were held in the nearby hamlet. Liaison was made with the local Grama Panchayath, the Nehru Yuvak Kendra as well as the local opinion makers. A beneficiary committee was organized and registered. The problem of scarcity of drinking water had been raised in the Grama Sabhas. So priority was given to the Drinking Water Distribution aspect. Generation of electricity could follow as a logical sequel, because the most important civil works were common to both. The Malampuzha Grama Panchayath agreed to include this as one of their projects under the Peoples Plan Campaign and to share some of the civil costs from drinking water distribution. The beneficiaries agreed to share some of the costs for electricity distribution network and do some voluntary labour for the civil works.

VIII. THE SECOND SET BACK

Even while the inhabitants of the nearby hamlets suffered from drinking water scarcity, some big landlords had been diverting the stream flow, further down from the weir site, for irrigation purposes. They have been doing this for several years, without any explicit sanction from the Forest or Irrigation Departments. When the news about this Drinking Water cum Micro Hydel Project spread among the people, these persons became apprehensive. They were afraid that their source of irrigation would be affected, or even cut off. They raised this issue with the Grama Panchayth, who assured them that no water would be removed from the stream as a result of electricity generation. Whatever is taken, will be routed back to the stream, just 300m down stream. As for drinking water, the quantity diverted would be very little, just to meet the household requirements of about 7o families. This diversion of about 21000LPD would not affect the water flow in the stream significantly, at all. But they were not satisfied with this explanation and submitted a petition to the District Collector, who referred it to IRTC.

The IRTC engineers had discussions with these aggrieved parties. We explained that the drinking water diversion is minimum: just one percent of the stream flow, even during the leanest period. It will not make any substantial difference to the irrigation use. Still they were not convinced and started a public campaign against this project in the press. There were some adverse reports arguing that this project would result in the drying up of be feader stream to the Malampuzha dam, and the Malampuzha dam caters to the irrigation needs of 25000ha, and therefore (!) this project will have adverse impact on the paddy cultivation in 25000ha ! Thus it was campaigned in the press and through bit notices that this Micro Hydel Project would cause the drying up and destruction of the Malampuzha Reservoir and toll the death knell for paddy cultivation in Palakkad district! (Appendix 7: Pres Cuttings and Publicity Material)

Fantastic as it may seem, they even managed to get the support of some well-known environmental activists for this vilification campaign. Prof. P.S. Panicker, a leading environmentalist of Palakkad became a signatory and key player in this campaign. Dr. Satheeshchandran Nair, one of the best respected environmental scientists of

Kerala, was taken to the site, and reportedly made a statement to the effect that this was an environmentally important location and the project would harm it. On the other hand, it was a degraded forest land with no three cover, and IRTC had been extra careful to design the project so that it would not result in any inundation of any land. Not a single tree would be cut and the diversion of forest land (which was practically barren rock) would be kept to minimum (only 0.095ha).

Another mishap occurred during this period, which affected the morale of our volunteers, badly. The work on the project was inaugurated by the District Collector and 'Shramdaan' started immediately there after. Most of the local inhabitants participated enthusiastically in the work on access road construction, bringing their own tools and implements. There was an existing foot path, which was cleared of under growth. Work was initiated at the Diversion Weir site also, by gathering rubble and sand from the river bed itself. A channel was cut on the rock for leading the outlet pipe.

Now certain officials of the Forest Department stepped in, probably instigated and influenced by the vested interests, citing violations of Forest Protection Act. They alleged that the clearing of undergrowth in the foot path amounted to 'destruction of the forest', and gathering of sand and rubble from the river bed was against the law. They booked a criminal case against our field staff and named the Director, IRTC as the 1st culprit.

Our contention was that we had been permitted by the MOEF to implement this project at the given site, which had been handed over to us, and we were only performing the permitted operations. But considering all aspects and implications of the matter, it was decided expedient to allow the offenses to be compounded and get the matter closed. This was later done, with the permission of the higher forest authorities.

The vested interests working against the project even tried some strong arm tactics, by engaging musclemen to disrupt the work and destroy some of the structures already built. This resulted in a police case, which further complicated matters.

IRTC conducted public hearings, press conferences and an effective campaign to counter this false propaganda. This was proving to be quite successful when the next blow came as a bolt from the blue.

IX. AN OP IN THE HIGH COURT

On 25th March 2002 an OP was filed in the High Court of Kerala, by M/S Anantha Krishnan, P.S. Panicker and others, under the banner of "Malampuzha Protection Council", calling for a stay on the implementation of the project, on the ground that it posed a threat to the environment. The petitioners argued that the diversion of water would result in irreparable damage to Malampuzha Reservoir and would endanger the paddy cultivation in Palakkad district. They also contended that IRTC were violating the provisions of the Forest Protection Act. We were able to counter their argument effectively and the Hon'ble High Court refused to grant a stay. However, the court observed that the permission granted by the MOEF did not mention specifically, the objective of generating electricity. Therefore, while permitting IRTC to proceed with the civil works, the court directed that a specific permission be sought from the MOEF for electricity generation, before generation of electricity was taken up.

Accordingly a special request was forwarded to the MOEF showing that no additional land would be required for this purpose, and all the civil works and installations required for this had already been included in our original request and this objective had been clearly indicated in our proposal. This was recommended by the CCF and forwarded to the MOEF office in Bangalore.

In the mean time, the forces against the project sent some complaints to the Government of India, and the Conservator of Forest from the MOEF Regional Office Bangalore came for a site inspection. He was fully convinced about the legitimacy of the IRTC project and openly debunked the contentions of the anti-project campaigners. We apprised him about the need for a specific permission for hydroelectric generation. He promised all help and went back, but the permission is yet to come, even after the lapse of more than one year.

X. THE LAST STRAW

Since the High Court had refused to issue an injunction, IRTC had proceeded with the civil works pertaining to the diversion weir, water conduit system, storage tank and pipe distribution network. Then the very person, Sri. Ananthakrishnan, filed an OS (No. 253/2002) before the Munsiff Court of Palakkad on 25th September 2002, alleging that the proposed Kavarakkundu Project would violate his rights to draw water from the stream for irrigation purposes. The irony of this person pleading before the High Court that the diversion of water for meeting the drinking needs of 70 families would result in the destruction of Malampuzha, and simultaneously pleading before the Munsiff Court that his rights for diverting the very same water for irrigation were threatened by the paltry diversion of 21 kilo litres per day, for drinking purposes, is worth pondering. Another irony is the role of well known and respected environmentalists in siding with a self confessed diverter of water, to oppose the legitimate efforts to supply drinking water and power to an impoverished hamlet.

We presented our arguments before the Munsiff. A Commission was appointed to make a field study. Since the plaintiff was not happy with its findings, he asked for a new Commission, who also supported the facts as presented by IRTC. But strangely enough, the learned Munsiff, in an unusual order, granted a stay on further work on the project. The court made the following poignant observation:

"The contention of the respondent that the irrigation of Mini Hydel Project (sic) will adversely affect the water system into the Malampuzha Reservoir cannot be accepted as a final answer. Since the petitioner succeeded in proving that there is every risk of water scarcity by diverting the natural flow of water as intended by the respondent, this Court unhesitatingly hold that the petitioner succeeded in make out (sic) a prima facie case warranting timely interference of the court in order to protect the right exercised by him as a riparian owner over the natural stream".

The arguments put forward by IRTC that the project is being implemented on behalf of the Grama Panchayath as a public utility project, to provide drinking water to 70 households, and that use as drinking water has priority over use for irrigation, etc. were rejected by the learned court.

IRTC went in appeal to the sub court, and the sub court, instead of vacating the stay, has returned the case to the Munsiff Court for speedy disposal. And there the matter rests.

XI. POST MORTEM

It may be too early to write a post mortem, because the project is not officially pronounced as dead. It may still be possible to revive it if the Munsiff Court's order is revoked, and if Sri. Ananthakrishanan refrains from going on appeals, and if the MOEF issues a specific sanction for generating electricity, and if the Grama Panchayth and the beneficiaries stand stead fast in their resolve to see it through.

But the project period is long over, the KRPLLD is being wound up, and IRTC is forced to close this chapter.

What have we learnt and what have we achieved?

1. It is certainly an achievement that even though no permanent bund/diversion weir could be built across the stream, all the water conduit systems are already in place, and the local people are able to use this system for distributing drinking water, using a 'temporary' diversion mechanism consisting of sand bags. Thus the supreme irony is that what Mr. Ananthakrishnan wanted to prevent, is happening, despite his machinations!
2. The Load Control Device and the Pump to be used as PAT are ready. The Pump has been delivered to us and the Load Controller is with IIT Delhi. We have not asked for it since the installation is not ready. There is an embarrassing impasse in our relations with Dr. S.S. Moorthy's group in IIT Delhi. However, we have the satisfaction that our personnel, Sri. Jayaprakash and Sunil have absorbed this technology, and we have benefited by it. Of course both these persons have left the service of IRTC. Mr. Jayaprakash did his M.Tech. with Prof. S.S. Moorthy in IIT Delhi and is now a lecturer in Kannur Engineering College. Sri. Sunil is an Engineer with the Indian Railways. A third person, who was associated with the Mechanical Engg. portion of the project, Sri. Aravind went to IISc Bangalore, and is now doing Ph.D in T.U Delft, Netherlands.
3. The Malampuzha Grama Panchayath had taken great interest in the project and sincerely tried to help us to see it through. But they could not effectively

counter the propaganda, or even the open goondaism of the economically powerful and politically well-connected opposition.

4. The beneficiaries, the inhabitants of Muthiramkunnu, Mudiyalambu and Nakkamada, numbering about 70 families, had offered their full support and earnestly participated in the voluntary works, especially in the initial stages. But they didn't have sufficient cohesion and determination to stand together and fight the opposition unitedly. Perhaps they were intimidated by the reach and resources of the rich landlords, who combined money, muscle and political patronage. In fact some of them became openly hostile and even tried to manhandle the IRTC personnel who were assisting with the project.

XII. THE BITTER LESSON

We are convinced that the initial enthusiasm shown by both the people of Attila, as well as Kavarakkundu were genuine and sincere. Maybe, if the project had proceeded as per schedule, with no hitches or delays, this enthusiasm would have continued, and led to fruitful development. But unfortunately it was not to be. The unexpected set backs and delays proved too much for these simple-minded people, who are result oriented. While for IRTC, the commitment to these programmes is based on ideology and intellectual conviction, for the ordinary people, what matters is 'results' and immediate gratification of felt needs. This weakness is to be countered and a genuine commitment to a new method of doing things is to be nurtured. A commitment which can withstand reverses and adversities is to be generated. For this, real grassroot level organizational work has to be done by persons or groups working amongst them, along with them and not just 'for' them. Only such an approach can sustain the good will and momentum required to fight the entrenched vested interests.

In retrospect, it might be argued that IRTC emphasized the technological aspects, and underestimated the sociological aspects, especially those aspects relating to the interplay of the existing power structures, and how our intervention might impact on them. This is an important lesson in any Action Research Programme.

Appendix-1

Minutes of the meeting held at Kirloskar Electric Company on 18-12-97.

Sub: Micro Hydel project jointly operated by ITT Delhi, Kirloskar Brothers Ltd. And Kirloskar Electric Company, supported by DST.

Members present :
: 1. Wg Cdr. Reghunath, KEC
: 2. Mr.Pradeep Mdan, KEC
: 3. Mr. C. Abel, KEC
: 4. Prof. S.S. Murthy, ITT Delhi
: 5. Jayaprakas, IRTC, Palakkad

A meeting was held in the office of Wg. Cdr. Reghunath, KEC Bangalore to finalise an action plan for field installation of induction generator based micro hydel system for autonomous power generation, in a site to be identified by Integrated Rural Technology Centre (IRTC), Palakkad, Kerala. The unit world be installed based on the technology developed by Prof. S.S. Murthy and his colleagues at ITT Delhi, as part of a project sponsored by Deptt. Of Science and technology. Govt. of India.

1. Overall Condination - Prof. S.S.Murthy, ITT, Delhi
2. Identification of site - Prof. R.V.G.Menon, IRTC *Site has since been identified)
3. Civil Works - IRTC, Palakkad
4. Turbine, Pump and Hyderaulic machinery Ubstakkatuib - IRTC & KBL
5. Induction Generator (Typical rating 7.5KW 4 pole) - KEC, Hublim
6. Coupling of 4&5 - IRTC, guided by KEC
7. Controller fabrication - KEC, Mysore (based on the technology provided by ITT Delhi)
   Comprising the following units
   a) Capacitor bank
   b) Load controller

c) PF controller
d) Panel
e) Protection
f) Instrumentation

8. Co-ordination of complete electric system (5+^+&) - KEC, Bangalore
9. Electrical distribution system for consumers - IRTC, Palalkkad

Appendix-2

The Attilla Micro Hyde Project

1. Project Area

1**. Source:** One of the water fall in the Attila stream has been located near the Hydraulic Ram structure in this area. The water comes as balance from the Hydraulic Ram can be utilised for power generation. It can give a head of 38m, and a flow of 40 litres per second.

The site is approachable and is about 8 km towards east from the Kalladikode junction which is about 12 km from the Olavakode railway station.

2. **Beneficiaries:** About 30 houses within 2 km radius has been identified where the electricity can be distributed. This place is an isolated one and is about 5 km away from the nearest transformer which is at Moonekkar. Five houses in this area have go connection from this transformer by a single phase line.

2. Design

The system consists of a storage tank, water conductor system and the power house.
The head available is 38m. The available flow is 40 litres/second. The system is designed for this input power of about 15 kW.
The output power is expected to be 6 kW. The general layout is shown in fig 1. The component parts are briefly explained below:

1. **Storage Tank:** The storage tank can be made by constructing a small pond near the Hydraulic Ram so that a temporary storage of about 9 cumec of water is to be stored for the smooth running of the system
2. **Water conductor system:** The water conductor system is to be made by joining PVC pipes with diameter of 8 inches. A screw type vale will be used in the turbine end. One pressure releasing value is to be used at the pond end.
3. **Power house and control room:** The power house is only a room of 3mx2mx3m with covering so as to accommodate the machinery. The control panel is provided in this room.
4. **Turbine (pump in reverse mode):** The use of separately designed, manufactured turbines and generators will not be cost-effective for micro

hydel schemes. As an alternative the centrifugal pump readily available in the market in the reverse mode will be cheaper option.

A pump model DBHS 80/26, Kirloskar make of 22m had discharge 96 m3/hr which is readily available in the market is found to be efficient after the detailed calculations.

5. Generator. It is found that induction generators are suitable for micro hydel power stations because of its advantage compared to conventional alternators. The advantages of induction generator include maintenance fee operation, rugged construction, brush less squirrel cage rotor, reduced unit cost, smaller size, simplicity of installation, long life and easy availability. For stand-alone operation of induction generators the excitation should be done by capacitors and it is called as Self Excited Induction Generators (SEIG). The main problem with a stand-alone unit is that when the load changes, the speed voltage and frequency of the system varies and hence a load controller is essential. The idea of constant load operation using an electronic load controller and artificial resistive load is well established. The main research content of this project include the field testing of the load controller developed at IIT Delhi.

6. Salient Features
7. Storage weir Nil
8. Storage Tank
   Type : Rectangular, Ferroc-ement slab with 3m x 3 m x 1 m size
   Back fill : Soil
   Sealing material : Cement
9. Water conductor system
   Type : PVC
   Reinforcement : Ferro-cement coated
   Total length : 170 m
10. Pump to be used as turbine
    Discharge : 96 m3/hr

Head :22m

Speed (rpm) :1450

Suction-delivery dia in mm 100x80

Model End section, back pull out DB 80/26 model

Make Kirloskar

11. Generator

Induction motor

7.5 kW, 3 phase, star connected.

4 pole

50 Hz

1500 rp

Kirloskar make.

12. Construction materials

The boulders required for the structure are available along the course of stream. Sand has to be brought from the nearby streams. Cement, steel and other minor items are to be carried by Jeeps to near the site. Local people will support in the construction works.

13. Implementing agency

The Integrated Rural Technology Centre (IRTC), Mundur, Palakkad, which is a non-profit organization will undertake the implementation work.

14. Operation and maintenance

A committee from the beneficiaries will look after the operation and maintenance under the guidance of IRTC with support from Jilla panchayath.

15. Estimate

1. Trench Wier	Nil ……
2. Water conductor system	81,000.00
3. Storage tank	10,000.00
4. Power house	20,000.00
5. Machinery and control	Nil……
6. Establishment and consultancy	10,000.00
Total	Rs. 1, 21,000.00

16. Detailed estimates

17. Water conductor system

Sl.No.	Item	Qty.	Rate (Rs)	Amount (Rs)
1.	PVC pipes Miscellaneous	170m	300	51000.00 30000.00
Total				81000

18. Storage tank

Sl.No.	Item	Qty.	Rate (Rs)	Amount (Rs)
1 2 3 4 5 6	Earthwork excavation and preparation site Gabion Soil cement back fill (5% cement) LDPE shee 100 Brick masonry for inlet Miscellaneous works	LS 40 m3 12 m3 30 m3	1000/m3 500/m3 10/m2 1200/m3	
	Total	1000		

19. Control room

Sl.No.	Item	Qty.	Rate (Rs)	Amount (Rs)
1	Preparation of site	LS	1200/m3	5000.00
2	and earth work	5 m3	5500/m3	6,000.00
3	excavation	15 m3		8,250.00
4	Brick masonry for			1,000.00
5	foundation and wall			1,5000.00
	Roofing with filler			2,750.00
	slab			
	Door (1 no.)			
	Window (2 nos.)			
	Miscellaneous			
Total				20000.00

Electrical Distribution system at Attila

Attila is a rural area which is in Karimba Panchayath, Palakkad. The primary distribution line to this place is by mans of an LT single phase line stretching about 4 km of length, through the dense tree area. The nearest transformer is near “Moonekkar’ and this is feeding by the a 11kV feeder of Mannarkad substation. Though 5 houses of this area is electrified, the remaining 30 houses are remaining unelectrified. The distance of the nearest 11 kV line is about 4 km from the proposed power house.

The micro hydel station of 6 kW at the Attila site will be installed by IRTC with the partial financial support of the Centre for Development Studies, Thiruvananthapuram and with the support from IITD Delhi, KEC, KBL and FCRI. The stand alone operation operation of induction motor as generator concept with the induction generator load controller developed by IIT Delhi is to be field tested here. The generating unit will be operated as a stand-alone unit and can supply power to the nearby 31 houses.

A detailed estimation of the distribution system is prepared. Aerial Buched Conducted (ABC) system is found suitable for installation because of its suitability in the forest area. The cutting of trees and tree branches can be avoided. The system is planned in such a manner that 6 numbers of 2 core cables each carrying 5A current will be drawn to the consumer points. For drawing 6 km of this line, the estimate comes to Rs 1, 50,000.

The details are given below.

1.The expense for 6 km of 2 core cable line		Rs. 1, 50,000
2. Miscellaneous	:	Rs. 50,000
Total (approximately)	:	Rs. 2,00,000

A beneficiary Committee consisting of local peoples will have to be formed under the leadership of the Jilla Panchayath energy committee. The beneficiary committee will have to undertake the responsibility for management of the system. For each house an average of 200W can be allowed as connected load.

The maintenance cost of the system is expected to be appropriated Rs. 5,000/- per annum. The operation and administrative costs are to be finalised by the beneficiary committee.

Appendix - 5

The Kavarakkundu Micro Hydel Project

The Kavarakkundu Water Project envisages the utilization of waters of the Kavarakkundu for supplying the basic needs for Domestic water supply. Sanitation, and lighting during the period of 4 hours in the night. The 70 families lacked in Muthiramkunnu, Mudiylambu and Nakkamada, who will be the beneficiaries of the proposed project have no reliable water supply near their dwellings. No satisfactory sanitary arrangements with water facility and they are dependent on Kerosene for their lighting. This project will provide 200 litres of safe water supply to the beneficiaries water to the Latrines which will be clustered together with each family dwelling allocated one latrine ensure responsibility for maintaining cleanliness of the allocated latrine. This will facilitate in providing more economic water and waste treatment. The revenue to be collected from the beneficiaries from the electricity charges will enable them to operate and maintain the facilities. From a preliminary survey has been ascertained that the beneficiaries will have not hesitation in meeting these charges since they spend a substantial part of the income for Kerosene. The project cost indicated in this note does not include the cost of the Latrines but includes the cost of supplying water to the joint latrine complex and the water supply to the cluster of dwellings at a distance of about 20 meters.

1. **Project Features.**

1.1 Source.

The Source is the Kallampuzha stream, which falls into the Malampuzha Reservoir. The source point is located at the head of a 18 meter fall so that the catchment is largely uninhabited. The site is approachable from the Malampuzha Reservoir by boat and through a motorable panchayath road. The source is close to the Rajadhani Estate which is maintained by the Kerala Forest Development Corporation. About 40 tribal houses and some belonging to the weaker sections are located about 2.5 kms from the source. These and the KFDC office and sheds can benefit fro the project.

1.2 Project Features

The lean flow in the stream is about 20 litres per second with an head of 22 meters available just downstream and a small pond of 600 cubic meters located about 100 meters downstream the project is capable of generating 10 KW of power for four hours in the peak time for lighting in the summer and considerable more power during the monsoon months. The pond serves two purposes (1). Pondage during the lean months and (2). Detention Basin for reducing the turbidity during the monsoon months when it is expected to be high. At this time there is no requirement for pondage for power. A six hours setting tank will be located within the main pond from which the pipe line to the water supply area will take off. There will be a filtration plant on the pipe line with the head available it will be possible to provide a rapid sand filter. Provision will also be made for disinfections as required.

2. Design

2.1 Diversion Structure:- A trench type diversion structure made of gabions and line with concrete and with a tope concrete facing is provided. There will be a scour vent and inlet for a 30 cms. Water conductor system. These will be provided with gate valves.

2.2 Water Conductor System:- A 100 meter long Ferro cement pipe lined with LDPE will form the main water conductor leading to the pond structure.

2.3 Pond:- The pond will be formed by the construction of a Gabion structure with LDPE membrane and a facing of Soil filled HDPE bags. The water face of the bag will be filled with Soil cement. From the pond one 30 cm. Pipeline will carry the water to the outdoor type pit power plant. The pond will be partitioned by a Gabion wall to provide a tank of 5 cubic meters a valve will be provided between the main pond and the tank top isolate the tank as required. The outdoor power plant will be equipped with 15 cm centrifugal pump, which will operate as turbine. It will be connected to a 12 KVA synchronous generator the speed regulation will be by self regulation with automatic closing with a hydraulic actuator in case the speed drops or rises beyond specified limits. The voltage regulator will be set at about 180 volts for the supply.

2.4 Costs:- The costs for the various components is estimated to be about Rs. 4 lakh

2.5 Benefits:- The project will supply a peak power of 10 KW which is very valuable in view of the deficit in the peak power that exists and which is expected to continue for years to come. If the surplus power available during the monsoon period is used as for cooking particularly for rice about an hectare of forest can be protected from fuel collectors. The saving in Kerosene of course need not be stressed in view of the subsidy and the Hydrocarbon supply position. The immense benefit of a combined water supply-sanitation project is also very obvious.

Implementing agency and Ownership:- AICAS and the Nehru Yuva Kendra will undertake the project. The Mallikarjuna Youth Society will provide all the local support. The implementing agency will also operate the facility for a year before during the execution of the project so that local personnel will be available to take over the management of the society after AICAS-Mallikarjuna move out of the area. The IRTC will provide the technical services for the implementation of the project. The funds for the power component is available with the IRTC from the Centre for Development Studies Thiruvananthapuram in a programme for research on Local Government.

Appendix-6

The FCRI Role

Minutes of Meetings

Sub: IRTC Project Micro Hydel Power System.

The following were the decisions taken at the meeting at FCRI on 07.01.1998:

1. The test procedure suggested were approved.
2. IRTC will make common Base plate, Break Drum with ferrode lining support for Torque Transducer, Frame for brake drum, couplins, and get them assembled within three weeks.
3. The test shall be started there after as per the test conditions mentioned in enclosed sheet.
4. The governing system will be developed with the help or Mr. M. Viswanathan Asst. Director of FCRI. Mr. P.V.Aravaind and Mr. Jayaprakash from IRTC will work with him for this..

Mermbers presents

1. Mr.M.S. Konnur, Direcotr, FCRI
2. Dr. K.Balakrishnan Dy Director. FCRI.
3. Dr. R.S. Madhusoodanan, Sr. MKtg. & Prof. Engr., FCRI
4. Mr. M. Viswanathan, Asst. Director, FCRI
5. Mr. K.Madhavan, Former Member Central Water Commission
6. Mr. P.V. Aravind, IRTC.

IN THE HIGH COURT OF KERALA AT ERNAKULAM

Present:
The Honourable The Chief Justice Mr.B.N.Srikrishna and
The Honourable Mr.Justice G.Sivarajan

Monday, the 25th day of March 2002/4th Chaithra 1924

O.P.No.1802/2002 M

Petitioners:

1. Malampuzha Dam Protection Council rep. by Secretary Dr.P.S.Panicker, S/o.N.S.P.Nair, Aged 58 years, residing at Pournami, Thurapalayam, Palakkad 1.

2. Malampuzha Dam Protection Council (Malampuzha Branch) rep. by President M.K.Ananthakrishnan, S/o.M.A.Kesavan Aged 61 years, residing at Mundankandath, Kizhakethara, Kottekadu, Palakkadu.

3. Malampuzha Dam Protection council (Malampuzha Branch) rep. by its Secretary A.S.Sekharan, S/o.K.Unni Ravi, Aged 69 years, Koonampakal House, Chiradu, Malampuzha.

By Advocate Sri.A.X.Varghese.

Respondents:

1. Union of India, rep. by Ministry of Environment and Forest, New Delhi.

2. State of Kerala rep. by Chief Secretary, Secretariat, Thiruvananthapuram.

3. Secretary, Irrigation Department, Secretariat, Thiruvananthapuram.

4. Secretary, Ministry of Forests, Secretariat, Thiruvananthapuram.

5. Chief Wild Life Warden, Kerala State, Trivandrum.

6. Secretary, Kerala State Electricity Board, Thiruvananthapuram.

7. Director, Integrated Rural Water Technology Centre, Palakkad.

8. Chief Conservator of Forest, Thiruvananthapuram.

By Advocate Sri.Thomas Antony for R1 and Sivan Madathil for R7

This Original Petition having come up for orders on 25.3.2002 the Court on the same day passed the following:

IN THE COURT OF THE MUNSIFF OF PALAKKAD

Present:- Smt.K.P.Indira, B.A., LL.B., Principal Munsiff

Wednesday, the 25th day of September, 2002

(3rd day of Karkkika Aswina, 1924 SE)

I.A.No.nos8/2002 in Original Suit No.253/2002

Ananthakrishnan, aged 61 years,
Kizhakkethara Mundankandath Veettil,
Kottekkad amsom, Palakked Taluk — Petitioner/Plaintiff

Vs:

Integrated Rural Technology Centre,
Mundur, Palakkad - 678 592.
Rep.by Director Dr.K.Unnikrishnan,
S/o.Pookeyil Narayanan Nair, aged 62
years. — Respondent/Defendant

This petition coming on 20-9-2002 for final hearing before me in the presence of Sri.P.Vasavan, Advocate for the petitioner and Sri.V.V. Girish, Advocate for the respondent and having stood over to this day for consideration, this court passed the following:-

O R D E R

The above suit is one for perpetual injunction.

2. Along with the suit the plaintiff/petitioner filed I.A.1380/02 under Order 39 Rule (1) seeking for an order of temporary injunction restraining the respondent from constructing dam or bund preventing the petitioner from drawing water from Kallanpuzha for his irrigation.

3. It has been averred by the petitioner that the petition schedule properties along with other items were acquired by his father Kesavan by virtue of his family partition as per document No.1102/1954 and later set apart to the petitioner as B-schedule by virtue of another partition between himself and his father as per document No.339/1958. The plaint schedule properties are paddy field, situates on the western shore of Kallanpuzha and it has been irrigated from Kallanpuzha for the past more than 100 years. No other irrigational facilities are available into the plaint schedule paddy fields.