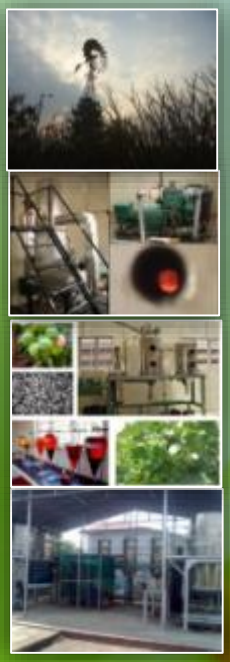
Departmental Brochure

School of Energy & Environment Management

Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal, M.P.



Facilities Available in the Energy Department

Rajiv Gandhi Proudyogiki Vishwavidyalaya,
Airport Road, Gandhi Nagar, Bhopal, M.P. –462033
Phone: 0755-2678822 Fax.No: 0755-2678819
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Vision

Active leadership in Energy & Power sectors for sustainable development, by providing a formidable support for the growth of Green Power in the country.

Mission

Imparting Formal and On-Job Education in Energy Technology by blending the frontier green power technologies with the aspect of safe, economic, and clean power. The School of Energy Technology would continue to strive for providing innovative and effective solutions for environmentally sustainable development and to help government.

Value

We value to our drive and commitment to society and science to provide latest Technology, which are environment friendly, and innovative to our nation and human being.

Attitude

We regularly strive to motivate Power professionals to tap, and work with their unique human endowments consciousness, imagination, honesty and willpower.

About the University

RGPV has been established vide Govt. of M.P Act 13 of 1998 to unify the technical education (Engineering/ Technology, MCA, Pharmacy and Architecture) in the State of Madhya Pradesh. Presently the university has in its fold 213 colleges of Engineering, 93 MCA Institutions, 95 colleges of Pharmacy and 4 colleges of Architecture. Besides this the University now also has it Constituent College of Engineering and 5 UTDs running PG programmes in various disciplines of technology.

One of the Post-Graduate Programme which is M-Tech (Energy Technology) which is an AICTE approved program since 2002 and UGC accredited w.e.f. 2008. The Energy and Environment Department is dedicated to provide formidable support to Government of India for the growth of Renewable Energy so as to meet target of 20% utilization by 2020. The Department is supporting the activities of Bureau of Energy Efficiency through its Publications, Energy Efficiency Projects, Energy Audit, various campaigns and power plant consultancy. The department has a fully fledged Energy park and Environment Lab for Teaching and Research. The M. Tech. (E&EM) course is a blend of Theory and Practice and the curriculum has been designed in consultation with IITs and leading Institutions of the country.

About the Department

THE FOCUS AREAS:

- Affordable Renewable Energy Technologies
- State-of-the-Art Clean Coal Technologies
- Zero Emission Technologies
- Climate Change

- Bio Fuels & Bio Diesel
- Bio Science in Waste Management
- Green House Gas emission reduction and CO2 Capture Technologies
- Power plant
- Nuclear power plant
- Carbon capture technologies specially for thermal power plants
- Wind and solar energy
- Coal handling process, Turbine study
- Energy audit
- Billing
- Power generation techniques
- Erection, Testing & operation of power plant

The department faculty also undertook specialized R&D projects and established some of the Renewable Energy devices through World Bank TEQIP project. Later, various impact projects were sponsored by AICTE, MNRE, DST and the nodal office of MNRE, the MP Urja Vikas Nigam, Bhopal. Some of the systems installed in the Energy Park include:

Solar Wind Hybrid System for Power Generation

- Biodiesel Reactor
- Biomass Gasifier
- Solar Pumps & Fountains
- CO_2 Sequestration Unit
- Solar-Biodiesel Hybrid Vehicle
- Solar Wind Hybrid Power Plants

The research oriented PG programs in Heat Power, power systems and Energy Technology are in the campus. Being tech savvy is an essential aspect of today's World Class infrastructure and Research in the educational institutes. The University has endeavored in development a state of the Art Green Energy Technology Park having renewable energy devices and Green House Gas abatement plant and a Biodiesel Plant. A full fledged CFD lab is operational with software like Fluent Software 6.0, Wind farm and Wasp for optimized fluid dynamics system design.

School of Energy & Environment Management, RGPV has been setup with a target of developing a talent pool of post graduates deeply engrossed in research and engaged in cutting edge R&D, innovation for the major thrust in National Missions like renewable Energy mission, power plant live projects from Nuclear, Thermal, hydro, Wind, Solar, hybrid, and Green House Gas

abatement mission and National mission on Bio-fuels and Biodiesel.

- **Courses offered:** M-Tech (Energy technology)
  Ph. D. (Energy Technology)

Faculties of the Department:

Dr. Vinod Krishna Sethi
(Director-UIT, & Head,EEM)
B-Tech (IIT-R), MS (UK), PhD (IIT Delhi), Ex Director Ministry of Power (CEA), Ex- Dy. Director – (National Power Training Institute)

Dr. Mukesh Pandey
(Professor & Dean-Energy Technology)
B.E. (MECH.), M-TECH (THERMAL), PhD

Ms. Savita Vyas
(Asst. Professor)
B.E., M.E, PhD. (Pursuing)

Dr. Pankaj Jain
(Asst. Professor)
B.E., M.TECH (Energy Technology), PhD

Mr. Anurag Gour
(Asst. Professor)
B.E., M-TECH (Energy Technology), PhD (Pursuing)

Mr. Ashish Shandilya
(Lab Technician)

Mr. Ayodhya Prasad Sharma
(Office assistant)

Ongoing/ Completed Projects:

S. No.	Name of the Project	Funding Agency	Name of PI & Co- PI	Remarks
1	2x12 kW Solar Wind Hybrid System at Hill top of RGPV.	MNRE Delhi	Dr. V K Sethi	Completed
2	Simulation & Optimization of Surface roughness in Turbine Blade cooling channel.	AICTE, Delhi	Dr. V. K. Sethi & Dr. Alok Chaube	Completed
3	Power Productivity Enhancement and optimization using Hybrid System of Solar Wind and Biomass.	AICTE, Delhi	Dr. V. K. Sethi	Completed
4 4A	Modeling and Simulation of Carbon Recycling Technology Through Conversion of CO_2 in to useful multi- purpose fuel. Extension Project- Process Stabilization, Evaluation and Analysis of CO_2 capture and its conversion into fuel molecules CO, H_2 CH_4 using pilot plant of CO_2 capture and sequestration at RGPV.	DST, Delhi	Dr. V. K. Sethi & Dr. A.K.S. Bhadoria	Completed On-going
5.	Enhance Power Performance of HAWT using optimum turbine design and dual rotor.	AICTE, RPS	Dr. Mukesh Pandey Er. Anurag Gour	On-going
6.	Optimization and Sensitivity Analysis of Solar, wind and biomass Hybrid System	MPCST	Dr. Mukesh Pandey	Completed
7.	An investigation in Operating Parameters of Wind Power Generation for optimum performance of unit	MPCST	Er. Pankaj Jain	On-going
8	30kW Concentrated Solar Power Plant	MNRE	Dr. V. K.Sethi Dr. Mukesh Pandey	Under Process

- **Publications:**

International	-	64
National	-	96
Book	-	16

Conferences, Seminars, Workshops etc.:

Attended

International	-	44
National	-	31

Conducted in last two years

International	-	02
National	-	02
Workshop	-	01

- **Award & Recognitions** - 02
- **Linkage with industries** - Sponsored M-Tech course for BHEL, MPUVNL
- **Extension services** - MoU with University of Houston
  - MoU with Altair
  - MOU on CSP with Tokyo University
- **Placement record** - 100 % through direct interviews in CPCB, Toshiba, NEERI, NHPC, LUPIN, TERI and various power projects and energy companies.
- **Departmental Library** - Total No. of Books: 315
- **Teaching Aids** - Power Point Presentation / Over Head Projector, Flip Charts & Models
- **Innovative R&D and IPR** - Solar-Biodiesel Hybrid Vehicle
  - CO_2 Sequestration Unit
  - Solar Wind Hybrid System for Power Generation
  - Biodiesel Reactor
  - Biomass Gasifier
- **Any Other:**

- 1. The Department is also working with Ministry of New & Renewable Energy in coordination with MP Urja Vikas Nigam, for installation of units of Solar Wind Hybrid Systems in various parts of the state.

2. The Department has been awarded a prestigious project under National programme on Carbon Sequestration by the Department of Science & Technology, Govt. of India.

M-TECH ENERGY TECHNOLOGY

A course in M. Tech (Energy Technology) was started in the year 2002 after approval of AICTE vide letter no. 07/01/MP/PG/2002/CIVIL-41 dated 23/08/2002 with an intake of 18 students. The focus areas for the department were identified as Power and Energy. The Power Industry is multi Disciplinary highly capital intensive and as any other sector ,human resource plays pivoted role in this sector ,power industry requires trained manpower for project planning implementation ,erection, commissioning, operation and maintenance ,protection, and transmission ,distribution.

No conventional engineering stream available in education that can equip a person with such vast knowledge of different input required for the job performance in the power sector. Therefore an after Graduation course in engineering, the M-Tech (Energy Technology) course, for power and Energy has been designed.

What Makes Us Different?

Following are the subjects which lead to emergence of M-Tech (Energy Technology) which have an edge over conventional electrical and mechanical or other post graduate courses when, its comes to energy sector

1) Power Generation Engineering.
2) Nuclear Energy
3) Hydro Power
4) Solar, wind and its hybrid system ,also installed in energy park
5) Steam generation and it’s auxiliaries
6) Power plant and electrical machine & its system

7) Energy audit
8) Focused also in green energy technology
9) Energy audit, billing ,and conservation system
10) HVDC, tariff, power plant control and instrumentation
11) Renewable energy, biomass also 10 kw installed at our energy park.
12) Coal handling process, simulator, and covers all type energy system.
13) Carbon capture technology also works in Energy Park.
14) Erection, commissioning, operation of power plant.
15) Latest technologies in nuclear power plant.
16) Most important, it provides as per curriculum the Dissertation work in power plants, industries, organizations, or student also can perform work in energy park, or university labs under project guide

DISSERTATION

The course Curriculum provides in its 2nd year (3rd and 4th Semesters) a Minor project and a Major Project of 3 and 5 months durations respectively. The dissertation work in Power plants,(Thermal, Hydro, Nuclear, Energy Audit ,etc) or in esteemed organization will not only provide exposure to the Students fraternity but would also pave way for an useful cooperation between this University and Organizations or industry for live experience .

INDUSTRY INTERFACE

As per the curriculum all students take part in thesis and live project in industry for industry interface /practical approach so, the course curriculum provides in its 2nd year (3rd and 4th Semesters) a Minor project and a Major Project of 3 and 5 months durations respectively. The dissertation work in esteemed organization will not only provide exposure to the Students fraternity but would also pave way for a useful cooperation between this University and your Organization. Few of the companies in which our student have undergoing their summer training, in addition to the University Energy park having wind, fuel, biomass energy,CO2 capture unit ,thin film technology, are:

1. ABB
2. BHEL.
3. BECHTEL
4. UPEB5.
5. MPCGL.
6. RELIANCE GROUP
7. NHPC
8. IPGCL
9. RRCAT
10. THERMAX LTD.
11. ENERGY INFRATECH(MALANA-2 HYDRO PROJECT)
12. GMR GROUP
13. SOLAR POWER

14. AVANTA POWER PROJECTS
15. NTPC, DIFFERENT STATE ELECTRICAL BOARDS.
16. DIFFERENT POWER PLANT, HYDRO,THERMAL,SOLAR,UNIT,
17. MNRE, EPCO, POLLUTION CONTROL BOARD, NHDC, NPCIL,
18. CDM Agency of MP.
19. ENERGY RELATED PROJECTS IN THE ENERGY PARK

Infrastructure resource-In the school of energy technology ,UTD, has complete with resources, class rooms, under the university 247 acres of campus all available for department, computer lab, CFD lab, energy park, environment laboratories, internet facilities all are available for students, all university lab ,library , hostel, also available for each of our student. The e-journal, e-library, facilities, power plant related notes, operation journals, departmental library also available for student in the university campus.

Knowledge Resources-Department has energy park with ,green energy centre tag and worked with MNRE, DST, EPCO, different power plant related project, books ,student also attend different ,international, national, conference, participate in paper presentation under guidance of faculty ,and university guided approach .e-library, journal, current magazines also available for student to take part of knowledge –mania.

Computer resources:

1. CFD lab.
2. Internet with LAN.
3. E-JOURNAL.
4. AUTOCAD, MATLAB LAB also available for student in university campus.
5. Carrier portal always available for student.

ABOUT ENERGY PARK AND DEPARTEMENTAL R&D

The Energy Technology Center under the EEM

The quest for Energy independence of the campus through Clean Energy Technologies has prompted RGPV to setup a "Green Energy Technology Center- GETC" having diverse focus areas including Clean Coal Technologies and CDM, Renewable Energy Technologies, Bio-fuels & Bio-diesel, and Energy Conservation & Management, with a clear objective and commitment to generate 1 MW green Power within the campus.

Accordingly RGPV has established a Green Energy Park in its wide spread campus. The elements which have been included are power generation from Wind, Solar, and Bio-mass. The benefits from this endeavor are fulfilling the electricity needs of a large proportion of the institutions and campus of the RGPV using Renewable Energy devices, serving as a learning and research laboratory for students of the RGPV and its constituent and affiliated institutions and acting as a demonstration and learning centre for personnel of organizations engaged in energy generation.

New Horizons of Engineering and Technology will descend on the modern structure of technological advancement and Solidarity. The RGPV and other Technical Universities of India join hand in shaping the Indian horizon in respect of capability in S&T core sectors such as InfoTech, Biotech, Bio-informatics, Pharma Tech, Nano Tech and Green Energy Technologies etc. New technological change will trigger a change wave in accelerating towards innovative infinite. Approaching in this infinite is the priority of Mankind. This can be achieved through Technology savvy campus and enlightened minds having capability to transform dreams of our Scientist President in a happier India of 2020. In fact we can achieve it by 2015 through.

Energy security and Energy independence is the prime concern of our time for transforming India into a knowledge superpower of the world. The Indian Power Sector, which has taken rapid strides and now reached to a installed capacity level of 1, 84,000 MW, has plans to add another one lakh MW within next five years. Global concern for reduction in emission of green house gases (GHG) especially CO2 emissions, is likely to put pressure on Indian Power System for adoption of improved generation technologies. It has already started witnessing a transition from Conventional Power Generation Technologies to the Green Power Technologies. A major thrust on CO2 reduction on long term and sustainable basis would come through adoption of advanced technologies of power generation like Supercritical/Ultra-supercritical power cycles, Integrated Gasification Combined Cycles (IGCC), Fluidized bed Combustion/Gasification technologies, Renewable Energy Technologies, Bio-fuels, and other such Green Energy Technologies.

This has prompted RGPV to setup a "Green Energy Technology Center- GETC" having diverse focus areas including Clean Coal Technologies, Renewable Energy Technologies, Bio-fuels & Bio-diesel, and Energy Conservation & Management.

The Green Energy Technology Center at RGTU is aimed to carry out R&D in:

- State-of-the-Art Clean Coal Technologies
- Affordable Renewable Energy Technologies
- Research Initiatives in Zero Emission Technologies
- Climate Change and CO2 Capture Technologies
- Bio Fuels & Bio Diesel
- Bio Science in Waste Management
- Green House Gas emission reduction and CO2 Capture Technologies+
- Clean Development Mechanism (CDM) and evolving Base Line Methodologies for emerging Technologies

- GETC – RGTU is Committed towards its Energy Friendly Campus:
- Through Use of Renewable Energy Sources (Solar, Wind Hybrid) for Campus Area Power needs.
- Use of Biomass Energy through Solid Waste and Hostel Kitchen waste
- Energy Farming For Bio-diesel from Petro plants – 2000 Petro Plants in campus

- Thousand liter /Annum Bio-diesel in house capacity
- To develop RGPV as an Energy independent campus in a span of one year through various initiatives.
- A one MW Power generation through Solar-Wind System at Hilltop
- Bio-diesel production @100 l/d, rising to 600 l/d

Broad Objectives of the Green Energy Center are:

- To promote research in Clean Coal Technologies like supercritical, IGCC and CFBC.
- To Develop state of the art Base line methodologies for clean/ green technologies for CDM.
- To Promote R&D in fuel cell, Biomass, Solar/ Wind Hybrid and integration.
- To develop Biodiesel trans-esterification Tech. and its application in automotive engines.
- To Promote Energy Efficiency Measures & develop Energy Conservation Awareness around

Green Power Technology Center shall work on <u>"Mission Energy Security and Energy Independence",</u> thus focusing on:

- Biomass for Rural Energy needs
- Solar for irrigation
- High Efficiency CNT Based PV Cells

- Hydrogen as Fuel for future
- Accelerated Program on Thorium based Nuclear Reactor
- Clean coal Technologies like IGCC
- Bio-fuels for Bio-Diesel
- Energy Efficiency Improvement through Energy Conservation Measures

Energy Security by 2020, Energy Independence by2030

THE IMPACT GREEN ENERGY TECHNOLOGY PROJECT:

Modeling & Simulation of Carbon Recycling Technology through Conversion of CO_2 into useful Multi Purpose fuel:

The project aims at development of a pilot plant for CO_2 capture and production of useful multipurpose fuel like Hydrogen, Methane and Algae growth for Bio diesel production in the Energy park of RGTU.

OVERALL EXPECTED OUT COME FROM CO2 PLANT:

Development of a working plant to Capture CO2, the prime GHG and generate non conventional Energy sources viz. H2, CH4, Bio-diesel and thus provide formidable support to National Mission on GHG reduction for combating Global warming and consequent Climate Change.

OBJECTIVES:

1. Sequester CO_2 and convert the same into useful multipurpose fuels.
2. Use CO_2 to grow micro algae to produce Bio-diesel and Methane Gas.
3. To establish a Pilot Plant for CO_2 sequestration and conversion in to multipurpose fuel.

To develop mathematical & chemical models for CO_2 sequestration, Gasifier & Algae pond systems.

For this purpose following four systems are incorporated:

- CO_2 sequestration system – Metallic solvent for CO_2 capture
- Catalytic Flash Reduction of CO_2 using charcoal from Gasifier.
- Production of Hydrogen from CO.
- Production of Methane using ‘Hydro Gasification of Biomass’ process.
- Pilot study to capture CO_2 for algae production and extraction of Biodiesel

OTHER INITIATIVES:

The Rajiv Gandhi Technological University is having 10 kW Biomass Gasifier and Bio-Diesel Reactor (100 LPD) in its Energy Park. Using Exhaust from Gasifier and Char coal, a pilot plant for capture of CO_2 based on Chemical solvent and for converting the same into useful fuel like Hydrogen for Fuel Cell application and Methane is being developed. Additionally, a Bio-fuel Incubator is being developed for producing variety of Algae culture for CO_2 capture. An Incubation Unit on fuel Cell is also being developed by RGPV in which Hydrogen from the pilot plant will be the prime input.

Facilities Available in the Energy Department

❖ Solar Pump compatible with 900 Wp Solar Thin Film Modules (for irrigation Purpose):

Specification:

1. Single junction Amorphous Silicon (a-sir)/CIGS Technology based modules
2. Monolithic cell to cell Serial connection enabled via laser technology
3. Frameless Glass -PVB- Glass modules with highly translucent soda lime glass.
4. Modules with the option of bonded back rails.

5. Made from nontoxic materials and are easily recyclable

Solar Pump compatible with 900 Wp Solar Thin Film Modules

Pump:

Sr.	Technical Parameter	Specification
1	Type	Centrifugal Submersible, Multistage
2	No. of Stages	14
3	Head at 50 Hz	30 m
4	Capacity at 50 Hz	42 Liter per minute
5	Delivery Size	32 mm
6	Bore Well Size	100 mm

Motor:

Sr.	Technical Parameter	Specification
1	Type	Oil Filled Submersible
2	Rating (Motor Power Out Put)	0.5 HP (0.37 k W)
3	Rated voltage	120 V
4	Phase	3
5	Frequency	50 Hz
6	Duty	S1
7	Enclosure	IP 68
8	Rated Current	4.85 amp
9	No. of Poles	2
10	RPM	2800
11	Class of Insulation	F

Solar Power Conditioning Unit (SPCU):

Sr.	Technical Parameter	Specification
1	Solar DC Input to Controller Vin	> / = 175 V as Vmpp
		< / = 380 V as Voc
2	Ambient Temperature	Up to 55° C
3	Enclosure	IP21
4	Controller Out Put (@1k W/m^2 Sun Intensity)	SVPWM, 3 Ph 120 V 50 Hz (Variable Voltage Variable frequency out put)

The above mentioned pumps are suitable for handling the water quality / characteristics as specified in relevant IS Standards.

❖ Biodiesel Production Unit 100 LPD/Day capacity

Specification:

Biodiesel is a fuel that has much the same characteristics as normal diesel oil, but as opposed to diesel it is not derived from petroleum but from vegetable oils or animal fat. Generally, vegetable oils are used such as sunflower oil, soy oil, rape oil or palm oil. Used oils may be used likewise very well indeed. To produce biodiesel from these oils, they are subjected to a chemical reaction, which is called transesterification. It is a chemical reaction that makes the glycerol present in the oil to be substituted by methanol, using a lye as a catalyst. Its result is a methyl ester. One of its examples is rape methyl ester (RME). A residue forms due to transesterification, called glycerine. This can be applied in various ways, one can think of such things as making soap.

STEPS TO PRODUCE BIODIESEL:

1. Pump feedstock in the reactor tank
2. Heat reactor tank to 55° C.
3. Pump Methanol in Premix tank
4. Add NaOH/KOH to Methanol
5. Mix for 25 minutes
6. Pump methoxide from the pre-mix tank in the reactor tank
7. Mix oil and methoxide for 45 minutes
8. Pump Methyl ester in to wash tank
9. After 18 hours settling drain glycerin
10. Water wash for two hours
11. Drain water
12. Pump clean biodiesel through filter system into storage tanks

❖ 10kWe Biomass Gasifier Unit (100 percent producer gas based)

Specification:

Biomass Gasification:

Biomass Gasification breaks solid carbohydrate materials ($CH_{1.4}O_{0.6}$) in to basic building block chemicals (CO, H_2, CO_2, H_2O, and CH_4) by first thermally depolymerizing the biomass particles (devolatilization) followed by hydrocarbon reforming and carbon reforming reactions.

The gasification process requires heat and an oxidant such as oxygen (O_2) or steam (H_2O_{vap}). Heat addition can occur **directly** by partial oxidation of the fuel or **indirectly** using some clever means of high rate indirect heat transfer.

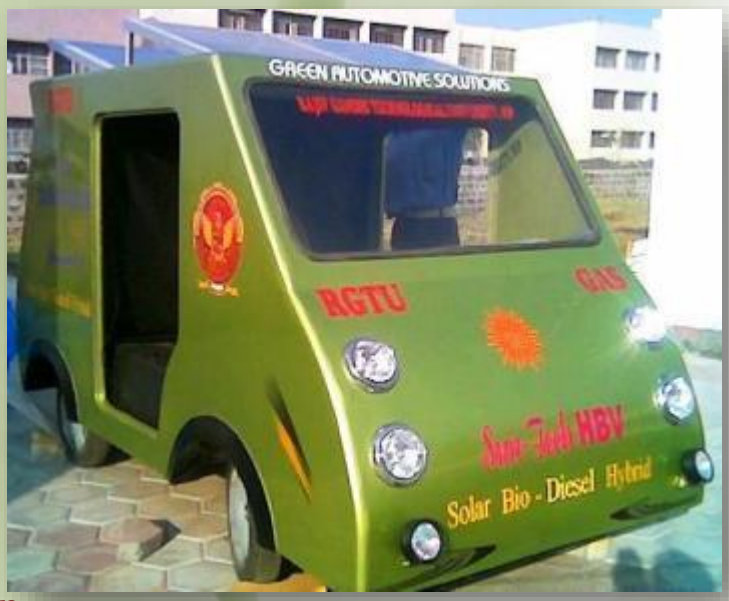
Oxygen (O_2) and air (21% O_2) are sometimes referred to as "**blast**" in classical solid fuel combustion jargon because oxygen reacts exothermically with the fuel. For example, when you blow air on hot coals in your fireplace, they glow more intensely—the blown air serves as blast.

Technical Specifications of Biomass Gasifier:

Gasifier	
Gasifier Model	Cosmo Cp-10
Mode of Operation (power mode)	Cold & Clean Gas
Gasifier Type	Down Draft
Rated Gas flow	25 Nm^3/hr
Average gas calorific value	1000 k cal/Nm^3
Gasification Temperature	1000-1200 degree centigrade
Output removal	Manual, once every six hours.

Fuel type & Size	Wood/woody waste with maximum dimension not exceeding 25 mm & 25 mm dia.
Permissible moisture content in Biomass	5-20% (Wet basis)
Biomass charging	Online batch mode, by topping up once every two to four hours
Rated Hourly consumption	Up to 17 kg.
Typical conversion efficiency	> 75%
Typical gas composition	CO- 19%, H_2-18%, CO_2d-10%, CH_4- upto 3%, N_2-50%
Engine Genset	
Rated output (gross)	11 kWe
Rated output (net)	10 kWe
Specific Biomass Consumption	Less than 1.5 kg/kWhr

❖ Solar Biodiesel Hybrid Car:



Specification:

Fuel Used:	Biodiesel
Lighting System & Starting system:	Through Solar Panels
RPM :	3600
HP:	7.5 CMVR
Model No:	GL400 II
Solar panels:	4 No. (Each of 12 Watt)
Battery amperage:	35 Amperes/hr

❖ Hydro Turbine Testing Rig (Pelton, Francis and Kaplan)

Specification:

❖ Closed Circuit Pelton Wheel Turbine Test Rig

a)	**PELTON WHEEL**		
	Type	:	Impulse
	Capacity	:	2.0 HP
	Rated Speed	:	1000 RPM
	Discharge Capacity	:	400 Litre / Minute
	Supply Head	:	40 mtrs
	Buckets	:	Gun metal
	Sphere (adjustable)	:	Gunmetal
	Casing	:	Mild steel
b)	**LOADING**	**:**	**ROPE BRAKE**
	Material	:	Cast Iron
	Drum Size	:	200 mm dia
c)	**SUPPLY PUMP SET**		
	Size	:	2 ½ ” x 2
	Discharge	:	400 Litre / min
	Total Head	:	45 mtrs
	Motor Capacity	:	7.5 HP
	Starter for Motor	:	DOL -Std Make
d)	**FLOW MEASUREMENT**		
	Venturimeter	:	CI Venturimeter for 50 mm pipe Line with pressure gauge for Measurement
e)	**PRESSURE MEASUREMENT**	:	pressure gauge for turbine head
f)	**SUMP TANK**		

	Material of Construction	:	3MM MS with FRP Coating
	Size	:	0.9 x 0.7 x 0.5 mtrs

Power Required:-Electrical Supply – 10 Hp, 3 Phase, 440 Volts, 50 Hz Ac Supply

❖ Closed Circuit Francis Turbine Test Rig

a)	**FRANCIS TURBINE**		
	Type	:	Inward Flow reaction
	Capacity	:	2.0 HP
	Rated Speed	:	1000 RPM
	Discharge Capacity	:	1000 Ltrs / min.
	Supply head	:	18 mtrs
	Guide Vanes Blade (adjustable)	:	Gun metal vanes (Aerofoil Shaped)
b)	**LOADING**	**:**	**ROPE BRAKE**
	Material	:	Cast Iron
	Drum Size	:	200 mm dia
c)	**SUPPLY PUMP SET**		
	Size	:	3”x 2 1/2”
	Discharge	:	1000 Liters / min
	Total Head	:	25 mtrs
	Motor Capacity	:	7.5 HP
	Starter for Motor	:	DOL– Crompton/Std Make
d)	**FLOW MEASUREMENT**		
	Venturimeter	:	CI Venturimeter for 65 mm pipe Line with pressure gauge for Measurement
e)	**PRESSURE MEASUREMENT**	:	pressure gauge for turbine head and vaccum gauge at draft tube
f)	**SUMP TANK**		
	Material of Construction	:	3MM MS with Frp Coating
	Size	:	1.0 x 0.7 x 0.5 mtrs

Power Required:-Electrical Supply – 7.5 Hp, 3 Phase, 440 Volts, 50 Hz Ac Supply

❖ Closed Circuit Kaplan Turbine Test Rig

a)	**KAPLAN TURBINE**		
	Type	:	Axial Flow Reaction Turbine
	Capacity	:	2.0 HP
	Rated Speed	:	1000 RPM
	Discharge Capacity	:	2000 Liters / min
	Head	:	8 meter
	Guide Vanes Blades(adjustable)	:	Gunmetal vanes (Aerofoil shaped)
b)	**LOADING**	:	ROPE BRAKE

	Material	:	Cast Iron
	Drum Size	:	200 mm dia
c)	**SUPPLY PUMP SET**		
	Size	:	4” x 4”
	Discharge	:	2000 Liters / min
	Motor Capacity	:	7.5 HP
	Head	:	8 meters
	Starter for Motor	:	Delta
d)	**FLOW MEASUREMENT**		
	Venturimeter	:	CI Venturimeter for 100 mm pipe Line with pressure gauge for Measurement
e)	**PRESSURE MEASUREMENT**	:	pressure gauge for turbine head and vaccum gauge at draft tube
f)	**SUMP TANK**		
	Material of Construction	:	3MM MS with FRP Coating
	Size	:	1.0 x 0.8 x 0.6 mtrs
g)	SPEED MEASUREMENT	**:**	**Digital Rpm Indicator**

Power Required:-Electrical Supply – 7.5 Hp, 3 Phase, 440 Volts, 50 Hz Ac Supply

❖ Wind Mill Pump for irrigation purpose:

Specification:

Mechanical Wind Pump:

Head: 03 meter height

Discharge

❖ 1.6 kW Solar Wind Hybrid System:

Specification: 1.3 kW generations – by Wind
300 watt -by Solar

Broad Specifications and Features of the Existing System:

A 1.6 kW Solar Wind Hybrid System has been designed and erected at Rajiv Gandhi Technological University Bhopal with a Solar-Wind ratio of 3: 13 i.e.300Watt Solar & 1300 Watt Wind. This optimized configuration has been chosen through WaSP software and series of experiments. A Biomass Gasifier is proposed to be integrated into the system for a reliable configuration of Hybrid system of the three Renewable sources.

Following instrumentation and equipments were used for setting up of Solar wind hybrid system together with instrumentation like Anemometer, and Radiation Pyranometer.

The Technical Specifications of Wind- hybrid System is as under:

Type	:	Tubular Lead Acid
Capacity	:	48V, 75 AH
Container	:	Made of Hard Rubber
Self Discharge Rate	:	< 4% Per Month
Ampere-hour efficiency	:	96%
Max. Depth of discharge	:	80%
Start Generating Wind Speed	:	2.5 m/s /8 kMPH
Survival Wind Speed	:	120 mph/200 kmph
Cut in Wind Speed	:	2.7 m/s/ 6 mph
PV Array (at STC)	:	300 Wp-

Power Conditioning Unit	:	2KVA
Battery Bank	:	48 V, 75 AH
Wind Electric Generator (Comprising of Tower, Dump Load & Other Accessories)	:	1300 W@ 11 m/s
Module Mounting Structure	:	MS Galvanized

Specifications of SPV Modules

Type	:	75W36 /38FR36
Power Output	:	75 Wp/ 38 Wp
Type of Cells	:	Crystalline Silicon
No. of Cells	:	36
Open Circuit Voltage	:	21.5 V
Short Circuit Current	:	4.8 A / 2.55 A
Current at Peak Power	:	4.42A / 2.29 A
Voltage at Peak Power	:	17 V
Conversion Efficiency	:	12.2%

Specifications of Wind Electric Generator:

Type	:	Whisper
Model	:	H-80
Capacity	:	1300 W @ 11 m/s
Diameter, M/F	:	3/10
Swept Area SqM/Sqft	:	7.3/80
Number of Blades	:	3
Blade Material	:	Injection Molded

❖ Solar Fountain 900watt capacity:

Specification:

The system components of SPV water pumping system are:

1. PV array
2. Motor pump set
3. Interface electronics
4. Connecting cables & switches
5. Support structure & tracking system
6. Pipes, etc.

System description installed at Energy Park:

REIL's 900 Wp SPV water Pumping System consists of the following:

1. SPV Modules 75 Wp - 08 Nos
2. DC surface Centrifugal 1hp pumps set - 01 nos
3. Mounting Structure for 08nos. of Modules with three axis manual tracking.
4. MCB for switching ON/OFF the pump.

SPV Array: The SPV array of 900 Wp capacity supply power to the pump in the day time. SPV Array consists of 2 nos SPV Panels each panel consist of 8 nos. SPV modules 4 Modules are connected in series and six such sets are connected in parallel.

DC Centrifugal Pump Set:

A high efficiency DC Monobloc motor pump set of 1 hp is used with solar PV power Pack. Pump and PV module characteristics are designed to match each other for better performance and to utilize maximum power of PV Array. Direct drive DC motor eliminates inverter. Pump is designed to start at low intensity of sun.

Technical details of a typical 1 hp SPV pump:

Solar PV panels	900 Wp comprising of 75 Wp modules
Motor pump set type	1 hp centrifugal DC monoblock/ AC submersible with inverter

Operating voltage	30V DC (nominal)
Maximum suction head	2.0 meters
Maximum dynamic head	10.0 meters
Bore well size	150 mm dia.
Required shadow free area	100 sq.m.
Module mounting structure	MS hot dipped galvanised
Average discharge of pump	SPV pump set will have the capacity to give discharge of 70,000 Liters on clear sunny day (approx.) subject to variation due to solar insolation and water table condition. This discharge will be suitable for irrigating 2-3 acres of land.

❖ Vertical Axis Wind Turbine:

❖ Automatic Weather Monitoring System (Attached with Kalpana Setelight-1):

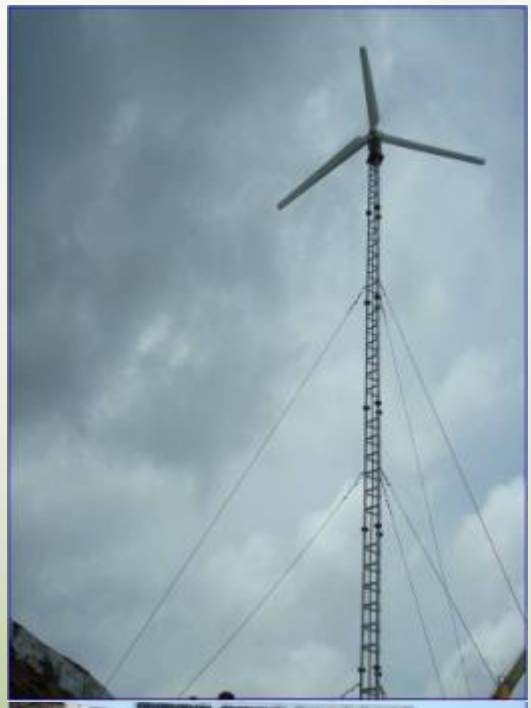
Specification:

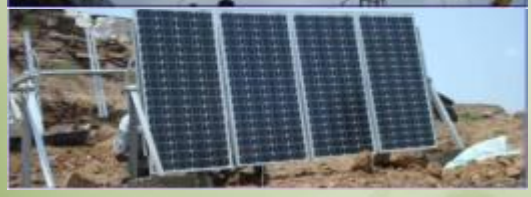
The Indian Space Research Organization (ISRO) has sponsored an indigenous Automatic Weather Station (AWS) for the BU-DRDO Centre for Life Sciences of the Bharathiar University for monitoring and observation of weather changes. The centre functioning under the aegis of the university is supported by the Defense Research and Development Organization (DRDO). ISRO's INSAT 3A and KALPANA 1 satellites carry data relay transponders which can receive data from remote platforms deployed on ground and water bodies. Meteorological application of these satellites-based data relay is one of its foremost applications. With data collection from local levels and remote and inaccessible areas through AWS, weather forecasts and services is said to improve significantly.

AWMS consist of following parts:

- Wind Measurement: Cup anemometers
- Humidity: Digital Humidity Measurement
- Leaf-Wetness: Leaf-Wetness Smart Sensor
- Rain Gauge: Standard rain gauge
- Solar Radiation: Pyranometer
- Temperature: Thermocouple Temperature Measurements

❖ Solar Wind Hybrid System: 12 kW capacity



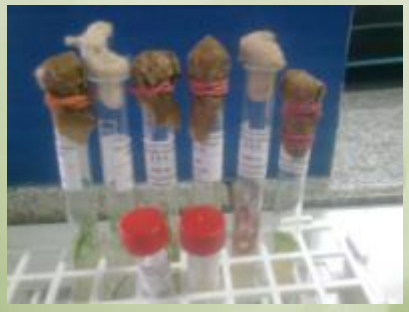


Specification:

Sr.	*Components*	*Specification*
01)	Wind Turbine	Rated Power : **10 kW**
		Maximum Power : 10 kW
		Output DC voltage : 240 VDC
		Type : 3 Blades upwind
		Startup wind speed : 2.5 m/s.
		Cut in wind speed : 3 m/s.
		Rated wind speed : 11 m/s.
		Cut out wind speed : 15 m/s.
		Rotor Diameter : 5 Mtr
		Rotor Speed : 180 rpm
		Timing manner : automatically adjust windward angle
		Over speed protection : Autofurl
		Temperature Range: -40 to + 60 deg.C.
		Generator: Permanent Magnet Alternator.
02)	**Tower for Wind Turbine**	Type : Self-supporting
		Tower Height : 12 Mtr +

		Tower Material : Pipe Section
03)	**Solar PV Panels**	Total Capacity : **2 KW**
		Panel Capacity : 100 Wp – 20 Nos or suitable
		Voltage : 240 VDC
		Make : Premier / Tata BP / (MNRE approved)
04)	**Mounting frame (SPV Panel)**	MS fabricated, epoxy painted
05)	Wind Power Center	Voltage : 240 V
06)	Solar Charge Controller	Voltage : 240 V
07)	Battery Bank	Type : Deep discharge tubular plate
		Capacity : 300Ah
		Voltage : 240 V
		Number of Batteries : 40 Nos Each of 150 AH, 12 V.
08)	Inverter	Type : Sine Wave
		Capacity : 10 KVA, 240 V DC
		Out-put voltage : 230 V AC
		Out-put frequency : 50 Hz
09)	**Manual Brake switch** for Wind Turbine along with a Manual Change Over switch and Power Meter.	

❖ CO_2 Capture & Sequestration Plant :

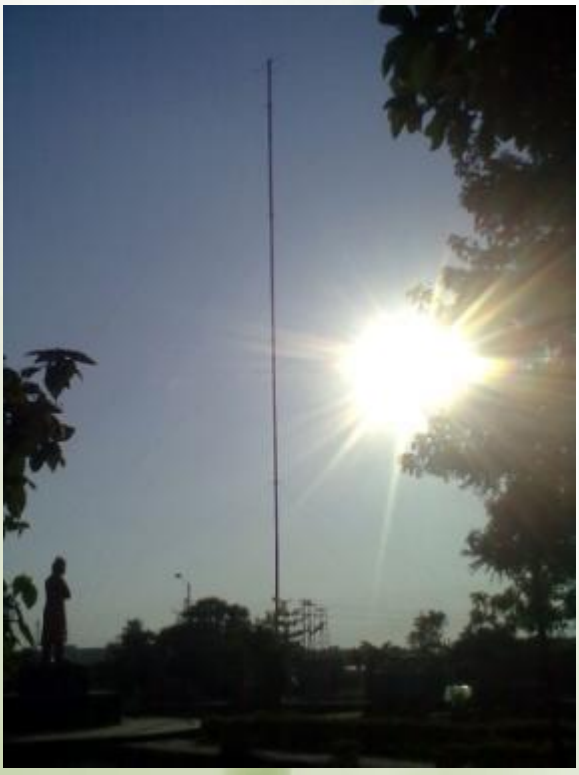


Description of the Pilot Plant:

- **Rated Capacity of the Capture of CO_2 :** 500 kg/ day
- **Source of CO_2** : Boiler of capacity 100kg/hr. steam & Biomass Gasifier of 10kWe
- **Solvent used for capture of CO_2** : Mono Ethanol Amine (MEA)
- **SOx & NOx Removal** : $NaHCO_3$
- **Catalytic Converters / Reduction Unit**

  - For Methane.... Input CO and H_2, Catalyst "R - 01 *
  - For Hydrogen.... Input CO and Steam, Catalyst "R - 02 *
  - For CO ... Input CO_2 and Charcoal / Lignite

❖ 40 meter mast height Wind Anemometer:



Specification:

Height 20 meter, 30 meter. 40 meter and 60 meter mast height – any one]

System Features

- Fully integrated components: tower, logger, sensors
- All calibrated 40C anemometers
- Industry proven *data* logger
- ice-rated Tall Tower
- Strong steel tube construction
- Easy to assemble and transport
- Compact Envirocrate packaging
- Remote data transfer options

Standard System includes: (with all accessories and auxiliaries)

- 254mm – 203mm (10.0-8.0”) diameter with galvanized steel base plate, guy wires, screw- in anchors, and all necessary hardware components for tower assembly.
- 15-channel data logger
- Non-volatile SD flash-memory card
- Steel shelter box enclosure with mounting hardware

- 40C calibrated anemometer with protective terminal boot
- 200P wind direction vane with protective terminal boot
- 110S temperature sensor with radiation shield
- Sensor side-mount boom with clamps
- 2C shielded sensor cable: two 60m, two 50m, two 40m
- 3C shielded sensor cable: one 60m, one 50m
- Grounding kit: two 2.1m (7’2”) ground rods and one 2.74m (9’) lightning spike
- Symphonie Data Retriever Software (Free download)
- guy guards/markers, 2.44m (8’)

❖ Solar PV Experimental Kit:

Specification:

Compact Solar Photovoltaic Module Stand

It consists of two faced Photovoltaic panel, which can be folded and reassembled at use. The module also contains a uniquely designed support stand with adjustable gears for micro-tilting the PV panel for accurate experiments and readings. This module also carries two lamps which can be regulated for variable radiation.

2 PV Modules of 37Wp each

2 Halogen lamps of 1000 watts each with regulator to modulate light intensity

Gear and altitude changing mechanism for the stand which is sturdy and fully portable on wheels

Main Controller

This has been designed keeping in view the user interactivity while connecting the terminals and simultaneously taking the corresponding readings. The main load indicator has been kept at the bottom to avoid the glare in the eye while conducting the experiments.

Components of Kit

This system has measuring units for various parameters like Temperature, Current, and Voltage of different networks of the circuits. Also has inbuilt Diodes, Batteries, Solar Charge controller and Inverter for completing a fully functional Stand along PV System.

This unit is composed of following sub units:-

- Potmeter – To draw the I –V curve by varying the load
  150 W / 12 Volt
- Charge Controller Unit
  12 Volt / 24 Volt Nominal Voltage
  5 Amperes Charge Current
  5 Ampere Load Current
- Inverter
  230 Volt / 150 W Output
  10 – 15 Volt input
- Different Meters to measure various parameters:
  1) DC Ammeter 20 Ampere and 2 Ampere
  2) DC Voltmeter of 20Volt and 200 Volts
  3) AC Ammeter 2 Ampere
  4) AC Voltmeter 250 Volt
  5) Temperature Meter – 100 Centigrade to 200 Centigrade

Battery

4.5 AH / 12 Volt Battery

Load Box

- AC Load (CFL Light)
- DC Load (LED Light)

Accessories

- Radiation Meter
- Connecting wires
- Shading elements

Data Logger Software with PC Interfacing

❖ Solar Thermal Experimental Kit:

Specification:

Components	Specification	Remarks/working
Water heating system (Collector and hot water tank)	Collector: area 0.716 m2 , it has glass cover known as glazing, absorber plate, 6 riser pipes, two header pipes, insulation, casing etc. Tank: two layer tanks with puf as insulation. tank capacity 50 L water	Collector: it is a Flat plate collector. It collects the solar radiation (radiation coming from the halogen system) and then transfer the heat to the water inside the pipe called risers Tank: it is a non pressurized aluminum tank. It store and help in circulating the water
Halogen system	21 halogen of 150 watt each are assembled in a metal sheet (halogen fixture). Halogen fixture's area: .0.72 m2 Number of halogen lamp: 21 Power :150 W each Regulator: capacity 5000 W	Halogen: it is artificial source of solar radiation. When experiments are performing inside a room it supplies the required solar radiation. Regulator: to perform experiments at different radiation level we can change by using the regulator
Radiation meter	Range: 0 to 1999 W/m2 Power supply: DC with the help of battery	To measure the radiation level on the collector
External water tanks capacity	Two FRP tank of 80 Litre	To supply cold water to the heating system and help in discharge the hot water tank
Water pump	Power supply: it is a hot water AC pump Power: 0.5 hp	To lift water upto the desired level. To facilitate the forced mode operation.

Water flow meter (for forced mode)	Sensor: Flow range : 0.5 to 25 LPM Supply voltage- 230 V AC.	Work on Mini turbine wheel based technology. To measure the water flow rate during the forced mode operation.
Stop watch	With electronic On-Off switch and a Reset button	To detect the time during natural flow rate measurement
Anemometer	Air velocity: Range : 0.4 to 45.0 m/sec Power supply: DC 4*1.5 AAA size	The anemometer can measure the air velocity and the ambient air temperature. The air flow sensor is a conventional angled vane arms with low friction ball bearing.
Pressure Gauges	Range: 0 to 6 bar pressure Power: 220 VAC	Semiconductor thin-film based technology. Works on the principle of generation of electrical signal due to exertion of pressure. To measure the inlet and outlet pressure
Thermometers	Sensor: Sensors are Class A sensor Range: -200 to 650 0C Display: Range: -100 to 2000C Supply Voltage: 230AC	Sensor is RTD based platinum probe. Works on the principle of variation of resistance with temperature. To measure the inlet, outlet, plate and tank water temperature
Water cooler	Capacity: 0.1 TR Power supply: AC	To supply cold water at the desire temperature
Fan	Range : 0 to 5 m/sec Power supply: AC with regulators	To supply the wind at the desire speed
Two ways Valves	There are 8 valves of half inch size each	By using the valves we can direct the water flow as per our requirement
Three way valve	There is a three way valve in the outlet side of the collector. the size of the valve is half inch	The water flow rate during the thermosyphonic mode of experiment is very small. The flow meter in the system can not measure the flow rate in this situation. So to measure the flow rate in this situation we use the three way valve
Insulation	These are porous rubber pipe of ¾ inch size	As heat flows from higher temperature to the low temperature side, during the experiment the water inside

		the pipe are hotter then the outside temperature so heat flows from water to the ambient. But this is not our desire. The insulation blocks this flow of heat from water to the ambient air.
Structure	All parts of the structure are made of mild steel	The structure help us in keeping the different components ate their respective position. The structure is completely collapsible. Four wheels are there to move the system from place to place. The halogen structure is separate from the main structure and we can move it separately.

❖ Automatic Weather Monitoring System (Portable)

Watch Dog - AWMS consist of following parts:

- Wind Measurement:
  Cup anemometers
- Humidity:
  Digital Humidity Measurement
- Leaf-Wetness:
  Leaf-Wetness Smart Sensor
- Rain Gauge:
  Standard rain gauge
- Solar Radiation:
  Pyranometer
- Temperature:
  Thermocouple Temperature Measurements