IDCOL R&D Initiatives

Community Based Decentralized DC Nanogrids for Combined Household and Productive Use

R&D institute

Centre for Energy Research, United International University

Achievement

This project received worldwide recognition and acclamation from many renowned international bodies. It was Winner of the 2016 Intersolar Award – "Outstanding Solar Project". This project also won the 2016 UN Momentum for Change Award as the first Bangladeshi institution.

Objective

- ✓ Integration of local generation and storage of SHSs
- ✓ Allowing electricity sharing through bidirectional power flows
- ✓ Allowing an efficient use of generation and storage

Outcome

In the framework of this R&D project, different topologies of solar powered smart DC nanogrids have been developed and piloted in rural Bangladesh. The project owes its innovative character due to the following achievements:

- ✓ A comparative assessment has been performed of three different topologies, namely

a) Central storage and generation couple with smart supply and demand response system

b) Central storage and generation in interconnected nanogrids

c) Decentralized storage and generation in peer-to-peer bottom-up nanogrids.

- ✓ A new Pay-As-You-Go and (PAYG) and Cash-In-As-You-Go (CAYG) technology has been successfully tested within the nanogrids
- ✓ Higher power DC appliances like water pumps and rice hullers have been successfully incorporated into SHS-based low voltage nanogrids

For detailed project report, click here.

Addressing the energy consumption issues of electrically assisted rickshaw

R&D institute

Control and Applications Research Centre (CARC), BRAC University, Dhaka

BRAC University was awarded a contract to conduct a one year long pilot project to provide a complete off-grid solution for power conversion for electric rickshaw-vans with PV panel and torque sensor paddle. The project completed in time and final report was submitted to IDCOL

Objective:

To evaluate:

- ✓ Feasibility and applicability of the developed technology
- ✓ Performance of the designed systems
- ✓ Impact on the national grid

Outcome:

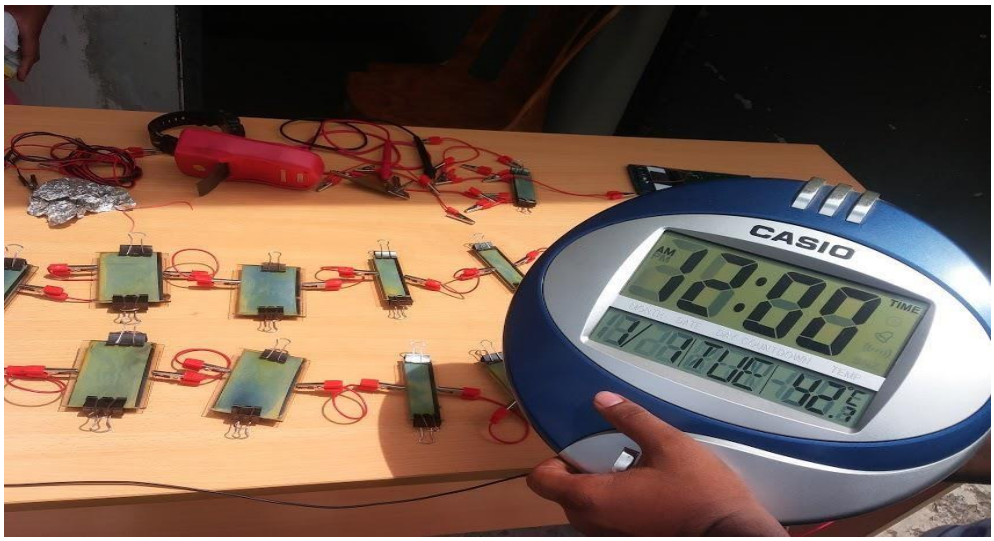
- ✓ 15 Units of solar powered vehicles are developed under the R&D Project. The vehicles are field tested and their performances are analyzed.
- ✓ Socio-economic analysis is done extensively to understand the future market production of these products in both local and global market.
- ✓ A business model is developed that uses the concept of the already successfully implemented project of solar home system in Bangladesh. Thus, despite having seemingly high cost initially, the payback calculations prove to be of greater advantage for the rural people

Click here for detailed project report.

Fabrication and Characterization of Dye Sensitized Solar Cell (DSSC) Using Natural Dye and its Impact in Bangladesh

R&D institute

Institute of Polymer & Radiation Technology, Atomic Energy Research Establishment, Bangladesh Atomic Energy Commission



IDCOL awarded a contract to Atomic Energy Research Establishment, Bangladesh Atomic Energy Commission to produce solar panel using local technology and resources

Objective

The project was meant to produce solar panel using local technology and resources by:

- ✓ Preparing natural dye absorbed TiO_2 coating based solar cell and characterizing the films to test the compatibility to use as solar cell.
- ✓ Identifying locally available natural dyes to increase the photoelectric performance.
- ✓ Exploring suitable solvent for extracting dye and purification of these days
- ✓ Separating the dyes and compare the cell performance with crude extract.
- ✓ Optimizing the thickness and annealing temperature of electrode for the best photoelectric performance.
- ✓ Find out suitable low cost carbon catalyst for counter electrode.
- ✓ Incorporation of other conductive nanoparticles e.g. carbon nanotube to maximize the cell efficiency

Outcome

- ✓ The energy conversion efficiency of the fabricated cell was analyzed by varying different parameters. The TiO_2 coating thickness and annealing temperature was also optimized.
- ✓ Best thickness and temperature were found 12-17 μm and 450°C respectively.

- ✓ Promising impact of gamma radiation for semiconductor band gap engineering was magnificently optimized
- ✓ As natural sensitizers viz. red amaranth, carrot, pomegranates, turmeric, beet root,
- ✓ To synthesize and characterize multiferroic nanoparticles to enhance their photocatalytic activity.
- ✓ To produce hydrogen by photocatalytic water melon, mango seed kernel, berry seed, etc. were tested
- ✓ In the present condition 25cm^2 prepared cell sample has equal energy conversion ability of 1.5V dry cell

For detailed project report, click here.

Solar Hydrogen Production via Water Splitting Using Locally Synthesized Nanoparticles as a Photocatalyst

R&D institute: Department of Physics, Bangladesh University of Engineering and Technology (BUET)

IDCOL awarded a contract to Bangladesh University of Engineering and Technology to conduct a research and development project on Hydrogen fuel production from water by solar irradiation

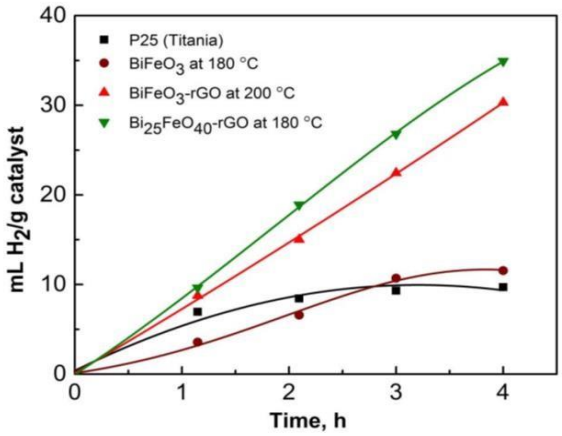


Figure: Volume versus time graph showing the volume of hydrogen evolved during the photocatalytic splitting water.

Objective

The main objectives of this research project were as follows:

Decomposition of water under ultraviolet–visible light irradiation using the synthesized nanoparticles as photocatalysts. The product hydrogen will be a good alternate fuel and can be used for power generation.

Outcome

- ✓ The rare earth element Gd was doped for improving the property of BFO but in hydrothermal process BFO itself shows improved property and after doping Gd the property of BFO were actually deteriorated at reaction temperature 160 °C.
- ✓ In the case of nanocomposite materials, both sillenite and perovskite phase bismuth ferrite reduced graphene oxide nanocomposites were successfully formed using a low cost hydrothermal process at reaction temperatures of 180°C and 200°C respectively. Such a phase transition can be useful for the formation of nanocomposites of graphene with either perovskite or sillenite phase of bismuth ferrites as desired.
- ✓ The obtained results bear significance since it provides a means of selective phase

formation of bismuth ferrites while forming composites with rGO by simply tweaking the temperature by 20°C. The magnetic properties of the synthesized nanocomposites were notably increased compared to that of pure BiFeO3.

- ✓ The lower bandgap of the composite would be able to generate higher number of e--h+ pairs and might be useful in photocatalytic experiments.
- ✓ The improved photodegradation activity toward Rhodamine B is attributed to the structural characteristics of sillenite type Bi25FeO40 and the great charge mobility of rGO, which retard the recombination of photoexcited pairs.
- ✓ The synthesized nanocomposites are particularly useful for solar hydrogen production via water splitting. In case of pure $BiFeO_3$, doping of expensive rareearth elements like Gd is required for improved properties. However, the synthesized composites demonstrate enhancements of their properties without addition of such a dopant.

For detailed project report, click here

Research and Development on Biogas Production Efficiency in Domestic Biogas Digesters suitable for Bangladesh

R&D Institute: Bureau of Socioeconomic Research and Training, Bangladesh Agricultural University

Bangladesh Agricultural University was awarded a contract to conduct a one year research program to develop and increase efficiency in domestic biogas digesters suitable for the context of Bangladesh

Objective:

- ✓ Fully characterize and quantify the constituents of the typical feedstock composition used in DBDs;
- ✓ Investigate possible augmentation of usual DBD feedstock with typical available household waste and biomass residues;
- ✓ Investigate the potential of individual parameters and combinations of these parameter which impact biogas production in DBDs to enhance more efficient conversion of feedstock to biogas; and
- ✓ Investigate the relationships between design and operating parameters and the performance of the biological and physical/chemical processes involved.

Outcome:

- ✓ Microbial community isolation and identification was done and biogas production efficiency of the isolated anaerobic bacteria from cow manure was analyzed
- ✓ Composition of different feedstock used in DBD including hybrid cow manure, local cow manure, poultry manure, 5%, 10%, 15% and 25% organic waste was evaluated

- ✓ Biogas production efficiency from mixing 5%,10%,15%, 25% organic waste with cow manure and poultry was investigated
- ✓ Performance of biogas production was evaluated for changing the feeding interval of the biogas plant by testing daily feeding vs 4th day interval and 7th day interval
- ✓ Two models of low cost bio gas reactor from locally available materials have been developed and their performance was tested
- ✓ Two new designs of Biogas Digestor based on understanding gained on biogas production process in the program have been developed and a comprehensive evaluation will be done in future

For detailed report, click here.

Development of Solar PV- Diesel Hybrid Mini Cold Storage for Rural Off-grid Areas of Bangladesh

R&D Institute: Dept. of Electrical and Electronic Engineering United International University

IDCOL awarded a grant to dept. of EEE, United International University to build a prototype of solar pv-diesel hybrid mini cold storage to be used in rural off-grid areas if Bangladesh

Objective:

- ✓ Develop a solar pv-diesel hybrid cold storage considering minimum diesel use and maximize use of solar energy
- ✓ Design the electrical and mechanical system of the cold storage
- ✓ Measure harvested solar energy in kWh
- ✓ Measure the required cooling load of the storage
- ✓ Inspect the condition of the stored fruits and vegetables and test various parameters to measure the freshness of the stored products

Outcome:

- ✓ A prototype cold storage has been developed.
- ✓ Temperature is measured at different points of the storage and found same (like 5°C).

Fig: Solar PV- Diesel Hybrid Mini Cold Storage on the rooftop of UIU University

- ✓ Cooling load calculation has been done
- ✓ 300 kg of vegetables stored for 19 days and found satisfactory and informative result.
- ✓ Carbon di oxide (CO2) has been measured (approx. 2140 ppm), which is generated from the respiratory of the vegetables.
- ✓ Maximum and minimum cost of storing in the cold storage is found to be BDT 0.85 and 0.25 per kg in a week respectively for the prototype model

- ✓ Cost benefit analysis has been done considering three different revenue model.

Overall the performance is satisfactory and seems to be a good solution for short term storing in rural off grid areas.

For detailed project report click here.

Development of Solar PV-based Water Transportation System for Bangladesh, a Solar PV-based Boat

R&D Institute: Dept. of Electrical and Electronic Engineering United International University

IDCOL granted an award to dept. of EEE, UIU to develop a solar PV based water transportation system to be used in the context of Bangladesh.

Objective:

- ✓ Build a prototype solar powered boat
- ✓ Determination of power requirement, selection of motor's specification, power requirement for motor and selection of solar panel has to be done considering practical ship design theory

Fig: Photograph of Solar boat near Patuakhali launch terminal

Outcome:

- ✓ Five solar powered wooden boats were developed
- ✓ 1 kW solar panel, 48 V 200 A-h battery packs and Brushless Shunt DC motor were used to develop the boat
- ✓ The boat's performance was evaluated in both still water and river water condition
- ✓ Cost benefit analysis shows the investment return time is around two years in this project

These ferry boats will be useful in the rivers where river current is not high like the estuary or the mouth of the river. Overall they can save lots of diesel fuel consumption and as a result reduce CO_2 emission.

For detailed project report click here.

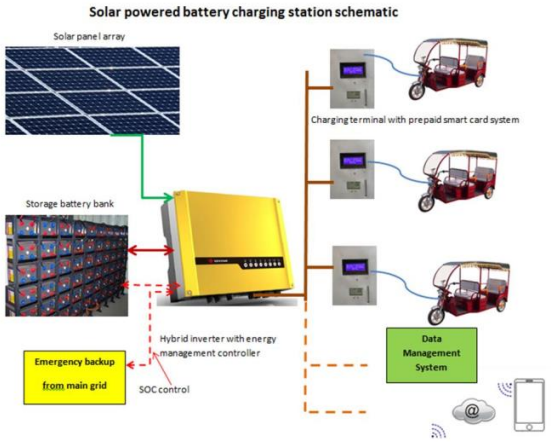
SOLAR POWERED BATTERY CHARGING STATION

R&D Institute: Solar-E-Technology

IDCOL awarded a grant to Solar-E-Technology to build a demo project at Chuadanga and conduct a comprehensive R & D exercise on a solar powered battery charging station

Objective:

- ✓ Develop a solar powered battery charging station for easy bikes
- ✓ Incorporate prepaid metering terminal
- ✓ Interfacing a bi directional/net metering system with utility supply (main) for the purpose of solar energy storage bank



Outcome:

- ✓ A prototype solar charging station was developed
- ✓ Energy produced by the PV system directly charges the vehicle during day time and excess energy is used to recharge the storage battery for night time use.
- ✓ State of the art charging technology: intelligent negative pulse current charger was incorporated which is 22% energy efficient and also doubles the life of the battery
- ✓ Smart card billing system and remote data management system were incorporated
- ✓ Cost benefit was conducted considering a commercial project of 400kWp and estimated payback period is 4.4 years based on 50% grant, 35% soft loan and 15% sponsor equity

The performance is satisfactory and seems to be a promising alternative and environmentally sustainable solution to meet up the on-going energy crises and to support the existing battery operated vehicles.

Click here for project report.

SOLAR HYBRID Cold storage

R&D Institute: Solar-E-Technology

With the financial assistance of World bank and IDCOL , Solar E Technology developed a demo solar hybrid cold storage project at Chuadanga and conducted a comprehensive R & D exercise.

Fig: Solar Hybrid Cold Storage R&D site at Chuadanga

Objective:

- ✓ Develop a pilot R&D cold storage
- ✓ Conduct a comprehensive R & D exercise on cool room temperature & humidity control performance
- ✓ Assessment of shelf life of different vegetables, fruits and flowers
- ✓ Assessment of freshness quality of produce after removing from storage

Outcome:

- ✓ A pilot cold storage project at Chuadanga was developed
- ✓ Solar with Hybrid PV inverter was the main source of energy, along with battery bank, diesel generator and grid electricity was provided as backup source
- ✓ Ultrasonic humidifier was used via humidity controller which was found to preserve perishable goods longer time
- ✓ Different fruits, vegetables, flowers was stored and shelf life was evaluated
- ✓ Power supply mix found to be 68% solar and 32% alternative source (grid & generator)

Temperature and humidity control performance, shelf life and freshness of different products was found to be excellent. **For detailed project report click here.**