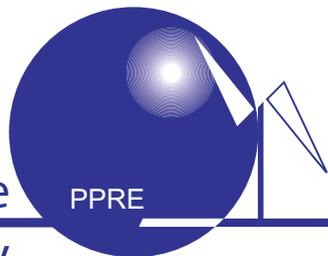


Postgraduate Programme
Renewable Energy



NEWSLETTER

2007 - Vol. 26

Imprint

News from Oldenburg	2
<i>Reunion/Seminars in Oldenburg</i>	2
<i>Alumni visiting Oldenburg</i>	5
<i>Case Study 2007</i>	8
<i>MSc - thesis projects</i>	12
<i>Experiences (Internships / Thesis)</i>	14
News from Alumni	19
<i>Careers</i>	19
<i>News from PPRE-Alumni in brief</i>	23
<i>News from EUREC-Alumni in brief</i>	50
Reports from Alumni	55
<i>A Heat Charged Electrochemical</i>	55
<i>Clean development mechanism (CDM)</i>	56
<i>Photovoltaic Applications in Sudan</i>	56
<i>Improved cook stoves & PPRE Alumni...</i>	59
<i>The Tech Museum Awards</i>	60
<i>Energy Efficiency in Ecuador</i>	62
<i>Banking on Oil Project in Kenya</i>	63
<i>How many tonnes of CO2</i>	64
<i>Potentials and Prospects of CIGS Thin Film Solar Cell</i>	65
Websites of interest	70
List of former participants	71
List of staff and usefull links	77

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Editorial

Dear alumni / reader,

On our annual excursion to Wind Energy Facilities in the North-West of Germany for the new MSc-students we again visited the old miller, Mr. Steenblock, in Mid October. He is still grinding corn with his 120-year-old windmill and most of our alumni will remember him. Actually, Mr. Steenblock was celebrating his 'Golden Wedding Day' - 50 years of marriage - the week before we met him. PPRE has still a few years ahead before that -- but with about 30 years of RE research and about 20 years of Postgraduate Education in RE we are moving steadily towards that goal.

Meanwhile our alumni network is growing rapidly comprising of 340 MSc-graduates (302 PPRE and 37 EUREC) from more than 70 countries. Over 80% of the alumni (some after more than 16 years!) write to us – as this newsletter shows with contributions from more than 130 alumni.

RE research activities at University of Oldenburg will expand, due to the local utility company's investment of 50 million Euro in the next 10 years. Construction of a new building, which will house the new EWE institute with facilities for 50 researches started already on the Wechloy Campus.

Worldwide RE related industries are creating hundreds of thousands of new jobs for high-qualified specialists and it looks like the currently sharpening discussions about global warming and climate change in combination with the rising oil price are creating a kind of RE boom.

Within a rapidly changing, globalised world it is an advantage to have both feet on the ground – like the old miller, who is using wind energy for decades. But instead of grinding corn, PPRE alumni in their world-wide RE network are well prepared to meet the challenges ahead.

Sunny Greetings from Oldenburg

Edu Knagge



30 years of RE research in Oldenburg – Reunion in Oldenburg

by Hansjörg Gabler, Stuttgart, 11.10.2007

September 2007, a sunny Friday and a sunny Saturday in Oldenburg, Germany, the temperatures are moderate, winds blow with 3 to 4 m/s.



60 people meet at the Vortragssaal der Bibliothek in Uhlhornsweg. They all are former students, scientists or teachers in the Physics Department of the University; they all belonged to the groups 'Physik Regenerativer Energiequellen (PRE)', 'Fahrradforschung' or 'Wissenschaftsgeschichte'. Falk Riess (still in Oldenburg) and Hansjörg Gabler (now at the 'Zentrum für Sonnenenergie- und Wasserstoff- Forschung (ZSW)' in Stuttgart) organised a first meeting of the alumni of alternative energy research and education in Oldenburg.

The University of Oldenburg has written history of Renewable Energy Research with its early start in 1980; with its broad field of topics which covered the modelling of components (PV modules, batteries, wind turbines etc.) and of energy supply systems, the monitoring and measuring of components and of realised systems; with its focus on 'Energy Meteorology'; with its work on Solar Process Heat and on Hydrogen as energy storage medium. And the University of Oldenburg has written history of University

education with its early efforts to establish a course on renewable energy topics, given in the English language and focused on students from developing countries.

Students and former staff from PRE (the same may be said of the 'Fahrradforscher' and the 'Wissenschaftshistoriker') are today spread all over Germany, some have founded their own companies successfully oper-

ating in wind energy and energy consulting. Some work in responsible positions in the booming renewable energy industry. Some are in administrative positions, and more are researching and teaching in universities, in universities of applied science and in independent energy research institutes.

The meeting was opened by the president of the university, Uwe Schneidewind and it followed a seminar program with presentations from Hansjörg Gabler, Falk Riess, Reinhard Schulz (Oldenburg), Detlev Heinemann, Igor Waldl, Joachim Luther and Otto Ulrich (Berlin) on the questions: 'where do we come from?', 'where are we now?' and 'where do we go?'. The day ended with a long party at the Energielabor in Wechloy. On Saturday the discussions were continued in cold and beautiful weather on a bus ride to wind parks in the Wesermarsch, during a long walk along the sea front of Bremerhaven and during a visit to the largest wind tunnel for wind turbines in Germany, constructed and operated by Gerd Gerdes, former diploma- and PhD student of PRE.

Yes, we learned from each other. But more important, friendships were renewed, old discussions and fights were continued, networks were strengthened and people met who had the same goal. These are the goals to help renewable energies to continue their

progress to gain larger and larger shares of the energy supply of our world, to contribute to progress for societies and to relieve the burden which our societies lay on the environment.

International Photovoltaics Summer School 2006 at Oldenburg University

Prepared by the Postgraduate Programme Renewable Energy (PPRE) and sponsored by the German Academic Exchange Service (DAAD) the International Alumni Summer School 2006 on Photovoltaics took place at Carl von Ossietzky University of Oldenburg from August 28 to September 2, 2006.

Nearly 70 participants from 28 countries worldwide joined the six days of summer school at the Wechloy campus of Oldenburg University.

Following a good tradition, the Summer School 2006 on Photovoltaics in Oldenburg marked the first part of a two-weeks Alumni Re-Invitation Initiative encouraged by DAAD. The first week in Oldenburg was timed as the 'warming-up' for successive participation in the 21st European (and world's largest) Photovoltaic Solar Energy Conference and Exhibition 2006, which took place in Dresden, Germany, from September 4-8, 2006¹ and the 'Freiberger Solartage' (Sept. 8-9, 2006) at the Technical University of Freiberg (Saxony).

First of all, the invitation addressed former and current DAAD scholars in the renewable energy field with specialisations in photovoltaics. Many of them, further related professionals and friends of the programme, took the opportunity to meet again in Oldenburg, to update their knowledge in PV and not least to refresh old connections and friendship and to share experiences.



Participants of Oldenburg PV Alumni Summer School 2006

In line with the competencies of the Postgraduate Programme Renewable Energy the Photovoltaics Summer School in Oldenburg focussed on the following topics:

¹ The programme of the 21st EU Conference on Photovoltaics 2006 in Dresden is still available at <http://www.photovoltaic-conference.com/71.0.html>

- Material Science Research oriented toward photovoltaics: heterogeneous thin film solar cells, organic solar cells
- Systems research oriented towards photovoltaics applications: energy meteorology, system optimised operating characteristics, grid connected and standalone PV systems
- Back-up systems: hydrogen and fuel cells
- Policy oriented case studies and lessons learned from several countries (e.g. rural electrification strategies, barriers of PV market penetrations.

Further parts of the programme were two days of very interesting excursions. The first one led us to the Institute of Solar Energy Research (ISFH), which is located in Hameln (near Hannover). The second venue was the

well known solar cell production company Q-Cells which is based in Thalheim (near Leipzig) as part of a fast growing industrial area especially hosting photovoltaic systems component manufacturers.

Contributions were presented by re-invited PPRE Alumni, staff of Oldenburg University and professionals and scientists from cooperating R&D institutions. The detailed programme is available as downloadable pdf file at the PPRE website at URL http://www.uni-oldenburg.de/ppre/download/Alumni/alumni_prog_2006.pdf

Detailed insights in most of the contributions are provided by the "Proceedings of the Summer School 2006 on Photovoltaics", edited by Michael Golba and Walter Neddermann. Please contact Edu Knagge at PPRE's office to get a copy.

Some farewells of graduates leaving Oldenburg

Hi Fellows,

As the saying goes " the sun rises for everyone. But some take advantage of it better than others", I salute you all for taking advantage of PPRE and EUREC than any other person to have come this far. May you become the focal point in Renewable Energy in your respective fields of endeavour and shine so brightly that our world may live.

Seth Mahu; Ghana (PPRE 2005/07)

Dear Colleagues,

I take this opportunity to say goodbye on my way back to the motherland-Uganda (Home-Sweet-Home) scheduled for 10th February.

I say that this was a unique moment, the first of its kind, and the last of this kind to have you guys, share with you lots of fun and experiences. Probably the next time we meet, we have added a few hours, days months, years..... to our age. ... and that will be another unique moment again in our lives.

I thank you for being such good friends, and where we had differences, I think cementing them and bridging that gap is what we have accomplished to date.

I welcome you all to the Masters' Club (courtesy of Camilo) and hope that this is the beginning of the whole new world and would like to wish you success and all the best in all you do.

Remember, "Brows may wrinkle, Hair grow grey, but friendship never knows decay". God bless you always
Tchüssss!!

Wycliff Jagwe, Uganda (PPRE 2005/07)

International symposium “Decentralised Energy Systems – Integrating Renewable Energy Technologies in Tomorrow’s Energy Supply”

The symposium, which took place February 15-16, 2007 at University of Oldenburg addressed current state-of-the-art renewable energy technologies and their contributions to a future energy supply system. The energy sector is one of the most vital domains for both global and regional development. Climate change, security of supply and sustainable development are fundamental challenges to be met in the coming decades. Renewable energies have increased their contribution to most countries’ energy mixes with breathtaking speed. This technological development comes along with structural change in most electricity markets due to liberalisation and unbundling efforts. As a result, decentralised solutions increasingly become an integral part of a so far predominantly centralised energy sector. The symposium aimed to bring together scientists and engineers with stakeholders from politics and industry on a European level to promote a successful mutual exchange on the European perspective of decentralised energy systems. The speakers were internationally renowned and leading experts in their fields.

Central topics of the symposium were:

- A. Photovoltaics
- B. Wind Power
- C. Bioenergy and Renewable Primary Products
- D. Storage and Balancing Technologies
- E. Management of Decentralised Energy Systems
- F. Grid Integration

The symposium was organised by ForWind, the Center for Wind Energy Research (www.forwind.de), in cooperation with the Assembly of European Regions (AER, www.a-e-r.org).

Altogether about 120 participants from 17 different countries attended this conference to see various presentations from prominent speakers of different European Institutions working in the field of renewables.

For details of the conference (programme, speakers –list, photo-gallery, etc.) please check:

<http://www.forwind.de/des/>

Alumni visiting Oldenburg in the last year

Seminars/lectures in PPRE/EUREC

Michael Sterner, Germany (PPRE 2005/07), who is doing his PhD-studies with ISET Kassel, Germany, presented the essence of his previous Master thesis in PPRE titled ‘Bio-

mass-to-Liquid Processes, Ecological and Economic Evaluation’ in summerterm of 2007.

George Pechlivanoglou from Greece (PPRE 05/07), who joined the Development and Innovations Dept. of Suzlon wind manufacturer in Berlin after his studies with us, offered a seminar about ‘Wind Energy Tech-

nology, Troubleshooting and Innovations' in June, 2007.

Topics covered were:

- 1) Brief description of the most common wind turbine designs;
- 2) Brief description of some not so common turbine designs;
- 3) Major problems and challenges for wind energy
 - a) Energy storage (Problems – Solutions)
 - b) Electronics & Control Systems (Problems – Solutions – Different approaches)
 - c) Pitch Systems (Problems – Solutions – Different approaches)
 - d) Yaw Systems (Problems – Solutions – Different approaches)
 - e) Monitoring & Maintenance (Problems – Solutions)
 - f) Blade Manufacturing
- 4) Blade damages & Blade Inspection
 - a) Automated robotic platform for IR blade inspection

Ms. Herena Torio Blanco from Spain (PPRE 05/07), presented a PhD student at the Fraunhofer Institut for Building Physics in Kassel, offered a seminar not only to present to PPRE and EUREC-students in December 2006, but also to other civil engineering & architecture students from the Polytechnic in Oldenburg.

Her lecture was titled:

“Moving toward a more sustainable built environment - Use of renewables and passive-housing”

Topics covered:

- 1) Introduction not only to passive-houses but also to possibilities of implementing renewables into them,
- 2) comparison of them with other technologies, their development,
- 3) the normative framework and philosophy that is beyond them.

Actually, it was a rather global look to the built environment (in Germany) and to the implementation of RE on it, with a special focus on passive measures.

Mr. Laurent Lecesve from France (EUREC 2004/05), offered a Seminar on 1st Dec. 2006 Seminar about “Management of Rural Electrification Projects with Renewable Energy Sources”

Topics covered:

- Basis on “Impacts of electrification
- Actual case studies:
 - ITEC program in Togo (Solar lanterns)
 - Jamaican SHS village
 - Togolese Solar Village
 - Hybrid systems in Ghana (PV-Wind and PV-Biogas) with a video
 - Peruvian hybrid system (PV-Diesel)
 - Feasibility study for a RE system connected to the grid in India
- New rural electrification project in Togo with a hydro-PV-biofuel hybrid system
 - Context and description of the whole project with a video
 - Proposed participative approach and methodology applied to this example
 - Possibility of practical training and/or case study (PPRE)

PV Aravind, India (PPRE 2000/01), who is still doing his PhD-studies at section of Thermal Power Engineering, Faculty of Design, Engineering and Production, Delft University of Technology, Netherlands, was invited to PPRE, University of Oldenburg in early July 2007 for providing a Gasification-Seminar to PPRE-students.

Dr. Gajanana Hegde, India (PPRE 1996/97), who joined as Program Officer of the Climate Change Secretariat (UNFCCC) in Bonn, Germany last year, gave a seminar about 'Update on Kyoto Flexibility Mechanisms (focus on CDM projects)' in November 2007.

Jan Lam, the Netherlands (PPRE), together with Felix ter Heegde he was invited to give a three day 'Domestic biogas compact course' titled 'Technology and mass dissemination; experiences from Asia' in early February, 2007. the fourth day of this seminar was reserved for European technology and global perspectives of biogas, including an excursion to local biogas plants.

Indradip Mitra, India (PPREW 2003/04), who is doing his PhD-studies at University of Kassel, Germany, offered a seminar in late Summerterm last year providing an introduction into LEAP-Software, which is an energy system planning programme.

Stelio Correia from Portugal (EUREC 2004/05), who joined Ersol PV manufacturer in Germany after his RE Master with us provided a seminar about quality control in PV cell production to RE-Master students at Oldenburg University in January, 2007.

Visits to PPRE

M.P. Ramesh, India (PPRE 1989/90), executive director centre for wind energy technology, visited Germany in the end of June last year and spent one afternoon with PPRE-staff at Energielabor at Oldenburg University to talk about the good old times but also to exchange more updated ideas.



Fellow Students from PPRE 1989/90 meet up in Oldenburg: M.P. Ramesh & Hans Holtorf (formerly know as Bloos)

Chayun Budiono, Indonesia (PPRE 92/93) visited University of Oldenburg on a business trip to Germany end of June 2007 as well to discuss possible co-operations in near future.

Fernando Vega., Honduras (PPRE 02/03), presently on staff at University in Arkansas, US, visited PPRE late July 2007 with a colleague. Besides visiting local biogas-plant and facilities, they were very much interested in the laboratory set up and equipment in our PPRE-labs, because they are thinking of implementing similar courses at their university in the US.

Mohamed Ali Hamid from Sudan (PPRE 92/93) re-joined the university of Oldenburg again in Spring 2007 for a couple of months as guest-researcher under the re-invitation program from DAAD.

(please see also his article on page 57)



M'med Ali simulating PV-System with INSEL-programme

16.000 SHS for Rural Electrification in Pakistan

Dr. Ekkehart Naumann, Germany (former Head of PPRE)

is working since last year as Integrated CIM-Expert at the Alternative Energy Development Board (AEDB) in Pakistan.

The AEDB is set to electrify 400 villages — 300 in Balochistan and 100 in Sindh — by the end of the current year in the first phase of the Roshan Pakistan Programme through alternative/renewable energy technologies.

Overall, some 16.000 Solar Home Systems will be installed in the Thar-Desert in South-East Pakistan near the Indian Border. Further info at: www.aedb.org

Case Study 2007 - Priceless Experience.

by Marcelo Theo, Brasil

Time is the best remedy of life. Time tells and also heals. Time is a good friend to augment sweet memories as well to wash sour ones away. Benefiting from this precious time gap between the conclusion of Case Study 2007 and the present moment, my metaphorical pen gently slides on the white background of my computer screen in order to give you an impression of an adventurous and exciting trip which took place somewhere in the Germanic part of

Europe in a gone June 2007.

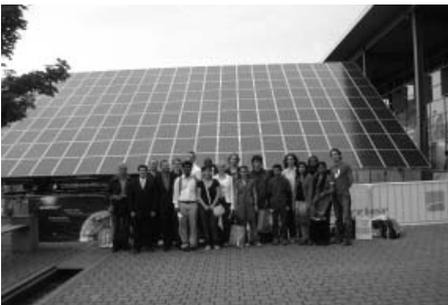
Case Study 2007 was basically an attempt to sew together the knowledge acquired throughout the course in a interdisciplinary team work project, consisted in a preparatory part, an excursion and a written report and presentation.

The preparatory part consisted of numerous seminars, segmented into various themes, as a guide for the groups to handle different aspects of the global project: project management, heat and electricity demand, biomass, solar radiation data, gasification, biomass to liquid and software simula-

tions. Meanwhile, the groups had meetings with the customer and internally, and the project was little by little being molded and brought to life. After the trip, which I am about to describe, a presentation was done and the hardest of all: a long and detailed report was produced by the groups, despite communication problems and time constraints.

The trip itself was outstanding a unique opportunity permanently stamped on each participant's reminiscences, a moment to make good friends and to bind the class together. It lasted "roughly" 10 days.

Before sunrise we were carefully conducted to sunny Freiburg, where we spent a few days between arrangements and leisure. The hostel was somewhat cozy with a well equipped kitchen, where we prepared our breakfast and a very well organized supper. Nights were still warm and the local beer, Gunter, tasty. During our stay in the "Free city", we joined Intersolar, the biggest Solar Energy Fair in Europe and visited Volk Wasserkraft AG in Gutach. Intersolar was absolutely huge - too big for some - and Volk Wasserkraft an interesting high-technology-medium-sized hydro-power turbines manufacturer.



PPRE-group at Intersolar 2007 Solar Energy Tradefair in Freiburg

A few hours drive through the Black Forest (Schwarz Wald) prepared our spirits to visit the Bioenergiedorf in Mauenheim. This interesting ecovillage was established around a biogas power plant built by one of the 400 village dwellers. This farmer provided one company, free of charge, the excess heat produced in his plant so that most of the village buildings could be supplied with heat. By doing so, he was able to sell his electricity for a better price and benefited from a two-cent bonus offered for those new biogas facilities (which efficiently used the surplus heat generated by the biogas engines). The company also installed a wood chip boiler, in order to provide a high quality and reliable heat supply for its customers, the village inhabitants.

The next stop was in the Solarsiedlung Engen, where a concept of energy efficiency is being tested in new home designs. The passive solarhouse in Solarsiedlung Engen is intended to severely reduce the energy consumption of new buildings by mixing architectural ideas, good insulation and renewable energy supply.

Friedrichshafen was the location for relaxing and spending a very warm night before crossing the border to Austria. This city is located at the Bodensee, a huge water mass (with elevated heat capacity) which happens to separate three Germanic nations: Germany, Austria and Switzerland. On that night, almost as if to celebrate the birthday of one of our fellow companions, Enzzo de Cuba, this coastal town was host to the most surreal manifestation of the journey: the "Leather Party" (those who witnessed can tell).

The wobbly bus snaked up the mountains as the cold air started to enter our nostrils.



PPRE 2006 -08 Group is in front of the entrance of Studlhutte at 2801 metres altitude

In Lucknerhaus the comfort of the four-wheeled vehicle was replaced by two-legged man power, and we strove a few hours up the Alps. Men and woman, only winners made to the top and enjoyed the beautiful days closer to the sky, at the 3000m of altitude of Stüdl Hütte.

At this physical and emotional apex of the trip, we shared confidences and learned more about each other, made friends, got closer to glaciers, hiked mountains, felt the wind on the face, laughed, did not take showers and learned that water and energy at this altitude is, indeed, as valuable as gold. Apart from the personal benefits, we also got to know the hybrid system which powers up Stüdl Hütte and shared some of our own experiences with each other.

On the way down, we visited the small Hydro Power Plant of Lucknerhaus and learned a little bit more about this kind of system. At the end of the day, we were white helmets while, inspecting a construction site in Unterhaching, a town close to Munich, where an interesting geothermal power plant project is being conducted by a soft spoken

but strong woman, who definitely gave inspiration to many in the group.

It was a pity that after a pleasurable night in its outskirts, we left on the following morning without really knowing the third biggest city in Germany. We headed directly to Leipzig for a free day in the birth place of Johann Sebastian Bach. The night was delighted by many, above all by the "Man of the Night". The Stasi museum in the following morning gave us an impressive insight of the German communist story. Before

heading to Kassel, we had an appointment at Q-cells, a very young company which has rapidly grown into one of today's world market leaders in pv-cells manufacturing.

Our last stop was Kassel, where we spent a warm night and enjoyed our last supper. The following day we had a very well-guided tour through SMA, manufacturer of inverters and controllers for renewable energy applications and to ISET, a research institute on renewables related to the University of Kassel.

The bus brought us back to the Wechloy parking lot late at night and we slowly waved goodbye. Many days had passed and a lot of experiences were lived during this intense moment of our lives. Nothing but one thought still lingers in my mind:

It was a priceless experience.

The sheperd and the yuppie

A shepherd was herding his flock in a remote pasture when suddenly a brand-new BMW drives up in a cloud of dust. The driver, a young man in an Armani suit, Gucci shoes, Ray Ban sunglasses and YSL tie, leans out the window and asks the shepherd: "If I tell you exactly how many sheep you have in your flock, will you give me one?"

The shepherd looks at the man, obviously a yuppie, then looks at his peacefully grazing flock and calmly answers: "Sure. Why not?"

The yuppie parks his car, whips out his Dell notebook computer, connects it to his AT&T cell phone, surfs to a NASA page on the internet, where he calls up a GPS satellite navigation system to get an exact fix on his location which he then feeds to another NASA satellite that scans the area in an ultra high resolution photo. The young man then opens the digital photo in Adobe Photoshop and exports it to an image processing facility in Hamburg, Germany. Within seconds, he receives an email on his Palm Pilot that the image has been processed and the data stored. He then accesses a MS-SQL database through an ODBC connected Excel spreadsheet with hundreds of complex formulas. He uploads all of this data via an email on his Blackberry and, after a few minutes, receives a response. Finally, he prints out a full color, 150-page report on his hi-tech, miniaturized HP LaserJet printer and finally turns to the shepherd and says: "You have exactly 1586 sheep."

That's right. Well, I guess you can take one of my sheep." says the shepherd.

He watches the young man select one of the animals and looks on amused as the young man stuffs it into the trunk of his car.

Then the shepherd says to the young man: "Hey, if I can tell you exactly what your business is, will you give me back my sheep?"

The young man thinks about it for a second and then says: "Okay, why not?"

"You're a consultant." says the shepherd.

"Wow! That's correct," says the yuppie, "but how did you guess that?"

"No guessing required", answered the shepherd. "You showed up here even though nobody called you; you want to get paid for an answer I already knew to a question I never asked; and you don't know crap about my business ... Now give me back my dog."

Sent by A. Peel (PPRE 2005/07)

MSc-Thesis Projects – PPRE 2005/07

Name, First Name	Institution	Thesis Title
Caag, Donnalyn Atienza	Fa. Atz, Amberg	Evaluation and Further Development of a Small-Scale Combustion Unit for Burning Grains and Straw Pellets
Jagwe, Wyclif	NORPLAN Uganda Limited, Uganda	Implementation of Rural Solar Photovoltaic Water Pumping Schemes in Uganda
Pechlivanoglou, Georgios	Suzlon / IDASWIND Ingenieurgesellschaft GmbH, Berlin	Robotic System for Wind Turbine Blade Inspection
Randig, Sebastian Johannes	TUV SUD Industrie Service GmbH, Carbon Management Service, München	Implementing the Kyoto Flexibility Mechanisms in the Caribbean Basin
Wilches Tamayo, Camilo Andrés	AREVA Energietechnik GmbH, Bremen	Analysis of the Pre-Drying in a Wood-Fired Biomass Power Plant
Sterner, Michael	University of Leipzig, Prof. Kaltschmidt	Technical Analysis and Assessment of Biomass-to-Liquid Technologies
Peel, Andrew W.	Passivhaus Institute, Darmstadt	Solar Gains in a Passive House – A Monthly Approach to Calculating Global Irradiation Entering a Shaded Window
Rojas, Carlos Mauricio	Planet GbR, Oldenburg / University of Oldenburg	Modelling of a Hydrogen Metal Hydride Storage with INSEL
Herraez Hernandez, Ivan	NORDEX GmbH, Hamburg	Structural Dynamic Analysis of the Generator Coupling System of Multi-Megawatt Wind Turbine
Torio, Herena	Fraunhofer-Institute for Building Physics, Kassel	Comparison of Ventilation and Solar Thermal Systems for Residential Buildings on the Basis of their Energy and Exergy Flows – Optimization and Perspectives
Wickramaratne, Widana Gamage Hashini Kanchana	University of Oldenburg, Energy Meteorology Dept.	Evaluation of Forecast of Power Production with Distributed PV-Systems
Khan, Ahmed Jahir	Inst. f Solar Energy Res. – ISFH - Hameln/Emmerthal	Development of the Input-Output Procedure for the Quality Assurance of Unglazed Swimming Pool Collectors
Castello Branco Paula Chaves, Patricia	University of Oldenburg, Inst. of Economics	The Clean Development Mechanism and the Promotion of Renewable Energy in Brazil
Beyn, Mulugeta W.	Lahmeyer Int., Bad Vibel	A New Approach for Wind Energy Development in Developing Countries of the Red Sea Region
Mahu, Seth Agbeve	GPCO, Canada	Wind Energy Assessment and Market Opportunities in Ghana
Hegel Pellecer, Rodolfo	Lahmeyer Int., Bad Vibel	Analysis of Crops and Technologies for Bio-Ethanol Production

Boruah, Dwipen	Inst. for Solar Energy – ISE – Freiburg	Solar Adsorption Cooling— Experimental Characterisation and Dynamic Modelling of Heat & Mass Transfer of ‘Water-Zeolite’ Adsorption Process
Sanchez Herrera, Diego Alejandro	Meteocontrol, Augsburg	Use of SOLIS Satellite-based Solar Spectral Irradiance for Characterization of Thin Film Photovoltaic Modules
Maharjan, Bhai Raja	Lahmeyer Int., Bad Vibel	CDM Baseline Assessment for CDM Project Candidates in South Asia

MSc-projects – EUREC-2005/06 - Topics / Institution

Name	First name	Host org.	Project title
ADNAN	Mohammad	University of Oldenburg, PPRE, Germany	Potential of Biofuels in Pakistan
GUILLOT	Bertrand	Solar Age Namibia & DRFN / ASMERADE Togo	Rural Electrification in Namibia & Togo
McCRACKEN	Philippe	Palau Energy Office, Koror, Republic of Palau	Renewable Energy Applications Plan Action
XUEREB	Steven	Trama TecnoAmbiental, Barcelona, Spain	Socio-economic Study about Hybrid Systems and Installations of Autonomous Grids
LOPEZ ALCALA	Leodegario	Technologie Transfer Zentrum (ttz), Bremerhaven, Germany	Anaerobic Digestion of Lignocelluloses Substrates - Theoretical Analysis and Laboratory Experiments
ANTONOPOULOS	Antonios	ETA Florence, Florence, Italy	Proposing a Renewable Energy Plan for the Sustainable Development of a Poor Region in Calabria, Italy
ROUZE	Jerome	University of Southampton, UK	Control of Microgrids
POLIZOIS	Theodoros-Theodoritos	Center of Renewable Energy Sources, Pikermi Attiki	Wake Effects
SADER	Hadi	SYNLIFT Systems GmbH, Berlin	Viable Membrane Processes (Seawater Desalination) as Wind Power Application
MONTES DE OCA ARJONA	Luis	Activos del Conocimiento S. L., Barcelona, Spain	The Biodiesel Production and Its Relation with CO2 Economy
SINGLEHURST	Robert	Queen’s University, Kingston, Canada	Analysis of Natural-Convection Solar Thermal Domestic Hot Water Systems, Commissioning and Testing of a Liquid-Desiccant Cooling System.

Experiences (Internships / Thesis)

1st impressions about PPRE – Program and Praktikum

Marcelo Vasconcellos, Brasil (PPRE 2006/08)

During our PPRE program, the students are requested to accomplish a two-month internship program, better known as practical training, which probably translated from the German word Praktikum. This Praktikum is a mandatory part of the whole Postgraduate Program in Renewable Energies in Carl von Ossietzky Universität Oldenburg.

When I was in Brazil, a couple years ago, even before I was accepted to the program, I contacted some Brazilian PPRE alumni to acquire more information about the future I was about to choose for myself.

Apart from Rejane and Patricia, who gave me valuable help, Everson Possamai was the one who first told me about Wittmund Biogasanlage. I had been working with biogas for some time and I was positive it would be my best choice to dive into the German biogas market. As soon as I received the first email informing that the company existed, I made up my mind. I would work there. Everson nicely advised me not to put my expectations too high as I still hadn't received my final acceptance from the program. Deep within me, I knew I would make it, but not without the normal challenges of the path. Determination is part of the business, but in the same way, detachment is important to deal with unfulfilled expectations. It sounds just like a Brazilian samba which says: "It is not I who sails; it is the ocean who sails me".



Gas Tests at Hygiene Tanks

"The program is not what you expect", said Patricia. "It is somewhat like physicists teaching engineers, it is different". On top of that, biomass is not the main focus of the course. Back then, my ship was raising the sails and hearing the weather forecast is always good to come up with an emergency plan. Within myself, I didn't expect any storm to sink my ship. I would learn whatever I could from other renewable energy sources and the biomass knowledge would need to be heavily complemented by the external environment, to which I intended to introduce myself. Kein Problem, at that time, no problem.

I must admit it was quite a shock to land in the physics department, to spend endless hours discussing tiny little issues or being

asked about the physical principle behind something absolutely clear for engineers (at least in their own dialect). I had prepared myself for the challenge and therefore I grew stronger. But if I could advise newcomer engineers, I would tell them to at least bring along their technical literature: "How Physicists think", "The Physical Principles behind Physicists" or at least an illustrated technical compendium and dictionary "Physicistish – Engineerish / Engineerish – Physicistish". It will be more than helpful.

The group visit in Wittmund Biogasanlage was the right moment to accomplish my long-awaited goal of performing the two-month Praktikum there. Technically, I ended up in the right place, not only because I had very good supervision - Manuela Beyer is almost like a super mom - but also because the power plant has a somewhat complex operation dynamics. In such an environment, the only reasonable outcome is to contribute and learn as much as possible. As I had been working with biogas for the previous few years, I could experience the concepts in depth and also give a good share of work.

My studies concentrated in the pre-hygiene residues must undergo before being digested and also on the use of excess heat to treat fertilizer, used in agriculture. The work environment was excellent, as well, and I laughed along with my co-workers, sometimes in German, sometimes in Platt Deutsch. Before the end of the Praktikum, we agreed on my Masters Thesis: to study the fermentation process or to keep working with the fertilizer heat treatment.



Marcelo doing Fertilizer Gas Analysis in Laboratory

I still not only keep in touch with them, but I have already joined Manuela Beyer in a few events: the Hannover Messe, a Biogas Forum close to Münster and the German Biogas Union group meeting, also in Münsterland. This has been really important for my future, by measuring the wind direction, into the biogas field.

After graduation I would like to stay around, possibly in Germany, for a few more years, either for a Doctorate or to work in the biogas industry. With a more solidified knowledge, experience and contacts, I will have more tools to help my country and the global village, through renewable energies, to adhere to greener values. My perspectives and expectations are high, but, as another song says: "I still haven't found what I'm looking for". If you find it, make sure you tell me.

Thesis Research at Meteocontrol GmbH

by *Diego Sanchez, Columbia (PPRE 05/07)*

Beginning October 2006 I moved from Oldenburg to Augsburg in Bavaria to start my research on the spectral effects on the electric current production of photovoltaic modules. Meteocontrol is a leader company which has been involved in the renewable energy market for about 30 years. Meteocontrol offers products and services in the fields of solar and wind energy, energetic efficiency and weather for the renewables. The firm was co-founded by a former PPRE,



Prof. MSc. Gerd Heilscher and is now part of a larger company, the Solar Strom A.G.

In the field of solar energy, Meteocontrol is involved in the monitoring of solar installations, in both construction and service phases. In the context of installations insurance, power production certificates of facilities are made for investors who want to know whether the installed modules are working according to the specifications of the manufacturer.

My Project is titled: Use of SOLIS Satellite-based Solar Spectral Irradiance for Characterization of Thin Film Photovoltaic Mod-

ules

The work I am performing at Meteocontrol seeks to improve the power prediction of thin film modules, aiming the integration in the monitoring and power certificates schemes of the company. My supervisor at the firm is Dip.Ing. FH Stefan Bofinger. The work is also supported by the Energy Meteorology group of Oldenburg University through Dr. Annette Hammer, Dr. Detlev Heinemann and Dr. Elke Lorenz. The idea

consists of using satellite-based spectral irradiance data supplied by this group for modeling the power production of such modules. In Augsburg we perform ground measurements of global broad band irradiance, module temperature, I_{sc} , U_{oc} , I_{mpp} and P_{mpp} .

The first step in the research is the modeling of I_{sc} as a function of one or several parameters considering the spectral variations due to clouds, atmosphere turbidity and other ambient influences affecting the solar irradiance distribution along the wavelength axis. I am currently finalizing this stage which constitutes my PPRE thesis work. This is the most relevant part of the power model, and after its completion, the link between the I_{sc} -spectral model and the power production must be carried out. We have had technical problems with the ground measurements, which have delayed the work; however, these have been

already solved. In the beginning the plan was to study amorphous Silicon, Cadmium-Telluride and poly-crystalline Silicon (reference) modules; however, due to the technical problems and time restrictions for the work submission, we consider now only a-Si and c-Si for the experimental part. The CdTe technology is still considered for the spectral theoretical analysis. Other limiting aspect is that we have mostly measurements for late autumn and winter 2006. However a few days ago we resumed the measure-

ments which benefit from the current clear skies, longer days and higher sun elevations (we measure on horizontal surface).

Technologies implemented with this production method: amorphous Silicon a-Si, Cooper-Indium Diselenide CIS and Cadmium-Telluride CdTe. Their spectral responses are in general narrower and lower than for crystalline Silicon, which turn them into more spectral-sensitive devices.

Roles of Mahu Seth Agbeve, Ghana (PPRE 2005/07) with GPCo Inc. Canada

Seth Agbeve MAHU joined the PPRE programme for the 2005/2007 academic year. Upon graduating from PPRE in March 2007, he took a short research appointment with GPCo Inc in Canada and works for the Ottawa office. The research forms part of his MSc thesis work which is in line with the company's interest in the potential wind energy market in Ghana. He was tasked with the following responsibilities in GPCo:

- identification and documentation of potential wind sites in Ghana;
- wind data quality control (QC) and reality checks for Ghana wind data. Further analysis of the wind data and energy projection using GPCo engineering tools;
- advice on the development of commercial wind energy project in Ghana;
- identification of government energy agencies and contacts vital for the Ghana wind project, development appropriate mechanisms for feasibility study in Ghana.

GPCo Inc is committed to the development of commercial wind energy projects in Ghana.

na.

Established in 1994, GPCo Inc. (www.gpco.ca) is one of Canada's leading and longest serving engineering firms specializing in the provision of a wide range of technical services to the global renewable energy industry. GPCo's current core business is wind engineering services for the Canadian market. GPCo specializes in the assessment of wind potential, the conduct of wind project feasibility studies and the development of wind energy projects across Canada and abroad. GPCo installs meteorological towers, performs wind resource assessments, prepares wind flow maps, optimizes wind farm layouts and projects energy yields for proposed wind farms. GPCo is currently working on over 7000 MW of wind projects in advanced development stages throughout eastern Canada, for various clients. Some 450 MW of these projects are either under construction or have government power purchase agreements (PPAs) and private financing already in place. GPCo presently operates over 150 meteorological masts and several SODAR installations throughout Canada and internationally.

GPCo develops training materials for short

and multi-day renewable energy courses and in particular offers specialized training related to the RETScreen® International software. GPCo staff includes a number of Certified RETScreen Trainers.



GPCo also provides consulting services relating to more than eight renewable energy technologies (RETs), including solar thermal for water and/or space heating, solar PV, wind turbines and ground source heat pumps. It also is a leader in the development of technical and financial analysis tools for the renewable energy industry. With Natural Resources Canada, GPCo has been a co-developer of the RETScreen® International renewable energy project analysis software that has been accessed by over 100,000 users in more than 219 countries. GPCo provides technical support for RETScreen® users worldwide and has delivered RETScreen® renewable energy workshops to over 1,000 professionals across Canada as well as in the Netherlands and South Korea.

GPCo's team consists of over 30 mechanical and electrical engineers, meteorologists, researchers, systems modelers, technology managers, logisticians, IT and GIS specialists, field technicians and highly qualified business administrators and project managers

The GPCo team

Contact:

1471, boulevard Lionel-Boulet, suite 26

Varenes Québec J3X 1P7 Canada

Phone : 450-929-0062 Fax: 450-929-1271

Email :

info@gpco.ca

www.gpco.ca

Field Research in Uganda

Mr. Jagwe Wycliff, Uganda returned to Uganda to work on his MSc-thesis project titled 'Implementation of Rural Solar Photo-voltaic Water Pumping Schemes in Uganda'. The trip was sponsored by DAAD.

During his stay Jagwe was involved in various projects (please see article in the back). One of them was the installation of a pyranometer at a site situated on the island on Lake Victoria. Actually he bought the equipment from Campbell Scientific and Kip & Zonnen (Mr. Kulschewski's Lab work in application!).



During the installation he realized that the winds at the beaches of the island are quite impressive. Hence he made a recommendation to install also anemometers in selected areas along the beaches on the island.

Careers

Summary of Job as low carbon housing consultant after PPRE

by Andrew Peel, Canada (PPRE 2005-07)

I am currently working as a low carbon housing consultant for the Building Research Establishment (BRE), based in Watford, England. BRE is a leading research and consultancy firm involved in all aspects of the construction industry. They are funded by the BRE Trust, a non-profit charitable organization. I am part of the housing team, which provides consultancy services to both governmental and non-governmental bodies in matters relating to the energy performance of building. A large portion of our team's work is for the Energy Saving Trust, a government initiated organization whose main objective is to promote construction standards that go beyond the building regulations.

As I've just begun my job, I'm still in training. The learning curve is steep but rewarding and enjoyable. My roles with the team are quite varied, but the main one is to provide Passivhaus consultancy services to the construction industry. A Passivhaus is a house whose space heating energy consumption is far below that of current houses (more can be read at www.passiv.de). I will also be involved in Passivhaus training of architects and builder planners.

These are exciting times to be working in the housing sector in England right now. The UK government has recently announced intentions to have all new houses built as zero-carbon houses starting in 2016. A zero-carbon house is essentially a house

whose net carbon dioxide emissions over a year are zero. This figure includes emissions for all energy services, such as space heating, hot water, lighting etc. Naturally, since houses will always consume some energy, this will require the supply of renewable energy. Thus, any electricity that is taken from the grid must be compensated by renewable generation either on- or offsite.

To help the industry achieve the zero-carbon goal, the government has developed the Code for Sustainable Homes. This document provides the framework for stepwise changes in the UK's building practices. It addresses nine areas, including energy demand, water consumption, materials, surface water run off, waste, pollution, health and well-being, management, and ecology. The Code is divided into six Levels, with each level representing a specific CO2 improvement with respect to the current building regulations and increasingly stringent criteria for the other eight categories. For instance, at code level 1, a 10% decrease in CO2 emissions from space, water heating, and lighting compared to building regulations is required. At level 3, a 25% decrease is required. After level 3, the requirements become more stringent. Level 4 requires 44%, level 5, 100%, and level 6, 100% of all energy use, including appliances (i.e. zero-carbon). The first step in the path to zero-carbon is to make Code Level 3 mandatory by 2010.

On a side note, I'd like to point out the benefits of learning German while enrolled in PPRE. It is because I worked hard at improving my German that I, ironically, ended up finding a job in the UK. I was originally

called upon to provide some translation services for a group from Great Britain who had come to Germany to tour some Passivhaus' sites. It was on this tour that I met my eventual boss. So I encourage the current and future PPRE's to put the effort in!

Cheers from England,

P.S. I miss the good times we had in Oldenburg! Looking forward to the next reunion!

My new job at Q-Cells, Germany

by Dr. Saïoa Tardon, Spain

Last year in May I finally finished my thesis on "Photoluminescence studies in a-Si:H/c-Si solar cells" under the supervision of Prof. G. H. Bauer in the Carl von Ossietzky Oldenburg. This was also the end of my time in Oldenburg, which I started in 2000 by studying PPRE. After applying to different jobs in the photovoltaic area I got a position in the technology department of the German company called Q-Cells AG – a solar cell manufacturer - in for July 2007.

During my PPRE-studies, photovoltaics was my favourite subject, but at that time I never thought that it would be a real alternative to the traditional energy sources. I thought that it was only appropriate for isolated areas and that it could, of course, be important together with other renewable energies.

But in Q-Cells we intend to push photovoltaic energy to become a real competitor of energy gained from fossil fuels. This goal will be approached by increasing the production and the efficiency of solar cells so

that the price will be reduced. Therefore this very young company is increasing speedily and has a lot of projects in order to improve the technology in the solar cells production technologies. To be working in this enthusiastic and dynamic atmosphere everyday is really motivating for me!

My PhD thesis at Daimler Chrysler Emissions Laboratory in Bremen, Germany

By Veronica Manka Fuh, Cameroon (PPRE 2000/01)

Due to of increasing air pollution, environmental organisations worldwide are forced to set up stricter standards and regulations aimed at reducing emissions. The automobile sector is greatly affected by some of these regulations and; this shoulders the duty of compliance to these standards. Essentially all vehicles must be emission certified before being released to the market; hence, the creation of the "DaimlerChrysler Emissions Laboratory".

The DaimlerChrysler emissions laboratory Bremen has the following as one of its mandates: Ensure compliance with global exhaust emissions, fuel consumption and noise level regulations by means of random sample testing. The first two tasks are achieved through legally prescribed exhaust emissions tests. Fuels with stated composition and properties must be used in carrying out these tests. These so-called test fuels, once received from the fuel manufacturer, are stored in tanks for later use.

My work, therefore, revolves around these test fuels and determining; the physical and

chemical changes of test fuels during storage; the constituents or components that change; the main factors influencing the changes; the effects of the changes on exhaust emissions; and the components of the fuel that should be analysed in the course of storage (and at what frequency), to guarantee the quality with time.

The tentative title of the PhD is “Changing properties of test fuels during storage and the effects on automotive emissions”.

The opportunity to carry out this PhD thesis was given to me early 2005. The process of obtaining permission from my job back home took some time, and that I finally

started working on the thesis late 2005. Coupled with the fact that I sometimes have to travel back home for some family imperatives, I have been able to put in one year and half of effective work. That notwithstanding, my target is to finish my doctoral thesis before 2009.

I must emphasize here that my renewable energy studies played a very big role in acquiring this position. The reason that prerequisites for application were not only a chemical background but also a good knowledge of energy and environmental-related aspects.

Jobs after M.Sc.-studies in Oldenburg

In this chapter we would like to present the different careers taken by our graduates right after their RE-Studies (M.Sc.) with us.

Career after PPRE-2005-07

Name	First name	Origin	Job After PPRE	Institution	Country	WWW
Khan	Ahmed Jahir	Bangladesh	Sub-divisional Engineer	Bangladesh Power Development Board	Bangladesh	www.bpdb.gov.bd
Boruah	Dwipen	Indien	Scientific Officer	Assam Energy Development Agency	India	
Maharjan	Bhai Raja	Nepal	Freelancer	Petro Engineering Consultancy Private Ltd.	Nepal	
Vera Tude-la Carreno	Luis Enrique Domingo	Peru	Researcher	Overspeed GmbH / Oldenburg University	Germany	www.overspeed.de / www.hywindbalance.com
Caag	Donnalyen Atienza	Philippines	Research Officer	Batangas State University, College of Engg.	Philippines	

Jagwe	Wyclif	Uganda	RE Project Engineer	NORPLAN Uganda Limited	Uganda	www.norplan.co.ug
Mahu	Seth Agbeve	Ghana	RE Project Engineer	GPCo Inc.	Canada / Ghana	www.gpco.ca/
Wickramarathne	Widana Gamage Hashini Kanchana	Sri Lanka	Management Trainee	MAS Holding	Sri Lanka	www.masholdings.com
Paula Chaves	Patricia Castello Branco	Brasil	PhD-Student	German Wind Energy Institute	Germany	www.dewi.de
Sanchez Herrera	Diego Alejandro	Columbia	RE Area Manager	Meteocontrol GmbH	Germany	www.meteocontrol.com
Wilches Tamayo	Camilo Andres	Colombia	Int. Project Engineer	biogas weserems GmbH & Co.KG	Germany	www.biogas-weserems.de
Beyn	Mulugeta Weldetnsae	Eritrea	RE Consultant	Lahmeyer International	Germany	www.lahmeyer.de
Sterner	Michael	Germany	PhD-Student	Institute of Solar Energy Techniques	Germany	www.iset.de
Hegel	Rodolfo	Guatemala	RE Consultant	Lahmeyer International	Germany	www.lahmeyer.de
Pechlivanoglou	Georgios	Greece	Research & Patent Engineer	Suzlon Windkraft	Germany	www.suzlon-wind.de
Peel	Andrew	Canada	RE Consultant	BRE Group	UK	www.bre.co.uk
Randig	Sebastian	Germany	Project Manager CDM	TÜV SÜD Industry Service GmbH	Germany	www.tuev-sued.de/climatechange
Rojas	Carlos Mauricio	Colombian	Research Assistant	University of Oldenburg	Germany	www.uni-oldenburg.de
Herráez Hernández	Iván	Spain	Development Wind Engineer	Nordex Energy GmbH	Germany	www.nordex-online.com/de
Torio Blanco	Herena	Spain	PhD-Student	Fraunhofer Institut for Building Physics in Kassel	Germany	www.ibp.fraunhofer.de

Career after EUEC-2005 / 2006

Name	First name	Origin	Job After EUEC	Institution	Country	WWW
ADNAN	Mohammad	Pakistan	Engineer	Glass Industries	Pakistan	
McCRA-CKEN	Philippe	Canadian	Energy Consultant	Local Government	Palau	
XUEREB	Steven	Maltese	RE Consultant (self employed)	Renewable Generation	Canada	www.renewable-generation.com
LOPEZ ALCALA	Leodegario	Mexican	Project Manager	Technology-Transfer-Centre	Germany	www.ttz-bremerhaven.de
SADER	Hadi	Lebanese	Engineer	SYNLIFT Systems GmbH, Berlin	Germany	www.synliftsystems.de
ROUZE	Jerome	French	Solar Energy Consultant	Transenergie	France	www.transenergie.fr
ANTO-NOPOULOS	Antonios	Canada	RE Engineer	ETA Renewable Energies	Italy	www.etaflorence.it
POLIZOIS	Theodoros-Theodoritos	Greek	Solar Engineer / Nat. Service	Alexakis Energy / Military	Greece	
GUILLOT	Bertrand	French	Renewable Energy Engineer	MATRIciel	Belgium	www.matriciel.be
MONTES DE OCA ARJONA	Luis	Spanish	Sales Engineer (Biofuels)	Activos del Conocimiento S. L.	Spain	www.grupoactivos.com

News from PPRE-Alumni in brief

1987-88

Mr. Eric Fischer, Brazil

is running nowadays his own consultancy called 'Efisher Consultoria Ambiental Ltda.' in Brasilia, Brazil. He is working in close partnership with a regional Institute for Technical Development. Additionally, he is sitting in the Board of Director of the German-Brazilian House in Brasilia, where he is involved

in environmental protection including renewables.

Mr. Gerd Heilscher, Germany

left meteocontrol GmbH in Augsburg, Germany - the company he himself actually founded years ago, in 2006 - to join the University of Ulm, Germany as Professor for Energy Data Management and Decentralized Energy Supply Systems.

1988-89

Mr. Ainea Kimaro, Tanzania

was working for Kigali Institute of Science in Rwanda for several years but returned last December 2006 to Tanzania, where he is rebuilding biogas and Solar plants (as he did before). He is focussing on what he can do best, namely installing large-scale biogas plants in the prisons and schools in the region. In Rwanda Ainea already designed the largest and most effective biogas plant, which, for the first time, can be built in modules, in any size. With this Innovation Ainea won a top prize in the Ashden Awards in 2005. Ainea acknowledged the contribution of Oldenburg University and for model he built he was using the small equipment grant offered to me by DAAD!

1989-90

Mr. Anil Misra, India

who joined the GTZ, India earlier in 2006 under its Natural Resource Management Programme did visit GTZ Headquarters in Eschborn, Germany, in September 2006. Due to time constraints, he could not visit PPRE in Oldenburg this time but promised to catch up on it next time.

Ms. Ulrike Jahn, Germany

got a new job in January 2006 as Head of Group PV Module Technology at the Bavarian Center for Applied Energy Research (ZAE Bayern), which is located in Erlangen, Germany – details at: <http://www.zae-bayern.de> or <http://www.iea-pvps-task2.org>

Mr. Partha Sarathi Mukherjee, India (PPRE 89/90)

is working for an NGO called DISHA as its Director (Projects). They work for promotion of micro-credits to poor and particularly women for income generation on the lines of Grameen Bank, Bangladesh, to provide vocational training to women and install basic health care services.

From April 2007 onwards, Partha is involved in implementing a project supported by The Rotary Foundation under its 3H Grants Programme. 3H indicates Health, Hunger and Humanity. The project proposes to target 4000 poor families in two blocks of Pune District of Maharashtra, India and bring them out of poverty within four years by providing micro-credit loan for income generation, vocational training to 3000 women and reducing IMR (Infant Mortality Rate) & MMR (Maternal Mortality Rate) by providing Health Care services to 50 villages. The activities have been started in 30 villages in last four months. They propose to reach 15000 poor families in next three years. Under vocational training, he proposes to give training on selling renewable energy technologies (biomass stove, PV lamps etc.) to a selected number of rural women on a trial basis. They can get small loans from DISHA initially and later on from Banks for scaling up.

1990-91

Mr. Isaac Ennison, Ghana

is employed at Ghana Atomic Energy Commission in the Nuclear Engineering and Material Science Department. Last year he was focusing his work on Energy Planning using IAEA computer tools, where he was work-

ing with a national team on an IAEA project “Planning for Sustainable Energy for Ghana”. They were developing an optimal energy mix for both long and short term duration and they were considering renewables and non renewables. Besides he is this doing his own research about a thermostorage cell (see article under reports from alumni)

Dr. Adam El Fadil, Sudan

is now manager of the first Sudanese solar PV cells industry besides his duties as Director of the Energy Research Institute (ERI), as informed by Gassir Farouk from Sudan (PPRE 94/95).

1991-92

Mr. Mahmoud El Hakiem, Sudan

is presently working in the National Committee for Energy in Sudan as informed by Gassir Farouk from Sudan (PPRE 94/95).

Mr. Aung Gyi, Myanmar

was working as a private tuition teacher at the end of 2006. Hence, he is not working in RE anymore, since he left his government job . Actually, Aung Gyi seems to have problems to realign himself with RE these days.

Mr. Patrick Mugisha, Uganda

who is lecturing at Makerere University in Kampala, Uganda, in both the renewable energy courses and electrical engineering wrote:

I was still planning on updating you on activities in Solar and other renewable energies like mini hydro in Uganda, but not much change has taken place since 2003 when Uganda Photovoltaic Pilot Project for Rural

Electrification (UPPPRE) ended with more than 2000 SHS installed countrywide. There is now an ongoing project in the Ministry of Energy called Energy for Rural Transformation with a component of Solar PV involving sizing systems for use in education sector mainly schools, health-hospitals and health centres, agriculture, residential telecommunication sector, etc. Also, their installation and maintenance practices and drawing up of standards (Codes of Practice in Design and Installation), training technicians and also planning introducing a new curriculum of RE in schools and colleges and support of student based projects at universities. I actually participated in standards formulation in the initial stages.

However, in future I see a career opportunity in solar business for rural electrification (use of solar lanterns, solar homes systems and therefore stocking solar panels, batteries Inverters, charge controllers, etc so that projects like 1000 Roof Programme can be implemented in rural communities but it requires a lot of money to invest. Remember: our electrification level is still less than 5% in the whole country and about 1% in rural areas. What was mainly hydro power for grid is now comprised of thermal power plants and then hydro, with a negligible portion from solar. This increased thermal power -hydro scenario has pushed up the tariffs in recent times.

Ms. Anna Ingwe Musungu, Tanzania

joined the GTZ Promotion-team of Private Sector Development in Agriculture (PSDA) as programme officer in Kenya. Their latest bulletin reports that stove activities under GTZ PSDA have been extended from July 2007 to Dec 2008. In the first phase, Jan 2006 – June 2007, the target was to dis-

seminate 45,000 stoves. Up to end of June 2007, 61,400 stoves had been produced and installed translating into 136%.

The main aim of the project is to empower dealers (producers, marketers, stockists and installers) to get involved in stove activities purely on commercial basis. This will continue to be area of focus for the extension period while consolidating other technologies, such as the household rocket stoves, improved firewood baking oven, institutional rocket stove, sterilizer for mushroom and passion fruit nurseries.

It is planned that by Dec 2008 a total of 85,000 stoves will have been disseminated.

1992-93

Mr. Chayun Budiono, Indonesia

His Indonesian company called Komplek BPP Teknologi is co-operating with Suntechnics, Singapore to install PV-systems in Indonesia.



Chayun Budiono (middle) in a business meeting with former PPPE-alumni at Suntechnics, namely Oliver Risse (lft.) and Boon Jin

In late June 2007 Chayun visited Oldenburg campus while being on a business trip to

Germany for his own company, which is very active in the field of RE in Indonesia.



Chayun on a site visit in front of a PV-system for Telecommunication he projected on a small island near Jakarta some 7 years ago

Ms. Jing Jing Wang, China

returned to Beijing, China some years ago, where she is now working for a local Chinese enterprise which produces mini high efficiency motors. After six years she managed to return to Germany while visiting the Industrial Fair in Hannover last year. Actually, she is travelling frequently to Europe and the States meanwhile and is looking forward to visiting Oldenburg University again during one of her next trips.

1993-94

Dr. Eng. Augustus Leon, India

Congratulations ! Augustus has successfully completed his "Doctor of Engineering" in Energy Technology in June, 2007. With that, he is closing a long but lovely and memorable chapter in his life at AIT.

Hence Augustus is all set to get serious in his current area of interest - the Clean Development Mechanism (CDM), in which he already has been working on a part-time

basis for the past two years, with involvement in seven biogas and biomass power projects. For the time being he will be staying in Thailand.

Presently Augustus is working as Technical Director in a private limited company called Renewable Cogen Asia in India (but all projects are in Thailand).

Alumni-re-union:

In 2006 Dr. Johnny Nahui-Ortiz (PPRE 93/94) was visiting Augustus on his way to China and earlier in 2007 Mr. Binu Parthan visited AIT on his return from a trip to Singapore. Note from Augustus: as you know, it is wonderful meeting old friends, and sharing good old memories.

Dr. Johnny Nahui-Ortiz, Peru

is organising and co-ordinating the IV International Energy Symposium, which was held in Lima, Peru, during 21-24 August, 2007.

Mr. Mesfin Mergia, Ethiopia

has been accepted as a Phd candidate at the University of Twente this summer. He will be working not on energy, but rather on water security. It is more of policy issues and based on two cases from Africa - specifically lower Zambezi river basin (Mozambique) and Lake Naivasha (Kenya).

1994/95

Mr. Enrique Fuentes, Chile

finally was promoted Professor at the Universidad de Tarapaca, Chile, where he is lecturing in the Electrical Engineering Department for ages already. Among others, Enrique is offering classes in Energy Re-

sources to students and is doing an on-line course in "Strategic Relevance of Energy Sources in the Southern L.A.Cone".



2 small WECs operating on campus at Universidad de Tarapaca, Chile

Additionally Enrique informed us that they have been granted the creation of a "Centre for Energy and Water" in Arica and that they are applying for some land in the high plateau (Altiplano) for the implementation of an multidisciplinary (renewable energy, health, agriculture, astronomy, meteorology) applied research laboratory. (Details to be announced later...)



Prof. Fuentes with his trainee Erik Patschke, Germany (PPRE 2006/08) in March 2007 at UTA, Chile

Mr. Gassir Farouk M' med Ibrahim, Sudan

After a long silence Gassir re-newed his contact with us: he left Alexandria, Egypt, in 2001. Presently he is working in Khartoum, Sudan, with Khartoum State Water Corporation at the Ministry of Housing and Public Utilities.

Mr. Debesai Ghebrehiwet, Eritrea

is the '2006 Environment Award Laureate' from 'The Techmuseum Awards' which are sponsored by Applied Material, US (www.techawards.org/).

Debesai, Director of the Energy Research and Training Center, and renewable energy specialist, received the award for designing a fuel-efficient, smokeless mogogo cooking stove, which offers simultaneously the possibility to reverse deforestation across the entire country, reduce the domestic burden and improve the health of hundreds of thousands of mothers, and improve the overall status of households, up to now constrained by lack of access to fuel wood. (see also article in the back)

1995-96

Mr. Oo Abdul Rosyid, Indonesia

successfully completed his PhD at Otto-von-Guericke-Universität Magdeburg, Germany, in May, 2006. There after he returned to Indonesia to join 'BALAI BESAR TEKNOLOGI ENERGI (B2TE-BPPT)' in Tangerang, where he is working in Hydrogen Research & Safety.

Mr. Abdallah Baba, Tunisia

As General Manager of the Alternative En-

ergy Systems "A.E.S" – company in Tunis he got an invitation from UNIDO to participate in the International Symposium On Solar Energy in Central Asia, held in Lanzhou from June 21 to 23, 2006. Actually he gave a presentation about the experience of Tunisia in the renewable energy application. His company has a good relationship with the UNIDO and the GNERI, Gansu Natural Energy Research Institute.

Mr. Godofredo Magpoc, Philippines

called us in 2006 to convey greetings and to inform us that he is still working at the National Power Corporation. They are very busy with the liberalisation of the electricity market.

Mr. Karsten Woelk, Germany

is employed for many years in the Sales Department at Solvis Solar Co., Braunschweig, Germany (www.solvis.de)

1996-97

Ms. Mirela Kamberi, Albania

After working for around five years as Director of Pollution Prevention in the Ministry of Environment, Forestry and Water Management, Mirela changed her position in 2006. She is now working as National Coordinator of a UNDP-GEF project "Market Transformation for Solar Thermal Heating in Albania" at the Ministry of Environment, Forestry and Water Management. This position was supported besides others due to her studies in Oldenburg. In her new position she will try to increase the cooperation with the program in Oldenburg.

Mr. Richard Morris, Australia,

is doing fine with his own company called Zebotec (www.zebotec.de). In 2006 they were busy with boat projects, backup power projects (fuel cell) and the solar business.

Mr. Orlando Perez, Bolivia

wrote us end of 2006: As you may notice I am still working for ELECTROPAZ S.A. in La Paz - Bolivia and I am the Customer Services Chief Engineer in charge of planning, projecting and installation new services to the called "Corporate Customers" (big industry, breweries, textiles, government, municipalities and so on).

As you may know, my country has faced a lot of problems which fortunately are gone. Now, our new president, Mr. Evo Morales has started the natural gas era, which means, for instance, that our electricity is mainly based on natural gas power plant production, and many of the industries and vehicles are running with natural gas.

Mr. Sebastian Sancho, Costa Rica & Mr. Matthias Belz, Germany,

(the letter actually founded the company after his PPRE-studies in Germany) represented the RALOS GmbH (www.ralos.de) at the 21st European PV Solarenergy-conference which took place in Dresden, Germany in September last year. During the exhibition and conference they met several of their previous PPRE-lecturers like Dr. Heinemann, Prof. Beyer, Dr. Schumacher Prof. Gabler, etc.

Latest news:

Ralos Ibérica P.D. S.L. managed their first big PV installation totalling 2.3MWp in Spain, after a long time of paperwork and some oth-

er constraints. It has been developed from scratch by Ralos Spanish branch. The owner will be a German investor fund, who is also involved in some other developments in Spain, which are under preparation.

The PV-plant is located in the province of Avila, about 130km North West of Madrid. It's supposed to be ready by mid November.



Ralos PV plant under construction in Avila, Spain

Dr. Gajanana Krishna Hegde, India,

who is working as Program Officer in the Climate Change Secretariat (UNFCCC) in Bonn, Germany, since 2005 was finally awarded his doctoral degree from Curtin University, Perth.

1997-98

Mr. Christoph Schröder, Germany

After working for the last 4-5 years with GTZ in China, Christoph informed us that he started his PhD-studies in the Institute of Hydraulic Engineering at University in Stuttgart in October 2006.

In July/August 2007 Christoph will definitely finish his last assignment with GTZ in China, to concentrate completely on his PhD-stud-

ies.

Mr. Binu Parthan, India

as Director of the Programme Co-ordination in the REEEP International S (www.reeep.org), he visited the United Nations Climate Change Conference in Nairobi in November, 2006, where he met up with **James Wafula (PPRE 92/93)** and **Bernard Osawa (PPRE 96/97)**. Besides the conference, Binu had a chance to visit Uganda for some business, as well.

Mr. Fernando Petrucci, Argentina,

who has been employed since 1998 at Wobben Windpower Industries (subsidiary of Enercon in L.A.) performing sales activities and support for local works in Argentina, mentioned recently that he met a EUREC-Master-Student from Argentina last year and that even in Argentina the RE interests and activities are increasing, despite the governmental policy. The energy shortage is reality and no energy conservation program is being undertaken. Fernando thinks that the local government still denies the energy crisis and just announced a tender for five gas-fired power plants, plus two which Siemens is already supplying (1,600 MW). Plus one nuclear power plant (Siemens technology), plus enlarging the water level in the biggest hydro-power plant is also in progress. Altogether, this means further environmental impact. On the other hand, not much is done about renewables or conservation so far, except for rural electrification.

Mr. Wisdom A. Togobo, Ghana,

Informed us in the middle last year that he travelled to Hangzhou, China, where he undertook a training programme on Small Hy-

dro Power Development. Wisdom is Head of RE section in the Ministry of Energy, and his department is collaborating with UNIDO and IN-SHP (International Network for Small Hydro Plant) to establish the first small hydro plant in Ghana.

Mid last year, the arrangements were far advanced for the development of a 30kW hydro plant in Tsatsadu in the Volta Region of Ghana. Meanwhile, UNIDO and IN-SHP donated the 30kW turbine and generator for the project, which was supposed to be completed and commissioned before the end of last year.

(It would be nice to have a picture and report about the project – editor)

Additionally Wisdom participated as a guest speaker at the opening session of the World Bioenergy 2006 conference in Jonkoping, Sweden, where he gave a speech on behalf of the Minister of Energy on Ghana's Perspective on Bioenergy.



Prime Minister of Sweden discussing with Wisdom A: Togobo at Bioenergy 2006

The worlds of rich and poor met at this conference. Sweden's prime minister, Dr. Goran Persson, represented the rich, who have everything to win by switching to bioen-

ergy. The poor majority of the world were represented by Wisdom Ahiataku-Togobo of the Ministry of Energy in Ghana. To them, bioenergy is a major threat.

In mid 2006 Wisdom was also seconded to the UNDP 'Household Energy For Cooking Project' as the National Project Coordinator for two years, for which his office is based at the Energy Commission. Of course, he will proceed working with the Ministry of Energy.

...and in April he wrote:

I think it is worth notifying you of the honour I had to receive MP Dr. Axel Berg, a member of the German parliament for Social Democratic Party (SPD) in Ghana from April 11-14, 2007. We met with the Ghana Minister for Energy where he had very fruitful discussions. We also visited some of the renewable energy installations in the countryside including the Akosombo hydro power plant, the locally made wind turbine for power and wind pump for irrigation



Wisdom shows MP Dr. Axel Berg, Germany some RE sites in Ghana

..and in May 2007 he wrote:

I bring you greetings from New York where I am attending the UN Commission for Sustainable Development CSD15. I have been

invited as one of the panellist for a debate in increasing access to modern energy in developing countries. It will be a TV style debate on healthy and affordable household energy. The programme will be telecast on the New York TV as well as on the WHO web.

Binu Parthan (see above) is also attending the conference to deliver a paper. I am looking forward to seeing him.



Wisdom meets Binu Parthan on CSD15 in New York

Details:

Together with WHO, GTZ and others a side event was organized during CSD15 to present solutions on healthy and affordable household energy on May 7, 2007.

Moderated by a former BBC TV journalist, a TV-style debate on healthy and affordable household energy was set up. Each panellist had five minutes in the "hot seat" to make a very short proposition on how to solve the problem of access to clean cooking energy among the poor and to prevent associated health problems. The other panellists then had the chance to challenge this proposition before they moved into the "hot seat" themselves, having to make their proposi-

tion. The discussion was then opened to the audience during the last 30 minutes,

I happen to be one of the panellist on the hot seat to present household energy situation and solutions from the African as well as from the policy perspective.

1998-99

Dr. Hans Jaoko, Kenya

finished his PhD in Environmental Science with respect to Modelling 'UVB radiation in mid latitude of Africa' at University of Mysore, India in 2006.

He wrote in the end of 2006:

I am happy to report that we have just successfully completed a 15-month pilot project titled "Banking on Oil", for which we won a World Bank certificate of recognition and funding to implement. This project was singled out by the judges as one that integrated aspects such as local governance, employment creation and policy dialogue as critical ingredients for management of used motor vehicle lubrication oil. The National Geographic Channel did a documentary, and we hope the world will know what we did and replicate our efforts.

At the moment, I am involved in a number of projects & energy policy dialogue in Somaliland. It's interesting to work with people in a country that has been at war over the last 15 years; a place where 70% of the population are refugees displaced in their own countries over these period. I am also trying to develop an innovative generator for providing rural communities with electricity. It's quite a fundamental innovation that uses local resources. We have completed the designs and in the process of

patenting the generator. I am working with a constituent college of the Catholic University of Eastern Africa to develop curriculum for renewable energy training as an elective course for postgraduate students.

I am also moderating a biogas policy dialogue on the "soft" issues of biogas energy production i.e. the gender involvement, social issues, environmental impact and economic benefits of biogas waste as organic fertilizer. Maybe, we can exchange more ideas on these "soft" issues with the PPRE fraternity in the near future.

Later in 3/2007 he wrote:

We intend to set up a Geospacial Product Application Laboratory here in Kenya at the Kenya Industrial Research and Development Institute. This should have remote sensing and GIS and also includes radar and lidar data application systems. We are not very competent in all these but believe that they can go along way in renewable and environmental resource mapping. We are looking forward to possible collaborators as individuals or institutions.

Ms. Yang Na, China

changed her job within the wind energy sector in Canada at the end of 2006. She moved from Montreal to Lethbridge, Alberta, an English speaking province, where she is working for a wind project developer called Wind Power Inc.. Her current job is dealing with wind energy consulting, including wind farm design, wind resource assessment, energy calculation, noise level evaluation, shadow flicker assessment, data logger programming, data collection, validation and reporting. Early in 2007 she was also doing macro wind resource mapping for Alberta, Canada.

About her immigration to Canada she wrote:

When I first immigrated to Canada, I felt very sorry to give up my stable and good income job in China. But now that I have the same life standard in Canada, I begin to like Canada. Maybe the only thing which we could not have here is the company of our relatives in China. It is another blessing from God that my husband got a good job here immediately after he completed his study in Montreal and came to Alberta to join with us on this Christmas.

Mr. Samudragupta Ashok Patil, India,

who is employed at Maharashtra Energy Development Agency in Pune, India wrote last year:

Moin Moin,

Sir, how are you and our Oldenburg? Just yesterday, I received the copy of our PPRE Newsletter. While going through it, all my memories of Oldenburg got activated. I believe everything is fine. During last year, I was involved in CDM related activities for our 3.75 MW wind power and other RE related projects in Maharashtra State. We have received the insurance of CERs for the small scale grid connected wind power project. However; we are trying to get registered with UNFCCC for 13 MW biomass and 8 MW municipal solid waste to power project.

Besides the above, I may like to inform you that we have a separate ministry for the promotion and development of 'Non-Conventional Energy Sources' in Maharashtra. This is the first statelevel ministry dealing exclusively for the RE sector. Perhaps you may know that recently India has entered into agreement with German govt. seeking

necessary cooperation for the development of RE sector. While undertaking state review of renewable energy programme in India, our state, Maharashtra, was selected for its remarkable work in promotion of RE programme. In view of this, the Indian govt. has directed our minister to attend the RE conference going to be held at Gelsenkirchen, Germany, from 6-8 Nov 2006. The Energy Department of Germany has requested our minister to inaugurate the conference. Our minister has agreed to do the inauguration. However he is willing to see certain renewable energy projects viz. wind, solar thermal, solar PV, hydro, municipal waste to power projects executed in Germany. The Energy Department of Germany has informed the Indo-Germany Chamber of Commerce to arrange for the minister's visit accordingly. In this visit we may like to know the RE projects that could be shown to the Hon. Minister (Non-Conventional Energy), GoM in Germany. Further, we may also like to know the possibility of developing tie-up regarding training or teaching related activities in our state universities. Today in the afternoon, the Indo-German Chamber of Commerce personnel are visiting our office to discuss this issue. In view of this, I deeply request you to let me know the possible places that could be shown to the Hon. Minister that have RE projects. Requesting your immediate reply soon.

1999-00

Mr. Musa Mzumbe, Tanzania,

started to work for UNDP/GEF in Tanzania in mid 2006. He is working for a project named 'Transformation of the Rural PV market'. The project website is online (www.solarmwanza.org), and much of their project updates will be regularly posted on the site.

Mr. Enhbold Ulziisuren, Mongolia,

joined the Ministry of Fuel and Energy in Ulaanbaatar, Mongolia, last year, where he is working for the National Renewable Energy Center. As researcher in the division for new energy sources, among others, he is working on introduction of fuel cells, heat pumps and stirling engines to Mongolia.

Earlier in 2007 Enhbold informed us that an RE law for Mongolia was approved for the first time by the Parliament (details under: <http://www.nrec.mn/>).

Concerning details about establishing the new RE Law, Enhbold wrote:

First establishment of Mongolian renewable energy law was initiated by B.Chadraa, Member of Parliament. First RE law proposal was developed by Dr.D. Gyagar, senior researcher of RE Scientific and Production Corporation. Before submission of RE Law proposal, German and Chinese RE laws were studied. First workshop on "Establishment of RE legislation in Mongolia" was organized at 11 Feb. 2003, in Ulaanbaatar by Ministry of Infrastructure, RE Scientific and Production Corporation, GTZ, and Integration LLC of Germany. In the workshop ten parliament members participated, P.Jasrai, B. Chadraa ..., and delegations of General Authority of Fuel and Energy, RE Scientific and Production Corporation, N.Enebish of Ministry of Fuel and Energy, GTZ experts U. Frings, E.Naumann (former head of PPRE), D.Uh, F. Asseline, H.J. Mueller. After several workshops, Mongolian RE law was approved by Parliament on 11 Jan. 2007.

Mr. Yubaraj Dahal, Nepal,

informed us in Feb., 2007, that he has been

living in Pennsylvania, USA, for three years where he is working as a SQL programmer in a company. Actually, he is looking for a job that is related to the RE field.

Mr. Alemu Tadesse, Ethiopia,

is doing his PhD at University of Connecticut, US. His graduation is scheduled for August 2007. Alemu is doing research in the field of remote sensing and GIS applications to environmental problems and resource management. Specifically, he is working on satellite rainfall estimation algorithms and tracking convective systems. They are also working on hydrologic modelling and make extensive use of GIS. His research team has already published a lot of papers and also installed lightning observations systems in Africa and Europe (<http://www.engr.uconn.edu/ZEUS>) and is conducting research in different areas.

Dr. Ali Salim Al-Alawi, Sultanate of Oman,

is part of the technical committee of the 'First World Water Sustainability -Renewable Energy Conference & Exhibition', which will take place November 25 – 29, 2007, in Maastricht, the Netherlands (info at www.wrenuk.co.uk)

Mr. Juan Rodriguez Paredes, Columbia,

who was working as a wind engineer for Deutsche Windguard Co. in Germany (www.windguard.de/) for many years, changed jobs recently and joined the German office of Garrad Hassan & Partners – wind consultants in Oldenburg.

Mr. Sham Subbarao, India,

was invited to Beijing, China, to present a paper at the Asia Biofuels Conference 2006 - scheduled from 10th to 12th October 2006. His presentation was about biomass technologies titled "Implication Of Biomass Fuel Efficient Technologies in Rural Areas" (<http://www.asiabiofuels.com/AsiaSchedule.htm>).

The three-day conference held in Beijing, China, discussed the aspects of using biofuels and biofuel technologies as alternative to non-renewable energy sources. The conference included topics on biomass energy technologies for thermal and electric requirement, ethanol and biodiesel projects. It also focused on securing financing and venture capital and other new technologies. Around 350 delegates attended the international conference. Papers were mainly presented on the topics such as ethanol and biodiesel projects. Overall the conference was good and informative. Sham got some good contacts at China for cooperative work in the field of biomass energy and renewable energy technologies. He also built up a contact to establish small bio-diesel plants as a small enterprise.



During this trip Sham had a meeting with his former fellow PPRE-student Mr. Robin Di Wang in Beijing, who working for a company called Hong Kong Energy in Beijing.

At the end of October 2006 Sham was invited to visit Dubai by a company namely AL USUF for a discussion on present trends in renewable energy technologies (In particular PV solar and bio-oils).

They are interested to know more on the present PV Solar Energy Systems / Building Integrated PV system and Bio-Oils.

2000-01

Dr. Saïoa Tardón, Spain,

successfully defended her PhD titled "Quantitative Photoluminescence Studies in a-Si:H/c-Si Solar Cells" in May 2006 at the University of Oldenburg.

After earning her PhD she immediately started to work for Q-cells company, which is a big PV-cell manufacturer in Germany (www.q-cells.de).

Mr. Srikanth Subbarao, India,

has been granted admission for PhD studies at the Centre for Energy Studies at University of Otago as well as International Global Change Institute at University of Waikato in New Zealand Mid of last year.

His thesis is about exploring potential opportunities for community based RE projects in developing countries through CDM and carbon financing.

Srikanth is interested to interact with the current PPRE students or other PPRE-alumni interested in similar areas of research.

Mr. Francis X. Ochieng, Kenya,

returned to Germany in mid-2007 to under-

take his PhD under DAAD sponsorship at the Endowed Chair of Wind Energy at the Institute of Aircraft Design, University of Stuttgart. His proposed research will be in the field of investigating correction models to be applied to the WAsP-programme in areas with dominant thermal effects using WRF/WAsP approach. Actually, Francis will do the thesis in cooperation with University of Oldenburg / Forwind – Institute and he will be doing most of his research here in Oldenburg, so he settled here with his wife in October, 2007.

Mr. Alger Gil Guerrero, Mexico,

Returned home to Mexico in 2006 where he joined GE Infrastructure / Aircraft Engines in Queretaro (www.ciat.com.mx). He wrote:

Due to unfortunate events concerning my intended PhD-studies in Germany and although I had the chance to go back to Montreal, I decided to come back home. I guess the best way to describe my feelings is to use a well known phrase from the Wizard of Oz...“There is no place like home...”

Although I am working in the Aviation field now, I still have the possibility to go back to Wind Energy here at GE, since we have a Wind Energy section recently created.

Mr. Ram Prasad Ghimire, Nepal,

was promoted earlier this year as a second class officer and transferred to Department of Mines and Geology in Lainchaour, Nepal

Dr. Edgar Anahua Quispe, Peru,

who was working after his PPRE-studies at ForWind - Center for Wind Energy Research at University of Oldenburg, successfully de-

fended his PhD dissertation titled “Stochastic analysis of wind turbine power curves” in October, 2007. Thereafter, Edgar moved with his family to Denmark, where he is employed at VESTAS Wind Manufacturer.

Mr. Kudakwashe Ndhulukula, Zimbabwe
(Alumnus of Renewable Energy M.Sc.-programme of University of Zimbabwe)

informed us early 2007 that he is now Coordinator at the Renewable Energy and Energy Efficiency Institute at the Polytechnic of Namibia in Windhoek. This is a new Institute, which they are building up, which will focus primarily on promotion of and research in REEE technologies and practice. As a young institute, they are exploring areas of cooperation and linkages with established institutes and bodies like PPRE. Namibia, as you are probably are aware, is well endowed with resources like solar, waves, wind and many others but still lacks capacity, both human and economic, to exploit these resources. In mid-2007 his institution has been quite busy with a couple of energy-related capacity-building projects.

You may contact him at: kndhlukula@polytechnic.edu.na

2001-02

Mr. Ibrahim Mohtad Shafi, Bangladesh
(PPRE 01/02)

who is working at the Bangladesh Power Development Board informed us in the end of 2006 that they are planning to install a 1000 KW wind-battery isolated stand alone system and that he is looking forward to having any possible contributions concerning such a project from other alumni experienced in that field.

**Mr. Bahy Saad Abdalla Abd El Messih
Egypt,**

was working at the German University in Cairo as lecturers, but moved to Spain in September of last year, where he was accepted in the "SOLNET" the first coordinated international PhD education program on Solar Thermal Engineering, which is part of "Marie-Curie Early Stage Research Training Network". He is working in the University of Lleida in Spain to optimise and investigate a PV-thermal generator for solar heating and cooling applications. His research work with respect to photovoltaic thermal concentrators is to evaluate a newly designed PV/T that uses mirrors to focus the sun rays on a PV module. Water passes under the cells to cool them down, and because it gets warmer from this heat exchange, it can be used for domestic hot water. Bahy is investigating the electrical and thermal performance as well as the quality of the mirrors.



Old Photovoltaic thermal concentrators (11
suns).

Dr. Anand Shukla, India,

finished his PhD-project titled 'Study of technological, economical and social as-

pects to energize off-grid region through distributed generation in developing countries' at Wuppertal Institute for Climate, Environment and Energy, Germany, and returned to India in mid-2006.

Later he wrote:

It is with great pleasure that I want to inform you that I defended my PhD dissertation on 12th January with flying colours. I was enrolled with the University of Osna-brück and worked on the topic of off-grid electrification, which I studied under three dimensions of the sustainable development - Social, economic and environment.

It took me approximately two years and ten months altogether to achieve this target. And this was again a great opportunity to learn various things, as if I compare my experiences in Oldenburg in 2001/02. I thank you all for the motivation and support I received from your side.

...and later:

I waited for long to collect some information on my further plans. The Wuppertal Institute is assessing some research possibilities in India. From now on, I will work on a business plan to explore various options and possibilities in the field of energy efficiency and RETs in India.

It is only a beginning and nothing can be said with confidence, but I hope to be able to prepare a fruitful conclusion of this study. Further info at: www.wisions.net.

Mr. Butchaiah Gadde, India,



Mr. O. Risse & Mr. B. Gadde at Suntechnics-Booth on the Expo in Bangkok

started his PhD studies at the Joint Graduate School of Energy and Environment (JGSEE), which is an autonomous graduate school instituted under the jurisdiction of the Council of the King Mongkut's University of Technology Thonburi in Thailand. In October last year, he completed his first semester, which means that no more coursework is to be done for him. Since then, he has been working on the PhD proposal, which will be related to energy policy, climate change and renewable energy.

In July, 2006, Butchaiah met Oliver Risse, Germany (PPRE 01/02), and Chayun Budiono, Indonesia (PPRE 94/95), on the Renewable Energy Expo in Bangkok.

Mr. Ernest Mazimpaka, Rwanda,

started his PhD-studies in the Energy Research Centre at University of Cape Town in South Africa in October, 2006, already. His

research is in the field of energy and development Studies.

Mr. Jörg Winterfeldt, Germany,

wrote:

Best wishes to everybody from Geesthacht near Hamburg. Currently I am a PhD student at the Institute for Coastal Research at the GKSS Research Centre. I am working in the department "Coastal Climate" on extreme value statistics of wind from observations (platforms, buoys, satellites) and atmospheric models/reanalyses. Until Sunday 13th of August 2006 I didn't have tornadoes on my mind as extreme wind events. I suddenly changed my mind when some friends and I saw this nice tornado during our weekend trip to the island of Fehmarn in North Germany. Although it seems that the tornado crushed right into these poor small Enercon wind mills (now I know what repowering means :-)), no emergency halt was necessary.



The tornado was at least 4 to 5 km behind the wind mills over the Baltic Sea. We were watching the tornado for around four minutes while taking pictures - then it disappeared. It was not only a close encounter

of a third kind but also a big motivation for extreme value statistics. Best regards, Jörg.

Mr. Santiago Sánchez, Ecuador,

was pleased to announce that, as of January, 2007, he was appointed Deputy Minister of Renewable Energy and Energy Efficiency of Ecuador at the Ministry of Energy and Mines of Ecuador, as part of the new administration of President Rafael Correa.

In addition he noted: These new responsibilities of serving my country could have not been possible had I not had the opportunity of studying at the PPRE during the years 2001- 2002. I count with all your support to accomplish all the activities planned to improve and disseminate RE and energy efficiency in my country.

Latest news: Santiago resigned from his Minister-job and returned to his private consultancy.

Mr. Asliddin Komilov, Uzbekistan,

informed us in November last year that he is engaged in a project called "Active promotion of solar and biomass energy use in Qashqadaryo province, Uzbekistan" funded by WISIONS (www.wisions.de) and that he was straggling to find sketches for sun tracking clockwork mechanism.

Furthermore he dropped a note that he also started his PhD "Development of PV devices for agricultural use" in the Institute of Physics and Techniques at Academy of Science of Uzbekistan.

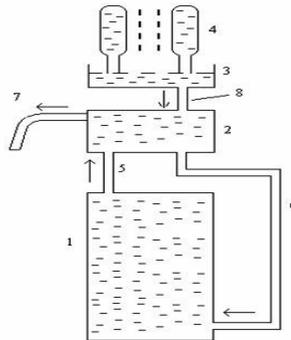
The project he works with is to develop a universal system that combines solar heating and a PV panel for agricultural and rural

use. A prototype was actually developed before he started his work, but it was never manufactured.

Hence, Asliddin financed it to find out its cons and pros. It is a combination of a flat, container a few millimeter thick covered with glass which has solar cells mounted on it. They made it with special glass, and via a special technique that is to be patented. It uses more of solar flux than PV panel, offering also heat and



Scheme water heating system of a combined heat and PV converter



- 1-Water container under the PV module
- 2-Water tank for heated water
- 3-Feed water level stabilizer
- 4-Feed water vessel
- 5,6-Water circulation pipeline
- 7-Hot water outlet
- 8-Feed water inlet

is better than solar collectors because it also produces electricity. It is a general evaluation of this product and he wants to find out more. He has already made some comments and modifications and is writing an article. With some luck, he will finish the experimental part of the work by next year and start writing his PhD work.

Mr. Jordi Avellaneda de la Calle, Spain,

successfully graduated from the MBA at IESTE, Barcelona, Spain, on May, 2006, and was hired by Maersk Logistics in Copenhagen in June, 06. Jordi decided to move from

the renewable energy world (from which he was disappointed because of two negative experiences) to the logistics world.

He wrote: The last year has been an amazing year and I have been able to travel all over the world, giving training seasons, and improving our operations. This does not mean I forgot renewables and Oldenburg. From time to time, I assist an NGO in solar projects and I am also taking some refresher training in the implementation of renewable projects.

I also receive, from time to time, questions from Spaniards that want to take the MSc in Oldenburg. I hope some of them manage to get there. Oldenburg is always a sweet memory in my life.

I hope I will be able to pass by Oldenburg at any time. The world is getting smaller and smaller – Jordi.

2002-03

Mr. Jhantu Kumar Saha, Bangladesh

Is still a PhD Student in the Functional Quantum Device Engineering Lab, Dept of Functional Materials Science & Engineering, Saitama University, Japan. Recently he is focusing his research on fabrication of microcrystalline and amorphous silicon thin film for thin film solar cells using plasma enhanced chemical vapour deposition. He already has several international journal papers about his research. In August 2007 Jhantu traveled to the USA to presenting three papers in the 22nd 'International conference on Amorphous and Nanocrystalline Semiconductors (www.icans22.org) organized by National Renewable Energy laboratory (NREL), Colorado, USA.

Jhantu is expecting to get his PhD on materials science in PV by March, 2008.

Ms. Jie Shao, China,

is working in the 'China Wind Power Research & Training Project' from the German Development Cooperation (GTZ) in Beijing, China. The objectives of this project are providing services to the wind energy industry in China; improving the professional and technical skills and knowledge for on-grid wind power utilization in China; and even offering policy consultancy to the Chinese government to promote development in renewable energy.

Mr. Gianpiero Nacci, Italy,

wrote at the end of 2006: I am still in London at the European Bank for Construction & Development –EBRD -, very busy with sustainable energy projects (mostly in the industrial sector but increasingly also in the residential) + carbon credits (we've two carbon funds managed by our team). Renewables are still quite difficult in our region but we're doing some hydro & biomass. We are trying to enter wind energy as well, but it's very difficult. Also we have a lot of interest for biofuels but markets are still evolving.

Mr. Alejandro Bango, Spain

After a three years working for a local consultancy on several projects, specially CDM market, Alejandro moved forward to the quality sector where he is working right now.

The company is the German subsidiary of TUV-Nord. He is following audit courses to become an ISO 9001, ISO 14001 auditor. His plan is to bring this experience to the RE

market, specially to the wind energy sector where the quality assessment is so important.

Alejandro is still living in Sao Paulo city, but in a short time, he is trying to move out to a quieter place somewhere around Sao Paulo or Rio de Janeiro, which still holds a certain glamour and life quality.

The RE sector in Brazil has steadily increased in size and business opportunities for the wind energy sector and mainly the big wind players are settling down in Brazil.

Mr. Fernando Vega, Honduras,

who is presently researcher/lecturer at private John Brown University (www.jbu.edu) in Arkansas, US, travelled end of July, 2007, for two weeks together with his colleague Prof. Young-Gurl Kim to Nairobi, Kenya, where they gave seminars on various aspects of rural development, including renewable energies, food development, water resource development, transportation, etc. On the way back they had a stop-over of three days in Oldenburg to visit PPRE-staff and -facilities at University of Oldenburg and to do site visits in the region to various biogas-plants.

This was done as part of the summer activities of the IBCD (Institute for Biblical Community Development) (www.IBCD.net) lead by Prof. Young - Gurl Kim at John Brown University. The overall mission of the institute is to train and empower missionaries and local community leaders in developing countries in various areas of development using appropriate technologies in order to improve the livelihoods of their communities.

Mr. Joo Yeol Lee, South Korea,

who is still employed as Project Engineer in Department Renewable Energies at Lahmeyer International GmbH in Bad Vibel, Germany, is glad to meet quite a few PPRE-students or graduates who joined the same company in recent years. Jay is still working for wind energy projects in South Korea, and the more years that pass the more clients and projects which are gained.

Mr. Manoj Khadka, Nepal,

was selected by UNDP of Nepal and joined this organisation in August, 2006, to work in rural energy project in Nepal Manoj decided to join UNDP to push his career on a long term basis. He needs to go to work at the rural areas for the implementation of rural energy schemes in Nepal.

2003-04

Spontaneous alumni meeting in Mid Germany in May/June 2007:



Andi Michel, Germany, Nicolas Veneranda, Argentina & Indradip Mitra, India

Mr. Firoz Ahmed, Bangladesh

was employed last year as teacher and co-

ordinator of Alternative Energy Engineering Technology program in a community college named Lampton College, School of Technology, Applied Sciences and Apprenticeship in Sarnia, Ontario, Canada. Firoz is supposed to implement and teach RE courses. Last Winter term he was teaching fluid mechanics and mechanical machines and preparing the materials for all three courses on wind, solar thermal/photovoltaic, small hydro, which he was lecturing in the first term this year. It seems that he is enjoying his work.

In May 2007 they installed a 1 KW wind turbine from Bergey Windpower Co. at their college site, which is a demonstration project for the exposure of our program to the community.

In late December 2006 the Dean of Technology, Maike Luiken, was visited PPRE facilities in Oldenburg University, Germany.

Mr. Everson Possamai, Brazil,

is still working for a multinational steel mill plant in Brazil as Environmental Manager. Over the time his duties have become more & more interesting. Everson is responsible for solid waste management of the plant in Porto Alegre, which is located close to where he is living with his family. In the free times, he is doing some calculations for solar water heating for showers (since he doesn't want to stay disconnected from RE). Everson wrote at their end of last year that, with respect to biofuels, things are booming in Brazil: 90 new sugar cane alcohol plants are under construction and biodiesel is on the way. About wind: His state is the leading one in wind energy power: a new park with 150 MW installed power started operation a few months ago. The partners are Enercon

and a Spanish company. If the Brazilian government is going to accomplish all promises, then many more windfarms will be installed in the near future.

In mid-2006 he received an unexpected visit: Alejandro Bango from Spain (PPRE 02/03) was involved with some duties with his company for the boss of Everson and hence took the chance to meet him in his office for a small PPRE-alumni-gathering.



Solar Cooker for US\$ 200

Latest news:

Together with a friend, Everson coordinated the construction of a solar cooker in a school as part of a volunteer program, sponsored by the steel mill where they work (note: the cooker structure is made of steel rebars produced by us). They gave classes on environmental education and allowed the students to do something practical for the environment. Their idea now is to show the solar cooker in public events together with the students. It boils one liter of water in 15min and costs about US\$ 200,00.

Mr. Andreas Michel, Germany,

who joined the GTZ after his PPRE-studies and is working in ProBEC - Programme for Biomass Energy Conservation in Malawi ever

since, informed us that their programme received the Green Oscar in 2006, the so-called Ashden Award. Aprovecho/ProBEC, southern Africa, has developed and distributed 1,500 stoves to institutions across southern Africa that are uniquely designed to dramatically cut fuel wood use and reduce indoor air pollution.

Details may be seen at: http://www.ashdenawards.org/media_summary06_southern_africa or http://www.ashdenawards.org/video_2006_malawi
Further info at: www.probec.org

Mr. Meirzhan Dosmailov, Kazakhstan

informed us in September, 2006, that he got another M.Sc.-degree at Portland State University, US, and is looking for a PhD position.

Mr. Matthieu Sarran, France

joined Lahmeyer Int. in Bad Vibel, near Frankfurt, in late 2005. Matthieu has been working on some interesting projects in Africa where he has gone several times.

Mr. Prashun Ratna Bajracharya, Nepal

left the Biogas Program in Nepal earlier in 2007 to join the Universal Consultancy Service Pvt. Ltd. (UCS). This organisation is working in the fields of microhydro, biogas with waste water treatment and quality control of solar PV.

Mr. Iresha Somarathan Palle Badalge, Sri Lanka,

is now Energy Manager of a biomass power plant, which was implemented by MAS-Holdings, Sri Lanka, to power one of their

factories.

Mr. Julio Rene Sanchez Contreras, Colombia,

is still working (with unlimited contract) - chiefly in solar thermal power - as Project Manager at the Renewable Energies Department, Energy Division, Lahmeyer International GmbH in Bad Vibel, Germany.

2004-06

Mr. Juan Carlos Moreno, Venezuela,

who joined the RE team of FUNDELEC, a governmental foundation, after his PPRE studies, informed us earlier this year that he is implementing solar systems in the Amazon region and that the local situation is quite optimistic, since many projects are going on at the moment. actually solar and wind are the main areas.

Mr. Sebastian Hermann, Germany

After his assignment with "Deutsche Energie Agentur" – DENA – in Berlin last year, he notified us that he would change jobs this year. In October 2007 he started working at UNIDO in Vienna, Austria, where he is involved in 'Renewable Energy' and 'Productive Use'.

Mr. Shahriar A. Md. Chowdhury, Bangladesh,

re-joined the Bangladesh Power Development Board after his PPRE-studies. He was planning (together with Ibrahim Mohtad Shafi - PPRE 2001/02) to promote RE activities in Bangladesh in an organisational capacity. They are trying to launch a new organisation naming "Centre for Renew-

able Energy Research”, in collaboration with United International University (UIU), Dhaka in Bangladesh (www.uiu.ac.bd). Some of their organisational goals are:

- Human resource development and capacity building in line of renewable energy activities;
- Penetrating the ideas of RE in high and mid-level policy makers and government officials;
- To provide short course/ training on different RE technologies among those who are working in rural development activities;
- To build up the RE lab facilities including solar cell measuring and testing, prototype wind turbines and wind tunnels, small biomass digesters, solar driers, solar home systems, solar cookers etc, to train and demonstrate these for people;
- To provide policy guideline to the government to promote the RE technologies;
- To provide consultancy services to determine the resources of RE and its proper utilization. etc.

Latest news: Shahriar resigned from the BPDB in April, 2007, since he realised that he can work more in RE and established the RE research centre in Bangladesh only as a University faculty member. Actually his university is providing him with all the necessary support and he is now enjoying giving RE classes seeing his students interested in RE.

Actually they are offering RE as an undergraduate course in Electrical and Electronic department for the first time in Bangladesh. Shahriar is responsible for the course design

and also to give the classes. He designed the course through expertise gained in Oldenburg and in Stuttgart (during his thesis work).

Mr. Boon Jin Tek, Malaysia,

is employed as engineer at Suntechnics Energy Systems Pte. Ltd. (www.suntechnics.com) in Singapore since Mid of last year. During practical training 2007 Boon Jin met up with present PPRE-Student Ms. Faraida Nafiri from Indonesia, who did her practical training at Suntechnics, Singapore.



3 generations of PPRE meet in Singapore: Oliver Risse (PPRE 01/02 – Director of Suntechnics, Singapore), Boon Jin Tek (PPRE 04/06) & Ida Nafiri (PPRE 06/08)

Mr. A.N.M. Zobayer, Bangladesh,

who was working in the Sustainable Rural Energy Project at the local Government Engineering Department, Bangladesh, informed us upon his return home that he and his family went to AIT Thailand in the middle of 2006, where he developed a biomass gasifier stove, which will be implemented in Bangladesh on a large scale. Additionally, he mentioned that they already installed 600 LED-based solar home systems in Bangladesh previously.

Latest news:

In 2007 Zobayer changed jobs. He is now works with GTZ Bangladesh as Program of-ficer (Renewable Energy) in a project called "Sustainable Energy system for Development"

Mr. Naveed Akhtkar, Pakistan,

quit in October, 2006 his job as Research Engineer at the Chair for Materials Processing in University of Bayreuth, Germany, to move to Birmingham, UK, where he received a full fee scholarship with a "Dorothy Hodgkin Award" at University of-Birmingham. His PhD is fully funded by E-ON (a German energy company), with full fee waiver and living allowances in UK. For three years, Naveed will do his PhD in Fuel Cell Modelling with a joint collaboration between Maths and Chemical Engg. Dept. at University of Birmingham.

Mr. Christian Heprevoo , Peru,

started to work as a pract. trainee at GE in Cologne right after his PPRE studies last year. After some months, Christiano shifted to Italy, where he was employed at 'Bio&Watt' – company in Mailand, which is a very new Italian company. They are working in a project which consists of developing the technology of downward and upward gasification. Their main objective is to develop gasifiers which can produce electricity from wood chips, sorghum, sugar cane, bagasse and rice husk. Earlier this year they were installing the first sold machine. Christiano is responsible for the design of the machines, mechanical, electrical and automation. He supervises the work of the specialist engineers in each branch. On the other side, he is investigating the part of the

Internal combustion engine, how it works when mixing the inlet air with the producer gas. It seems like Christiano is enjoying his present duties, since he can also apply the knowledge gained in the Mechatronics Engineering studies he did in Peru.

Mr. Maksim Toropov, Kyrgyzstan,

wrote:

I'm glad to inform you that I'm starting from 01.08.07 with a job in Würzburg at SunCarrier (www.suncarrier.com) as a trainee for project manager. By the way, this is the company where we did a group photo with PPRE on InterSolar2007. SunCarrier is realizing projects for big PV plants on their huge tracking constructions around the Europe. This is a growing division of a+f GmbH (www.art-form.de), the subsidiary of Gilde-meister AG (www.gildemeister.com). And in some months I'll have a chance to supervise one of the parts in production chain such as sale, supply, engineering / research, project realization or service.

Mr. David Otieno, Kenya,

who joined the German Technical Cooperation (GTZ) as Regional Energy Advisory after PPRE, informed us that GTZ at the moment has a strong focus on biomass (household level) related activities in Kenya. These are mainly biogas and improved cook stoves under the private sector development in agriculture. On the policy level, there are discussions to support the energy policy discussions in the country, as well as the regional discussions under EAC on developing a regional energy scale up strategy for the East Africa member countries. Actually, they are getting new requests from the Kenyan government, and this may change what we do in Kenya in the near future.

Since his responsibilities cover not only Kenya, but also Tanzania, Uganda, Rwanda and Ethiopia, he also has the chance to deal with different projects like MHP, solar PV, energy policy and other off-grid alternatives.

2005-07

Mr. George Pechlivanoglou, Greece,

continued to work for Suzlon (and its daughter company Idaswind) after his thesis, where he has now obtained a permanent contract. He is employed as a Research & Patent Engineer in the Innovations Department at Suzlon Windkraft GmbH in Berlin (www.suzlon-wind.de). In detail he wrote: I am in the very pleasant situation to inform you that since the beginning of March I am officially a regular employee of Suzlon Windkraft GmbH with a permanent contract. I am working in Kreuzberg, Berlin at the Research, Development & Innovation department of Suzlon Windkraft GmbH, and my tasks mostly involve patent analysis, engineering troubleshooting and innovation design. Additionally, I continue the development of the robot for the wind turbine blade inspection, which is currently undergoing its 5th and final version.



George P. experiences "The power of the wind" with a Parafoil Kite at a Wind Park near Prenzlau, Germany.

Mr. Sebastian Randig, Germany.

As Project Manager with respect to CDM/ Auditing of Clean Development Mechanism Projects at TÜV SÜD Industry Service GmbH, Carbon Management Service (www.tuev-sued.de/climatechange), Sebastian Randig is travelling quite frequently to China these days.

(Please see also his report about present duties)

Ms. Herena Torio Blanco, Spain,

PhD student at the Fraunhofer Institute for Building Physics in Kassel (www.ibp.fraunhofer.de), and in cooperation with the TU Munich. The PhD is focused on the integration of solar thermal and surface - geothermal (Erdwärme) energies in the built environment both for heating and cooling purposes. It aims at pinpointing the best-use possibilities for these systems, as well as their main optimisation chances.

Herena also did her M.Sc.-thesis project at the same Institute.

She receives a grant for her PhD studies from the DBU (Deutsche Bundestiftung Umwelt – German Environmental Foundation).

Mr. Rodolfo Hegel, Guatemala,

started as an RE consultant with Lahmeyer International in Bad Vibel, Germany. He is working in the Renewable Energy Department as a support for the Latin American Projects (where among others Mr. Wesly U. Vargas from Costa Rica – PPRE 1998-99 – is employed for many years) and focuses in biomass and Rural Electrification for this and other regions. Rodolfo did his M.Sc.-

thesis project with Lahmeyer before.

Mr. Ahmed Jahir Khan, Bangladesh;

started to work in Bangladesh Power Development Board (BPDB) (www.bpdb.gov.bd) after PPRE as sub-divisional Engineer in the planning division. BPDB is responsible for generation, transmission and distribution of electricity all over the country. He is a permanent employee of this organization. Presently Jahir is involved a feasibility study of a 10 MW Wind Power Project, which is done in cooperation with a JICA (Japan International Cooperation Agency) team. The Japanese government is funding this project.

Mr. Camilo Andres Wilches Tamayo, Colombia,

got a job as Project Engineer in charge of international projects (Latin America and Spain but he is also working in a project in Indonesia) right after his studies with us. He is employed at biogas Weser-Ems GmbH & Co.KG (www.biogas-weser-ems.de/), which is located near to Oldenburg. The company has been in existence for only seven years, but they have already built more than 100 power plants.

His new company has a good possibility to obtain a contract in Colombia. If this is the case, Camilo will go to develop the project. Camilo seems to be very happy with his work, since he has many responsibilities and is learning a lot.

Camilo has a two-year contract with the company. Thereafter, he would like to start a PhD program in Germany (Duisburg or Stuttgart).

Mr. Luis Enrique Domingo Vera Tudela Carreno, Peru,

Is currently working for the Hywindbalance project (see www.hywindbalance.com), to improve the wind power supply by using energy storage (in form of hydrogen) in order to ameliorate the offer of scheduled energy from wind power producers to the electricity market. Officially, he is employed as researcher at Overspeed GmbH (www.overspeed.de), where he did his thesis project as well. His present position is fixed until the end of march, 2008. What comes after that is not decided yet. Luis is looking forward to project development activities, mainly in wind and biomass fields.

Mr. Andrew Peel, Canada,

wrote: I've recently started a job in England at the British Research Establishment. They do pretty much everything to do with buildings. I'm working as part of the Low Energy/Low Carbon Housing Team as a consultant.

There's a lot of activity in the UK at the moment in low energy housing. The government recently announced that by 2016, all new buildings will have to be zero-carbon buildings (i.e. their net emissions over the course of the year have to be zero). And they've recently released a document called "The Code for Sustainable Homes", which outlines the various requirements. It looks at more than just the energy, considering things such as waste water, construction materials and waste, and pollution.

This is a very impressive (though surprising) announcement and it's generating a lot of interest in low carbon housing from builders. So we'll certainly have our work cut out for us. Internet: www.bre.co.uk

(please see also detailed description of his job under reports)

Ms. Donna Caag, the Philippines,

re-joined the Batangas State University in the College of Engineering, Research Office and Review Center as faculty member upon her return after PPRE. She is looking forward to get a PhD position in the future.

Mr. Dwipen Boruah, India,

returned to his former employer, the Assam Energy Development Agency, as Scientific Office after his studies with us. Dwipen is working for some new projects, (e.g. he is planning to initiate some grid connected PV and biomass power projects, which will be very new for the region).

Ms. Hashini Wickramarathne, Sri Lanka,

got a job in a Company in Sri Lanka upon return after PPRE, although it's not related directly to renewables. It's a company which manufactures garments. It's one of the biggest apparel manufacture companies in Sri Lanka, and it supplies over 50% of Victoria's Secret products. Hashini joined the company as management trainee in May, 2007. The company is called MAS Holding - www.masholdings.com. Actually, the companies cares about energy, since they built a biomass power plant already to power one of their factories. The energy manager of the project is a former PPRE student, named Iresha Somarathna Palle Badalge from Sri Lanka (PPRE 03/04).

For the time being, Hashini will be working in another group of the company. But in future, they might introduce this power-concept to other factories, as well, so she might be able

to work with renewables again.

Mr. Ivan Herrarez, Spain,

was also directly absorbed after his PPRE-studies by the company where he did his Master-project. He is now working permanently for Nordex Energy GmbH, where he has joined the Central Engineering Department in Norderstedt, Germany. He is a development engineer in the Basic Machine Design Department, where he is mainly involved in structural dynamic calculations of the wind energy converters (pure mechanical engineering). The job seems to be very interesting and the work environment is also nice.

Mr. Seth Mahu, Ghana,

did some work as RE researcher for GPCo Inc. in Canada after PPRE. It is a leading technical consultancy firm in the development of wind energy in North America and elsewhere. Seth is working on a proposed commercial wind farm project for Ghana. Although Seth is, at the moment, non permanently employed (he returned to Oldenburg in June 2007 already to help his Vida giving birth to their first on Matthew late June) he sees the future for this project quite promising and is looking forward to be part of it upon his return to Ghana. Latest news: Seth Mahu return with his family to Ghana, where he is working as country representative from GPCo Inc.

Mr. Michael Sterner, Germany,

started his PhD-studies at Institute of Solar Energy Techniques (www.iset.de) in Kassel, Germany right after PPRE.

The preliminary topic of his research is 'The

Contribution of Bioenergy to an Integrated and Sustainable Energy Supply' with keywords like 'Sustainable Land Use', 'Energy Balances', 'Climate Effectiveness', 'Technological, Economical, Environmental Analysis & Assessment'. (more info to come...)

Mr. Bhairaja Maharjan, Nepal,

returned home after PPRE to look after his own consultancy firm for now, which is called Petro Engineering Consultancy Private Limited located in Kathmandu, Nepal. End of the year, Bhai Raja will most probably join his wife for a while, who is studying Regional Planning in Giessen, Germany.

Mr. Mulugeta Weldetnsae Beyn, Eritrea,

extended his contract with Lahmeyer as Trainee Engineer after his did his final M.Sc.-thesis 'A New Approach for Wind Energy Development in Developing Countries of the Red Sea Region' with them, as well. Mulugeta plans to return back home in autumn, 2007.

Mr. Jagwe Wyclif, Uganda,

is employed at a Norwegian Consultancy firm - NORPLAN Uganda Limited (www.norplan.co.ug and www.norplan.com) consulting engineers and planners - in Uganda since his return from Oldenburg. He is doing lots of work in rural electrification power projects plus solar-PV. More precisely, Jagwe is working on several projects:

- 1- Hybrid solar water pumping systems for water supply to rural off-grid towns with populations of 5,000-15,000 people;
- 2- Design and construction supervision of a 600kW solar power plant in hybrid

with 2x350kVA diesel gensets, plus design of associated 33kV electricity grid to power a 40km long island on Lake Victoria;

- 3- Electrical engineering for a 3kV 250km rural electrification power line serving about ten rural towns and villages in Northern Uganda.



Jagwe at a 23.4 kWp solar-water pumping system, which he designed while still in Oldenburg. He supervised construction and now it is complete, ready for commissioning. The picture was taken when making the final inspection to instruct the contractor to commence with commissioning activities.

He is also giving assistance to the United Nations Organization for Project Services (UNOPS) in Juba Southern Sudan to carry out feasibility, design and supervise construction of Hybrid-solar/diesel/grid power plants to supply energy to 11-government commission facilities in the region.

On a personal basis, Jagwe came back to Kampala in February, 2007, and installed about five solar-PV systems by May, 2007. This obviously opened his eyes so that he registered his own company. He also did a lot of consultancy on house-hold electricity and hybrid PV-systems.

Jagwe also met with **David Otieno from**

Kenya (PPRE- 04/06) several times, who is now the projects coordinator for east-Africa projects for GTZ and his company has signed up a contract with GTZ, so the future seems to be bright.

Ms. Patricia Chaves, Brasil,

started her PhD-studies at the German Wind Energy Institute (www.dewi.de) in Wilhelmshaven, Germany, in October, 2007. The preliminary title of her research study is "Economic survey of a Wind Farm portfolio". The task is to analyze and quantify the influences, risks and optimization possibilities

of a portfolio of wind farms. How location, technology and O&M have influence on the reduction of risks and improvement of the economical attractiveness of the investment when assembling a portfolio of wind farms. (more info to come, since her work is only at its very early stages).

News from EUREC-Alumni in brief

2004-05 (EUREC-M.Sc.)

Mr. Tristan Lermite, UK,

was working at ttz-bremerhaven, where he also did his thesis-project, as a trainee project manager on biomass projects after his EUREC-studies.

At the beginning of this year he received a job offer in the biomass sector. After several months of searching for a proper job, the situation changed end of last/beginning of this year drastically, since there are many jobs available now in the UK and companies have been asking Tristan for interviews almost weekly!

In April 2007 Tristan joined a company

called Econergy Ltd.: <http://www.econergy.ltd.uk/WhyWfuel.html>

Tristan's job title is Project Manager SW Region. It involves visiting sites where a biomass boiler is to be installed, and working on the system design/specification/economics etc. Also looking into the supply of biomass/servicing and maintenance needs.

In August he wrote:

I've been working for about three months now, working and living in Bristol in SW England.

I am currently managing about 15 projects for boilers ranging from about 50-500kW. These are log/chip/pellet boilers. I typically do a site visit, and assess the place for heat

loads and suitability for the installation, produce a quote document, and then manage when parts/boiler are manufactured, and when plumbers/electricians etc. go on site, and answer any queries along the way.

Demand is very high, and I am kept very busy!!

Mr. Romaric Thiebaut, France,

changed his job but stayed in the same company. He is now in Spain (Galicia) working for Vestas (manufacturer of wind turbines) since mid-October 2006. Before, he worked for Vestas blades factory in Isle of Wright, UK.

Mr. João Paulo Costa, Portugal,

informed us that after his EUREC-Studies, he joined a team, working in CIEMAT (Madrid), to develop an electricity power plant using parabolic collectors technology and gas and molten salt circuits as the reception heat fluids. It is a two-year project.

Mr. Denis Thomas, Belgium,

informed us about his duties at "Energie Facteur 4 asbl" (www.ef4.be), where he has been employed since May of last year, as follows:

I'm still working for the same association, trying to implement at least ten photovoltaic projects on public building in some pilot municipalities. After 3-4 months of preparation, the project has finally started, and I just finished my two busiest weeks with the visit of the ten municipalities (one by one explaining them what are photovoltaics, how does they work, how can it be implemented on a building...). And that was great. Even

if PV is unknown here, you see people are very interested. And I always wanted to be some kind of teacher, so I'm very pleased to do these kinds of things. Moreover, I've been charged to advise any person in Wallonia who wants information. Then I am in close contact with all the professionals of PV in Wallonia, and I sometimes give a conference about PV: how to set up a project, which subsidies and so on. I also developed our website: www.ef4.be. As you see, I am very happy with my work. The good thing is that I have many responsibilities and that I can manage my time as I want. I can work from home any time I want, and I am busy very often with visits and so on. I think this was a job sized for me or maybe I sized it for me...

Mr. Duncan Ansell, UK,

is no longer working as Marine Resource Analyst at Marines Current Turbines Ltd, Bristol, UK.

He moved to Toronto recently, where he is getting married to a Canadian. He got a new job in the offshore oil exploration industry, for the time being, but would like to find something in renewables in Canada again in near future.

Mr. Laurent Lecesve, France,

started his PhD with Prof. Schmidt from Inst. of Solar Energy Technic (ISET) in Kassel, Germany after his Master-Studies with us. His PhD is focusing on 'Hybrid Systems (HS) within Mini-Grid for Rural Electrification and water supply'.

Details may be seen at:
www.hybridenergies.org/

2005-06 (EUREC-M.Sc.)

Mr. Leodegario Lopez, Mexico,

finally managed to finish his M.Sc.-thesis at the Technology-Transfer-Centre – TTZ – in Bremerhaven, Germany, in June, 2007. Afterwards Leo extended his contract at TTZ with better conditions (not that good anyway) as project manager (taxes in Germany kill you!!) for two years. He is working on cellulose ethanol and biogas reactors (bio-fuels).

Mr. Antonio Antonopoulos from Canada

is working full-time as an engineer on international RE projects for ETA Renewable Energies (<http://www.etaflorence.it>), where he also did his final project. The main project he is working on is a “master plan” for a “sustainable community” in the United Arab Emirates, outside of Abu Dhabi. He is developing, with one other colleague at ETA, the renewable energy strategy for the Masdar Initiative, “the world’s first zero carbon city”. Due to Antonio, this is a really exciting project, on the order of \$20 billion!! Here you may find more info about it:

- press release: <http://www.fosterandpartners.com/News/291/Default.aspx>
- the project site: <http://www.fosterandpartners.com/Projects/1515/Default.aspx>
- a fancy video about it: <http://www.masdaruae.com/text/v-files.aspx>

Comments from Antonio: I’m really lucky to have gotten into this project, as it’s a world’s first and really exciting, and in six months I have had almost every single RE technology issue crammed into my brain, but it leaves

almost no time for even sleep sometimes!!

Mr. Jerome Rouze, France,

After finishing his project in the UK, he returned to France where he started to work as consultant in solar energy for Transenergie (www.transenergie.fr).

Mr. Steven Xuereb, Canada/Malta,

wrote:

After completing the EUREC Master, I returned to my home town Toronto, Canada. I hadn’t lived there for seven years, so it was very exciting for me. Upon arriving, I set up my own renewable energy consulting business, concentrating on wind farms and autonomous electrification projects. Currently I’m working as a sub-contractor for Airtricity, an Irish wind farm developer, assisting on preparing bids for large wind farms across Canada. The Canadian wind energy market is still in its infancy so most of the work is still in development.

Initially I will be concentrating on offering my services as an Operational Manager for wind farms in Ontario. This will include doing performance analysis, dealing with warranty issues, supervising maintenance and repair work, producing regular reports, being the contact to local community members, ensuring safety and certification regulations on site, being the liaison to the electrical utility and looking after all other technical issues. In addition I will be offering consulting for autonomous rural electrification projects for cottages and communities in remote areas of Ontario, including on Native Canadian reserves where diesel generators are often used for electricity supply. My services will include seeking governmental and private funding, socio-economic evalu-

ations of the communities to be electrified, coordination of the project implementation and periodic monitoring and evaluation.

I plan to continue working independently and hopefully will be in a position next year to have some partners in my business to help expand into other areas of the renewable energy industry.

My new company: Renewable Generation (www.renewable-generation.com)

E-mail:

sxuereb@renewable-generation.com

Mr. Bertrand Guillot, France,

started to work in July, 2007, as a Renewable Energy engineer for a Belgian company called MATRIciel (www.matriciel.be) in Louvain-la-neuve. They are doing consulting in sustainable architecture (actually it's a spin-off from the bio-climatic architecture department of the Université Catholique de Louvain).

Mr. Hadi Sader, Lebanon,

joined SYNLIIFT Systems GmbH in Berlin, Germany (www.synliftsystems.de), as a product development engineer after his studies with us. Basically, he is continuing the work he started in his internship. The project is an R&D project, studying a "wind - reverse osmosis desalination plant", operated in variable mode. His specific task is on the simulation of the complete plant (wind turbine, energy storage, pumps, membranes...).

Synlift is a relatively new company that offers 'Applied solutions for wind power'. SYNLIIFT Systems implements challenging wind energy projects worldwide. Their core

competencies are site development, construction & commissioning and operation management. Additionally, they design and launch innovative wind power applications.

Mr. Luis MONTES DE OCA ARJONA, Spain,

stayed at the company where he did his project in Barcelona, Spain. The company is called Activos del Conocimiento S. L. (www.grupoactivos.com/) and is dealing with Biodiesel mainly.

Luis is doing marketing, where he is in charge of contacting new potential clients to consume biodiesel, which are transport companies, gas stations etc. He is advising customers about biodiesel. Additionally, he researches new markets and searches new suppliers for soybean oil, their main raw material.

Mr. Mohammed Adnan, Pakistan,

Returned to Pakistan, where he is working in Glass Industry for troubleshooting in Glass composition on temporary basis. Latest news: Mohammed returned to Germany, to properly finish of his M.Sc.-programme and to check out PhD-possibilities.

Mr. Philippe McCracken, Canada

who did his thesis on 'Solar Electrification of Island Communities in Palau' is still living and working in Palau following his project. He is working on energy conservation policy. Basically, he is writing energy conservation strategies for the government, to help it reduce its electricity and fuel use. He is also working on an EU project that will:

- install 100 kW of grid-tied PV capacity at the Capitol building (his role is to get the utility to maintain the systems)
- install solar street lights at intersections along the highway that goes around the main island (He'll be drawing up the technical specifications)
- draft an Energy Efficiency Action Plan, which will propose actions that can be taken on the national level to reduce Palau's energy use. (done by Philippe)
- hire an Energy Planner to work within the Energy Office, and train him/her (done by Philippe)

Hence, Philippe is still in RE but is slowly leaning towards energy efficiency and conservation. He plans to leave in mid-November to travel a bit and will be on the job market by January of next year.

Mr. Robert Singlehurst, Canada,

accepted a position with EnerWorks Inc., in Dorchester, Ontario, near the city of London, about 180km west of Toronto. They are a solar thermal manufacturer. Please check out their website at www.EnerWorks.com. Robert will be a Product Support and Train-

ing Engineer at this company.

Mr. Theodoros-Theodoritos Polizois, Greece,

has been working for four months in a small company called Alexakis Energy installing PV-systems after his EUREC-studies. Thereafter, Theo was ordered to serve the army, where he joined the engineering division until February of next year. In October he will leave the island of Lesvos, where he is serving now, and return in a military campus near Athens until coming February. Theo is looking forward to finally getting a job in Renewables !

Mr. Yunus Teksan, Turkey,

who unfortunately left the EUREC-programme after 1 term only informed us that he returned to Istanbul, where he started to work in Teksan Generator Ltd. (www.teksangenerator.com). There he is studying on ERP (enterprise resource planning) project which is on process to be implemented in the factory. Since April Yunus also had to join the army for a while.

A HEAT CHARGED ELECTRO-CHEMICAL - THERMOSTORAGE CELL

Issac Ennison, Ghana (PPRE 1990/91)

informed us about a new type of electro-chemical cell that he has conceived and which he would like to discuss with other experts. Actually Isaac is looking for suitable reagents for which he could need some help and inputs. For any feedback please contact: iennison@yahoo.com.

Principle:

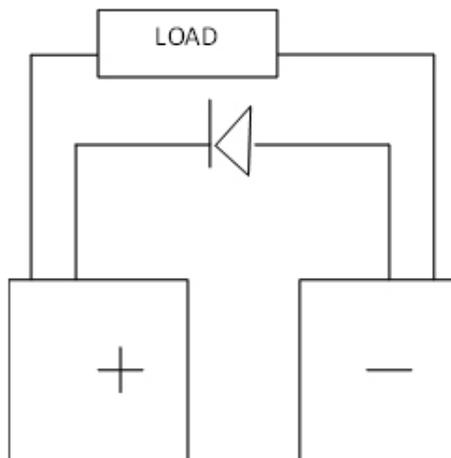
The proposed cell is charged by heating it. Obviously developing such as cell will help in solar energy applications. It works on principle of chemical equilibrium whereby heat is applied for an endothermic chemical reaction to take place during the charging process. During the discharge process, the cell is in the cold state and it therefore discharges in accordance with the Le-Chatelier's principle of chemical equilibrium.

Design concept

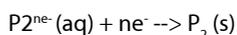
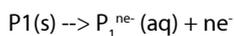
A secondary cell that is charged by heat is proposed. The operation of this cell is based on equilibrium in electrochemical system. Chemical reactions are mostly the REDOX type. In this particular case equilibrium chemical reactions which are endothermic in one direction and exothermic in the opposite direction are to be studied. The endothermic stage represents the charge process and the exothermic stage represents the discharge process. A typical cell is represented in the diagram below.

During the charging stage electrons pass

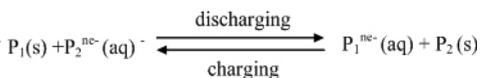
through the lower connection from the negative to the positive half cells. A diode is connected in the reverse biased mode across the positive and the negative half cells to prevent the self discharge in the cold state.



If P1 and P2 are the positive and negative electrodes respectively, then the following equations apply during the discharge phase.



The reverse reaction applies for the charging state. The over all reaction is given as follows;



The charging stage occurs when heat applied to the cell shifts the equilibrium to favor the reverse reaction. In the cold state, the equilibrium shifts to favor the forward reaction. As already mentioned, a diode is connected between the two electrodes to prevent the flow of electrons during the cold state thus preventing self discharge.

Clean development mechanism (CDM) - first experiences of validating renewable energy projects in China

by Sebastian Randig, Germany (PPRE 05/07)

In April 2006 I have officially joined TÜV SÜD Carbon Management Service department, an accredited entity for validation and verification of CDM project activities under the UNFCCC, as project manager CDM. It was a good start giving me the opportunity to go to China already during the first month, where I validated two hydropower projects.



The marked of emission reduction certificates is growing quickly, in CDM alone the number of registered projects has doubled from 280 in August 2006 to 560 in May 2007. Though in terms of numbers renewable energy projects contribute considerable, the estimated emission reductions of this project type is relatively small due to the fact that renewable energy projects generally displace fossil fuel based electricity in a grid - a measure that directly avoids CO2 emissions whereas other projects avoid methane or even stronger GHGs. Nevertheless the project IRR can vary/increase by help of certified emission reductions (CER) revenues some 2 to 6 % for hydro, wind and biomass projects of suitable size (up to 15MW of small scale CDM and above 15MW for regular scale CDM). Studies suggest that the investment involved in making a renewable energy project a CDM project can vary from \$50.000 up to \$300.000 (UNEP2006: CDM an assessment of

Sebastian in front of the Power house under construction at " Gansu Huanghe Chaijiaxia Hydropower Station Project" (4 turbines, overall capacity = 100MW, head of only 7m !)

progress). That clearly shows the restriction of the mechanism to relatively large projects.

From the little experience what I have gained by now, I can tell that the key issue of CDM project registration is the proper proof of the additionality. That means the proof that the project would not have taken place in absence of the mechanism i.e. the project is not business as usual. In the two projects

that I have assessed in detail by now, this was achieved by providing evidence for the investment barrier faced by the project participants. Unless counting in the CER revenues the projects would not be able to reach the benchmark that make the investment viable.

As very few countries by now, mainly India, China, Brazil and Mexico account for most of the

projects it is my wish that more projects will evolve from the poorer developing world. I believe that especially Africa has a huge potential.

Photovoltaic Applications in Sudan A Best Practice Paper

by Mohamed Ali Hamid, Sudan (PPRE 92/93)

There has been growing efforts in Sudan for the use and wide dissemination of photovoltaic systems. This has started by Research and Development/Technology Transfers since 1970. In recent years, there have been considerable achievements in this field in terms of projects funded by UNDP and the Ministry of Energy. The latest major development took place by

the implementation of the UNDP/GEF/GoS financed PV project under the theme: Barrier Removal to Secure PV Market Penetration in Semi-Urban Sudan. This project has lasted from 2001 to 2006 and resulted in a number of serious steps taken towards the wide use of PV, especially for rural electrification country wide, including awareness raising, field demonstrations, policies, creating financing modalities and several related studies. As a result several government financed PV rural electrification programs were implemented with a total amount of 560kWp installed capacity. Those programs are targeting meeting electricity need for basic services in rural communities. Through those programs number of schools, health facilities and rural clubs were equipped with PV power supplies. In summary a tremendous ground work has been done and now it is the role of the Solar/PV community to proof that, things are done in the proper way.

The above steps have led to the situation where a number of new PV providers emerged involved in the supply and installation of PV systems, but as the experience is not that long, and even many are newcomers to the technology, several misconducts were observed. These are related to the quality of imported PV equipment, sy-

stem sizing and selection of appropriate components and systems compatibility. This study is intended to investigate the above situation and analyze the possible options for each component and work out standard design for PV systems applicable to rural needs in Sudan as learned from previous practices. The outcome to be used as „**BEST PRACTICE PAPER**“ for PV application in Sudan.

In particular, the study has relied on the INSEL Professional Simulation program as the tool to verify the performance of the prevailing systems and moreover, to rectify errors and mismatches associated with those designs. For those who are familiar with INSEL in earlier versions, now the program has changed a lot and is marketed by the company **doppelintegral** (Info at: E-Mail: info@insel.eu Website: www.insel.eu)

The selling price is 1500.00 Euro, but all PPRE Alumni can purchase their licensed copy of the professional version at a discounted price of only 75.00 Euro plus VAT.

For the case of Sudan, the most common systems investigated are shown in the table below (typical PV systems for rural electrification):

By observing the system performance by

No.	PV System Components	Load (W)	Time Hours
1	1x50Wp Module 1x(6 or 8A)/12V Controller 1x12V/120AH Car Battery	3x20W DC Lamps	6 hrs/night
2	1x50Wp Module 1x(6 or 8A)/12V Controller 1x12V/120AH Car Battery	3x20W DC Lamps 1x60W TV	6 hrs/night
3	2x50Wp Module 1x12A/12V Controller 2x12V/120AH Car Battery	6x20W DC Lamps 1x60W TV	6 hrs/night
4	8x50Wp Module 2x20A/12V Controller 3x12V/120AH Car Battery 1x800W DC/AC Inverter	8x20W DC Lamps 2x150AC (Computers) 1x40W Fan	4hrs/night 3hrs/day 3hrs/day

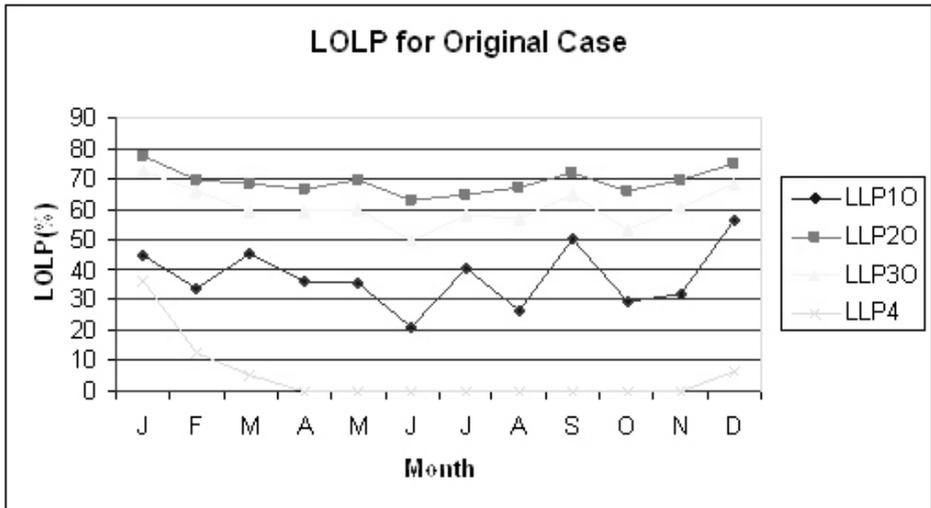
simulation over a typical year, several mismatches were identified for the first three systems. The fourth system showed good performance results. Accordingly modifications were made to the first three designs

and best performances were obtained with component figures and ratings shown below:

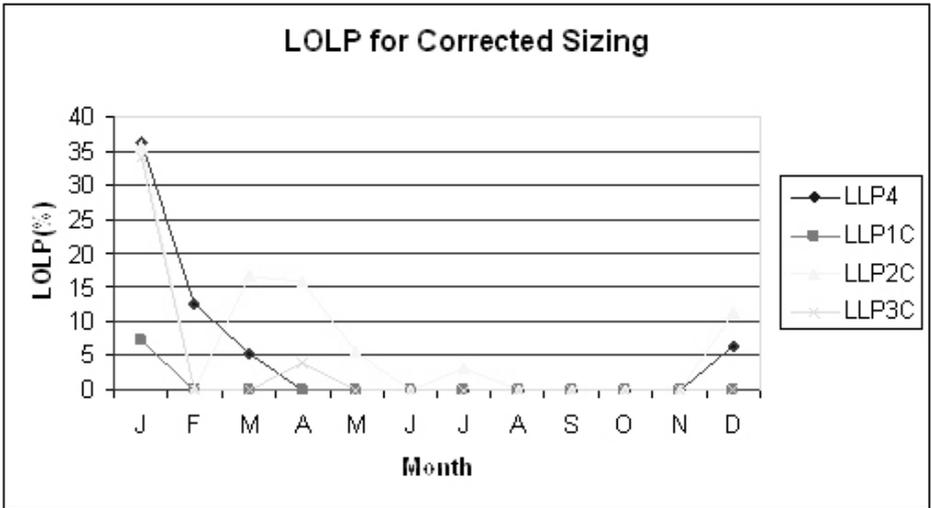
No.	PV System Components	Load (W)	Time Hours
1	2x50Wp Module 1x12V/6A/6A Controller 1x12V/100AH Car Battery	3x20W DC Lamps	6 hrs/night
2	3x50Wp Module 1x 12V/10A/10A Controller 1x12V/100AH Car Battery	3x20W DC Lamps 1x60W TV	6 hrs/night
3	5x50Wp Module 1x12V/20A/20A Controller 2x12V/125AH Car Battery	6x20W DC Lamps 1x60W TV	6 hrs/night
4	8x50Wp Module 1x12V/40A/40A Controller 3x12V/120AH Car Battery 1x800W DC/AC Inverter	8x20W DC Lamps 2x150AC (Computers) 1x40W Fan	4hrs/night 3hrs/day 3hrs/day

One of the indicators used to model the quality of the PV system was the loss of load probability (LOLP). Simulation results

obtained for this indicator are shown below for the existing and proposed (corrected) design for each system:



Note: LLP10≡ System.1, LLP20≡ System.2, LLP30≡ System.3, LLP40≡ System.4



Note : LLP1O≡ System.1, LLP2O≡ System.2, LLP3O≡ System.3, LLP4O≡ System.4

Using the same program different indicators was used to qualify the design this has included supply system outputs, storage system performance and load coverage. The modified design table shown above was the result of the overall results that led to the best performance.

The analyses were made with respect to meteorological conditions of the Central Sudan represented by Khartoum weather data.

A final note is that, PV applications in Sudan were not confined to rural electrification, but the biggest is in the telecommunication, oil industry, aviation industries. Those are applications where system design and installations were done in a very professional way and not suffering design and installation problems and hence limited the rural electrification sector where most of the problems emerged.

IMPROVED COOK STOVES & PPRE ALUMNI meet during GTZ Workshop in Malawi

by Andi Michel, Germany (PPRE 2004/06)

In March 2007 the GTZ Programme for Biomass Energy Conservation (ProBEC) hosted a GTZ regional technical workshop about improved cooking stoves. Participants came from 10 countries. Out of them there were 4 PPRE Alumni, Samson Tolessa (PPRE 94/95) and Anteneh Gulilat.(PPRE 02/03 - both from Ethiopia, Anna Ingwe (PPRE91/92) from Kenya/Tansania and Andi Michel (PPRE 03/04) from Germany.

During the five days of the workshop several technical problems concerning improved cooking stoves for biomass fuels were discussed. Due to the big expertise that was present solutions were found and shared. Topics like efficiencies, emissions, construction and materials were covered beside many others.

Still, there are open questions to be answered in the future. More researchers are needed in this field, today's student should consider this when deciding for a research topic during their studies.



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The focus of Andi Michel's work in Malawi is on energy efficient fire wood stoves. The main technology in Malawi for institutional cooking is based on the Rocket Stove principal. With applying this technology for big stoves (>100Liter) saving of over 90% can be achieved compared to open fire. Besides that ProBEC is going to look into developing and setting up production capacities for a new type of a charcoal household stove. The first tests with the MCS (Maputo Ceramic Stove) show promising results which are far better than the best available technology so far, the kenyan ceramic jiko.

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The latest development is the so called ESPERANZA Stove, an improved fire wood stove. It is built from ordinary bricks, with a concept of "air insulation" that preheats the primary combustion air. Using ordinary bricks it becomes a low cost solution, recapturing the heat increases efficiency and power and reduces fuel consumption and emissions. A more detailed description will follow.

The Tech Museum Awards

2006 Environment Award Laureate: Mr. Debesai Ghebrehiwet, Eritrea (PPRE 1994/95)

Project Overview:

Debesai Ghebrehiwet, Director of the Energy Research and Training Center, and renewable energy specialist, has designed a fuel-efficient, smokeless mogogo cooking stove, which offers simultaneously the possibility to reverse deforestation across the entire country, reduce the domestic burden and improve the health of hundreds of thousands of mothers, and improve the overall status of households up to now constrained by lack of access to fuel wood.

Problem Addressed:

Eritrea is located in the Sub-Saharan desert where the availability of wood is scarce. The traditional mogogo stove is inefficient, smoky, and consumes much energy, leading to deforestation, and diminished standards of living. When wood supplies are used up, dung is used for cooking fuel instead of agricultural fertilizer. The smoke traditional stoves emit causes eye and lung disease for most women and their children. The traditional mogogo also sits on the floor and is open, putting children at risk for potential stove burns.

Technology Solution:

Debesai Ghebrehiwet's stove design is a triple adjacent stove with one plate and fire box for cooking Ingera, the main local food, one for cooking Kicha, the main local bread, and another for cooking sauces. The stove has a chimney and a valve to remove smoke and control airflow. Air flows through the bottom of the stove and through a ceramic fire grate at the bottom of the firebox. The firebox is about half a meter in diameter for the ingera and kicha stoves and about twenty-five centimeters in diameter for the sauces pot stove. The firebox is built curved hollowed ceramic brick are strong, easy to use, and thermally insulated. The stove is three times as efficient as typical traditional Eritrean wood stoves. Energy Research Training Center promotes the project by training villagers in stove moulds using systems as well as construction, assisting (and often funding) the distribution of the key stove parts and monitoring and follow-up of the many village-level stove projects.

About The Tech Awards

(Info: <http://www.techawards.org/>)

The Tech Museum Awards is an international Awards program that honors innovators from around the world who are applying technology to benefit humanity.

The Tech Awards program inspires global engagement in applying technology to humanity's most pressing problems by recognizing the best of those who are utilizing innovative technology solutions to address

the most urgent critical issues facing our planet. People all over the world are profoundly improving the human condition in the areas of education, equality, environment, health, and economic development through the use of technology. It is the goal of The Tech Awards to showcase their compelling stories and reward their brilliant accomplishments.

Each year, candidates are nominated and then invited to submit applications. Individuals, for-profit companies, and not-for-profit organizations are eligible. International pan-



Debesai presenting the award trophy he received in San Jose, California in Nov. 2006

els of judges review the applications and annually select 25 Laureates. Awards are presented in five categories: Health, Education, Environment, Economic Development, and Equality. Five Laureates in each category are honored and one Laureate per category receives \$50,000. Laureates are honored at an annual Gala event and inducted into the Tech Laureate Venture Network (TLVN). The TLVN is the extension of the Awards from an annual event to a year round program. The goal of the TLVN is to create opportunities

for learning, networking, and exposure to assist the Laureates in furthering their work.

The Awards program was launched in November 2000, and the first Awards Gala was held in 2001. The concept for the Awards and the five universal categories were inspired in part by the State of the Future report, published by the Millennium Project of the American Council of the United Nations University. The report recommends that award recognition is an effective way to accelerate scientific breakthrough and technological applications to improve the human condition. The Awards categories are based on the 15 Global Challenges identified in the report.

Energy Efficiency in Ecuador

by Johnny Nahui Ortiz, Ph.D. Lima-PERU, PPRE 93/94

Starting in September 2005, I was involved for over 15 months in directing a project associated with Energy Efficiency in Ecuador. The project was part of a larger one conducted by PROMEC (Proyecto de Modernización de los Sectores Eléctrico, de Telecomunicaciones y Servicios Rurales) and sponsored by the World Bank.

The energy efficiency project included energy auditing, implementation of energy savings opportunities and post-implementation monitoring. Additional aspects such as communication strategies, financing proposals, training and development of a potential market for ESCOs were also included.

The following areas were considered as part of the Energy Efficiency project:

1. Industrial Sector, a total of 10 industrial plants were selected for the project
2. Commercial Sector, a total of 7 hotels were considered as part of the project
3. Hotels Sector, a total of 8 public buildings were selected for the project
4. Hospitals Sector, a total of 2 public hospitals were considered as part of the project
5. Efficient lighting for Residential use, a total of 4 electric distribution companies were considered as part of the project. A preliminary target of 1 million compact fluorescent units (15 W and 23 W) was considered as replacement of incandescent bulbs (60 W and 100 W).
6. Efficient lighting for Public Street Lighting use, a total of 2 electric distribution companies were considered as part of the project.

In order to conduct the energy auditing process for industries, hotels, public buildings and hospitals, a total of 10 engineering firms were selected as "in-progress ESCOs". Santiago Sanchez (PPRE 2001/02) owns one of such participating ESCOs.

The energy efficiency project considered the following stages:

1. Field Measurement, consisting of data retrieval in terms of energy consumption in the facility and the use of proper instrumentation to conduct measurements were appropriate.
2. Energy Audit Report, containing an energy analysis and diagnostic for the facility as well as the opportunities identified in terms of energy savings and cost reduction.

3. Post-Implementation Monitoring, including the ESCO's approach towards facilitating implementation of the recommendations found in the energy auditing. Special attention was paid to ESCO's performance as a basic training to survive in a performance contracting environment.

My participation in the above project was quite exciting since it turned to be a two-way learning process. Besides the engagement with the fascinating energy world, I also had the opportunity to get to know Ecuador (I carried out almost 20 trips last year!) and made new friends and reinforced the old ones.

Banking on Oil Project in Kenya

by Dr. Hans Jaoko, Kenya (PPRE 98/99)

Every year Kenya generates 13 million litres of used lubricating oil from about 40 million litres of new oil. The used oil generated simply disappears from view - poured into sewers, spread on roads or dumped with other garbage. To address such a situation, the project pioneered a novel approach of collecting and recycling waste engine oils. Motor vehicle mechanics earn credit points for safe collection of used oils; credit points gained are redeemed by the mechanics in the form of cash, or accumulated as savings against which loan is obtained. The used oil is sold to re-users, recyclers and oil companies for safe disposal.

The benefits of the project is to provide an incentive scheme through which participants make money and access loans by trading pollutant hence curtailing poor

disposal. The project addresses the oil pollution problem at three important levels: Policy level by establishing demand driven policy formulation and implementation; Meso level by working with institutions and industry networks; micro-level by working with mechanics and households to curtail poor used oil disposal.

The idea: This project pioneers a novel approach of collecting and recycling used oils in which motor vehicle mechanics earn credit points for safe collection of used oils. The credit points gained can be redeemed by the mechanics in the form of cash or accumulated as savings against which loan is obtained. The used oil is sold to re-users, recyclers and oil companies for safe disposal.

Goal : To improve livelihoods of slum dwellers by reducing the incidence of disposal of used engine oils into Mukuru-Ngong River by motor mechanics operating along the riverbanks.

Purpose : To pilot and expand a collection and recycling scheme in which motor vehicle mechanics gain credit points for safe collection of used engine oils. The points earned by participants in the scheme enable the participants to earn money and access loans.

Used engine oil accounts for almost 91% of oil pollutants in the Mukuru-Ngong river. Most of the oil originate from motor vehicle mechanics who dispose the used oil directly into the river, or into open drainage systems. Motor vehicle mechanics have no incentive to look for costly means of disposing used oil. Neither are there any mechanisms in place to provide safe disposal that ensure environmental sustainability. "Banking on Oil" is an incentive scheme which enables

the mechanics to collect and trade waste oil for cash or to accumulate savings. This savings then allows the mechanics to access credit for improving their businesses.

This approach is unique in a number of ways:

- **An incentive to make money out of pollutant/waste.** Used oil is worthless to many people. A chance to earn money or access loans by trading waste is attractive to the target group, most of who are in survival businesses.

- **Targeting the cause rather than the symptom.** Motor mechanics are a major cause of oil pollution (estimated at about 78%). By involving them in this scheme, the project ensures that the problem is arrested at source.

- **Other approaches have had minimal impact.** Mechanical and other methods for removing oil from river water are expensive and unsustainable. The good approach is to stop oil disposal into the river. That's the starting point.

- **Poor disposal of pollutants is a result of weak environmental governance.** This not only requires better policies, but a demand driven compliance to such policies. This project hopes to pilot a demand side approach to environmental governance.

- **The use of credit points redeemable in cash or loan provides an opportunity for mechanics to grow their businesses.** This ties livelihood of the mechanics to the safe collection of used oil.

- **The project highlights opportunities for environmentally friendly enterprises**

available within the slum areas, e.g. waste oil collection, which is potentially beneficial to their health.

How many tonnes of CO2 equivalent are reduced for each m3 of biogas burned?

Question sent by Everson Possamai, Brasil (PPRE 03/04)

Answer by Ram Dhital, Nepal (PPRE 2000/01)

Just to inform you that two biogas projects here in Nepal have been registered in CDM EB. A biogas plant produces biogas, thermal energy for cooking. The power equivalent of one installed biogas plant ranges from 1.16 kW to 2.32 kW. We have bundled about 9000 household biogas plants to make installed capacity slightly less than 15MW. Which will fit for small scale methodology.

The baseline is GHG emissions from burning of fuel wood and kerosene. The GHG emission are CO2 emissions from burning of kerosene and unsustainable fuelwood and CH4 emission from burning of fuelwood. For the project emission there is no direct emission from the biogas plant. The only emission that needs to be looked at is the fugitive emission when methane leaks from the digester.

We determine the annual performance ratio of installed biogas plants and emission reduction factor applicable to the installed biogas plants. We also determine the geographic location and size of plants. If ER factor > 5 we apply 4.99tCO2/plant/per year If ER factor < 5, we apply the exact weighted

ER. We have obtained from the field that annual weighted ER factor is 8.99. The plant size varies from 4 to 10 cum but mostly 6 cum plants are built in rural areas. We have taken 4.99t CO₂/plant/year to make our project which will fit within small scale methodology.

Annual performance ratio is about 98% and we calculate the annual ER based on this. Hope this helps you. If you need further information, do not hesitate to contact us.

Potentials and Prospects of CIGS Thin Film Solar Cell

*Shahriar Ahmed Chowdhury
M.Sc. (PPRE), Assistant Professor, Department of Electrical and Electronics Engineering, United International University, Dhaka, Bangladesh.*

Abstract

Copper Indium Gallium di-Selenide (CIGS)-based solar cells (glass/Mo/co-evaporate CIGS/CdS/ZnO/ZnO:Al) are presently one of the best candidates for the new generation of large-scale and low-cost photovoltaic (PV) devices. Highly efficient cells are obtained and large-area modules have been started producing at the industrial level. They are becoming popular due to some striking advantages of the CIGS over the conventional solar cell materials. CIGS solar cells are made from different and very thin layer of some microns. The deposition of amorphous or polycrystalline thin films onto a low cost substrate material at moderate temperatures not only lowers the required input of energy and material but, more importantly, it offers the possibility of easier module interconnection. The buffer layer is the concern of CIGS thin film

solar cell. Present technology of Cadmium Sulphide (CdS) buffer deposition not only makes the total process difficult, but also its toxicity limits its commercial usages due to environmental reasons. The objective of this paper is to give an overview of the potential of the CIGS thin film solar cells and the scope of future development of the buffer layer.

Keywords: Photovoltaics, Thin film, Cu(In,Ga)Se₂ solar cell, Buffer layer.

Introduction

The main barrier impeding the expansion of solar powered energy is the high price of the PV module. Solar industry is in the midst of an argument over which material will dominate the future for harvesting the sunlight. Solar panels made from Silicon currently account for more than 90 percent of the solar cell industry. Silicon has become one of the most studied materials ever discovered for solar cell. However, the production cost of Silicon panels remains relatively high and the production rate is not capable of meeting the growing demand in the sector. Research work has been going on worldwide to find out new types of solar cell materials which can provide low cost and higher efficiency in solar energy conversion. The polycrystalline CIGS thin film solar module shows potential to overcome the current price barrier.

The basic component of a CIGS solar cell is the Cu(In,Ga)Se₂ absorber layer, where the conversion of photons (with an energy greater than the band-gap energy of CIGS) into electron-hole pairs take place. For thin-film cells, polycrystalline, slightly Cu-deficient, p-type material is used. Best cell efficiencies have been obtained when the CIGS was prepared by evaporation of the constituent elements in vacuum. An n-type semiconductor film, often called

“buffer” layer, on top of the CIGS absorber is required to establish an electric field at the p–n junction (depletion or space-charge region). When electrons are photo-excited within the space charge region, they are transported to the n-side owing to the electric field and thus generate an electric current. When photon absorption takes place in the quasi-neutral region of the absorber, the photo-excited electrons diffuse and may arrive at the space-charge region at some stage, whereupon they are again swept cross the p–n junction. Of course, some of the photo-excited electrons will be lost for current generation owing to recombination in the space-charge or in the quasi-neutral region, especially if the photo-excitation takes place far away from the junction. Ideally, the buffer layer exhibits a much higher carrier density than the absorber, such that most of the space-charge region extends into the absorber and thus carrier collection is improved. In addition, the band gap of the buffer layer should be wide, such that most of the incoming radiation can be transmitted to the absorber. Owing to the exponential decrease in light intensity caused by absorption, the incident photons are then absorbed predominantly in the front part of the absorber, ideally within the depletion region. For efficient transport of the photo generated carriers, ohmic front and back contact layers with high conductivities are required. The front contact (on top of the buffer layer, also called “window” layer) should be as transparent to the incoming radiation as possible. Often, especially for laboratory cells, current collection is supported by a metal grid deposited on the front contact. The back contact consists usually of an opaque metal film, unless a semi-transparent cell (e.g. for tandem devices) is desired.

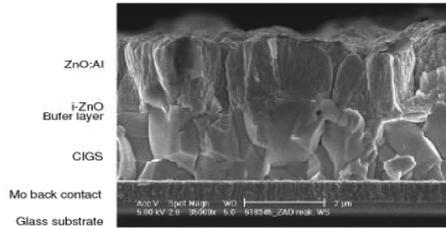


Figure: Scanning Electron Microscopic picture of the CIGS solar cell. Different very thin layers are shown in the picture. The total thickness of the cell is 3-4 micron.

The advantages of CIGS over other solar cell materials

The production cost of CIGS solar panels is much less and it has some striking advantages over other photovoltaic materials.

1. They are not produced from single crystals. So, there is no need to prepare single large crystal as in crystalline silicon solar cells, where the large crystal preparation is costlier.
2. Small quantities of materials are needed as they can be fabricated in very thin films (5–6 μm).
3. They need less materials and low energy inputs for fabrication, So they are cheaper than the other solar cells.
4. They can be fabricated on any surfaces (even on flexible substrates) such as metal foil, fibre, glass, plastic, roof-tiles, and surfaces of other building surface materials and even in fabrics. So, the CIGS solar cells fabricated on flexible substrates can be used to cover the uneven surfaces of any installation which faces the sunlight and thus can provide electricity.
5. They can be fabricated on larger areas (so far up to 120 cm x 60 cm).
6. The band-width of spectral response of CIGS solar cell is the highest among the known solar cell materials. This indicates

that CIGS can absorb a wide band of sunlight to produce electricity.

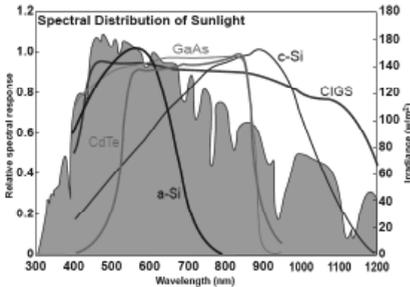


Figure: Spectral response of common solar cell materials along with the sun spectrum.. It is seen that the CIGS covers the largest spectrum followed by Gallium-Arsenide(GaAs) and crystalline Silicon (c-Si)

7. The energy band gap of CIGS can be varied by varying the stoichiometry of the ingredients of the absorber layer. In order to ensure sufficient absorption of the solar irradiation, the band gap of the absorber should be in the range of 1.0 to 1.8 eV with an optimum around 1.48 eV [1]. For amorphous silicon (a-Si) the band gap is 1.8 eV, but it can be lowered by alloying with Ge. CdTe has a band gap of 1.44 eV which is very close to the optimum and in the Cu(In,Ga)Se₂ system the band gap can be varied from 1.04 to 1.68 eV, depending on the Ga/(Ga+In) ratio. Of all these thin film materials, Cu(In,Ga)Se₂ yields the highest efficiency of up to 19.5% with atomic ratio of Ga/(In + Ga), approximately 0.25 and Cu/(In+Ga) 0.88 to 0.95 [2]. In CdTe cells the efficiencies are up to 16.0%. The highest reported efficiency for a-Si solar cells is 12.7% for an unstabilized cell [3]. These three materials have a high absorption coefficient for visible light which is in the order of 10⁵ cm⁻¹. Thus, thin absorber layers with a thickness of only about 1 to 2 μm are sufficient for a complete absorption of light. In contrast, Si

solar cells need a thickness of about 300 μm or elaborate light trapping structures for the absorption.

8. They can be optimized for low or diffused radiation. It can be done by fabricating the absorber layer a Cu poor Cu(In, Ga)Se₂.

9. Monolithic interconnection is possible so that they do not need the metal current collecting grid lines over the cells which decrease the solar energy capture area of the panels.

The Buffer Layer in the CIGS Solar Cell

The function of the buffer layer

The standard device structure of Cu(In,Ga)Se₂ based solar cells include a very thin buffer layer between the CIGS absorber layer and the transparent ZnO front electrode. The buffer layer forms the heterojunction between the p-type single crystal of Cu(In,Ga)Se₂ and the thin film of n-type buffer. The beneficial effects of the buffer layer range from modifying the CIGS surface chemistry to protecting the sensitive interface during the subsequent window deposition. Buffer layers are deposited over the CIGS absorber layer by different methods, namely, Chemical Bath Deposition (CBD), Atomic Layer Deposition (ALD), Sputtering and Physical Vapour Deposition (PVD).

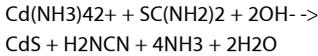
Standard buffer layer

The standard buffer layer of the Chalcopyrite thin film CIGS solar cells is the chemical bath deposited (CBD) CdS. This buffer layer is generally made in alkaline aqueous solution (PH>9) of the following constituents:

- 1.A Cadmium salt CdSO₄, CdCl₂, CdI₂ etc.
- 2.A complexing agent NH₃ /NH₄OH
- 3.A Sulfur precursor SC(NH₂)₂ (Thiourea)

The concentrations of the various compo-

nents of the solution can be varied depending on the process going on. The CIGS film is immersed in a bath containing the solution and the deposition takes place in a few minutes at a temperature of 60°C to 80°C. The chemical reaction that takes place is as follows:



The growth of CdS thin films by CBD occurs from ion by ion reaction or by clustering of colloidal particles. Depending on the bath condition, the resulting CdS lattice structure may be cubic, hexagonal or a mixture predominately hexagonal. The films consist of crystallites with grain size of the order of tens of nanometers.

When CIGS films are immersed in the chemical bath for deposition of CdS, they are also subjected to chemical etching of the surface. In particular, native oxides are removed by Ammonia. Thus the CBD process cleans the CIGS surface and enables the epitaxial growth of CdS buffer layer. The highest recorded efficiency of a cell with CdS buffer layer is 19.5% by NREL in 2005.

Hindrances to mass commercialization of CIGS solar cell

The major concern of CIGS solar cell is to replace the Cadmium Sulfide buffer layer grown by chemical bath deposition (CBD), a wet thin film deposition technique.

Research works are going on in different laboratories to substitute the toxic CdS buffer layer by other non-toxic low absorbing materials for the following reasons -

- i. The expected environmental risks arising from implementation of a CBD CdS process in a CIGS module production line.
- ii. The expected technological problems

caused by a non vacuum CBD process in a vacuum in line production.

- iii. The potential of increasing current generation in the spectral region of 350-550 nm, and therefore increasing the cell efficiency.
- iv. The prohibition of Cadmium in electrical or electronic equipment by legal regulations in some countries is also a negative factor in marketing of Cd-containing CIGS-based thin film modules.

Alternate buffer layers

Several alternative buffer layers for CIGS-based solar cell have been developed in the last decade. It is observed that the buffer layer used in the different laboratories is mainly chalcogenides (oxides, sulfides and selenides) of two elements, Zinc and Indium. The buffer layer deposition methods include Chemical Bath Deposition (CBD), Atomic Layer Deposition (ALD), Metal Organic Chemical Vapour Deposition (MOCVD) (metalorganic vapour phase epitaxy (MOVPE)), Ion Layer Gas Reaction (ILGAR), evaporation and sputtering.

The comparability to the standard CBD CdS cell is an indicator for the quality of a Cd-free device. The performances of the cells developed in different laboratories are not only depending on the buffer layer but more on the techniques of depositing the absorber layer.

The composition of buffer layer often depends on the deposition method and the preparation conditions. In the following sections some potential buffer layers, their deposition processes and performances are described briefly.

The ZnS based buffer layers

One of the most potential candidates for the replacement of CBD CdS buffer layer is the ZnS based buffer layer. It shows the highest efficiency among the alternate buffer lay-

ers. This is non-toxic and the material cost is relatively low. CBD ZnS buffer deposition method shows the highest performance (efficiency 18.6%).

ZnSe-based buffer layer

This type of buffer layer is deposited by CBD, MOCVD or MOVPE, ALD processes. ZnSe buffer can provide extremely low thickness for high efficient cells. The thickness required for this buffer layer is in the range of 5 – 10 nm. The CBD process shows the highest performance of active area efficiency of 15.7% by Hahn-Meitner-Institute (HMI) in Berlin. This method uses the chemicals Zn-salt/ Ammonia/ Selenourea and a Cu(In,Ga)(Se,S)₂- absorber. [4]

ZnInSex and InSex buffer layer

ZnInSex and InSex buffer layers are deposited by co-evaporation. The buffer is continuously evaporated on CIGS. The maximum cell efficiency so far is 13% for InSex buffer [5] and 15.3% for ZnInSex buffer [6].

ZnO and ZnMgO buffer layer

ZnO buffer layer can be deposited by ALD, ED (Electro Deposition), MOCVD, CBD, ILGAR and sputtering. The best result is a device with a sputtered buffer. MOCVD or sputtered ZnO buffer can also be said as buffer-free cell when the ZnO window is directly deposited on CIGS by MOCVD or sputtering. The buffer-free CIGS is advantageous in reducing production cost as it eliminates an additional buffer layer deposition step by a different technology.

Sputter ZnMgO buffer is another potential candidate for the replacement of the CBD CdS buffer. This high band gap buffer has reached an efficiency of 16.2% (active area) by Matsushita Electric Industries. [7]

The In₂S₃ and In(OH)₃ based buffer layer

One of the promising alternate buffer layers is the Indium (In)-based buffer. The demonstrative efficiency of the In-based buffer is comparable to the CBD CdS. Hindrance to using the In-based buffer is the high price for the Indium precursors. The deposition techniques for the Indium-based buffer layers are CBD, ALD, PVD and magnetron sputtering. The highest efficiency obtained with In₂S₃ buffer layer by ALD method is 16.4% on cells for 0.1 cm² area and 12.9% for a 30X30 cm² module.[8]

Conclusion

CIGS thin film Solar cell has the every potential to dominate the future photovoltaic market. The main obstacle to its popularity is its toxic CdS buffer which is deposited by wet CBD process. The development of Cadmium-free buffer layers grown by vacuum processes for Cu(In,Ga)S₂ (CIGS) solar cells is interesting in regard to environmental aspects and to the implementation in industrial production. Numerous studies concern Cadmium-free buffer layers has been done. The highest total area cell efficiency with alternate buffer layer of 18.6% was achieved by NREL and AGU with a CBD ZnS based buffer layer on a three-stage-process absorber, while the other buffers are at the level of 15-17%. In parallel, the outcome of much effort to establishing a vapour-phase process is considered more advantageous for process integration in a vacuum production line environment. Present research shows the potential of getting environment-friendly dry vacuum deposition process of the buffer material which fits the total vacuum industrial production line. Thus the cost of the CIGS solar cell is expected to be reduced and the popularity increased.

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www.iea-pvps.org	Market Survey „Trends in photovoltaic applications“ as free download available	E. Knagge
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www.ilea.org/	A really nice, informative, easy-to-read website on life cycle analysis. Unfortunately, the institute is no longer in operation. But the available articles are worth reading.	A. Peel
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www.inseldi.com/index.php?id=21&l=1	INSFL - Integrated Simulation Environment Language	K. Blum
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http://web.worldbank.org/WBSITE/EXTERNAL/ TOPICS/EXTENERGY/EXTRETOOLKIT/0,,menuPK:1040440~pagePK:64168427~piPK:64168435~theSitePK:1040428,00.html	The world bank „RE-toolkit“ - it's a HUGE resource, with everything divided into „grid-connected“, „mini grid“, „stand alone“. you can go to the „project tools“ category where you can find case studies, economic analyses, and a lot of ebooks in the „knowledge documents“ part	A. Antonopoulos
www.world-wind-energy.info	Here is an interesting site for the World Wind Energy Association, with explanations in several topics (Technology, Planning, Operation & Maintenance, Grid Integration and Storage, etc) with some videos too.	R. Hegel
http://reisi.iset.uni-kassel.de/	REISl, „Renewable Energy Information System on Internet“ – great wind statistics	A. Antonopoulos
http://re.jrc.ec.europa.eu/pvgis/apps/radmonth.php?lang=en&map=europe	Nice interactive site for Solar irradiation data estimation and PV installation potential estimation...- Unfortunately only for Europe / near Asia and Africa...	M. Sterner
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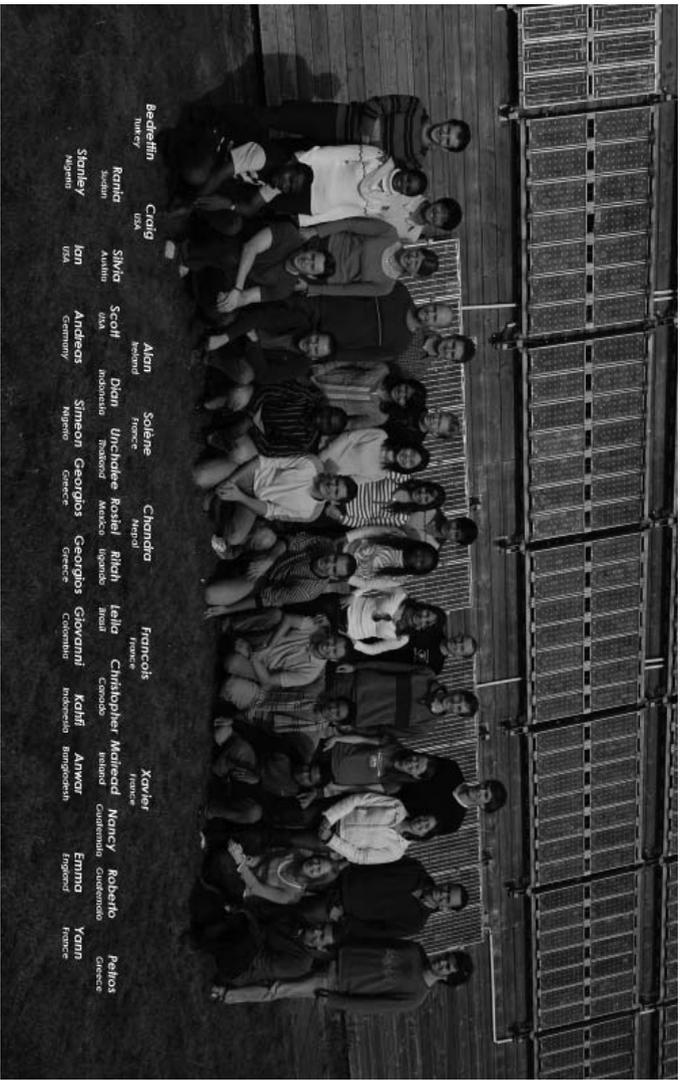
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