Souvenir

20th One Day National Conference on

ADVANCEMENT IN RENEWABLE ENERGY TECHNOLOGIES

22nd December 2017

Organized by

V. P. M.'s Polytechnic, Thane

Vision: Ensuring Skill Development Through Quality Technical Education

Approved by: All India Council for Technical Education, New Delhi.

Recognized by: Directorate of Technical Education, Maharashtra State, Mumbai.

Affiliated by: Maharashtra State Board of Technical Education, Mumbai.

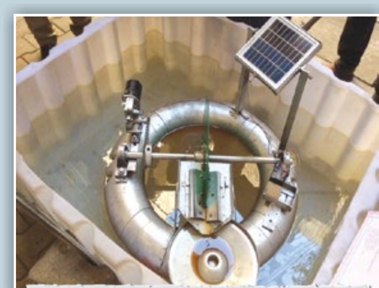
Address:

Building No. 1, 'Jnanadweepa', College Campus,

Chendani Bunder Road, Thane West, Thane, Maharashtra 400601

Website: www.vpmthane.org

STUDENT'S INITIATIVE IN RENEWABLE ENERGY FILED


Sea Oil Separator


Energy Generation From Waste


Advanced Technology In
Wind & Solar Hybrid System


Hydro Iron


Solar Based Control System


Solar Electric Fence Safety


Solar Inverter


Portable Hydro Turbine


Spherical Solar Generator


Green Building


Open Hydro Turbine


Solar Radiation Measurement Kit


Solar Power Generation
For Polytechnic Building


Electricity Generation From Hair


Light Control By Pir Sensor


Award Winning Projects


Electrical Installation In Polytechnic


Smart Car


Renewable Energy Day Celebration

Vidya Prasarak Mandal, Thane

।।प्रज्वलितो ज्ञानमयः प्रदिपः।।

VPM Thane is an Educational Trust established in the year 1935, to encourage and give full scope of education in Thane and surrounding region for which there was limited facility during sixties. The Mandal started its first college in 1968-69 on a 13.5 acres marshy creek land gifted by the Government of Maharashtra for educational purposes. The Institutes of the Campus, enthusiastically and zealously cater annually to the basic needs of education of nearly 16,000 students from K.G to P.G through its Marathi and English Medium Schools, Arts, Commerce, Science, Law, Polytechnic, Management Studies, Information Technology Centre, Advanced Study Centre. The Campus provides State-Of-The-Art facilities to the students with the latest technologies to make them competent for the future career opportunities.

In the year 2012, VPM started an Engineering College at Velneshwar Village in Ratnagiri District for catering to the needs of rural population.

V.P.M.'s Polytechnic, Thane

Vision : Ensuring skill development through quality technical education.

Mission: Imparting creative learning by innovative methodologies to expose the talents by the way of MSBTE (Maharashtra State Board of Technical Education) curriculum.

Vidya Prasarak Mandal's Polytechnic Thane, the Self-financed Institute, was started by the Management in the year 1983. Polytechnic so far has trained over 9000+ diploma holders, 1000+ Advance Diploma Students, 5000+ Certificate course students. Important features include quality academic activities implementation, extensive co-curricular activities, National Conferences, Industrial visits, In-plant Training and Value Addition Programmes. Polytechnic, its students and staff have won awards at State and National level regularly. Institute is a trust worthy partner of Affiliating body Maharashtra State Board of Technical Education, Mumbai as a Project Institute for Curriculum Revision, Faculty Training lab Manual Development, Conduct of Semester Exams, Academic Monitoring, Career Fair and other activities. Institute has upgraded its Infrastructure, Faculty, Equipment's, and Teaching Learning process from time to time to meet changing technology needs and industry expectations.

- **Year of Start** : 1983
- **Year of First AICTE Approval** : 1994
- **Year of Accreditation** : 2004 (for 3 yrs) & 2017(for 3 yrs)
- **Best ISTE Chapter Award** : 2009,2016
- **Year of Best Polytechnic Award** : 2009, 2015

Polytechnic Journey so far....

Major Achievements

Year	Activity
1983	Polytechnic started with four Diploma Programmes – Chemical Engineering, Electrical Power Systems, Industrial Electronics and Instrumentation.
1989	Visit of State Government Team for Polytechnic Gradation. Received 'A' Grade.
1992	Inauguration of Indian Society of Technical Education Chapter. Chief guest – Prof. B.B. Chopane – Director, Technical Education, Maharashtra State.
2000	Millennium Information Technology Exhibition inaugurated by Hon'ble Union Minister Information Technology & Parliamentary affairs Mr. Pramod Mahajan.

2001-02	Start of Diploma in Information Technology& Diploma in Computer Engineering, Advance Diploma in Industrial Safety
2005	Visit of Infosys founder Mr. N.R. Narayanamurthy as a Key Note Speaker at the Conference Challenges to Indian Multinationals.
2005	Received AICTE Grant of Rs. 5,00,000/-AICTEMODROBS Grant to Electrical Power System Department
2006	Prof. D.K. Nayak, Principal nominated as Member of Governing Council, Board of Apprenticeship Training Western Region, Mumbai.
2006	Installation of Automatic Weather Stations (AWS), developed and maintained by India Meteorological Department (IMD) Government of India.
2009	District Level Energy Park developed with the partial grant of Rs.4.75 lakhs from Ministry of New and Renewable Energy, New Delhi.
2009	Start of Advance Diploma in Energy Management & Audit
2013, 2015, 2016	MSBTE Letter of Appreciation for Excellent Academic Performance in all the Diploma and Two Advance Diploma Programmes.
2013	Student's Project (EPS Dept) - Open Hydro System selected by MSBTE and filed for Indian Patent.
2013	IOSH, UK Graduate Membership Accreditation for Advance Diploma in Industrial Safety Programme.
2014	Prof. D.K. Nayak, Principal received ISTE Ranganathan Engineering College National Award for Best Polytechnic Principal at the 44th ISTE National Annual convention.
2004, 2010, 2012 & 2015,	Received ISTE Narsee Monjee Student Project Award
2015	Received MSBTE Best Laboratory Award to Polytechnic Electrical Power System department.
2016	Dr. (Mrs.) G. S. Ingawale, Sr. Lecturer filed for Indian Patent for her Invention in Measurement of Potential & Chemical Kinetics of Lantadene by using immobilized Enzyme.

ISTE Staff Awards

Year	Activity
2006	Mrs. S.S. Kulkarni received ISTE L&T National Award Best M. Tech. Thesis in Electrical and Electronics Engineering.
2008	Prof. D.K. Nayak, Principal received Rajarambapu Patil National Award for Promising Engineering Teacher (below 50 years of age) for creative work done in Technical Education (Polytechnics) from Indian Society for Technical Education (ISTE), New Delhi
2013	Dr. Usha Raghavan, Head of Information Technology Department has been conferred ISTE U.P. Government National Award for an outstanding work done in specified areas of Engineering and Technology for the year 2013 at 43rd ISTE National Annual Convention held at T.K.I.E.T. Warananagar, Kolhapur, Dist-Maharashtra.
2014	Dr. Mrs. Geetali S. Ingawale, Sr. Lecturer, honoured with ISTE Best Polytechnic Teacher Award for the year 2014 for Maharashtra and Goa States in the 44thISTE National Annual convention.
2014	Mrs. Sujata M. Gupte, Controller of Examination placed Second Position in Zonal level ISTE Srinivasa Ramanujan Mathematics Competition 2014-2015 and placed Third Prize in National level.
2014	Ms. Amisha Mestry, Lecturer in Industrial Electronics Department placed Second Position in Zonal level ISTE Srinivasa Ramanujan Mathematics Competition 2014-2015.
2014	Ms. Rizvi Fatima Ismat, Lecturer in Mathematics placed First Position in Zonal level ISTE Srinivasa Ramanujan Mathematics Competition 2014-2015 and placed Fourth Prize in National level.
2015	Mrs. Santhi M. Laguduva. Lecturer, Industrial Electronics Department received ISTE – L & T National Award for Best M. Tech Thesis in Electrical & Electronics Engineering 2015.

MSBTE State Level Toppers

Year	Name of the Student	Course	Percentage	MSBTE Rank
1996	Ms. Joshi Bhakti B.	Elect. Power System	79.91	First
1996	Mr. Oak Parag V.	Elect. Power System	79.45	Second
1996	Mr. Deshmane Mahesh J.	Instrumentation	80.27	First
1997	Mr. Bafna Milind B.	Chemical Engg	81.96	First

1997	Mr. Narkar Chandan K.	Industrial Electronics	82.77	First
1997	Mr. Hande Tushar T.	Elect. Power System	78.82	Second
1997	Mr. Buddhikot Mandar D.	Elect. Power System	78.27	Third
1998	Mr. Inamdar Mandar S.	Elect. Power System	72.98	First
1999	Mr. Lamkhande Dattaram T.	Elect. Power System	77.17	First
1999	Mr. Girkar Jayesh H.	Elect. Power System	72.78	First
2001	Mr. Narkar Vyankatesh V.	Industrial Electronics	84.29	Sixteenth
2002	Ms. Narkar Kirti Kamlakar	Industrial Electronics	85.14	Sixteenth
2004	Mr. Zingre Shreyas R.	Elect. Power System	83.31	First
2005	Mr. Kher Vaibhav	Elect. Power System	87.54	First
2006	Mr. Gokhale Kedar Dilip	Elect. Power System	87.00	First
2006	Mr. Rangari Rameez Anwar	Chemical Engg	78.96	Second
2007	Mr. Mukadam Jasim Wazir	Chemical Engg	82.00	Second
2008	Mr. Singh Shashank S.	Inform. Technology	89.58	Second
2008	Ms. Sarangdhar Grishma D.	Chemical Engg	83.04	Third
2009	Mr. Waghmare Abhijit Arun	Chemical Engg	89.06	Second
2014	Ms. Vaity Priya Jitendra	Inform. Technology	91.56	Third

List of National Conferences organized since 2004

Date & Year	Name of Conference
8th August 2004	Pollution of Water Bodies in Urban Area
27th & 28th August 2005	Alternative Energy Sources
8th & 9th December 2006	Geo – Informatics.
3rd February 2007	Innovations in Safety, Health and Environment.
5th January 2008	Latest Trends in Nano Technology
18th October 2008	Corrosion Prevention through advanced technologies.
10th January 2009	Biometrics, RFID and Emerging Technologies for Automatic Identification
19th September 2009	Advancements in Medical Instrumentation.
10th October 2009	Safety Practices for Peace, Productivity and Profits
3rd July 2010	Broader Perspectives of Language, Thinking and Technology
23rd October, 2010	Technology – a Strategy for Safety in Infrastructure
20th August 2011	Future Power Systems for Green & Clean World
15th October 2011	Progress and Prosper through Entrepreneurs & Intra-preneurs
5th January 2013	Emerging Trends in Solar Technologies
4th January 2014	Process Safety Management
16th & 17th January 2015	Next Generation Electronic
7th February 2015	Industry Expectation from safety Managers
19th December 2015	Life Safety - Today & Tomorrow
17th December 2016	Environment, Health & Safety

Department of Electrical Power System

Vision: *"Empowering students with best knowledge of Electrical Power System through innovative learning Methodologies."*
Mission: *"To accomplish excellent standards of quality technical education by keeping pace with changing technologies and create technical manpower in electrical power system with capabilities to accept new challenges."*

Department of Electrical Power System was established in 1983 and conduct All India Council of Technical Education (AICTE) recognised course with 60 intake capacity. Its constant endeavor to impart the best knowledge in Electrical Power Systems, department has been accredited by **National Board of Accreditation** in the year 2004 for **three years & re- accreditated in 2017 for three years.**

Electro vision - one day seminar

Department has five well equipped laboratories.. Department has received a grant of Rs. 5 lacs from AICTE under MODROBS for modernization of laboratories. Many of equipments are fabricated by students under guidance of experienced staff. Under able leadership of HOD and with co-operative staff and students, department is achieving goals. Experienced and dedicated staff of department helps to carryout teaching and learning process smoothly.

Department received 'Best Laboratory Award' by MSBTE with cash prize of Rs 50,000/ for Electrical Machine lab for acc yr 2015-16 & Electrical Measurement lab for acc yr 2016-17.

Meritorious students of the Department have kept the trend of securing top position in the Merit List of Electrical Engg. Group declared by MSBTE (from 1996 onwards). Professional skills of our students can be seen when they participate in national, state level and regional level project as well as paper presentation competitions. Students also showed their proficiency through innovative projects & project models which were exhibited in international level Exhibition - ELECRAMA and state level, project competition like DIPEX, VENTURA etc. and won prizes.

Department is keeping proper interaction & developed a relation with various power utilities like **MERC,MSEDCL, TATA Power Co. Ltd., Reliance Ind. Ltd., BSES, LDC, BARC.& Academic institute like IIT Mumbai , V.J.T.I, Mumbai, A.C.Patil college of Engineering, Father Agnel COE.** Department has successfully organized two days National conference on 'Alternative Energy Sources' on 27th - 28th August 2005 & National Conference On **"Future Power System for Green and Clean World"** on 20th August 2011.

Every year Electrical Power System Department (EPS) celebrates Renewable Energy Day (RED) to create awareness of Renewable Energy, their practical applications in day to day life & latest innovation in the Energy field. On this occasion department organizes State Level technical paper presentation competition, slogan & poster competition related to renewable energy sources & its applications for polytechnic students.

Well Equipped Department Laboratories

Mrs. N.V.Vader
HOD, EPS Dept.

VPM's Polytechnic, Thane

With immense pleasure we cordially invite you for the

One Day National Conference

"Advancement in Renewable Energy Technologies"

Inaugural Function

Friday 22nd December, 2017 at 9.00 am

Chief guest

Dr. Anuradda Ganesh,

Director,

Advanced Engineering, Cummins Technologies India Ltd..Pune

Guest of Honor

Dr. S K Mahajan,

Jt. Director

Directorate Technical Education, Maharashtra

Dr. Sanjay Gopal,

Associate Professor VJTI, Mumbai

Advisory committee member

Keynote Speaker

Dr. Chetan Singh Solanki

Professor, Dept. of Energy Science and Engineering IIT, Bombay

Head of Million SOUL Project, Govt. of India

Mrs. N. V. Vader
Organizing Secretary
Head- EPS Dept.

Dr. V. V. Bedekar
Chief Patron
Chairman, VPM, Thane

Dr. D. K. Nayak
Convener
Principal

Conference venue

Thorle Bajirao Peshwe Sabhagruha

'Jnanadweepa', College Campus, Thane (W)- 400601, Maharashtra, India

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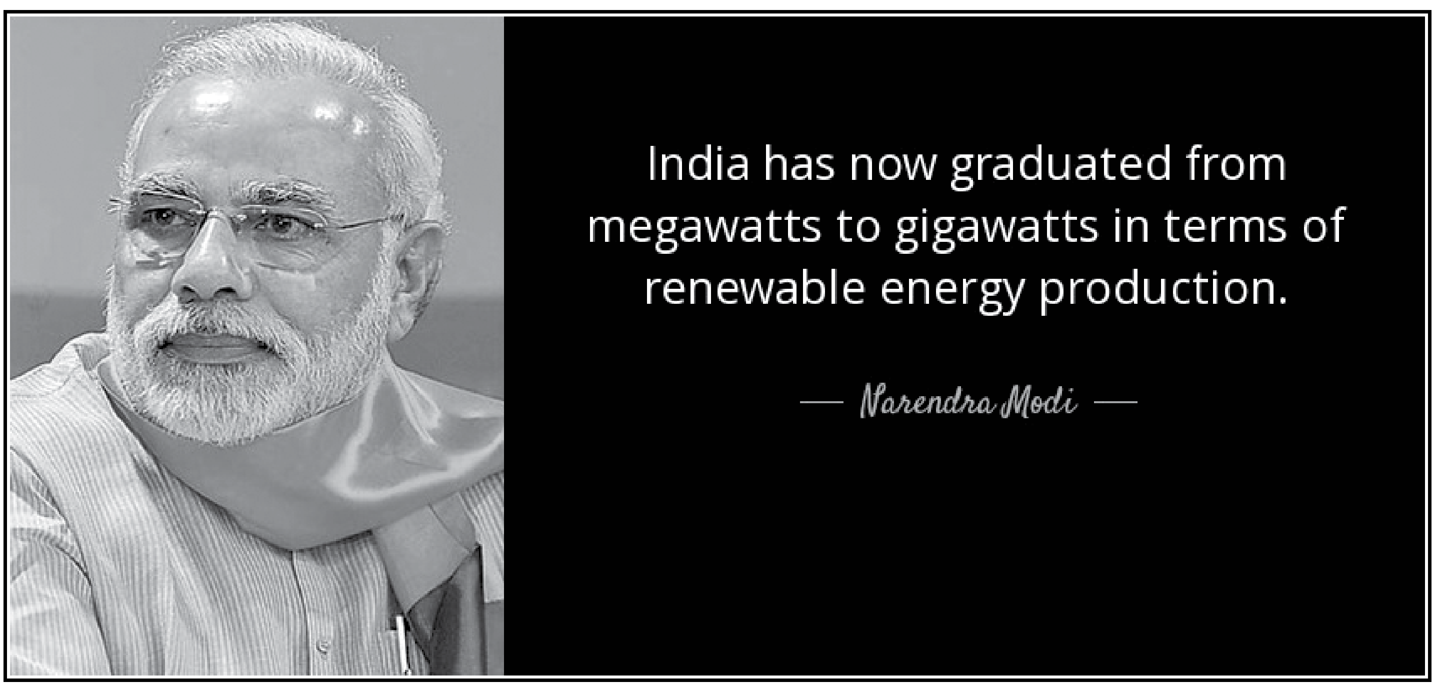

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Shri.B. M. Kardille Dy. Secretary, Regional Board of Technical Education, Mumbai
Dr. Pratibha Sharma Department of Energy Science and Engineering, IIT Bombay, Mumbai
Dr. Sanjay Gopal Associate Professor, Veermata Jijabai Technological Institute, Mumbai.
Mr. Sunil Pote Dy. City Engineer, Electrical, Thane Municipal Corporation, Thane
Mrs. Chaya R. Bhonslay Quality Assurance & Inspection – Electrical, Tata Power Co. Ltd., Mumbai
Mr. H. H. Patil Manager (Environment & Energy Efficiency) MEDA Pune

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Jt. Organizing Secretary Mrs. R.U. Patil, Sr. Lecturer, Department of Electrical Power System

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Mrs. Shayma

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Hospitality Committee
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Mrs. S.D. Khandagale
Mrs. N.S. Nangare
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Miss. Latasha Keshwani
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Dr G.S.Ingavale

Dr. V V Bedekar,
Chairman,
Vidya Prasarak Mandal,
Thane
Chief Petron of
NC ARET-2017

Message from Chief Patron

A rising awareness worldwide about Renewable Energy and Energy Efficiency are critical, not only for addressing climate change but also for creating new economic opportunities. And also it provides energy access to the billions of people still living without modern energy services. Over the past decade, and particularly in recent years, advances in renewable energy technologies, increases in capacity and rapid cost reductions have occurred globally. This has attracted significant investment in renewable energy field.

Clean energy made critical strides in 2016. An increasing national interest in the use of renewable energy for electricity generation has stimulated a need for performance of current and emerging renewable technology options. In particular, the availability of suitable and sufficient energy sources, development of environmental friendly utilization technologies and the cost of energy have become extremely important factors needing immediate attention. In this context, several schemes have been proposed for developing new and renewable energy technologies.

Vidya Parsark Mandal has always been a supporter of issues of global significance and takes lead to provide platform for researchers and industrialist to spread not only awareness but also to stress its importance. It also provides form for educationalist and young minds to present their views and interact with field experts.

I am happy that our Polytechnic is organizing One Day National conference on “Advancement in Renewable Energy Technologies” on 22nd December 2017. The objective of this conference is to provide opportunity to young generation to augment their views on green technologies and its sustainability to become vigilant citizens.

I congratulate the organizers as well as participants of this conference for recognizing the need and importance of the topic and contributing to this event in a big way.

It gives me great pleaser to present this souvenir to you. I am sure it will change your perspective on Renewable Energy Technologies and empower you to take right decisions in every walk of life.

I convey my Best Wishes for the success of the National Conference.

Dr. D.K. Nayak,
Principal & Convener
V.P.M’s Polytechnic,
Thane

Message from the Convener...
Advancement in Renewable Technologies

It gives me immense pleasure to welcome you all attendees, renowned Speakers, Subject Experts and distinguished Guests at One Day National Conference on Advancement in Renewable Energy Technology V.P.M’s Polytechnic, Thane announces this conference to provide an excellent platform to know, exchange new ideas, discuss new developments & finally look at the challenges ahead in the field of Renewable Energy.

Growing energy demand and the increased use of renewable energy have changed the landscape of power networks, leading to new challenges. Dependency on fossil fuels poses several major problems namely - global warming, rapidly rising costs and strategic concerns regarding security of fuel supply. By utilizing the renewable energy sources, a large reduction in CO_2 emissions and running costs is expected.

The new advancements in Renewable Technologies today are the best option that the human race has to fulfill its needs with minimal ecological disruption, which is what eco-based technologies are all about. Renewable energy can provide substantial benefits for our climate, health and economy. In India, the technologies in the field of renewable energy are advancing fast and government policies are creating enabling conditions for its societal penetration.It is our belief that the renewable energy value chain offers solutions forincreasing energy access, security of supply, emissions reduction, sustainable developmentand significant improvement in socio-economic development.

It is our sincere hope that this conference, will serve as a catalyst for renewables, helping to some extent meet the energy needs for all.

Best Wishes to All!!

Message from the Desk of Organizers

Mrs Rajashree Patil,
Jt-Organising Secretary, ARET-2017
Sr. Lecturer Elect. Power Sys. Depart.

Mrs Nisha Vader,
Organising Secretary, ARET-2017
Head of Elect. Power Sys. Depart.

Dear Colleagues,

We are indeed privileged and delighted to host the 20th National Conference of our Polytechnic.

Renewable energy is battling for new emerging technology for many years as it is the only solution of future energy. Last two decades have witnessed significant use of RE applications. Professionals have plethora of scope in these areas to work for innovation of new technologies & their commercialization. Platform is our national conference on “Advancement in Renewable Energy Technologies” to be held in Thane, the most vibrant smart city of India.

Without financial support, such event would not have been possible and we are very much thankful to MSBTE, MNRE & MEDA.

As Organising Secretary of ARET- 2017, we wish Researchers, Engineers, Manufacturers, Practitioners and Customers from all parts of the country will interact with the experts in this academic environment.

We hope that all of you will enjoy the academic feast, warm hospitality of Gujarat, rich heritage of the region and culture. We are thankful to the members of Advisory committee, for their timely guidance and valuable suggestions.

I am thankful to Dr V V Bedekar, Chief Patron, Chairman and also honourable members of Vidya Parasark Mandal for their support. We are also thankful to our Principal Dr D K Nayak for believing in our capabilities and entrusting us with the responsibility of organizing national conference third time.

Active support of all delegates and participants will continue to encourage us to highlight the areas for building career of young budding engineers.

“The three great essentials to achieve success for conference are hard work; persistency & common sense.”

Message

Dr. S.K. Mahajan ,
Joint Director,
Directorate of Technical Education,
Maharashtra.

The importance of renewable Energy technology has been growing significantly since the beginning of the 21st century and will continue throughout this century. Expectation has been growing worldwide for renewable energy technologies as a solution for energy and global environmental issues. According to studies on long time projections, renewable energy may satisfy half the world’s energy needs by 2025. This would put renewable energy on the same level of importance as conventional energy.

I am glad to learn that Electrical Power System Department of V.P.M’s Polytechnic, Thane is organizing One Day National conference on “Advancement in Renewable Energy Technology on 22nd December 2017. The theme of the conference is very apt and timely.

I wish the National Conference all success.

Message

Dr. Vinod M. Mohitkar,
Director,
Maharashtra State Board of Technical Education,
Mumbai.

I have great pleasure to note that Electrical Power System Department of V.P.M’s Polytechnic, Thane is organizing One Day National conference on “Advancement in Renewable Energy Technologies” on 22nd December 2017.

The applications of any advanced science and engineering aims to help the nation for it’s development. Power Engineers in the present day scenario have a challenge to provide reliable electrical energy supplies. It is essential for those professionals of electrical power to get newest updates of electrical energy and its advanced applications to meet the challenges.

I hope this conference will help in exchanging the experience and certainly induce innovative ideas among the participants paving way for inventions, new technologies and come out with solutions to achieve a national goal on this Renewable EnergY field.

I extend my best wishes for the conference.

With warm greetings...

Dr. Sanjay Mangala Gopal,
Associate Dean (Students' & Alumni) and Former Head and Associate Professor in Mechanical Engineering, Veermata Jijabai Technological Institute (VJTI), Matunga, Mumbai & Coordinator, Akshay Urja Abhiyan – Campaign for Renewable Energy, Thane.

Message

It is indeed an honour to be able to participate in the 20th National Conference on `Advancement in Renewable Energy Technology`. I truly believe that this is a fundamentally important subject for the sustainable future of us, humans and our mother earth. VPM polytechnic by organizing conference on this topic has helped to increase awareness and impart most up-to-date knowledge to the students who are future technologists and engineers. Time has come when they need to expand their imagination and inventiveness over and above mere engineering field and impart social and environmental aspect to their technical knowledge. This conference helps achieve the same.

Sustainable development, as is understood today, is not only about technological or economical development, but about maintaining ecological balance of the environment and foster equality, happiness, prosperity and social justice to all the people on the Earth. Because of the globalization and industrialization most cities have become centres of new technological and economical growth. As a result, increasing energy use along with increasing pollution are major issues of the cities which can be effectively addressed by adopting Sustainable Energy Utility (SEU) model. It is a gift of the Centre for Energy and Environmental Policy (CEEP) at the University of Delaware, USA and its Director the Noble Laureate Dr. John Byrne. It is a model of three level strategies; adopting energy conservation (EC) techniques, using energy efficient (EE) gadgets and maximum utilization of renewable energy (RE) sources. An integrated economic and environmental approach in policy making and incorporating peoples` participation in implementation, which can be termed as `Public – Public Partnership` can be a viable approach to address serious issues of energy crisis, climate change and environmental degradation facing urban centres all over the world, effectively.

No doubt concern for economic growth is important. However, considering economy as supreme without even bothering for ecology and environment is dangerous. Whatever may be the level of development humankind has achieved through technology, it will sustain only if the mother earth survives. In less than two centuries of industrial development, we have already ruined the nature beyond critical limits. Global warming, untimely rains and many such so called natural calamities of enormous magnitude are the results of unlimited greed of the humans! While addressing the issue through technological solutions, it is necessary to compliment it by suitable policy measures through bottom-up pressure of communities. Conducting free energy audits of housing societies and recommending no or low cost solutions pertaining to EC, EE and RE of SEU model as initiated by Akshay Urja Abhiyan (Campaign for Renewable Energy) in Thane, is one of the ways to enrol communities for the cause of sustainable future and creating Citizens' Energy Movement!

Renewable energy sources are the hope of the future and to harness these resources research and development in Renewable Energy Technologies are the key factors. The initiatives like this conference will go long way in fostering awareness and new inventions in this field. I sincerely wish to congratulate the institution for taking this initiative to organize this conference and all team members for striving to make it effective and successful.

With warm greetings...

The future of our chilidren
The future of our planet
it's in OUR hands

that's why Energy Matters

Mrs. Chaya R. Bhonslay,
Head of Quality Assurance
& Inspection – Electrical,
Tata Power Co. Ltd., Mumbai
Advisory Committee
Member NC.

Message

I congratulate VPM polytechnic for hosting this national level conference. It is indeed an honour for such a prestigious event about Renewable Energy to take place here.

Energy has remained central to all our developmental needs, yet we need to protect our environment for the benefit of us all and future generations. It therefore goes without saying that urgent deployment of Renewable energy technologies is an over-riding and crucial priority for us.

The renewable energy market is growing fast and India is currently on its way to change the energy mix.There is no doubt that around the world, the developing countries are seeking to rapidly scale-up renewable energy investments. At the same time, the technology cost of renewable energy has been experiencing remarkably steady falls over the past decade.

I hope that, this conference will help participants and student community to be able to reflect upon the progress made on the deployment of Renewable Energy technologies and identify gaps and challenges, as our country map a clear way forward.

I thank all the participating in this conference. It is a step in the right direction that we deliberate the way forward. I am looking forward to interactive deliberations by all participants and wish you a successful outcome from this conference.

Thank you and all the best!!

Mr. Sunil Pote,
Dy. City Engineer,
(Electrical),
Thane Municipal
Corporation, Thane.

Message

Energy industry especially power generation and utilization is playing a greater role in the progress of our nation. It is essential for professional engineers, research scholars engaged in electrical power generation and applications of this industry to understand the updates that are coming up from time to time. Creating a platform for the power engineering professionals to share and express their views in the advancement of Renewable energy and its applications gives a great opportunity to know about the progress achieved by the power industry today. I hope the Conference on "Advancement in Renewable Energy Technologies" would certainly help everyone to have the latest updates and a better understanding of the power industry today.

VPM's Polytechnic, Thane is one of the renowned institutions in Thane region. It has played a key role in spreading awareness of renewable to the society. I am associated with this esteemed institute for more than a decade. I am extremely delightful to know that Electrical Power System Department of V.P.M's Polytechnic, Thane is organizing One Day National conference on "Advancement in Renewable Technologies on 22nd December 2017

I extend my best wishes to the polytechnic, who continuously sustains their efforts, in attaining excellence and my best compliments to the organizers of the polytechnic for arranging a conference on the topic which is the need of the hour.

With warm greetings...

Mr. H. H. Patil,
Maharashtra Energy
Development Agency.

Message

I am extremely delighted to know that V.P.M's Polytechnic, Thane is organizing 20th National conference on "Advancement in Renewable Energy Technologies" on 22nd December 2017.

I hope that this conference would surely induce modern ideas among the participants paving way for new inventions in the Renewable Energy sector

I extend my best wishes to V.P.M's Polytechnic, who continuously sustains their efforts, in attaining excellence and my best compliments to the organizers of the polytechnic for arranging this conference.

With warm greetings...

First Precursory workshop of National Conference on Advancement in Renewable Energy Technologies

Date: 04/03/2017

Renewable energy is battling for new emerging technology for many years as it is the only solution of future energy. Last two decades have witnessed significant use of RE applications.

Professionals have plethora of scope in these areas to work for innovation of new technologies & their commercialization Electrical Power System Dept. of VPM's Polytechnic is organizing 20th one day conference on "Advancements in Renewable Energy Technologies" on 22nd Dec.2017.

Related to forthcoming conference a **Precursory Workshop** was organized by the department. Principal Prof. D.K Nayak explained the importance of Renewable Energy in current energy scenario. He also motivated students to focus on Renewable Energy Technology for their future work and generate their own model.

Mrs. N.V. Vader, Head, Electrical Power System dept. conducted the session on **"Integration of smart grid with future energy"**. The session highlighted need of advanced technology in operation of grid network and the adoption of smart grid in Indian Power Sector. The significance of Renewable Energy technology and its integration with the future grid system. More stress was given on career opportunities for young engineers of all streams.

Mrs. S.S.Kulkarni, Sr.Lecturer, Electrical Power System Dept. conducted the second session on **"The use of solar energy for various applications"**. The session was on designing aspects of solar system. The session was motivational for the students to become **solar entrepreneurs.**

The final year EPS students who won state level paper presentation competition at Jalgaon Polytechnic also presented their paper titled "Energy Generation by Future Energy Source(RE) for future generations"

The precursory workshop concluded with highlighting the need of professionals working in Renewable Energy technology.

Conference organizing
Mrs. N.V. Vader HOD, EPS Dept.
Secretary:

Mrs. R.U. Patil,
Sr. Lecturer, Joint organizing Secretary

"Renewable Energy Day- 2017" 2^{nd} Precursory workshop of 20^{th} NC on 'Advancement in Renewable Energy Technologies'

'Renewable Energy Day' is celebrated to create effective awareness of Renewable Energy & innovation in the Energy Field. Every year Electrical Power System Department is celebrating this occasion by organizing state level technical paper presentation, posters & slogan competitions and various programs on Renewable Energy field. It is 12th consecutive year of celebration.

On 19^{th} August department organized second Precursory Workshop of upcoming National conference on **'Advancement in Renewable Energy Technologies'** with 3 informative sessions on Advanced Technologies in Renewable Energy.

Inaugural Session: The Program was inaugurated by Chief Guest – **Mrs Chaya Bhonsale** Head - QA & I (Electrical) Tata Power Company Limited, Mumbai. Principal & convener of conference Prof D.K.Nayak addressed audience about the objectives of upcoming conference. He inspired & motivated students to move step towards Latest technologies of Renewable Energy., Mrs N.V.Vader HOD,EPS Department & Organizing Secretary of National Conference gave the details of workshop & provoked young mind for new scope in RE field.

SESSION 1

Mrs Chaya Bhonsale Head - QA & I (Electrical) Tata Power Company Limited, Mumbai conducted session on **'Industrial approach toward Renewable Energy System.'** She highlighted the major Role of TATA power in Renewable Energy Scenario. She discussed about the new challenges in this Renewable field. She presented Indian Power Scenario & how Renewable trajectory is improved in India by giving statistical data. Mrs Bhosale also gave details of incentives available for Renewable & evolving business models in Renewable Energy. Participants also got information about Solar rooftops & Job opportunities in this field.

SESSION 2

Dr H A Mangalvedekar Retd. Professor, V.J. Technological Institute, Matunga presented session on **Future Power System Scenario**. He highlighted the functioning of power system grid with integration of RE system. He also highlighted the expectations from young engineers & need for innovations in Renewable Energy.

SESSION 3

Mr. Kedar Anand Nadgaundi Executive Director of ,Levicon Group conducted session on **'Career opportunities with Solar System'** He gave basic information related to solar panel., LED based solar home lights and street lights using lithium batteries. He also discussed how solar power is integrated with grid & concept of net metering. Mr Nadgaundi also gave information about latest solar pumping systems to all participants.

DEMONSTRATION SESSION

Demonstration session

After the presentation demonstration of latest solar products- all types of LED Lamp, Solar Street Light, Solar Lantern, OFF grid & ON grid Inverter, Solar Pumping System to all participants was carried out by Levicon team to give real approach towards latest models of technology.

All partcipannts saw various types of Modern LED lamps, off grid & on grid inverter models..They got the opportunity to see actual working of soalr street lamp using. Students observed compactness of latest solar lantern by using lithium batteries..They also collected information of lithium batteries & understood benfits of it .

Participants actively interacted with spekaers & team of Levicon Group..Enthusiastic & active participation of all participants of worksop helps to fulfil the objectives ofprecursory workshop of National Conference.

Participants of Precursory Workshop

Organising Team

Mrs N.V.Vader - Organizing Secretary of conference. HOD,EPS

We are, quite literally gambling with the future of our planet - for the sake of hamburgers

V.P.M.'s Polytechnic, Thane

20th One Day National Conference

Advancement in Renewable Energy Technologies

22nd December 2017

Schedule

8.30 to 9.00 AM	**Registration**	
Inaugural session		
9.00 AM to 10.00 AM	**Inauguration**	**Dr. Anuradda Ganesh** (Chief Guest) Director, Adv. Engg.,Cummins Technologies India Ltd.Pune **Dr S.K.Mahajan,** (Guest of honor) Joint Director, Directorate of Technical Education,Maharashtra **Dr. Sanjay Gopal,** Associate Professor VJTI, Mumbai **Dr. V.V. Bedekar ,** (Chief Patron) Chairman, Vidya Prasarak Mandal Thane
10.00 to 11.00 AM	**Key Note address**	**Dr Chetan Singh Solanki** (Key note speaker) Professor in Dept. of Energy Science & Engg. IIT Bombay
SHORT BREAK		
(First Session)- Chair Person Dr. Sanjay Gopal, Associate Professor, V.J.T.I, Mumbai		
11.15 to 11.45	**View on Sustainable Future Energy**	**Dr. Sanjay Gopal,** Associate Professor VJTI, Mumbai
11.45to 12.30	**Contribution by Municipal Corporation in RET**	**Mr. Sunil Pote** (Invitee) Dy. City Engineer,(Electrical), Thane Municipal Corporation, Thane
12.30 to 1.00 PM	**P1- Solar based tech. for agriculture & Agro based Industries-An effort of DBSKKV, Dapoli**	**Dr A.G.Mohod, Dr Y.P.Khandetod,** Mr H.Y.Shrirame, Dept. of Electr. & Other Energy Sources, College of Agril Engg & Tech,DBSKKV, Dapoli.
	P2- Overview of Renewable Energy Market in India.	**Mr. Gaurav Mahashabde** Lead Business Analyst, Tata Power Co Ltd. Mumbai **Mrs. Nisha Vader,** Energy Manager, HOD- Elect. Power Sys. Dept. VPM's Polytechnic,Thane
1.00 PM to 2.00 PM	**LUNCH BREAK**	
(Chair person Dr. H A Mangalvedekar Ex Professor VJTI Matunga		
2 PM to 2.30 PM	**Issues with Wind generation**	**Mr. Shamsundar V Deo,** (Invitee) (Former Technical Member MSEB Pune, Former director Suzlon,
2.30 to 3 PM	**Impact of Renewable Energy Sources on Power Quality**	**Dr Kanetkar V R** (Invitee) Consultant – Technical Services Vertiv Energy Private Limited, Thane (West)

3 PM to 3.45 PM	**P 3 Study Of Temperature Profile Of Solar Cabinet Dryers**	**Mr. M. B. Patil, Mrs P P Chavan, Dr A G Mohod , Mr H Y Shrirame** Asst. Prof. Instrumentation Dept.College of Agril Engg and Tech,DBSKKV, Dapoli.
	P4 - Free & open source Simulation Software tools for Rooftop PV Installation with case study	**Mrs. S S Kulkarni,** Sr Lecturer, Elect. Power Sys. Dept V.P.M.'s Polytechnic Thane
	P5- A study on Carbon Tax - Pros & Cons, Effects on Env. & Economy	**Mr Arif Mohammad B. Attar,** Lecturer, Sanjay Ghodawat Polytechnic., Atigre, Kolhapur
Short Break		
4 PM	**Valedictory**	**Dr H A Mangalvedekar (Chief Guest)** Ex Professor VJTI Matunga
(Second Parallel session - Venue AV Room) Chair person – Mrs. Chaya Bhonsale Head - QA & I (Electrical) Tata Power Company Limited, Mumbai		
1.	**P6- Review of Sustainable Energy Sources for Future**	**Mr.Tushar.R.Pokharkar**, HOD, Electrical Dept. A.C.Patil Polytechnic.Kharghar.
2.	**P 7-A Review of green energy-mission 2022**	**Mrs. Surbhi Mehta,** Lecturer, Elect. Power Sys. Dept ,V.P.M.'s Polytechnic Thane
3.	**P 8- Net metering –Evolution in Solar PV System**	**Mrs. R.U.Patil,** Sr Lecturer , Elect. Power Sys. Dept , VPM's Polytechnic Thane **Mrs. Swati K Nadgaundi,** Ass professor BVCOE Navi Mumbai
4.	**P 9-Study on the Properties of Castor (Ricinus communis) for the Production of Biodiesel**	**Mr. H. Y. Shrirame, Dr. A. G. Mohod,** Dept. of Electr. & Other Energy Sources, College of Agril Engg and Tech,DBSKKV, Dapoli - **Dr. N. L.Panwar,** Department of Renewable Energy Sources, College of Tech. & Engg, MPUAT, Udaipur, Rajasthan,
5.	**P10-Solar PV Cooling - A Review of Technologies**	**Mrs. Anice Alias,** Sr Lecturer, Elect. Power Sys. Dept ,VPM's Polytechnic Thane
6.	**P11-IOT based system for photovoltaic monitoring**	**Prof. Anjum Mujawar,** HOD Electronic & Telecommunication Vidyalankar Polytechnic, Wadala, Mumbai
7.	**P12-Fuel cell For Standalone Application Using FPGA Based Controller**	**Mrs. Shyma K V,** Lecturer, Depart. of Electrical Power System,VPM Polytechnic Thane
8.	**P13-Effects Of Renewable Energy On Smart bag**	**Mr. Pratik Tawde,** Lecturer Electronics and Telecommunication Department Vidyalankar Polytechnic,Wadala
9.	**P14-Advance Flywheel Battery And Their Applications**	**Sarkar Omkar VIkas, Student** Sharad Institute of Technology, Polytechnic, Yadrav, Ichalkaranji-Kolhapur
10.	**P15-Sustainable Future Energy Sources**	**Dangare Shubham P.Student** Sharad institute of Technology Polytechnic, Yadrav, Ichalkaranji-Kolhapur
11.	**P16- Measurable – verifiable of carbon emission, carbon tax**	**Prathmesh C. Jadhav, Student** Sharad institute of Technology Polytechnic, Yadrav, Ichalkaranji-Kolhapur

Mrs.N.V.Vader
HOD & Organizing Secretary

Mrs. R.U.Patil
Sr.Lecturer & Joint Secretary

The Dual Challenge of Energy and Environment - India Transportation Sector

Dr. Anuradda Ganesh, Director ,
RIC, Cummins Technologies India Pvt. Ltd.

Dr. Anuradda Ganesh is currently the Director of Research, Innovation and Compliance (RIC) at Cummins Technologies India Private Limited (CTIPL). A PhD in Chemical Engineering, she brings in a rare combination of excellence in academia as well as industry. Prior to joining Cummins, she was heading the Department of Energy Science and Engineering at IIT Bombay for 25years. She is global expert on Alternate fuels and its applications and has contributed to intellectual property with over 60 journal publications with over 2000 citations, couple of chapters' publication and five granted patents. Dr Ganesh is keenly interested in academic- industry – government-society relationship development. She is currently serving in various National level Committees1 representing Cummins and as Subject Matter Expert.

She has a flair for societal cause exemplified through development of technology for rural applications and by participation in various national level projects for rural development, alternate fuels and emissions control. She works as a technical consultant for the "Clean Air in Delhi" project sponsored by Cummins Inc, partnered with CII and NITI AAYOG. She has conceived and established the Centre for Research and Intellectual Entrepreneurship at Cummins College of Engineering for Women, wherein the objective is to inculcate research, innovation and entrepreneurship skills to Faculty as well as the women engineers in the making.

She received the "Most Innovative Energy Saving Product" Award under the CII National Awards for Excellence in Energy Management 2010. Amongst other achievements - she was invited to address select Senate Members at Capitol Hill, USA on 'The Road to Copenhagen: Energy Solutions for Emerging Economies'. She was conferred the 'Best Woman Achiever for Excellence in Area of Expertise' for the year 2012 by The Women Pilot Association.

Fossil fuel powered prime movers have a long history and they have evolved tremendously from perspective of emissions, fuel economy, power density, drivability, weight optimization. In recent decades, gaseous and particulate emissions has become key requirement in internal combustion engine evolution while energy dependency, low cost of operationand greenhouse gas concern has pushed fuel economy to be better. Both requirements – fuel economy and lower emissions does not necessarily complement each other and hence trade-offs, component technology development and aftertreatment systems have been recent technology focus.

Energy dependency has been major focus by Government of India and recent times and has been working comprehensively on driving alternate fuel technology to reduce crude oil imports substantially while promoting cleaner fuels. Compressed natural gas (CNG) has been a successful alternate fuel promoted India, largely in Metro cities satisfying emissions concerns and helping lowering crude oil dependency. This aspect is now evolving seriously seeking use of Methanol made out of surplus coal, promoting Ethanol, Dimethyl Ester (DME) and their possible use in day to day fuel such as Methanol blended gasoline, Methanol powered railways and ships / inland waterway barges to name a few.

Energy dependency concern has also driven Government agencies to introduce fuel economy norms. M1 and N1 category vehicles are being introduced with CAFÉ based FE norms and BEE labelling whereas HD vehicles are declared with constant speed based fuel consumption norms in two phases. Light and medium duty commercial vehicles are now being brought under similar norms in order to cover entire passenger and commercial vehicle portfolio.

Similarly, India's concern with vehicular pollution has prompted it to skip BS V norms and announce BS VI emission norms in April 2020, something that will make a positive impact on clean air nationwide. While above measures are being implemented positively and in pace unprecedented in India, Government has also given indications about major move towards electrification of vehicles as well as railways in coming years. India's drive on clean and renewable energy in the form of hydal, solar and wind energy being invested for will be backbone of electrical energy needs for future electric vehicles.

Today we probably stand at position where best of the fuel, engine technology is being evolved along with widespread opportunities and benefits of connected technologies while we see certain transition into electric mobility, at least for certain applications in near future. The quest for cleaner, healthier environment and greater efficiency will continue driving technological innovations.

Solar PV Technologies for Reliable Off-grid Power for Rural Areas

Chetan. S. Solanki [a], Rohit Sharma [b], Amruta Joshi [c], Jayendran Venkateswaran [d]

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Principal Investigator, National Center for Photovoltaic Research and Education (NCPRE), and Solar Urja Lamp Program, IIT Bombay, Mumbai, India
bProject Research Scientist, Department of Energy Science and Engineering, SoULS Group,IIT Bombay,India
c Department of Energy Science and Engineering, IIT Bombay, Mumbai, India
dAssociate ProfessorDepartment of Industrial Engineering and Operations Research, IIT Bombay, Mumbai, India
**(chetanss@iitb.ac.in)*

Abstract

Goal 7 of the United Nations Sustainable Development Programme (UNDP) calls for ensuring access to affordable, reliable, sustainable and modern energy services for all. Lack of access to electricity and modern energy sources significantly limits economic development and entraps millions in extreme poverty. Currently, 23.9 crore people were still without electricity in India. Off-grid solar PV technologies hold potential as a reliable and sustainable solution to supply basic electricity needs. Last few years have seen greatly increased uptake and drastic cost reductions of solar photovoltaics. Following a literature survey, this paper discusses the current status of photovoltaic (PV) technology and the limitations of past solar off-grid implementation. We present a market-driven Solar Ecosystem by Local for Local (SELL) for rural areas that involve local communities at each level of operation such as assembly, sale, after-sales service, and even manufacturing along with experience of implementing localized solar energy solutions. Deployment of off-grid solar photovoltaic technology with SELL approach involving interactions between local communities, institutions, government and non-government organization will bring brings economic benefits, social acceptance, education and environmental welfare of people living in rural areas.

Introduction

India is facing an energy dilemma: energy security needs to be achieved even as per-capita energy consumption is lower than the ideal. Around 4.05 crore rural households in India are currently bereft of electricity. These are households in remote villages where grid extension is techno-economically infeasible or households in unconnected hamlets of grid connected villages or they are un-electrified households within electrified villages. The main reason for lower electrification rates and higher costs of electricity in rural areas worldwide is higher cost of grid extension in remote rural areas than in urban areas. High transmission and distribution losses and high cost of maintenance in remote rural areas makes it unattractive, especially since many people are poor and thus unable to pay for electric services [1].

At the current rate of electrification, it is estimated to take an additional 7–13 years to electrify existing un-electrified rural households. Considering the households being added every year due to population growth, India will have to more than double the current rate of electrification. Further, the delivered cost of electricity to the Government for electrifying the last mile households can be as high as Rs. 231 in hilly areas (5 kW peak load, 0.1 load factor, 25 km distribution lines [1]. Moreover, even if grid connection is established, quality and reliability of grid based electricity supply remain a matter of concern. Access to electricity increased non-agricultural incomes of rural households by about 9% over an 11-year period; however, access to good quality electricity (in terms of fewer outages and more hours per day) increased non-agricultural incomes by about 28.6% [2]. Poor quality of power supply, affordability of monthly charges and difficult procedures for getting a connection and payment of bills are the major reasons for many poor households living in electrified villages to choose to remain without electricity [3].

Current status of photovoltaic (PV) technology

Solar photovoltaic (PV) is considered to be an imperative technological solution for leading towards transformation of the energy systems to the sustainable ones [4]. The advancements in PV industry are critical to uphold it in competition with conventional energy sources as well as other renewable energy sources [5]. The researchers from the various international laboratories and industrial set-ups worldwide have been striving to attain this for decades; by utilizing diverse new materials or new processes and cell designs on well-known material like silicon (Si) which is the workhorse of not only the semiconductor industry but also for solar cell industry. The two fold challenge for PV is to accomplish the high efficiency solar cells and modules but at low cost.

The improvement of cell efficiency is ongoing process and through technological developments, it gets revised. The efficiencies of selected current state-of-art single and multi-junction solar cells can be seen in Fig. 1. It can be observed from the bar chart, the highest reported efficiency for mono-crystalline Si (c-Si) solar cell is 26.7%

using n-type Si on 79cm2 solar cell whereas it also reached 21.9% for lower cost alternative multi-crystalline Si (mc-Si) cell, on 4cm2 area [6]. The thin film materials including copper indium gallium sulphide (CIGS), cadmium telluride (CdTe) have been catching up fast with Si, in terms of cell efficiency on smaller size cells. The best cell efficiency of CIGS is 21.7% and CdTe is 21%. Along with single junction solar cells, there have been efforts for multi-junction cells; reaching the efficiency of 38.8% for III-V materials on 5 junction cell, 35.9% for III-V materials in tandem with Si and 14% for triple junction amorphous Si (a-Si) cell [6]. Other materials with notable improvement in efficiency include perovskites, dye sensitized and organic solar cells.

Typically the solar PV module efficiency made from a particular cell technology has lower efficiency then the cell efficiency, due to mismatch losses occurs in converting cells to modules. It can also be noted from the Fig. 1, the highest efficiency of n-type c-Si module (made using n-type c-Si cells) is 24.4% and similarly the highest efficiency of mc-Si module (made using mc-Si cells) is 19.9%. The best efficiency of CIGS and CdTe modules are 19.2% and 18.6% respectively. The modules mentioned in this paragraph are commercially produced at large scale.

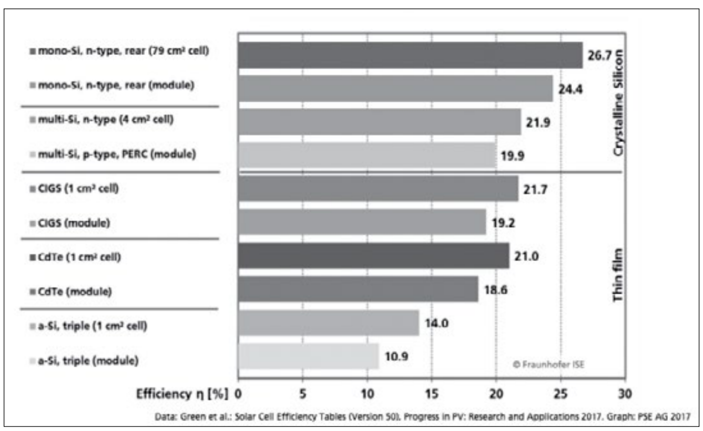

Figure 1: Efficiency of different solar PV technologies [4]

Since the efficiencies demonstrated for non-Si materials are still on the small area solar cells, the market share of c-Si based technologies is 90% and other thin films is 10% even at the end of 2016, when the production capacity is estimated to be more than 90GWp [5]. Thus, the responsibility of cost reduction of PV has to be handled primarily by Si PV industry. The PV module prices have been continuously reducing since last 30 years as the production volumes are increasing. This is demonstrate in Fig. 2. For doubling of cumulative PV module sells the drop in prices have been following rate of about 22.5%. The average PV module prices have come down to around 0.5 US$ per Wp which has resulted in very competitive solar electricity cost as compared to electricity from other means like using fossil fuel and wind energy technologies.

Limitations of past solar off-grid implementation

There is a strong complementarity between conventional grid electricity and off-grid solar electricity. Yet, in the past, large scale solar

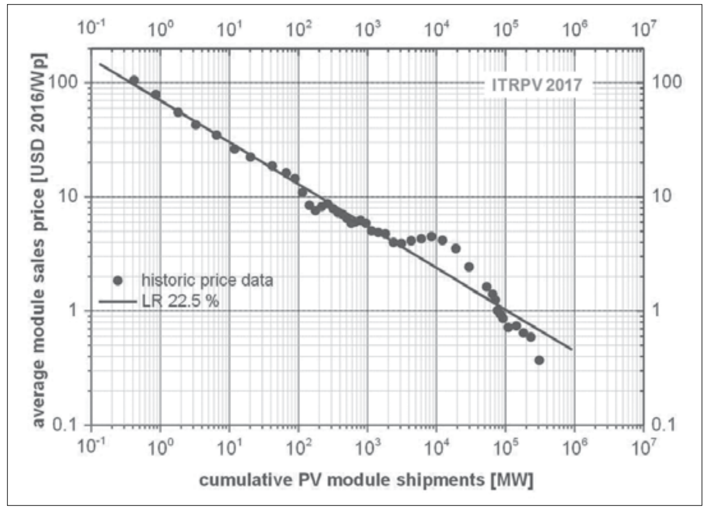

Figure 2: Price trends of PV modules with respect to cumulative shipments [5]

photovoltaic (PV) implementation programmes have faced hurdles in the form of high dissemination cost, lack of aftersales services, poor public awareness, lack of skilled workforce and supply shortages. This has led to widespread mistrust in solar technology, especially in rural areas. Empirical evidence suggests that involving local communities is crucial for successful dissemination, implementation, and sustainability of solar PV interventions [7, 8, & 9].

Opportunities offered by localized solar ecosystems

Effective rural electrification in India requires a timely, cost-effective and reliable solution. Such a solution needs to be implemented in a localized manner and can be achieved through the creation of a solar ecosystem. The ecosystem would provide critical access to electricity and solar products through local production and distribution. Local people can be trained to own, manage and operate solar enterprises. Such a market-driven ecosystem can be termed as SELL as shown in Fig. 3. This would involve local communities at each level of operation such as assembly, sale, after-sales service, and even manufacturing.

The basic idea is to make each rural areas self-sufficient in terms of meeting its power requirement by creating localized solar ecosystem

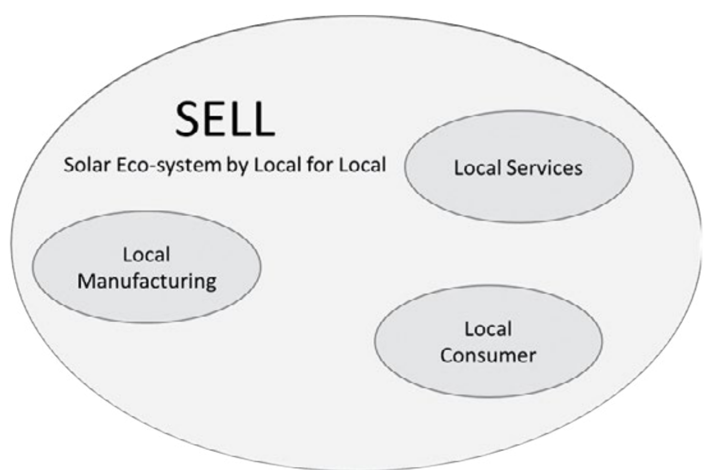

Figure 3: Solar ecosystem for rural electrification

for supply and service of electricity solutions. Apart from installation and maintenance of solar systems like rooftop systems, solar home lighting systems and solar street lighting systems, locals can take up manufacturing as well. The localized solar ecosystem integrates the tribal women vertically into the solar supply chain. A combination of solar eco system and super-efficient loads can provide for all rural electricity needs in a reliable, cost-effective and sustained manner.

Establishing a local solar ecosystem by localized supply and service would provide timely, cost-effective and reliable electricity to the rural consumers. In terms of horizontal expansion, the solar panel manufacturing enterprises would speed up the deployment of systems such as solar street lights, solar water pumps, solar home lighting systems and other solar products. The availability of the components in a localized manner would help bring down costs and optimize the logistics to a large extent. This would be a stepping stone towards building completely indigenous solar products. Localization would result in creation of direct and indirect technology-based rural employment. Creation of local assets and manufacturing infrastructure, and availability of robust after sales and maintenance services would boost the overall rural economy. Implementation of solar ecosystems would result in addressing the electricity requirements of the rural consumers through local market-based mechanism thereby creating positive externalities that would jumpstart technology-based progress of rural India.

Experience of implementing localized solar energy solutions

IIT Bombay has implemented the Million Solar Urja Lamp Program (MSP) to provide clean light to the most marginalized and deprived communities. Solar study lamps was provided to one million to rural school going children's in four Indian states of Madhya Pradesh, Maharashtra, Rajasthan and Odisha over February 2014 to March 2016. More than 1,500 local people were trained to assemble, distribute and repair & maintain the lamps. Free after-sales service for a year was provided in the intervention blocks through trained locals to ensure timely repairs and sustained use by the households. The program covered 23 districts, 97 sub-districts and more than 10,900 villages. There were 54 A&D centers and 350 repair centers in operation under the program, with training provided to 1,409 local people. Based on the favorable outcome of the previous interventions, IIT Bombay has initiated the Solar Urja through Localization for Sustainability (SoULS) program where 7.5 million lamps will be distributed in the central part of India wherein household electrification is less than 50%. SoULS is an implementation concept enveloping for development and dissemination of solar products through the localized mechanism, that can be sustained over a period of time. The core concepts of the SoULS model are shown in Fig. 4. A solar PV manufacturing plant, one of the first of its kind in the country, has been established in the tribal village of Dungarpur in Rajasthan which is owned by local tribal women to serve local markets. The SoULS project aims to find permanent and reliable solar electricity solutions for households in the remote rural areas which are not connected to the electricity grid through localization for sustainability.

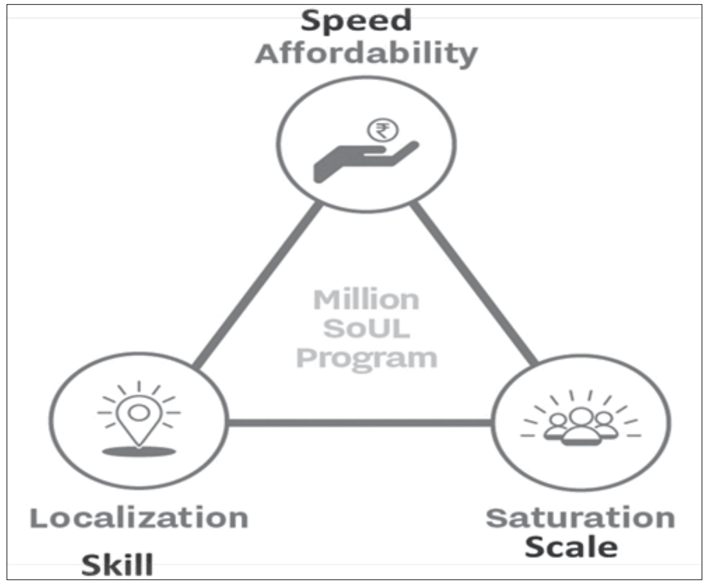

Figure 4: Solar Urja through Localization for Sustainability (SoULS) model

Conclusion

Access to electricity is important to bring a subtle socio-economic development to the underprivileged communities in India's rural areas. Despite of abundant solar potential, institutional and techno-economic feasibilities the long term success of solar PV technologies is depending on social acceptance. Fossil fuel is dominated as primary energy supplies in India, which will produce large emissions from electricity generation which may have severe impact on climate and environment. As conventional approaches fall short, such communities in remote rural areas need an energy source that is decentralized, affordable, reliable, and clean to meet their basic energy requirement. Hence utilizing renewable energy sources [off-grid solar PV technology, in this context] in a cost-effective way for basic electricity needs of remote rural communities not only improves the living standard of the people but also contribute to reduce carbon emissions. The SELL approach for the deployment of solar PV technologies approach involving interactions between local communities, institutions, government and non-government organization will bring brings economic benefits, social acceptance, education and environmental welfare of people living in rural areas.

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Author's calculations based on monthly electrification data from January 2017 to May 2017, accessed from the Garv App on 27 September 2017.

About Author:

Dr. Chetan Singh Solanki
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He is a Doctorate from IMEC (Interuniversity Micro-electronics Center), Ketholik University, Leuven, Belgium in 2004. He has Completed M.Tech from IIT Bombay His Research Interest are Solar Photovoltaic, Thin-film silicon solar cells, PV solar concentrator, PV module cleaning, Carbon nano tubes (CNT)

It is sunlight in modified form which turns all the windmills and water wheels and the machinery which they drive. It is the energy derived from coal and petroleum (fossil sunlight) which propels our steam and gas engines, our locomotives and automobiles. ... Food is simply sunlight in cold storage.

- John Harvey Kellogg

A Review of Regulations for NET Metering for Roof-Top Solar Photo-Voltaic Systems

Vijay L Sonavane
Advisor India Smart Grid Forum, New Delhi, Former Member MERC Mumbai

1.0 Introduction:

Electricity has always been a prime mover for the development of the country. All India installed Electricity generation capacity as on 31st Oct. 2017 is over 331 GW. The all India installed capacity of Renewable Energy sources is 60 GW (18.2 %). The installed Solar Generation is 15 GW out of which Solar Rooftop PV generation Installed capacity is 1.7 GW.

In its effort towards reducing impact of Green House Gases and caring for climate change, India is targeting the installation of 175GW of renewable energy capacity by 2022, which is an ambitious target that includes 60GW of large and medium-scale grid connected solar power projects, 60GW of wind, 40GW of Solar Rooftop projects, 10 GW of bio-power and 5GW of small hydro. As a result, renewable energy in India has seen more fervent investments, capacity building activity and a steeper fall in per unit energy supply tariff than any other energy source in the country.

2.0 Legal Framework for Renewable Energy:

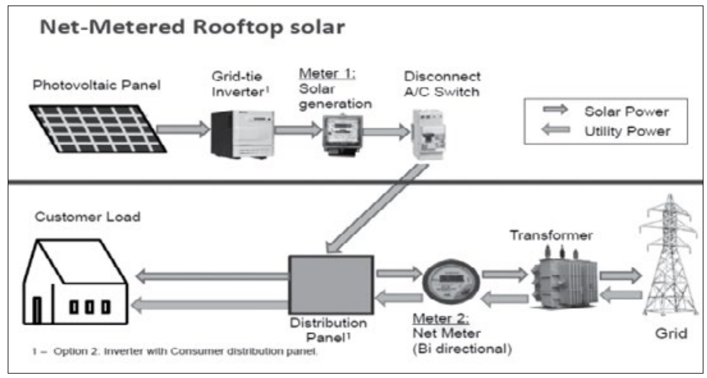
As per S 61(h) of the Electricity Act 2003, promotion of generation of energy from Renewable sources has been the explicit responsibility of the Regulatory Commissions.

Basically, ACT is the legislation passed by the Parliament. Normally Acts set out the broad legal/policy principles. The REGULATIONS are commonly known as "subsidiary legislation. Regulations include guidelines that dictate how the provisions of the Act are applied.

Accordingly since 2003, Maharashtra Electricity Regulatory Commission (MERC) has issued a number of proactive Regulations for development of Renewable Energy in Maharashtra. In its endeavor to help promoting Solar Roof top Systems in Maharashtra, MERC has issued MERC (Net metering for Solar Roof Top PV Systems) on 10 Sept 2015. The Amendment to these Regulations was issued on 21 July 2017. These are discussed in following paras.

3.0 Salient features of MERC Solar Roof Top PV Regulations 2015:

Solar PV System installed on Consumer's premises, owned and operated by such Consumer or by a third party, that uses sunlight for direct conversion into electricity through PV technology, is called "Roof Top PV Solar system." As per MERC Regulations, cumulative capacity of all solar PV systems under net-metering arrangement, under any Distribution Transformer (DT) shall not exceed 40% rated capacity of DT.



Any Consumer of Discom can have Solar PV Generation capacity less than or equal to of 1 MW, installed on a rooftop or any other Mounting structure in his premises to meet all or part of his own electrical power requirement. However, the capacity of Roof-top Solar PV System to be connected at the Consumer's premises shall not exceed his Contract Demand (in kVA) or Sanctioned load (in kW). Net Metering is to be provided by the Discom on non-discriminatory (first come, first serve) basis to Eligible Consumers, who have installed or intend to install Roof-top Solar PV Systems connected to Discom's Network.

"Net meter" is an Energy meter capable of recording both Energy Import & Export and also recording the NET (Import/Export) of Energy. In the Net Metering arrangement Roof Top Solar PV system, with a net meter is installed at consumer's premises. The consumer can deliver surplus Energy to Discom, after setting off the quantum of electricity supplied by Discom.

Net Meter is single-phase or 3-phase meter located at the point of inter-connection as ascertained by Discom and Standards specified by CEA. The Net Meters are being procured and installed by Discom and are installed in accordance with the provisions of Supply Code, by replacing consumer's existing meter. However consumer may opt to procure Net Meter, at his cost, which shall be installed, after testing by Discom. For TOD Consumers, Net Meter installed shall be capable of recording TOD slot wise consumption & Generation.

Interface of Solar PV System with outgoing terminal of meter (cutout point) is the interconnection point. HT Consumers are permitted install and connect Roof-top Solar Systems at their LT Bus bar System. Net Meter in such case shall be installed on HT side of Transformer.

As per the Standards of Performance Regulations, less than 8 KW

Solar PV system can be connected on single phase 230 Volt system. For 3 phase 415 Volts system, the limit is 150 KW (for Municipal Corporation areas) and 80 KW for other areas. On 11KV, consumer can install up to 1 MW Solar PV system.

As per these Regulations, Roof-top Solar PV Systems with or without battery back-up are permitted. In case of a battery back-up, inverter shall have a separate back-up wiring to prevent battery power from flowing into the grid in absence of grid supply, and an automatic as well as manual isolation switch needs to be provided. Consumer needs to provide appropriate protection for islanding of Rooftop Solar PV System, from Distribution network; in the event of grid or supply failure.

Procedure for Application & Registration:

Consumer can apply to Discom for connectivity of Roof-top Solar PV System with Discom's Network by paying Registration fees (Rs. 500/- up to 5KW sanctioned load & Rs. 1,000 for more than 5KW sanctioned load). In order to standardize, the "Procedure for Application for connectivity of Roof-top Solar system" is enclosed in the Regulations, as Annexure I. "Model Application Form, along with check-list", is provided as Annexure 2, in Regulations. Discom needs to acknowledge receipt of such application. In case of any deficiencies, Discom needs to issue notice to consumer to rectify, within 15 days.

After approval of connectivity of Roof-top System with Discom's Network, Discom and Consumer shall enter into a "Net Metering Connection Agreement "(for 20 years). "Model Net Metering Connection Agreement" is also enclosed as Annexure 3 to the Regulations.

Energy Accounting and its Settlement: Accounting of electricity exported and imported by Consumer shall become effective from the date of connectivity. For each billing cycle, Discom shall separately indicate:

If (a): KWH exported by Consumer (b): KWH imported by Consumer

If (b>a): Net KWH billed for payment to Consumer and If (a>b): Net KWH carried over to next billing cycle

At the end of each Financial Year, the net credited excess energy shall be to be purchased by the Discom at Average Pooled Power purchase Cost (APPC), in month of April of the next FY.As per MERC's MYT tariff order for MSEDCL APPC for 2017-18 is Rs.4.01/ Unit & Rs. 4.09/Unit in FY 2018-19. In case of billing Disputes, the Consumer can approach the Consumer Grievance Redressal Forum (CGRF) and also the Electricity Ombudsman.

4.0 Salient features of MERC Solar Roof Top PV (First Amendment) Regulations 2017:

In this Amendment Regulation, the Commission has defined "Renewable Energy'' as the grid quality electricity generated from Renewable Energy sources, including a combination of such sources and also the term "Renewable Energy Generating System" as the Renewable Energy power system installed on a Consumer's premises, and owned and/or operated by such Consumer or by a third party, that uses Renewable Energy for conversion into electricity. Further, "Renewable Energy sources" are defined as the renewable sources or combination of such sources, such as Mini, Micro and Small Hydro, Wind, Solar, Biomass including bagasse, bio-fuel, urban or Municipal Solid Waste.

In fact, with this Amendment, the facility of Net Metering which was only available for Roof Top Solar PV systems is extended to all sources of Renewable Energy generation for capacities less than one MW, installed at Consumer premises . This is a very proactive step taken by the Commission in promoting Renewable Energy and increasing the involvement of consumers in of development of Renewable Energy.

5.0 Conclusions:

In order to help small consumers to participate in the National Program of Renewable Energy Development, MERC has proactively issued the Regulations for "Net Metering for Solar roof Top PV Systems" in Sept 2015. In July 2017, MERC has amended the Regulations & extended the scope for Net Metering to include all other Renewable sources of less than 1 MW capacity at Consumer premises.

These Regulations are complete code. Model formats for application form, Agreement are also included in Regulations. Consumers with RE Generation of less than 1 MW capacity are eligible for net metering (i.e. locally fulfilling their demands & if excess generation is available, it will be absorbed by Discom). The Consumer will then in real sense be a Smart "Prosumer" (Producer & Consumer of Electricity). Monthly Energy accounting of consumers with Net Metering is the responsibility of Discom. Such Proactive Regulations will help us fulfilling the Govt of India's target of 175 GW of Renewable Generation by 2022.

I THINK THE FUTURE FOR SOLAR ENERGY IS BRIGHT

KEN SALAZAR

About Author:

VIJAY L. SONAVANE
Master of Electrical Engineering, University of Pune, 1975

- About 42 years' Experience in the Indian Power Sector. August 2009 to August 2014 , worked as State Electricity Regulator for Maharashtra (in MERC) During Sept 2014-March 2015: Advisor, MERC, Mumbai
- Presently Advisor India Smart Grid Forum, a Govt of India PPP initiative, Senior Advisor MP Ensystems Pvt.Ltd Mumbai and also working as an independent Energy Consultant
- Felicitated by the Institution of Engineers (India) as "Eminent Engineer" in recognition of outstanding contribution in the field of Electrical Engineering, during the 32nd National Convention of Electrical Engineers at Pune on 11th Nov 2016.
- Issued more than 850 Orders as a State Regulator which includes the areas of promoting competition, promoting Renewable Energy, protecting interest of consumers, tariff determination for Regulated entities etc.
- Conceived & enacted DSM Regulations 2010 for Maharashtra & was instrumental in various DSM Schemes by Distribution Licensees. Was involved in Drafting Smart Grid Regulations and also study Report by FOR on Impact of EVs on Grid.
- Prior to joining MERC, working with Maharashtra State Electricity Distribution Company Ltd. (MSEDCL), the largest Distribution Utility in India. During the association of 34 years with MSEDCL (erstwhile MSEB), worked at various Positions from Assistant Engineer to the Director (Projects)
- Deputed for training Programs, study tour to Siemens West Germany in 1981-82, Southern Electric, Atlanta USA in 1994, Colorado utilities in US in 2007, South Korea in 2009, Lawrence Berkeley National laboratory in 2010, CIGRE Paris in 2012, 2014, Singapore in 2012 & 2014, Kuala Lumpur in 2011,2013, Jan 2014 USAID study tour for Smart Grid Projects in US
- Guest faculty in Power System Management at various Engineering Colleges/ Management Institutes in Mumbai/ Pune University, ASCI Hyderabad & utilities' training centers

It is time for a sustainable energy policy which puts consumers, the environment, human health, and peace first.

DENNIS KUCINICH

Thane city experimenting on Net Zero concept

Mr. Sunil Pote,
Dy. City Engineer,(Electrical), Thane Municipal Corporation,

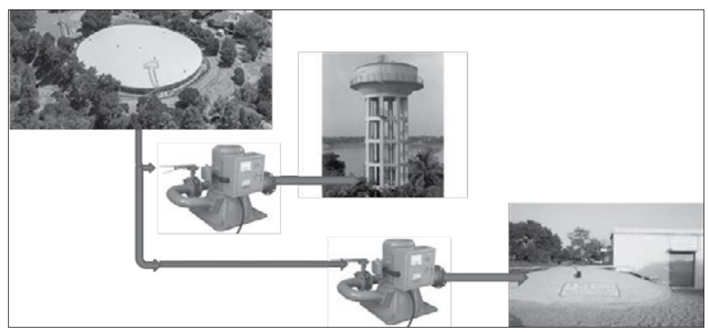
The concept of Net Zero Thane is the objective decided by the Honorable Commissioner of Thane Municipal Corporation and pursued with planned initiatives in the area of adopting mission mode action plan

Initiative to adopt Roof Top Solar Photo Voltaic Systems under net-metering

54 Schools having 267KW cumulative installed capacity is unique proposition to reduce 356,845 units from conventional energy. The facility will also cultivate in the minds of students the use of Solar Panels not for only generation of electrical power but as shed to work under the same. The shed 10 Sq Mtrs per KW capacity is planned 4 mtrs above ground so that the space under the same can be used. Depending on the electrical energy demand of the school 1KW to 50KW plant capacity has been planned. Already two schools are commissioned. The GHG reduction by equivalent of 0.017MT CO2per year.

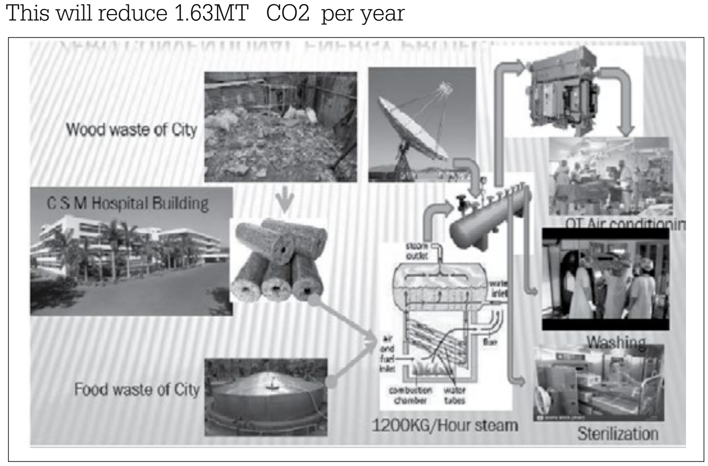
10MW cumulative capacity on various facilities of Thane Municipal Corporation

26 Locations , capacity of plant 5KW to 1MW, generation of solar photo voltaic energy 14.5 GWh per annum which will reduce GHG emission by equivalent of 0.68MT CO_2 per year. 10MW cumulative capacity per year on the rooftop of Citizen buildings will further reduce 0.68MT CO_2 per year and next five year this value will be 3.4MT CO_2 per year. 10 MW per year energy efficiency promotion through Citizen initiative will also reduce 0.68MT CO_2 per year and next five year this value will be 3.4MT CO_2 per year. 15MW solar on rooftop on various buildings and open spaces will reduce 1.02MT CO_2 per year .



Tidal Stream Power

The city is first time planning to harness tidal stream power with initially one MW capacity, on success city will have 8MW capacity. This will reduce 1.63MT CO2 per year



Hydro Power generation in pipe lines:

One more initiative taken by city to tap the potential available in the pipe lines of main distribution system of treated water. Total capacity planned is 60KW and the energy per annum generation will be 353831 contributing to saving of 0.017 MT CO_2 per year .

.**Carbon foot print from waste:**

The wood waste of city is getting converted into Briquettes, the methane generated from bio degradable waste, and solar water heating has been put together to achieve the electricity free air conditioning and to meet the requirement of washing and sterilization in the city hospital. This will further save 0.057 MT CO_2 per year.

Promotion of electric vehicles:

The electrical vehicle promotion has been planned in such a way that in next 4 years 60000 two wheelers and 10000 three wheeler will run on the city roads. With this efforts the noise pollution will be reduced and addition benefit will be drawn because of saving 0.64 MT CO_2 per year.

100 electric buses for Public transport : Fossil fuel based buses will be replaced with 100% electric buses and the electricity will partly be provided from solar energy. This will reduce 63.42 T of CO_2 per bus per year.

Promotion of LED Street Lighting :

12000 conventional street lights to be retrofitted with energy efficient LED, currently TMC has retrofitted 7000 LED street lights. Expected energy savings from the LED will be about 68% and is also expected to reduce the energy demand for municipal street lighting by 1.1 MW. This will reduce 0.68 MT of CO_2 per year for 12000 LED street lights.

The total Carbon savings for 1st year will be 6.101 MT of CO_2.

For 2nd year savings will be 7.461 MT of CO_2

For 3rd year savings will be 8.821 MT of CO_2

For 4th year savings will be 10.181 MT of CO_2

For 5th year savings will be 11.541 MT of CO_2

About Author:

Mr.Sunil Pote,
Dy. City Engineer,(Electrical), Thane Municipal Corporation,

Mr. Sunil Pote, is a Dy. City Engineer,(Electrical), Thane Municipal Corporation, Thane He has 32 years of field f Experience. His major contribution in all the electrical capital and maintenance works related to Municipal Corporation such as HVAC, street lighting, indoor lighting, water pumping, HT/ LT installations, etc.His Field of specialization is Energy Conservation and use of renewable energy. He received the first prize in "State Level award for Excellence in Energy conservation and Management from year 2004 to 2016 ." (Successive 11 years) from MEDA.Hon' President of India awarded First Prize in "National Energy Conservation Award- 2005" in Govt. Building Sector.He also received awards for excellent performance in the field of renewable energy from MNRE , New Delhi."SKOCH Smart Governance Award, 2015". 'SKOCH smart City Award 2016'.& 2017 & International Earth Hour City Challenge Award from WWF International's Director General, Marco Lambertini.

Renewable Energy Technologies-Wind energy

Shyamsunder Venkatesh Deo

The economic prosperity is measured by Per Capita Generation (PCG) & Per Capita Consumption (PCC). However, the develop nation speaks on PCC. The develop countries have recorded PCC as under:-

S.No.	Country	PCC (in KWH)
1	Iceland	53000
2	Norway	27450
3	USA	13000
4	Australia	10000
5	South Korea	10500
6	Japan	7800
7	Austria	8500
8	Saudi	8700
9	China	4000
10	Brazil	2500
11	India	500

As regards India as installed in electrical domain 330 GW as on 31.03.2017. The break-up is as under:-

- Thermal (i.e. coal & gas) - 221 GW
- Hydro - 441 GW
- Nuclear- 6.7 GW
- Renewables - 57 GW

In Renewable Energy Technology (RET) the share of 57 GW comprises of wide 32 GW & solar 12.5 GW. This speaks of major share is from coal. However, the RA share for FY 2017 is 18% on capacity basis & about 10% on energy basis. As per the version planned by Ministry of Renewables, Govt. of Maharashtra, the share on capacity basis will be 31% & 17% on energy basis. To achieve this, the capacity allocation by end of 13th plan i.e. March 2022 is fixed as 60 GW for wind, 100 GW for solar, 5 GW on hydro & 9.8 GW on bio mass.

The state of Maharashtra has installed capacity on power generation is 41.27 GW comprising of 26 GW Thermal, 3.14 GW Gas, 3.38 GW Hydro, 756 MW Nuclear, 7.5 GW Renewable Technology. Out of 7.5 GW RET, wind is 4.7 GW, solar PV 400 KW, Bio-Gas 1.85 GW.

Government of Maharashtra has brought out policy in July 2015 to install 14400 MW through RET comprising of 5000 MW wind, 7500 solar PV, 400 MW small hydro, 300 MW bio-mass, 200 MW industrial waste & 1000 MW bio-gas.

As regards Wind Generation, the policy support was given by Govt of Maharashtra through its policy of 1998 wherein the first 150 MW wind form capacity was built-up in Satara district. The policy had attractive comforts through accelerated depreciation & support of energy tariff to be paid to investors by State Distribution Company. In this face the developers has installed the induction generators in large share & a few capacities on variable speed through power electronics. The capacity was in the range of 250-350 KW with 50 mtr hub height. This capacity of wind turbine has gradually jumped up to 600 KW, 1500 KW & increasing the hub height to 70 mtr. The reason to increase the hub height as well as router diameter is to harness optimum energy beyond 50 mtr height & make the investment viable on return on equity & servicing the debt.

Wind Turbines installed are induction type where by the turbine needs reactive support which is provided by mechanical switch capacitor bank. However, the power system is confronted to supply reactive support which impacts on voltage regulation. Basically, wind generation is optimum during rainy season i.e. June-September when system loads are minimum & therefore is not a major threat to voltage profile. However R&D has taken place & new machines of 2 MW rating are designed with power electronics devices to address reactive energy in absorbing / supplying to grid. This is term as Doubly Fed Induction Generator This means when the grid voltage is high, it will consume reactive power & when system voltage starts dipping the reactive support will be given to the grid.

Wind Energy installation require foot print (land requirement) & internal path ways & therefore the land between the two turbines & between the turbine rows, the land is available for agriculture, horticulture, flowry culture.

The develop nation are exploring off-shore wind turbine installation where the capacity utilization factory is much higher than on-shore installation. However, in view of increase cost on civil foundation in sea & infra-structure to bring power to on-shore & to meet the capex, the rating of each wind turbine has to be in the range of 3-5 MW.

Generally it is debated that energy from RE sources is costlier than energy from coal. But if addressed on impact on environment due to green house gas & air quality (social cost) there is definite advantage & comfort to address. The greatest advantage of wind & solar technology water requirement for almost zero on contrast to huge water requirement for fossil base generation & nuclear base generation.

Renewable energy resources are predominant in the states of Rajasthan, Gujarat, Maharashtra, Karnataka, Tamil Nadu & Andhra Pradesh. Therefore, the target decided at India level would create a sizable energy generation in the order of north-west, west-south. This has warranted to provide green energy corridor to carry renewable power on All India basis.

The infrastructure planned through Central Transmission Utility & State Transmission Utility will boost power flow capacity from 72 GW to 118 GW by March 2022.

Wind power will never be more than a supplemental source of electric power & utilizes have traditionally viewed as a fuel saver. As soon as wind & solar sources are variable & intermittent. The variation in quantum of power is from hour to hour & from season to season.

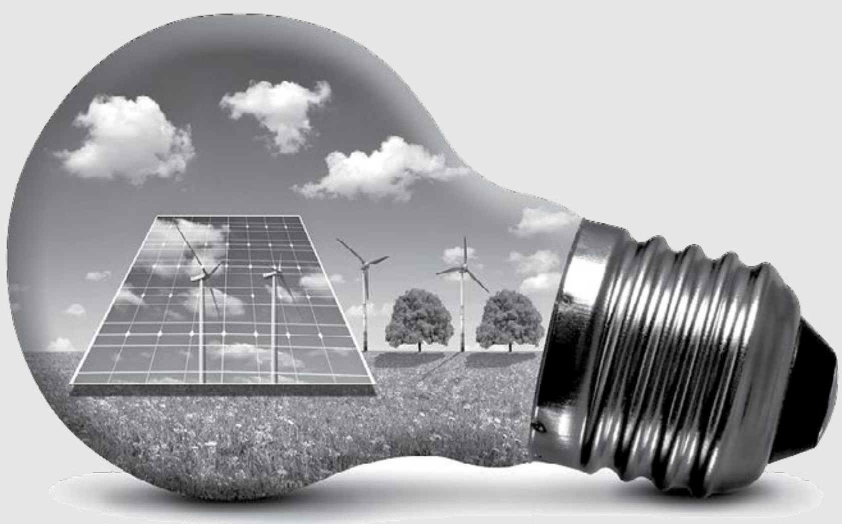
In short, there are number of myths surrounding integration of renewable specially wind in electrical network because of variability of resource. Though there are technical issues surrounding grid integration they are no way insurmountable nor cost of integration excessive. There are technical & managerial means to do so at modest cost.

About Author:

Mr. Shyamsunder Venkatesh Deo

Mr. Shyamsunder Venkatesh Deo completed B.E. (Electrical) in 1961 from Osmania University, Hyderabad Deccan. Joined as Jr. Engineer in MSEB from Sept. 1961. Retired as Technical Member in March 2001 from MSEB. He Worked as Advisor in Suzlon Energy Ltd., Pune from Sept. 2001 to March 2010.He is Advisor to EPC-Solar PV Projects to:-M/s Rely-On-Solar, Pune & Enrich Energy Ltd, Pune.

The fuel in the earth will be exhausted in a thousand or more years, and its mineral wealth, but man will find substitutes for these in the winds, the waves, the sun's heat, and so forth. (1916)



John Burroughs

Impact of Renewable Energy Sources on Power Quality

V. R. Kanetkar
Consultant – Technical Services
Vertiv Energy Private Limited, Thane (West)

1.0. Introduction

Presently in India, the installed power capacity is approximately 329.23 GW (329230MW). The renewable energy sources contribute approximately 31.3%. The wind power constitutes approximately 31.2 GW and the solar power constitutes approximately 16.2 GW by the end of September 2017. Both wind and solar power contributions are expected to grow fast with a growth rate over 10%. India is the world's third largest producer and fourth largest consumer of electricity.

The National Grid (India) is the high-voltage electric power transmissionnetwork in mainland India, connecting power stations and major substations and ensuring that electricity generated anywhere in mainland India can be used to satisfy demand elsewhere. The National Grid is owned, operated, and maintained by state-ownedPower Grid Corporation of India. It is one of the largest operational synchronous grids in the world with 329.23 GW of installed power generation capacity as on 30 June 2017 [1].

The world loses over Billions of US Dollars on power quality (PQ). The direct costs of downtime in India due to bad power quality (PQ) are to the tune of Rs 20,000 crore per annum [2]. The indirect costs could be very high compared to this figure.

Power quality (PQ), hence, has become a very important aspect of the electric supply for various considerations. It encompasses many issues in relation to voltage variation, voltage and current imbalance, voltage and current harmonics and corresponding distortions caused on the fundamental sinusoidal waveform, voltage sags and swells, power / voltage interruption, voltage transients, sudden voltage dips or rises, intracycle dips, frequency change etc.

This paper mainly deals with power quality issues in relation to mainly two renewable energy sources, wind and solar,and is arranged as below.

- Basic power quality (PQ) issues
- Related international organizations and standards
- Regulatory body in India
- Specific issues in relation to solar and wind and use of four-quadrant converters
- Possible use of solar and wind converters for grid power quality (PQ) improvement
- Conclusion

2.0. Basic Power Quality (PQ) Issues

Power quality (P) is mainly related to deviations from sinusoidal nature of the supply voltage, its specified amplitude, and its frequency. No deviations indicate good power quality. The power quality (PQ) issues as far as supply voltage (transmission and distribution included) mainly cover the following.

- Voltage variation
- Voltage flicker, sag and swell
- Voltage transients
- Voltage unbalance
- Voltage or supply interruption
- Voltage distortion (mainly caused by distortion of the current drawn and limited short circuit capacity or higher short circuit impedance at the Point of Common Coupling(PCC))
- Frequency variation

Most importantly, the above network effects cause damage or maloperation of loads connected down the line, stoppages of the processes, impact on drive or converter designs, heating of transformers and cables, resonances and many others which finally results into operational reliability issues of connected equipment(s) and finally financial loss. The resultant loss is in Billions of Dollars (over Rs 20000 Crores as far as India is concerned).

Power quality (PQ), hence, is a very concerned area for every country including India and the research is basically concentrated in overcoming or mitigating the power quality (PQ) issues reliably and economically. There are over 700 international publications per annum in power quality from 2007 to 2014 [3] which reflects the gravity of situation in power quality (PQ) faced by the world.

The international and national standards try to cover the power quality (PQ) issues with certain guidelines which can help the supply network to remain in healthy condition despite fast changing complex and non-linear loads.

3.0. Related International Organizations and Standards

There are many international organizations which have been active in bringing out power quality (PQ) standards and these include IEC, IEEE, EN, CIGRE, etc. Generally, the standards cover definitions, essential technical background surrounding the main issues, prescribed limits for operation, application explaining how to apply the standard, measurement issues, and requirement of specific measurement methods and apparatus / meters to measure the related and necessary parameters. This could be covered in same standards or its parts.

In European countries continuity of supply (transient interruption, short interruption and long interruption) and voltage monitoring are considered as evaluating factor when assessing the DISCOM performance. In addition, indices such as SAIDI, SAIFI, MAIFI, ASIDI, ASIFI, CAIDI, CML, ENS, and IEEE 1366-2003 indicators, CTAIDI, TIEPI and NEIPI are used to quantify long interruptions [2].

Some of the important standards related to power quality (PQ) are listed here. These may not be found listed in a specific way or method. However, these are important and applicable as of now. Please note that that the description is for guidance.

3.1. IEC Standards

- IEC 61000 and parts: EMI and EMC
- IEC 61000 -2-4: Environment - Compatibility levels in industrial plants for low-frequency conducted disturbances
- IEC 61000-3-2: Limits for harmonic current emissions(≤16A)
- IEC 61000-3-3: Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems (≤16A)
- IEC 61000-3-4 Limits on harmonic current emissions (>16A)
- IEC 61000-3-5: Limits of voltage fluctuations and flicker in low-voltage power supply systems for equipment with rated current (> 75 A)
- IEC 61000-3-6: Limits - Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems
- IEC 61000-4-7: Testing and measurement techniques – General guide on harmonics and inter-harmonics measurements and instrumentation, for power supply systems and equipment connected thereto
- IEC 61000-4-11: voltage sag immunity (≤16 A)
- IEC 61000-4-30: Testing and measurement techniques - Power quality measurement methods
- IEC 61000-4-34: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests (>16 A)

(Other IEC standards of interest could be IEC 61000-2-4/5/6/8/14, IEC 61000-3-2/3/4/5/6/7/9/11/12, and IEC 61000-4-7/11/13/15/27/29. IECD SC 77 is the main committee working on EMC which also covers power quality standards or recommendations)

3.2 IEEE Standards

- IEEE P446: Emergency and standby power
- IEEE 519: Harmonic Control in Electrical Power Systems
- IEEE P519A: Guide for Applying Harmonic Limits on Power Systems
- IEEE P1100: Power and Grounding Electronic Equipment (Emerald Book)
- IEEE 1159: Monitoring Electric Power Quality
- IEEE 1159-1: Guide for Recorder and Data Acquisition Requirements
- IEEE 1159-2: Power Quality Event Characterization
- IEEE 1159-3: Data File Format for Power Quality Data Interchange
- IEEE 1346: Power System Compatibility with Process Equipment
- IEEE P1409: Distribution Custom Power
- IEEE 1433: Power Quality Definitions (P1433 WG)
- IEEE P1453: Voltage flicker (WG)
- IEEE 1459: Definitions for the measurement of electric power quantities
- IEEE P1547: Distributed Resources and Electric Power Systems Interconnection
- IEEE P1564: Voltage Sag Indices
- IEEE P1668: Response of electrical equipment to voltage sags (Under development in 2009)

(IEEE SCC-22 is the main Power Quality Standards Coordinating Committee)

3.3 EN Standards

EN 50160: Voltage characteristics in public distribution systems
EN50160 Guide for the EN 50160 standard.

3.4 Other Standards and Relevant Information

Most of the Europeans countries have adopted EN50160 standard as voltage quality legislation, regulations and standardization. IEEE 519 is also an accepted standard worldwide and is also accepted in India.

The other international organizations working on power quality include CIGRE (International Council for Large Electric System), UIE (International Union for Electricity Applications), CENELEC(European Committee for Electro technical Standardization), UNIPEDE (International Union of Producers and Distributors of Electrical Energy), ANSI (American National Standards Institute), CIRED (International Conference on Electricity Distribution), SEMI (Semiconductor Equipment and Materials institute), and ITIC (Information Technology industry Council).

The reliability indices for the power quality (PQ) are covered in SAIFI, SAIDI and CAIDI. As an additional information, power quality (PQ) standards classified based on the topic or relevant parameter are given in **Table -1.**

In European countries continuity of supply (transient interruption, short interruption, and long interruption) and voltage monitoring are considered as evaluating factors when assessing the DISCOM (Distribution Company) performance. In addition, indices such as SAIDI, SAIFI, MAIFI, ASIDI, ASIFI, CAIDI, CML, ENS, IEEE 1366-2003, CTAIDI, TIEPI, and NEIPI are used to quantify long interruptions [2]. CEER (Council of European Energy Regulators) report, recently released in 2016, gives latest information on benchmarking utility performance parameters [5].

4.0 Regulatory Body in India

Central Electricity Authority (CEA) is the main body related to electricity authority in India. The functions and duties of CEA are delineated under Section 73 of the Electricity Act, 2003. Besides, CEA has to discharge various other functions as well under Section 3 (National Electricity Policy & Plan), 8 (Hydro Electric Generation),

Table -1 : Power Quality (PQ) standards by topic [4]

Topics	Relevant Standards				
Grounding	**IEEE std 446 [B75]**	**IEEE std 141 [B70]**	**IEEE std 142 [B71]**	**IEEE std 1100 [B87]**	**ANSI/NPFA 70 [B67]**
Powering	**ANSI CS4.1 [B65]**	**IEEE std 141 [B70]**	**IEEE std 446 [B75]**	**IEEE std 1100 [B87]**	**IEEE std 1250 [B88]**
Surge protection	IEEE C62 Series [B93]	IEEE std 141 [B70]	IEEE std 142 [B71]	NPFA 78 [B97]	UL1449 [B99]
Harmonics	IEEE C 57.110 [B90]	IEEE std 519 [B79]	IEEE std 519 [B79]	IEEE std 929 [B83]	IEEE std 1001 [B87]
Disturbances	ANSI C 62.41 [B91]	IEEE std 1100 [B87]	IEEE std 11592	IEEE std 1250 [B88]	
Life and fire safety	FIPS PUB94 [B68]	ANSI/NPFA 70 [B67]	NPFA 75 [B96]	UL 1478 [B17]	UL 1950 [B18]
Mitigation equipment	IEEE std 446 [B75]	IEEE std 1035 [B85]	IEEE std 1100 [B87]	IEEE std 1250 [B88]	NEMA-UPS [B94]
Telecommunications equipment	FIPS PUB94 [B68]	IEEE std 487 [B76]	IEEE std 1100 [B87]		
Noise control	FIPS PUB94 [B68]	IEEE std 518 [B78]	IEEE std 1050 [B86]		
Utility interface	IEEE std 446 [B75]	IEEE std 929 [B83]	IEEE std 1001 [B84]	IEEE std 1035 [B85]	
Monitoring	IEEE std 1100 [B87]	IEEE std 11592			
Load immunity	IEEE std 141 [B70]	IEEE std 446 [B75]	IEEE std 1100 [B87]	IEEE std 11592	IEEE P1346 [B89]
System reliability	IEEE std 493 [B77]				

[2]IEEE std 1159 -1995 is this standard

34 (Grid Standards), 53 (Provision relating to Safety and Electric Supply), 55 (Use of Meters) and 177 (Making of Regulations) of the Electricity Act, 2003 [1].

Central Electricity Regulatory Commission (CERC), a key regulator of power sector in India, is a statutory body functioning with quasi-judicial status under sec – 76 of the Electricity Act 2003. CERC was initially constituted on 24 July 1998 under the Ministry of Power's Electricity Regulatory Commissions Act, 1998 for rationalization of electricity tariffs, transparent policies regarding subsidies, promotion of efficient and environmentally benign policies, and for matters connected Electricity Tariff regulation. CERC was instituted primarily to regulate the tariff of Power Generating companies owned or controlled by the government of India, and any other generating company which has a composite scheme for power generation and interstate transmission of energy, including tariffs of generating companies [1].

As entrusted by the Electricity Act, 2003 the CERC has the responsibility to discharge the following mandatory and advisory functions (as per CEA website).

Mandatory Functions

- Regulate the tariff of generating companies owned or controlled by the Central Government
- Regulate the tariff of generating companies other than those owned or controlled by the Central Government specified in clause (a), if such generating companies enter into or otherwise have a composite scheme for generation and sale of electricity in more than one State
- Regulate the inter-State transmission of electricity
- Determine tariff for inter-State transmission of electricity
- Issue licenses to persons to function as transmission licensee and electricity trader with respect to their inter-State operations
- Improve access to information for all stakeholders
- Adjudicate upon disputes involving generating companies or transmission licensee in regard to matters connected with clauses (a) to (d) above and to refer any dispute for arbitration
- Levy fees for the purposes of the Act
- Specify Grid Code having regard to Grid Standards
- Specify and enforce the standards with respect to quality, continuity and reliability of service by licensees
- Fix the trading margin in the inter-State trading of electricity, if considered, necessary
- Discharge such other functions as may be assigned under the Act

Advisory Functions

- Formulation of National Electricity Policy and Tariff Policy
- Promotion of competition, efficiency and economy in the activities of the electricity industry
- Promotion of investment in electricity industry
- Any other matter referred to the Central Commission by the Central Government

Apart from CERC, the act also introduced a provision for the states to create the State Electricity Regulation Commission (SERC) along with the power to set the tariffs without having to enact separate state laws [1]. More or less the SERCs function with similar objectives as that of CERC for their won states.

It can be noted that power quality (PQ), associated issues, and

Table -2: Power Quality (PQ) standards prescribed in CEA and CERC regulations [2]

Power Quality parameters	Limits prescribed in the regulations		
	CEA - Grid Standard Regulation	CEA – Technical Standard for Grid Connectivity	CERC – Indian Electricity Grid Code
Voltage Variation			
765 kV	+5% and -5%	Maximum 3% and minimum 1.5% for step changes	+5% and -5%
400 kV	+5% and -5%		+5% and -5%
220 kV	+11% and -10%		+11% and -10%
132 kV	+10% and -8%		+10% and -8%
110 kV	+10% and -10%		+10% and -10%
66 kV	+9% and -9%		+9% and -9%
33 kV	+9% and -9%		+9% and -9%
Harmonics	THD – 5% with single harmonic content not exceeding 3% for 33 to 132 kV THD – 1.5% with single harmonic content not exceeding 1% for 765 kV THD - 2% with single harmonic content not exceeding 1.5% for 400 kV THD - 2.5% with single harmonic not exceeding 2% for 220 kV	THD – 5% with single harmonic content not exceeding 3%	
Voltage Unbalance	1.5% for 765 kV and 400 kV 2% for 400 kV 3% for 33 to 132 kV	3% for 33 kV and above	

standards fall within the functional responsibilities of CERC and SERCs.

Table -2 gives information on power quality standards prescribed by CEA and CERC. These cover voltage variation, harmonics, and voltage unbalance.

4.1 Specific Issues in Relation to Solar and Wind and Use of Four Quadrant Converters

Problems faced by centralized power generation and losses due to long transmission lines have created and also renewed interest on distributed generation (DG). The DG integrates a renewable energy system (RES) with grids which improves the energy efficiency and also reduction in unwarranted emissions. With integration of the renewable energy system (RES) with grids, power quality (PQ) of the medium to low voltage systems is becoming a major area of interest. This integration mainly takes place with the help of power electronic converters which need to follow power quality (PQ) standards during the integration [5].

Custom power devices like STATCON/M (static converter), TCR (Thyristor Controlled Reactor), TSC (Thyristor Switched Capacitor), DVR (Direct Voltage Restorer), AHF (Active Harmonic Filter), UPFC (Unified Power Flow Controller) and few others are power quality control devices used for grids feeding power to various non-linear loads presently used in various industries.

The renewable energy systems (RESs), mainly solar and wind have penetrated the distributed generation (DG) to a considerable extent. Typical solar and wind systems feeding power into the grid are shown in figs. 1(a) and (b) [5].

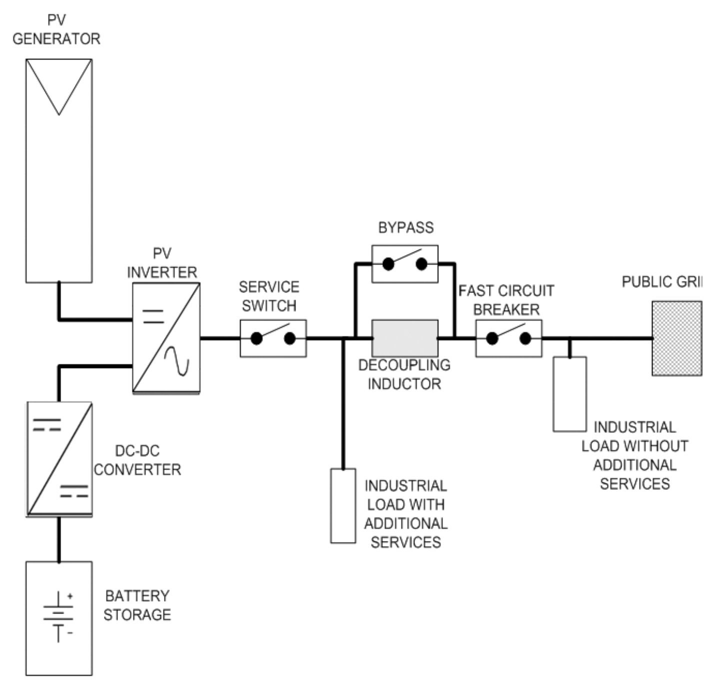


Figure 1(a): Solar system feeding load and grid and also Using battery [5]

The converters / inverters used in such systems could be two-level (which is the basic) or multilevel. As an example, a two-level converter / inverter are shown in fig. 2(a). The fundamental voltage

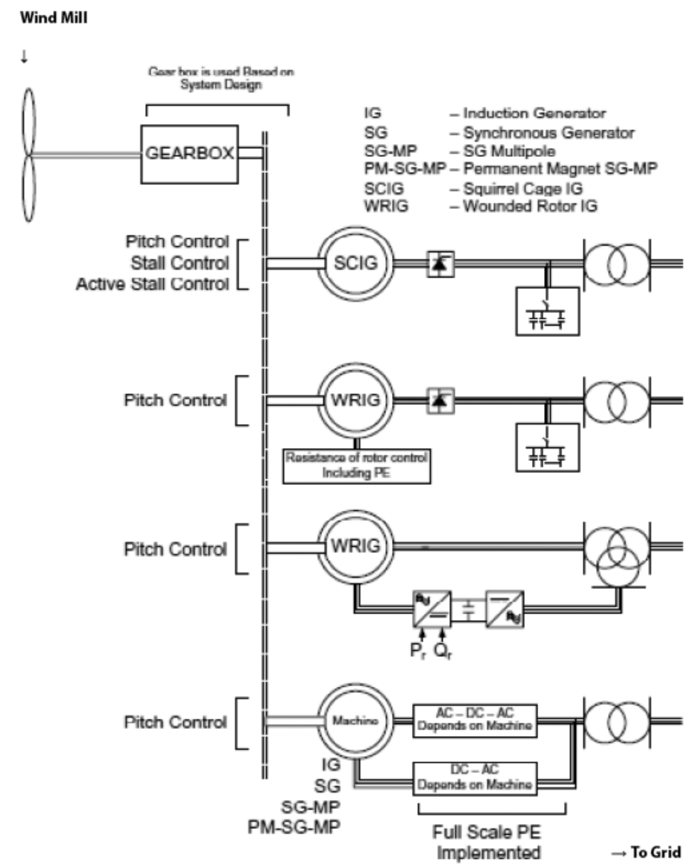


Figure 1(b): Wind mill systems [6]

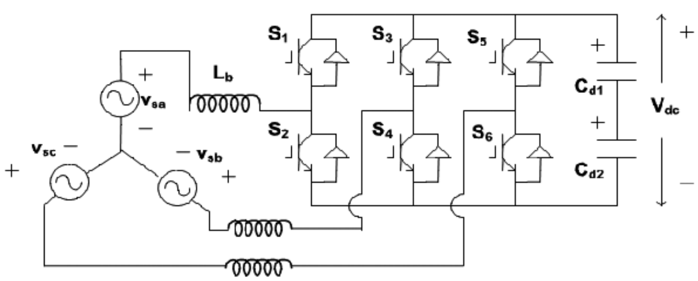
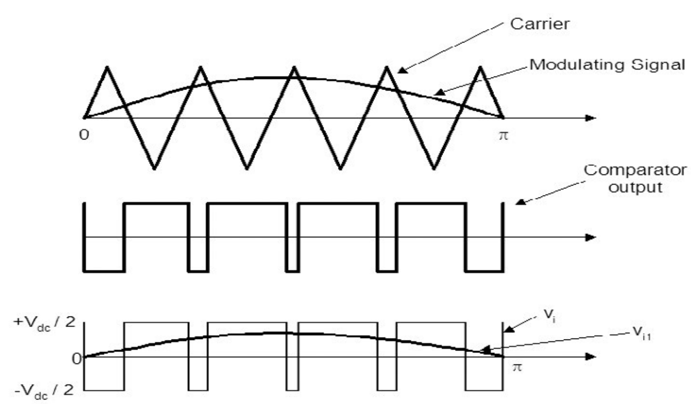


Figure 2(a): Two level voltage source converter with SPWM



Two level PWM generation based on SPWM method

Figure 2(b): Fundamental voltage

produced due to the switching devices using SPWM (Sinusoidal Pulse Width Modulation) technique is also shown in fig. 2(b).

This is the terminal voltage which appears between midpoint of the converter / inverter leg and the midpoint of the dc bus. The switching voltage hence consists of fundamental component and switching frequency component. If the switching frequency to fundamental frequency ratio is mf, the harmonics produced by this converter / inverter will be mf ±1, 2mf ±1, 3mf±1 and so on considering that mf is odd. Thus, if the switching frequency of the converter / inverter is 2050, the first harmonic will be 41st which is quite away from the fundamental frequency. It can be filtered by a small value capacitor also to avoid the corresponding harmonic entering the supply system. The amplitude of the fundamental voltage is given by Mi * Vdc/2.

The converter / inverter shown in fig. 2(a) is called as four-quadrant converter / inverter since it can control the current drawn at any given power factor angle (usually called as power angle) with respect to the incoming supply voltage. The converter switches are bi-directional switches (consisting of GTOs or IGBTs or any other self-commutated devices) and antiparallel diodes and hence they can carry current in both directions.

The displacement and amplitude of the fundamental voltage appearing at the converter / inverter terminals dictate the four-quadrant operation. Thus, the same converter / inverter can work as power delivering converter at +1 power factor or regenerating converter at -1 power factor or converter drawing inductive / capacitive current at ±0 power factor or any other power factor as desired based.

When power level goes up, the switching frequency comes down as switching losses are directly proportional to the switching frequency. Hence, at higher power levels, multilevel operation using series and parallel combination of converters is desired to keep the individual converter losses or overall losses under control. The research, hence, is always centered on producing close to sinusoidal fundamental voltage appearing at the converter terminals with reduced switching frequency. Multilevel operation helps it at the cost of complexity of the control. It should also be noted that the ripple current riding on the fundamental input current drawn by the converter mainly depends upon the dc bus voltage, the switching frequency, and the input inductance (called normally as boost inductance).

Design of the converter / inverter depends upon input voltage, its variation and imbalance, frequency and its variation, the maximum fundamental current drawn or supplied, acceptable switching frequency ripple, dc bus percentage voltage ripple, and dynamics of the converter.Based on these inputs or specifications, the design is carried out and the component ratings and parameters are selected through number of iterations [6-12].

The renewable energy systems (RESs) use such converters / inverters (two-level or multilevel) with single winding or multi-winding transformer connected between the grid and the converters / inverters.

The converter (here onwards used in its generic form to indicate converter / inverter) used in solar or wind systems raises several issues in relation to its grid related performance and these could be as below.

Design related: Basic design of the converter (to an extent explained above) needs to be extremely rugged and reliable. This would mean the power circuit, the control (analog or digital or hybrid), the interlocking and sequencing, fault coordination, converter blocking and releasing the pulses / power, protection aspects, ac / dc filters, and finally the integration. The converter needs to offer a definite working or operational reliability against all kinds of supply disturbances (steady state or transient) which includes voltage sags and swells, voltage variation and imbalance, sudden voltage dips and interruptions / grid collapse, sudden load changes in grid, different and varying incoming voltage distortions etc.

Disturbances related: Figure 3 gives some of the supply network disturbances. Slow varying voltage (sags or swells) or distortion can be handled by the controller if incoming voltage filters are properly designed and fundamental component is properly detected by the controller.

Most of these controllers work on cycle to cycle synchronization and hence can lock properly with incoming voltage with an

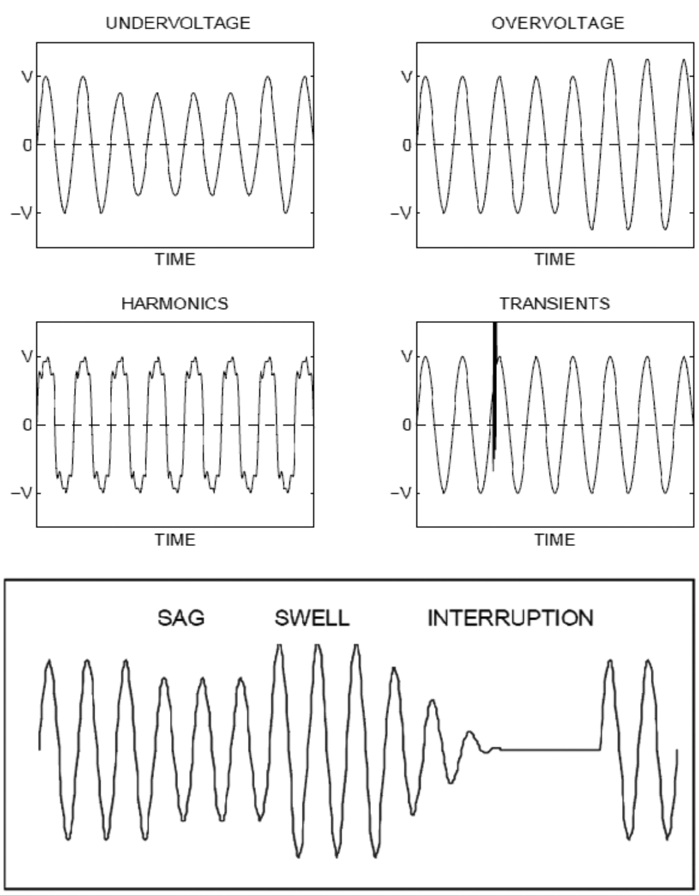


Figure 3: Supply network disturbances

assumption that last cycle information is not going to change suddenly in following cycle. Sudden load changes (more importantly regeneration in the grid) is controlled but can face very tough and difficult situations, especially when grid collapses or wind changes direction / speed (for wind mills) or when sun rays and related intensity suddenly changes due to clouds (for solar panels). If the size of the installation is small (say less than 3 MW), the regenerating power can be diverted to resistor banks momentarily to avoid dc bus voltage suddenly going high However, when the installation sizes are high, (say beyond 1 MW or few MW with clusters representing parks), it is necessary to divert the regenerating power to artificial water ponds till windmill speed come down below a safe limit. One needs to use very fast closing breakers (less than 50 to 200 msecs) to divert this power and also size the dc bus capacitors properly for accommodating the changeover without causing high voltages due to active power involved. This is a challenge for the designer. Design of such parks is more difficult due to choices available for common dc bus linking and optimization there upon. Under such situations choice of the converters with and without multi-winding transformer and the entire integration of different wind or solar converters poses a great opportunity as well as risk together.

The solar or wind converters can be used for supplying certain amount of reactive power (inductive or capacitive) and current / voltage harmonic compensation, in addition to the basic duty of regenerating power into the grid. However, this will have to be taken into account when the converter design is carried out.

The most important issue, hence, is related to the availability of solar or wind converters against grid disturbances as covered earlier, prime energy parameters and related disturbances (wind or sun rays / intensity), and internal faults and recovery thereof / evacuation (especially for wind converters during grid failure).

Another undesirable consequence of early requirements placed on solar converters is their response to voltage dips and short interrupts to avoid "islanding operation." Standards require that the converter separate itself from the electric grid within 160 ms in the event that the supply voltage goes outside specified tolerances (usually about ± 10 % from V-nom) [13].

The solar converter, as seen from fig. 4, disconnects within 10 ms

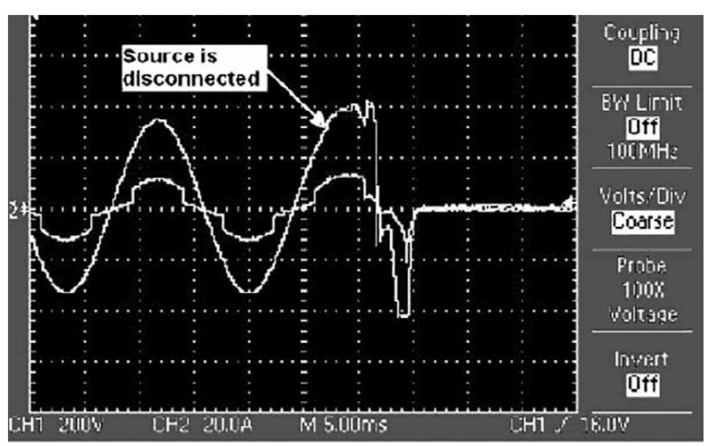


Figure 4: Inverter response to voltage dips [13]

and remains "off-line" – sometimes for as long as several minutes. Such a response will generally aggravate the "dip" as the power contribution from the converter "goes away". It is now recognized that a certain amount of low voltage ride through (LVRT) is much more desirable [13]. This is shown in fig. 5. The above arguments are also true to an extent for wind converters.

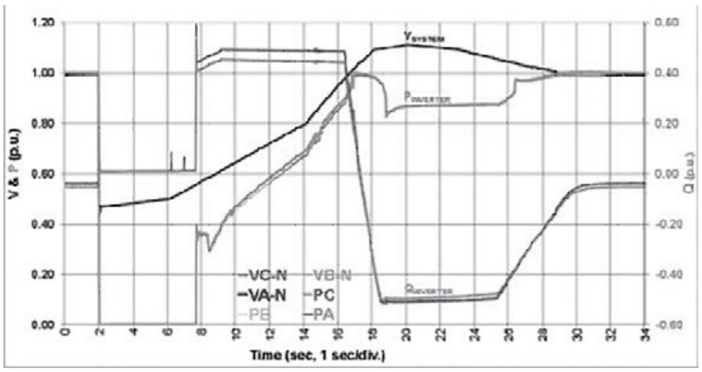


Figure 5: LVRT capability mode PV inverter type [13]

5.0 Possible Use of Solar and Wind converters for Grid Power Quality (PQ) Improvement

It is true that well designed solar converters can be employed for reactive power control or active harmonic control in grid applications, as shown in fig. 6. The dynamic reactive power control offers considerable voltage profile improvement while the harmonic control allows grid voltage total harmonic distortion reduction. This is apart from the supply of active power control in the grid which is the main function of solar converters. Usually, the same is not true for wind converters unless front end converter towards the grid is a four-quadrant converter. When the same is not true, devices like STATCON/M or active filter need to be employed in shunt to achieve the required support for the grid.

Apart from above the converters, especially the solar converters, have the potential to be used for voltage correction or stabilization, voltage distortion correction, and compensation for sudden voltage dips mainly through the battery energy storage (refer fig. 7). The energy storage using batteries also can be used in these applications, especially when solar power is not interrupts or is available as in nights. Further, very high energy storage especially

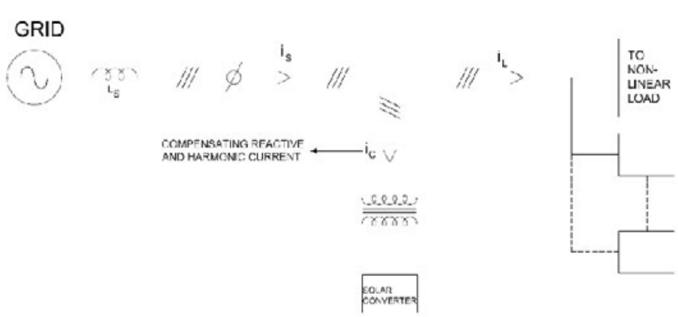


Figure 6: Solar converter for reactive power and current Harmonic compensation

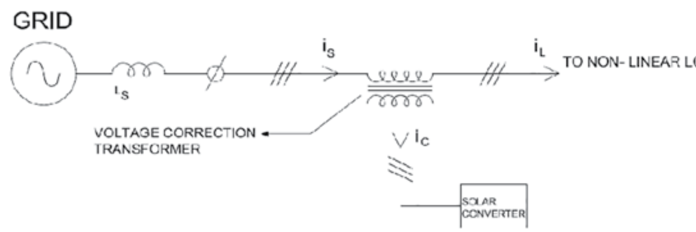


Figure 7: Solar converter for grid voltage correction

is used for compensating dips associated with very high power and high voltage equipment.

The most desirable performance for the solar or windmill converters will be as below.

- Assured basic reliability through design
- Assured protections and overcoming of the faults with certain redundancy offered
- Feature to ensure sudden low voltage ride through supporting the grid dips
- Properly implemented protection for grid failure
- No loss of synchronization during different grid and / or load disturbances
- Controlled power flow and grid support within specified network variations

True, the technology has answered many of these requirements separately, but needs to answer it in a consolidated and economical way. Similarly, the potential for solving or addressing many power quality issues the research holds the key.

6.0 Conclusion

Solar and wind converters show a great possibility of improving the power generation or an increased percentage in overall power generation scenario in coming years. It is necessary that the operational reliability aspect of such converters, especially through design, is an issue of prime concern while dealing with all kinds of network disturbances or interruptions. On the other side, these converters show a large potential for addressing and solving grid power quality issues. The continued research will only help in establishing the operational reliability and answering the grid power quality problems.

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Once the renewable infrastructure is built, the fuel is free forever. Unlike carbon-based fuels, the wind and the sun and the earth itself provide fuel that is free, in amounts that are effectively limitless.

....AL GORE

Index of Confernece Papers

Solar Energy based technologies for agriculture and Agro based Industries-An effort of DBSKKV, Dapoli

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Abstract
Solar energy in the tropical country like India is abundantly available for the utilization. Sufficient quantity of solar energy is available for almost 300 days per annum and has potential to meet major portion of the domestic, agriculture as well as industrial utilization. The majority of the capital investors, planners, policy holders, technocrats and industries are concentrated on the development of large scale solar energy systems for power generation. These systems are capital intensive and beyond the reach of individual household as well as small scale processors.

This paper deals with the various solar energy technologies developed and prorogated for rural area such as Solar dryer for fish and other agricultural produce, solar SPV operated grass cutter, Solar PV operated widicide applicator, Solar PV operated paddy winnover, Solar operated ethanol production technology, solar operated cooking system and oil extractor etc. These technologies are highly efficient and need to propagate in to the masses for its wider application and utilization.

Keywords: *Solar energy, thermal, agriculture industries, solar tunnel dryer, SPV*

INTRODUCTION

Solar energy in the tropical country like India is abundantly available for the utilization. Sufficient quantity of solar energy is available for almost 300 days per annum and has potential to meet major portion of the domestic, agriculture as well as industrial utilization. The majority of the capital investors, planners, policy holders, technocrats and industries are concentrated on the development of large scale solar energy systems for power generation. These systems are capital intensive and beyond the reach of individual household as well as slam scale processors.Limited access to energy is one of the challenges that must be overcome for small- and medium-sized enterprises to establish themselves in rural areas.The most commonly available renewable energy sources in and around the post harvest operations/industries are solar, wind, biomass and process bio-waste.

The renewable energy sources, which are abundantly available in nature, has vast potential to provide the substitute for the commonly used mechanical, electrical, heating/cooling form of energy in agro processing industries.

The solar energy technologies can be used for direct conversion into electricity using photovoltaic and into heat (thermal) energy in the temperature range of 50 to 200 0C.

METHODOLOGY/EXPERIMENTATION

The various solar energy based technologies for heat and power generation was design, developed and evaluated for the different unit operations required in agriculture and agro based industries.

Table1. Solar Energy Technologies for Agriculture and Agro-based Industries developed at DBSKKV, Dapoli

SN	Technology/Equipment	Use
1	Solar Tunnel Dryer	Drying of Fish, Grapes, Vegetables etc
2	SPV operated Sprayer	Weedicide application
3	SPV operated Winnower	Paddy winnowing
4	Solar ethanol distillator	Cashew apple ethanol production
5	Parabolic solar cooker	Cooking and Oil extractor

The developed solar energy based technologies were techno-economically evaluated for its application.

RESULTS

The technical details of various solar energy based technologies are summerised as follows:

Solar Tunnel Dryer:

The natural convection walk in type solar tunnel dryer was design, developed and evaluated for drying of different agricultural products like fish, vegetables, mango pulp, grapes etc.

Specifications of Solar Tunnel Dryer

SN	Parameters	Value
1	Collector Area, sq. m	37.5
2	Width of dryer, m	3.75
3	Length of dryer, m	10
4	Drying tray area, sq.m.	30 (2.5 /tray)
7	Height of tunnel, m	2.0
8	Cover, UV stabilized	200 µm
9	Chimney, m	3 Nos., Ø 0.30 m,
10	Fresh air vent area, sq.m	0.05
11	Exhaust Fan, single phase	2 Nos, Brushless AC
12	Door	1.75 m x 1.75 m

The solar tunnel dryer is useful for drying of different agriculture products. The average 28 % saving in time was observed using solar tunnel dryer over open sun drying method with average drying efficiency of 19 %. The Solar tunnel dryer can be used for Vegetables, Fruits, Chemicals, Agro /Industrial products, Grains, Seed, Medicinal plants, Herbs and Raw Cashew-nut seeds etc.[Rathore and Panwar, 2010].

SPV operated Sprayer:

The maximum field efficiency of SPV operated Sprayer was found at the discharge of 200 ml/min (98.12 %) and minimum field efficiency was found at the discharge rate 100 ml/min (87.09%). [Sasaki et al. 2014] The cost of operation of SPV operated weedicide sprayer (189.53 Rs. /ha) was economically feasible than manual weeding operation (7740 Rs. /ha) and manually operated knapsack sprayer (359.2 Rs. / ha).

Specifications of SPV operated weedicide sprayer

Sr. No.	Component	Specification	Material used
1.	Solar Photovoltaic Panel	5 W, 6 V Size: 28 cm*17.5 cm	-
2.	D.C. Motor	Voltage :6 volt	-
3.	Spinning Disc Nozzle	RPM :4000-4400 Diameter: 9 cm	HDPE
4	Battery	Voltage :6 V Current:4.5 Ah	Sealed Lead Acid Battery
5.	Lance	Length :2.1 m Diameter:4 cm	HDPE
6	Frame	Height : 32 cm Breath : 22 cm Width:12 cm	Mild Steel
7	Connecting Rod	Height: 73 cm Bend Pipe length: 40 cm Diameter:2 cm	Galvanized Iron Pipe
8	Switch	1 No. on/off	-
9	Accessories	Two abdomen belt	Nylon
10	Tank	Capacity: 5 liter Height : 10 cm Breadth: 7 cm Width: 4.5 cm	HDPE
11	Weight of Solar Operated Weedicide Sprayer with	11.5 kg	-

SPV operated winnower:

It was observed that, newly developed portable solar photovoltaic (SPV) operated paddy winnower is technoeconomicaly suitable for winnowing of paddy at the feed rate of 120 kg/h. The average cleaning efficiency of SPV operated paddy winnower is more than 90% with low operating cost of 0.25 Rs./kg.[Kadam, 2011]

Specifications of SPV operated winnower

Sr. No.	Component	Specification
1.	Solar Photovoltaic Panel	Power : 37 W, Voltage : 12 V
2.	D.C. Motor	Power :18 W,Voltage :12 volt
3.	Centrifugal Blower	RPM :2800
4.	Hopper	Capacity: 10 kg, Size =40x40x20
5.	Speed regulator	12 v
6.	Castor wheel	4 No.
7.	Switch	1 No. on/off
8.	Frame	100 cm x 70 cmx 40cm

Solar ethanol distillator:

The solar energy based distillation system was used to distill the fermented cashew apple juice. The hybrid mode of distillation resulted maximum distillate output 5905 ml at 20 mm initial depth and the maximum distillation recovery 53.6 % at 10 mm depth. The comparative distillation performance showed that modified active mode of distillation increased maximum 83 to 88 per cent alcohol concentration of ethanol after each distillation.[Meukama et al, 20014]

Parabolic solar cooker:

Concentrated energy from solar parabolic cooker is useful for household cooking as well as extraction of cashew nut shell oil. The parabolic solar cooker achieved about 250-300 oC temperature at the focal spot in clear sunny day.

Specifications of Parabolic Solar Cooker (SK-14) for CSNL Extractor

Sr. No.	Component	Specification
1	Diameter	1.4 m
2	Reflecting area	2.2 m^2
3	Reflector	Aluminum sheets
4	Temperature	200 to 300 oC
5	Efficiency	40 %
6	Capacity	1.3 liter per day

CONCLUSIONS

Solar power is an immense source of directly useable energy and ultimately creates other energy resources: biomass, wind, hydropower and wave energy. Utilized these various solar energy technologies developed and prorogated by DBSKKV for rural area such as Solar Tunnel Dryer for fish and other agricultural produce, SPV operated Sprayer for widicide application, Solar PV operated paddy winnover, Solar operated ethanol production technology, Parabolic solar cooker for cooking and oil extractor to meet their need and create the rural employments.

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Studies show that investments to spur renewable energy and boost energy efficiency generate far more jobs than oil and coal.

...JEFF GOODELL

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“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

... Gro Harlem Brundtland

Overview of Renewable Energy Market in India

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Abstract

With a strong objective to achieve low carbon pathway, Indian government is reshaping its energy policy structure to encourage the clean and green generation sources. Government support to the renewable capacity addition is motivated by its commitment in Paris agreement. As per these accords, India target's to achieve 175GW from renewable sources by 2020; of which 100GW is expected to be fulfilled by solar and about 60GW by wind sources. This is very well translated into changing policy structures. Apart from this, increased competition, overcapacity of solar modules in China and easier availability of funds are contributing to the present commotion in Indian renewable sector.

With this background, the paper gives a holistic view of renewable sector in India, changing policies and emerging financial structures along with emphasizing on solar and wind sector individually.

1.0 Introduction

Similar to the telecom sector, where launch of mobile phones and rapid penetrations of internet services posed treat to the traditional telecom companies, like wise, several elements are also affecting the way a traditional power utility functions. Grid parity achieved by the renewable energy sources making it economically and technologically viable. Stricter emission norms for conventional sources and enhanced awareness about the energy conservation lead to the muted demand which is posing serious challenges to the present day utilities. Majority of the turmoil in the power sector is the result of economic dynamics in the renewable energy market.

India's renewable policy initiatives which got initiated as R&D in 1982 have matured over the period of time and soon set to achieve the ambitious targets with strong government support. The result of which, Indian renewable energy market is the second best in world as per EY's Renewable Energy Attractive Index. India's installed renewable power generation capacity increased at a Compound Annual Growth Rate (CAGR) of 8.39 per cent (from 42.4 GW in FY07 to 102.9 GW in FY18) as of July 2017, which is 31.2 per cent of the total installed capacity.

According to India Solar CEO survey 2017 conducted by Bridge to India, industry is more optimistic on the renewable growth prospects. However, prudent about individual business growth outlook i.e. sector will grow, but 'will my Business grows?' is the question. Possible reason can be falling tariffs, squeezing profitability and increased competition.

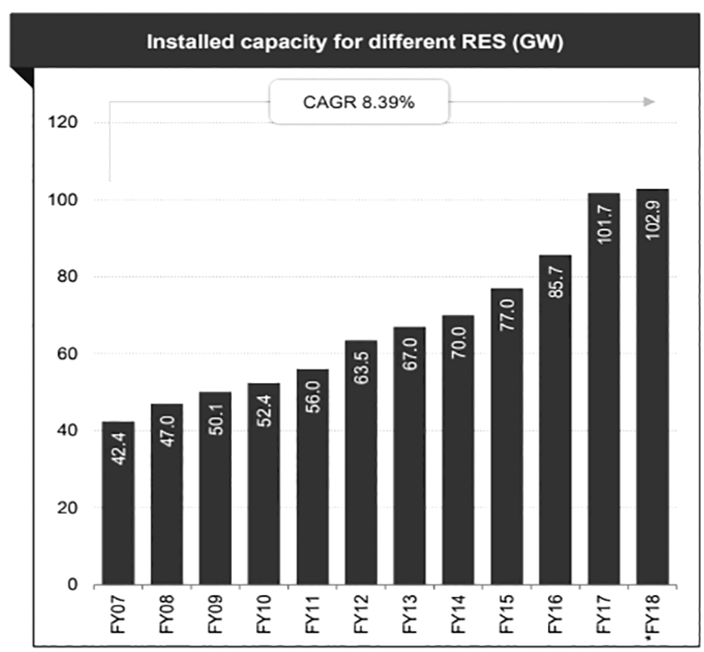


Fig-1: Installed RES capacity, IBEF

Dynamism in renewable sector is majorly driven by two factors:

- Changing paradigm of renewable energy policies
- Cheaper and easier funding availability

1.1 Changing paradigm of renewable energy policies

Policy landscape of power sector has undergone significant evolution and the transition is observed in three phases as below:

Fig-2: Evolution of renewable energy policies

In the embryonic stage, when technology was new to developers and financers, the policy aimed to encourage renewable with direct subsidies and attractive depreciation linked tax breaks. MNRE provided capital subsidies to biomass projects and demonstration projects in the wind sector. Accelerated depreciation is one of the important drivers allowing 80% depreciation in first year thereby improving cash flows. Along with this 10 years tax holidays were also provided to industrial undertaking generating renewable energy.

With advancement of technology, policy moved to performance linked incentives in form of preferential tariffs and Generation based tariff. Feed in tariffs was instrumental in the first phase of National Solar Mission where special tariffs in the range of Rs.9.5 to Rs.13 were provided. In 2009, under generation based incentives, Rs.0.5 were provided for each unit fed into the grid for the period not less than 4 year and upto 10 years.

Now the focus of policies is on the encouraging the renewable energy through market linked mechanisms like Renewable Purchase Obligation (RPO). RPO is the minimum share of consumption that the state has to fulfill through renewable sources. Under this mechanism, there would be no dependency of the project developers on the government schemes for the project viability. However, for many states, even meeting the RPO was not possible mainly because less renewable generation owing to geographical location and so Renewable Energy Certificate (REC) was introduced by CERC in 2010. Going one step ahead, projects now are won through competitive

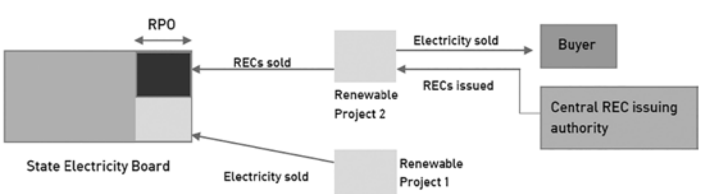


Fig-3: RPO and REC mechanism

bidding and auctions, which is bring a great churn in Indian renewable market.

REC is issues by CERC for every one MWh of renewable energy produced to the developer. It represents only the environmental nature of renewable energy and buyers are free to sell the power anywhere according to their will.

1.2 Finance cost

The approach of awarding renewable projects which emerged in 2017 has tightened the profit margins of project developers, forcing them to come up with unconventional financial structures. This led to emergence of Supplier coupled financing.

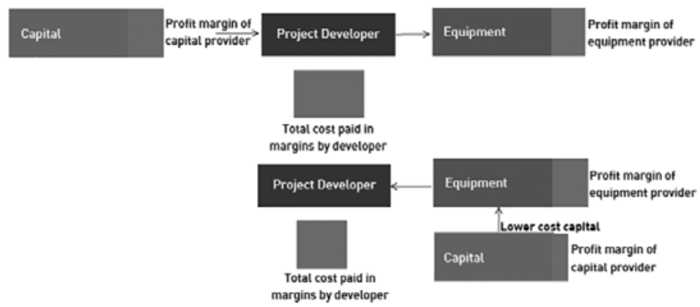


Fig-4: Supplier coupled financing

The core idea of the methodology is that, when a developer raises capital from different entity and equipment from different entities, he pays profit margin to two entities i.e. financer as well as equipment provider. In the innovative Supplier coupled financing, technology provider plays an additional role of raising capital, thereby reducing the overall margin to be paid.

Other financial incentives provided by government of India are:

Viability gap funding (VGF): Capital subsidy is provided to project developers bidding for project at pre-determined rate. SECI has already allocated 4835 MW of new capacity under VGF and another 785MW of tenders are in process.

Accelerated depreciation: The renewable projects are eligible to avail depreciation benefits of 80% of asset value in first year thereby improving cash-flows. Since April 2017, this has been reduced to 40%.

Ten-years corporate tax holidays: 10 years of tax holidays were provided to renewable projects to encourage developers so far, however, this is withdrawn from April 2017 onwards.

In addition to this, government has also allowed 100% FDI in renewable project.

2.0 Solar sector overview

Solar generation in India has tripled to 12GW in last 3 years in line with Government's target to generate 175GW from renewable by 2020; of which about 100GW is targeted through solar. This has created a multi-billion dollar market for Chinese product makers who are facing over capacity in their homeland and steep duties in Europe. 85% of India's solar modules needs are met from China which makes it to approximately $2 billion market, as reported by Mint on 30th Oct, 2017.

2.1 Technology

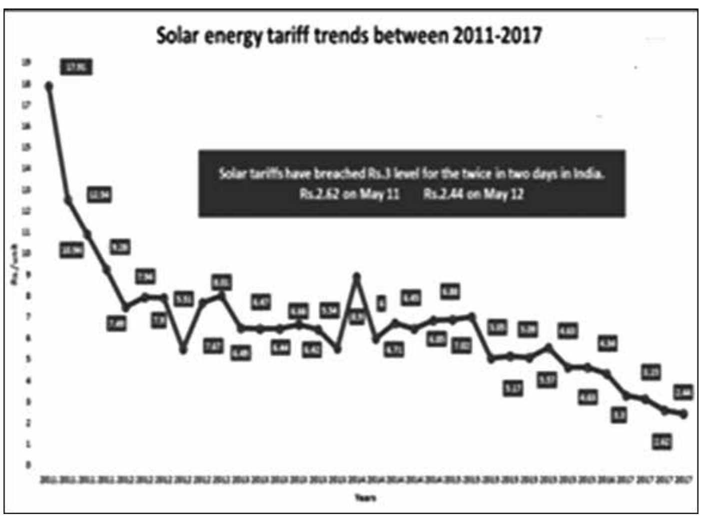
While substantial R&D is going on in Solar sector to improve the module efficiency and overall output, it is yet to be translated commercially. Polysilicon, the basic raw material for modules, which was costing $475/kg in 2008 is now available at $17/kg leading to radical reduction in panel costing. New innovations like floating solar power plant and solar tree are being explored; however, these technologies are under research and presently at nascent stage.

Solar roof top is another emerging way to promote the use of natural energy. By end of December 2016, installed solar rooftop capacity is estimated to be 1247MW as per Bridge to India in India Solar Handbook 2017. As per same source, 11.9GW capacity addition is estimated in India between 2017 and 2021.

2.2 Changes in Business Model

Supplier coupled financing, as elaborated above, is broadly used in solar sector. Technology providers in solar area are majorly foreign entities who have access to low cost capital. This innovative financing has reduced the cost by 10-15% per unit. Solar Parks is one more emerging area where land, roads, evacuation lines etc. are provided to developers, which minimizes their business risks. Government aims to develop 40,000MW of Solar parks of which 8900MW have already been allocated in 8 solar parks.

2.3 Falling solar tariff in India



Solar tariffs in India has fallen more than 40% in last 16 months achieving the record low rate of Rs.2.44/unit in an auction conducted by SECI in May 2017. The winning bid was to setup 200MW plant in Bhadla, Rajasthan and was awarded to Acme. Over capacity in China, low cost of funding and increased competition due to auctions initiated by government has caused the prices to fall down at this level. Further, strengthening of rupee over USD is one skeptical assumption which developers are relying on while quoting the per unit price.

2.4 Challenges to the solar sector

Pace of new tender announcements and auctions have reduced significantly over past few months. Southern states have frontloaded their capacities with Karnataka reaching to 69% of its March 2020 targets (with present installed and tendered capacity), Andra Pradesh and Telangana achieving 74% and 70% respectively causing the slowdown from here onwards. Falling tariffs are also causing remorse among the DISCOMs which have completed auctions at higher rates in recent past and are refusing to sign the PPA with developers is creating lot of uncertainties.

Also, falling module prices internationally is making the domestic module manufacturer sub scale and uncompetitive, making them obsolete.

3.0 Wind sector overview

As on 30th June 2017, wind generation capacity in India is 32,508MW which constitutes to about 10% of total capacity of India. The changing market structure and policy environment are bringing in new trends in wind sector.

3.1 Technology

The average WTG capacity in 2000 was 0.3 MW, 0.75MW in 2008 which further increased to 1.25MW in 2012. With improved R&D, currently WTGs of capacity 2-2.5 MW are being deployed in India. Higher rating calls for higher hub height and sweep area. For Eg. Turbine of 1.25MW had hub height of 52m and sweep area of 3200Sq.m, while the hub height for commercially available 2.1MW is 79M and sweep area is 6000sq.m.

This allows the higher generation from the turbine. The increased hub height and sweep area are making the wind turbines commercially viable even in class-3 sites, thereby significantly increasing the wind generation potential across the country.

3.2 Changes in Business Model

As government is moving away from accelerated depreciation benefits to direct tax and on the other hand, technological improvements bringing down the investment costs, wind business is becoming attractive as Independent Power Producers (IPP) even without depreciation benefits. According to IBEF, more than 30% of the wind projects during 2011-12 were based on IPP model.

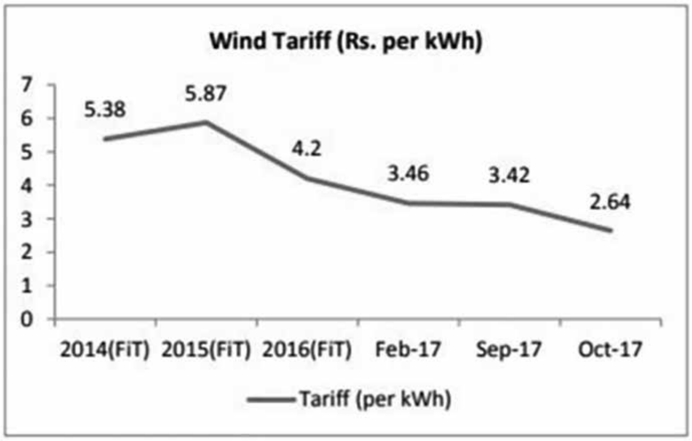
There is also change in the nature of Power Purchase Agreements (PPA). With the competitive pricing, wind project developers are increasingly confident to sell their power through Merchant route. Merchant selling is a risk prone platform where sellers enter into short term agreement with buyer rather than long term PPA. This allows them to realize higher tariff when demand is higher.

3.3 Falling wind tariff

In the second auction of 1GW wind project, conducted by SECI, whose results were declared in October 2017, wind power tariff reached all time low of Rs.2.64/unit. Re-New Power Ventures and Orange Sironj Wind Power bid to win these contracts of 250MW each. This auction witnessed 23% fall in tariff within last six months.

3.4 Challenges in wind sector

Over the last five years, cost of WTG installation has reduced 20% while



Source: CERC & State ERCs

cost of solar installation has reduced 80%, making solar more attractive. Class-1 and Class-2 (high wind) sites have also been saturated, thus leading to the slowing down the further growth.

4.0 Way forward

Wind and solar have largest potential for growth among other renewable sources and will lead the growth in coming years, as mentioned in a study conducted by MNRE.

Saubhagya scheme launched by government aimed to electrify all households in India by December 2018, and 24 x 7 power initiative of UP government is expected to improve the overall residential demand by 15% over the period of 3-4 years. This will lead to increase in thermal PLFs by 15 basis points but majorly the demand is estimated to be served by renewable.

As mentioned above, the availability of higher size of wind plants is making it feasible to deploy WTGs even in Class-3 regions. This will increase the present wind potential from 65,000MW to 1,50,000MW, as per the expert's opinion in India Brand Equity Foundation report: Renewable energy- Emerging trends and potential.

Solar energy achieved grid parity in May 2017 auction of Bhadla, Rajasthan which was followed by wind in October 2017 in the results of SECI auctions held in May 2017. The question is whether these bids are sustainable? Experts are skeptical about the basic assumptions of further availability of cheaper funds and strengthening of INR made in these winning bids. Further, quality of hardware is being compromised in order to maintain the positive margin by developers.

The slowing down of auctions post the recent low bids in wind and solar will provide a breathing space to the renewable industry to consolidate at rational and realistic rates. Discoms should ensure that quality is not being compromised by developers who are quoting and winning low bids.

Rather than accepting the downward trend of renewable merrily, there is need to analyze case by case feasibility of every project. Sustainable low cost renewable energy derived from these cautious and concentrated efforts of both developers and governments will only contribute to strengthen the power sector which is backbone of any country's economy.

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Study of Temperature Profile of Solar Cabinet Dryers

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Abstract: *Drying is one of the most conventional methods used to preserve and store agricultural products. Solar dryer maintains consistent air temperature. Heat storage material increases the drying time as compared to open air drying. Drying temperature varies according to the type of product. In order to identify the temperature variation, three different shaped cabinet dryers were studied from morning to evening with respect to solar intensity. It was observed that in case of regular shaped cabinet dryer, maximum temperature of 65.5°C was achieved at 12:00 pm and 27.6°C with sunshine intensity of 990W/m² and 28W/m² respectively. In case of box type cabinet dryer, maximum temperature of 71.1°C was achieved at 12:00 pm and 29.5°C with sunshine intensity of 990W/m² and 28W/m² respectively. In case of pyramid dryer, maximum temperature of 51.3°C was achieved at 12.00 noon and 27.5°C with sunshine intensity of 990W/m² and 28W/m² respectively. Over drying under drying is the major limitation in solar dryers. Different temperature control strategies help in overcoming this limitation. Applying control strategy needs temperature measurement inside the solar dryer. Conventional glass thermometer provides local indications and cannot be used in signal conditioning. To overcome the above mentioned limitations of solar dryer as well as local indicators of temperature, different temperature sensor based controllers were suggested in the paper.*

Keywords – *Drying, Solar dryer, temperature sensor, thermistor, transistor, relay, PID*

1. INTRODUCTION

Drying is one of the most conventional methods used for preservation and storage, which works on the basis of reduction in the water content in the product. The reduction in the water content brings more physical as well as chemical stability in the product. It also reduces the weight and volume of the product and hence the transportation cost can be reduced. The process of drying improves the quality of product and reduces product loss due to moisture content. For drying and dehydration of any product several techniques have been employed which are solar drying, freeze drying, osmotic dehydration, etc. The problem in the conventional drying process is, it is carried out manually and does not have any control. A strict monitoring of every process is thus required to ensure the quality of the product supplied as dried fruit. The main disadvantages of open-air sun drying, mostly are contamination, theft or damage by birds, rats or insects also it fairly is slow drying and no protection from rain, dew or any storm.

The disadvantages of open air sun drying can be overcome with the use of different dryers. Within that, electric based dryer require more operational cost than solar dryers. In India, drying of agricultural product is shifted from traditional method to modern method to avoid post-harvest losses and maintain nutritional importance. Drying increases shelf life of the product and reduces transportation as well as storage cost. For drying of fruits and vegetables, tunnel solar dryer such as cabinet dryer is mostly used and it has good efficiency and is very economical. Therefore day by day modern solar dryers are also introduced for agricultural food processing industries increasing the value of the agriculture product.

The indirect forced convection solar dryer with heat storage material enables to maintain consistent air temperature inside the dryer. The inclusion of heat storage material also increases the drying time by about 4 h per day [1]. The temperature rise inside the drying cabinet of a simple and inexpensive mixed mode solar cabinet was up to 24oC (74%) for a hours immediately after 12.00(noon). The drying rate, collector efficiency and percentage of moist removed (dry basis) for drying yam chips were 0.62 kgh, 57.5 % and 85.4%respectively [2]. Solar energy in Konkan region was available for 8 to 9 months in a year with average sunshine hours ranging from 6.5 to 8 h per day. The average solar energy ranged between 450 – 500 W/m2-day [3].

Drying temperature affects the product quality of food products. Hence, monitoring temperature inside solar dryer is important aspect. After monitoring various control strategies can be applied with the use of different sensing and control strategies. The necessary power source required for sensor and control circuitry can be supplied with the help Solar Photovoltaics (SPV).

Solar panel consist of photovoltaic cells convert that solar energy in to the electric energy. Further that current generated by the solar cells was supplied to the battery via electric wires. One controller was placed between the solar panel and the battery which control the current which was supplied to battery [4].

This paper is organized as follow: In section II performance of slant edge solar cabinet dryer, box type solar cabinet dryer and pyramid shaped cabinet dryer is discussed. In section III comparison of above three dryers is discussed. In section IV various temperature sensor based controllers are suggested.

2. PERFORMANCE OF SOLAR CABINET DRYERS

Performance of solar dryers are determined according to temperature inside the dryer from morning to evening period by using digital thermometer and digital solarimeter.

A. Slant edge solar cabinet dryer

Cabinet dryer are direct solar dryer are simple in construction are used for drying of different agriculture food products. Fig.1 show slant edge cabinet dryer and table 1.1 show the performance of it. Fig.2 show temperature profile of the same.

Fig.1 slant edge solar cabinet dryer

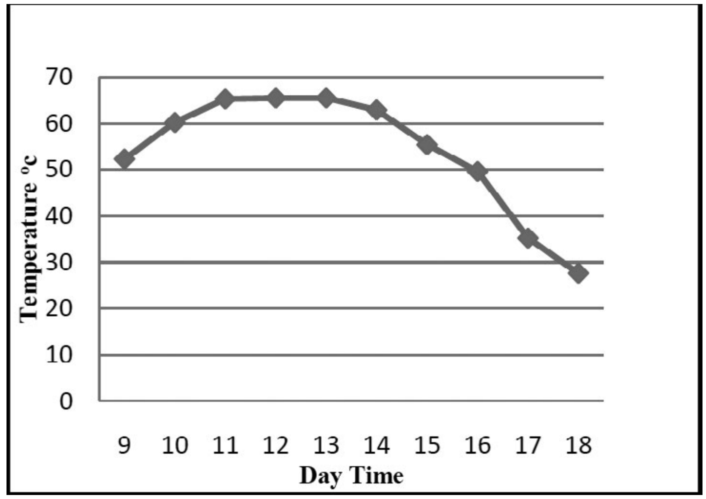

Fig.2 Temperature of slant edge solar cabinet dryer vs. day time

B. Box type solar cabinet dryer

Box type cabinet dryers are compact in size and generally preferred for drying fruits and vegetables. Fig.3 show box type cabinet dryer and Table II show the performance of it. Fig.4 show temperature profile of the same.

Fig.3 Box type solar cabinet dryer

Table I Performance of slant edge solar cabinet dryer

Sr. No	Time of day	Sunshine Intensity (W/M^2)	Temperature (°c)
1	9.00	506	54.4
2	10.00	757	60.4
3	11.00	909	68.5
4	12.00	990	71.1
5	13.00	831	71.4
6	14.00	734	61.1
7	15.00	603	52.6
8	16.00	384	50.5
9	17.00	127	41.2
10	18.00	28	29.5

Table II Performance of box type solar cabinet dryer

Sr. No	Time of day	Sunshine Intensity (W/M^2)	Temperature (°c)
1	9.00	506	54.4
2	10.00	757	60.4
3	11.00	909	68.5
4	12.00	990	71.1
5	13.00	831	71.4
6	14.00	734	61.1
7	15.00	603	52.6
8	16.00	384	50.5
9	17.00	127	41.2
10	18.00	28	29.5

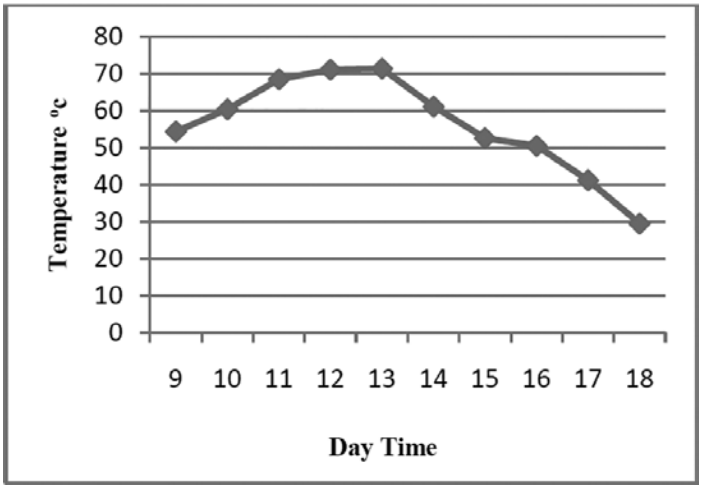

Fig.4 Temperature of box type solar cabinet dryer vs. day time

C. Pyramid shaped solar cabinet dryer

Pyramid shaped solar cabinet dryers enclose comparatively less hot air inside the dryer. Fig.5 show pyramid shaped solar cabinet dryer and Table III show the performance of it. Fig.6 shows temperature profile of the same.

Fig.5 Pyramid shaped solar cabinet dryer

Table III Performance of pyramid shaped solar cabinet dryer

Sr. No	Time of day	Sunshine Intensity (W/M²)	Temperature (°c)
1	9.00	506	42.4
2	10.00	757	47.8
3	11.00	909	48.4
4	12.00	990	51.3
5	13.00	831	51.6
6	14.00	734	48.2
7	15.00	603	44.7
8	16.00	384	41.7
9	17.00	127	35.1
10	18.00	28	27.5

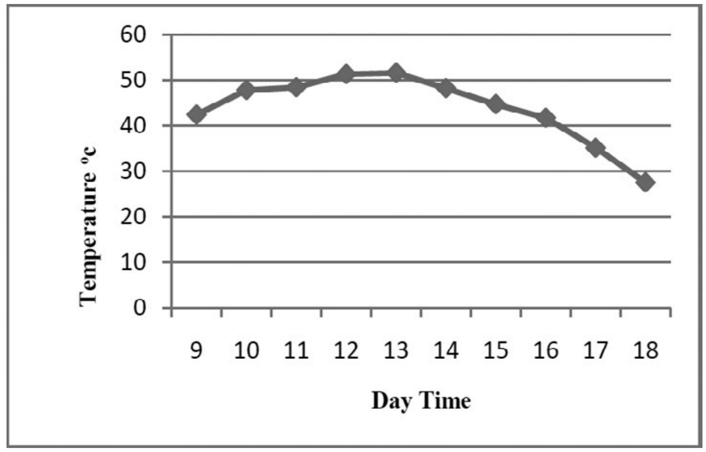

Fig.6 Temperature of pyramid shaped solar cabinet dryer vs. day time

3. COMPARISON

Selection of a specific dryer depends on the agricultural food product and the temperature required for drying that product. Graphical comparison of the mentioned three dryers is depicted in Fig.7.

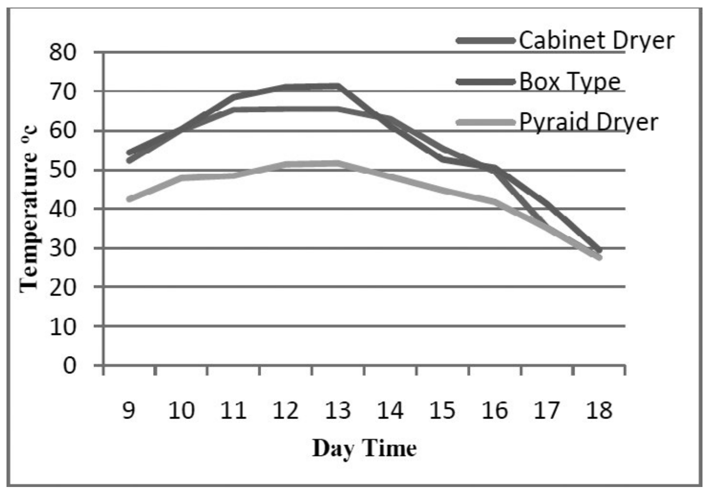

Fig.7 Comparison of performance of three dryers

The maximum temperature inside any type of solar dryer is attained at noon. The rate of temperature inside box type solar cabinet dryer is faster as compared to other two types of dryers. The maximum temperature attained at noon inside the box type solar cabinet dryer is more as compared to rest of the two.

The major disadvantage of pyramid shaped dryer is lower temperature. The only advantage of it is that it contains more agricultural food products since size of the drying chamber is more.

4. TEMPERATURE SENSOR BASED CONTROLLERS

As discussed earlier, solar dryers are more efficient than open sun drying. Still, over drying due to excess temperature and increasing time for drying due to lower temperature is the limitation in solar dryers. Over and under drying of food products damage food product quality. Now days, solar dryers are associated with exhaust fan to pull hot air out from the cabinet. Referring Fig.7, from 9 to 11:30 am at morning and from 1:30 pm at afternoon to 6 pm at evening, temperature inside dryer cabinet is less. This temperature is not sufficient for drying food products having more moisture content like fish. Furthermore, the exhaust fan gets ON as soon as solar radiations fall on SPV panel which powers it. As a result, the temperature inside cabinet increases at a slower rate in the above mentioned region. This is not desirable. A suitable control strategy can overcome this deficiency.

Sensors are required to measure the temperature inside cabinet. These sensors will give signal to comparator. Comparator compares this measurement signal along with the desired input (set point) and gives error signal to controller, which accordingly takes action to control operation of exhaust fan. Local indicators like thermometer are very easy to use, but the major limitation being of signal conditioning. They cannot provide output in electrical form and hence are not suitable for control circuitry. Thermistor, Resistance Temperature Detector (RTD), Thermocouple etc are suitable sensors for such application. Out of these three, for solar cabinet dryers thermistor is ideal. It has low temperature range and within that range it is very sensitive.

Fig. 8 shows the sensor, comparator and controller along with solar cabinet dryer. Following control devices/strategies can be utilized:

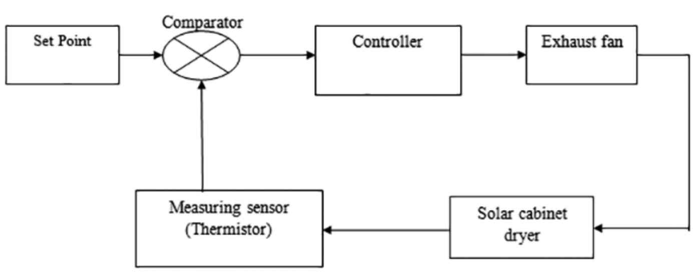

Fig.8 block diagram of control strategy

1. Transistor

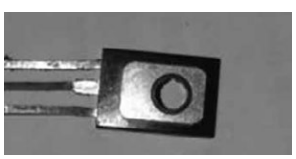

Fig.9 Transistor (BD 139)

A typical npn/pnp power transistor is very simple to operate and efficient control element. It acts as a switch along with some resisistors. It acts as ON/OFF switch, operating fan very effectively

2. Relay

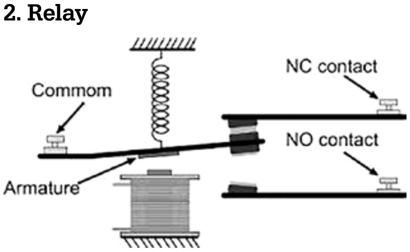

Fig.10 Relay

Relay being used in several applications as ON/OFF controllers is a reliable controller for solar cabinet dryer which can be coupled with exhaust fan with some additional circuitry.

3. Microcontroller

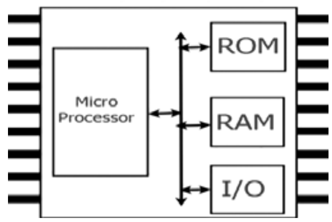

Fig.11 Microcontroller

8051 or PIC microcontroller integrated circuit (IC) of any series serves as a good controller. It is continuous type of controller. Microcontroller circuitry requires external power supply which can be supplied by SPV panel. Additional resistors and necessary wiring circuitry is essential to work with microcontrollers. One can simply generate an algorithm of control strategy like ON/OFF, Proportional (P), Proportional plus Integral (PI) or Proportional plus Integral plus Derivative (PID) into the microcontroller.

V. CONCLUSION

In this paper, performance of slant edge solar cabinet dryer, box type solar cabinet dryer and pyramid shaped solar cabinet dryer is evaluated. Accordingly temperature profile of above three dryers is studied. In case of box type dryer, temperature attained inside the cabinet is more as compared to rest of the two. These dryers are not coupled with exhaust fan. Hence, there is no control of temperature inside the cabinet. The temperature inside the solar cabinet dryer should be maintained at specific level according to food product to get better product quality. Sensors like thermistor, RTD, thermocouple is recommended for measurement of temperature. A controller like Transistor, relay and microcontroller is suggested to maintain the temperature inside solar dryer cabinet at desired point.

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Free and Open Source Simulation Software Tools for rooftop PV installation with a case study

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Abstract: *In the era of fast depletion of fossil fuels, it is necessary to switch over to the renewable and nonconventional energy sources. Solar photovoltaic system or solar power system is one of the renewable energy systems which use PV modules to convert sunlight into electricity. The electricity generated can be stored or used directly, fed back into grid line or combined with one or more other electricity generators or more renewable energy source. Solar PV system is very reliable and clean source of electricity that can suit a wide range of applications such as residence, industry, agriculture, livestock, etc. The best way to judge the performance of a PV system is to use correct simulation software that will suit the need of a customer. Different professional and free software are available in the market. The choice depends on Designer and a Customer.*

Keywords - *fossil fuels, PV modules, rooftop*

1. INTRODUCTION

The project under consideration for which PV system is to be provided, involves number of steps to get the desired output. One of the crucial and preliminary stages in evaluation of solar PV potential is the type of software used for getting useful output from the project. Most of the software has built in features. They are mostly user friendly.

A designer can get himself acquainted with the software selected for analysis of PV project. Once he is used to then it becomes easier to handle it for further stages [6].

Some of the open source simulation software is described below. More light is thrown on PV WATT calculator with one example of our VPM's Polytechnic. The possible production of no. of units per year which can be generated by PV rooftop can be known. From this we can decide at the early stage, whether to go SOLAR or not. The maps and software packages allow decision maker to take the first step in analyzing the potential for solar PV at a particular location [5].

The journey through some FOSS used for PV is as follows:

- **PVMSD**

It is an open source geographic information system (GIS) based software used for PV calculations.

It is a PV system layout designing software. Unique to PVMSD is the layout design of a PV system combined with optimization of panel orientation and estimation of energy generation.

Its GIS interface provides an intuitive and relatively easy method to assess parameters such as PV arrangement, nearby objects, weather data and PV panel parameters.

- **RET Screen**

It provides amazing, and free, tools for fiscal, GHG and lifecycle evaluation of renewable energy projects. They provide excel worksheets, instructions, case studies, textbooks, etc. and they do it in 30 languages.

A decision support tool is developed with the contribution of numerous experts from the Canadian government, industry, and academia. The software can be used worldwide to evaluate the energy production and savings, costs, emission reductions, financial viability and risk for various types of Renewable-energy and Energy-efficient Technologies (RETs)

The software can model a wide variety of projects such as large scale multi-array central power plants, distributed power systems located on commercial buildings and houses, industrial remote wind-PV-genset hybrid power supplies, stand-alone battery storage systems for lighting. For agriculture and water supply applications the daily and annual electricity use for water pumping can be estimated using a convenient water pumping tool. The software (available in multiple languages) also includes product, project and climate databases, and a detailed user manual.

- **NREL Solar Advisor Model (SAM)**

SAM allows users to investigate the impact of variations in physical, cost, and financial parameters to better understand their impact on key figures of merit.

The Solar Advisor Model evaluates several types of financing (from residential to utility-scale) and a variety of technology-specific cost models for all Solar Energy Technologies Program (SETP).The SETP technologies currently represented in SAM include concentrating solar power (CSP) parabolic trough and dish-Stirling systems and photovoltaic (PV) flat plate and concentrating technologies. SAM uses the total installed cost, which is the sum of direct and indirect costs, to calculate the levelized cost of energy. Because how costs are assigned to each category does not affect the total installed cost, you can either choose to distribute profit, overhead, shipping, and other costs among the component categories (module, inverter, BOS, Installation) or include them as a single value in the indirect category (miscellaneous).

- **ESP-r**

ESP-r is an integrated modeling tool for the simulation of the thermal, visual and acoustic performance of buildings and the assessment of the energy use and gaseous emissions associated with the environmental control systems and constructional materials. In this software, the system is equipped to model heat, air, moisture and electrical power flows at user determined resolution.

Building geometry can be defined via CAD tools, in-built CAD facilities or click-on-grid or image. ESP-r supports a building representation of arbitrary complexity (but most users work with models of 10-50 thermal zones. Models can be exported to other assessments tools such as Energy Plus, Radiance (visual simulations) or VRML worlds. As required, component networks can be defined to represent, for example, HVAC systems, distributed fluid flow (for the building-side air or plant-side working fluids) and electrical distribution systems. Alternatively, users can use idealized environmental controls for early design-stage explorations.

- **Open source GIS tools:**

To promote rooftop solar photovoltaic (SPV) systems, especially in Indian solar cities, a user-friendly tool is required to investigate solar resource potential in locations of interest and perform pre-processed analysis. Geographic Information System (GIS) is the obvious tool to achieve this because it provides visual reference – a map of the entire city showing the buildings those have solar PV installation potential. An important part of every web-based GIS tool is its mapping or, visualization technology, which makes it possible to show data in the form of maps [2].

The Energy and Resources Institute (TERI) developed the first cloud based open-source Web-GIS Tool for estimating Rooftop Solar Power potential for Indian Solar Cities.

- **PV WATT Calculator: [4]**

PVWatt calculator calculates the energy production and cost savings of connected grid photovoltaic (PV) systems throughout the world (USA, UK, Europe, France, Italy, Spain...) It is totally free, and allows anybody to easily estimate the performance of worldwide PV projects.

PVWATTS incorporates NREL's 40 km resolution solar resource data to permit site-specific calculations.

This calculator also provides estimated monthly and annual irradiation and energy production in kilowatts and energy value. Users can select a location and choose to use default values or their own system parameters for size, electric cost, array type, tilt angle, and azimuth angle. In addition, the PVWatts calculator can provide hourly performance data for the selected location.

This is developed by NREL (National Renewable Energy Laboratory, USA). NREL is the only federal laboratory dedicated to the research, development, commercialization, and deployment of renewable energy and energy efficiency technologies. In countries like USA, it is the most commonly used software tool used for deciding optimum PV system output. It has all inbuilt features with user friendly commands. It allows designer to take appropriate decisions.

Users cannot change the following system parameters [4]:

- installed nominal operating cell temperature (INOCT) of 45degC
- power degradation due to temperature of 0.5%/degC
- angle-of-incidence (reflection) losses for a glass PV module cover
- photovoltaic cell technology : crystalline silicon (mono, poly)

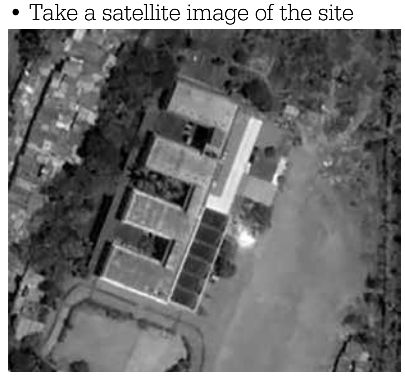
In India, a PV designer mostly uses PVSYST as a simulation tool for PV calculations and generating reports related to it.

This software is most preferred by architects, engineers, and researchers, and found to be very helpful tool for education. It includes and explains in detail the procedures and the models used.

It is a commercial and Licensed software but mentioned in this paper to know which software is used in India versus the one used in outside countries like US and Europe.

2. PROCEDURE [4]

- Take a satellite image of the site

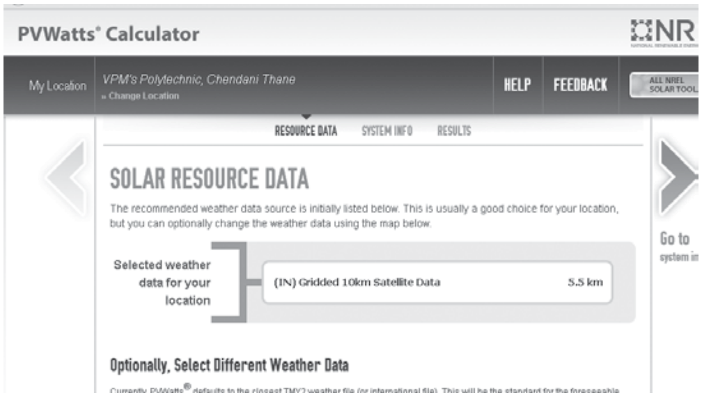


Satellite Image of VPM's Polytechnic, Thane

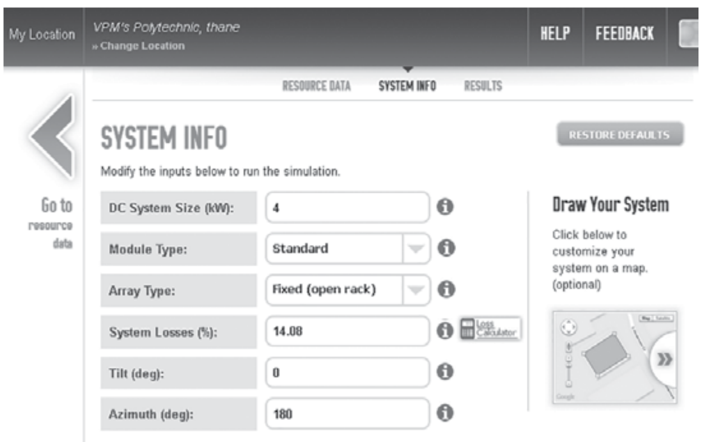
Red marking indicates the possible boundary of installation of solar panels

- Enter home or business address

• An indication of weather data is obtained by clicking on the above address



• System info is obtained about the business address selected. It includes DC system size, module type, array type, system losses, tilt and azimuth. Fill the required data for the selected site. A map can also be plotted of the selected site.



The losses for the each site will differ and enter those values for your site in above window

• After clicking the results are obtained for number of units generated per year for that selected site.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Energy Value ($)
January	6.36	573	2,081
February	7.03	564	2,046
March	7.38	656	2,382
April	7.13	619	2,246
May	6.69	606	2,201
June	4.49	410	1,489
July	3.71	353	1,283
August	4.14	392	1,422
September	4.81	431	1,566
October	5.99	540	1,959
November	6.41	549	1,994
December	6.12	544	1,976

From the above results, the analysis of other parameters can be done. These parameters include [7]

- total load calculation of the building
- available area in m2
- selection of PV module and array
- selection of Inverter and other wiring accessories
- costing

3 FUTURE SCOPE

From the above case study of VPM's Polytechnic, Thane, It is clear that this software described here can be applied to any site of interest. The work of the designer is reduced to a large extent and saves lot of business time of the designer/decision maker. This is just an approximate analysis by PV WATT.

For detailed study of the site, it is necessary to take exact measurements, all load calculations etc. The results obtained can be compared with other software tools if required to verify the authenticity of PVWATT. But it can be a reliable and robust tool for the designers of PV.

It can be concluded that these software tools give insight to the designer about PV installation, layout etc. Along with this software tool Sun charts, Site survey, Experience of designer also count for the success of the project.

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A study on Carbon Tax - Pros and Cons, Effects on Environment & Economy

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Abstract : *Industries, consumers and many other resources emit carbon dioxide, methane, nitrous oxide, and other greenhouse gases by burning fossil fuels, producing cement, cattle farming, clearing land, and other activities. Those emissions build up in the atmosphere and trap heat, warm the atmosphere, raise sea levels, disturb rainfall patterns, storm intensity, and increase the risk of sudden climate changes. Rising carbon dioxide concentrations also alter the chemical balance of the oceans, harming flora & fauna and other marine life. A carbon tax is a direct levy on emissions for covered entities, it can take the form of special taxes on specific goods and fuels, or it may be economy wide. Under a direct carbon tax, compliant entities must report their emissions on an annual basis and pay a tax for each ton emitted. In this paper, the study of necessity and pros-&-cons of carbon tax are discussed. Moreover, its effect on environment and economy of country is focused.*

Keywords: *Carbon tax, Emission, Excess Burden, Direct Levy, Climate Change*

1. INTRODUCTION

"Climate Change is the greatest market failure the world has ever seen". -The Stern Review: The Economics of Climate Change (2006)

On July 1, 2010, India introduced a nationwide carbon tax of 50 rupees per tonne ($1.07/t) of coal both produced and imported into India. In a budget speech in 2014, the finance Minister increased the price to 100 rupees per tonne ($1.60/t at $60.5 conversion) [3] In India coal is used to power more than half of the country's electricity generation.[2]

India's total coal production is estimated to reach 571.87 million tons in the year ending March 2010 and is expected to import around 100 million tons. The carbon tax expects to raise 25 billion rupees ($535 million) for the financial year 2010–2011. According to then Finance Minister, the clean energy tax will help to finance a National Clean Energy Fund (NCEF)[2] Industry bodies have not favored the levy and fear that the resultant higher price of coal could trigger inflation. [1]

While many remain apprehensive, a carbon tax is a step towards helping India meets their voluntary target to reduce the amount of carbon dioxide released per unit of gross domestic product by 25% from 2005 levels by 2020. Environment Minister told reporters in June 2010 that a domestic tax should come before a global carbon tax, and India has imposed one while others debate the issue. With the new government in India in 2014, the carbon tax has been further increased form 100 Rs per tonne to 200 Rs per tonne in the Budget 2015-16.[2][3] Currently the carbon tax stands at 400rs per tonne.

2. PROS

- Carbon Taxes may be used as a method to generate revenue for the public sector, and may be used to displace other taxes, such as corporate income tax or VAT.
- Carbon Taxes provide certainty for business community.
- Carbon Taxes are easy to implement and do not require complex financial infrastructure to function. [5]

3. CONS

- No guarantee of achieving emissions reduction goals.
- Taxes can be politically unpalatable.
- No mechanism to profit from "Over Compliance" with target goals.
- Many unduly impact key industries. [5]

4. TAXING CARBON DIOXIDE WHEN MONITORING EMISSIONS IS DIFFICULT

Most carbon emissions come from combustion of coal, oil, and natural gas. In principle, policymakers could require emitters to install monitoring equipment and then tax based on actual emissions. In practice, that would be prohibitively expensive except at the largest power plants. Because of the simple chemistry of combustion— an atom of carbon in fuel becomes a molecule of carbon dioxide—a close substitute is to tax the carbon content of fuel.

Like most analysts, we use "carbon tax" to mean a tax on carbon dioxide equivalents. As its name implies, carbon dioxide contains one atom of carbon (atomic weight 12) for every two of oxygen. A CO_2 molecule thus weighs about 3.7 (44/12) times as much as a carbon atom. No exact relationship exists for electricity because of differences in fuels and production efficiency.

5. ECONOMY

The Revenue Implications of Taxing Carbon Dioxide Emissions

Interest has been growing internationally and in the United States in taxing the carbon that is released into the atmosphere in the form of carbon dioxide when fossil fuels are burned. Advocates of a carbon tax in the United States cite two potential benefits from such a tax: It could serve as an important source of federal revenues, and it would reduce CO2 emissions by setting a price on carbon dioxide—the most prevalent of the greenhouse gases that trap heat in the Earth's atmosphere. Such a price would ensure that the costs of products and activities that involve CO2 emissions incorporate some of the potential costs of damage from climate change.

In 2014, Indian Government finalized the carbon tax as Rs. 100/- per tonne which has been further increased to Rs. 200/- per tonne in the Budget 2015-16[2][3] Currently the carbon tax stands at Rs. 400/- per tonne.

6. HOW WOULD A TAX AFFECT THE ECONOMY?

Taxes often distort economic incentives and reduce the value of economic activity. Taxes on goods and services, for example, can prompt consumers to work less or to substitute home production for market work. Taxes on income have the same effect, and can also cause people to save and invest less for the future. Taxes on specific goods and services cause consumers to replace them with less-taxed alternatives they would otherwise not prefer. And taxes on select production methods cause firms to substitute to less-efficient, untaxed methods to reduce their tax liability.

These efficiency costs—often known as excess burden because they are a burden on top of the taxes that people pay—are a real downside of most taxes.35 Policymakers should therefore take care to ensure that the benefits that flow from taxes—the goods, services, and income supports that the government provides—justify the direct cost and excess burden of taxation. Economists use a variety of models to estimate the efficiency cost of taxes (separate models are typically used to estimate the benefits that those revenues finance). Those models calculate the cost of taxation based on estimates or assumptions about the size of consumer responses to changes to prices, worker responses to their after-tax wages, saver responses to their after-tax return to saving, and business responses to the relative costs of productive inputs (capital, labor, and intermediate inputs, including fuels). Taxes on activities for which there are good substitutes in production or consumption impose larger efficiency costs per dollar raised than taxes on activities for which there are no close substitutes. This happens because households and businesses substantially reduce their participation in the taxed activity, so the burden is the forgone benefit of their preferred activity rather than the tax payments themselves. Taxes imposed on broad tax bases at lower rates typically impose less efficiency costs than taxes on narrower bases at higher rates. For this reason, economists have generally found that taxes that discriminate among goods or production methods impose larger efficiency costs than taxes on

broad measures of consumption or income. If one ignores their environmental benefits, carbon taxes generally fit into the former category, imposing three distortions: they distort the choice between work and leisure, just as all consumption and income taxes do; they raise the prices of selected goods and services, causing consumers to switch to less preferred options; and they raise production costs by causing producers to switch to more costly forms of energy or to use other more costly inputs. The second and third changes are, of course, the whole point of a carbon tax. The goal is for households to consume and firms to less intensively produce carbon. Those changes come at a cost, however, which is what the economic models attempt to quantify.

Scenario –

Thermal Power station of 500MW capacity may require 5000-5500 tonnes of coal per day. Calorific value of Indian coal ranges from 4000KCal/Kg to 4500KCal/Kg. Average constituent of Indian coal is – 40% Carbon, 30% Volatile and 30% Ash.

TMT bar manufacturing company with around 8 tonne furnace capacity may require 25 tonnes of coal per day.

According to September 2017 report, price of coal in market is hiked upto Rs. 36,000/- per tonne.

It means, Thermal power station has to pay 20lacs-22lacs per day and TMT manufacturing plant has to pay 10,000/- per day, carbon tax to government.

Before 2014 Rs/Tonne	2014-15	2015-16	Current
50/-	100/-	200/-	400/-

Table No. 01. Carbon Tax rates [8]

7. CLIMATE CHANGES

Prior to the Paris climate conference, countries submitted their proposed climate commitments, including specific targets for emissions reductions. So far, 187 countries— accounting for 97 percent of global greenhouse gas emissions—have submitted their climate pledges.4 These commitments can now be formally submitted as part of the Paris agreement.

United States: cut economy-wide emissions of greenhouse gas emissions by 26 to 28 percent below its 2005 level by 2025 and make best efforts to reduce its emissions by 28 percent.

India: reduce emissions intensity by 33 to 35 percent from 2005 levels by 2030, increase cumulative electric power installed capacity from non-fossil fuel energy resources to 40 percent by 2030, and create additional carbon sequestration of 2.5 to 3 billion tons of carbon dioxide equivalent by 2030.

8. WILL THESE ACTIONS ON CLIMATE CHANGE ACTUALLY BE IMPLEMENTED?

Since the 2009 Copenhagen Accord, nations have rolled up their sleeves and implemented domestic actions to move toward low-carbon economies, including renewable energy targets, cap-and-trade programs, and sector-specific policies. For example, more than 160 countries now have renewable energy targets and policies.5 China has just announced a new set of domestic actions including plans for a national cap-and-trade program, and climate policies have been adopted in the vast majority of the world's major economies. Countries have realized that it is in their own interest to cut their carbon pollution. They have concluded that, far from destroying the economy, domestic climate action produces real benefits for their citizens, including new jobs, reduced poverty, and lower mortality rates. And as natural disasters increase in frequency and intensity, they have seen that not addressing climate change has real and lasting consequences.

9. THE IMPACT OF CLIMATE CHANGE ON THE ECONOMY

Climate change has the potential to create a wide range of economic impacts. In all likelihood all sectors of the economy will be affected. Some impacts will gradually affect economic processes, such as the effect of increasing temperature on energy demand, whereas others may come as extreme events, such as sudden floods or forest fires. Impacts may be either negative or positive. For example, agriculture may become more productive or tourism may flourish in areas experiencing higher or lower temperatures. However, in a global level, the negative impacts will generally outweigh the economic benefits. Beside industry specific impacts, the economy as a whole may be at risk in certain areas due to an

increase in sea level and an increase in runoff by rivers. Coastal zones usually contain large human populations and a high concentration of economic activities. Flooding and extreme storm events may seriously disrupt economic activities and cause loss of produced capital. The same is true for areas adjacent to major river systems which may be subject to flooding when precipitation and overland flow increases.

Assessing the impact of climate change faces a fundamental challenge of complexity. The set of mechanisms through which climate may influence economic outcomes, positive or negative is extremely large and difficult to investigate. For example, a decrease in agricultural output or value added products may be induced by climate change. However, climate change is only one driver among many that will shape agriculture in future decades. Other factors, such as technological developments, socio-economic factors or other environmental issues could have a similar large impact. [5]

10. CONCLUSION

In addition the practical necessity of data collection and enforcement, it will be the duty of regulators to consider which segments of the economy have real opportunities to reduce emissions.

For example, electricity generators may find it difficult to achieve meaningful emissions reductions if low-carbon generation assets are not available. Thus any short-term emissions reductions will be generated through reducing demand or improving efficiency. One key goal of introducing emissions pricing is to generate demand for low carbon technologies, driving innovation and creating new industries. An additional consideration, related to reduction opportunities, is whether or not the technologies to achieve reductions can be sourced locally. If there is no local capacity to produce, install, and operate low carbon solutions the costs of compliance will be higher and the tax will cause capital will flow out of the country when low carbon goods are imported.

Carbon taxes can be targeted to support specific fuels and technologies, which regulators favor for use in their region. This support is not limited to investments made with collected revenues; although many regions choose do re-invest collected taxes into green projects. Both Finland and the United Kingdom, for example, mandate lower tax costs for combined heat and power (CHP) facilities. Sweden's carbon tax, on the other hand, has resulted in increased biomass use for heating and industry, because these fuels are considered renewable under their program.

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Review of Sustainable Energy Resources for Future

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Abstract - *Over the decades since independence,the generation of power has been dominated by the fossil fuel sources.But in the last few years,the most utilized fuels i..e coal,gas or oil,will sooner or later get exhausted.So ,This paper gives discussions, speculations & calculations about the sustainable energy sources i.e renewable energy sources.As renewable energy sources are available in nature as long as the earth lasts.There is a pressing need to accelerate the development of advanced clean energy technologies in order to address the global challenges of energy security,climate change & sustainable development.*

Keywords - *Renewable Energy, Energy Security, Climate change, Sustainable Development, Global Challenges.*

1. INTRODUCTION

We are presently facing an enormous challenge of Need of Sustainable energy.The economic growth in many countries makes progress in living conditions available to most of people than in the past.Therefore, the Generation capacity needs to increase drastically in coming years.But it can no longer be satisfied by the conventional means.The sky rocketing evolution of prices is basically linked to the fact that we are approaching the Ceiling of the conventional energy supply.

To achieve the goal of sustainable energy Renewable energies like wind power solar power biomass power, fuel cells are needed to focussed.

2. RENEWABLE ENERGY SOURCES

The oil crisis during the decade of 1970s forced the countries across the continents to search for alternative sources for energy generation.Taking into consideration the environmentally benign nature of renewable energy resources and lowering dependence on fossil fuels ,the governmentshave specified mandatory targets for enhancing share of renewable energy generation in the total electricity generation.Wind and Solar power are likely to be part of the solution to climate change.One of the major hindrances that is preventinglarge- scale deployment of wind and solar energy is the issue of intermittency.

A. WIND ENERGY

The flow of wind in our atmosphere is mainly caused by uneven heating of the earth surface by the sun.Thus,Wind energy is an indirect manifestation of the sun's energy.The wind energy has a good potential to be a source of renewable and pollution free power.

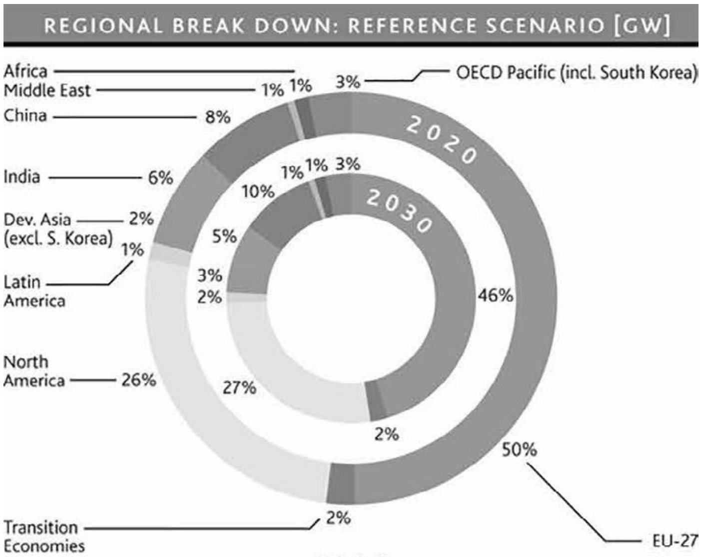
The annual wind energy installtions have grown at a rate of about 27.9% CAGR.LeadingThe Global Wind Energy Council released its biennial Global Wind Energy Outlook today, outlining scenarios where wind could reach 2110 GW and supply 20% of global electricity by 2030.It will create 2.4 million new jobs and reducing CO_2 emissions by more than 3.3 billion tonnes per year, and attract annual investment of about €200 billion. Trend in wind business is towards the offshore installations in seabeds with over 50 m depths,where the potential is higher with more reliable wind speeds.The impact from the offshore installations is such that with reliable wind speeds and higher annual energy generation,the cost/ kwh of electricity generated can lead to overall reductions in cost of wind energyaround the world.

Wind power generation capacity in India has significantly increased in recent years. As of the end of July 2017 the total installed wind power capacity was 32.56 GW, mainly spread across the South, West and North regions. By the end of 2015, India had the fourth largest installed wind power capacity in the world. The levelised tariff of wind power reached a record low of 3.46 (5.4¢ US) per kWh (without any direct or indirect subsidies) during auctions for wind projects in February 2017.

B. SOLAR ENERGY

After the wind power generation Solar energy is the second advanced generation across the globe.Withinsolar,it is the photovoltaic (PV) power generationthat has moved ahead of the concentrated PV solar thermal system (CST).

Solar energy, radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar energy technologies include solar heating, solar photovoltaics, concentrated solar power and solar



2020

EU-27	175 GW
Transition Economies	7 GW
North America	92 GW
Latin America	5 GW
Dev. Asia (excl. S. Korea)	7 GW
India	20 GW
China	27 GW
Middle East	2 GW
Africa	4 GW
OECD Pacific (incl. South Korea)	12 GW

2030

EU-27	224 GW
Transition Economies	11 GW
North America	132 GW
Latin America	8 GW
Dev. Asia (excl. S. Korea)	16 GW
India	27 GW
China	49 GW
Middle East	4 GW
Africa	7 GW
OECD Pacific (incl. South Korea)	16 GW

Fig.1. Regional Breakdown: Reference Scenario in GW
About 1% to 3% of the solar energy falling on earth surface
Gets converted into wind energy.

architecture, which can make considerable contributions to solving some of the most urgent problems the world now faces. The International Energy Agency projected that solar power could provide "a third of the global final energy demand after 2060, while CO2 emissions would be reduced to very low levels.Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic systems and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air. From 2012 to 2016 solar capacity tripled and now provides 1.3% of global energy.

C. BIOMASS ENERGY

Biomass based power generation uses agricultural residues as fuel for power generation either in boiler or gasifier. Chemically biomass refers to hydrocarbons containing hydrogen, carbon and oxygen. Weextraxct biomass from various sources such as plants,tress,agriculturalcrops,raw materials from forest,household waste and wood.Biomass is a renewable energy source because the growth of new plants and trees replenishes the supply.It is found I almost all regions of the world.It has been used extensively in the development of societies since the beginning of civilizations.

It is estimated that biomass contributes to about 14% of the worlds total energy requirement.Every year, about 55 million tonnes of municipal solid waste (MSW) and 38 billion litres of sewage are generated in the urban areas of India. In addition, large quantities of solid and liquid wastes are generated by industries. Waste generation in India is expected to increase rapidly in the future. As more people migrate to urban areas and as incomes increase, consumption levels are likely to rise, as are rates of waste generation. It is estimated that the amount of waste generated in India will increase at a per capita rate of approximately 1-1.33% annually. This has significant impacts on the amount of land that is and will be needed for disposal, economic costs of collecting and transporting waste, and the environmental consequences of increased MSW generation levels.

India has had a long involvement with anaerobic digestion and biogas technologies. Waste water treatment plants in the country have been established which produce renewable energy from sewage gas. However, there is still significant untapped potential. Also wastes from the distillery sector are on some sites converted into biogas to run in a gas engine to generate onsite power.

D. FUEL CELLS

Fuel cells is one of the new etrants in the clean energy space. There are large number of fuel cells based on different fuel sources.But the hydrogen is the ultimate fuel for these fuel cells,the base fuel like natural gas/methanol etc.are reformed to be fed into these cells.

Hydrogen can be used for power generation and also for transport applications. It is possible to use hydrogen in internal combustion (IC) engines, directly or mixed with diesel and compressed natural gas (CNG) or hydrogen can also be used directly as a fuel in fuel cells to produce electricity. Hydrogen energy is often mentioned as a potential solution for several challenges that the global energy system is facing. The advantages are the fact that hydrogen use results in nearly zero emissions at end-use, and that hydrogen opens up the possibility of decentralized production on the basis of a variety of fuels. But it is found that hydrogen will not play a major role in India without considerable research, technology innovations and cost reductions, mainly in fuel cell technology. This section provides inputs on the status of hydrogen energy in India.

The efficiency of these systems has reached about 60% in power generation and about 80% in cogeneration.In the Indian conditions,heat is not a standard requirement unlike Europe or US and hence the efficiency of power generatio needs to be built up further for best application. Challenges in fuel storage and availability are to be addressed and also the capital cost of the equipment.The costs of fuel cells today ,are in the rage of above US $2.5/watt and need to be reduced further to have a competitive cost of power.Power from fuel cells could be termed as clean as it may still be utilizing some hydrocarbon fuel and ot a renewable resource.

4. CONCLUSIONS

This study reviews that Renewable energy is the only option for generating Sustainable energy for future.Renwables will be available for longer time as compared to conventioal energy sources with less impact on environment .But there is need to develop new technologies which can be used to reduce cosntraintssuch as problem of intermittency and cost uneffectiveness.

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“Nature is inexhaustibly sustainable if we care for it.

It is our universal responsibility to pass a healthy earth on to future generations.”

... Sylvia Dolson

A Review on Green Energy: Mission 2022

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Abstract - *India is a country with more than 1.2 billion people accounting for more than 17% of world's population. In 2008, the fifth highest energy user in the world is India. Nevertheless, India as a country suffers from significant energy poverty and electricity deficits. A most of the Indian population does not have access to convenient energy services like LPG and electricity. In recent years energy consumption in India has been increasing at a relatively fast rate due to change in lifestyle with an economy projected to grow at 8-9% per year. This paper shows the recent scenario of the energy and the growing opportunities in establishing a new renewable industry in India. Current scenario, strategies, perspective and promotion of wind energy sources has also been summarized. In addition to this major achievements of renewable energy have also been described. An ambitious target of 175 GW installed capacity of renewable energy sources by 2022 has been put forth by the Government of India.*

Keywords - *Renewable energy; wind; solar; waste to energy; Small Hydro Power (SHP);*

1. INTRODUCTION

Now a days renewable energy sources are need of the time. With growing population and its needs, we are moving towards the world with full of pollution and less amount of conventional energy sources left for the future generations. As we know main problem with the conventional energy sources is that they are exhaustible and causing harm to the environment, although in terms of efficiency and availability conventional sources have the edge over the renewable energy sources. India is lagging behind in terms of renewable energy sources use. In India, the Ministry of New and Renewable Energy Sources is taking efforts for the development in use of renewable energy sources. India is having large potential of renewable energy sources, although all of it is not being consumed for the energy production. Main contributors of this renewable power are wind, solar and biomass and hydropower.

Ministry of New and Renewable Energy Sources has started making plans for the development of renewable energy sector with some big changes. The ministry has mission to grow electricity from renewables to massive value of 175 GW by the year 2022, which is at this time below 43 GW. This increase in renewable electricity includes solar power contributing 100 GW, wind power with 60 GW, also 10 GW and 5 GW from bio power and small hydro power respectively. Completing these ambitious targets would take India to the leading position in green energy production, leaving back many developed countries around the world. Getting 40% aggregate electric power from the renewable energy sources is Indian government's goal.

2. COMPARISON OF RENEWABLE ENERGY POTENTIAL IN INDIA VS. INSTALLED CAPACITY VS. FUTURE GOALS

When we talk about the potential of the renewable energy, India is the country which has very large potential of producing renewable power, while considering the grid connected and off grid power also. MNRE has set a target for India to achieve 175 GW power from the renewable energy sources. Table 1 gives the exact scenario of what is the potential in India of producing the renewable power, what is the current installed capacity of each type of renewable energy source and how much we need to develop renewable energy sector to achieve the goal by 2022. It has been observed that since 2009, installed capacity of wind power is increased from 683 MW to 27.44 GW, biomass power from 131 MW to 4.8 GW and waste to energy from 4.7 MW to 115 MW by July 2016, which is big leap from the previous achievements.

Table I. Comparison of Renewable Energy Potential Vs. Installed Capacity Vs. Target

Source	Estimated Potential (MW)	Installed Capacity (MW)	Target (MW)	Percentage achieved
Wind Power	102772	27441.15	60000	45.73
Small Hydro Power	19749	4304.27	5000	86.08
Solar Power	749000	8062.00	100000	8.062
Waste to Power	2556	115.08	10000	49.75
Biomass power	22538	4860.83		
Total	896615	44783.33	175000	25.59

As of April 2016

3. WIND POWER

Wind power is using the air flow to rotate the wind turbines connected with mechanical generators to produce the electricity. It is an alternative to use of the conventional energy sources. Conventional energy sources produce pollution, greenhouse gasses and are not renewable. Advantages of wind power are that it is renewable, widely distributed, clean, produces no greenhouse gasses and uses very little land. Wind power is the highest contributor to the total renewable power. It is also growing very rapidly with time.

Recently, India has produced 38,822 megawatts (MW) electricity from renewable energy sources with more than 24,000 MW based on wind energy system apart from the total renewable installed capacity. The wind energy sector is one of the growing sectors for power generation in various states of India. It is having huge potential to bridge the gap between generation and demand. The Government of India has a plan for installing wind energy capacity of 32,352 MW by 2017 and 60, 000 MW by 2022. The wind energy systems may not be technically adequate, at all places because of variable wind speeds. It has been observed that the environmental protection has been possible mainly by the reduction of carbon dioxide (CO2) and Nitrous oxide (NO). An effort has been made to find out the possibility of wind energy that can help perform to meet our energy needs and alleviate the greenhouse gas (GHG) emission. The overall installed capacity of power generation in India is divided into three sectors, namely state sector, central sector and private sector having their power installed capacity of 97.951GW, 74.807 GW, and 115.248 GW respectively.

The wind power development was started in 1986 with the first wind farm set up in coastal areas of Gujarat (Okha), Tamil Nadu (Tuticorin) and Maharashtra (Ratnagiri) with 55 kW turbines. This capacity is largely increased within few years during which India was the 4th largest in wind power installed capacity. According to National Institute of Wind Energy (NIWE) potential of wind resources in India is 302 GW at 100m Hub height. The total installed capacity of wind power in India is 27.441 GW as of July 2016. North, South and West are the main regions that provide the most power. In the year 2015 India overtaken Spain and became the 4th largest producer of wind power. As of March 2015, end, East and North regions have no grid. Wind power contributes nearly 8.6% of total installed power generation capacity in India. Table 2 gives the information about the state wise potential and installed capacity of wind power in India. From the table 1 it can be seen that wind power has to be increased by up to 55% to reach the target by 2022.

Table II. State-Wise Wind Power Potential and Installed Capacity (MW) In India

States	Potential (MW)	Installed Capacity (MW)
Andhra Pradesh	578	389.75
Chhattisgarh	1221	55.9
Gujarat	1333	52.3
Karnataka	1131	238.32
Madhya Pradesh	1044	737.28
Maharashtra	1364	36
Punjab	1887	112.78
Rajasthan	3172	140.50
Tamil Nadu	1039	111.3
Telangana	1070	662.3
Uttar Pradesh	1617	936.7
Total	15456	3473.13

4. WASTE TO ENERGY

- The energy received in form of heat or electricity from primary treatment of waste is known as Waste to energy. Most of the waste to energy processes produce electricity or heat by direct combustion of the waste materials or converting it to combustible fuel. Most common method of getting energy from the waste materials is incineration, which includes combustion of organic materials such as waste with some amount of energy recovery. There are various techniques available for converting waste to energy without direct combustion of waste. More amount of electricity is received by some procedures than the energy received by direct combustion, due to the separation of corrosive components from converted fuel which permits attaining the higher combustion temperatures.
- About 38 billion liters of sewage and 55 million tons of solid wastes are generated from urban areas in India every year. The large amount of liquid and solid wastes are generated from industries also adds up this, and is expected that this will increase rapidly in the future. In turn this will increase the power generated from the waste. By July 2016 the amount power generated from the waste to energy is very small of about 115 MW. Combining both waste to energy and biomass power India has target to reach to 10 GW by 2022.

5. SMALL HYDRO POWER

Small hydro is the generation from hydroelectric power on a small scale serving to a small community or industry. The capacity of the small varies from 1 to 20 MW. Small hydro is further divided into mini hydro with capacity of 100 to 1000 KW and micro hydro having capacity of 5 to 100 KW. Small hydro power plants can be built for the areas where it is not economical to provide the electricity from the grid. Since this type projects are small in size so they have minimal impact on the environment as compared to large hydro power plants which submerges large area. In 2013, the report by International Center on Small Hydro Power found that the world potential is around 173GW while the overall installed capacity of the world is 75 GW. If we consider the small hydro power in India, it is developing at faster rate. India has the potential of 20 GW power from the small hydro.

The installed capacity of small hydro power is 4.3 GW. Considering the target set by the MNRE to get 5GW from small hydro, India is almost 85% on the way of making it.

6. NEW TECHNOLOGIES IN RENEWABLE ENERGY SOURCES

A. HYDROGEN ENERGY

Hydrogen being a clean fuel and an energy carrier, it can be used for various applications. These applications of hydrogen energy will substitute the liquid and fossil fuels. As hydrogen fuel after the burning process gives only water as emission product. This makes the hydrogen energy a clean source. This often requires combustion or electrochemical cells for the power production, which is used to power the electrical devices and vehicles. Various research, development and demonstration projects are conducted by MNRE on different aspects of hydrogen energy with its production, storage and use of hydrogen as fuel for generation various energies such as electrical, mechanical and thermal. The application of hydrogen energy in fuel cells has been demonstrated already.

Pure hydrogen is not found naturally on earth in large quantities, it requires lot of energy to produce it. There are many ways of production of hydrogen such as electrolysis and steam-methane reforming process.

Large quantity of hydrogen is found in hydrocarbons, water and other organic matter. But it is a challenge to derive the hydrogen efficiently from these sources. Electrolysis of water can give hydrogen but this process is not energy efficient.

Hydrogen is also used as energy carrier or energy storing medium. Hydrogen fuel is being used as liquid propellant in rockets also it gives motive power. One more problem with hydrogen fuel is, it is difficult to store. It requires high pressure containers or cryogenic temperature.

B. CHEMICAL ENERGY

Chemical Energy is defined as the ability of chemical substance to undergo transformation through a chemical reaction and change to other chemical substances. This can also be used for electricity production. The examples of conversion of chemical energy to electrical energy is Fuel cells, which produces electricity through reaction of hydrogen with air or oxygen along with production of heat and water.

MNRE has developed a program named Chemical Sources of Energy Program. The development of various uses of fuel cell technology is the main objective of this program. Greater modularity, noise-less operation, compactness and conversion efficiency can be achieved by this fuel cell technology. These types of cells are environment friendly. Hydrogen is used as the primary fuel. Different types of other fuels also can be used in production of hydrogen gas using reformers. Because of the compact nature of the fuel cells, they are useful in decentralized power generation as well as in automotive application.

Phosphoric Acid Fuel Cells (PAFCs) and Polymer Electrolyte Membrane or Proton Exchange Membrane Fuel Cells (PEMFCs) prototypes in sizes of kW have been developed in India. These samples are demonstrated for power generation and transport sector along with their use in hybrid vehicles. Various developments are done to improve technology for production of fuel cell systems.

C. BATTERY OPERATED VEHICLES

Battery operated vehicles (BOV) are the type of electric vehicles that uses chemical energy stored in rechargeable batteries for their operation. BOV have motors installed in them instead of internal combustion engines and get power from the battery packs. Vehicles which use both battery power and internal combustion engine are considered as hybrid vehicles not BOV.

MNRE is promoting the development, research and demonstration projects in the field of battery operated vehicles.

BOVs in country, which doesn't harm the nature in any form. That's how India is concentrating on the power from battery operated vehicles.

D. GEO-THERMAL ENERGY

The thermal energy which is stored inside the earth is known as geo-thermal energy. This thermal energy can be used for the production of the electricity. Heat inside the earth is produced from radioactive decay and due to geothermal gradient, which is the difference in temperature between the core of the planet and its surface. Temperature near the core mantle boundary can reach over 4000°c. This much temperature and high pressure causes rock to melt and the solid mantle of the earth behaves plastically. This mantle transfers the heat upwards which causes the heating of the water near to it. There are two ways of using heat produced from the geothermal. Either steam generated under the earth surface can be directly used in turbines or the heat from the earth used to convert the water into steam and then to the turbines to produce the electricity.

Geothermal power is very reliable, cost-effective, sustainable and environment friendly in nature. Since last 25years MNRE is supporting research and development and expansion of the geothermal energy. MNRE has targeted to get about 1000 MW from the geothermal energy by 2022.Resource assessment is being planned for harnessing the potential of geothermal resources.

Downside of the geothermal energy is that it is sight specific. Some points are available very remotely and transmitting energy from that far is costly affair. Also, the capital cost of the geothermal is much higher compared to other renewable resources.

E. OCEAN ENERGY

Almost 70 percent of the earth's surface is covered by the water containing very large amount of energy in many forms such as wave, tidal, marine current and thermal gradient. Energy potential contained by seas and oceans is way more than our present energy needs. India already has long coastline where enough tides are available to rotate the turbine and in turn produce the energy. Various technologies for production of energy from ocean are currently under development. The movement of water present in the ocean produces large amount of kinetic energy, this energy also can be used for the production of electricity. Ocean energy mainly includes wave power i.e. power generated from the surface waves, tidal power which includes the power obtained from the kinetic energy which is produced by large bodies of moving water.

Ocean energy has very high amount of renewable energy potential. Ocean energy will also help India in reaching the 2022 target of 175GW from renewable energy sources.

F. BIO FUELS

Biofuel is a fuel which is produced from the various biological processes including agricultural and anaerobic digestion. While conventional fuels are produced from geological process which requires many years for the process.

These fuels can be derived from various materials such as plants, agricultural and domestic wastes. Renewable biofuels are derived from the conversion of biomass which is done in 3 distinctive methods. These involves chemical conversion, biochemical conversion and thermal conversion which will give the fuel in solid, liquid or gas form that may be directly used as biofuels thus playing a key role in meeting the country's energy demand. National policy on biofuels was announced in December 2009, having major goals of development and utilization of non-food.

7. RECENT INVESTMENTS IN WIND POWER SECTOR IN INDIA

Around 293 global and domestic companies have committed to generating 266 GW of solar, wind, mini hydro and biomass-based power in India over the next 5-10 years. Some major investments and developments in the Indian power sector are as follows:

- Sun Edison is the largest renewable energy company in the world which planned to continue its focus on 'Make in India' for further reducing the cost of solar energy and developing over 15 GW of the wind and solar projects in the country by 2022.
- Sterlite Grid is India largest private operator of transmission systems which is joining hands with United State major Burn & McDonnell for its Rs 3000 crore power transmission project in the Kashmir valley.
- Inox Wind Ltd is a subsidiary of Gujarat Fluor Chemicals which provides a wind energy solutions and plans to two-time increase it's invent capacity to 1,600 MW at a total investment of Rs 200 crore (US$ 31.6 million) by the end of the next financial year.
- Reliance Power Limited has signed a grant with the Government of Rajasthan for making 6,000 MW of solar power projects in the next 10 years.
- Hilliard Energy has planned to invest Rs 3,600 crore (US$ 600 million) in Ananthapur, Andhra Pradesh in the solar and wind power sector for the generation power of 650 MW.
- Sun Edison signed an agreement to acquire continuum wind energy, with assets in India. The company would take over 242 MW of wind power operating that continuum owns and operates in Maharashtra and Gujarat with 170 MW of assets under construction.

8. IMPACT OF POLICY AND VISION 2022

During the last many years the share of renewable energy has steadily increased due to the initiative taken by Government of India. It is estimated that total share of renewable energy will be 15.9% by 2022. In the larger perspective of grid power an innovative scheme is being tried in India called as tail-end grid.

So far the emphasis has been on large plants whether they are wind, solar, hydro or biomass. Locations for wind and hydro are fixed. However, for biomass the difficulties of ensuring collection and transportation of fuel are leading towards smaller plants. For solar PV, a total of 100 MW capacity is being set up with smaller plants of 100 KW to 2 MW, which are connected to grid through 11 kV feeders. It is expected that small plants would reduce the transmission losses by 5-7% with respect to large capacity plants of 50 - 100 MW size and improve both voltage and frequency at the tail end. The same approach is being planned for biomass based power plants of up to 2 MW capacity as the logistics of fuel management would become much more manageable and more environmentally friendly. It is envisaged that hundreds of such plants will be built in the next few years thus improving the transmission infrastructure.

9. CONCLUSION

The present energy scenario in India is not satisfactory. The power supply position prevailing in the country is characterized by persistent shortages and unreliability and also high prices for industrial consumers.

India, with its vast population and limited natural resources or meeting its energy requirements, needs to maintain its momentum of growth and this can be made possible only with a clear strategy for use of best possible energy options available.

India needs to have a strategy for meeting its energy needs by 2022. The broad vision behind energy policy must be to meet energy demands reliably with energy which is clean and affordable and this must be done in an environmentally sustainable manner using different forms of energy.

Increasing population of the world has to meet the increasing energy demands. Fulfillment of this energy cannot be done only by conventional energy sources. Renewable energy sources play a major role in energy fulfillment as well as the development of any country. It can be seen that India has enormous amount of potential in renewable energy sources. It is needed to use this potential in right way in order to achieve the energy demands. Ministry of New and Renewable Energy sources (MNRE) has already taken few steps towards the developing renewable energy sources and set up the target for year 2022. This will be achieved by utilizing the potential in wind, solar, biomass, small hydro and waste to energy power. Wind power is reached up to 50% near the target of getting 60 GW from it. While solar is only 8% on track of getting 100 GW. While small hydro power has almost reached the target of 5GW, and biomass is also half through to the target of getting 10 GW. If India is able to achieve this amount capacity in coming years, it will be in world leaders for renewable energy production.

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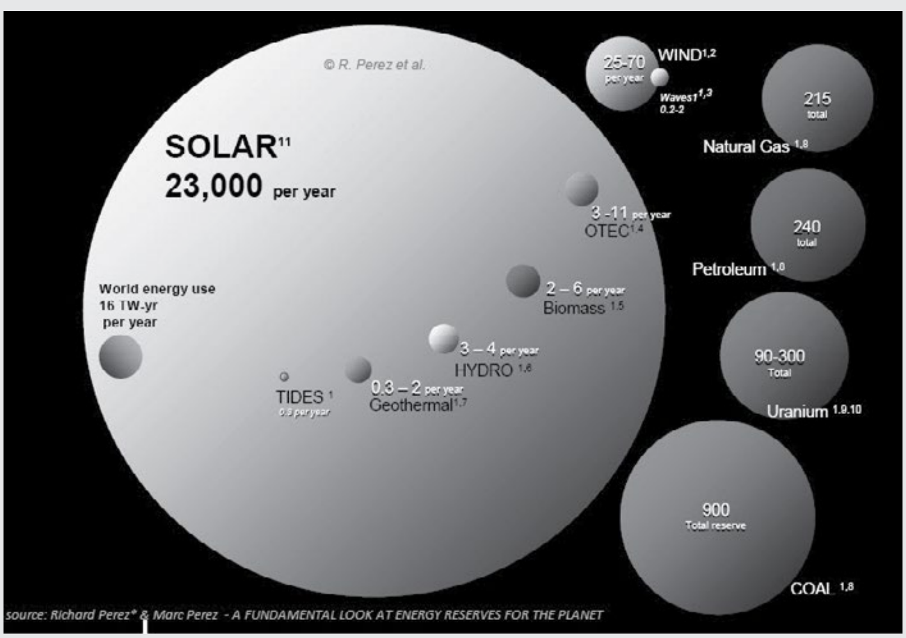
The use of solar energy offers huge potential for natural resource and climate protection, and for the expansion of renewable energies on the road to a future-oriented energy supply.



...MARGARETA WOLF

Net Metering –Evolution in Solar PV System

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Abstract

Solar energy is inexhaustible, available abundant in nature and free from pollution. The solar photovoltaic (PV) systems are a perfect solution for urban residential areas since the system is noiseless. The main problem with solar energy is its intermittency. In order to have reliable power, storage batteries are required in case of off-grid system thus it increases the overall cost of a system. In case of grid connected solar PV system the demand can be satisfied by using solar energy and the energy drawn from grid without using batteries. In this system, if the solar PV panel produces surplus power, then that has to be supplied to the grid and the exported surplus power must be accounted. The energy meter has to account for imported power from the grid to consumer system and the exported power from the consumer system to grid. This paper discussesdevelopment of bidirectional net meter in grid connected solar PV system that keeps track of the difference between the electricity imported from grid and the surplus energy or exported electricity to grid.

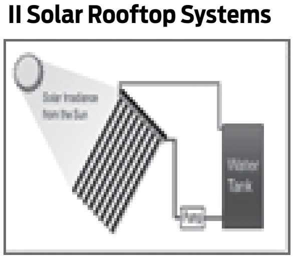
Key words: Solar PV roof top, Grid system, bidirectional meter

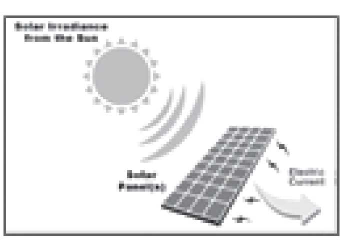
I Introduction

Solar PV generation – Need of the hour

Fossil fuel sources like coal, oil and gas are limited. Uses of these sources have huge socialand environmental implications (local as well as global. In last year India has imported coal worth ~ Rs. 73,000 Cr. So our national priority is to reduce use of fossil fuel and increase renewable energy (RE) generation. Our National target is to have 1, 75,000 MW generation of RE by yr 2022, of which 100 GW from Solar. Our Rooftop capacity target for solar rooftop is 40,000 MW, out of this inMaharashtra Rooftop capacity target is 4,700MW. 100 MW of solar rooftop in Pune avoided emission of 134,800 tons of CO_2/year. This rooftop results in saving of 116500 tons of coal& also saving of 500 acres of land which is required for coal mining and power station

II Solar Rooftop Systems





Use of rooftop system is Heat& Electricity as shown in diagram. Solar Rooftop PV system – key components areSolar Panels which converts sunrays into electricity & Inverter which aggregates generation from each panel and, converts to grid electricity (AC – grid voltage)

Types Rooftop Solar PV

- Grid Connected Solar System: It is without battery back-up. Excess electricity is fed back to grid. So cannot be used during power cuts
- Grid Interactive Solar System: Connected to the grid, but including battery backup. So Solar generation first charges battery and excess generation is sent to grid
- Off-Grid Solar System: Only charges battery, not connected to grid, can support small appliances.

III Net Metering

How Net Metering Works?

Consumers install solar PV and generate electricity. Generated electricity is fed back in to the MSEDCL grid. Electricity use of the consumer continues as usual. At the end of the month MSEDCL bills consumer only forNet electricity drawn by the consumer

▪ Example of net metering

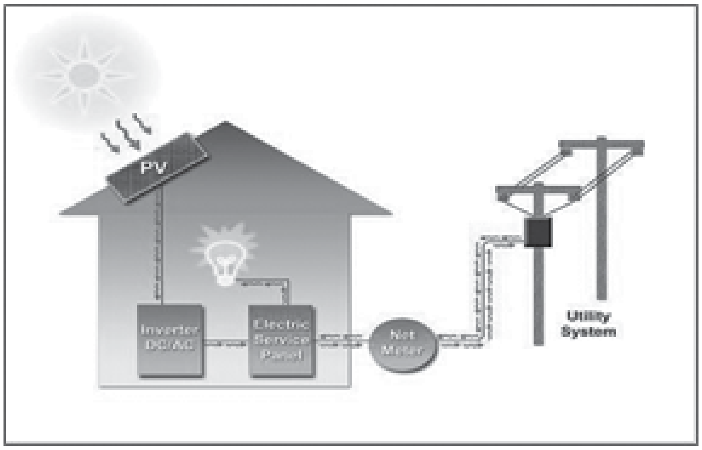
- Total Electricity consumption – 300 units
- Solar Electricity generated / sent to the grid - 200 units
- MSEDCL bill - 300 – 200 = 100 units

Net metering mechanism provides usages of a bidirectional meter which has facility to record both import and export energy values. Prime focus is on utilizing self-produced electricity by renewable energy sources and excess or surplus is sold to utilities or grid. It results into reduction of electricity bills. Solar photovoltaic system is used significantly in net metering.

Net energy metering (NEM) is a substitute for feed-in- tariff (FiT) for the encouragement and advancement of small scale distributed generation, especially in the residential sector. Currently, the applications of NEM are relatively confined but due to active role of many countries, it is gradually acquiring its foothold in the smart grid paradigm.

Advantages of Net Metering

NEM does not need a battery– saves cost (MSEDCL acts as battery!).



Solar generation on holidays etc. is not wasted, as it is fed back in to the grid and credit is given when it is used (MSEDCL acts as energy bank!)

Since electricity is generated and used locally it helps to reduce distribution losses. Small system size and investment allows even small consumers to take benefit of and participate in renewable energy generation

Net-Metering allows export of excess Solar Power to the Grid when the load is lower than generation and users get the benefit of exported units to offset imported units during the night when Solar Power is not available. They are designed to operate in Self-Consumption applications to reduce Electricity Bills by upto 90%. States like Karnataka have allowed End Users to install Rooftop Solar Plants at 1.5 times their sanctioned load and export excess Solar Power at Rs 7.08/ unit. But in other states, Users are allowed to offset their Monthly Electricity Consumption through Solar Power Generation hence limited to Self- Consumption applications. All Net-Metering Systems can be offered with or without battery backup. Sites with frequent power cuts but reliable grid supply must opt for Net-Metering with Backup Solution.

Economics and Operation

Area Required (shadow free – south facing) : 100 Sq. ft / kWGeneration : ~ 1350- 1450 kWh / kW / Year.

System Size	kWp	1	5	50
Generation	(kWh pa)	1,350 - 1,450	6,750 - 7,250	67,500 – 72,500
Area required	(sq. ft.)	100	500	5000
App. Cost per kW (Without Subsidy)	Rs. Lakhs	0.9 - 1.2	0.85 – 1	0.70 - 0.85

Table 1 Approximate cost/KW

Net metering will be allowed at different voltage levels. Table 2. showsconnecting voltages for various capacity ranges of
Rooftop

Table 2. Interconnection with respect to capacity range

Capacity Range	Connecting Voltage
Up to 10 kWp	240 V
10 to 15 kWp	240/415 V
15 to 50 kWp	415 V
50 to 100 kWp	415 V
> 100 kWp	11 kV

Cost Benefit

Cost of electricity generation using a Rooftop Solar PV system is Rs. 6.50 - 8.00 /kWh . Solar Costs fixed over lifetime, while Utility Tariffs are rising Energy Charges including Electricity Duty at 16% (does not incl. fixed costs)

LT Residential consumers above 100 units/ months	> 8.3 Rs/kWh
LT Commercial consumers above 500 units/month	>11.5Rs/kWh
LT Industrial consumer above 20 kW	> 8.1 Rs/kWh

Table 3 Cost of generation using Roof top solar PV

Why we should install a Rooftop Solar System?

We must contribute in saving environment while saving money .Go Green and save Money. Cost of power drawn from grid will keep increasing and solar will prevent your electricity bill from increasing. You can become partially or fully self-sufficient with regard to your electricity requirement. Low and easy operation and maintenance limited to cleaning of panels. Additional incentives – 30% subsidy from MNRE on capital cost of system (for residential and social sectors). Nodal agency. Commercial and Industrial Users can avail an accelerated depreciation on Solar Plants

Financing / Ownership Options

From MEDA - Fully Self-Financed and Owned or partly self-financed & partly from bank loan, from RBI provision to include Solar Rooftop PV systems as a part of their home loan by public sector banks .Priority Sector lending status as well. Third Party Ownership with no upfront capital investment from consumer. System leased to consumer. Third Party is responsible for O&M, performance.

(MERC) Net Metering Regulations - 2015 - Eligibility

Any consumer who wants to setup a Solar Rooftop Power Plant up to a maximum capacity of 1 MW is eligible. Maximum limit for Solar Rooftop System Size: Limited to sanctioned load. Additionally, voltage wise inter-connection limits as follows Singlephase : < 8 kW; Three phase : <150 kW;11kV:> 150 kW MSEDCL approval. The total capacity of solar plants connected to a distribution transformer (DT) should not exceed 40% of the DT Capacity. All approvals for connection to be provided on first come first serve basis. On approval for installation of system the consumer and MSEDCL will sign net metering agreement for 20 years.

System Installation Details

System can be installed on Roof or any Mounting Structure (Ground, Shed, Superstructures etc.) in consumer premises.

System maybe owned by consumer directly or by Third Party leasing such system. Excess generation in a month carried over to next month. Excessgeneration at the end of the year will be purchased by MSEDCL at the average power purchase price as approved by the commission. If a consumer is within the ambit of time of day tariff, the peak and off- peak generation is adjusted against respective consumption and excess generation in any time slot is adjusted in off peak slot

IV NM development

Thane Municipal Corporation (TMC) has installed a solar net metering (SNM) at its Vartaknagar office making it the first government body to adopt this system after the net metering policy, 2015 was passed in collaboration with MERC.

The solar panels installed on the roof top of the ward office building generate electricity. The generated power directly released into the power grid of MSEDCL and the meter will show the number of units generated. The person/agency can use the units generated by his roof top solar panel and if he uses extra units then he will be billed for that.These panels have 25 kilo watts capacity and will generate 100 units of electricity per day which is enough to take care of daily electricityneeds

After this, TMC installed 25 kilo watts SNM at its Majiwada, Manpada and Uthalsar ward offices.

Apart from companies, even individuals can install this system and generate their own electricity. For residences, one needs a 5 KW SNM plant which comes at a cost of around Rs1 to 1.5 lacs. Among private individuals, Bharitya Janata Party MLA Kirit Somaiya has installed this system at his residence in Mulund.

Solar Power Green Energy House.

This system has been configured to power an average Indian home which has an electricity bill of around Rs 1000 / month assuming 1 Kwh costs Rs 5....The 1000 W solar panels working between 9 am to 5 pm in 8 hours can capture 1000x8= 8 Kwh / day approx.

It consists of the following -

1) 1000 W of solar panels - approx 10 sq meter of area

2) 1 KW pure sinewave inverter - will first take the DC current from the solar panels and convert in into a 220V AC supply and give it directly to power your appliances. In case enough power from the sun is not available they start drawing power from the battery bank. When both power from solar panels and batteries is not available they start drawing power from the main grid line. They have an in built solar charge controller.

Optional Additional Investments –

1) MPPT Charge Controller - This (max power point tracker) charge controller makes the solar panels work at peak efficiency on the I-V curve This MPPT controller shows solar panel power output, energy generated and several other parameters....also allows wiring at 24V.... they help boost output by around 30% especially during cloudy days.... further they prevent battery overcharge, overdischarge and reverse flow from battery to solar panels during night hours.

2) 12V x 150 Ah battery x 4 pcs – We can use Tubular battery.

The solar panels can generate some 4-5 Kwh of energy everyday. Discharging batteries to only 30% depth of discharge level means a 4 x 3 = 12 Kwh battery bank will be needed. A 12V , 150 Ah battery stores 12x150 = 1800 Wh or 1.8 Kwh. Eight such batteries can store some 14.4 Kwh which should be enough. The lower the depth of discharge the longer the battery life.

3) Solar Tracker - They rotate the solar panels along with the sun and can boost output from solar panels by approx. 30% esp in summers.

Environmental Benefits –

1) Over its expected 35 year life the 1 KW solar panel system will provide equivalent CO_2 reduction as planting 145 trees !!Each KWh of electricity from a coal fired plant uses approx 1 Kg of coal, so this system saves burning of 8 Kgs of coal per day per home. In a year it reduces release of 2000 Kgs of Carbon dioxide.

2) Each kWh of electricity produced by Coal Fired electricity uses 2.5 litres of water. By installing a 1Kw Home Solar Panel System you will be saving the environment around 3,750 litres of water every year !!

Benefits To Human Beings –

India consumes more than 400 million tonnes of coal. Around 60-100 million tonnes is imported. The import bill for coal is thus likely to be between Rs 30,000 crocre - Rs 60,000 crocre. Coal mining in itself is a major environmental problem...There are around 7,50,000 official workers in mines registered with Directorate General for Mines Safety (DGMS), Dhanbad, India...of them around 190 workers die every year in mine accidents....many suffer from coal miner's pneumoconiosis.

A 500 MW coal fired plant serving 1,40,000 people costs Rs 2,000 crocre to build and burns 400,000 kgs of coal in 1 hour...this is fed with 3-5 train loads of coal per day...it uses 2.2 billion gallons of water per year which is enough for a city of 2,50,000 people...the process also releases 37 lakh tons (1 tonne = 1000 kgs) of CO2...10,000 tons of sulphur dioxide...10,200 tons of nitrogen dioxide... 1,25,000 tons of ash & 1,93,000 tons of sludge....30-40% of this electricity generated is lost in transmission....coal reserves may not last beyond 50-60 years.... electricity generated is sold at Rs 3.50 / Kwh (solar Rs 15/kwh) which should have been Rs 10 / kwh....India generates around 70,000 MW of electricity using coal... US, China & Australia also get around 70% of their electricity by burning mountains of coal...this is neither healthy nor sustainable..

On the contrary a 500 MW solar power plant would cost less than Rs 10,000 crore and needs nothing more than general cleaning of solar panels...

Conclusion:

The facilitation of net metering of the RTS PV system will provide a major boost to the promotion of this solar energy use by end consumer. Net metering will encourage the consumer to also become a generator and this distributed generation will help the country in long run. In July 2017, MERC has amended the Regulations & extended the scope for Net Metering to include all otherRenewable sources of less than 1 MW capacity at Consumer premises. So that small consumers can participate in the National Program of Renewable EnergyDevelopment. The Consumer will then in real sense be a Smart "Prosumer" (Producer & Consumer of Electricity). Such Proactive Regulations will help to fulfill the Govt of India's target of 175 GW of Renewable Generation by 2022.

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Study on the Properties of Castor (Ricinus communis) for the Production of Biodiesel

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Abstract - *Energy is the basic need for economic growth and it is vital to the sustenance of a Modern economy. Future economic growth crucially depends on the long-term availability of energy from different sources that are affordable, accessible anti environmental friendly. Biodiesel has become an alternative source of energy for future. There are various types of raw material like Jatropha curcus L, Pongamia Pinnata (Karanja), Castor (Ricinus communis), Moha, Undi, Saemuruba, Cotton seed and Hevca brasiliensis (Rubber) etc. Out of these Castor (Ricinus communis) can be a definite source of raw material due to its high content of oil content and contained 90% of fatty acids in castor oil are ricinoleic acid. Castor (Ricinus communis) is tropical crop and an annual crop can sustain arid conditions. After transesterification process of Castor oil shows excellent properties like calorific value, Kinematic viscosity, Flash point, Fire point and acid value etc. Detail study intends to identify all advantages and disadvantages of Castor (Ricinus communis) as a sustainable feedstock for the production of Biodiesel equivalent to fossil fuel as per ASTM 6751.*

Keywords - *Castor (Ricinus communis), Transesterification, Biodiesel, Fuel properties.*

1. INTRODUCTION

Energy is the prime mover of economic growth and is vital to the sustenance of a modern economy. Future economic growth crucially depends on the long-term availability of energy from difference sources that are affordable, accessible and environmentally friendly. Use of vegetable oil in diesel engine is not a radically new concept as the inventor of diesel engine “Rudolf Diesel” demonstrated his first diesel engine at the World Exhibition at Paris in 1900 AD by using peanut oil as fuel. Vegetable oil (m)ethyl esters, commonly referred to as ‘‘biodiesel,’’ are prominent options as alternative diesel fuels[1]. Biodiesel is methyl or ethyl ester of fatty acid made from virgin or used vegetable oils (both edible & non-edible) and animal fats. The main commodity sources for biodiesel in India can be non-edible oils obtained from plant species such as Jatropha Curcas (Ratanjyot), Pongamia Pinnata (Karanj) and Hevca brasiliensis (Rubber) etc. The majority of the methyl esters produced are done by the base catalyst transesterification of the oil with methanol, as it is the most economical, requires low temperature, high conversion with minimum side reactions and less reaction time [2]. Biodiesel can be blended at any level with petroleum diesel to create a biodiesel blend or can be used in its pure form. Biodiesel operates in CI (compression ignition) engine, which essentially require very little or no engine modifications as biodiesel has similar properties to petroleum diesel fuels. The use of biodiesel in conventional diesel engines results in substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matters. Biodiesel is considered as clean fuel since it has almost no sulphur, no aromatics and has about 10 per cent built-in oxygen, which helps it to burn fully. Its higher cetane number improves the ignition quality even when blended in the petroleum diesel [3].

2. WHY CASTOR (Ricinus communis)?

India is the world leader in castor seed and oil production and dominates the international castor oil trade. Varied opinions are held regarding the exact land of origin of the castor plant. Some workers view that though castor is cultivated throughout India, yet it is indigenous to Africa. The worldwide area under cultivation, production and yield of castor beans is presented in Table-1 and Table-2 present the above said in Indian context.

A. Castor plant (Ricinus communis)

The castor oil plant (Ricinus communis) is a species of flowering plant in the spurge family, Euphorbiaceae. The Indian variety of castor has 48 per cent oil content of which 42 per cent can be extracted, while the cake retains the rest. The oil itself contains a number of fatty acids similar to those in cooking oils, such as oleic acid, linoleic acid, stearic

Castor Tree **Castor Fruit** **Castor Seed**

Fig. 1: Castor Tree, Fruit and Seed

acid and palmitic acid. India's castor production fluctuates between 0.6 to 1 million tonnes a year. The state of Gujarat accounts for over 80% of India's castor seed production, followed by Andhra Pradesh and Rajasthan. Castor is a Kharif crop sown in July to October and the harvesting season is from October to April [4]. India's annually exports is around quarter million tons of commercial castor oil, 1,50,000 tons of castor seed extractions (castor meal), and about 20,000 tons of castor seed [5]. Figure 1 shows Castor tree, fruits and seed of castor (Ricinus communis). There is a large scope for improving India's earning from castor by converting the castor oil to various derivatives.

Castor oil has an unusual composition and chemistry, which makes it quite valuable. Ninety percent of fatty acids in castor oil are ricinoleic acid. Ricinoleic acid, a monounsaturated, 18-carbon fatty acid, has a hydroxyl functional group at the twelfth carbon, a very uncommon property for a biological fatty acid. Castor oil also contains 3-4% of both oleic and linoleic acids. Castor oil maintains its fluidity at both extremely high and low temperatures. An average composition of castor seed oil is presented in Table 3.

B. Castor in Food and preservative

In the food industry, castor oil (food grade) is used in food

Table 1 : World Area, Production and Productivity of Castor Beans During 2005

Country	Area in ha	Production in tonnes Tonnes	Yield in kg ha^{-1}
World	1,409,79	1,393,812	988
Angola	13,500	3,500	259
Brazil	214,751	176,743	823
China	270,000	268,000	993
India	800,000	870,000	1087
Thailand	13,500	10,000	741

Table 2: Area, Production and Yield of Castor In India (2002 - 03)

State	Area in ha.	Production in tonnes Tonnes	Yield in (kg ha^{-1})
Andhra Pradesh	227	85	380
Gujarat	242	283	1170
Karnataka	17	14	820
Bihar	5	3	600
Tamilnadu	19	6	310
Maharashtra	30	7	230
All India	585	428	730

Fatty acid	Composition (per cent)
Ricinoleate Ricinoleic acid	85 to 95
Oleate Oleic acid	6 to 2
Linoleate Linoleic acid	5 to 1
Linolenate Linolenic acid	1 to 0.5
Stearate Stearic acid	1 to 0.5
Palmitate Palmitic acid	1 to 0.5
Dihydroxystearic acid, Dihydroxyoctadecanoic acid	0.5 to 0.3
Trace amounts (other) fatty acids	0.5 to 0.2

additives, flavorings, candy, as a mold inhibitor, and in packaging. Polyoxyethylated castor oil is also used in the food industries.

C. Medicinal Use of Castor Oil

Today, the United States Food and Drug Administration (FDA) recognizes Castor oil as generally safe and effective (GRASE) for over-the-counter use as a laxative, but it is not a preferred drug to treat constipation. Besides being a laxative, Castor oil is used throughout the world to help women start labor. One of Castor oil's derivatives undecylenic acid is also FDA approved for over-the-counter use on skin disorders or skin problems. Pure cold pressed Castor oil has a bland (neutral) taste with no discernable flavor. When additives are added to pure cold pressed Castor oil, the oil becomes adulterated and can taste bad. Also, pure cold pressed Castor oil is potent and can be an eye irritant similar to pepper spray, so avoid contact with eyes. Ricinoleic acid is the main component of Castor oil and it exerts anti-inflammatory effects. A study found that castor oil decreased pain more than ultrasound gel or vaseline during extracorporeal shock wave application.

D. Industrial Castor Oil

Today, chemical engineers have come up with many uses of castor oil and its derivatives such as: Polyamide 11 (Nylon 11) engineering plastic, lubricating grease, coatings, inks, sealant, aircraft lubricants, surfactants, emulsifiers, encapsulants, plastic films, plasticizer for coatings, and components for shatterproof safety glass. The castor oil and its derivatives have become an important commodity to the chemical industry.

3. MATERIAL AND METHODS

A. Castor Oil

A colorless or pale yellowish Castor oil: Fresh and filtered moisture free castor oil was used.

B. Alcohol

Anhydrous methanol (pure CH_3OH) with percentage purity of 99 per cent was used in the transesterification reaction to prepare biodiesel form castor oil in order to prevent saponification.

C. Catalyst

The alcoholic solution of analytical grade (AR) potassium hydroxide

(KOH) percentage purity 85 per sent was used as catalyst in the reaction. Since it is not generally 99-100 per sent pure, the quality should be calculated accordingly. Good quality catalyst should be used to get good yield of biodiesel.

D. Esterification of Castor Seed Oil and Biodiesel Characterization

Castor oil was converted into biodiesel through the alkaline transesterification reaction for which potassium hydroxide was used as catalyst with methanol. Two percent of the potassium hydroxide catalyst was dissolved in methanol (30% by weight) and mixture was added to the castor seed oil. Then the prepared mixture was stirred at 60°C for 30 min. Thereafter the reactant material was poured into transparent vessel and allowed for cooling at room temperature for 6–8 h. It was allowed to settle for separation of glycerol as bottom layer.

The upper layer of biodiesel was put into another transparent vessel for washing with equal amount of water. The biodiesel was heated up to 110°C for 10 min to remove excess water. Then biodiesel was cooled down to room temperature before use, presenting a 94% yield.

Transesterification, which is also called alcoholysis, is a process of substitution of the radical of an ester by the radical of one alcohol. Like hydrolysis, except for the fact of using an alcohol instead of water. The transesterification reaction is represented by the general equation [6].

RCOOR" + R"OH ↔ RCOOR" + R'OH

The important properties of transesterified oil were evaluated for comparison with standard. These are given in Table 4. The presence of a bigger content of hydroxylacid in the castor oil is reflected in its coligative properties, such as high values viscosity and density [7]. Density of the fuel was found using density bottle, kinematic Viscosity of the oil was determined with the help of Redwood Viscometer No. 1 and flash point was obtained from electrically heated Pensky-Martens apparatus as per the standard test procedure of Bureau of Indian Standards (IS: 1448–1970). The gross calorific value of the castor oil, castor methyl ester and diesel were determined with the help of Bomb Calorimeter (IS: 1359–1959). The prepared castor methyl ester (CME) was mixed with diesel in three different blends i.e. B5, B10 and B20.

Table 4: Fuel Properties of Plant Oil & Their Biodiesel in Comparison with Diesel

Properties	Castor oil	Castor methyl ester	Diesel
Density, g/ml	0.96	0.913	0.849
Kinematic viscosity, cS@ 380C	226.82	10.50	5.80
Gross calorific value, MJ/ kg	36.20	39.16	47.4
Flash point, °C	317	149	47
Fire point, °C	324	158	68
Acid value, mg KOH/g	1.642	1.008	0.00
Free fatty acid content, %	2.8	1.86	0.00

4. RESULTS AND DISCUSSION

Biodiesel properties:

The important fuel properties of castor seed oil and its methyl ester were measured and compared with that of diesel (Table 4). The presence of a bigger content of hydroxyacid in the castor oil is reflected in its coligative properties, such as high values of viscosity and density [8]. It is observed that the density of castor oil (0.96 g/ml) and its methyl ester (0.913 g/ml) is quite close to that of diesel (0.830 g/ml). The density of castor methyl ester is 1.1 times that of diesel, whereas density of castor oil is 1.15 times of diesel.

The kinematic viscosity of castor oil is higher than diesel. Kinematic viscosity of castor oil is 226.82 cS 'at' 38°C. Kinematic viscosity of castor oil methyl ester is 8.50 cS 'at' 38°C, which is 1.4 times that of diesel. Hence, kinematic viscosity of castor methyl ester is quite comparable with the diesel. It is clear from Table 4 that oil had lower gross calorific value compared to that of diesel. The gross calorific value of castor methyl ester (43.16 MJ kg-1) and castor oil (36.20 MJ kg-1) is quite low as compared to that of diesel (46.22 MJ kg-1). The flash point of castor methyl ester is lower than that of its oil. The flash point of castor oil is 317°C, whilst the flash point of castor methyl ester is 129°C, which is much higher than that of the diesel (47°C). The higher flash point of methyl ester is attributed to longer carbon chain. The acid value of castor oil is higher (1.64%). On esterification, the acid value reduces drastically to 1.01%, which is 0% in the case of diesel. At elevated temperatures, fatty acids react with metal parts and fatty acid metal can be introduced into the engine cylinder and can increase wear. The per cent of free fatty acid in castor oil is 1.642 which is not so high, which could interfere with conversion and recovery of methyl ester. On esterification, the values of FFA reduce slightly and FFA of castor oil methyl ester is 1.44%. The value of free fatty acid content of diesel oil is zero. The yield of castor methyl ester was about 95.8%.

5. CONCLUSIONS

The major fatty acids in Castor (Ricinus communis) crude oil were ricinoleic acid, Linoleic acid, Oleic acid, Estearic acid and Palmitic acid observed. The castor oil exhibited good physic chemical properties and could be used as a biodiesel feedstock and industrial application. The transesterfication process of castor oil is carried with alkaline catalyst, and it produces 95.8% yield. It does not contain sulphur and has greater cetane number, which indicated better quality of ignition, and has more oxygen, making its combustion more efficient [9]. In Indian context, castor oil biodiesel has a great potential to be used in large scale as fuel for compression ignition engine. Biodiesel can be an attractive transportation fuel for use in environmentally sensitive applications due to its biodegradable nature, and offers promise to reduce particulate and toxic emission.

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Solar PV Cooling - A Review of Technologies

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Abstract : *One of the main obstacles that face the operation of photovoltaic panels (PV) is overheating due to excessive solar radiation and high ambient temperatures. The efficiency of photovoltaic panels decreases as the panels' temperature increases, which results in deduction of electricity generation.Although the overall efficiency of PV cells ranges from about 5 % - 20 %, it is still higher than the total indirect efficiency when it comes to wind and biomass efficiency. However, it has been shown that theoverall efficiency of photovoltaic cells drops drastically with an increase in temperature. Therate of decrease ranges from 0.25 % to 0.5 % per degree Celsius, depending on the cell material used. Especially for concentrated PV cells, which use concentrated sunlight toproduce larger amounts of power, and reduce the cost of generally expensive PV equipment, it has been observed that high temperatures greatly decrease the working life of the whole system. Therefore, reducing the operating temperature of photovoltaic cells is important for the PV panel to work efficiently and protect cells from irreversible damage. In order to reduce this effect, different cooling methods were proposed and investigated.*

This paper deals withvarious active and passive coolingmethods forSolar PV panels and the effect of cooling on operating temperature, power, efficiency .This paper also explain cost effective cooling method which can be used for domestic applications

Key words – *solar panel heating, need of cooling, various technologies, Phase changes Materials (PCMs), Hybrid Photovoltaic/Thermal (PV/T) solar system.*

1. Over heating effect on PV efficiency

PV cells absorb up to 80% of the incident solar radiation, however only small part of the absorbed incident energy is converted into electricity depending on the conversion efficiency of the PV cell technology used. The remainder energy is dissipated as heat and the PV module can reach temperatures as high as 40°C above ambient. This is due the fact that PV cells convert a certain wavelength of the incoming irradiation that contributes to the direct conversion of light into electricity, while the rest is dissipated as heat. The limited efficiency is associated with the band-gap energy of the semiconductor material.

For crystalline silicon PV cells, a drop in the electrical power output of about 0.2-0.5% was reported for every 1°C rise in the PV module temperature principally due to the temperature dependence of the open-circuit voltage of the cell depending on the PV technology. Such property of

PV cells are known as the Temperature Coefficient of the PV cell. The operating temperature is one of the important factors that can affect the efficiency of the PV panels. The effects of temperature on photovoltaic efficiency can attribute to the influences on the current and voltage of the PV panels. This can be easily found on the I-V curve of the panels shown Fig 1 (a).

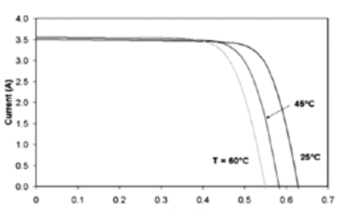

Fig 1. (a)

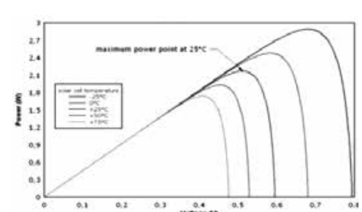

Fig 1. (b)

The P–V characteristic is the relation between the electrical power output P of the solar cell and the output voltage V, while the solar irradiance E and module temperature Tm are kept constant. The maximum power output from the solar cells decreases as the cell temperature increases, as can be seen in Fig.1(b). This indicates that heating of the PV panels can affect the output of the panels significantly.

The influence of PV panel temperature over output parameters

2. Cooling techniques for PV panel:

It has been observed that high temperatures greatly decrease the working life of the whole PV system. Cooling mechanisms and the development of cooling techniques continues. It has been shown that a sizable amount of power can be gained, up to a total of 5 %, by utilization of a cooling system. Nevertheless, a large amount of irradiated energy (up to 87 %) converts into heat. More recent developments have been concentrated on harnessing that waste heat into useful thermal energy. Various methods can be employed to achieve cooling of PV systems such as liquid based, Air-based, heat pipe-based, PCM-based. However, the optimum cooling solution is critically dependent on several factors such as, PV technology employed, types of concentrators geometries and weather conditions at which the system is installed.

2.1. Types of Cooling

The two types of cooling distinguished are:

1. Passive cooling 2. Active cooling

Passive cooling mechanisms refer to technologies used to extract and/or minimize heat absorption from/of the PV panel without additional power consumption. The mechanism implies transporting heat from where it is generated and dissipating it to the environment .Wide varieties of passive cooling options are available, simplest forms involve application of solids of high thermal conductivity metals, such as aluminium and copper, or an array of fins or other extruded surfaces to enhance heat transfer to the ambient . More complex systems involve the use of phase changematerials (PCMs) and various methods for natural circulation, in addition to the use ofheat pipes that are able to transfer heat efficiently through a boiling-condensing process.

Active cooling systems comprise of heat extraction utilizing devices such as fans to force air or pump water to the panels to extract away the heat .These systems are powered using energy to affect some kind of heat transfer usually by convection and conduction. Although an active system consumes power, they are commonly used in situations where the added efficiency to the panels is greater than the energy demanded to power the system, examples include solar power plants in deserts. These systems may also be used in situations where some additional benefit can be achieved, such as waste heat recovery for domestic water heating. For both passive and active cooling systems, the commonly used cooling mediums are air and water. However, the thermal properties of air make it less efficient as a coolant medium. Therefore, air cooling is not well suited to the extraction of thermal energy from the PV absorber at hot regions. Water cooling on the other hand, permits operation at much higher temperature levels and allows waste heat recovery to be employed more efficiently. Hence, air cooling is less favourable option in much case.

3. Various Cooling Methods:

3.1 Air-Based Photovoltaic cooling System:

The use of forced air enhances heat extraction resulting in further improved performance of air photovoltaic systems when compared with naturally ventilated ones. Several design concepts have been illustrated by researchers with respect to air flow patterns in addition to presence of front glazing to achieve optimum performance of PV modules. However, due to low density and small heat capacity of air, improvements in the practical performance of air-based photovoltaic collectors are limited, making air less favourable option.

3.2. Liquid-Based Photovoltaic cooling System :

At high operating temperature conditions, air cooling fails to accommodate the temperature rise at the surface of PV cells causing critical drop in their conversion efficiency. Liquid cooling offers a better alternative to air cooling utilizing coolant as heat extraction medium to maintain desired operating temperature of PV cells and a more efficient utilization of thermal energy captured. Liquid-based PV collectors are superior to air-based ones due to higher specific heat capacity of coolants employed leading to further improved overall performance. In addition liquid-based PV collectors offer less temperature fluctuations compared to air-based PV making them more favourable. Liquid-based PV collector uses two types of liquid viz. system utilizing water and system utilizing liquid refrigerants as heat extraction fluids.

3.3 Phase change material cooling, (PCM.)

A phase change material (PCM) is a substance with a high heat of fusion which, melting and solidifying at a certain temperature, is capable of storing and releasing large amounts of energy. Heat is absorbed or released when the material changes from solid to liquid and vice versa; thus, PCMs are classified as latent heat storage (LHS) units. Latent heat storage using PCMs is superior to sensible heat storage due to their higher energy storage density within a smaller temperature range. These materials are classified as organics consisting of paraffin wax, and fatty acids, inorganic consisting of salt hydrates, and eutectic mixtures of organic and inorganic PCMs.

Latent heatstorage can be achieved through

liquid–>solid, solid–>liquid, solid–>gas and liquid–>gas phase changes. However, only solid–>liquid and liquid–>solid phase changes are practical for PCMs. Although liquid–gas transitions have a higher heat of transformation than solid–liquid transitions, liquid->gas phase changes are impractical for thermal storage because large volumes or high pressures are required to store the materials in their gas phase. Solid–solid phase changes are typically very slow and have a relatively low heat of transformation.

Solid–liquid PCMs: Initially they behave like sensible heat storage (SHS) materials; their temperature rises as they absorb heat. Unlike conventional SHS materials, however, when PCMs reach the temperature at which they change phase (their melting temperature) they absorb large amounts of heat at an almost constant temperature. The PCM continues to absorb heat without a significant rise in temperature until all the material is transformed to the liquid phase. When the ambient temperature around a liquid material falls, the PCM solidifies, releasing its stored latent heat. A large number of PCMs are available in any required temperature range from −5 up to 190 °C.

Within the human comfort range between 20–30 °C, some PCMs are very effective. They store 5 to 14 times more heat per unit volume than conventional storage materials such as water, masonry or rock.

Solid-Solid PCM Materials

Although this can't be viewed as cooling in the strict sense, it has the result of maintaining thesame temperature. It can still be counted as a passive technique mainly because of the fact thatno additional work is needed to take away the heat - it is dissipated mostly conductively. With the right type of PCM material, a decrease of 15 °Crelative to reference PV cell can be achieved, for a period of 5 hours, at insolation of1000 W/m2. PV modules with nominal power of 65W were used, with 50 mm of PCMmaterial from the back, with vertical aluminium fins to enhance conduction. The power gainwas higher by 9.7 % than that from a reference PV module.

3.4. Heat Pipe-Based Photovoltaic cooling System

Heat pipe cooling is combination of phase change cooling together with convection ofcooling medium. On one side, cooling medium evaporates and expands (or rises, depending ofthe variant) taking up heat. On the other side, medium condensates and releases the heat intothe surrounding. The medium travels back as liquid via capillary tubes and evaporates, thuscompleting the cycle.

Heat pipes provide an ideal solution for heat removal and transmission, with one end serving as a thermal energy collector and the other end as a thermal energy dissipater. Heat pipes have been considered for thermal management applications of PV technology due to the advantagessuch technology provide over other cooling means such as aiding uniform temperature distribution of PV cells.

Tang et al. used heat pipe system shown in Fig. 2 to cool down a PV panel of 0.0625 m2. Absolute increase in efficiency was measured. The increase in efficiency was 2.6 % and decrease in temperature was by 4.7 °C,athighest illumination. Maximum increase in power yield was 8.4%. The size of heat pipe mustbe taken into account for this case. Heat pipe size is approximately the same as the size of thecell

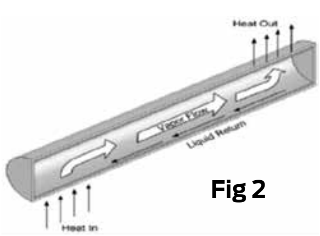

Fig 2

3.5. Cooling Technique by Water Spraying

This method is to cool the PV panels using the least amount of water and energy. A non-pressurized cooling system has been developed based on spraying the PV panels by water once in a while.An experimental setup was developed to study the effect of cooling by water on the performance of photovoltaic (PV) panels of a PV power plant which is installed in the German University in Cairo (GUC) in Egypt shown in Fig. 3.

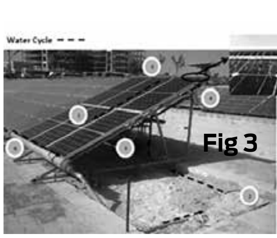

Fig 3

This cooling system consists of six main parts as follows:

1. Six PV modules of 185 W peak-output each.
2. Aluminium water tank of 0.3 m3 capacity.
3. Centrifugal pump of 1 hp input power.
4. One stage industrial transparent water filter.
5. 120 water nozzles for spraying water over the panels.
6. Drain pipe for collecting the water and return it back to the tank.

The water pump sucks the water from the middle of the water tank via a suction pipe to avoid sucking any dust. The suction pipe consists of a non-return valve and a strainer to avoid sucking of large particles that could damage the water pump. The sucked water passes through the water filter, and then, it is sprayed over the PV modules for cooling. Water is sprayed using water nozzles, which are installed at the upper side of the modules, as shown in Fig.3. Afterward, the water used for cooling is collected at the lower part of the PV modules via a drain pipe, and then, it returns back to the water tank such that the water cycle is closed.

This design is employed to minimize the consumption of water which is crucial in desert regions. The water tank is buried in the ground to avoid heating by solar radiation and also to cool the water inside the tank by the surrounding ground. The hot water coming from the PV panels is cooled due to mixing with the large amount of cold water inside the tank, i.e., 250 kg of water, and the surrounding ground, and therefore, the temperature of the cooling water was assumed to be constant at 25 °C.

The PV panels yields the highest output energy if cooling of the panels starts when the temperature of the PV panels reaches the maximum allowable temperature (MAT), i.e., 45 °C. The MAT is a compromise temperature between the output energy from the PV panels and the energy needed for cooling.

3.6 Hybrid Photovoltaic/Thermal (PV/T) solar system

Hybrid Photovoltaic/Thermal (PV/T) solar system is one of the most popular methods for cooling the photovoltaic panels now a day. The hybrid system consists of a solar photovoltaic panels combined with a cooling system. The cooling agent i.e. water or air is circulated around the PV panels for cooling the solar cells, such that the warmwater or air leaving the panels may be used for domestic applications such as domestic heating.

Dubey and Tiwari designed an integrated combined system of a photovoltaic (PV) panel with a thermal (T) solar water heater. The hybrid PV/T solar system has been designed and tested in outdoor condition of New Delhi. They measured the efficiency of the solar PV panels under three different cases, namely Case A – the absorber of the solar collector is fully covered by the PV module, Case B – the absorber is 50% covered by the PV module, and Case C – the absorber is partially covered by PV module, i.e., 30%. Dubey and Tiwari found that there is a significant increase in the instantaneous efficiency of the solar collector from 33% to 64% as we go from Case A to Case C, simultaneously. The increase in the efficiency is due to increase in glazing area.

3.7 Nanofluids cooling:

Nanofluids are considered to be dispersed mixtures of cooling fluid and solid nano particles. Most of the particles used are metal oxides, for example Al2O3 or CuO particles. Weight percentage of dispersed particles is around 0.1-2.0 %. The particles haveBrownian motion through cooling fluid. Main advantages of Nano fluids are greater thermalconductivity (therefore connectivity) and somewhat greater heat capacity Maindisadvantage is pumping process and overall change in flow regime, i.e. characteristicturbulent flow occurs at different speeds and geometries, when compared with regular fluids.

3.8. Solar cells cooling by transparent coating

After a full day in the sun, solar cells in California can approach temperatures of 80° C (175° F), even in winter months. Excessive heat can pose problems because, while the cells need sunlight to harvest energy, they also lose efficiency as they heat up. A standard silicon cell, for example, will drop from 20 to 19 percent efficiency by heating up just 10° C (18° F) or so.

Fig 4

A transparent silicon coating that radiates heat into space can help solar cells maintain high levels of efficiency throughout the day. Stanford engineers have developed a transparent silicon overlay. that can increase the efficiency of solar cells by keeping them cool. The cover collects and then radiates heat directly into space, without interfering with incoming photons. If mass-produced, the development could be used to cool down any device in the open air – for instance, to complement air conditioningin cars.

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3.9 Passive Occupied Space Cooling

The night-time cooler ambient can be used to charge the latent heat capacity of various " PositiveTemperature Eutectic" solutions between +4 °C (39F) and+27 °C (80F) without the use of any refrigeration machinery by simply allowing the surrounding air to freeze these solutions. It is then possible later for the stored energy by the Positive Eutectic Thermal Energy Storage "PETES", to be released back to the occupied space during daytime to handle the heat gains. This technique is generally called Passive Cooling and it may enable the charging process to take place by means of free cooling, i.e. without running the chillers and as a result becomes a very economical and environmentally friendly system. Furthermore, PETES opens new opportunities to explore heat balance for the existing and new systems, which could offer significant overall system efficiency improvements.

3.10 Rainwater cooling technology for photovoltaic panels for domestic houses

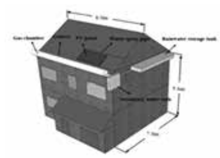


Fig 5 (a)

Figure 5 (a) & 5 (b) shown illustrates proposed solar-driven rainwater cooling system experimented by Shenyi Wu and Chenguang Xiong from U.K..

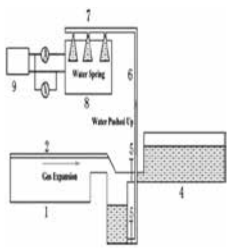


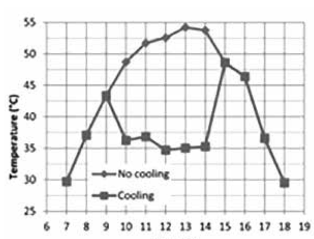
Fig 5 (a)

Fig. 5 (a) shows 3-D model of the solar-driven rainwater cooling system installed on the roof.

The system consists of a PV module with an area of 1.46 m2, maximum efficiency of 15.4% and maximum power output of 250 W, a gas expansion chamber, a rainwater storage tank and a secondary water tank. A cylindrical gas expansion chamber is installed at the eaves whereas the secondary water tank, which is connected to the gas expansion chamber, is hung at the side of the house. Gutters

Are installed on both south- and north-facing roofs in order to maximize the rainwater harvesting. On receiving the solar radiation, the gas in the chamber expands with the temperature increase. The rainwater in the tank is pushed upwards by the expanding gas so that it flows over the PV panel through a distribution tube on the top as shown in Figure 5(b). The rainwater is not considered being reused to reduce the cost and simplify the system structure in this case.

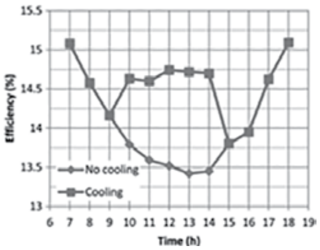
1. Gas Chamber
2. Absorber surface
3. Secondary Water Tank
4. Rainwater Storage Tank
5. Valve
6. Water spray pipe
7. Nozzles
8. PV module
9. Control Panel



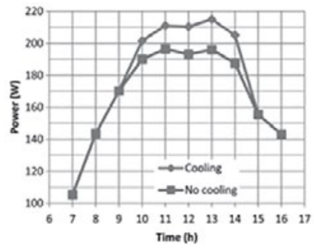
Comparison of the temperature between with cooling and without cooling to the PV panel

On the design day, the solar-driven rainwater cooling system is able to pump 152 l of water to PV modules. The maximum reduction in the temperature of the cells reaches 19°C and average electrical yield is increased by 8.3%. For the solar-driven rainwater cooling system operating between April and September, this cooling system can increase the electricity generation by 33.4 kWh annually.

Performance of the PV module cooled by the system are shown in the following graphs.



Comparison of the efficiencies between with cooling and without cooling to the PV panel



Comparison of the power between with cooling and without cooling to the PV panel

The most significant point of this approach is that it utilizes rainwater and solar energy to cool the PV panels—improving PV system efficiency with no requirement for additional energy input. This system it has the potential for further exploration

3.11 Conclusion

Various methods can be employed to achieve cooling action for PV systems. However, the optimum cooling solution is critically dependent on several factors such as, system arrangement, PV technology employed, types of concentrators' geometries, and weather condition at which the system is installed. Hybrid PV System offer a practical solution to increase the electrical power production from PV panels and reduce the heating loads, in addition to the recovery of heat extracted from the panels.Heat extraction from PV modules utilizing various mechanisms was presented.Various designs employing air, liquid, heat pipe, PCM and thermoelectric modules to aid cooling of PV cells were discussed along with the parameters influencing the system performance. Air cooling of PV system provides a simple technique to thermally regulate the temperature of PV cells owing to minimal use of material and low operating cost among other PV cooling technologies. On the other hand, liquid cooling offers a better alternative to air cooling utilizing coolant allowing a more efficient utilization of thermal energy captured. In addition, liquid based PVT collectors offer less temperature fluctuations compared to air-based PVT making them more favourable in aiding a homogenous temperature distribution on the surface of PV modules.PV module with water flow exhibit lower module temperature than that without water flow leading to higher electrical efficiency. Loss of efficiency due to a raised temperature of PV arrays can be reduced by heat removal from the front surface into the water spray across the cells which absorb the heat generated by the cells during the day. It is found that spraying water over the photovoltaic cells strongly improves the system and subsystem efficiencies.

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- Involved in Revision of curriculum of MSBTE for Electrical Engineering group with semester pattern
- Worked for Development of Manual for MSBTE Diploma in Electrical Engineering for the various subjects.

TRUST THE VIBES, ENERGY NEVER LIES.

IOT BASED INTELLIGENT SOLAR MONITROING SYSTEM

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Abstract: *Paper described an effective implementation of a smart remote monitoring system for solar Photovoltaic (PV) and Power Conditioning Unit (PCU) using IoT of Rooftop Solar Photovoltaic systems or any solar power plant.. The proposed system design can monitor solar PV PCU in order to solve management problems, maintenance ,grid monitoring, shortens the mean time to repair as well as predict the solar energy generation . A proposed paper is a smart IoT based monitoring system uses MQTT protocol as well as cloud service of Amazon. The result of our demonstration shows that the system can monitor store and manipulate data from solar PV PCU. Thus, the remote monitoring functions are realized in real-time. Monitoring of real time generation data obtained from solar photovoltaic plants will be optimized the overall performance of the solar power plant and to maintain the grid stability. The System has the access to power generation and export data in real-time and can process further to find out any important issue with equipment to resolve them effectively and predict power generation with increased certainty. When contemplating the use of a solar electric photo voltaic system, it is important to assess how much energy the system can produce according to the location, orientation, and plant conversion efficiency. Due to changes in solar irradiance, temperature and other factors Solar Photovoltaic plants yields variable power generation. Thus sensory system will collect the data with the help of Raspberry Pi processor which is connected to internet via router and communicate to server with the help of MQTT protocol which can effective and provide intelligent decision making from cloud.*

Keywords : *IOT, Raspberry pi, Cloud , MQTT protocol, Amazon web service*

1. INTRODUCTION

Internet of Things (IoT) is an ecosystem of connected physical objects that are accessible through the internet. The 'thing' in IoT could be a person with a ECG Monitoring or Solar System with built-in-sensors, i.e. objects that have been assigned an IP address and have the ability to collect and transfer data over a network without manual assistance or intervention. The device which can represent digitally in embedded technology to interact with internal states or the external environment to provide vital information to take further decisions.

Indian solar energy industry though slows but experiences unprecedented growth which results in upgrading its IT infrastructure for proactive monitoring. Rising consumer interest in clean energy, newly available tax incentives as The Government had launched Jawaharlal Nehru National Solar Mission during 2010-11, which is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge. It will also constitute a major.

Contribution by India to the global effort to meet the challenges of climate change. There is a large potential available for generating solar power using unutilized space on rooftops and wastelands around buildings. Small quantities of power generated by each individual household, industrial building, commercial building or any other type of building can be used to partly fulfill the requirement of the building occupants and surplus, if any, can be fed into the grid. The distribution of solar PV subsidy has started the adoption of solar PV solutions at the household level on a good note. The claimed benefits of solar PV along with the added incentives of central and state government subsidies has made the overall solution quite attractive for every household. MNRE has fixed the price at INR 69,000 / kW. Central government gives 30% subsidy on the mentioned price. A couple of state governments have also added state specific subsidies on top of the central government subsidy.

As more Rooftop Solar Photovoltaic frameworks are getting incorporated into the current commercial market, which needed monitoring of constant era information got from sun oriented photovoltaic plants so as to improve the general execution of the sun oriented power plant and to keep up system .Use of latest raspberry pi processor which has added advantage of inbuilt Wi-Fi and high end processor. All the process data can be uploaded to cloud services provided by amazon. Various Methods including GSM,Zigbee can be used to communicate to server.But use of Wi-Fi is the better choice to monitor data remotely.

2. PROPOSED CONCEPT OF IOT BASED SYSTEM FOR PHOTOVOLTAIC MONITORING:

The proposed ARM11 easily available with additional features based system to monitor remotely efficiently of photovoltaic structure through an IoT based system. The information from the sensors is transmitted by methods for the flexible radio compose. The raspberry pi is used to send data to the remote server using Wi Fi and to the Cloud. IoT application IoT application schematic for the Solar Power Plant is showed up in figure 1. The schematic divided into three parts as sensing processing and communicating.

Sensing incorporates current sensors, voltage sensors, pyranometer for irradiance estimation and distinctive sensors, The Raspberry Pi communicate with the sensing element and begin to transmit data to server via Wi-Fi and Internet using the MQTT protocol.

The data sent to cloud via amazon cloud service can be gathered at server end and can be analyzed as per the requirement.

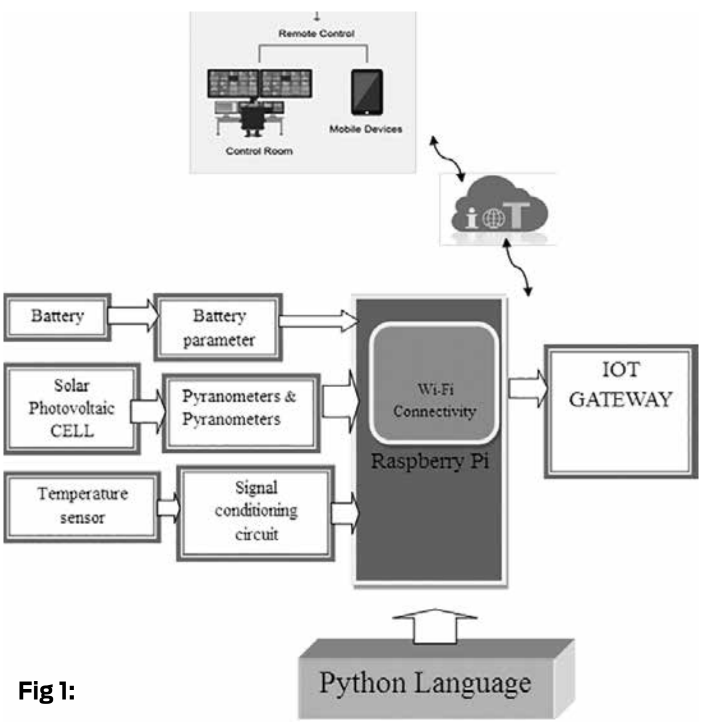


Fig 1:

3. COMPLETE SYSTEM DESIGN:

Monitoring and control of photovoltaic systems is essential for reliable functioning and maximum yield of any solar electric system. The simplest monitoring of an inverter can be performed by reading values on display - display as well as remotely transmission of various parameters is part of our grid-connected inverter. Most important inverter and grid related parameters are available on LCD as well as on cloud server. Values like PV array power, AC grid power, PV array current are usually available. For sophisticated monitoring and control purposes environmental data - like module temperature, ambient temperature, solar radiation, wind speed can also be transmitted to server and further analyzed.

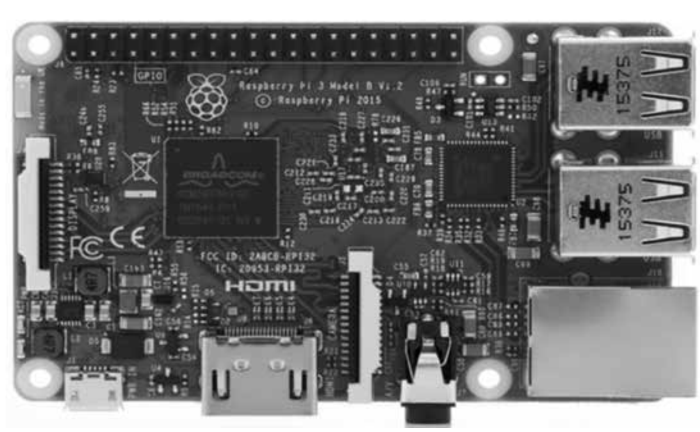
Sensors like Temperature sensors are usually PT100 or PT1000 sensors are used . Solar radiation is measured with reference solar cells (Si-mono). Digital inputs are available and can be used for net-meter/control equipment interconnection.

Pyranometers and pyrheliometers are most common used instruments for solar irradiance measurements. Pyranometers are used for global irradiance measurements typical in the wavelength range from 300 to 3000 nm - UV light to infra red radiation. In low cost models silicon photo diodes are used as sensor but in professional instruments thermopiles are used. Pyranometers do not require much maintenance and are designed for long life service. These system can interface to RPI with suitable interfaces and data can be transmitted to server .

Calculate the energy that is being generated in all the connected solar energy systems. • Analysis of energy generation pattern • Fault/ Problem detection • Real-time visualization of the solar systems • Implement Google Prediction API

4. CLOUD PROTOCOL : MQTT

MQTT is protocol, which is bandwidth-efficient and uses little battery power, the protocol uses a publish/subscribe architecture in contrast to HTTP with its request/response paradigm.Publish/ Subscribe is event-driven and enables messages to be pushed to clients. The central communication point for solar parameter is the MQTT broker, it is in charge of dispatching all messages related to solar parameter between the senders and the rightful receivers. Each solar client that publishes a message to the broker includes a topic into the message. The topic is the routing information for the broker. Each client that wants to receive messages subscribes to a certain topic and the broker delivers all messages with the matching topic to the client. Therefore the clients don't have to know each other, they only communicate over the topic. This architecture



enables highly scalable solutions without dependencies between the data producers and the data consumers.

5. TECHNICAL SPECIFICATION:

- Broadcom BCM2837 64bit ARMv7 Quad Core Processor powered Single Board Computer running at 1.2GHz
- 1GB RAM
- BCM43143 WiFi on board
- Bluetooth Low Energy (BLE) on board
- 40pin extended GPIO
- 4 x USB 2 ports
- 4 pole Stereo output and Composite video port
- Full size HDMI
- CSI camera port for connecting the Raspberry Pi camera
- DSI display port for connecting the Raspberry Pi touch screen display
- Micro SD port for loading your operating system and storing data
- Upgraded switched Micro USB power source (now supports up to 2.4 Amps)
- Expected to have the same form factor has the Pi 2 Model B, however the LEDs will change position :

CloudMQTT are managed Mosquitto servers in the cloud

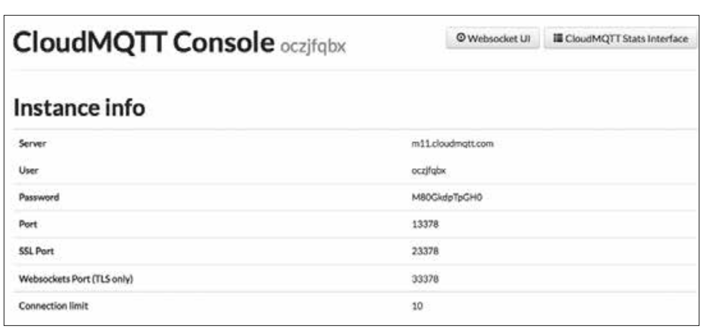
Mosquitto implements the MQ Telemetry Transport protocol, MQTT, which provides lightweight methods of carrying out messaging using a publish/subscribe message queuing model.

1. First Create a CloudMQTT instance
2. Create an account and login to the control panel and press
3. Create+ to create a new instance.
4. Choose a name for the instance and the datacenter to host the instance. To get started you need to sign up for a customer plan. What plan you want to use depend of your needs.
5. We offer four different plans for different needs.

Using JAVA software cloud instances are fed and created a web page which will display graphically all the values and analysis is done as per the requirement

MQTT client for Java/JVM is PAHO . Add the dependencies for the library or download the jar files and include them into the solar GUI.

A.Cloud Configuration:



CloudMQTT Console oczjfqbx

Websocket UI | CloudMQTT Stats Interface

Instance info

Server	m11.cloudmqtt.com
User	oczjfqbx
Password	M80GkdpTpGH0
Port	13378
SSL Port	23378
Websockets Port (TLS only)	33378
Connection limit	10

6. FUTURE WORK

The distinctiveness of the proposed system is that it will be easier to monitor the performance of a solar power plant in a holistic level . a continuous O&M program is essential to optimize energy yield and maximize the lifetime and viability of the entire plant and its individual components The IoT based system will populate dedicated web server based database with real time data of the plant parameters , that will enhance the decision making process of the concerned authority. The generation monitoring, fault detection of the plants in real time will be visible in the web server . Large scale grid integration of the solar power plants will require huge data analytics for decision making. The data populated about generation, irradiance profile, ambient temperature of a plant in database can be used for historical analysis. This approach has to be modified in future by using sophisticated database technologies

7. CONCLUSION:

IoT based monitoring of a solar power plant is a Vital step to renewable energy sources which are getting integrated into utility grid. Thus automation and intellectualization of solar power plant monitoring will Enhance future decision making process for large scale solar power plant and grid integration of such plants. In proposed paper an IoT based remote monitoring system for solar power plant, the approach is studied, implemented and successfully achieved the remote transmission of data to a server for supervision using MQTT Protocol with Amazon web service. IoT based remote monitoring will improve energy efficiency [4] of the system by making use of low power consuming advanced wireless modules. Web server based interface will significantly reduce time of manual Supervision and provide plant management as well as support in maintenance monitoring of the activities can lead to an optimal performance of the plant. The integration should be accomplished throughout

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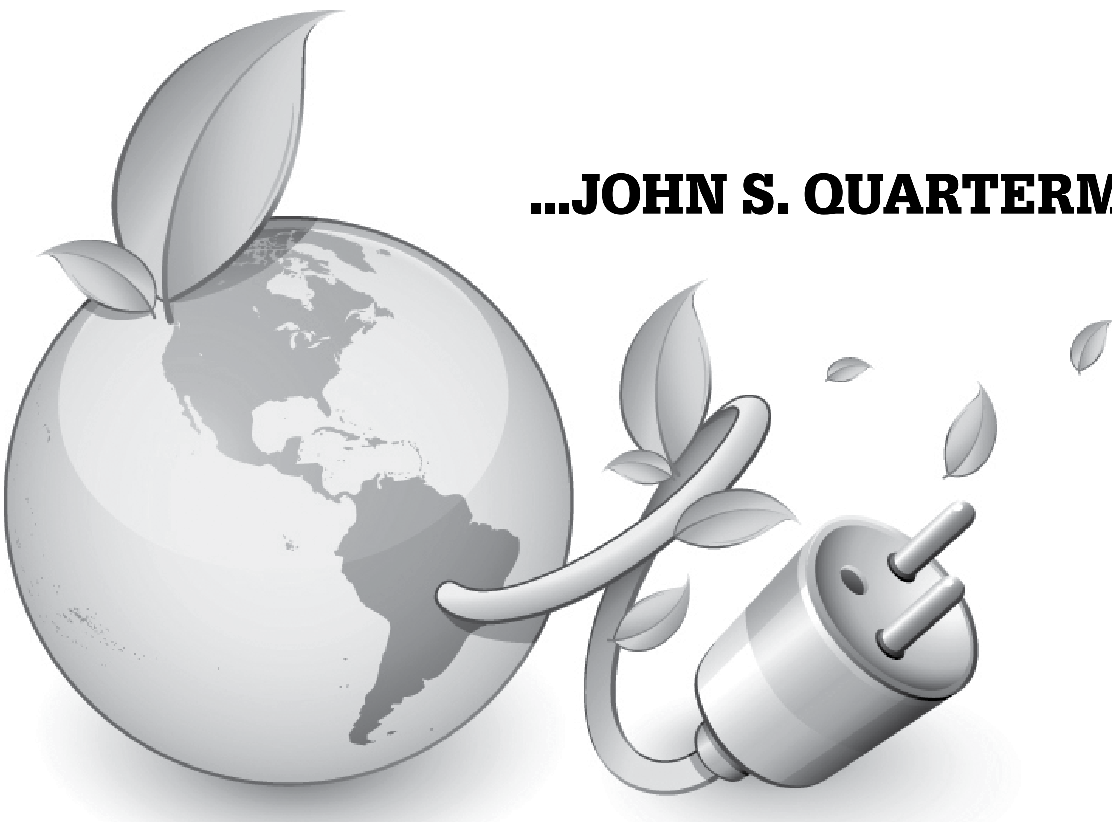
- Developed various product using embedded and IoT

Customer solar energy generation reduces wear on utility lines because most of that solar power is used behind the meter and never travels through the wires.

...JOHN S. QUARTERMAN



Fuel cell based stand alone system using Field Programmable Gate Array Controller

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Abstract : *In the recent years, increase in consumption of energy, instability of crude oil price and global climate change has forced researchers to focus more on renewable energy sources. There are different renewable energy sources available (such as photovoltaic and wind energy), they have some major limitations. The potential techniques which can provide renewable energy are fuel cell technology. Solid oxide fuel cell (SOFC) is more efficient, environmental friendly renewable energy source. This paper focuses study on load/grid connected fuel cell power system (FCPS) and examine the possibility of FPGA based hardware prototyping for a complex fuel cell system. The Fuel cell system can be used as a backup power source for household and commercial units. Load/grid connected fuel cell power system mainly comprises of a fuel cell module, DC-DC converter and DC-AC inverter. The output voltage of fuel cell is fed to a DC-DC converter to step up the output voltage. FPGA (Field Programmable Gate Array) based PI controller is implemented. So that we can use this system controller efficiently for controlling the output voltage of DC-DC converter. The output voltage of DC-DC converter is fed to DC-AC inverter. When the required numbers of fuel cells are not available, DC-DC converter is used to step up the output voltage of fuel cell. When there is a malfunction in fuel cell or shortage of hydrogen then a battery is used to provide backup power.*

Keywords: *DC-DC Converter, DC-AC inverter, FPGA, PI Controller,PWM-VSI Controller,*

1. INTRODUCTION

There has been a sharp rise in consumption of energy worldwide since the last decade. Mostly generation of energy depends on fossil fuel which has a limited supply. Generation of power via conventional methods also causes irreversible damage to the environment. The demand of electrical energy is increasing every day and to meet the demand of energy using renewable energy sources like wind power, solar power, biomass power from past few decades...India is one of the first country to set up the department of non-conventional energy sources. The major part of the renewable energy comes from wind power and solar power but one drawback of wind and solar energy sources is their variability. Due to the practical limitation of wind and solar energy, chemical energy is widely used for generation of electricity. This thesis primarily focuses on reduction and the complexity of a fuel cell controller.

A fuel cell is a device which converts stored chemical energy (hydrogen, oxygen) to electrical energy [1-3]. The conversion of the fuel to energy takes place via an electrochemical process which is non-polluting and efficient. One of the major advantages of a fuel cell system is that it can be placed at any site in a distribution system without geographic limitations to provide optimal benefit, and they are not intermittent in nature. Fuel cells offer numerous advantages over conventional power plants to help them achieve that goal and widespread adoption, such as: High efficiency, even at part-load, few moving parts resulting in quiet operation, higher reliability, lower maintenance and longer operating life, Zero or low emission of greenhouse gases, Combined Heat and Power (CHP) capability, without the need for additional systems (i.e., low temperature fuel cells can provide district heating while high temperature fuel cells can provide high-quality industrial steam). Different types of fuel cells exist in the world. From these fuel cells, solid oxide fuel cell (SOFC) is an important one [4, 5] because of its high efficiency and solid material (electrolytic material is ceramic) it uses

Fuel cell is widely used in space, military and vehicular applications. Indian companies import fuel cell stack from North America and European Union and modify the stack to the requirement. In order to commercialize the fuel cell as an affordable medium of renewable energy sources, study has to be concentrate to develop fuel cell based low cost energy management system which will provide backup energy to household and commercial establishments at an affordable energy per unit cost. Digital control of DC/DC converter and DC/AC inverter plays a very important role in providing reliable supply to load/grid connected system. So, research has to be concentrated on state of art control techniques of the converter-inverter topology. Though there are several digital processors to implement the control law, the ideal processor has to be reliable, modular and low cost. The primary aim of this paper is to study how to develop a modular, low cost digital control scheme for converter-inverter topology which will eventually lead to a fuel cell based energy management system, which provides backup energy to household and commercial units at a reasonable energy per unit cost. Dynamic mathematical model of SOFC is developed to find out output voltage, efficiency, over potential loss and power density of fuel cell stack. Conventional Proportional-Integral (PI) controller and FPGA based PI controller is implemented. The output voltage of DC-DC converter is fed to DC-AC inverter. When the required numbers of fuel cells are not available, DC-DC converter is used to step up the output voltage of fuel cell. When there is a malfunction in fuel cell or shortage of hydrogen then a battery is used to provide backup power.

The PI controller provides the compensation in the feedback loop of the closed loop system of SOFC model. PI controller is a particular case of lag-lead compensator which guarantees reduced steady-state error with acceptable rise times. A buck converter has good stability margin but poor steady-state accuracy. It is one of the most common types of feedback controllers used in many dynamic systems. It is widely used in different areas such as process control, manufacturing, robotics, and power systems. Due to its simple structure and robust performance, PI controller is mostly preferred in industries as it does not require precise analytical model of the system to be controlled. It is quite easy to tune the parameters as well.

An FPGA based control scheme is proposed for the DC-DC buck converter to guarantee the stable and low output voltage against load variations in the output voltage of SOFC model [8] .FPGAs are configurable ICs and are used to implement logic functions. They ensure ease of design, lower development costs, more product revenue, and the opportunity to speed products to the market. At the same time, they are superior to software-based controllers as they are more compact, power-efficient while adding high speed capabilities [6]. The conventional microprocessors are serial machines which perform one instruction at a time, while the structure of FPGA is adapted to parallel, which means that the performance is several degrees better. Another advantage is that only one FPGA chip is capable of performing multiple functions including control, signal processing, and system input and output. This greatly reduces the number of ICs required and increases the reliability. Using VHDL as our coding language to implement the proposed controller onto the FPGA. VHDL is a hardware description language that can be used to model a digital system at a different level of abstraction, ranging from the algorithmic level to the gate level with different modeling styles. It gives us freedom of describing a digital system in the concurrent or sequential or mixed behavior with or without timing.

2. SYSTEM MODELING

A. Working of fuel cell

A fuel cell is a device that generates electricity by a chemical reaction. Every fuel cell has two electrodes called, respectively, the anode and cathode. The reactions that produce electricity take place at the electrodes. Every fuel cell also has an electrolyte as shown in the fig 2.1[7], which carries electrically charged particles from one electrode to the other, and a catalyst, which speeds the reactions at the electrodes. Hydrogen is the basic fuel, but fuel cells also require oxygen. One great appeal of fuel cells is that they generate electricity with very little pollution–much of the hydrogen and oxygen used in generating electricity ultimately combines to form a harmless byproduct, namely water. The Hydrogen atoms enter a fuel cell at the anode where a chemical reaction strips them of their electrons. The hydrogen atoms are now "ionized," and carry a positive electrical charge. The negatively charged electrons provide the current through wires to do work Oxygen enters the fuel cell at the cathode and, in some cell types (like the one illustrated above), it there combines with electrons returning from the electrical circuit and hydrogen ions that have traveled through the electrolyte from the anode.

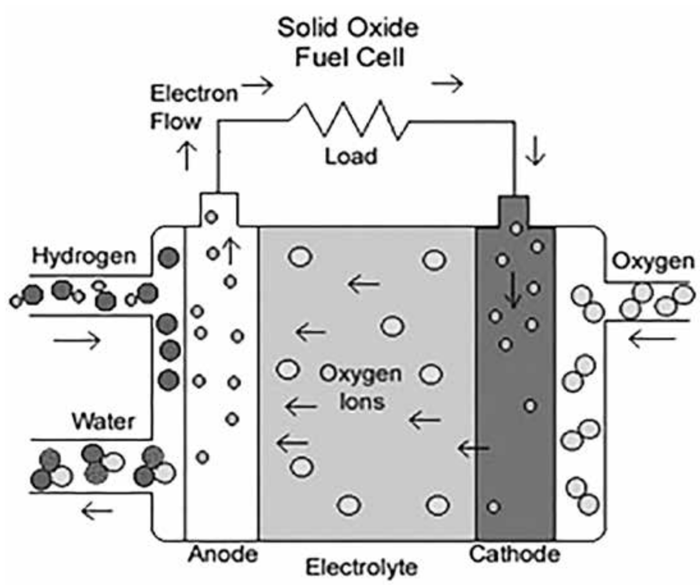


Fig 2.1 working of fuel cell

Whether they combine at anode or cathode, together hydrogen and oxygen form water, which drains from the cell. As long as a fuel cell is supplied with hydrogen and oxygen, it will generate electricity.

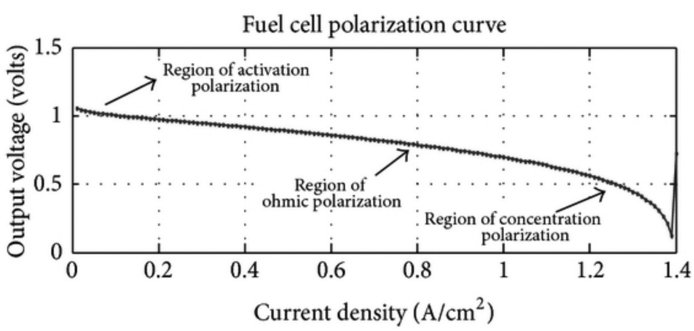
Solid Oxide fuel cells (SOFC) use a hard, ceramic compound of metal (like calcium or zirconium) oxides (chemically, O2) as electrolyte. Efficiency is about 60 percent, and operating temperatures are about 1,000 degrees C (about 1,800 degrees F). Cells output is up to 100 kW. At such high temperatures a reformer is not required to extract hydrogen from the fuel, and waste heat can be recycled to make additional electricity. However, the high temperature limits applications of SOFC units and they tend to be rather large. While solid electrolytes cannot leak, they can crack.

B. Modeling of Fuel Cell System

The fuel cell voltage is usually very small, around 1.2 V. Due to their low output voltage it becomes necessary to stack many cells that need to be connected in cascaded series and parallel to increase its power capacity. Several sources contribute to irreversible losses in a practical fuel cell. The losses are called polarization, over potential, or overvoltage, originate primarily from three sources: 1) Activation polarization 2) Ohmic polarization 3) concentration polarization. The expression for stack output voltage Vfc of a fuel cell can be obtained applying Nernst's equation and also taking into account the voltage losses such as the ohmic, activation and mass transportation (concentration) losses

C. V-I Characteristics Curve SOFC Stack

The response of the fuel cell stacks which produces DC electric power from the chemical reaction of hydrogen and oxygen is much faster than that of the reformer [9, 10].The performance of a fuel cell can be expressed by the polarization curve, which describes the cell voltage- current (V-I) characteristics are shown in the fig 2.2 of the fuel cell that are highly non-linear.



2.2 V-I Characteristics of Fuel cell

In fig seen that a linear region exists because as the current density increases the voltage drops due to its ohmic nature. This region is called ohmic polarisation, it is mainly due to internal resistance offered by various components. At low current level, the ohmic loss becomes less significant; the increase in output voltage is mainly due to activity of the chemical reactions. So this region is also called active polarization. At very high current density the voltage fall down significantly because of the reduction of gas exchange efficiency, flooding of water in catalyst and this region is also called concentration polarization.(Optimization of fuel cell operating conditions, design of the power conditioning units, design of fuel cell stack systems, and design of controllers depend on such characteristics.)

The power output verses current (P-I) characteristics of the fuel cell stack is shown in Fig.2.3. It is observed that the power output increases continuously with the increase in load current and attains its maximum value at certain load current. However after this value is attained, the power output falls rapidly due to the sudden increase in the ohmic and concentration (mass) losses.

The simulation results of efficiency of fuel cell stack is shown in Fig.2.4.The efficiency of an actual fuel cell can be expressed in terms of the ratio of the operating cell voltage to the ideal cell voltage.

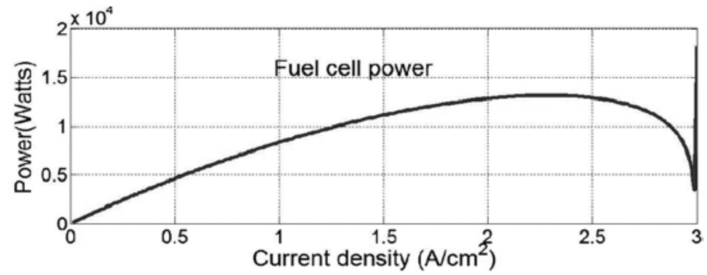


Fig 2.3 P-I characteristics of the fuel cell stack

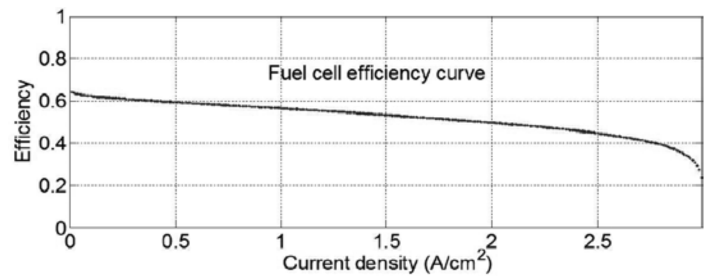


Fig 2.4 Efficiency characteristics of fuel cell

The actual cell voltage is less than the ideal cell voltage because of the losses associated with cell polarization and the iR loss,

The efficiency of the fuel cell can be written in terms of the actual cell voltage is

$$\frac{Vfc}{Uf.1.48}$$

Where Vfc is the Fuel cell output voltage
Uf is the utilization factor

D. Power Switches Interface Methods

It is obvious that the output power of fuel cell cannot be used directly to the load or to the grid. It needs to be conditioned before interfacing to the load or to the grid. So, the power conditioning unit (PCU) are employed which converts the power generated by fuel cell into a usable form. The basic components of any of such topologies include Power source (SOFC), DC-DC Converter, A support battery/PV array Boost/Buck converter L-C filters at input or output side Static switches

E. Fuel cell with DC-DC converter

A model for SOFC and DC-DC buck converter is presented in [7, 11]. The circuit of this model is illustrated in Figure 2.5. Voltage sensing is done by simple voltage dividing circuit which gives Vdc. This Vdc is subtracted from Vdcref using an op-amp subtractor circuit. This error signal e(t) = Vdcref-Vdc is fed to the FPGA based PI+PWM controller

To have a more efficient conversion of power from the fuel cell stack to the load, it has been considered the application of DC-DC converters. DC-DC converters are used to convert the unregulated DC input into a regulated DC output at a desired voltage level. The average DC output voltage must be controlled to equal a desired

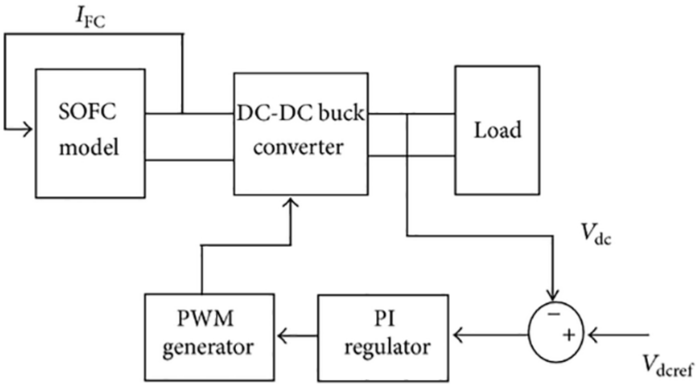


Fig 2.5 Block diagram of fuel cell with DC-DC buck converter.

level despite variations in the input voltage and output load. This is accomplished through the control of the ON and OFF times of the switches present in the converters.

One of the methods of controlling the output voltage is called Pulse Width Modulation (PWM). It employs switching at a constant frequency and adjusts the ON-time of the switch to control the output voltage. The duty-cycle defined as the ratio of the ON-time to the switching time period, is generated by comparing a signal-level control voltage with a repetitive waveform, typically a saw tooth. This control voltage signal is obtained by amplifying the error between the reference signal and the actual signal. The frequency of the repetitive waveform establishes the switching frequency, which is in the few kilohertz to a few hundred kilohertz range. Advantages of PWM switched converters include low component count, constant frequency operation, and relatively simple control and are commercial available. Figure 2.6 shows the DC output voltage of SOFC model. This DC output voltage from SOFC model is fed to DC-DC buck converter as an input. It steps down the voltage from 40 V to 19 V which is stable.

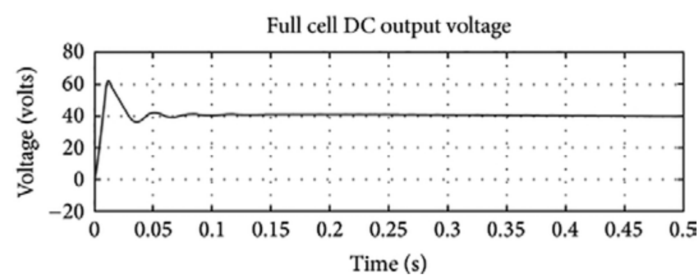


Fig 2.6 DC of output voltage fuel cell

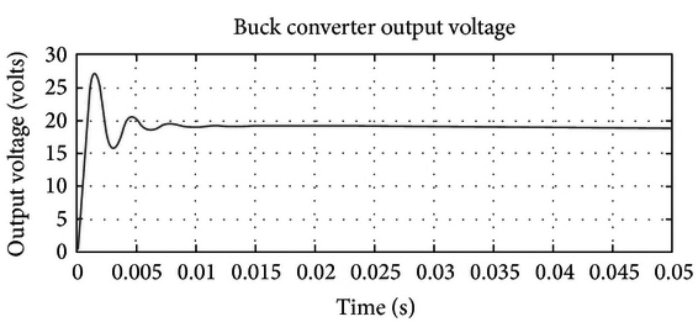


Fig 2.7 Output voltage of buck converter

3. CONTROLSTRATEGIES

DC-DC converter is one of the primary power-conditioning systems in a fuel cell power system. To get the required output voltage from DC-DC converter, closed loop control is essential. There are different linear and non-linear control strategies for DC-DC converter. The main objective of the controller is to maintain the desired output voltage and compensate for any disturbances. The most widely used linear control strategy for DC-DC converter is voltage mode control using PI controller

A. PWM Technique

Switch-mode DC-DC converters utilize one or more switches to transform DC from one level to another. In a DC-DC converter with a given input voltage, the average output voltage is controlled by controlling duty cycle of the switch pulse. There are two methods for the generation of PWM, one by switching at a constant frequency and adjusting the on duration of the switch to control the average output voltage. The other method; where both the switching frequency and the on duration of the switch are varied.

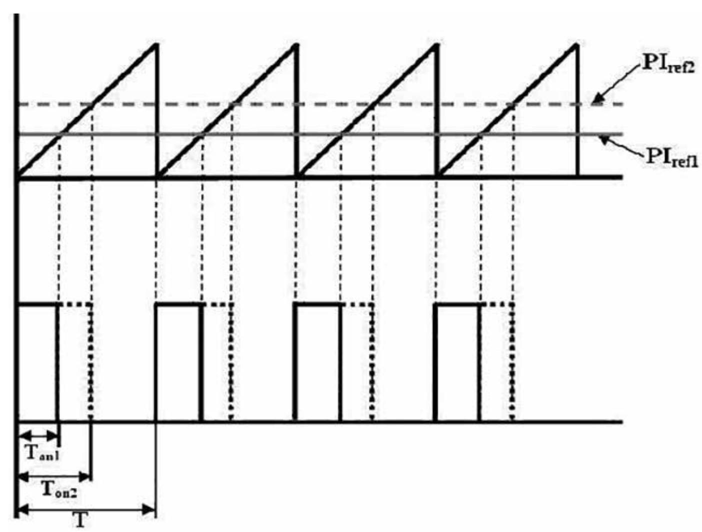


Fig.2.8 PWM duty cycle control structure

Here we adopt, a fixed frequency PWM technique is used. A repetitive signal which decides the frequency of PWM is compared with the PI output which acts as a reference signal. When PI output is more than the repetitive signal, then the PWM signal is high and vice-versa. When PI output changes, the ON period of the PWM signal changes as shown .Hence, we can control the buck converter output voltages.

B. FPGA Controller

This section implements voltage mode controller for DC-DC converter using FPGA. Voltage mode controller using PI controller is chosen because the control logic is simple and it's easy to implement. The PI and PWM controller when configured on Field Programmable Gate Arrays (FPGAs) improves the speed, accuracy, power, compactness, and cost effectiveness of the system implementation. So scientists have shifted to digital domain to control the converter. With low cost digital computing device available in the market, digital control of DC-DC converter is one of the widely studied areas.

In digital control, the control algorithm is implemented in any of the digital computing device. The PWM signal generation is done by comparing a stable reference signal which is here taken from a PI controller with a repetitive saw-tooth signal. A repetitive signal is generated by a counter, which counts from zero to maximum value and when it reaches the maximum count, the counter is reset to zero again. This process is repeated concurrently in a process block. The frequency of the PWM signal is decided by the frequency of this repetitive signal. The N-bit comparator is used, which compares the counter count and the reference signal input. When the reference input is higher than the repetitive signal the output of PWM signal is low, and when the reference input is lower than the repetitive signal the output of PWM signal is high. In this way, the PWM signal is generated which drives the power switch of the converter. .Switch-mode DC-DC converters utilize one or more switches to transform DC from one level to another. In a DC-DC converter with a given input voltage, the average output voltage is controlled by controlling duty cycle of the switch pulse. There are two methods for the generation of PWM, one by switching at a constant frequency and adjusting the on duration of the switch to control the average output voltage. The other method; where both the switching frequency and the on duration of the switch are varied. So, a 24-bit counter and comparator are taken.

C. Prototype Model of Controller [12]

A prototype model of DC-DC buck converter is shown in Fig2.11. The buck converter is designed with L = 8 mH; C = 100 uF, and load R = 20 ohms. The duty cycle of the PWM signal with constant load is 50% as shown in Fig. 2.12 By changing the load; current varies

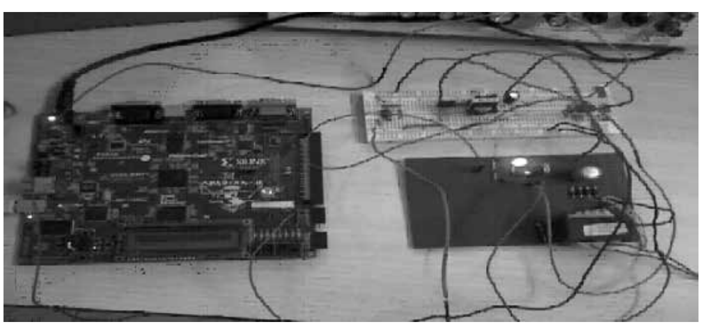


Fig.2.11 Prototype of buck converter with FPGA based PI & PWM controller

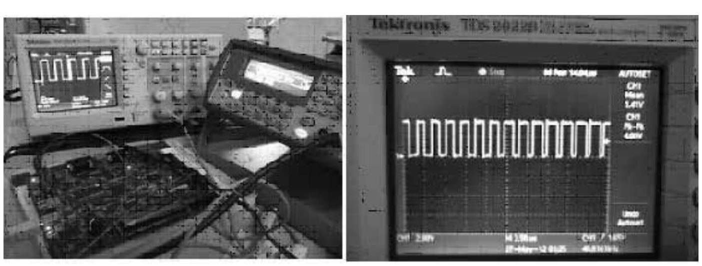


Figure 2.12 (a) PWM switching pulse with constant load. (b) Duty cycle change with the variation of load.

which changes the voltage. For constant voltage, the duty cycle of the PWM switching pulse will change accordingly. From the V-I characteristics curve of SOFC model, a decrease in the output voltage with an increase in current density is shown. So, for a constant output voltage, the duty cycle will increase gradually .Voltage sensing is done by simple voltage dividing circuit which gives Vdc. This Vdc is subtracted from Vdcref using an op-amp subtractor circuit. This error signal e(t) = Vdcref-Vdc is fed to the FPGA based PI+PWM controller which is synthesized in XC3S500E development board. It is given to ADC (Analog to Digital conversion) module of XC3S500E board. LTC1407A-1 ADC converter IC has been used in this board which gives 14-bit digital output represented in 2's complement binary value. It has a precision of 14-bit. Maximum sampling rate which can be achieved is approximately 1.5 MHz Using PI modules, the error e(t) is minimized and PWM output is generated with its reference and output is taken from I/O pin F8 of XC3S500E board. Using opto-coupler (HCPL817), PWM signal is interfaced with the DC-DC buck converter. The opto-coupler provides isolation between the FPGA board and the power circuit.

D. PWM-VSI Current controller for load or grid connected FUEL CELL

Fuel cell generates DC output voltage which should be converted to AC by using DC-AC inverter. The inverter output is used for utility application as well as for distributed generation. Inverters can be either voltage source inverter (VSI) or current source inverter (CSI). In VSI, DC source has negligible impedance and terminal voltage remains constant with load variations. The voltage source inverter is more convenient because it is efficient, compact, economical and faster device in comparison to current source inverter. Here, inverter output voltage is dependent on the load impedance and thus terminal voltage can change substantially with changes in the load On the basis of the output waveform, inverters can be classified as square wave or pulse-width modulation (PWM) inverters. Square wave inverters produce a square wave AC voltage which is of constant magnitude. To get the sinusoidal waveform, LC filter circuit can be used at the output of the inverter Most of the current control techniques used in load/grid connected fuel cell power system is PWM-VSI control strategy. This thesis uses a VSI current controller technique within the inverter.

Fuel cell provides a DC output voltage whose magnitude is increased or decreased by a power electronic converter .For utility and grid connected applications the output of converter is fed to DC-AC inverter. A DC-link capacitor is connected in the intermediate stage of DC-DC converter and DC-AC inverter. The DC-AC inverter is controlled by PWM-VSI technique.

4 SIMULATED RESULTS ANALYSIS [12]

A fuel cell power system is considered as a backup power source for residential and industrial loads. Fuel cell provides a low DC voltage which has to be converted to AC for different standalone and grid application. For conversion of DC to AC, a DC-AC inverter is used. The

DC-AC inverter requires accurate gate pulses which are generated by different control configurations of PWM-VSI. The main objective of is to simulate fuel cell based power system in different possible configurations. The fuel cell power system consists of fuel cell, battery, DC-DC converter, DC-AC inverter, load and grid.

A. Configuration of Load/Grid Connected Fuel Cell Power System

Certain critical loads need uninterrupted/continuous power. It is also desirable to provide continuous supply to residential/commercial/industrial loads, which is provided by a grid. When due to any unavoidable circumstances (like thunderstorm, cyclone, grid maintenance), the grid is not able to provide 24 hour supply to the load, a backup power is necessary. There are many renewable energy sources which provide an efficient backup power, but fuel cell based backup power is considered more reliable than others.

When fuel cell is connected as a backup power supply, there can be different real life scenario like non-availability of required number of fuel cells, malfunction of fuel cell which will hamper the supply of backup power. Considering the above mentioned situation, this paper considers three different investigations where fuel cell acts as a backup power supply. When there is less number of fuel cells available then the DC output voltage is also low, so a DC-DC boost converter is used to increase the output DC voltage level. When there is no grid supply and a malfunctioned fuel cell then a battery is connected to provide backup power supply. Another configuration is when there is sufficient number of fuel cells then the fuel cell output is no longer required to be stepped up and can be directly fed to the inverter through DC-link capacitor.

C. Simulation Results of Fuel Cell Power System [12]

The DC-DC boost converter output voltage is shown in Fig.4.1 This boost converter is used to increase the fuel cell output (400 V DC) up to 500 V DC regulated voltage.

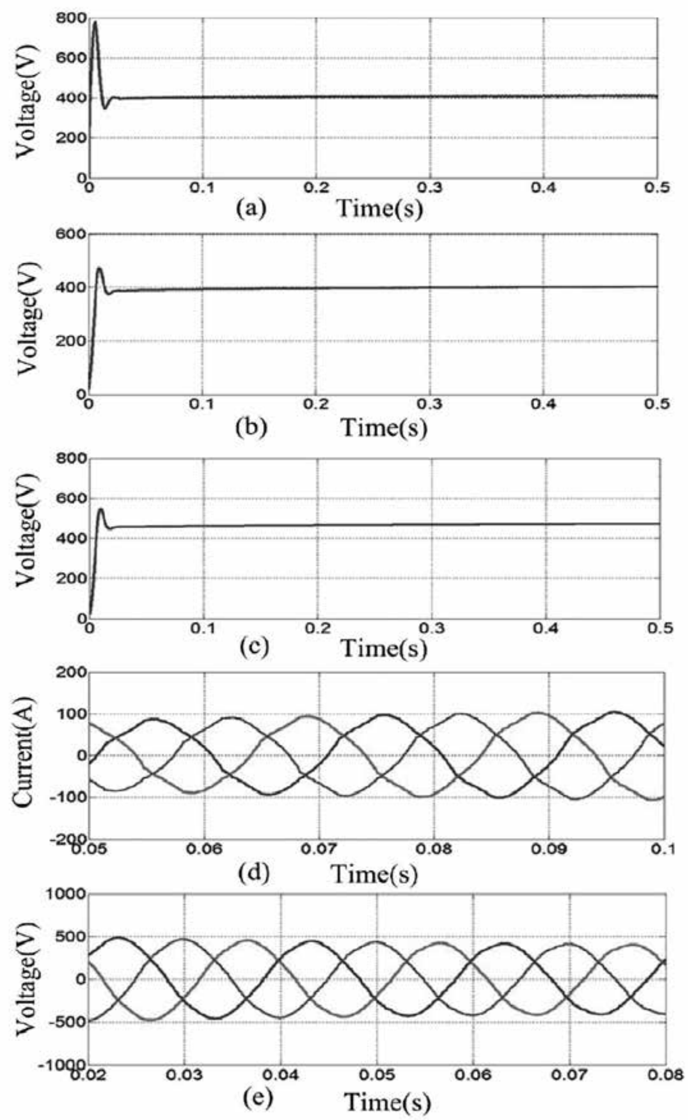


Fig4.1. Simulation results and analysis
Simulation waveform of (a) Fuel cell output voltage, (b) DC-link capacitor voltage, (c) Inverter output current, and (d) Inverter output voltage

5. CONCLUSION

This paper proposes study of FPGA based fuel cell system consist of, DC-DC converter, DC-AC converter and load. In fuel cell system model FPGA controller is use to control the voltage level of converter. PI in conjunction with PWM controller scheme is proposed for DC-DC converter that guarantees a stable and desired output voltage and this control scheme is implemented using FPGA that simplifies circuits and adds flexibility. The controller facilitates computing the pulse width and switches the MOSFET so that desired output voltage is obtained. The Fuel cell system which can be used as a backup power source for household and commercial units

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Unless the sun dies, winds stop, plants die and rivers stop running, there will always be green energy to be had. Some of these energy sources are completely free and we have them no matter what.

Why not take advantage of them?

...EDGAR CERVANTES

Advancement in Alternative Energy Sources

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ABSTRACT: *Alternative energy is any energy sources that is an alternative to fossile fuel*
1. wind energy
2. nuclear energy
3. solar energy

Solar energy is the energy, the earth receives from the sun, primarily as visible light and other forms of electromagnetic radiation. The solar portal provides an overview of the information on energypedia related to solar energy. Look for specific topics, latest articles or uploaded documents and announce upcoming events.
The artificial leaf — a silicon solar cell with different catalytic materials bonded onto its two sides - needs no external wires or control circuits to operate. Simply placed in a container of water and exposed to sunlight, it quickly begins to generate streams of bubbles: oxygen bubbles from one side and hydrogen bubbles from the other. If placed in a container that has a barrier to separate the two sides, the two streams of bubbles can be collected and stored, and used later to deliver power: for example, by feeding them into a fuel cell that combines them once again into water while delivering an electric current.
A new system for making liquid fuel from sunlight, water, and air is a promising step for solar fuels. The bionic leaf is one step closer to reality.

Keywords:
1.alternative energy sources
2.wind energy
3.nuclear energy
4.solar energy(artificial leaf)

INTRODUCTION:

Daniel Nocera, a professor of energy science at Harvard who pioneered the use of artificial photosynthesis, says that he and his colleague Pamela Silver have devised a system that completes the process of making liquid fuel from sunlight, carbon dioxide, and water.

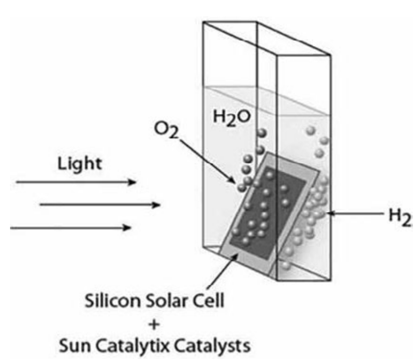
And they've done it at an efficiency of 10 percent, using pure carbon dioxide—in other words, one-tenth of the energy in sunlight is captured and turned into fuel. That is much higher than natural photosynthesis, which converts about 1 percent of solar energy into the carbohydrates used by plants, and it could be a milestone in the shift away from fossil fuels. The new system is described in a new paper in Science.

'Water splitting is one of the grand challenges for chemistry and interest in solar to fuels and artificial photosynthesis is still growing very strongly,' says James Durrant, who works in this area at Imperial College London, UK. 'However, a commercially viable water splitting device is still likely to be several years away.'

Hydrogen is the simplest solar fuel to synthesize, since it involves only the transference of two electrons to two protons. It must, however, be done stepwise, with formation of an intermediate hydride anion:

$2e^- + 2H^+ \leftrightarrow H^+ + H^- \leftrightarrow H_2$

The proton-to-hydrogen converting catalysts present in



Growing research

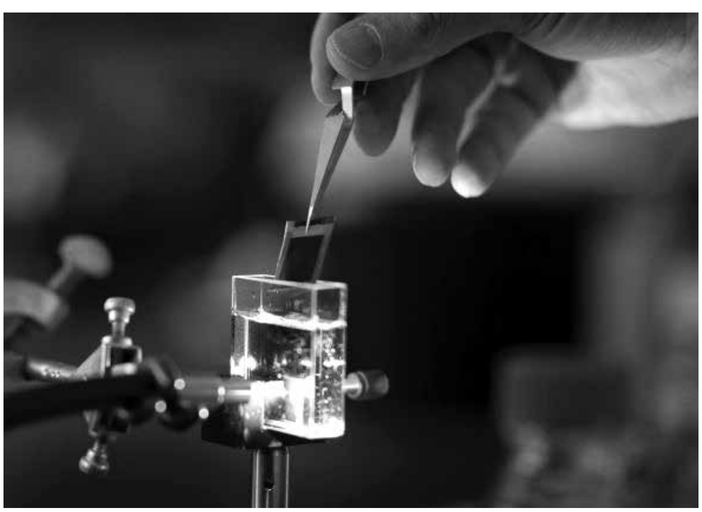
As crude oil prices rise again and easily accessible reserves continue to dwindle, research is once again focusing on converting solar energy into fuels. However, little has been commercialised. While we know a lot more this time around, adds Lyons, the problems are still there. Rushing a product to commercialisation before it's ready, he warns, 'can queer the pitch for an entire field'. nature are hydrogenases. These are enzymes that can either reduce protons to molecular hydrogen or oxidize hydrogen to protons and electrons.

Professor Daniel Nocera's project entitled "Patterning Silicon with Catalysts for High Efficiency Solar-to-Fuels Conversion" is one of seven selected for funding in early February by the newly established Harvard University Climate Change Solutions Fund. This initiative, a priority of President Drew Faust, seeks collaborative solutions to the problem of climate change, in particular the creation of affordable and renewable carbon-neutral energy sources like the bionic leaf and the artificial leaf.

I really turned to science because I could carry it with me.

His adviser at Caltech, Harry Gray, had done pioneering work in photosynthesis, the process by which plants convert sunlight into usable energy. Alternative energy was much in the air because of the Arab oil embargo of the 1970s, and Nocera became captivated by the idea of using sunlight like a leaf does, to split water into hydrogen and oxygen. "I went to graduate school to do that," he says, and spent the next 30 years trying to get the idea to work. But an innovative idea in energy, he learned, isn't enough; the idea has to be cheap enough to compete "against the cold, hard facts of a real economic system."

In 1995, a special issue of the journal Accounts of Chemical Researchasked leading chemists to describe "holy grail" projects in the field; one of the essays, by Allen J. Bard and Marye Anne Fox, then at the University of Texas at Austin, described the process of splitting water using sunlight. The sheer simplicity of the process conceals its chemical elegance—it takes energy to break chemical bonds, such as the bonds that hold hydrogen atoms to oxygen in a molecule of water, and plants use the energy of sunlight to break those bonds. The result is hydrogen and oxygen. Plants release oxygen into the air and repurpose the hydrogen to make food, in the form of carbohydrates. But hydrogen on its own, as a gas, is a clean and storable form of energy known as a chemical fuel; it can be stored for later use, and that's what Nocera was after.



The leaf is actually a thin sandwich of inorganic materials that uses the energy of sunlight to break the chemical bonds holding hydrogen and oxygen atoms together in ordinary H2O. The leaf works because the middle of the sandwich is what's called a photovoltaic wafer, which converts sunlight into wireless electricity, and that electricity is then channeled to the outer layer of the "leaf," which is coated with different chemical catalysts on either side. One accelerates the formation of hydrogen gas, the other oxygen.

Meet the Artificial Leaf

The idea is simple and elegant, but not easy and especially not easy without considerable cost. (John Turner of the National Renewable Energy Laboratory in Colorado had in fact achieved a version of water-splitting years earlier, but the process used prohibitively expensive materials.) Nocera began working on a cheap and simple approach during his grad school days at Caltech, continued after he took a job as a professor at Michigan State University in 1984, and finally declared success in a splashy 2011 paper in Science as a professor at Massachusetts Institute of Technology, where he moved in 1997.

Renewable Energy Celebrity

Armed with this basic invention, Nocera leaped ahead—too far and too fast, according to some of his critics—to a radical vision of how the artificial leaf would revolutionize the world. In a scenario he often shares in talks, he sees artificial leaves on the roof of every house, using sunlight to convert ordinary tap water into hydrogen and oxygen; the photovoltaic cells could provide electricity during daylight hours, and the hydrogen could be stored and later converted in a fuel cell to electricity overnight. Your house would become your personal power plant and your gas station, fueling the hydrogen-powered cars that Nocera says are already on the way. And, as he likes to say, "You can buy all this stuff on Google today."

Nocera wakes up every morning thinking about how to make the artificial leaf technology cheaper, more efficient, and simpler so that it will be impossible to resist the frugality of its innovation.

"People say, 'Oh, it's so nice that Nocera is doing something for the poor.' It makes my blood curdle! I'm not helping the poor. I'm a jerk! The poor are helping me. They don't have an infrastructure, so they'll walk you to a renewable energy future."

Disadvantages

- Safe storing of hydrogen gas
- Freeing in u ero temperatures
- The efficiency needs to e improved.
- For high performance the cost due to huge silicon solar cell increases

Working

When artificial leaf placed in a container of water and exposed to sunlight it quickly begins to generate streams of bubbles: oxygen bubbles from one side and hydrogen bubbles from the other.

The two streams of bubbles can be collected and stored and used later to deliver power The device is made entirely of earth-abundant, inexpensive material mostly silicon, cobalt and nickel and works in ordinary water.

Conclusion

Right now, it's not clear which path will eventually lead to renewable fuels from solar energy. To continue his airplane analogy Lewis compares artificial photosynthesis at the moment to the Wright brother's first flights. 'We're just getting off the ground, we're not flying 747s yet.' And one which converts chemical energy into electrical energy..

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Solar power, wind power, the way forward is to collaborate with nature – it's the only way we are going to get to the other end of the 21st century.

...BJORK

Advance flywheel battery and its application

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Abstract: *History of electrical energy storage system was started of 20th century, when lead acid batteries and nickel cadmium were been introduced. In 1929 pumped hydroelectric storage was put in to action for major use. Flywheel Energy Storage System (FESS) of the first generation, which have been available since 1970 which uses a large steel rotating body on mechanical bearing.*

Storage of electricity is also as important as that of the generating it. It can be stored in number of ways. FESS consists of storing electric energy in mechanical form. This system has overtaken other types of energy storage in aspects of cost, space, weight and with no adverse effect on environment. It simply consist of high strength rotors, which is suspended by magnetic bearing, which spins in a vacuum enclosure and can later be used to convert, this spinning action i.e.(stored kinetic energy) into electrical energy. It also includes all the design calculations, material; components etc. This system has respect according to their applications. Some are as follows in rail traction, ships, spacecrafts, satellites, automobiles, micro grid technologies and in NASA G2 Flywheel energy storage system. It can be controlled by some software's too.This system has become viable solution for the need of transportation, electric utility & aerospace industries. FESS offers a unique characteristic of very high cycle and calendar life. Future of FESS remains very bright. It can be further applied in manufacturing field too, as it has great efficiency and it has no adverse effect on environment.

Keywords: *FESS, NASA G2 flywheel, Magnetic bearings, hydroelectric storage*

1. INTRODUCTION

By the scenario, it has confirmed that the first flywheels were introduced in order to store rotational energy and then further utilize it whenever required. The amount of energy stored in a flywheel is proportional to the square of its rotational speed. The typical example of flywheel is reciprocating engine. But use of this flywheel to store electrical energy, has been proven in many cases. Its main aim is to replace or to reduce the chemical batteries.

Most of the universities and research centers are developing or studying this for its further concept. It can be developed in such a way that to store both energies storage and momentum control. It requires a good advancement in material technology, bearing (magnetic bearings) and power electronics in order to store energy at high RPM and also at high percentage.

A flywheel is with high life cycle, a long calendar, faster response. The flywheel was installed in a mechanical bearing, This increases its efficiency, but the further part that is flywheel with magnetic bearing has too reliable and has been proved more efficient. This system has application in following technologies such as;

1. CVT flybrid system
2. Buses
3. Cars
4. Traction
5. Aircrafts
6. Space crafts
7. Micro grid stabilization
8. UPS

Each of the systems are been explained further.

Flywheel energy storage is a main area of research since this paper opens up possibilities for new end application.

2. LITERATURE REVIEW

A shaft less magnetically levitated multifunctional space craft flywheel storage system by Ken Stevens.

The research was made in field of space craft. The traditional battery system was been replaced by nontraditional flywheel battery in order to store energy at larger extent as compared to that of lead acid batteries. Hence the improvement in design, got 60,000 rpm, they got

200 Wh/kg. The traditional system got replacement through flywheel energy storage system.

It was believed that for spacecraft application the magnet motion flywheel energy storage system can have higher performance than current electrochemical battery.

3. COMPONENENTS OF FLYWHEEL

Flywheel is a construction of various components which includes composite rim, flywheel rotor, motor/generator, radial magnetic bearing, and hub last but not the least main component magnetic bearings. Each of those is been described below.

1. Rotor

The usable kinetic energy stored in a flywheel is the speed interval over which it is allowed to operate. Kinetic energy grows gradually with the speed, for a rotating body, this implies that the energy for a mass element grows gradually with radius and rotational speed. Unidirectional wound carbon composites exhibit extreme strength in one direction, which implies that a thin rotating shell is optimal, since most of the centrifugal stress is developed in the circumferential direction. By placing mass to the periphery, it is better utilized (a higher speed at a larger radius results in higher kinetic energy per mass element). Flywheel optimized for higher speed operation is usually of higher energy density, although the speed can impede power transfer capabilities.

2. Magnetic bearing

A shaft moving in a vacuum chamber without any physical contact between both are done by magnetic suspensions. A bright example of this is system are maglev traction system. For instance, they are able to levitate a rotating shaft and permit relative motion with very low friction and no mechanical wear.

However a closed vacuum and very low loss requirement suggest the use of magnetic bearings. It allows a gravity free application to the rotor and provides a equilibrium position with equal air gap at each end.

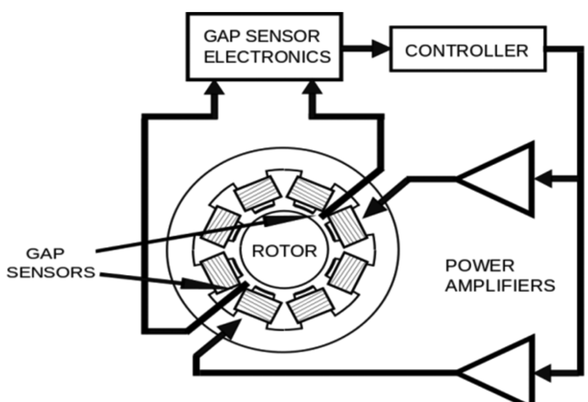

Fig 1 Construction of magnetic bearing

This is a normal construction of magnetic bearing to provide a friction less motion. It works on the principle of electromagnetic suspensions.

Comparison between magnetic and mechanical bearing is as fallows;

Table1. Comparison between magnetic and mechanical bearing

Mechanical bearing	Magnetic bearings
High stiffness per volume.	Larger footprint for a given stiffness.
It is known to all.	It still un matured.
It requires lubricant.	It doesn't require any lubricant.
High losses as compared to opposition.	Fewer losses.
It requires active cooling system.	May not required.

Hence it is needed to replace mechanical by magnetic bearings, in order to have fewer losses in output.

3. Motor / Generator

Energy saved in the flywheel is been transferred to a synchronous machine that serves as both a motor for accelerating the wheel and a generator for delivering useful power to a load. A permanent magnet type motor provides highest efficiency and highest power density. Other type of motors would be more appropriate as per the applications. As the flywheel is intended to operate between 20,000 to 60,000 RPM, with power requirements of motor is 1 KW at 20,000 RPM and 3 KW at 60,000 RPM.

Comparison of electric machines for best suitable for the application of flywheel is as fallows.

Table2. Comparison of motors/Generators

Machines	Asynchronous	Variable Reluctance	Permanent Magnet Synchronous
Power	High	Medium & low	Medium & low
Specific power rotor losses	Medium(-0.7 KW/kg) Copper and iron	Medium(-0.7 KW/kg)	High(-1.2 KW/kg) Very low
Efficiency	High (93.4%)	High (93%)	High (95.5%)
Cost	Low	Low	High

4. Applications

Applications of flywheel has been facilitated in many fields which includes automotive, space, aeronautics, power generation, marine life, traction systems, physics laboratories and many more.

Some of them are as fallows;

1. Automotive applications

Volvo announced a flywheel system fitted to the rear axle of its S60 sedan. Braking action spins the flywheel at up to 60,000 rpm and stops the front-mounted engine. Flywheel energy is applied via a special transmission to partially or completely power the vehicle. The

20-centimetre (7.9 in), 6-kilogram (13 lb) carbon fiber flywheel spins in a vacuum to eliminate friction. When partnered with a four-cylinder engine, it offers up to a 25 percent reduction in fuel consumption versus a comparably performing turbo six-cylinder, providing an 80 hp boost and allowing it to reach 100 kilometers per hour (62 mph) in 5.5 seconds.

2. UPS system

UPS system Uninterruptible Power Supply is an system which supplies power to electrical appliances when there is fail in main signal cut off. Flywheel battery has replaced the chemical batteries in terms of efficiency and cost with many other disciples.

3. Aircraft launching system

Flywheels are used to accumulate energy from the ship's power supply, for rapid release into the electromagnetic aircraft launch system. The shipboard power system cannot on its own supply the high power transients necessary to launch aircraft. Each of four rotors will store 121 MJ at 6400 rpm. They can store 122 MJ in 45 seconds and release it in 2–3 seconds.

4. Wind turbines

Flywheels may be used to store energy generated by wind turbines during off-peak periods or during high wind speeds.

5. Micro grid technology

Flywheels systems are used as short term spinning reserve for momentary grid frequency regulation and balancing. As it has no carbon emissions, faster response times and ability to buy power at off-peak hours are among the advantages of using flywheels instead of chemical batteries.

6. Rail tractions

Flywheel energy storage has also been used in traction system in order to store energy and also to boost their speed.

7. Space craft

NASA's Glenn Research Center has applied a carbon fiber rim and titanium hub designed to rotate at 60,000 RPM under the guidance of magnetic bearings. Stores around 525 W-hr.

Comparison between FESS and traditional storage system

Table 3. Compare between FESS and Chemical Battery

FESS	Chemical Batteries
Higher efficiency	Low, based on application.
No chemicals used.	Full of chemicals.
Longer life.	Fewer life cycles.
No temperature effect.	Can be affected by varying temperature.
No common failures.	Common failures.
Not yet matured.	Very commonly used.

Future scope

Use of this application in space craft by NASA has clearly proved that this system has a great scope in future. As our space craft and aircraft launching systems requires much energy in the stored form but without chemical solution due to adverse effect of it at higher altitudes. This system can feed up the required needs of storing systems. It also can be used in thermal power plant systems, as attachment to turbine shaft.

Conclusion

This system has a very vast application in the future of saving of electrical energy. This saved energy can be used to generate some amount of energy to useful extent. It also has many more application to come in newly field.

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"Sustainable Future Energy"

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Abstract: *This paper covers the information about the sustainable future energy and the importance of the sustainable energy. The paper gives information about future scope of sustainable energy. In 21st Century the needs of humans exceeding the limits of energy consumption which affects or increases the strain on traditional energy. The traditional energy sources are limited and after some years they totally extinct. To accommodate these situation human beings has to find new sources to fulfill the requirements the energy. For current situation alternate sources are emerging which are known as sustainable energy. Sustainable energy has mainly two pillars named as renewable energy and using energy efficiency.*

Keywords: *Renewable energy, Energy efficiency, Sustainable energy, Accommodate, Extinct.*

1. INTRODUCTION

No any country can complete their fulfillment of energy without traditional energy sources, because there is no any alternate source discovered. But the sources of traditional energy are limited so they extinct after some years. India consumes 3660000 barrels per day which is equivalent to 581940000 Liters. The CO2 produced in Kg/ liter of fuel is ranges from 2.11 – 2.71 these numbers are terrifying this happens only about India, consider about world the results are frightened.

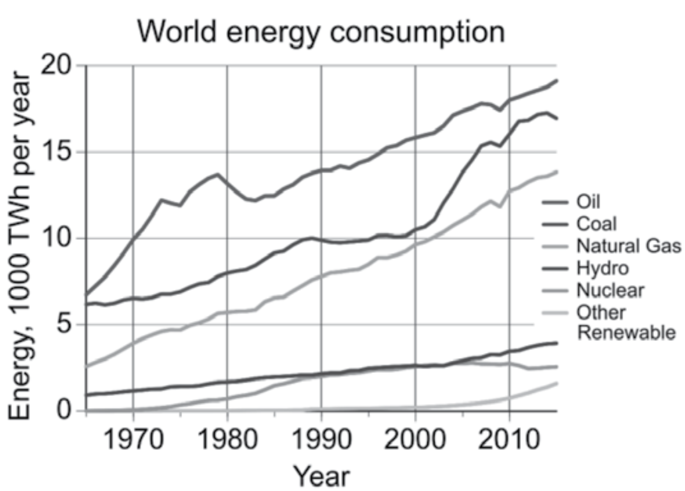

Fig 1.1 – world energy consumption with comparison of different energy sources.

Fig. 1.1 shows the comparison between different types of sources with statistical graph. As shown in fig the amount of energy produces by using renewable energy sources is negligible as compared to the other sources like Oil, Coal, Natural Gas and Nuclear sources and these sources has limited sources and they can depletes after some years, this is very terrifying. To accommodate this condition world has to shift near to the nontraditional energy a source which is sustainable to future.

'If there is will there is way' this phrase is all time correct because the alternate source is founded / discovered which is named as sustainable energy sources. These sources are reliable, easy to reproduce or can be use carefully with awareness and mostly important they are environmentally concerned as well as human friendly energy source.

There are mainly two pillars of sustainable energy which are renewable sources and energy efficiency. As discussing about the renewable energy it is totally dissimilar with the traditional energy because, traditional energy produces harmful gases, the sources of traditional energy are limited and the can execute after some time but, on the other hand the renewable energy is eco-friendly, this type of energy sources can be reproduce that is infinite so there no fear of execution of energy.

On the other hand the energy efficiency can plays the important role in supporting to the renewable energy and the combined structure of this two things are known as sustainable future energy.

In renewable energy there are many sources which are Sunlight, Hydro power, Wind power, geothermal energy, Tides, Rain, Etc. The example of energy efficiency is "using of fluorescent lights/LED lights at replacement of old incandescent light."

2. OBJECTIVES

1. To supplement efforts in bridging gap between demand and supply of energy with renewable energy sources replacing traditional sources or by using hybrid systems.
2. To create awareness for moving towards clean reliable, secure and competitive energy supply.
3. Power sources like Sun, Wind and nuclear power are considered

to determine the kind of energy that they can provide.

4. To create awareness about wastage of energy, to reduce the energy use by switching it of when not required as well as use efficient devices (Use of LED bulbs instead of florescent or incandescent bulbs).

3. LITERATURE REVIEW

T. M. Razykov etal [1] – Commented about current development in mono- and polycrystalline thin film photovoltaic technology based on semiconductors.

Yinghao Chu etal [2] – commented on topic "Review and Comparison of Different Solar Energy Technologies." Stated that there are many harmful effects of using traditional energy and also gives reasons how solar energy gives support to clean and sustainable energy as well as advantages of solar energy over traditional energy.

Ashish S. Ingole etal [3] – Stated that "Now a day's electricity is most needed facility for the human being. All the conventional energy resources are depleting day by day. So all human beings have to shift from conventional to non-conventional energy resources. In this the combination of two energy resources is takes place i.e. wind and solar energy, which is more efficient."

Charles F. Kutscher etal [4] – gives the information about geothermal energy sources present in USA as well as history related to USA about geothermal energy sources, in USA there are more than 20 Geothermal energy production plants present at current situation and that plants provides 2200 MW clean and reliable electricity. Total identified sources can produce 20000 MW power in US and if all undiscovered sources will founds then 5 times energy can produced.

Chiyembekezo S. etal [5] – Stated that Hydropower is an important renewable energy resource worldwide. However, its development is accompanied with environmental and social drawbacks. Issues of degradation of the environment and climate change can negatively impact hydropower generation. A sustainable hydropower project is possible, but needs proper planning and careful system design to manage the challenges. Well-planned hydropower projects can contribute to supply sustainable energy.

Kenneth Gillingham etal [6] – stated that "Energy efficiency and conservation are considered key means for reducing greenhouse gas emissions and achieving other energy policy goals, but associated market behavior and policy responses have engendered debates in the economic literature."

4. DISADVANTAGES OF TRADITIONAL ENERGY SOURCES

There are many advantages of using traditional energy sources but "As every coin has two sides" we can not neglect the disadvantages. Traditional sources can produce harmful gases and they can spread in environment which is harmful for human being as well as on the Forest life. These sources have limited storage so they can deplete after some years. Due to combustion of fossil fuels, coal some gases like CO_2, HC, NOx from cars, etc are released into air.

These sources extracted by mining so high costly machines are used which have a result as these sources are more costly.

If think about the atomic or nuclear energy also there is a very big risk of radiation which can directly impacted on human genes and then total generation can be infected by this and it causes long term effects on environment.

5. ADVANTAGES

There are many advantages while using the sustainable energy sources as well as disadvantages are present but disadvantages are very few and negligible as compared to advantages. There are many reasons to use this modern sustainable future energy sources as alternative source to the traditional energy. The sustainable energy source gives more stability to the human life, advantages of sustainable energy are as follows:-

1. There is no any fear of run out of renewable energy because as its name indicates that this kind of sources can be produced easily so this source is sustainable energy system.
2. The renewable energy sources are a clean and reliable energy source that is it gives trust about sustainability of energy for future.
3. The renewable energy sources are natural sources, so they are environmentally concerned as well as it helps to save the traditional energy sources.
4. As the energy sources are natural so they can also economically good for the country as well as for world.
5. The renewable energy plants has low operating cost because, if the windmills was setup then on other operating cost is required.
6. There is no any effect on daily life due to renewable energy production plants because, if solar panels are placed over roof of houses then it produces energy at day time without any requirement of supervision.
7. Using energy efficient is an efficient way to give support for countries economical conditions because energy efficiency reduces the cost of heating, electricity if proper method is used to conduct energy use.
8. If use of energy is under control then the requirement of energy is also some much reduced and it is leads to decrease in amount of traditional fuels used to generate energy.
9. Energy efficiency can give the contribution for sustainability for future energy sources.

6. FUTURE SCOPE AND CURRENT ENERGY USE

In future the most of the energy requirements will be fulfils by renewable energy sources and efficiency energy use produces awareness to reduce the use of conventional energy or fuel usage.

Current energy usage is as shown in fig 1.1 and the renewable energy operated power plants continuously increasing from 1996 to 2011 and always growing in future also the capacitiy of producing the clean as well as sustainable energy is also increasing, it gives the output as in future there is an balanced fulfillment of energy requirement from renewable sources and non renewable energy sources and the efficient energy use is act as a backbone for conventional energy sources as well as for non conventional sources.

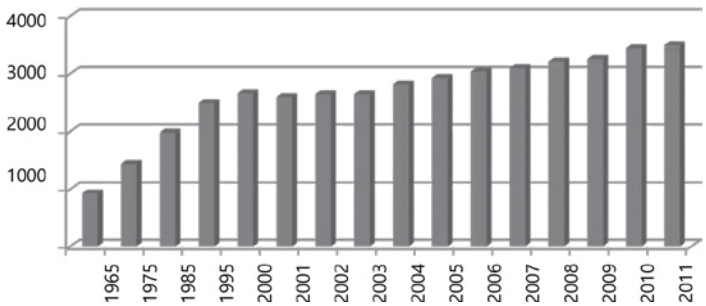

Fig 1.2 worldwide hydro electricity consumption (in TWH)

As shown in fig 1.2 the consumption of electricity produced by using hydro power plant is increases, that it indicates the peoples are attracted towards the hydro energy at the start in 1996 very few countries accept this sources after that when the advantages of this sources is spread all over the world then one by one all countries shows the interest to produce energy from this non conventional but effective source.

Mostly after traditional energy sources only hydro power plant can give or sustain the load of requirement of electricity. The most efficient energy source in renewable energy source is hydro power plants.

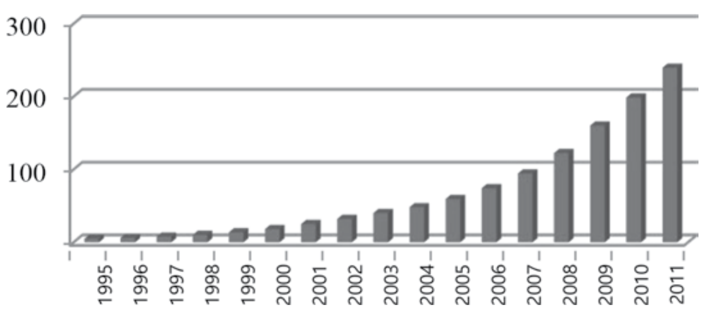

Fig. 1.3 cumulatively installed wind turbine capacity (in GW)

The wind turbines or wind mills is a good energy source but it has some limitations like it requires the area having high altitude. The ideal place has to be found first for placing a wind mill and then it planted but this source can give also a clean energy and operating cost is very low, once if windmill was placed then it can provide energy as possible.

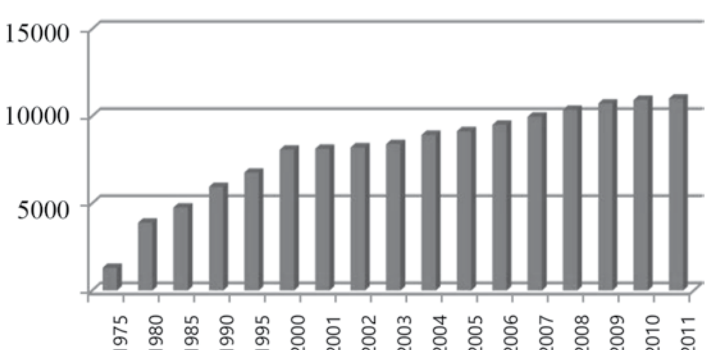

Fig. 1.5 cumulatively installed geothermal capacity (in MW)

All renewable sources except solar energy can able to give Alternative current (AC current) but solar energy can give Direct Current (DC current) which has an advantage of that it can be stored easily in cells or batteries.

Geo thermal is newly introduced before some years this is also a good source of energy, but these energy can be used by mining towards in the earth nucleus. This energy can be extracted from highly hot rocks called as Magma. The extreme heat is present in magma, but these energy hot rocks just few miles beneath the earth surface which heated due to magma because Magma is very dangerous to handle.

As seen in above all graphs the world tries to move towards the renewable energy sources to produce the sustainability in energy field in future.

7. CONCLUDING REMARK

In current condition, energy demand is increasing day by day due to vast use of Electricity, Transportation, Etc. and most of the energy demand is fulfilled by using fossil fuels, nuclear power, Coal, Etc which are traditional energy. Continuous heavy use of this energy sources can produces an heavy stress on energy sources because the there are limited sources of traditional energy so this sources will depleted in several years.

At this condition world will have to accept that, it is necessary that we will have to deplete our dependency on traditional energy source to reduce pollution, Economical disturbance, Etc and world will have to use renewable energy sources and proper use of supplied energy to satisfied energy efficiency, it's very important to reduce the stress producing on energy supply.

After some years if stress on energy supply will not reduced then the energy production is very costly and may be impossible to produce as well as now a days the Global warming is an biggest environmental disaster withstand with various pollution related problems due to use of traditional energy. So here we conclude that we have to achieve that stage in which we are not mostly depend on traditional energy which results greater number of use of non traditional sources.

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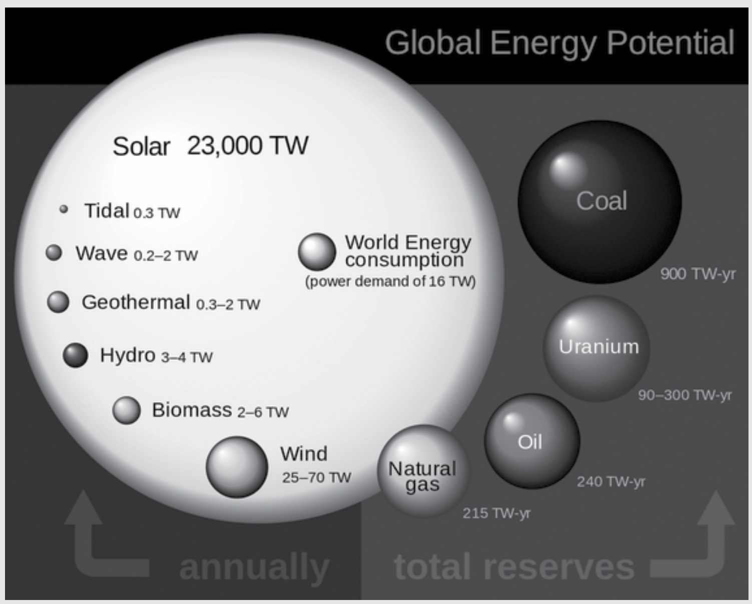

All energy is ultimately derived for the sun and harvesting it directly through solar power seems to be the best way to transition to renewable energy.

...PETER RIVE

"Measurable – verifiable of carbon emission, carbon tax"

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Abstract: *As seen in the past (1990-1992), reference of carbon tax system has been started in Norway and Netherlands. There was increase in total emission of both the countries.*
In world the total emission had been increased by 2.11% from 1990-1999.Carbon tax is highly recommended by economists and various international organizations as an efficient market based pollution restriction remedy. Many countries like Australia, Sweden and Denmark have already started to apply for the 'Carbon Tax System'. This paper esteemed the study about supply and demand of CO2 Emission in developed, developing as well as undeveloped countries and also discuss about issues in
the design of such tax at world scenario. So by using carbon tax system we can diminish amount of CO2, NO x as well as various hydrocarbons .It will develop high amount of renewable energy sources and start to lower the tax rates. This paper also highlights about advantages, disadvantages, effects of this tax system on the world's economy with live examples.

Keywords : *Carbon policy, comparative growth carbon in different countries, various GR'S.*

1. INTRODUCTION

Carbon tax existed on international platform 20 years before. Carbon tax system emerged in North European countries like Finland, Netherland, Norway, Sweden and Denmark in between period of 1990-1992. Finland is the first countries who employ carbon tax system. After 10 years, United kingdom starts to charge on carbon emission.

Recently U.S.A. pass it's carbon policy namely Fedral Carbon Policy. The U.S. house of representatives passed a G.R. which is known as "H.R. 2454" which means "The American Clean energy and Security act of 2009". This Fedral Carbon Policy focused on taxing of fossil fuel production and it's imports. This tax charges 10-15 per ton of CO2 in year 2009 and this charges varies time to time.

Before carbon tax system comes in exist carbon cap and trade system was in present. But carbon cap and trade system is relatively inflexible comparing with carbon tax system. To gain more benefits carbon taxing is employed, this system is used as effective weapon to control the carbon emission which leads to serious crisis like Global warming, Ozone depletion, Long period draughts etc.

The paper discuss the carbon implementation on domestic as well as international level. It is also shows effectiveness of laws created due to carbon emission. Although all carbon taxes has its core is co2 and green house gas emission. Paper also shows country wise carbon production and tax rates.

2. LITERATURE REVIEW

Annegrete Bruvoll etal [1] studied on green house gas emission and stated that "Norwegian carbon taxes are largest in the world. Carbon tax system is modest tax system in world and also effective remedy to restrict green house gas emission. He also analyses the carbon emission percentage since 1990."

Gilbert E. Metcalf etal [2] focused on design of tax which charged on emission of green house gases in South Africa and also noted that "A tax forces individuals to consider the full set of consequences from emissions." Julius Andersson etal [3] Focused on Value Added Tax (VAT) in Sweden charge for green house gas emission and researched that CO2 emission in Swedish transport sector was reduced up to 11% in which 6% reduction happens due to carbon tax system.

Nicholas Rivers etal [4] Researched on effect of carbon tax system on agriculture field in British Columbia province, the province unilaterally charging carbon tax on fossil fuels which use under British-Columbia border.

Sunder Ramaswamy etal [5] Studied that few countries adopt carbon tax system and operate it in efficient manner and what its effect on Indian tax system, also studies beneficial condition of this system for India.

3. HISTORY AND CURRENT AFFAIRS

In early of 20th century carbon emission percentage was reached up to 2.11%. It became necessary to reduce this carbon emission. This necessity became a base of carbon tax system. In the early of 1990 carbon tax system became part of economic system in some northern European countries like Finland (1990), Netherland (1990), Norway (1991), Sweden(1991) and Denmark (1992). Finland was the first country to adopt carbon tax policy for reduction of carbon in their country.

1) Finland: Finland was the first country to adopt carbon tax which ejected in 1990. Finland's carbon tax policy is totally separated from excise duties on fossil fuels which are used for transportation as well as industrial purpose. This tax is applicable on gasoline, diesel, light fuels, heavy fuels, jet fuels, and aviation gasoline, coals like Peat and Bituminous and Natural gas. At present finish government declare that Co2 emission minimize up to 4 metric tons due to carbon tax policy.

2) Netherland: The Netherland's carbon tax policy starts in 1990. This carbon tax policy is applicable for natural gas, electricity, blast furnaces, coke ovens, crude oil refineries, carbon gas, gasoline, diesel and light fuels also. In the year of 1996, the Netherland's carbon tax rate is $20 per metric ton. At that time, carbon tax is the majority tax in dutch government.

The dutch government planning that Co2 reduction takes place 1.7 to 2.7 million metric tons annually up to 2000. Which is approximately 5% and up to 2010 it reduced up to 3.6 to 3.8 million metric tons which reaches 4.6 to 5.1 million tons in future(up to 2020).

3) India: India is world's largest coal producer in world. In the early 1970 India's coal production became nationalized. At that time India's coal production was 70 million tons which reaches 638.5 million tons at 2015 to 2016. 1st July 2010 India launched carbon tax system. Indians pay 50 rupees per ton carbon tax system on coal which produced & imported in India. In 2014 this cost reaches up to 100 rupees per ton & now up to 400 rupees per ton in 2016.Carbon tax system in India comes under finance act 2010 under section 83{3} which levied as excise duty.

Table 1.1 – Annual Coal expenditure in India

Financial year	Expenditure
2011 to 2012	Rs. 2580 crore
2012 to 2013	Rs. 3050 crore
2013 to 2014	Rs. 3520 crore
2014 to 2015	Rs. 6587 crore

4) South Africa: The South African carbon tax system existed in 1st September 2015 which was announced by their former finance minister Mr. Pravin Gordhan. This carbon tax system is applicable for new vehicles. This tax will applicable during the purchasing of vehicle and continued until it scraps. This tax is first applicable

Table 1.2 – Statistics and graphical representation

Fuel	CO_2 emission	Tax per unit	Tax per Kwh of electricity
gasoline	19.6 lb/US gal (2.35 kg/L)	n/a	n/a
diesel fuel	22.3 lb/US gal (2.67 kg/L)	n/a	n/a
jet fuel	22.1 lb/US gal (2.65 kg/L)	n/a	n/a
natural gas	0.1206 lb/cu ft (1.93 kg/m3)	117 lb/MBTU (181 g/kWh)	$0.0066
Lignite coal	2791 lb/ton (1.396 kg/kg)	215 lb/MBTU (333 g/kWh)	$0.0121
Bituminous coal	3715 lb/ton (1.858 kg/kg)	213 lb/MBTU (330 g/kWh)	$0.0119
Coal peat	4931 lb/ton (2.466 kg/kg)	205 lb/MBTU (317 g/kWh)	$0.0115
Anthracite coal	5685 lb/ton (2.843 kg/kg)	227 lb/MBTU (351 g/kWh)	$0.0127

to passengers cars but after words it is applicable to commercial vehicles also.

Mr. David powels who is the chief of National Association of Automobile Manufacturer Association of South Africa oppose taxation to light commercial vehicles. The carbon tax system plantation in south Africa is to achieve power output by sustainable path which leads to depletion of carbon percentage in environment.

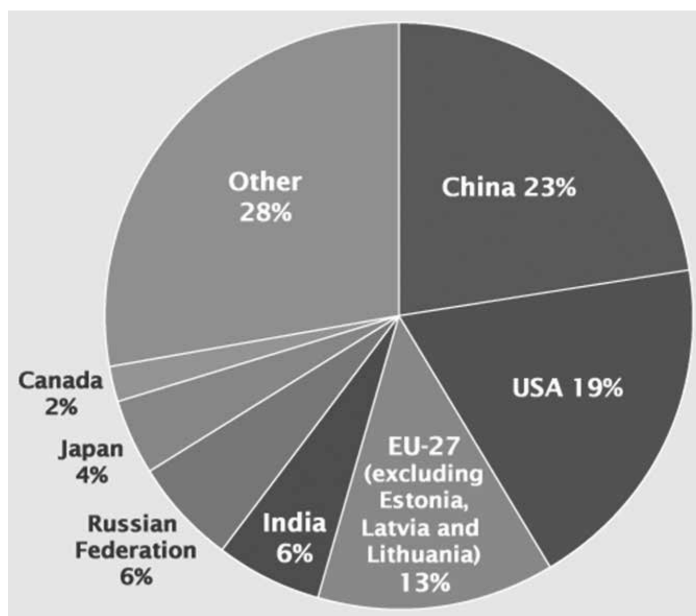

Fig 1.1 – Carbon emission in world (in %)

Above pie chart shows percentage of carbon emission by developed as well as undeveloped countries. Hazardous result of carbon percentage is represented in percentage manner.

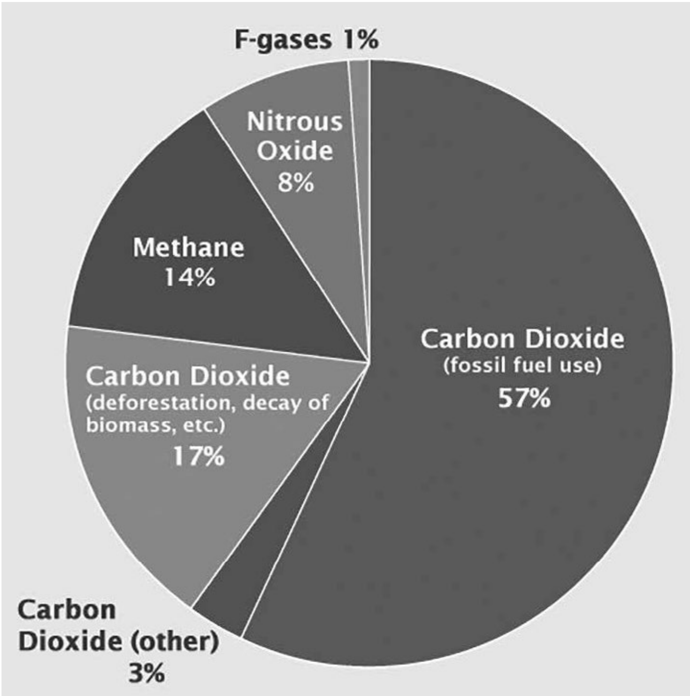

Fig 1.2 – Carbon Content in atmosphere (in %)

Table 1.3 Internal Carbon Prices for Various Companies.

Company name	Carbon pricing (in $)
Mahindra and Mahindra	10
Infosys	10
Adani gas	10
Shell	40
Google	13
Microsoft	6

5. ADVANTAGES

The purpose of the carbon tax system is to reduce green house gasses emission in atmosphere. This tax helps to decrease dependency on fossil fuel which is used for various purposes and convert this use of fossil fuel into renewable energy sources.

Before carbon tax system cap and trade system was followed to restrict carbon emission but this system had some limitation and troubles which was cleared by carbon tax system.

Carbon tax system encourages researchers to find alternative source and its routine application. This results in more environment friendly ideas and systems will be generated, accepted and it become convenient for use. Carbon tax also helps to increase revenue. It was observed that in 2011, carbon tax raises up to 20$ per ton which totally reaches up to 1.2 trillion. This amount is helpful for research and development of green energy.

6. CONCLUDING REMARK

The analysis of above paper suggests that carbon tax is efficient and convenient way to deplete the carbon emission. The paper highlights carbon emission percentage and various countries carbon system which concern with various taxes like VAT (Value Added Tax).

Before some years, carbon emission reaches up to 36.2 billion metric tons. The largest carbon dioxide producers countries are USA, Russia, India, China. In which China emits largest amount of CO2 in world.

In current condition, energy demand is increasing day by day due to vast use of Electricity, Transportation, Etc. and most of the energy demand is fulfilled by using fossil fuels, nuclear power, Coal, Etc which are traditional energy sources. Continuous heavy use of this energy sources causes larger amount of CO2 production which tends to disastrous environmental activities like global warming, climate change, lack of rain, over flooding etc. so this paper conclude that worldwide carbon emission increases vastly to prevent this carbon tax system act as an excellent remedy. But there is some uncertainties in this tax also which have to clarify for its efficient working. Also we will have to decrease our dependency on traditional fuel sources.

6. Future Scope

The carbon tax system was introduced in 1990 to reduce carbon emission. Finland was first country who adopts carbon tax and at present Denmark, Finland, Germany, Ireland, Italy, The Netherland, Norway, Slovenia, United Kingdom, Sweden, Switzerland, USA, India etc.

In future the traditional energy sources will be executed so human territory will have to find new energy sources. Also at present we are facing major crises like Global Warming, Ozone Layer Depletion, Draughts, and Infertility of soil.

To overcome from this crisis and for conserving atmosphere carbon tax must be adopt by each and every country of world. Also we will have to make this tax system as strong and strict as possible to reduce carbon emission.

Some graphs and charts show vast carbon emission in atmosphere.

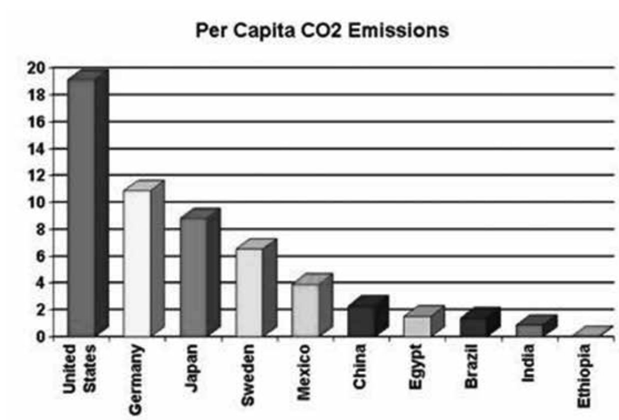

Fig 1.3 – Carbon Content by various countries.

Above graph shows that carbon emission reaches at hazardous level.

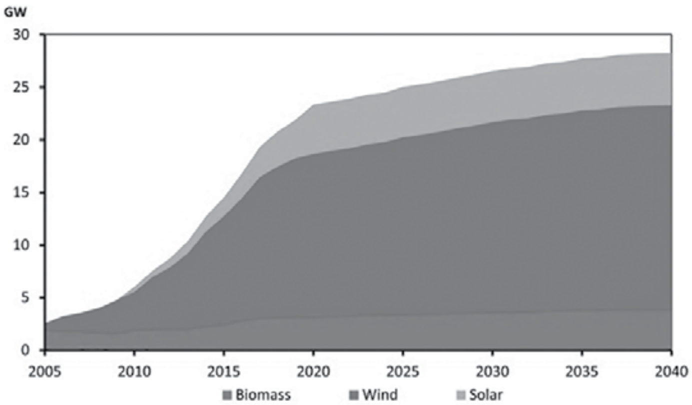

Fig 1.4 – Usage of clean energy source after carbon tax implementation and its future scope

This graph indicates after using carbon tax system carbon emission depletes in some amount and people turn towards clean energy source which is convenient and eco-friendly. This graph also forecast that up to 2040 clean energy usage increases which resulting in superior success of carbon tax system.

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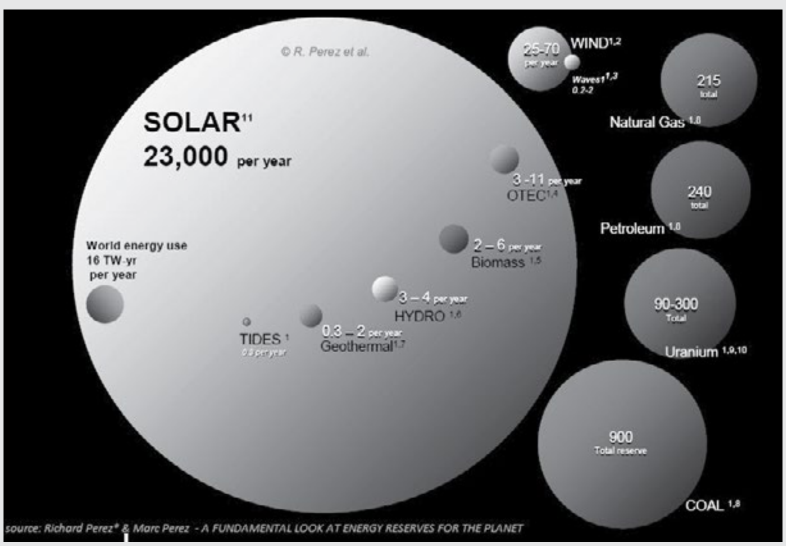

The whole idea of the solar project is to do something useful and replace dirty energy with clean energy.

...NICK KELLY

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इंस्ट्रुमेंटेशन	इंस्ट्रुमेंटेशन टेक्निशियन	१२वी पास, आय.टी.आय. (इलेक्ट्रॉनिक्स/इंस्ट्रुमेंटेशन/इलेक्ट्रिकल)

कालावधी ४ महिने

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विद्या प्रसारक मंडळाचे तंत्रनिकेतन स्थापना १९८३

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