Honda Y-E-S Forum

Honda Y-E-S Forum 2016

Achieving Energy Security through Ecotechnology

エコテクノロジーで エネルギー安全保障を実現する

公益財団法人 本田財団
HONDA FOUNDATION
Organized by Honda Foundation

November 19 (Sat), 2016

Acknowledgement from Honda Y-E-S Awardee Representatives

The completion of this Honda Y-E-S Forum 2016 could not be possible without the participation from these following people and organizations who strongly supported us in various ways. To begin with, we would like to sincerely thank you to Honda Foundation that initiated this forum, as well as, provided financial, intellectual and physical support.

Special thanks go to the Honda Prize Laureate for sacrifice the time attending the forum and giving meaningful suggestions. Also, we would like to express our deep appreciation to the panel moderator for running a very productive panel discussion, our indebtedness to the keynote speakers and guest speakers who presented a very astonishing idea regrading to eco-technology which really light up and inspire the audiences to pursue their goals.

A deep sense of gratitude we give to Japan Science and Technology Agency (JST) for their support and helped us coordinate our forum. A big thank to Japan International Cooperation Agency (JICA) for attending our forum and a special thank to Chiyoda Corporation for creating an interesting industrial exhibition.

We would like to convey our gratefulness to Embassies of Cambodia, India, Lao, Myanmar and Vietnam in Japan, participating universities and Y-E-S awardees currently studying in Japan for interesting in our forum.

Our thanks and appreciation also go to the poster contestants who enthusiastically made full efforts in presenting their research fields, making our forum filled with diversity of eco-technology topics. Thanks to our judges who worked very hard on bringing out the most proper and outstanding research poster. Their contributions are sincerely appreciated and gratefully acknowledged.

Moreover, we would also like to acknowledge the Fukutake Hall, University of Tokyo and the staffs who gave permission to use all required facilities and materials to achieve the tasks.

We appreciate the comments and guidance given by other audiences who came to the forum, those suggestions will definitely benefit and help improving all Honda Y-E-S awardees' skill.

Last but not least, we would like to give a big thank to all Honda Y-E-S Alumni members that sacrificed their time and strength, working together to make this Honda Y-E-S Forum 2016 successful.

About the Honda Y-E-S Award

We started the Honda Y-E-S (Young Engineer and Scientist's) Award program for young students to foster future leaders of science and technology fields in 2006 as a part of the Honda Foundation's 30th anniversary project. Now this program is implemented in 5 Asian countries; Vietnam, India, Cambodia, Laos and Myanmar. This system grants awards to students who have excelled in the area of science and technology and who continue to aspire to higher academic achievement. Furthermore, the grant is awarded in two stages. The program hopes to promote dissemination of Ecotechnology among the young generations and at the same time to strengthen interaction and exchange between Japanese youths and young people expect to lead science, technology and industry in their respective countries.

For further information, please visit our website: http://www.hondafoundation.jp/en/index.html

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主催
公益財団法人 本田財団
HONDA FOUNDATION
Organized by Honda Foundation

後援
科学技術振興機構
Japan Science and Technology Agency
Supported by Japan Science and Technology Agency

2016年 11月19日（土）10:00-17:30
場所：東京大学大学院 情報学環 福武ホール
東京都文京区本郷7-3-1

November 19 (Sat), 2016 10:00-17:30
Fukutake Hall, The University of Tokyo
7-3-1, Hongo, Bunkyo-ku, Tokyo

Message from the President

ご 挨 拶

20世紀は、生産、運輸、通信などの活動における様々な技術革新が、目覚ましい経済成長と大いなる繁栄をもたらしました。にも関わらず、この成果は環境破壊や地域紛争などの深刻で複雑な問題をも引き起こしています。

このような問題を解決するために様々な研究や努力が試みられています。先進国は制度改革や技術革新などを通じて、問題の克服においてある程度の成果を上げています。開発途上国の一部は、現在その発展の萌芽の時期を脱して飛躍的な成長の段階へ移行しつつありますが、その一方で、石油などの化石燃料の枯渇や、際限なく増えていく都市部でのエネルギー需要、非効率的なエネルギー使用など、経済活動の拡大に伴うエネルギー安全保障に関する種々の問題が、目下の課題となっています。今こそ、世界の国々が手を結び、私たちの社会が繁栄し続けることができるよう対処することが期待されており、それこそが人類のあるべき進化の姿と考えます。

このような状況を踏まえ、今回2回目の開催となるHonda Y-E-S Forumは、「エコテクノロジーでエネルギー安全保障を実現する」をテーマと致しました。Honda Y-E-S Forumは、日本を含むアジアの学識経験者や研究者、若手科学者が、地域の課題認識や、その解決に科学技術が果たすべき役割などを議論する場として企画されました。プログラムに関わる各国が協力し合いながら、理工系の人材育成ならびに人的ネットワーク拡大に貢献することがその狙いです。

アジアの、そして世界の国々が、エネルギー安全保障に配慮しながら、お互いに手を携えてどのように人類の発展の道筋を描いていくのか。この問いへの答えを探求するのが、このForumの目的でもあります。将来のリーダーを嘱望される若い人々を後押しして、彼らが地球の持続可能性にポジティブな変化をもたらすよう、我々の取組みが少しでも貢献できるなら大変幸いなことであります。

In the 20th century, various technology innovations in production, transportation, telecommunication, and other activities have brought a spectacular economic growth and great prosperity. Nevertheless, this achievement has caused serious and complex issues, including environmental destructions and regional conflicts.

Various research and efforts have been done to confront these problems. Industrialized countries have produced results in overcoming them to some extent, through structural reform, innovative technologies, etc. Among some of the developing countries, a transition is taking place with economic development moving away from its initial infancy stage toward dramatic growth. However, alongside such expansion in economic activities, energy security issues such as oil and other fossil fuel depletion, ever-increasing energy demand in urban areas, the inefficient usage of energy, etc., have become present challenges. Now it is a time for countries around the world to join hands and take action to secure the continuous prosperity of our society. This is the direction in which we believe humankind should evolve.

Having such situation as background, “Achieving Energy Security through Ecotechnology” came to be the theme of the second Honda Y-E-S Forum, which had been designed as a venue for discussion among the academic experts and researchers, young scientists and engineers of Asia, including Japan, to raise up the consciousness of issues in the region and the role that science and technology should fulfill in resolving them. The Forum hopes to contribute to human resources development in science and technology fields, and human network growth in the area through cooperation between countries involved in the program.

How do the Asian countries and the rest of the world cooperate and plan together the direction of progress for humanity, with their attention focused on the energy security? Answering this question is the purpose of this Forum. We hope that through our activities, we can do something to encourage young people who are expected to be future leaders, to make positive changes for the global sustainability.

公益財団法人 本田財団
理事長

石田寛人

Hiroto Ishida
President, Honda Foundation

Program プログラム

9:30 開場　Doors Open

10:00 開会挨拶　Opening Remarks
石田 寛人　本田財団 理事長　Hiroto Ishida, President, Honda Foundation

10:15 Y-E-S 奨励賞受賞者によるプレゼンテーション　Presentations by the Y-E-S Awardees
アジア各国におけるエネルギー安全保障について
- ■ ベトナム Vietnam　ベトナムにおけるエネルギー：現状と風力発電の潜在性 Energy in Vietnam: Current Status and the Potential of Wind Power
- ■ インド India　インドのエネルギー安全保障のための再生可能エネルギー利用 Renewable Energy Interventions for Energy Security in India
- ■ カンボジア Cambodia　都市部貧困地域での省エネルギー　Energy Saving in Poor Urban Settlements
- ■ ラオス Laos　ラオスにおける将来のエネルギートレンドに対応する水力発電 Hydropower to Deal with Future Energy Trend in Lao PDR
- ■ ミャンマー Myanmar　ミャンマーにおけるエネルギー価格政策　Energy Pricing Policies in Myanmar

11:30 エネルギー関連技術について Y-E-S 奨励賞受賞者によるプレゼンテーション　Presentation by the Y-E-S Awardee Specialized in Energy
電気自動車で地球を救う－制御工学の視点から　Save Our Planet with Electric Vehicles – From the Control Engineering Point of View
Nguyen Binh Minh, Ph.D.（2006 年 Honda Y-E-S 奨励賞受賞者）（2006 Honda Y-E-S Awardee）

11:50 研究ポスターコンテスト プレゼンテーション　Research Poster Contest Presentation

12:20 展示企業プレゼンテーション（千代田化工建設(株)）　Industrial Exhibition Presentation by Chiyoda Corporation

12:30 ランチタイム／研究ポスター観覧・投票　Lunch time / Research Poster Viewing and Voting

14:15 基調講演 1　Keynote Speech 1
再生可能燃料による持続可能文明への転換　Renewable Fuel: the Pathway to Sustainable Civilization
中野 義昭　博士　東京大学 大学院工学系研究科電気系工学専攻 教授
Yoshiaki Nakano, Ph.D.　Professor, Dept. of Electrical Engineering and Information Systems, Graduate School of Engineering, the University of Tokyo

基調講演 2　Keynote Speech 2
嵐の中の将来エネルギーと持続可能な原子力　Stormy Energy Future and Sustainable Nuclear Power
田中 伸男　氏　笹川平和財団 理事長 / 国際エネルギー機関 (IEA) 元事務局長
Mr. Nobuo Tanaka　President, The Sasakawa Peace Foundation / Former Executive Director of International Energy Agency（IEA）

（休憩 Break）

15:15 パネルディスカッション　Panel Discussion
ファシリテーター：内田 裕久　博士　Facilitator: Hirohisa Uchida, D.Sc.

（休憩 Break）

17:00 本田賞受賞者挨拶　Remarks by Honda Prize Laureate

研究ポスターコンテスト発表＆表彰　Award Ceremony for Research Poster Contest

閉会挨拶　Closing Remarks

17:30 閉会　Closing

Exhibition 企業展示

CHIYODA CORPORATION

千代田化工建設は、戦後日本の再建復興期である1948年に誕生した総合エンジニアリング会社です。「エネルギーと環境の調和」を経営理念とし、国内外にLNG・石油・ガス・化学をはじめとする様々なプラント・施設の建設実績を多数有しています。

現在は、コア事業であるLNG・石油・ガス等のエネルギー分野の他、再生可能エネルギー、水素エネルギー、ライフサイエンス分野等も成長分野として注力し、また、海洋資源開発分野の遂行体制を整備するなど、事業拡大への取組も着実に進めています。

当社を取りまく事業環境は大きく変化していますが、エンジニアリング会社として技術の研鑽に励み、時代を的確に捉え、より一層社会の持続的発展に貢献してまいります。

Chiyoda Corporation was founded in 1948 and has numerous accomplishments implementing projects in energy fields including LNG, Oil, Gas and Petrochemical under the corporate philosophy of “enhancing its business by aiming for harmony between energy and the environment”.

Recently, we have focused on not only LNG, Oil, Gas and Petrochemical fields but also increased activity in the growing fields of renewable energy, H_2 energy and life science. We have also been developing infrastructure for subsea projects in an endeavor to expand our business portfolios.

Although we recognize that conditions in our operating environment have changed drastically, as an integrated engineering company, we wish to seize the moment and continue to contribute to the sustainable development of society through tireless dedication to technologies.

Speaker Profile

Vietnam

1.受賞年/ Y-E-S Award Year
2.学歴/ Education
3.現在の職業/ Current Occupation

ベトナム

Nguyen Thi Phuong Thao

1.2007年 Y-E-S 奨励賞受賞者
2.ダナン大学工科大学 機械製造 / 長岡技術科学大学にて博士号取得
3.ドゥイタン大学研究員

1. 2007 Y-E-S Awardee
2.Machinery Manufacturing, Da Nang University of Technology / Ph.D. from Nagaoka University of Technology
3.Researcher at the Institute of Research and Development, Duy Tan University

Nguyen The Tuyen

1.2012年 Y-E-S 奨励賞受賞者
2.ベトナム国家大学ハノイ校工科大学 電子工学・電気通信
3.フリーランスWeb アナリスト

1.2012 Y-E-S Awardee
2.Electronics & Telecommunications, University of Engineering & Technology-VNU Hanoi
3.Freelance Web Analyst

Vu Truong Minh

1.2014年 Y-E-S 奨励賞受賞者
2.ハノイ工科大学 環境科学技術
3.ハノイ工科大学 研究員

1.2014 Y-E-S Awardee
2.Environmental Engineering, Hanoi University of Science and Technology (HUST)
3.Researcher at HUST

India

1.受賞年/ Y-E-S Award Year
2.学歴/ Education
3.現在の職業/ Current Occupation

インド

Sumeet Sanjay Gattewar

1.2008年 Y-E-S 奨励賞受賞者
2.インド工科大学カラグプール校 機械工学
3.教育関連会社IIT-HOME CEO

1.2008 Y-E-S Awardee
2.Mechanical Engineering, IIT Kharagpur
3.CEO, IIT-HOME, a unit of True Education Institute Pvt. Ltd.

Jay Deepak Parikh

1.2009年 Y-E-S 奨励賞受賞者
2.インド工科大学ボンベイ校 電気工学 / インド経営大学院にてMBA取得
3.Bain&Co社 コンサルタント

1.2009 Y-E-S Awardee
2.Electrical Engineering, IIT Bombay / MBA from IIM Ahmedabad
3.Consultant at Bain & Co.

Saumya Kapoor

1.2012年 Y-E-S 奨励賞受賞者
2.インド工科大学カンプール校 化学工学/ インド経営大学院にてMBA取得
3.マッキンゼー・アンド・カンパニー コンサルタント

1.2012 Y-E-S Awardee
2.Chemical Engineering, IIT Kanpur / MBA from IIM Ahmedabad
3.Consultant at McKinsey & Co.

Cambodia

1.受賞年/ Y-E-S Award Year
2.学歴/ Education
3.現在の職業/ Current Occupation

カンボジア

Thorn Sopheaktra

1.2011年Y-E-S 奨励賞受賞者
2.王立プノンペン大学　生化学
3.初等教育のためのカンボジア・アクション 科学教育専門家

1.2011 Y-E-S Awardee
2.Biochemistry, Royal University of Phnom Penh
3.Science Education Specialist at Kampuchean Action for Primary Education (KAPE)

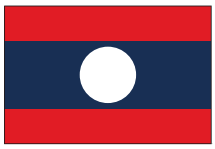
Phon Bunheng

1.2014年 Y-E-S 奨励賞受賞者
2.カンボジア工科大学　建築工学
3.フリーランス建築家

1.2014 Y-E-S Awardee
2.Architectural Engineering, Institute of Technology of Cambodia
3.Freelance Architect

※所属・役職名は開催当時のものです。
※Organizations and titles are at the time of the Forum.

Speaker Profile



Laos

ラオス

1.受賞年/ Y-E-S Award Year
2.学歴/ Education
3.現在の職業/ Current Occupation

Nalinh Thoummala

1.2015年 Y-E-S 奨励賞受賞者
2.ラオス国立大学工学部 コンピューター工学・情報技術
3.ラオス国立大学在学中

1.2015 Y-E-S Awardee
2.Information Technology Engineering, National University of Laos (NUOL)
3.Studying at NUOL

Anoulak Hongvanthong

1.2015年Y-E-S 奨励賞受賞者
2.ラオス国立大学工学部 電気工学
3.ラオス国立大学在学中

1.2015Y-E-S Awardee
2.Electrical Engineering, National University of Laos (NUOL)
3.Studying at NUOL

Myanmar

ミャンマー

1.受賞年/ Y-E-S Award Year
2.学歴/ Education
3.現在の職業/ Current Occupation

Kay Khaing Kyaw

1.2014年Y-E-S 奨励賞受賞者
2.工科大学マンダレー校 土木工学
3.アジア工科大学修士課程（タイ）

1.2014 Y-E-S Awardee
2.Civil Engineering, Technological University Mandalay
3.Studying in a master course on Water Engineering and Management in Asian Institute of Technology (AIT), Thailand

※所属·役職名は開催当時のものです。
※Organizations and titles are at the time of the Forum.

Speaker Profile

東京大学 大学院工学系研究科電気系工学専攻 教授

中野 義昭 博士

略歴

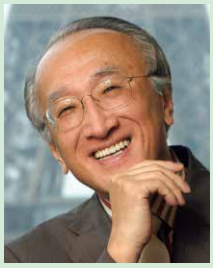
1987年3月　東京大学大学院工学系研究科電子工学専門課程博士課程修了、工学博士
2000年10月 東京大学大学院工学系研究科電子工学専攻 教授
2010年4月　東京大学先端科学技術研究センター 所長
2013年4月　東京大学大学院工学系研究科電気系工学専攻 教授、現在にいたる。

また、カリフォルニア大学サンタバーバラ校 客員助教授、NEDO革新的太陽光発電技術開発事業プロジェクトリーダなどを務めた他、IEEE LEOS理事、応用物理学会理事、APEX/JJAP誌編集委員長、電子情報通信学会理事、同エレクトロニクスソサイエティ会長、光産業技術振興協会評議員などを歴任。

Yoshiaki Nakano, Ph.D.

Professor, Dept. of Electrical Engineering and Information Systems, Graduate School of Engineering, the University of Tokyo
Major research fields: Semiconductor optoelectronics, high-efficiency solar cells, photonic integrated circuits

He received Ph. D. degrees in electronic engineering, from the University of Tokyo, Japan, in 1987. In 2000, he became professor, the Department of Electronic Engineering, the University of Tokyo. He moved to Research Center for Advanced Science and Technology, the University of Tokyo, in 2002 as a professor, and served as the Director General of the center from 2010 till 2013. Then he moved back to the School of Engineering to fill up the current professorship position with the Dept. of Electrical Engineering and Information Systems. Also, he was a visiting associate professor at the University of California, Santa Barbara.
He was the President of Electronics Society, the Institute of Electronics, Information and Communication Engineers (IEICE), an elected member of the Board of Governors of IEEE LEOS, a member of the Board of Directors of the Japan Society of Applied Physics (JSAP), the Editor-in-Chief of Applied Physics Express (APEX) and Japanese Journal of Applied Physics (JJAP), and a member of the Board of Directors of the Japan Institute of Electronics Packaging (JIEP). He is an associate member of the Science Council of Japan. He is also Fellow of IEICE, Fellow of JSAP, and a member of IEEE EDS and OSA.



笹川平和財団理事長
国際エネルギー機関 (IEA) 元事務局長

田中 伸男 氏

略歴

笹川平和財団 理事長、国際エネルギー機関(IEA) 元事務局長 (2007-2011)
1972年東京大学経済学部卒業、1973年通商産業省 (現経済産業省) 入省、通商機構部長などを歴任
外務省在米国日本大使館公使、OECDでは科学技術産業局長なども務めた。

Mr. Nobuo Tanaka

President, The Sasakawa Peace Foundation,
Former Executive Director of International Energy Agency(IEA)

Nobuo Tanaka is President of The Sasakawa Peace Foundation.
He was Executive Director of the International Energy Agency (IEA) from 2007 to 2011.
He began his career in 1973 in the Ministry of Economy, Trade and Industry (METI) and served in a number of high-ranking positions, including Director-General of the Multilateral Trade System Department. He was Minister for Industry, Trade and Energy at the Embassy of Japan, Washington DC. He also was Director for Science, Technology and Industry (DSTI) of the OECD in Paris.

Nguyen Binh Minh, Ph.D. (2006 年 Honda Y-E-S 奨励賞受賞者) (2006 Honda Y-E-S Awardee)

2015年東京大学で科学博士号を取得。現在は科学技術振興機構(JST)研究員及び東京大学大学院情報理工学系研究科情報物理コンピュータ部門研究員。現在の研究テーマは電気自動車の運動制御、ビジュアル自動制御システム、状態推定理論、マルチエージェント制御理論とその応用など。

He received the Ph.D. degree in science from the University of Tokyo in 2015. He is currently a Researcher at Japan Science and Technology Agency (JST) and the Department of Information Physics and Computing, Graduate School of Information Science and Technology, the University of Tokyo. His current research interests include motion control of electric vehicles, visual servo systems, state estimation theory, multi-agent control theory and its applications.

※所属·役職名は開催当時のものです。
※Organizations and titles are at the time of the Forum.

Biography of Panel Discussion Facilitator

内田　裕久（うちだ ひろひさ）

東海大学工学部原子力工学科・平和戦略国際研究所（SPIRIT）教授／株式会社ケイエスピー　代表取締役社長／本田財団　業務執行理事

東海大学工学修士（1975）、シュツットガルト大学理学博士（Dr. rerum naturalium1977.）、ドイツ材料学会（DGM）名誉会員（2015）、国際水素エネルギー協会（IAHE）フェロー(2014)。
マックス・プランク材料研究所勤務（1975-81）を経て、1981 年より東海大学工学部勤務。研究推進部長、工学部長、副学長、学校法人理事・評議員等を歴任。この間、パリ第11大学（Orsay）招聘教授、UNESCO 国際産学官連携委員、神奈川県知事参与等兼任。専門は水素と材料、水素エネルギー。米国ゴードンリサーチコンファレンス招待講演（1989、1997）など発表論文、著書は多数。国際水素エネルギー協会（IAHE）フェロー・副会長など、水素エネルギーの社会普及に活躍。材料科学分野での功績に対してドイツ材料学会名誉会員となった（2015）。

Hirohisa Uchida, D.Sc.

Professor, School of Engineering and Strategic Peace and International Research Institute (SPIRIT), Tokai University / President & CEO, KSP Inc. / Executive Director, HONDA Foundation

He received Master's degree in Materials Science (1975), Tokai University, and Doctor's degree (Dr. rerum naturalium), University of Stuttgart, Germany. He was researcher at Max-Planck-Institute for Metals Research (1975-1981), and moved to Tokai University serving as Executive Director of Research Promotion, Dean of School of Engineering, Vice Chancellor, Member of Board of Trustees and Councilors of Tokai University Educational System. Concurrently, he was Invited Professor of University of Paris Orsay, member of UNESCO University-Industry-Government Cooperation Committee, Counselor of Governor of Kanagawa Prefecture.
His main field is hydrogen and materials, and hydrogen energy. He was invited by the Gordon research Conference in 1989 and 1997, and published many papers and books. He is active to realize hydrogen society by serving as fellow and vice president of International Association for Hydrogen Energy (IAHE). Because of his high research activity, he was awarded as Honorary Member of German Society of Materials Science (DGM) in 2015.

※所属･役職名は開催当時のものです。
※Organizations and titles are at the time of the Forum.

Opening Remarks

Hiroto Ishida
President, Honda Foundation

Greetings from President at the Y-E-S Forum

Thank you for the introduction. I would like to thank everyone who joined today's forum despite your very busy schedule. On the occasion of the holding of this forum, I would like to deeply express my gratitude for all the support and cooperation offered from various fields, including Japanese universities for joining and applying for the Research Poster Contest.

The Foundation has been developing the grant program "Y-E-S Award" for awarding excellent undergraduate students in science and technology universities in 5 countries, starting with Vietnam 11 years ago, followed by India, Laos, Cambodia, and Myanmar. The representatives of awardees in each country have planned, discussed, and organized today's Y-E-S forum by further extending the Y-E-S Award program. The main purpose of this forum is to contribute to developing the skills and abilities of young scientists and engineers in Asia. It also aims to expand the human network through communications among awardees and with Japanese scientists, getting to know Japanese academics and experts, and bringing back what is learnt during the forum to home countries.

The theme for today's discussion is "Achieving Energy Security through Ecotechnology."
In these countries which are undergoing transition to further development stages, energy demand has expanded with the increase of economic activity. There are becoming major issues of not only stable supply, rational price and environmental conservation but also issues of creating a pathway for conversion from fossil fuels to renewable energy sources.
Recognizing such issues, the role that science and technology has to play in tackling them will be further discussed during this forum. I am also expecting this forum to be an opportunity that triggers and accelerates further cooperation among countries beyond national borders.

This is the second Y-E-S forum and hopefully will be held every year. Today as the second step, we will endeavor to improve this forum to be more fruitful and meaningful for many young scientists. Therefore, we welcome candid and frank opinions so that we can make things better for next time.

I would like to conclude my greeting by asking for your continued cooperation with the Foundation in the future. And please spend nice time in this lovely hall at the University of Tokyo. Thank you.

Nguyen Thi Phuong Thao

2007 Y-E-S Awardee
in Vietnam

Opening Remark by Thao

Good morning, Ladies and Gentlemen. I am Nguyen Thi Phuong Thao from Vietnam. As a Y-E-S awardee and a member of preparation committee for the Y-E-S Forum 2016, I couldn't be more delighted to welcome you all to the Honda Y-E-S Forum 2016.

Once a wise man said, when the last tree has been felled, the last river poisoned and the last fish caught, man will know, that he cannot eat money.

For such a long time, we had put the profit over the human and using the term progress to excuse for the mass destruction of this planet. We have passed the carbon tipping point, and climate change is not a hoax. The earth is our only home and we may not be able to save it to our next generation.

So why did it happen?

For such a long time, I kept blaming the governments and some VIP people who can do something but kept doing nothing. But then I realized that the power to cure this planet is not in their hands. It is in your hands and in my hand. We are the young people with the power of youth, knowledge, and dream. I believe that we can turn back the hand of time, and return this planet as green as we received it from the mother nature.

But that is not a story of one year or of one individual. We need the sharing and cooperating of all the young engineers and scientists. The idea behind this forum has been to bring together on a platform the young engineers and scientists to discuss and find ecotechnological solutions to problems faced in each country and in the world as a whole.

The topic for the forum this year is "Achieving Energy Security through Ecotechnology" – which unquestionably relates to the classical problem faced by human– How can we balance the needs, the resources, and the environment, and ensure doing so for generations to come? This seems to be an abysmal unanswerable question for generations. However, while working on the forum and learning about the works of the capable minds in this field, kindled my hopes of seeing it become a reality in the near future.

I hope that all the audience present here today share the same enlightenment and optimism. I strongly urge for an open and free participation from all the audience to make this forum an interactive platform and extract possible benefits out of the event today to make it mutually beneficial to us.

Please enjoy the forum.

Thank you.

Presentation by the Y-E-S Awardees

Nguyen Thi Phuong Thao
2007 Y-E-S Awardee
Nguyen The Tuyen
2012 Y-E-S Awardee
Vu Truong Minh
2014 Y-E-S Awardee

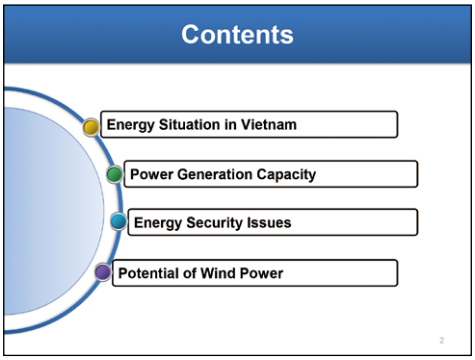
Energy in Vietnam: Current Status and the Potential of Wind Power

Good morning, Ladies and Gentlemen. Welcome to the Honda Y-E-S Forum 2016

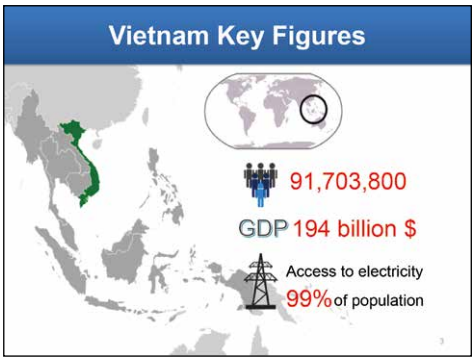
I am Vu Truong Minh. Today, on behalf of the Vietnam team, I would like to present you the current status of energy and the potential of wind power in Vietnam.

In this talk, we would like to draw the overall picture about the energy situation in Vietnam, her Power Generation Capacity and the issues of energy security she is facing. We also would like to introduce wind power as a potential solution to achieve energy security in Vietnam.

Now, please have some look at the energy situation in Vietnam.



Firstly, there are some look at some key figures in Vietnam. Vietnam is located in the South East Asia with the population of more than 91 million people and the GDP of 194 Billion dollars with 99 percent of the population gaining access to the electricity.

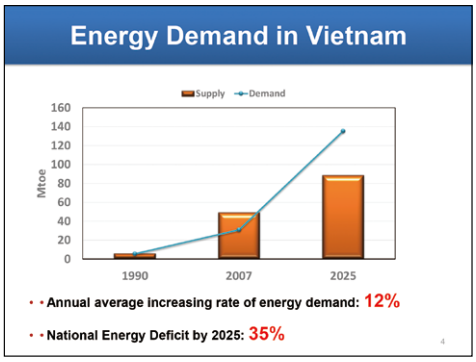


This graph illustrates the comparison between the total demand for energy to develop economy and the possible supply of energy converted to Mtoe between 1990 and 2025.

From the graph that the shortage of energy to meet the demand for economic development will be inevitable by 2025 when the amount of energy being able to exploit is much lower than the demand for energy.

It is estimated that the demand for energy will rise to 135 Mtoe in 2025 with the annually-average increasing rate of 12%, and the lack of energy is anticipated to happen with the national energy deficit of 35%.

(Mtoe – Megatonne of Oil Equivalent)

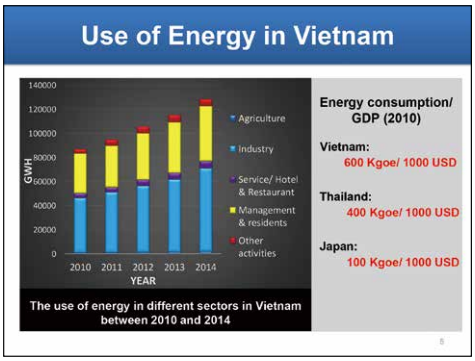


This chart illustrates the changes in the use of energy in different sectors in Vietnam between 2010 and 2014. It is noticeable that all of the sectors saw upward trends in the use of energy.

The use of energy in the industrial sector was the highest over the period, which was followed by that in the management and resident sectors.

It can be easy to see in the right side, which is the relationships between energy consumption and GDP in Vietnam, Thailand Japan in 2010. It is clear that Vietnam had to use 600 Kgoe to produce 1000USD, while Thailand just used 400 Kgoe to create the same GDP. Meanwhile, to create 1000USD, Japan just used only 100 Kgoe. Consequently, Vietnam has been using energy really ineffectively.

(Kgoe – Kilogram of Oil Equivalent)

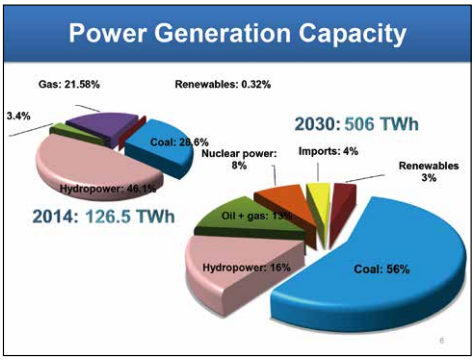


This graph indicates the structure of energy in Vietnam. This provides information on the contribution of different kinds of energy to Vietnam power generation capacity in 2014 and 2030.

In 2014, the power generation capacity mainly originated from three main sources of energy including gas (almost 22%), coal (nearly 29%) and hydropower (46%), whereas renewable energy accounted a small portion with only 0.32%.

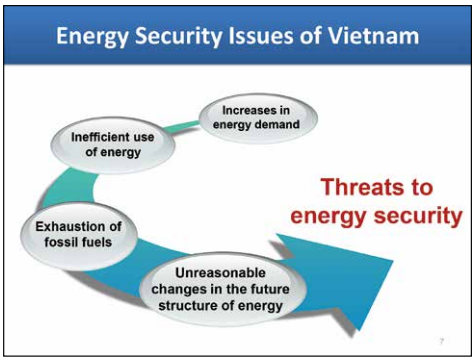
The structure of energy is predicted to change a lot in 2030. Coal is forecast to be the main source of energy with 56%. In contrast, the share of hydropower is expected to decrease to 16% because of the impact of climate change and the concerns for the negative impacts of hydropower plants on the environment.

The contribution of renewables to power generation capacity is anticipated to increase almost 10 times from 0.32% in 2014 to 3% in 2030. And, one striking point is that in 2030, nuclear power is predicted to be available and contribute 8% of total energy and Vietnam will have to import energy.



To conclude, the increase in the demand for energy consumption and the inefficient use of energy cause the overexploitation of natural resources, especially fossil fuels to develop economy. So, sooner or later this will lead to the lack of energy in the future.

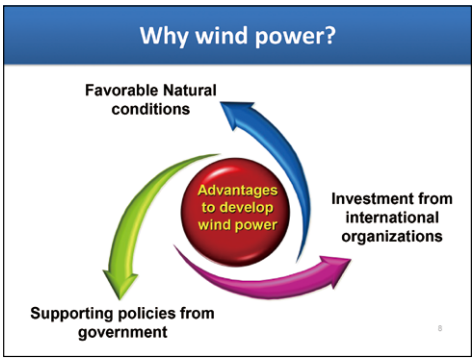
In addition, the changes in the future structure of energy are unreasonable. The reason is that the reservoir of fossil fuels such as coal has been very limited so far, so the development based on coal is really unsustainable. Vietnam will become an import energy country, so she has to depend on the energy supply from other countries. About hydropower, this kind of energy is causing many negative effects on nature and humans. An example for this was the disastrous flood just happened in the middle of Vietnam in October in 2016. One of the main causes of this disaster is due to releasing water suddenly from dams at hydropower plants. So, these sources of energy are not really sustainable. As a consequence, there are many threats to energy security and the environment in the future.



Vietnam has a high potential for renewable energy resources, such as biomass, solar, and wind. Among them, wind power has many advantages and is considered as one of the most possible measures to solve the energy issues in Vietnam.

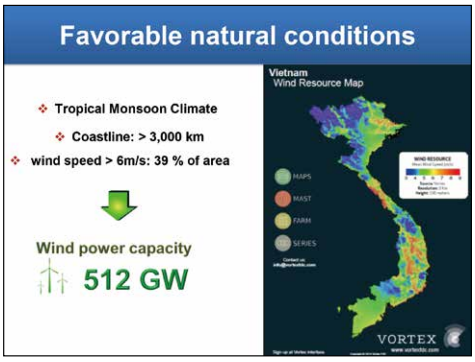
First of all, we have favourable natural conditions to develop the wind power.

Moreover, the government has provided many supporting policies to develop wind power projects in recent years. We are also receiving many investments from international organizations to scale up renewable energies, especially for wind power projects.



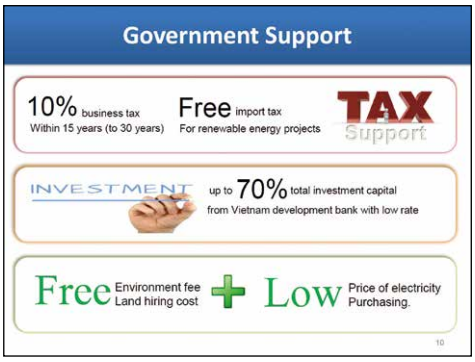
The first one, about the favourable natural conditions. This is a map of wind resource in Vietnam.

Vietnam has the coastline of over 3,000 km and is located in the tropical monsoon climate. According to a research from World Bank, over 39% of the area of Vietnam is estimated that the annual average speed of wind is more than 6 m/s at the height of 65 meters. This wind level is equivalent to the total capacity of electricity generation of 512 GW. So, the potential of the exploitation of wind energy is very huge.



The second one about the government support. The government provides tax support policy to wind power project, including free import Tax for importing goods used for building up the renewable energy projects. The business tax is also discounted to only 10% per year within 15 years (can last up to 30 years with large projects).

When constructing wind power plants, companies or organizations can receive the support for the initial investment capital up to 70% of the total investment capital from Vietnam Development Bank with low interest rate. In addition, the wind power projects will be free cost of land hiring and environmental protection. Besides, the purchase price of electricity of companies producing wind energy will be applied tariffs avoided cost.

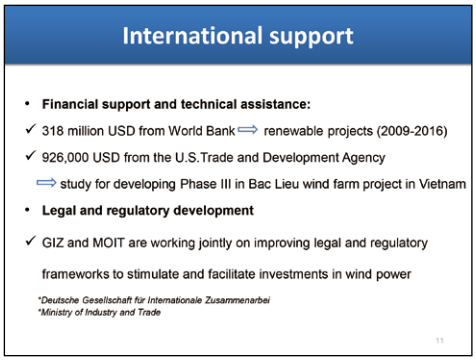


When it comes to external supports, many international organizations also agree to help Vietnam scale up wind power projects, through financial support, technical assistance and legal and regulatory development.

In terms of finance, World Bank already engaged to support renewable energy projects in Vietnam with 318 million USD in the period from 2009 to 2016. The US Trade and Development Agency provided 926,000 USD to study for developing Phase III in Bac Lieu wind farm project.

About the legal and regulatory supports, GIZ and MoIT are working jointly on improving legal and regulatory frameworks to stimulate and facilitate investments in wind power in Vietnam.

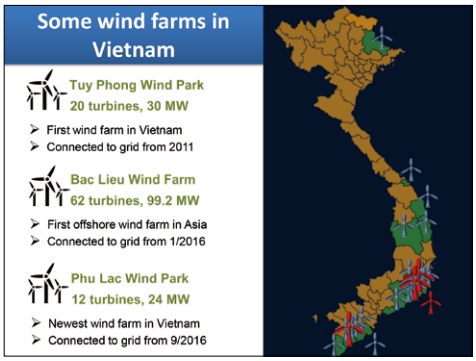
(GIZ-Deutsche Gesellschaft für Internationale Zusammenarbei)
(MoIT-Ministry of Industry and Trade)



This slide refers to some typical wind farms in Vietnam. All of these wind plants are located in provinces having the most potential of wind energy such as Bac Lieu province, Binh Thuan province.

Wind Farm in Bac Lieu is the largest wind farm in Vietnam with 62 wind turbines. This wind farm has the total generation capacity of 99.2 MW. It is also the first offshore wind farm in Asia.

Two other wind parks Tuy Phong and Phu Lac are located in Binh Thuan province with the electricity generation capacity of 30 MW and 24 MW, respectively.



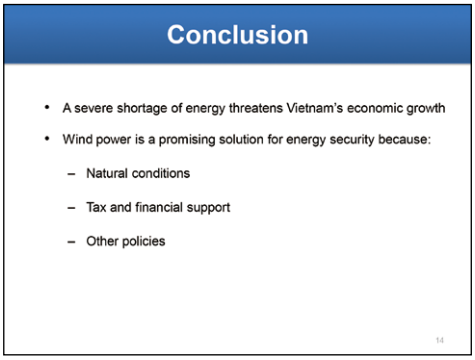
This slide would like to introduce you one of the creative and typical projects about wind power in Hanoi, Vietnam.

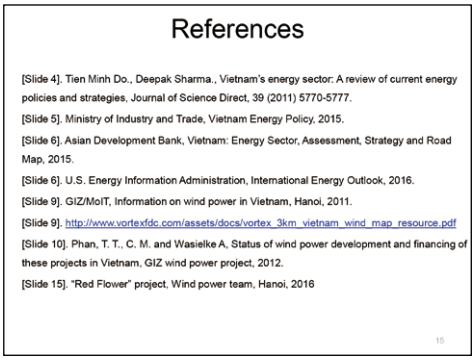
This slum includes 28 families living along Red river in Hanoi, Vietnam. Living too far from the power station, the cost of electricity here is five times higher than usual cost, and electricity is almost unaffordable for these people who survive on only few dollars per day. They used to deny electricity, or just dared to use a small amount of it. Now, arrows of red-bucket flowers flies over the slum and provide them with free electricity from wind power. These wind turbines are made from old motors from printers and plastic buckets. They worked with the wind speed of just 0.4 m/s.The overall system costs only $44. They can generate enough energy to light bulbs for about 4 hours by night.

Le Vu Cuong – Project Creator said that he hoped it was just the beginning of a greater effort to bring clean energy to poor families across the country.

In conclusion, Vietnam has been facing a shortage of energy in order to develop economy. Wind power is considered as one of the most environmentally-friendly and promising solutions to achieve the energy security in Vietnam as the following reasons:

- Natural conditions are really beneficial for the installation of wind power plants.
- Wind power has been receiving many supports related to the investment capital, the purchase price of electricity, tax and other policies from Vietnamese Government and International Organizations.

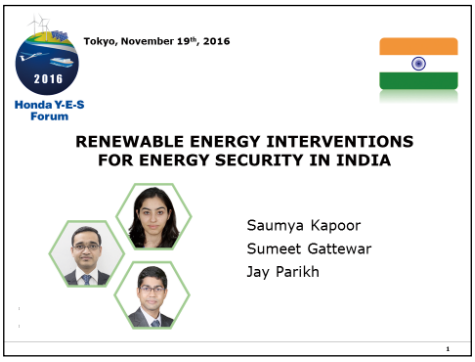




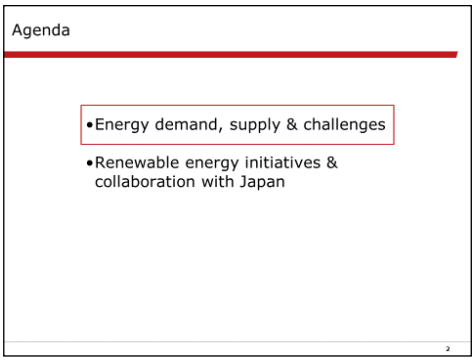
Sumeet Sanjay Gattewar
2008 Y-E-S Awardee
Jay Deepak Parikh
2009 Y-E-S Awardee
Saumya Kapoor
2012 Y-E-S Awardee

Renewable Energy Interventions for Energy Security in India

Good morning everyone. On behalf of the India team I will presenting on the topic 'Renewable Energy Interventions for Energy Security In India".



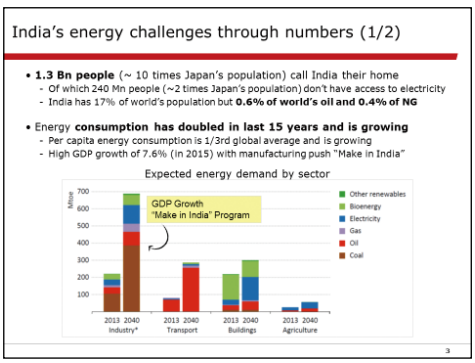
In terms of layout, we will start by looking at energy demand, supply and challenges. Thereafter we will look at how the country is addressing the challenges including collaborations with other countries like Japan.



Since India is a large country, I will be taking the help of numbers to describe the energy challenge she is facing.

India is a country of 1.3Bn people which is ~ 10 times Japan's population. To put things into context India has 17% of the world's population but only 0.6% of the world's oil and 0.4% of the Natural Gas.

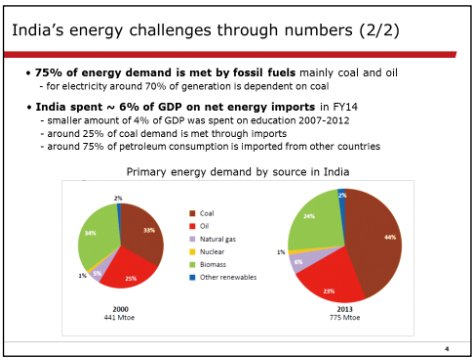
The challenge is not just the population but the increasing energy consumption too. Energy consumption per capita has doubled in the last 15 years and it's expected to grow for two reasons. First, currently



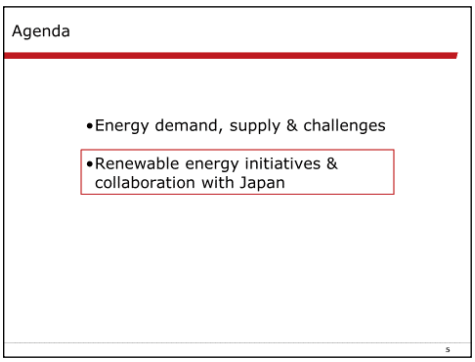
Indian people are using less energy about 1/3 of global average per person. However, let imagine if Indian people start using the energy as same as US or Japan. Indian GDP is growing at a fast pace, in 2015 we grew at 7.6%. This economic growth is increasing the energy demand in the industrial sector (as can be seen in the graph).

On the supply side, India is dependent mainly on non-renewable fossil fuels as energy source. ~75% of her energy needs are met through fossil fuels, mainly oil and coal (refer graph) . Around 70% of the electricity generation is dependent on coal.

Since India does not have big reserves of fossil based fuels, the country imports most of her energy needs. In FY14 India spent ~6% of the GDP on energy imports. For a young country it spent a lower amount ~ 4% of the GDP on education.

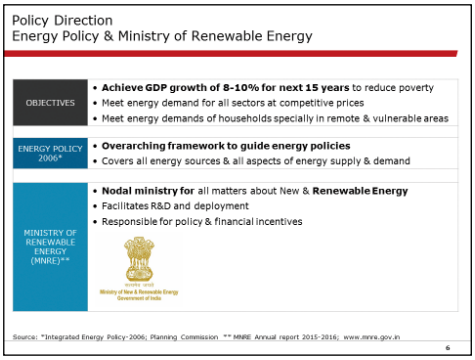


Now that we have looked at the challenges India faces in terms of energy demand and supply, we will look at the measures being taken to address these challenges.

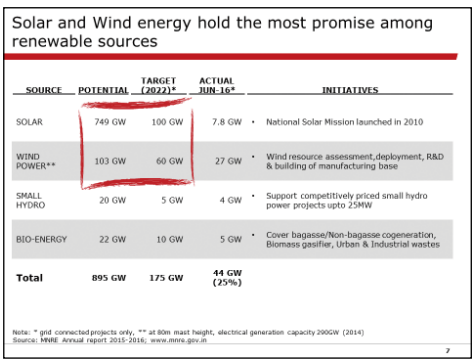


For successful execution it is very important to have a good policy support. India's energy policy has set an objective to allow the GDP to grow at 8-10% in the next 15 years. This economic prosperity is expected to reduce poverty.

India released the Energy policy In 2006 which is an overarching framework to guide energy policies. The second step was the creation of the Ministry of New and Renewable energy which acts as the nodal agency for all matters concerning new and renewable energy.

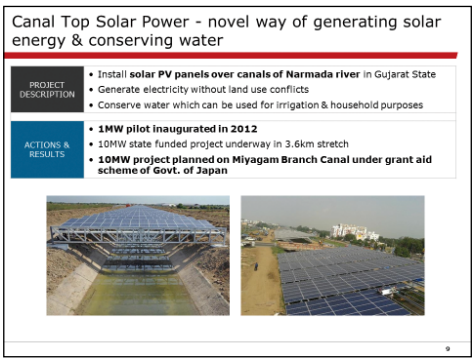


This table shows the major renewable energy sources targeted by India and the various initiatives being conducted to harness these sources. India is a tropical country with abundant sunlight. It also has a long coastline. Hence solar and wind are the main renewable sources being targeted.

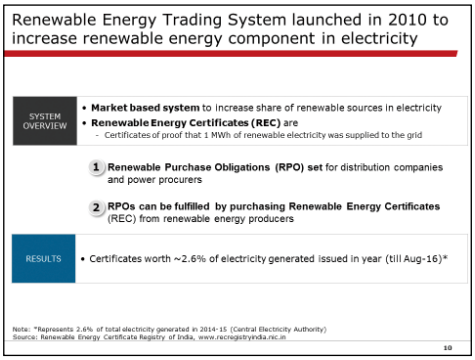


Solar development is being pursued under the National Solar Mission. Under this program a number of large grid connected solar projects have been commissioned. This image is of one such project in the desert state of Rajasthan. It is spread over 700 acres which is approximately around 190 baseball fields.

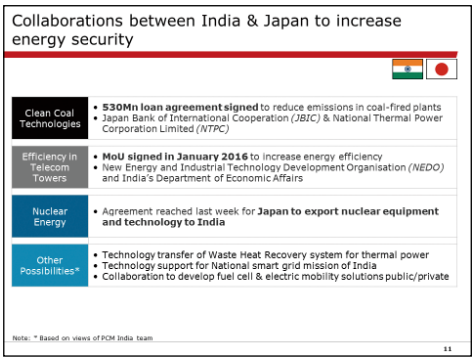
A novel way of capturing solar energy has been the Canal top solar power projects. Under these projects solar PV panels are laid over canals. This helps to setup solar projects without land use issues and also conserves water by reducing evaporation. The first such project was inaugurated in 2012 and currently there is a 10MW project being planned with the help of the Japanese government.



Another scheme to increase the contribution of renewable energy in electricity supply is the Renewable Energy Trading Scheme. Under this scheme power distribution companies have a set purchase obligation for renewable sources. This obligation can be fulfilled by purchasing power or by purchasing certificates which signify the supply of renewable power to the grid.



Now that we have seen a few initiatives being taken to manage the energy challenge let us look at areas where Japan and India have collaborated. Recent Indo – Japanese collaborations have been in clean coal technologies, efficiency of telecom towers and nuclear energy production. The details are given in the slide.

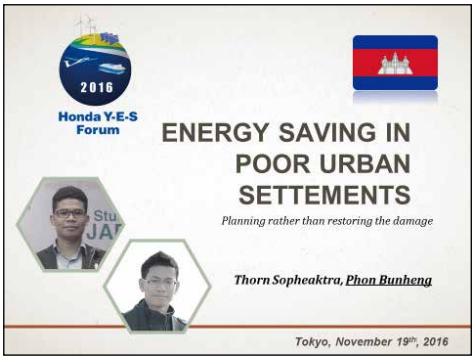


Thorn Sopheaktra
2011 Y-E-S Awardee
Phon Bunheng
2014 Y-E-S Awardee

Energy Saving in Poor Urban Settlements

Even there is development on some slum areas in Phnom Penh, there still lie a large number of the poor urban settlements.

With some knowledge on energy security, we as architects working on the project to save energy and to make beneficial changes to the community master plan.



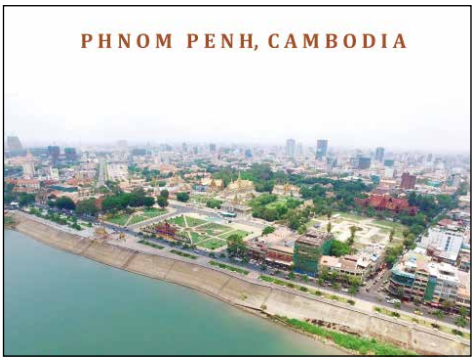
We will develop the project through 2 main processes by improving the urban area and propose housing solution for energy saving.

However, we should take a look on the overview of Phnom Penh city and the chosen area for some ideas.

Phnom Penh is the capital of Cambodia for few centuries ago. Until now, the city expands itself twice from 6 to 12 districts. Now, the total area reach up to 678.5 square kilometers.

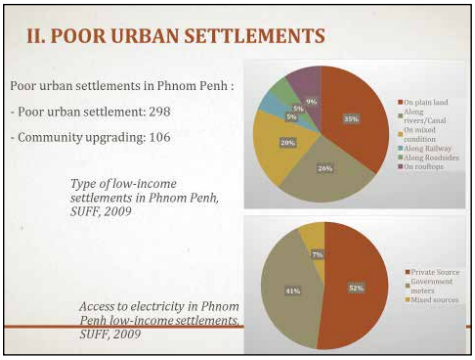
The dramatic increase of population makes Cambodia find it is hard to provide sufficient housing solutions. Surprisingly, the data from World Bank show us that this small city with less proper planning has up to 2.2 million people in 2016.

The city center of Phnom Penh has proper planning. However, a few kilometers from there, we will find numerous of poor urban settlements.

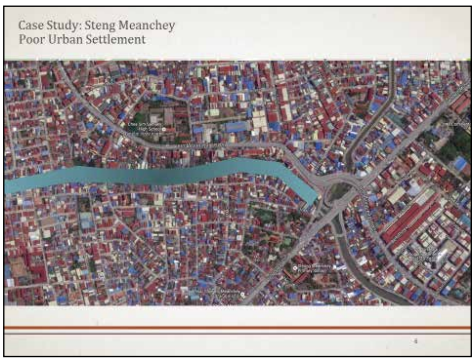


The first pie chart show the proportion of type of poor urban settlement in Phnom Penh. We found that most of the slum areas are built on plain land and along rivers or canals. It's base on the report of SUFF in 2009.

The second pie chart illustrates clearly that the private sources are the main electricity supplier after the Government source in 2009. However, based on the survey in some slum areas in Phnom Penh, the current supplier of electricity in this 2016 are mainly from Government meters.



The highlighted zone is the selected area for our case study. It's located in Steng Meanchey district, which is just several kilometers from the city center. From the map, we see that most of the houses are being built directly on the canals.

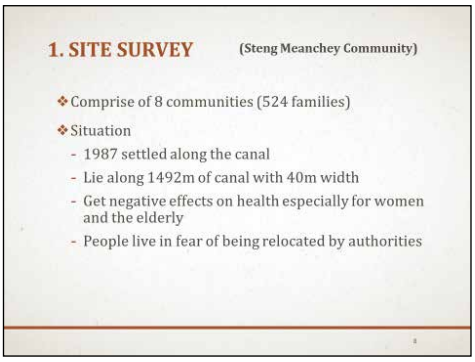


From the overview of the slum area, we work with the community and government sectors to improve the whole area base on the four steps below.

The project will be fully analyzed and recorded the data through the survey, proceeded by defining the concept of the area, followed by community mapping and finalized by land upgrading proposal.

To summary our survey, the whole area is comprised of 8 communities and which equal to 524 households.

The people have settled down along the 1492 meters canal since 1987. Until now, the scramble settlement causes lots of problems, namely, waste disposal, health condition, and accessibility the public service. Until recently, the people still live in fear, the fear of being relocated to the new place by authorities without proper compensation.

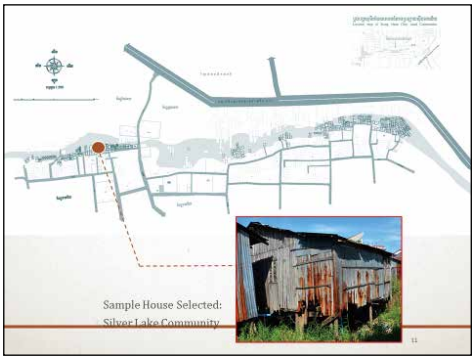


The pictures could tell us that people are usually build their houses directly on the canals and all type of waste are being disposed directly into it, as we can understand from the black water of the canal.

After seeing the challenges that people are facing, we work with community itself to make a better change to the whole community by identify the 4 main goals to achieve.

First, reducing environmental impact, then, achieving Energy Saving which is one of our main goal. At the same time, we will improve the community through using more sustainable materials and finally, creating sustainable community.

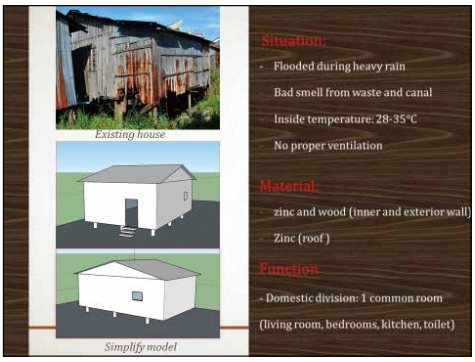
Among the 524 family, we randomly select a house in one of the 8 communities. Then, we will analyze the house in detail before proceeding to the solution ideas.



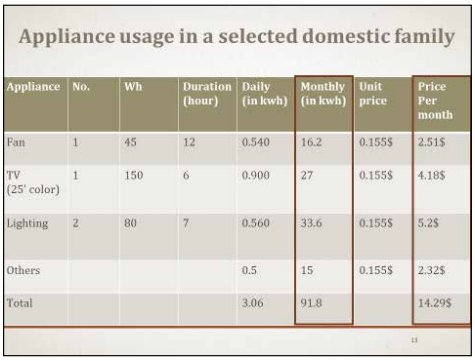
It's already hard to imagine the living condition be like from the first glance on the picture.

The house has a very basic design. The most of part of the wall and roof are made from zinc which is a heat-absorbed material. During day time, zinc traps the heat inside the house and bring the temperature up to 35 degree during rainy season and up to 37 or 38 degree during dry season. Without any proper ventilation throughout the house, the people living inside try to find their ways staying in the houses by using artificial ventilation, fans. In short, the house condition make them use much electricity than the usual need.

Surprisingly, the domestic division of the house is just one common room. Every functions of the house are in one floor and one room with little part of wooden panel.



Look into more detail of the use of electricity of that family. They need to spend up to 14.29$ per month which is equal to 91.8 kw. The amount of money might seem reasonable for many people but for local community, it is a large proportion of their monthly expenditure.


Appliance usage in a selected domestic family

Appliance	No.	Wh	Duration (hour)	Daily (in kwh)	Monthly (in kwh)	Unit price	Price Per month
Fan	1	45	12	0.540	16.2	0.155$	2.51$
TV (25' color)	1	150	6	0.900	27	0.155$	4.18$
Lighting	2	80	7	0.560	33.6	0.155$	5.2$
Others				0.5	15	0.155$	2.32$
Total				3.06	91.8		14.29$

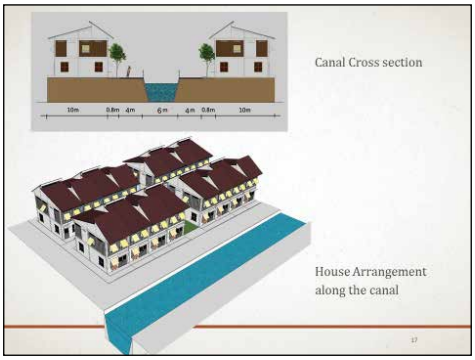
To process our sustainable design, we started by sharing the ideas with community. We asked all volunteer people to share their concepts on the master plan of the area. Whatever the proposals they made, whatever the ideas they want, we with government sectors take them into consideration. Then, we process to the technical part and try to apply their concepts into the reality as much as we can. This to ensure that, the sustainable community is defined until the needs of the people are valued.

After working with community and all related sectors, we come up to the final stage of the community master plan. This plan provides more green space to the area with playgrounds, market, as well as more public space. The houses are arranged along the canal which is accessible by all the nearby roads.

The same thing to the process of master plan, we ask all the representative from all 8 communities to propose the dream houses they want.

Most of the proposals houses they made are: two-storey house, with limited width of 4 meters and length of 8 meters. One of the major interest is the use of the house for small commercial purpose.

The house is arranged along the 6-meter canal section. The sewage system will connect to the sceptic tank of each house before allow the water to go into the canal.

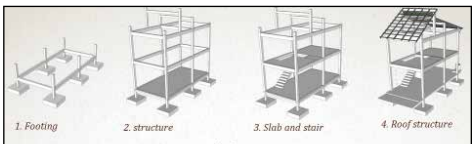


Here is the final design of the house !

There is two floors, each one serve different function. The ground floor used for commercial purpose, family room (living room), and kitchen, while the first floor used for resting. The house will be suitable for less than 6-members family.

We architect try to minimize the cost of the building construction as we can. The total cost is 5272 dollars. However, after substitute some existing material from the previous house, the price will reduce into some amount.

To ensure long-term life span, the house structure is built in concrete.



Bill of Quantity

Items	Quantity	Unit	Unit price	Total Price ($)
Column	2.3	m3	$ 70	161
Pile cape	1.6	m3	$ 70	112
Slab	6.2	m3	$ 50	310
Beam	4.8	m3	$ 50	240
Stair	1.5	m3	$ 50	75
Roof	47	m2	$ 32	1504
Water System		job	$ 250	250
Electricity		job	$ 210	210
Tile	60	m2	$ 9	540
Window	8	unit	$ 30	240
Door	4	unit	$ 50	200
Brick wall (200mm)	33	m2	$ 18	594
Wooden interior wall	42	m2	$ 8	336
Others	-	job		500
Total				**5272 $**

The designed house is simply open to the outside more than the existing one.

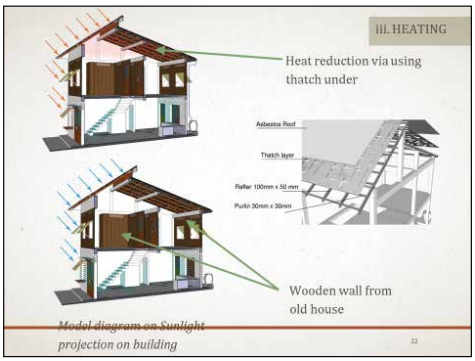
To ensure the sustainability of the house design, we will take a look on 4 main factors of the house. First, it's shading.

The shading over each window and door is placed to protect direct sunlight to go into the house while keep enough light to go through. Therefore, the house can get enough light with less heat. This can lessen the usage time of any kind of light during day time.

Secondly, we will make system for water collection. As Cambodia is in monsoon weather, the rainy season usually last 6 months with 3 to 4 months raining consecutively, therefore, the household could save some water for general usage.

To keep the inside temperature below 35 degree, the layer of the roof and wall are taken into consideration. Two low-cost materials are used for roofing with the top layer of asbestos roof and lower layer of thatch. Thatch is made from bamboo and which is sustainable, local and low cost material. Thatch is not only keep the inside temperature not to get warmer but also help to reduce the noise cause from the outside. Secondly, the wooden wall is used in most part of the house both interior and exterior. Again, the wood absorb little heat while keeping the inside house with adequate temperature.

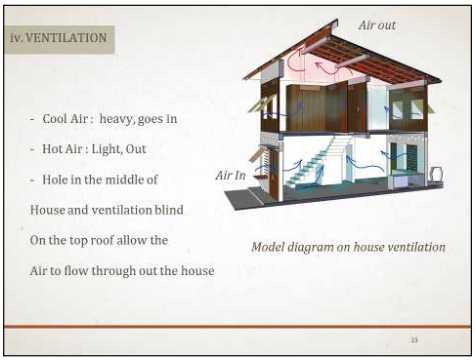
The use of wood and bamboo in these parts enable the inside people not to use fan or use very little fan.



Finally, the proper ventilation of the house will enable the people inside to use of fan during both day and night time.

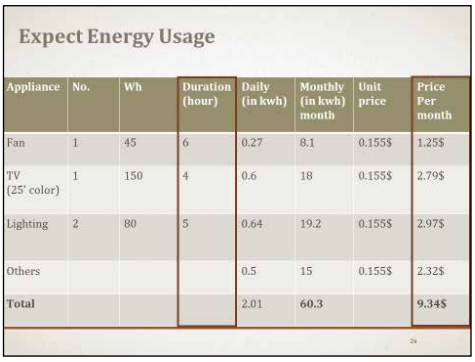
As we know the hot air is light while the cold air is heavy. From the doors, windows and ventilation blinds, the air can go into the house easily and going up to the blind of the roof, allowing the continue air flow inside the house at all time.

With all the main factors we see including shading, water collection, heating and ventilation, people will change their way of using electricity. Using almost no light during day time and using very time for fan would result in a major change in saving electricity consumption in each household.



As we can see from the result we get, the time people spend on fan, TV, and Lighting are reduced resulting in the monthly expenditure of the electricity to just 9.34 dollars.

Actually, the time people watch less TV is because of the development of the master plan. With more green space for sport, playground, the kids and teenagers like to spend more time with friends rather than staying at home watching TV.

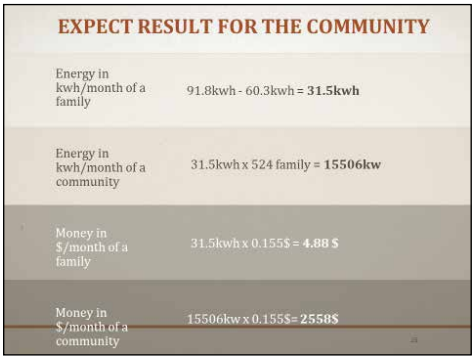


Expect Energy Usage

Appliance	No.	Wh	Duration (hour)	Daily (in kwh)	Monthly (in kwh) month	Unit price	Price Per month
Fan	1	45	6	0.27	8.1	0.155$	1.25$
TV (25' color)	1	150	4	0.6	18	0.155$	2.79$
Lighting	2	80	5	0.64	19.2	0.155$	2.97$
Others				0.5	15	0.155$	2.32$
Total				2.01	**60.3**		**9.34$**

We can sum up the saving amount of electricity consumption per household is 31.5 kwh which is equal to 15506kwh for 424 families. That is a large amount of saving for poor urban settlement.

Since the unit price of electricity per kilowatt hour is 0.155$, therefore, the total amount of money community could save is up to 2558 dollars. With this saving amount of money, the local people could use for other development purpose instead of wasting on the useless usage amount of electricity.



EXPECT RESULT FOR THE COMMUNITY

Energy in kwh/month of a family	91.8kwh - 60.3kwh = **31.5kwh**
Energy in kwh/month of a community	31.5kwh x 524 family = **15506kw**
Money in $/month of a family	31.5kwh x 0.155$ = **4.88 $**
Money in $/month of a community	15506kw x 0.155$= **2558$**

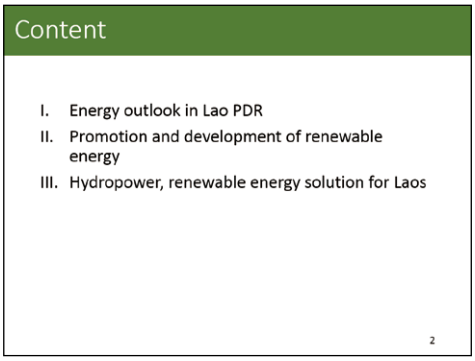
After all, the whole project is not only for electricity saving but also for plenty of solution to the community. The project will help to provide proper housing, improving lifestyle, providing better healthy environment, bringing sustainable community and reducing pollution.

AFTER THE DEVELOPMENT

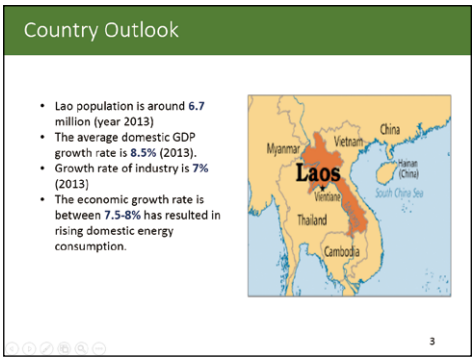
- Energy Saving
- Proper housing
- Improving lifestyle
- Better heath
- Sustainable community
- Reducing pollution

Nalinh Thoummala
2015 Y-E-S Awardee
Anoulak Hongvanthong
2015 Y-E-S Awardee

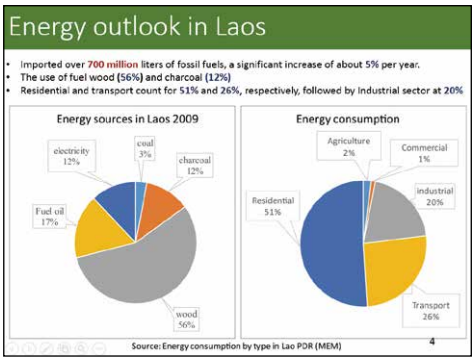
Hydropower to Deal with Future Energy Trend in Lao PDR



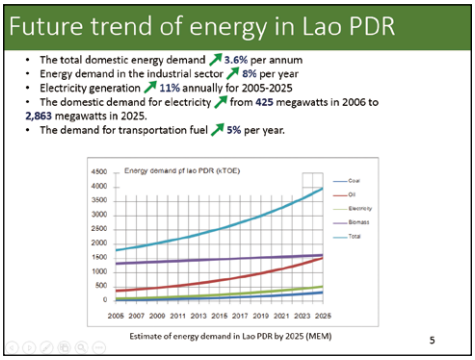
These are some general information of Lao PDR that somehow influence the energy consumption within country. The population of Lao PDR is approximately 6.7 million people (2013). The average domestic GDP growth rate is 8.5% and growth rate of industry is around 7%. The economic growth rate is between 7.5-8 percent during the sixth five-year plan has resulted in rising domestic energy consumption. At present, although economic growth has slowed down due to international financial crisis, energy demand of the country continues to rise.



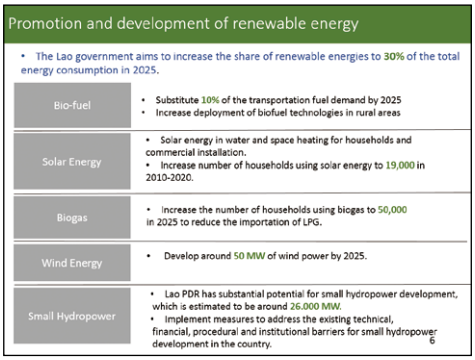
The overview of current energy consumption in Laos, it is mainly in the form of traditional fuels since it imported over 700 million liters of fossil fuels, but it's used was only 17% of all energy consumption. In 2009, wood and charcoal were the most used energy resource accounted for 68% of the total energy consumption. Major energy consumers are from residential sector, accounting for 51%, and transport accounting for 26% followed by industrial sector for 20%. The demand for energy by the transport sector has increased due to rapid increased in private vehicle ownership.



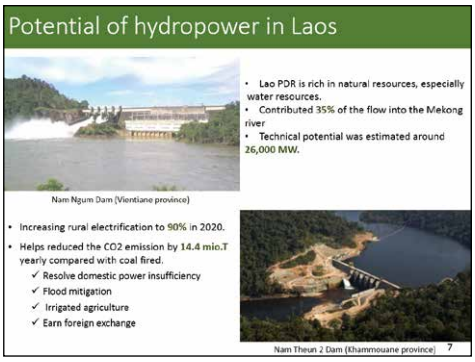
From the graph illustrated shows that The total domestic energy demand is anticipated to increase by 3.6 percent per annum, especially in industrial sector Energy demand is increasing at around 8 percent per year, Electricity generation is predicted to increase at 11 percent annually from 2005 to 2025 because domestic demand for electricity will increase from 425 megawatts in 2006 to 2,863 megawatts in 2025. Further, the demand for transportation fuel is predicted to increase by 5 percent per year.



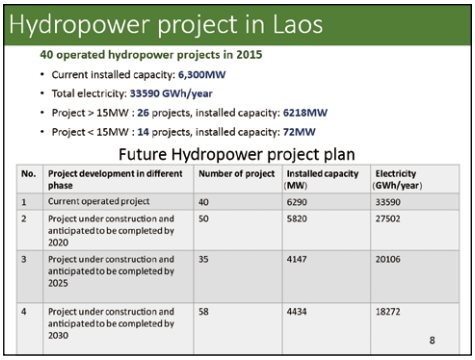
As we could see, the energy demand in Laos is definitely increasing year by year, so it becomes the government's responsibility to cove with such issue in order to meet with the rising demand as well as concerning about sustainable development… currently, the government is on attempt to promote and put strong development on renewable energy. They aim to increase the share of renewable energies to 30% of the total energy consumption in 2025 by developing on a wide range of newly renewable energy. For biofuel, the government plan to adopt biofuel to substitute 10% of the transportation fuel demand by 2025. Next is solar energy. For the period 2010-2020, the government under the rural electrification master plan (REMP) aims to upscale the program covering additional 19,000 households within 11 provinces. For biogas, the government aims to sustain these initiatives by up scaling and increasing the number of households using biogas to 50,000 in 2025 to reduce the importation of LPG. For wind energy, the government aims to develop around 50 MW of wind power by 2025. And the last one is hydropower, Lao PDR has substantial potential for hydropower development, which is estimated to be around 26.000 MW.



The reason why government particularly focus on hydropower as a solution for energy security is because as following: Lao PDR is rich in natural resources, especially water resources which contributed 35% of the flow into the Mekong river (more than any other countries), which technical potential was estimated around 26,000 MW, where yet counted small scale hydropower sites. It also plays an important role in meeting the country's objectives of increasing rural electrification coverage from the current level of 70% to 90% in 2020. With the present electric power generated by hydropower of 16,000GWh in Lao PDR helps reduced the CO2 emission by 14.4 mio.T yearly compared with coal fired and hydropower not only built to resolve domestic power insufficiency, but also help in flood mitigation, irrigated agriculture, earn foreign exchange from export of power to neighboring countries.

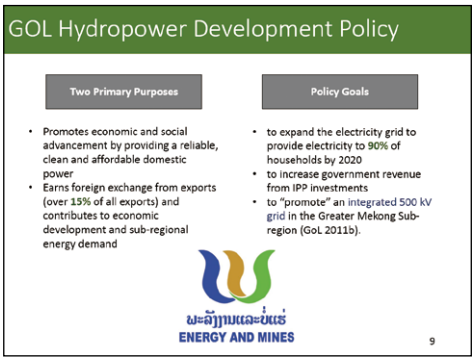


It was reported that there are overall 40 operated hydropower projects in the year 2015 and the total installed capacity is around 6.300MW. From total projects, the project that can generate electricity greater than 15MW has 26 projects and the rest is called small scale hydropower.

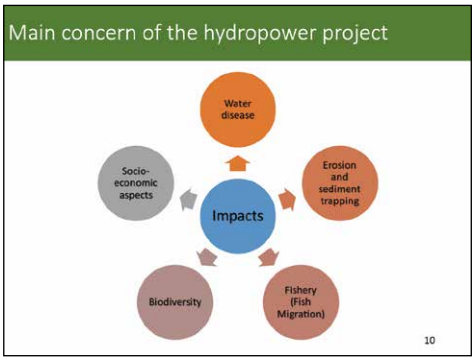


The policy goals for developing hydropower are:

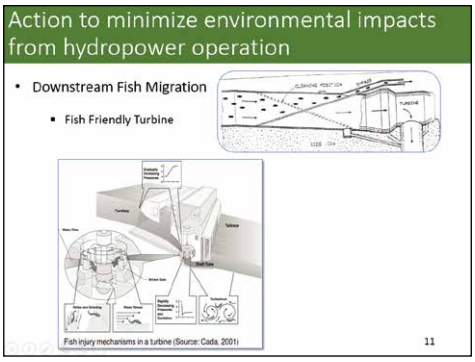
- to expand the electricity grid.
- to provide electricity to 90% of households by 2020.
- to increase government revenue from IPP investments.
- to "promote" an integrated 500 kV grid in the Greater Mekong Sub-region.



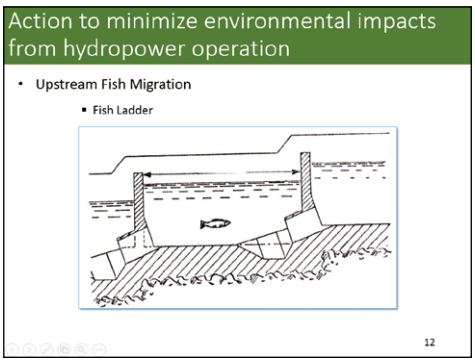
However, we can't say that hydropower will only return us benefits. It also has some negative impacts that we all have to concern.
Water disease: During the dam construction, there will be unproved number of sediment into the water and make water dirty.
Erosion and sediment trapping: Because of the soil which is come with the water would struck in the dam.
Fishery: Dam will block the way of fish. In some case, fishes has been disappear from the river.
Biodiversity: Decreasing number of aquatic species.
Social-economic aspects: Fishery will receive impact by decreasing amount of fish. Furthermore, local people who live near the hydropower project will need to be moved out because of flood.



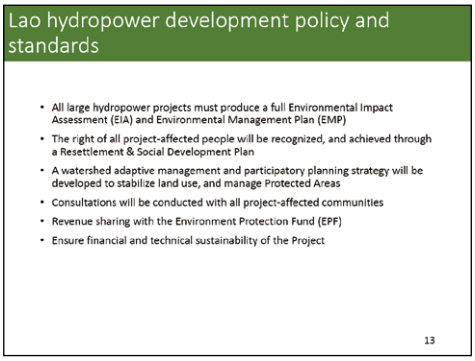
Fish friendly turbine will be used in the case of downstream fish migration. There are two options for fish to go through. First option, when turbine is running fish will be divided into specific fish way. Second option, in case of turbine stop running fish can swim exactly through the turbine. (The turbine must be safe for all fishes to go through, it would have well done design for prevent fishes injured).



In case of upstream fish migration. Fishes can clam up the river by the fish ladder. (Fish ladder is kind of different level of water. Which is design for fish can easily jump or swim up to the upstream without injured). Designing the fish ladder for each dam. The engineer had to carefully study the ability of fish to swim up river. Naturally, fish will swim in opposite way of water current. The design of fish ladder should allow water flow all the time and the water current should not be stronger than the fish ability. Then, fishes will automatically swim up to the upstream.



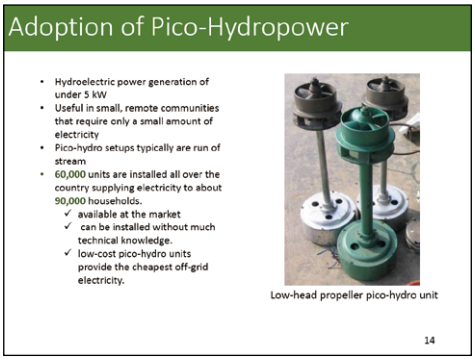
- Before starting the Hydropower project, all projects must produce a full Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP). For confirming that environmental will be protected.
- People who have an effect from the project will be giving the resettlement and improving the livelihood.
- A watershed adaptive management and participatory planning strategy will be developed to stabilize land use, and manage Protected Areas.
- Consultations will be conducted with all project-affected communities.
- Yearly Revenue form hydropower project must be sharing with the Environment Protection Fund (EPF).
- The project needs to ensure financial and technical sustainability for the dam longer using life.



Pico hydropower is a kind of very small hydroelectric power generate power under 5 kW. It is useful in small and remote communities. Which can't access to the electricity grid. The Place require only a small amount of electricity. For example, to power one or two fluorescent light bulbs and a TV or radio. Pico hydropower doesn't need a reservoir, it's technically run-of-stream.

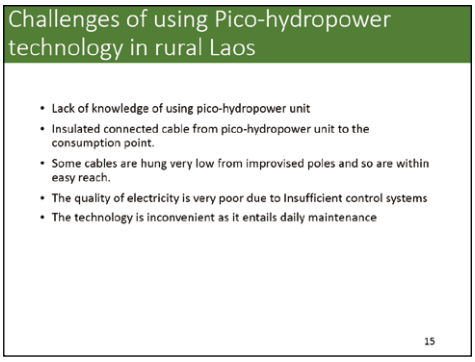
Presently, around 60,000 units had been installed in all over the country and supply electricity to about 90,000 households.

The factors make Pico-hydro so favorite in rural Laos. Because, it's available at the market, easy to install and especially low cost.



The situation of using Pico-hydropower in rural Laos is not much efficient. There still have number of drawbacks of using this technology such as:

- The cable that connects the Pico-hydropower unit to the consumption point is not insulated. So, this would be easily damage people.
- Some cables are hung very low from improvised poles and so are within easy reach.
- Without the control systems, the quality of electricity is very poor and often damages lamps and other electrical equipment.
- This technology may also be inconvenient because need a daily maintenance (e.g., taking Pico out of the water and removing garbage).



Recently, there are number of projects aiming to improve quality of using Pico-Hydropower in rural Laos. For example: 'shared Pico-Hydropower project in Angsang village' the village in northern part of Laos.

The project was supported by Sunlabob and LIRE.

- The shared Pico-Hydropower system, including 2 x 1kW low head turbines with electronic or automatic Load control for better energy quality, and a 1.5 km low voltage grid to support electricity to the village.

The aim of the project is to:

First, to demonstrate how a rural village can use Pico-hydro as a community-based service.

Second, to share the financial costs and workload.

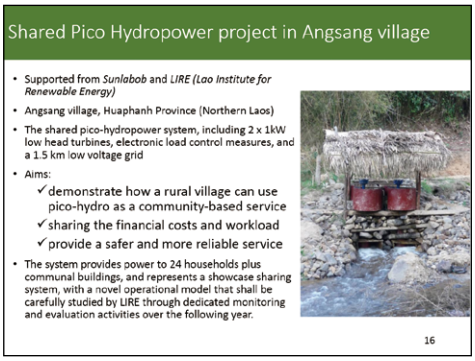
Third, to provide a safer and more reliable service for the village.

All of these are situations and solutions of energy security in Laos.

In brief:

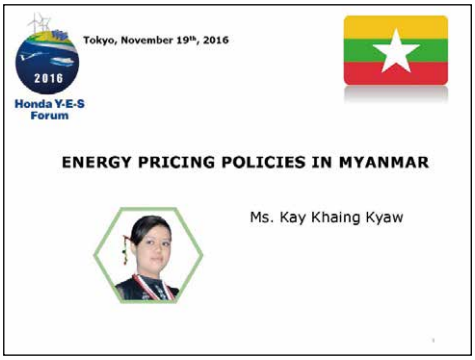
Laos PDR is mainly base on Hydropower Plant to supply electricity for whole country.

Beside that government of Laos has adopted some kinds of renewable energy to supply energy in remote area of Laos.

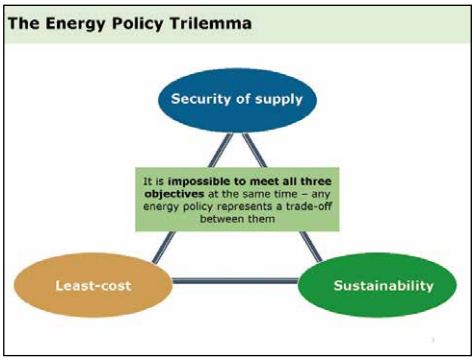


Kay Khaing Kyaw
2014 Y-E-S Awardee

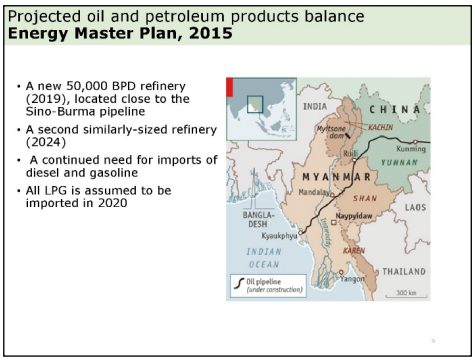
Energy Pricing Policies in Myanmar



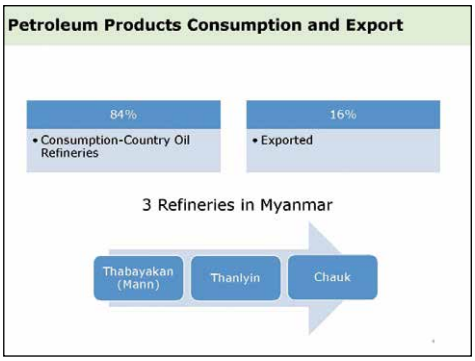
It is impossible to meet three objectives; Security of supply, least cost and sustainability at the same time but any energy policy can trade between them.



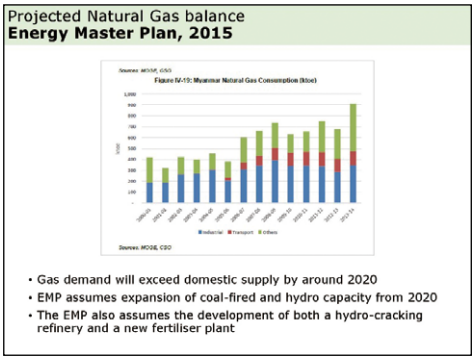
According to Energy Master Plan 2015, it is targeted to build a new 50,000 BPD(Barrels Per Day) refinery in 2019 which is located close to the Sino-Burma pipeline. Sino- Burma pipeline is shown in figure which is connected with Kumming in China and Kyaukphyu in Myanmar. Also EMP(Energy Master Plan) targets to import diesel and gasoline and it is assumed that all LPG(Liquified Petroleum Gas) will be imported in 2020.



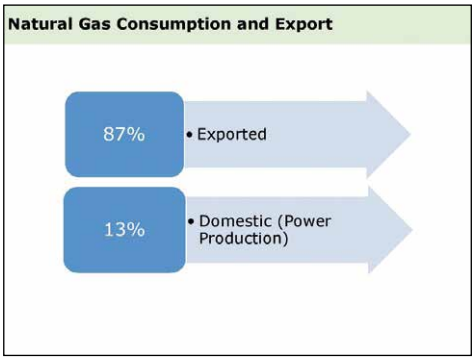
Myanmar has 3 main refineries ; Mann Thabayakan, Thanlyin and chauk which produce petroleum. From that, 84% of petroleum is consumed and 16% is exported.



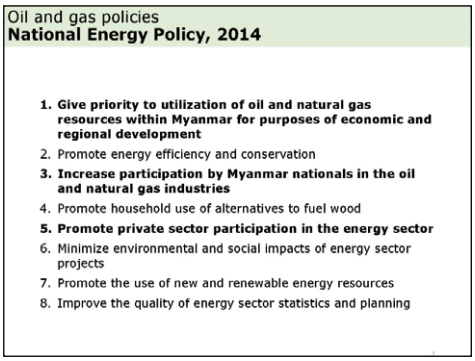
For the natural gas balance, EMP(Energy Master Plan) forecasts that gas demand will exceed domestic supply by around 2020.From the bar chart, industry is the highest demand which comes from fertilizer plant. EMP(Energy Master Plan) also assumes expansion of coal fired and hydro capacity in 2020.



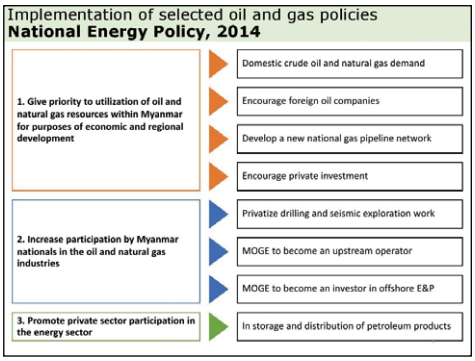
In case of Natural gas consumption and export, 87% of total Natural gas is exported and only 13% is domestic use.



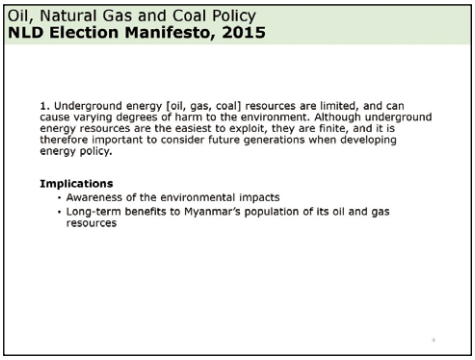
According to National Energy Policy 2014, it draws 8 main targets. Of them all, the highlighted 3 targets are important. First one is to give priority to utilization of oil and natural gas resources within Myanmar in economic and regional development. It is also important to attract Myanmar nationals in oil and natural gas industries and promote private sector participation in energy sector.



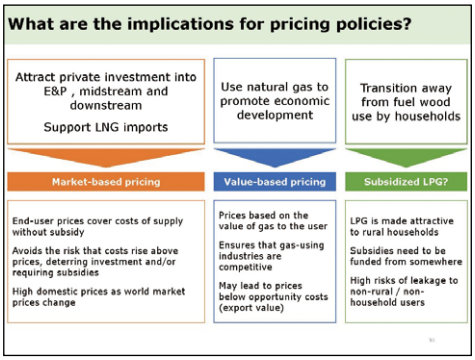
As three main targets are mentioned in previous slide, some implementations are required to their respective targets. For the first one, it is required to fulfill domestic crude oil and natural gas demand. It is also important to encourage foreign oil companies and private investment. Then, it is needed to develop a new national gas pipeline network. For the second target, private drilling and seismic exploration work are required and MOGE(Myanmar Oil and Gas Enterprise) should become upstream operator and investor in offshore E&P(Exploration and Production).



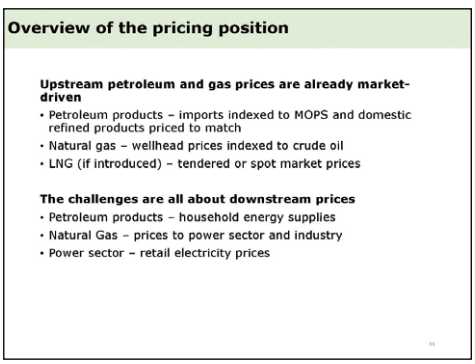
Underground energy resources are easiest to exploit and finite. Therefore it is important to consider young generation in developing energy policy. In that case, implications such as awareness of the environmental impacts and long term benefits of oil and gas to local community are required.



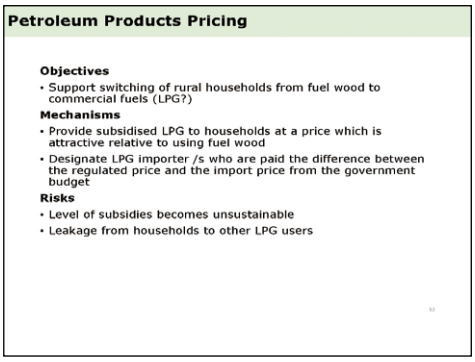
In case of implications for pricing policies, three main components are divided. Firstly, attraction of private investment into E&P(Exploration and Production), mainstream and downstream and Supporting LNG(Liquified Natural Gas) imports are based on Market-based pricing. It is directly concerned with covering of end user supply on costs of supply without subsidy, avoiding the risk of rising costs and changing of world market prices effect on domestic prices .Second component is using natural gas to promote economic development which is based on Value-based pricing. It is concerned with prices based on the value of gas to the user, ensuring that gas using industries are competitive and prices below opportunity costs. Final component is transition away from fuel wood use by households which is based on subsidizing LPG(Liquified Petroleum Gas). LPG has to be made attractive to rural households but it has high risks of leakage to users.



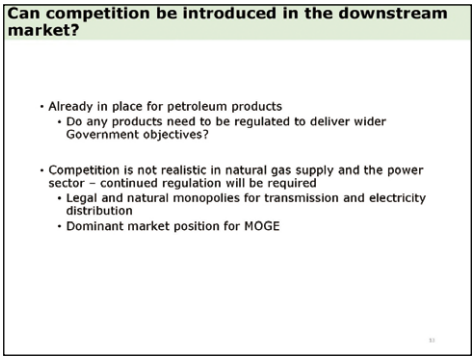
For overview of pricing position, upstream petroleum and gas prices are already market driven. But there are still challenges in downstream prices such as household energy supplies in petroleum products, prices to power sector and industry in natural gas and retail electricity prices in power sector.



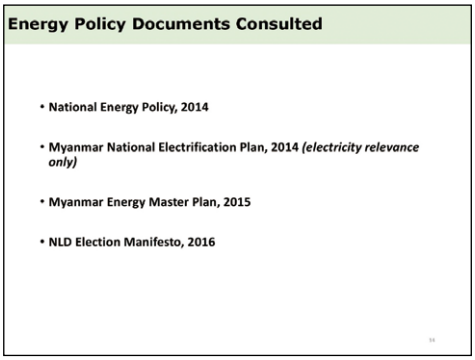
For petroleum products pricing, the main objective of switching of rural households from fuel wood to commercial fuels (LPG). In case, 2 mechanisms are required. First one is to provide subsidized LPG to households at a price which is attractive relative to using fuel wood. Second one is to designate LPG importer. But there are also risks such as level of subsidies becomes unsustainable and leakage from households to other LPG users.



Some questions are come out. Can competition be introduced in the downstream market? As petroleum products are already in market, do any products need to be regulated to deliver wider Government objectives? Competition is not realistic in natural gas supply and power sector so that continued regulation such as legal and natural monopolies for transmission and electricity distribution and dominant market position for MOGE(Myanmar Oil and Gas Enterprise) will be required.



In the presentation, 4 main energy policies (which is shown on slides) are discussed.



These are some abbreviations which are written in the report.
LPG = Liquified Petroleum Gas
BPD = Barrels Per Day
LNG = Liquified Natural Gas
EMP = Energy Master Plan
MOGE = Myanmar Oil and Gas Enterprise
E & P = Exploration and Production

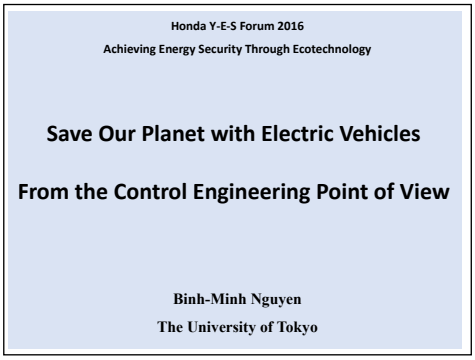
Presentation by the Y-E-S Awardee Specialized in Energy

Nguyen Binh Minh, Ph.D.
2006 Y-E-S Awardee

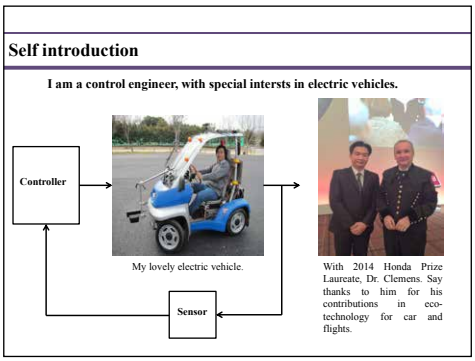
Save Our Planet with Electric Vehicles
– From the Control Engineering Point of View

As you know there are many ways to tackle the energy's problem and develop the eco-technologies. For example, you may know that two years ago, Dr. Clemens got the Honda prize. He tried to compile Mathematics, Computer Science and in the new design technology of the motor. The Keynote speaker today, Dr. Tanaka, he tried to improve the sustainability of nuclear power. And like Nakano sensei, you can try to develop like high efficiency solar cells.

I think every person has a path to follow and I myself have my way of thinking.

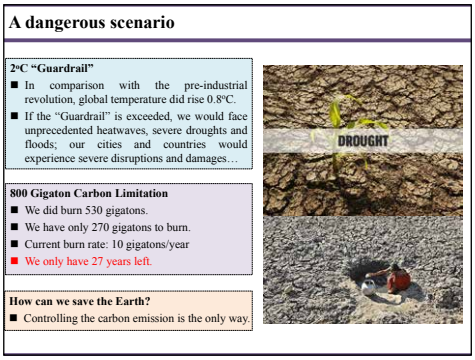


It's me on this slide, and this is my lovely EV [Electric Vehicle]. I am a Control Engineer with special interest in EV. My job is to design a controller to improve the behavior of the EV in many aspects such as the safety, economics, comfort, etcetera. Today, from the view point of a Control Engineer, I will tell you how we Control Engineer can contribute to save our mother earth with the EV.



I guess many of you have seen this report, the IPCC report. You have seen it? Raise your hand. How many of you? Okay.

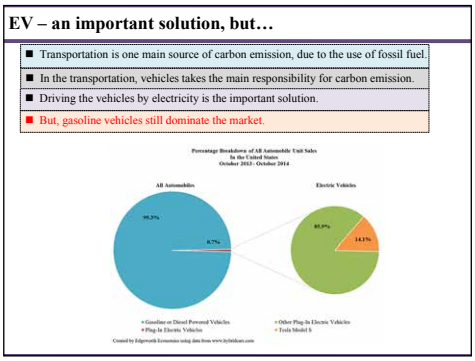
So, what can we know from this report? I think this is one of the most important scientific paper in this century. It states that as human being, we did break the dynamic balance of the earth's energy system because we did burn too much carbon. Second, you may know that in comparison with the pre-industrial revolution, global temperature did rise 0.8°C. Is it a too small number? But the fact is if the global temperature rose more than 2°C in comparison with the pre-industrial revolution, our society, our civilization will be destroyed with heat rays, severe drought, floods and other term. In many places in our earth, you can see this photo. You don't want this to happen,



right?

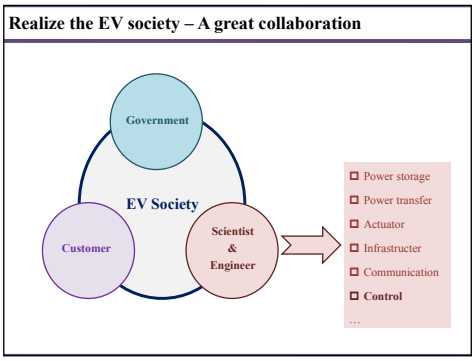
Here is the other important number to tell you. There's a limitation of carbon that you can burn. This is 1,800 Gigaton of carbon. We did burn 530 Gigatons. So, with the current burn rate of 10 Gigatons per year, only 27 years left. If we burn more carbon, our world would be destroyed because we exceed the 2°C "Guardrail". So, how can we protect our earth? The answer is we should control the carbon emission and change the way we use and generate energy.

So, in this slide, I use some data from IEA to show that transportation sector is one main source of carbon emission. About 23%, ranked number two, right? And it's because it uses fossil fuel. For more than 100 years, we did produce too much gasoline car. And in the transportation sector, the vehicle, especially the light weight vehicle, takes the main responsibility for carbon emission. So, it's natural and simple to see that if you can drive the vehicle by electricity, you can cut down the carbon emission from the transportation sector. EV has many advantages like low pollution, low noise level, low maintenance and low cost per kilometer.



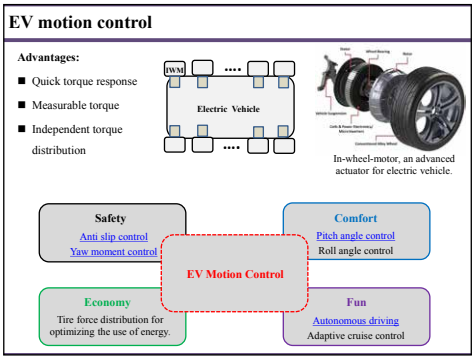
However, the gasoline vehicle still dominates the market. How can we realize an EV society, how can we transfer our means of transportation to EV?

I think to realize the EV society is one of the great collaboration, and it needs the collaboration of many sectors like the government, the customer, the companies, the scientists and the engineer circle. For example, as a customer, you should improve the understanding of the global warming problem. In Japan, using a budget of one-month-salary, I can buy a second-hand gasoline car easily. But, please do not save much money, let's use half-year-salary to buy an EV since it is better to save our Earth.



So, among the scientists and engineer sector, you can see that there are many ways of researches, such as design the power storage, power transfer, new actuator, establishing the infrastructure for the EV, communication and control… My field of study is only one tiny part with tiny contribution to this figure, but I hope that its contribution is somehow interesting to you.

Actually, EV motion control has been developed 20 years ago, and there are many things to say about this topic. Today, I only pick up the in-wheel-motor to talk about the EV. It can be installed in each wheel of the vehicle. Based on this motor, our group at Hori-Fujimoto Lab has developed the philosophy of EV control. My ex-supervisor, Hori-sensei has summarized this philosophy in several keywords.



First, "very quick torque response". So, you can use the motor torque as a control input. You may not need ABS (Anti-Break-System) anymore, but you can directly control motor torque for anti-slip purpose.

Second, "The torque can be measured". It's very important that you can estimate many motion variables, for example, the road friction co-efficient.

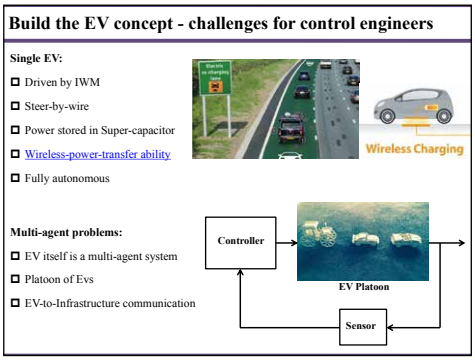
Last but not least, "independent torque distribution". This means you can control the torque of each wheel independently. Based on

its advantage, you can develop many controls like yaw moment control, to maintain the vehicle stability for lane-changing or cornering at high speed.

Then, I would like to show you some key words of EV motion control using certain advantage that you can develop the behavior of EV in many aspects, like safety, comfort, economy or fun. For example economics, by optimizing the distribution ratio of the motor torque at each wheel, you can improve the efficiency of energy uses. You can extend the driving distance of electric vehicle with the same total energy.

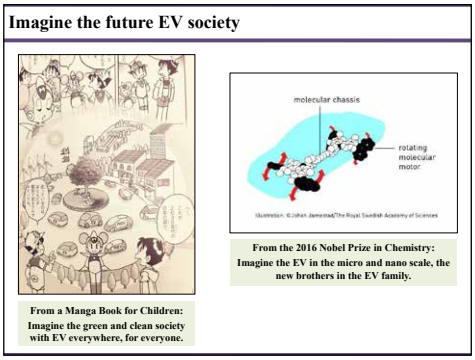
I also want to show you some of the video of the test at our group. For example, this test is conducted by me. It's autonomous driving of electric vehicle based on the EV motor controls and active steering. And from this video, you can see that by using the very fast torque response and the feedback loop from the motor speed to the control system, we can improve the stability of the vehicle on the low slippery road. OK, I want to return to my slide.

From the viewpoint of control engineer, we have built the EV concept as follow. For a single EV, I think that it should be driven by in-wheel-motor, equipped with steer-by-wire, and the power should be stored in the super capacitor. It has the ability of wireless power transfer and fully autonomous. For example, in the future when you are driving the car and the power is going down, you need to move to the charging lane and it's the automatic lane charging's task. Then, wireless-powertransfer-ability can help you to recharge the car and you don't have to stop the car anymore. So, the Electric Vehicle should be very convenient and very interesting.

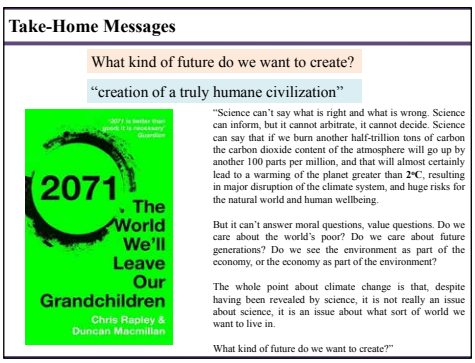


And there are still many challenges from the viewpoint of Control Engineer that I would like to share with you. The EV itself is a multi-agent system in which each agent is one motor. And the platoon of EV is also another multi-agent system. The control design is not only for a single car, but for a platoon of Electric Vehicles. The control design is becoming very complex and it's really a challenge that we have to overcome and develop new technologies and new control theory. Moreover, look at this figure, when we have V2X system, many vehicles can connect together and also connect to the infrastructure. How to develop the new communication and control technology for such huge system, is a challenge for you and for me to solve.

Before I conclude my talk, I want to show you that to solve the problems, we should imagine the future society like the Japanese children reading this type of manga 10 years ago. And here it is a new imagination from the 2016 Nobel Prize in Chemistry: Electric Vehicle at Nano Scale. The electric vehicle is not that very big with the weight from a hundred to a thousand kilograms. It can be at a Nano Scale. So please look at this figure and think about the future of this Electric Vehicle and its applications.



This is a take home message for you coming from a book that I bought from the Todai bookstore few months ago. And I have to say that the whole point about climate change is that despite having been revealed by science, this is not really an issue about science, but this is an issue about what sort of world you want to live. So, please think about the question, "What kind of future you want to create?" For this question, you might take the answer from Honda foundation's website: "To create a truly humane civilization". Please think about the answer for yourself, for the countries, for the cities, for the family as well.

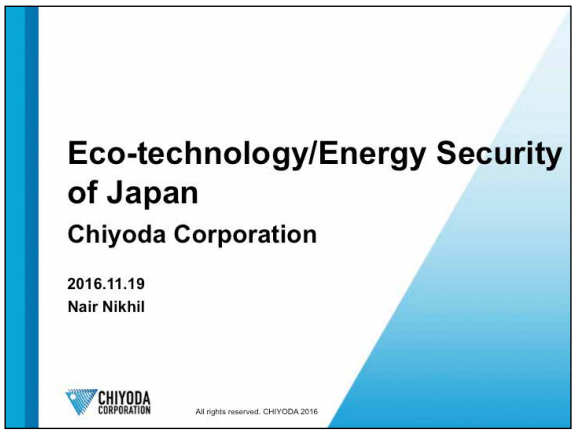


Industrial Exhibition Presentation

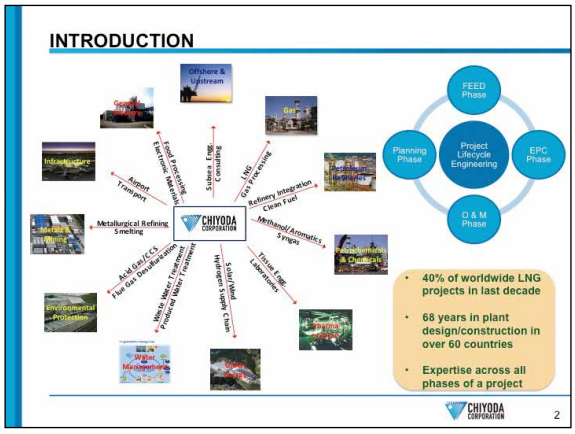
Nikhil Nair
Chiyoda Corporation

Eco-technology/Energy Security of Japan

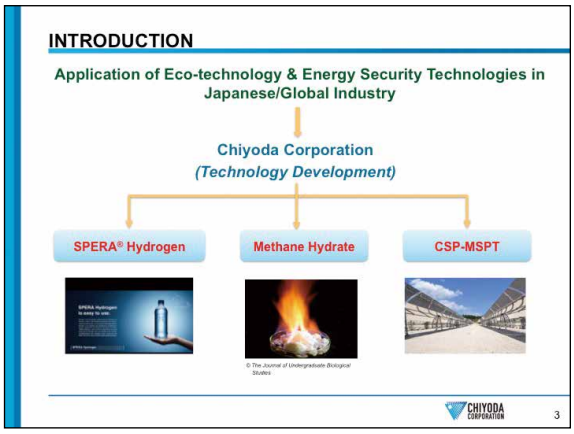
As the Industrial Exhibitor on this forum, Chiyoda Corporation would like to introduce briefly a few technologies which highlight application of eco-technologies as well as some which focus on securing the energy security of Japan.



A brief introduction to Chiyoda. We are an Engineering contractor with our core business being execution of LNG projects, which includes providing engineering, procurement and construction services, typically known as EPC services. Chiyoda is one of the world's leading LNG contractors with successful execution of huge projects all across the globe. However, as you see here, Chiyoda is not limited to just LNG projects and we provide engineering services across most of the chemical & energy industry, ranging from offshore/upstream, intermediates, pharmaceuticals, green energy, and water management. We have also diversified into the non-chemical sectors such as life-sciences, space technology and infrastructure development. Chiyoda offers solutions across all phases of a project, right from the conceptual planning of a plant to its operation and maintenance.



Of particular focus today will be another facet of Chiyoda, that is technology development with a vision of applying eco-technologies worldwide for the benefit of society. Japan has been at the forefront of integrating and applying eco-technological solutions to the chemical industry for the welfare of society. Chiyoda Corporation has been actively involved in such technologies, with an eye also on securing Japan's energy security. Today, we take a look at some of the technologies being developed at Chiyoda, with special emphasis on the two important aspects of today's forum, Eco-technology & Energy Security.



-SPERA Hydrogen

A technology and supply chain system aimed at taking Japan forward into a hydrogen-based society, moving away from Carbon society.

-Methane Hydrate

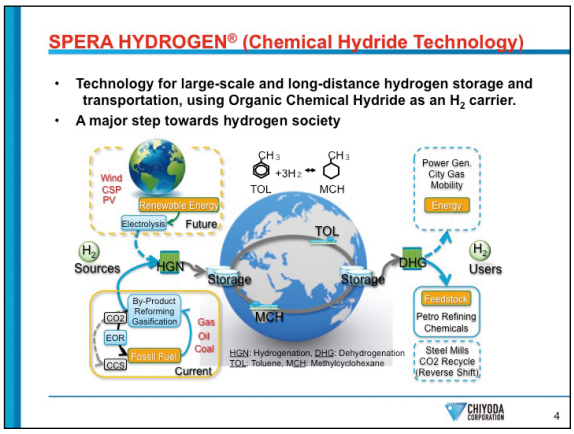
A focus on ensuring Japan's energy security based on the enormous reserves of Methane Hydrate under the ocean floor, in the vicinity of Japan.

-CSP-MSPT:

Renewable energy technology aimed at utilizing solar energy based on high-efficiency molten salt technology.

SPERA is Chiyoda's proprietary technology for largescale and long-distance hydrogen storage and transportation. There is a conscious effort in Japan to push away from carbon society to greener energy, such as hydrogen. This aids in elimination of fossil fuels since it is envisioned that eventually hydrogen will be produced from renewable energy sources.

Hydrogen from various sources (either conventional or renewable) is attached to toluene by conventional and well-commercialized hydrogenation process, resulting in Methylcyclohexane (MCH), which now becomes a carrier of hydrogen. MCH is then transported overseas in liquid form through tankers to the user destinations. Here, MCH is dehydrogenated using Chiyoda's proprietary dehydrogenation catalyst to release hydrogen for end uses. The dehydrogenated MCH (now toluene), is shipped back to the hydrogen production site for further cycles.



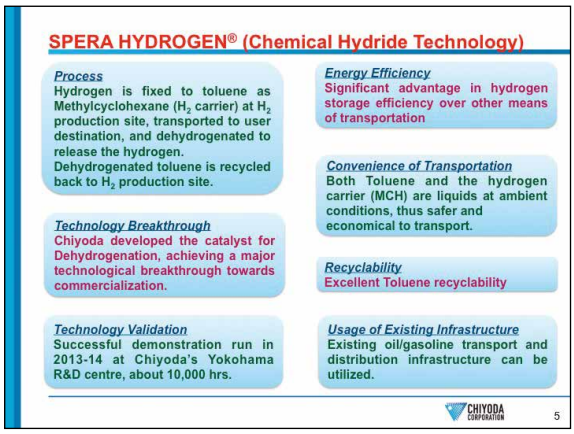
We will take a look at the significant aspects of this method over other means of hydrogen transport.

Technology Breakthrough: Though the concept of using Organic Chemical Hydrides (OCH) was known long ago, the process was not commercialized due to challenges in dehydrogenation technology. Chiyoda managed to overcome this.

Technology Validation: Once the technology was conceptually developed, it was validated in 2013-14.

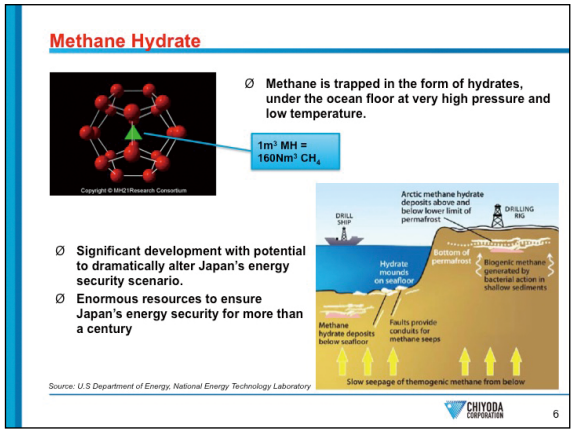
Convenience of Transportation: A significant advantage of OCH is that both MCH and toluene are in liquid state under any conditions across the globe.

Usage of Existing Infrastructure: Since they are in liquid form, existing infrastructure can be utilized without the need for setting up new systems.



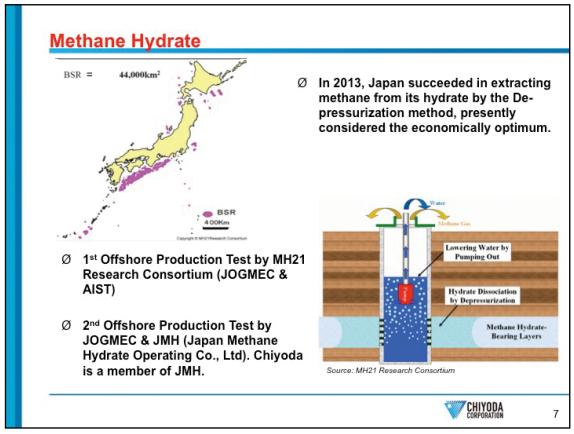
Next, we will have a look at one of the developments with immense potential for Japan: Methane Hydrates (MH). MH is essentially methane, trapped in the form of hydrates, formed under conditions of very high pressures and low temperature. Thus, they are found below the ocean floor and permafrost layers, which provide such ideal conditions for formation of hydrates in the solid form.

Why is this significant for Japan? Because, Japan has enormous reserves of MH, enough to ensure its energy security for more than a century. This could essentially be a game-changer for Japan, which has traditionally been an energy importer.

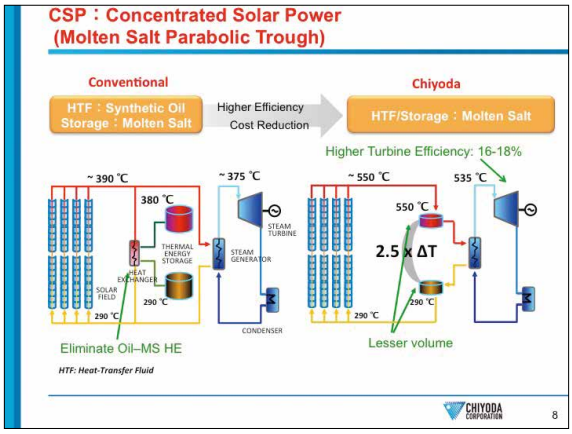


The south coast of Japan, called the Nankai trough, is rich in MH with substantial resources spread across roughly 44,000 km^2. However, what has really changed the scene for Japan is the success in extracting the methane from its hydrate state. In 2013, a Japanese consortium including JOGMEC, succeeded in extracting methane by the Depressurization method, which has been found to be the most economical so far. This has paved the way for MH extraction on a commercial scale.

Further improvements and technology developments are ongoing to make it a success. Chiyoda is also a stakeholder and member of JMH (Japan Methane Hydrate Operating Co., Ltd), tasked with the 2nd offshore production test next year and we are keen to contribute to Japan's energy security. There are various methods of possible extraction of MH. The figure on the right indicates the Depressurization method of extraction, which is the economically optimum method. Additional details are provided in the poster.



Finally , we take a look at Concentrated Solar Power (CSP), a means to capture solar energy. Chiyoda has invested in CSP, focusing on MSPT (Molten Salt Parabolic Trough) technology.



A basic CSP system comprises a solar field where solar reflectors concentrate the solar energy onto a tube, carrying some fluid to absorb this radiation and transport it to a thermal storage section, and further to the power generation unit. The left side of the figure shows the conventional system based on synthetic oil being used as Heat Transfer Fluid (HTF), while only the storage medium is molten salt. On the right is the Chiyoda process, where both HTF and storage medium is molten salt. What are the advantages in this?

The primary limitation with using oil as an HTF is that it can be heated only upto 390 degC, whereas molten salt can be heated upto 550 degC. In simple terms, it means a higher percentage of solar energy is captured.

So, MSPT achieves an operating temperature difference of 2.5 times that of Hot oil system.

What this means is that significant benefits are obtained such as:

1) A higher steam temperature for the power generation turbine, and thus a higher efficiency, in the range of 16-18%.

2) The 2.5 times increase in operating temperature translates to considerable reduction of thermal energy storage volume.

3) Finally, since HTF and storage medium are the same, it eliminates the need for an heat exchanger to transfer heat from the HTF to the molten salt.

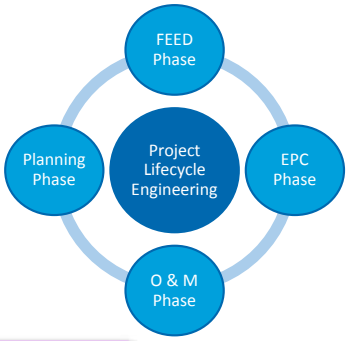
Keeping in mind the fact that very few companies in the world manufacture Molten Salt Receiving tube, Chiyoda took a significant step in securing Japan's energy security by investing in one such company and developing forward the molten salt technology.

Further details can be obtained from the posters accompanying this presentation or visit us at
www.chiyoda-corp.com/en

Chiyoda Corporation
Concentrated Solar Power (CSP-MSPT)
Molten Salt Parabolic Trough

Portfolio of Chiyoda Corporation

Services/ Expertise



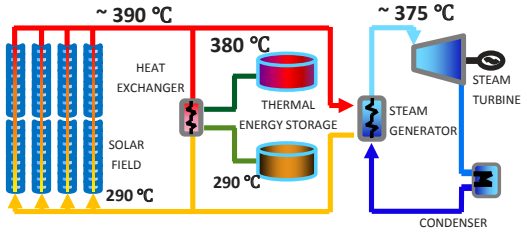
- Established in 1948
- Global presence with projects in over 60 countries
- Major Projects:
  - *Papua New Guinea LNG Plant, 2014 (3.45 MMTPY x 2 trains)*
  - *Qatargas LNG Plant, 2010 (7.8 MMTPY x 7 trains)*
- Commercialized Technologies:
  - *CT-121 (Flue Gas Desulfurization)*
  - *Biofiner (Waste Water Treatment)*

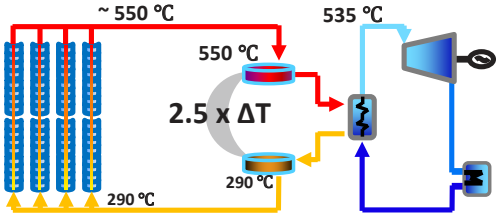
Molten Salt Parabolic Trough System

Conventional
HTF : Synthetic Oil
Storage : Molten Salt

Higher Efficiency
Cost Reduction

Chiyoda
HTF/Storage : Molten Salt





HTF: Heat-Transfer Fluid

- 2.5 times lesser Thermal Energy Storage Volume
- Higher Turbine Efficiency: 16-18%
- Elimination of Oil-MS Exchanger

Chiyoda & Energy Security for Japan

Archimede Solar Energy (ASE, Italy) is one of the very few manufacturers of commercialized receiver tube for Molten Salt as HTF

- **Investment in ASE as a shareholder**
- **Complete engineering services (EPC: Engineering, Procurement & Construction) for the Solar Field as well as downstream units such as power generation/chemical plants**

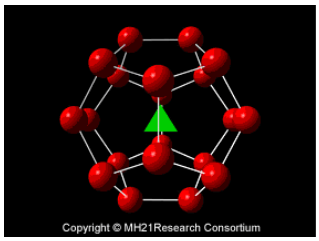
Successful Demonstration

- **DNI (Direct Normal Irradiation): 1527 kWh/m²/yr**
- **Collecting Area: 3398m²**
- **Solar Collectors: 6 (1 Loop)**
- **Operating Temperature: 290～550℃**
- **Thermal Storage Capacity: 4.27MWh**
- **Gross Power: 0.35MWe eqvt.**

CHIYODA CORPORATION

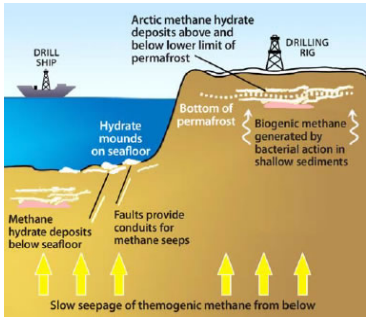
Methane Hydrates

Existence of Methane Hydrates



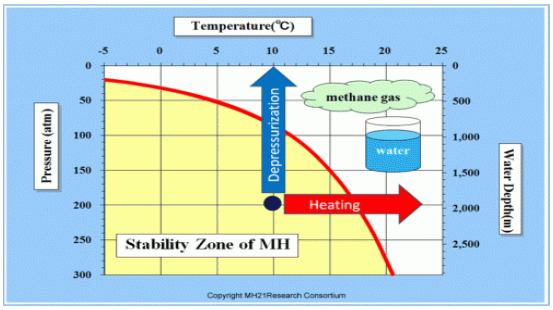
1 m^3 MH = 160 Nm^3 CH_4

Methane is trapped in the form of hydrates, under the ocean floor/permafrost at very high pressure and low temperature

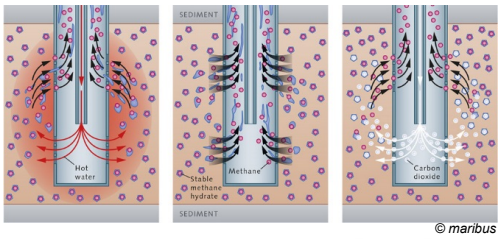


Source: U.S Department of Energy, National Energy Technology Laboratory

Phase Diagram for Methane Hydrate



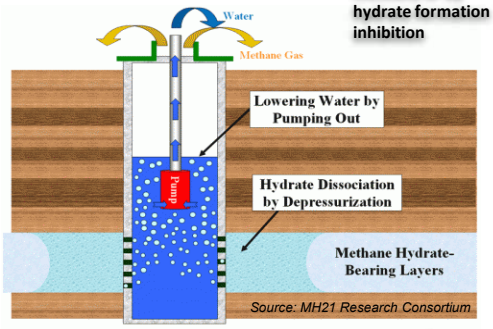
Methane Hydrate Extraction Methods



Heating
Hydrate Dissociation by raising temperature

De-pressurization
Hydrate Dissociation by lowering pressure

Chemical/Inhibitor Injection
Displacement of Methane or by hydrate formation inhibition



De-pressurization Method used by JOGMEC

Development Schedule of Hydrate Extraction

Phase-1

BASIC STUDY
- 2001: • Two-dimensional seismic survey (Eastern Nankai Trough) • 1st Onshore Production Test (Canada)
- 2002: Three-dimensional seismic survey (Eastern Nankai Trough)
- 2003: Exploratory Test Well Drilling
- 2004
- 2005: Interim evaluation
- 2006
- 2007: • 2nd Onshore Production Test (1st Winter, Canada) • 2nd Onshore Production Test (2nd Winter, Canada)
- 2008: Phase-1 Final Evaluation

Phase-2
- Analysis of technical issues during the Offshore Production Test
- Recommendation of Economical Production Method
- Evaluation of MH distribution off the Japan coast
- Recommendation of Environmental Impact Assessment methods from Offshore Production Test

- 2009
- 2010: • Preparation for Offshore Production Test • Onshore Production Test
- 2011
- 2012: Interim Evaluation
- 2013: 1st Offshore Production Test
- 2014: 2nd Offshore Production Test
- 2015: Phase-2 Final Evaluation

Phase-3
- 2016: Preparation for Commercial Production
- 2017: Comprehensive Evaluation (Economic, Environmental Impact)
- 2018: Project Final Evaluation

* Revised schedule at end of Phase-1

As a stakeholder and member of JMH (Japan Methane Hydrate Operating Co., Ltd), Chiyoda can offer its expertise in engineering and offshore/subsea services for the commercial development of the hydrate field.

Source: MH21 Research Consortium

1st Offshore Production Test: Phase-2

- Extraction Duration: 6 days
- Gas production: 10000-50000 m^3/day
- Gas Pressure/Temperature: ~ 150 kPa/15° C
- Pressure fluctuations (Sudden/Steady): 1 MPa/50 kPa
- By-product Water: 500 m3/day, 2 MPa/15° C

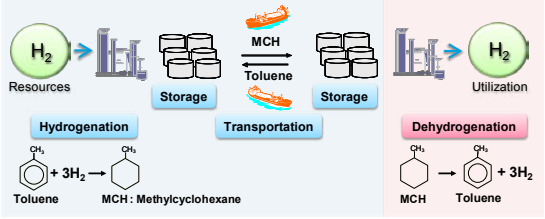
CHIYODA CORPORATION

SPERA HYDROGEN ® System for Large-scale H_2 Storage and Transportation

Organic Chemical Hydride Method

Modification for OCH method based on commercialized technology

R&D

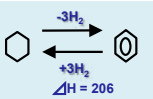
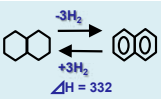


We, Chiyoda have
- Developed new dehydrogenation catalyst and process
- Demonstrated new process for OCH method in a pilot plant

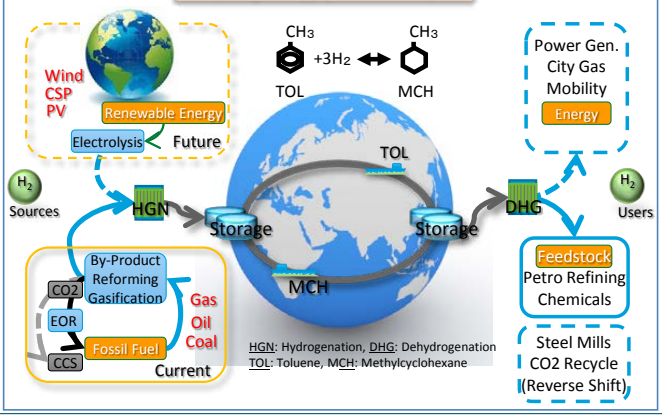
Demonstration Plant Performance

- Capacity: 50 Nm^3-H_2/h (H_2 storage & generation)
- Operation time: about 10,000 h
- Hydrogenation (H_2 storage reaction)
  - Conversion: >99% Selectivity: > 99%
  - Yield (H_2 storage ratio): > 99%
- Dehydrogenation (H_2 generation)
  - Conversion: >95% Selectivity: > 99%
  - Yield (H_2 generation ratio): > 95%
- H2 storage & transfer ratio: > 95%

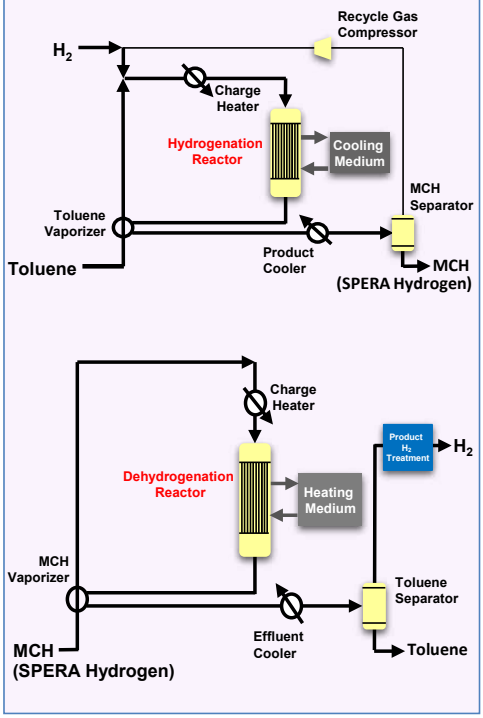
Selection of Hydride System

	MCH—Toluene		Cyclohexane —Benzene		Decalin—Naphthalene	
	MCH	Toluene	Cyclohexane	Benzene	Decalin	Naphthalene
Molecular formula	C_7H_{14}	C_7H_8	C_6H_{12}	C_6H_6	$C_{10}H_{18}$	$C_{10}H_8$
Chemical equation						
	-3H2, +3H2, ⊿H = 205 kJ/mol		-3H2, +3H2, ⊿H = 206 kJ/mol		-3H2, +3H2, ⊿H = 332 kJ/mol	
Molar mass(g/mol)	98.2	92.1	84.2	78.1	138.3	128.2
Phase @RT	**Liquid**	**Liquid**	**Liquid**	**Liquid**	**Liquid**	**Solid**
Density(g/cm^3)	0.77	0.87	0.78	0.87	0.90	0.98
Melting point (deg.C)	**-127**	**-95**	**7**	**6**	Cis:**-43** Trans:**-30**	**80**
Boiling point (deg.C)	101	111	81	80	Cis:195 Trans:186	218
H_2 store density (wt%)	6.2	—	7.2	—	7.3	—
($kg\text{-}H_2/m^3$)	47	—	56	—	65	—

Hydrogen Supply Chain Concept



Hydrogenation/Dehydrogenation Process



Conclusion

SPERA Hydrogen process is a highly promising technology for large scale and long distance hydrogen storage and transportation.

- Developed new dehydrogenation catalyst and process
- Demonstrated in 50Nm^3-H_2/h scale successfully

Business developments are progressing and the hydrogen supply chain concept has reached the first practical stage in Japan.

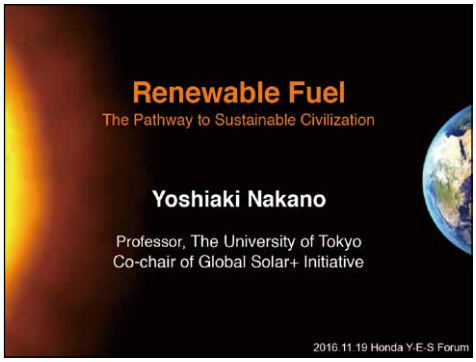
CHIYODA CORPORATION

Keynote Speech

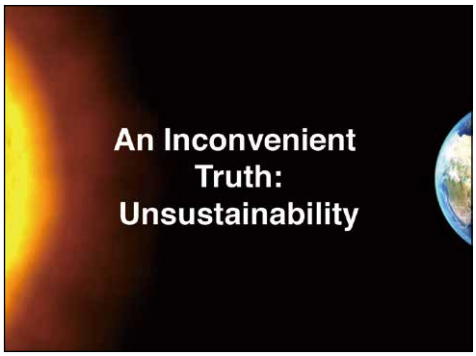
Yoshiaki Nakano, Ph.D.
Professor,
The University of Tokyo

Renewable Fuel: the Pathway to Sustainable Civilization

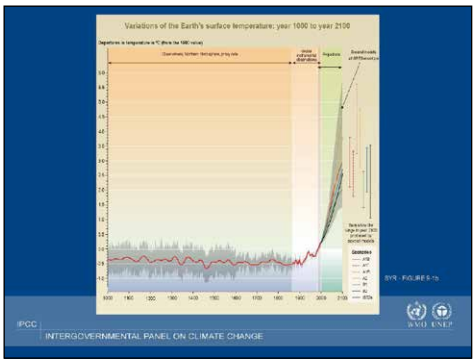
Good Afternoon. As I was introduced, my name is Nakano, from the University of Tokyo. As a professor of the University of Tokyo, I would really like to thank you all for coming over to the Hongo Campus of the University of Tokyo, which is the main campus of this university. What I'm going to talk about today is renewable fuel. And I think this is the only way to change the world, purely sustainable.



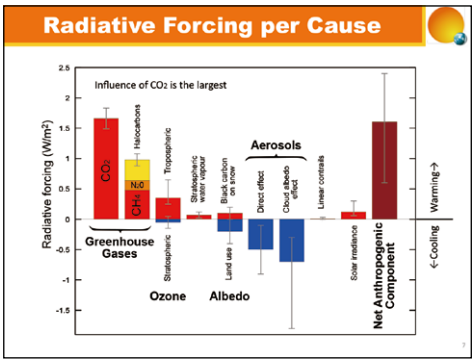
There is an inconvenient truth, which is unsustainability.



Most of the presenters today have already pointed out that we are facing a severe global warming problem.

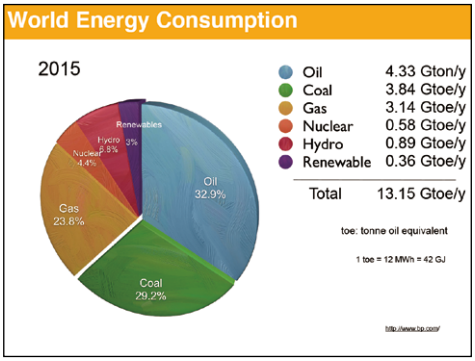


There are many factors that contribute to the warming and cooling. But the warming effect is actually larger than the cooling effect, so that the world is now becoming warmer every decade.

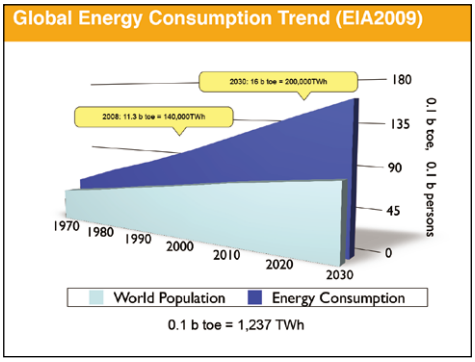


We have already looked at the energy profile of each country from the morning presentations, from many of our Y-E-S past awardees. This is about the world, including all the nations.

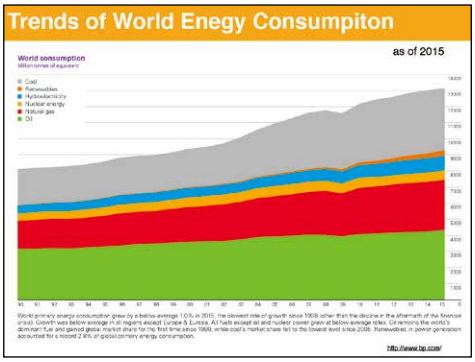
World energy consumption profile is something like this: oil, coal, gas, they are three major parts. Nuclear, hydro and other renewables, they are between 10% to 20%. So, in order to stop the global warming, we have to reduce the oil, coal, gas part as soon as possible. We have only 27 years left, that was pointed out by one presentation. And the global tendency of the energy consumption is growing, increasing.



And this is almost in proportion to the growth of the population or it is actually more than the proportional increase of the population and therefore, we have a very big problem.

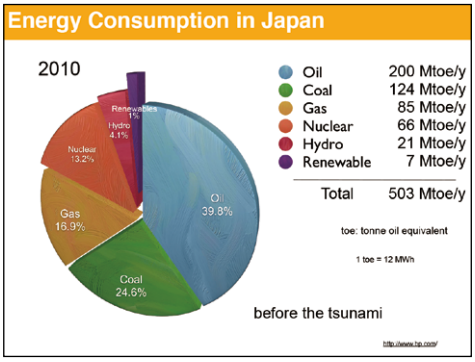


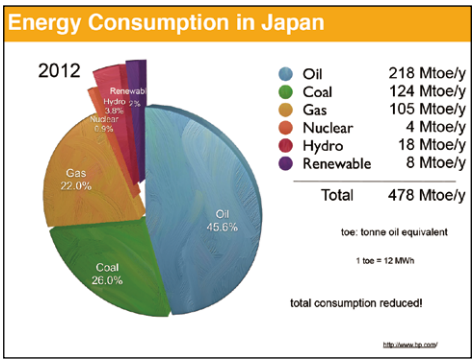
This is also the trend of our world energy consumption. The upper gray part is coal, this green part is oil and this red is gas. The rest are either nuclear or renewables. Regardless of types of the energy source the total amount is always larger, growing, and increasing.

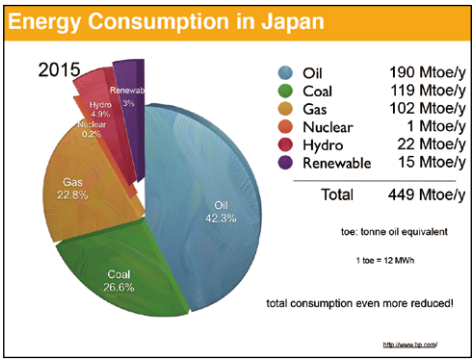


But this morning, we haven't seen any energy profile about Japan. I would like to show you the energy profile/portfolio in Japan, before Tsunami, before the East Japan earthquake and disaster. We had a large percentage of nuclear and we had a very small amount of renewables before tsunami. After tsunami, it became like this: the nuclear part shrunk very much, so that was compensated by the increase of mostly gas usage. We became to emit more carbon dioxide than before. This is a bad thing, but one thing good is that if you look at the total amount, before tsunami, we used 500 megaton oil equivalent, but after tsunami, the total amount reduced to 480. Today, this is actually statistics in 2015, we have increased the renewable energy portion quite a bit and also, the total amount of the energy consumption reduced.

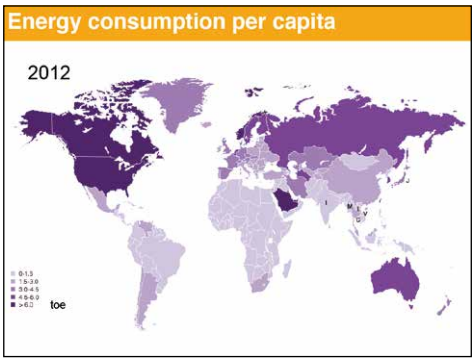
We are a country consuming less energy year by year. This is due to the decrease of the population, this is one thing. The slow economy is another thing and also the saving of energy. Energy saving became very much popular these days, people pay money for saving energy. This is one thing that happened after tsunami attack. Even though worldwide energy usage is increasing, we might do something to stop or reduce the consumption of energy.



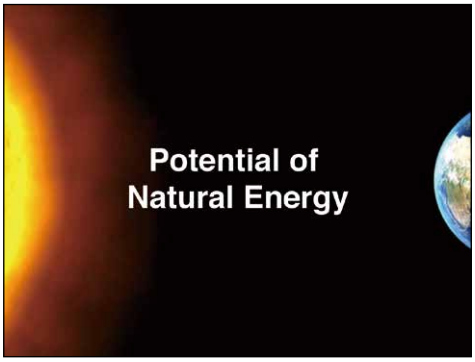




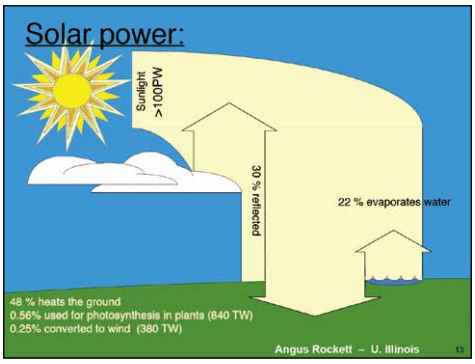
This is energy consumption per capita. We have seen some from the Y-E-S awardees this morning. All of us are not so bad in terms of the energy consumption per capita. Japan is consuming a little bit more, but there are several countries consuming a lot; U.S., Saudi, so the world can do something better than current situation.

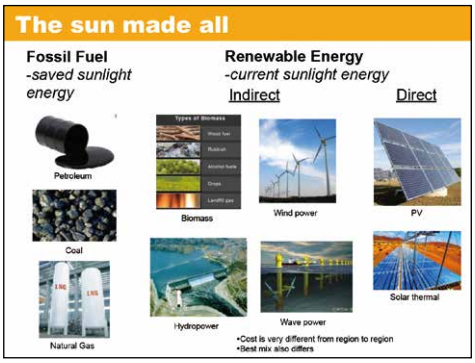


So, let me speak about the potential of natural energy. Maybe most of you know this fact, the amount of energy delivered from the sun to the Earth is very large, more than hundred petawatt. Of course, large fraction is instantaneously reflected into outer space. But other fraction used to drive many things, like wind, or waves, or plants, which I will show you later. We can say that this planet's main and only source of energy is the sun.

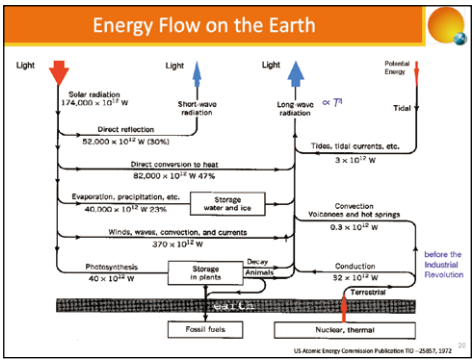


The current main energies are fossil fuels of course, but they are actually sunlight energy. Sunlight energy in the past, accumulated sunlight energy is now being used as petroleum, coal or natural gas. These are the current sunlight energies, the sunlight creates wind, waves and creates the rain to make hydro power generation possible. Also, sunlight grows the plants and that is being used as a biomass. These are the sunlight energy of today, helping people to get the energy out. PV(Photovoltaic) and CSP(Concentrating Solar Power), or solar thermal, they are the direct usage of the sunlight. Whereas there are indirect usage of the sunlight energy, because light energy is already converted into different forms.

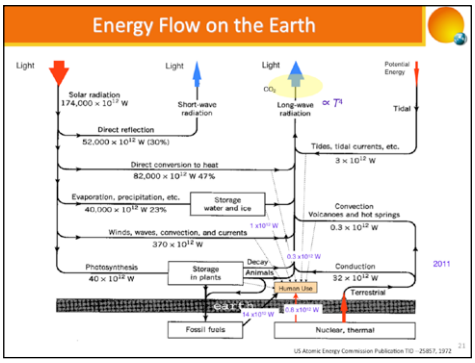




This is the energy flow on this planet. The biggest and almost all the input of energy is from the sun, in the form of light. Large fraction actually reflected directly into outer space. But other portions used in different ways: direct heating of the ground, evaporation of the water to create the rain and snow, and some used to generate waves, convection and currents and small fraction used as photosynthesis. This is going to become biomass. One thing nice with photosynthesis is it is going to be stored for long time. Some became fossil fuel and we are making use of the fossil fuel very much. Some, for example, direct heating of the ground is going to go out again, into space as a black-body radiation. There is some production from the interaction with the moon, but that production is not big as compared with these energies.

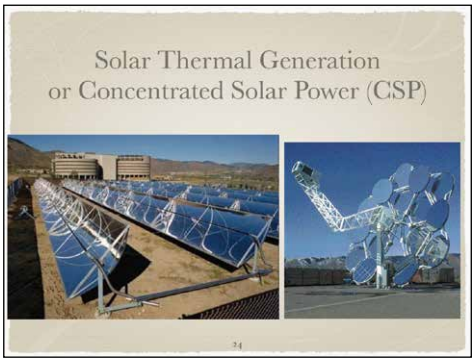


What we've been doing, human beings doing, is getting energy out of the huge energy flow of this planet. We dig fossil fuel to get the main energy. We convert some of the mass into energy which is nuclear. We started to make use of the other source of the natural energies, like biomass, hydropower generation, hydro is here, this is wind. And this is PV. PV making use of the largest fraction of energy flow from sunlight into daily life. Converting the large energy of sunlight into the electricity for daily life, which is very nice. We sometimes use the tide and we sometimes use the geothermal but unfortunately up until now, the fraction of getting natural energy from these energy flows has been very much small, as compared with the energy leaking out from the ground.



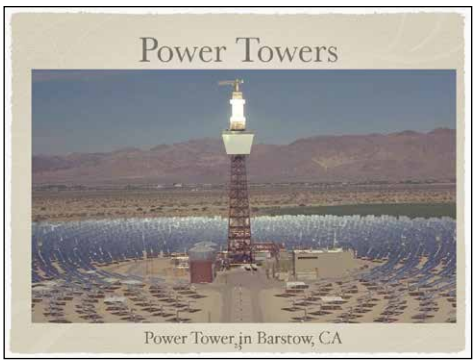
What we need to do is to stop digging and make use of the other source of the natural energies. But it is not very easy to get large amount of energy out of the natural flow. One thing we can do is to convert sunlight into heat,

Like this one

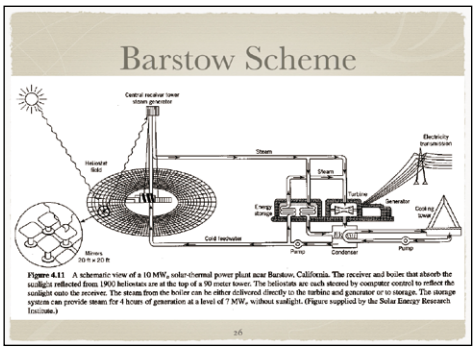


Or this one.

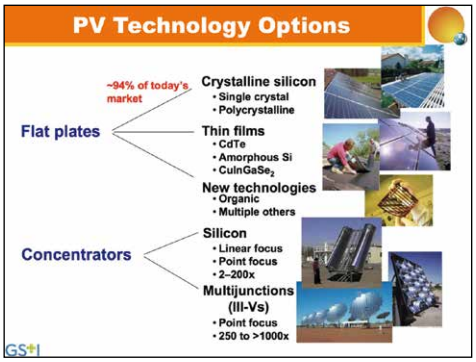
And then make steam and the steam will rotate the turbine to get the electricity.



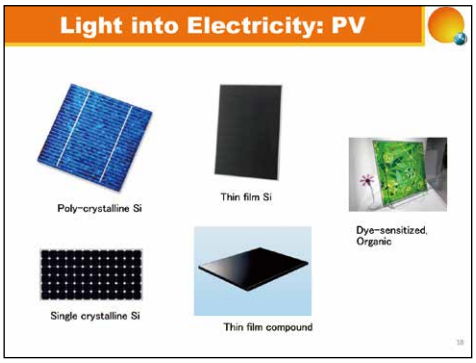
But as you can tell, this is very indirect way of converting sunlight energy into useful energy. So, light into heat, into mechanical motion, then electricity. Each conversion, we have a loss. This is not very efficient way of making use of the sunlight energy.



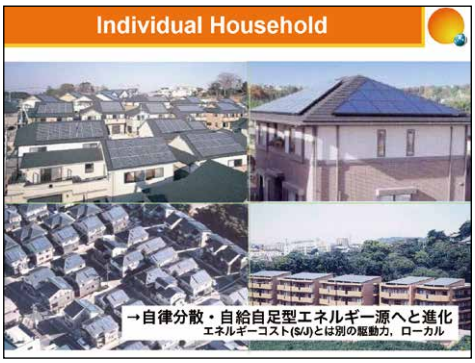
PV is a direct conversion of light into electricity. There are many different types of the PV technologies, but they are mostly quite efficient as compared to other means of getting natural energy. That's the reason why many people are working on this PV.



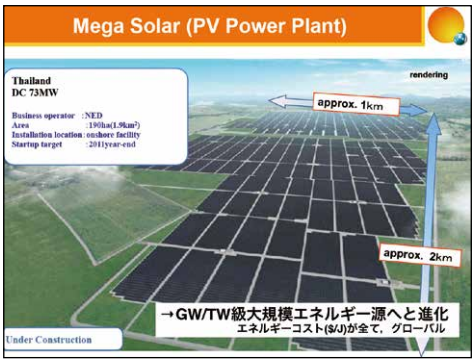
We have these days, thin film panels, besides the traditional crystal type of the PV cells.



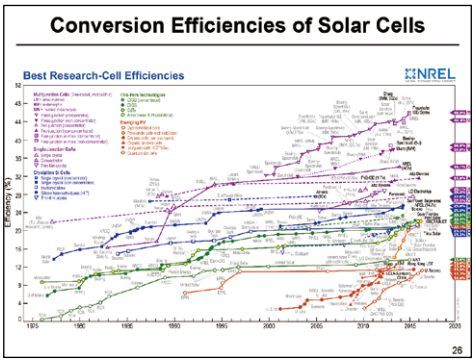
You have already seen many different types of the PV cells and they are already being deployed on the rooftop. These are the cases in Japan.



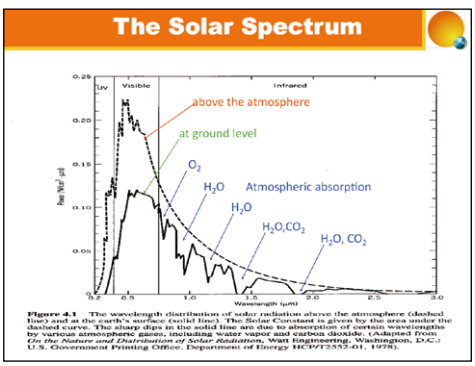
And this is one big scale PV power plant already constructed in Thailand. But we have to consider about the efficiency more seriously.



This is the chart made and updated by National Renewable Energy Laboratory in the United States every few months. It's showing the conversion efficiency from sunlight into electricity. As time progresses, we are 2016, if you look at the current situation the highest conversion efficiency is 46%. That means we can convert almost 50% of sunlight energy into electricity. But normal PV cells, like shown here. They have actually very much lower efficiency than this one. They are mostly shown by the blue line or green lines, they are made out of silicon. And silicon, single junction solar cells theoretical efficiency limit is around 30%. So most of the silicon cell efficiency is reaching to the theoretical limit. And that is the reason why the efficiency doesn't go up, and they are rather saturated. Whereas there are several other solar cells having energy efficiency more than 30%, and it is actually increasing more and more every year because the theoretical limit of these solar cells is up high, more than 50%, sometimes more than 60%. We have a large room for improvement for these solar cells.

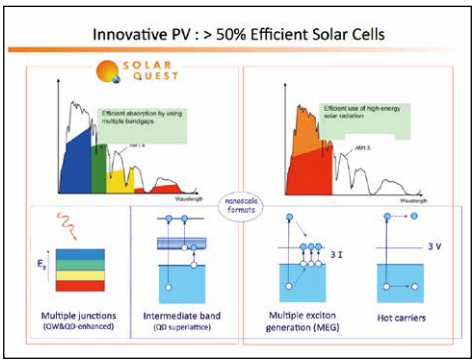


The reason why the solar cell efficiency is not 100% is that the sunlight contains a lot of different type of photons, different lights, from red to violet. But not only those visible lights, but also it includes the infrared and the ultraviolet. In order to make solar cell efficiency 100%, we have to convert visible light, UV light and the infrared light into electricity at the same time, which is very difficult. That is the reason why solar cell efficiency is always below 50%.

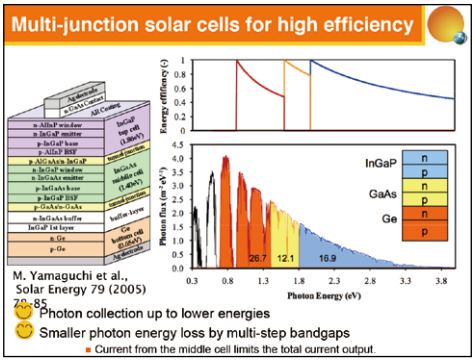


There are several techniques to make absorption of all different photons possible. One easy, simple way is to stack different PV cells, each of them absorbing a different part of the solar spectrum. This one absorb UV, this one visible, this one red and this one for example infrared, to try to absorb almost all the sunlight energy.

The cell I have shown a few slides back, that 46% is actually recorded by the solar cell of this type. It is called multiple-junction type solar cell.

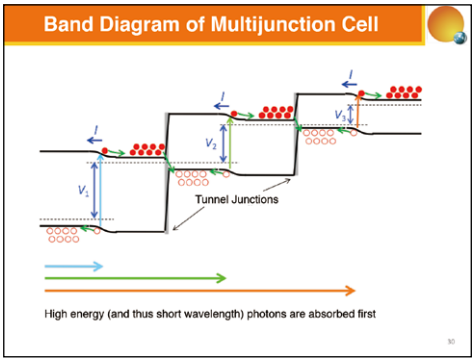


This is one embodiment of such a solar cell. There is germanium solar cell, gallium arsenide solar cell, indium gallium phosphide solar cell to absorb different wavelengths or different colour of the light to produce as high efficiency as possible.

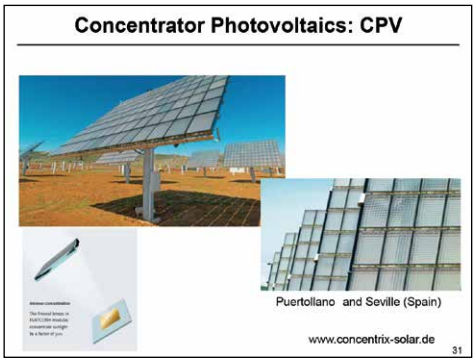


The problem of such solar cell is that the cell itself is very expensive as compared with the silicon. We just can't make it big.

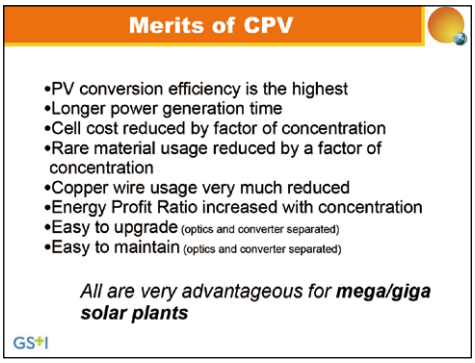
And also, the reason why we can't make it big is, there is always limitation of the material resources. It uses for example germanium or indium, they are not very abundant on this planet. So, we need to limit the size as small as possible. But we need to absorb the large area of light as much as possible. So, what we do is to use optics, lens, mirror, or any type of optics to concentrate the light onto a very small chip of the solar cell. This is called concentrator photovoltaics. In short, it is called CPV.



Although the panel of CPV look quite similar to silicon PV panels, most of the things are made out of either plastic, glass or the metal, like iron or aluminium. We use very small amount of the semiconductors like gallium arsenide because the chip itself is very small. For example, 2mm by 2mm, very tiny chip can absorb huge amount of energy. In the CPV case, the size of the cell is no longer a problem. The cost of the cell is no longer a problem because we use very small chip anyway.

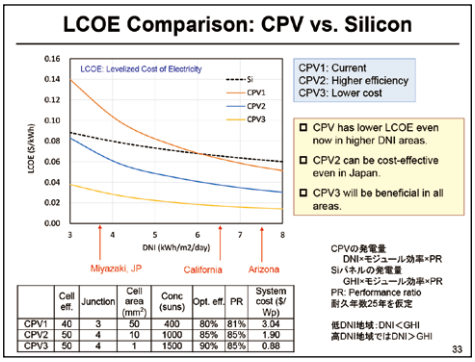


There are many merits of the CPV, but because of the time limitation, I will skip. One thing good with CPV is not only the efficiency is high, but also there are many rooms for the cost reduction. The silicon solar cell, we have already reduced the cost, almost as small as possible. So, cost reduction for silicon solar cell is not very much expected for next few decades. But CPV, there are many rooms of cost reduction.

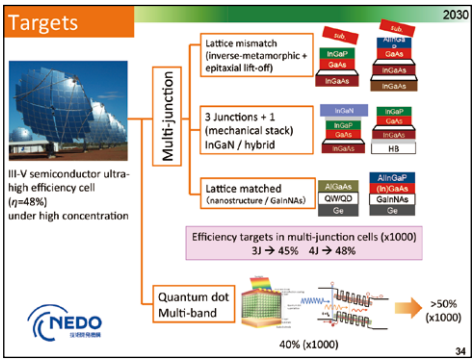


This is our current situation but we can reduce the cost down from this situation to this and this. For example, one third, one fourth type of cost reduction would be possible for the case of the CPV.

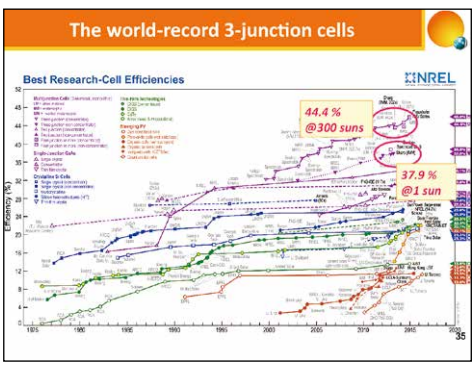
However, the biggest drawback of CPV as compared with the regular, normal, silicon PV is it requires direct insolation. If it is cloudy, it doesn't work. This kind of concentration doesn't work well if it is cloudy, if we don't see sun directly. We need direct sunshine or sunlight, that means this kind of cell needs to be used in the region where sunny day is a majority. That is the reason why the cost changes with the amount of DNI(Direct Normal irradiance). High DNI can be obtained in California or Arizona, whereas in Japan DNI is very small. Even Miyazaki has lower DNI than California or Arizona. If we use CPV in Japan, cost of electricity is going to be high. But if we use CPV in Arizona, cost is already 50% of the cost in Japan. So, this kind of solar cell needs to be used in such sunny region, or in desert.

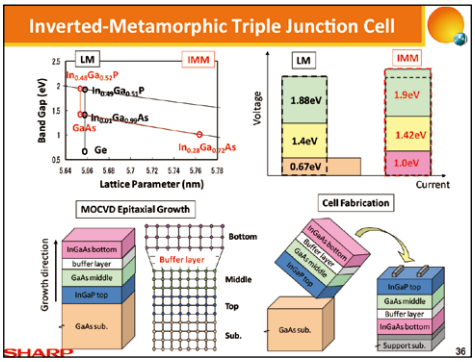


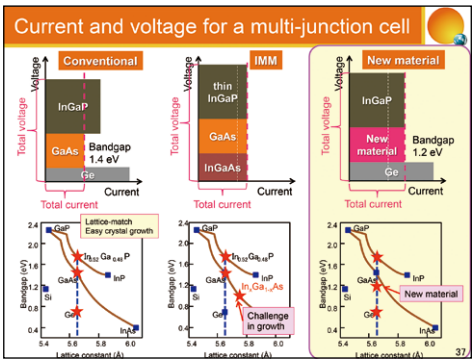
There are many research projects going on in Japan, in Europe, in the US, trying to create a new record of the conversion efficiency. We are talking about who is going to be the first guy to break the 50% conversion efficiency limit. We of course want to become the first guy, we just can't tell who is going to be.

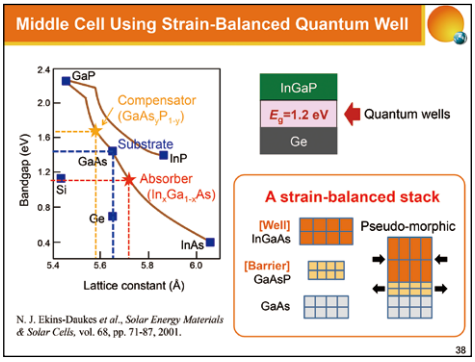


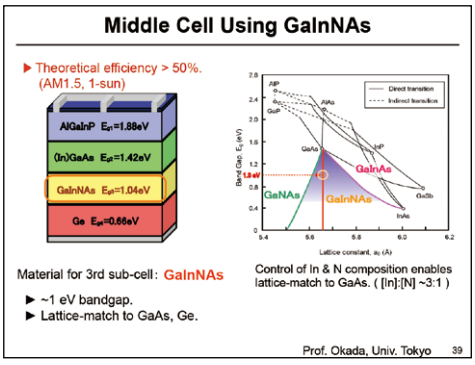
Anyway, there is a real competition happening in the world to increase the efficiency even higher. These are the records that we, Japanese project recorded, 44% for precision triple-junction cell, 38% for triple-junction cell without sunlight concentration. These are the highest number as non-concentrator and also triple-junction cell. But as I told you before the ultimate high efficiency is now 46%, which is recorded by the German group. So, we are trying to beat that number now. There are many ways that we can beat, or we can go beyond the 50% conversion efficiency, but because of the limitation of time, I skip all these things.

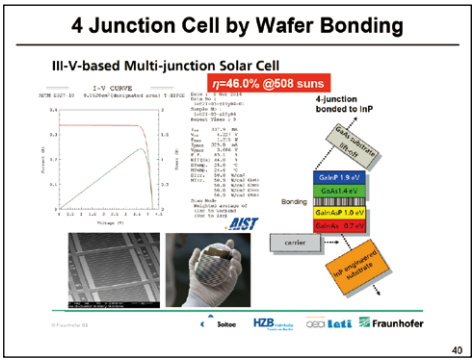



Inverted-Metamorphic Triple Junction Cell
LM
IMM
Band Gap (eV)
Lattice Parameter (nm)
Voltage
Current
1.88eV
1.4eV
0.67eV
1.9eV
1.42eV
1.0eV
MOCVD Epitaxial Growth
Cell Fabrication
Growth direction
InGaAs bottom
buffer layer
GaAs middle
InGaP top
GaAs sub.
Bottom
Middle
Top
Sub.
Support sub.
SHARP
36


Current and voltage for a multi-junction cell
Conventional
IMM
New material
Total voltage
Voltage
InGaP
GaAs
Ge
thin InGaP
InGaAs
New material
Bandgap 1.4 eV
Bandgap 1.2 eV
Current
Total current
Lattice-match Easy crystal growth
Challenge in growth
New material
Bandgap (eV)
Lattice constant (Å)
37

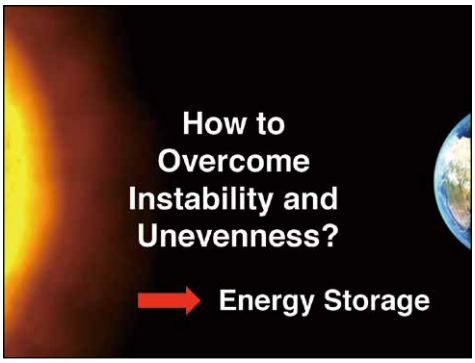

Middle Cell Using Strain-Balanced Quantum Well
GaP
Compensator (GaAsyP1-y)
Substrate
InP
GaAs
Absorber (InxGa1-xAs)
Si
Ge
InAs
Bandgap (eV)
Lattice constant (Å)
InGaP
Eg=1.2 eV
Ge
Quantum wells
A strain-balanced stack
[Well] InGaAs
[Barrier] GaAsP
GaAs
Pseudo-morphic
N. J. Ekins-Daukes et al., Solar Energy Materials & Solar Cells, vol. 68, pp. 71-87, 2001.
38

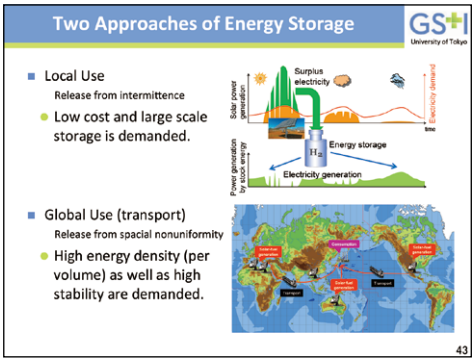

Middle Cell Using GaInNAs
Theoretical efficiency > 50%. (AM1.5, 1-sun)
AlGaInP Eg1=1.88eV
(In)GaAs Eg2=1.42eV
GaInNAs Eg3=1.04eV
Ge Eg4=0.66eV
Material for 3rd sub-cell: GaInNAs
~1 eV bandgap.
Lattice-match to GaAs, Ge.
Direct transition
Indirect transition
GaInAs
GaNAs
GaInNAs
1.0 eV
Control of In & N composition enables lattice-match to GaAs. ([In]:[N] ~3:1)
Prof. Okada, Univ. Tokyo
39

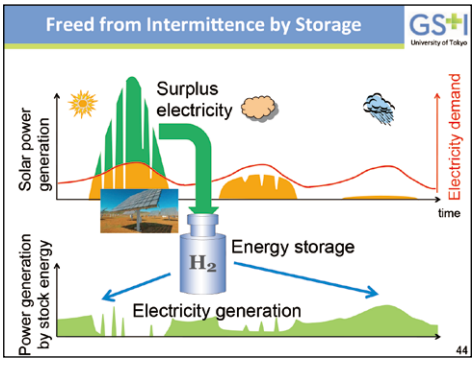

4 Junction Cell by Wafer Bonding
III-V-based Multi-junction Solar Cell
η=46.0% @508 suns
4-junction bonded to InP
GaAs substrate
GaInP 1.9 eV
GaInAs 1.4 eV
GaInAsP 1.0 eV
GaInAs 0.7 eV
Bonding
carrier
InP engineered substrate
AIST
Soitec
HZB
CEA Leti
Fraunhofer
40

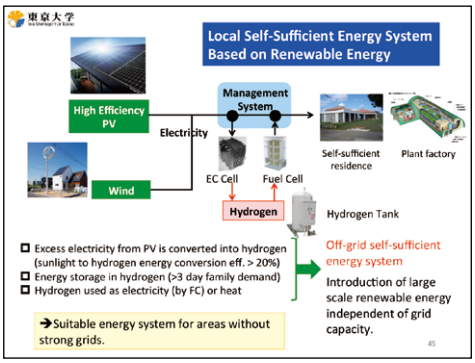
The next big problem about the renewables, is how to overcome the instability in time and also unevenness in space. This is of course being solved by the energy storage. In the morning session, we have already seen the energy storage using hydrogen, this is one of the best ways to store renewable energy. Also, we saw in the presentation by the Chiyoda group, the hydrogen can be transported in the form of the chemical hydride. Hydrogen is great. Hydrogen is, I should say, the first renewable fuel to be utilized in the current society. This is already being demonstrated in the morning presentation and also in the poster session.

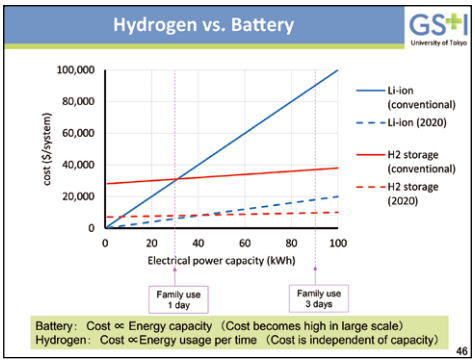
The most important thing is to produce hydrogen out of renewable energy, than from the fossil fuels. The hydrogen is better than battery if the amount of the energy stored becomes large. If the amount of energy stored could be small, battery will be better. It is just simply a matter of how large amount of energy you'd like to store. Battery can only store family use of one day, so it's not very good. Family usage of three days if you need that energy stored, then you'd better switch to hydrogen.

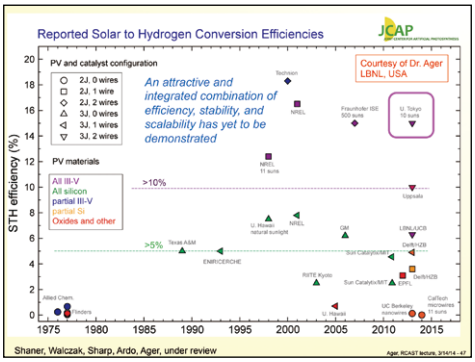




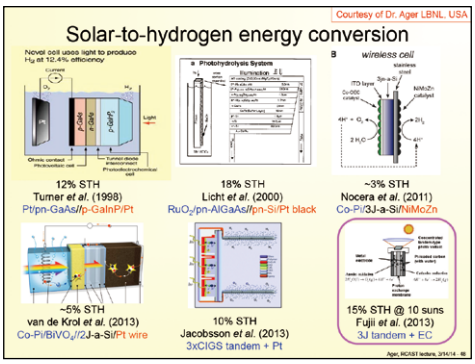


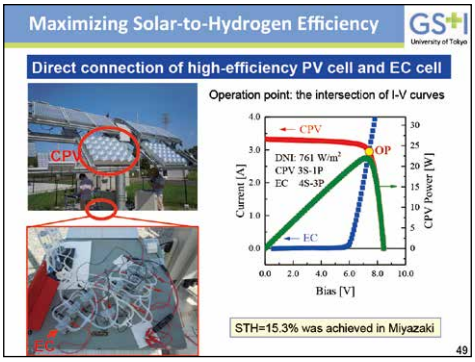


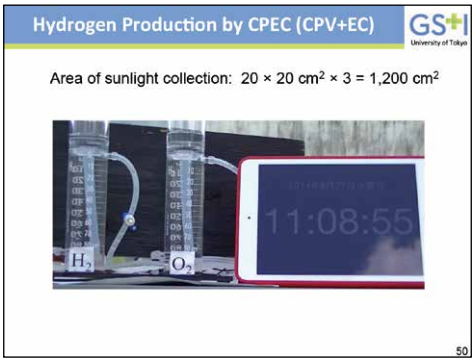




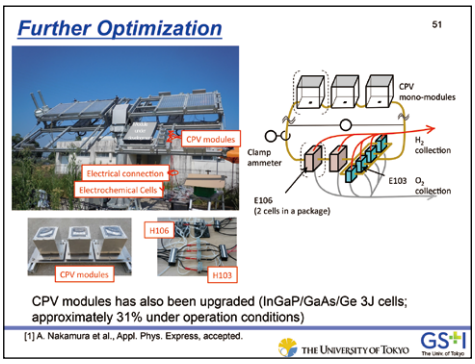
There are many different ways to make renewable hydrogen. One famous way is to use photo catalyst, but we've been trying to make use of the high conversion efficiency solar cell to produce hydrogen. So, this is a direct connection of the high efficiency solar cell with the commercially available electrolyser, this experiment was done in Miyazaki. Right after starting shining solar cell under the sunlight, we started to create hydrogen and oxygen in this way by water splitting. The solar cell itself was not very large but we can produce hydrogen and oxygen in this pace, which is very fast.

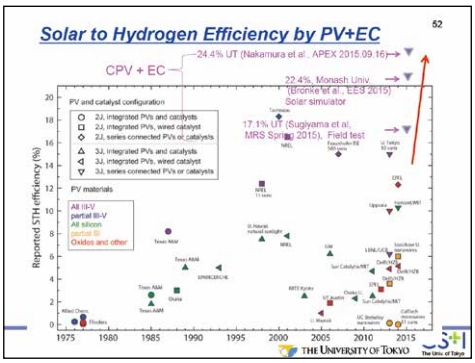


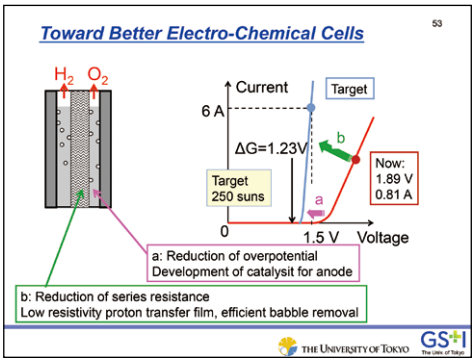


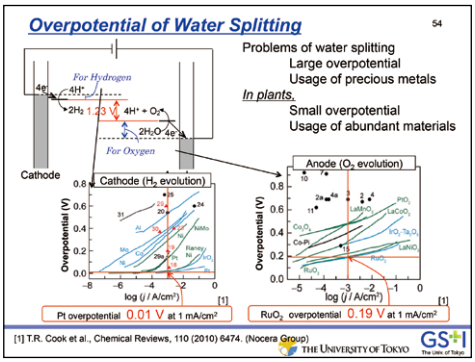


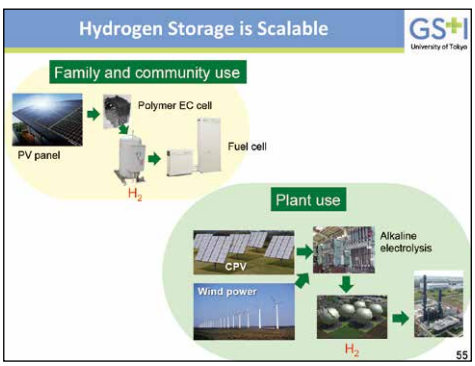
By changing the connection of the high efficiency solar cells and the electrolyzer, then we could even achieve 24% of the sunlight into hydrogen conversion efficiency. Normal PV cell gives you 10% or 15% of the sunlight to electricity conversion. This one, sunlight into hydrogen is 25%. So, one fourth of the sunlight energy could be stored in the form of hydrogen. This is going to change the way how you use renewable energy. There are many things that we need to do, we have also seen many examples in the poster session too. We need to improve the water splitting technology even more, in the sense that we have to accept the unstable renewable electricity that will damage the electrode of the electrolyser, that problem needs to be fixed.



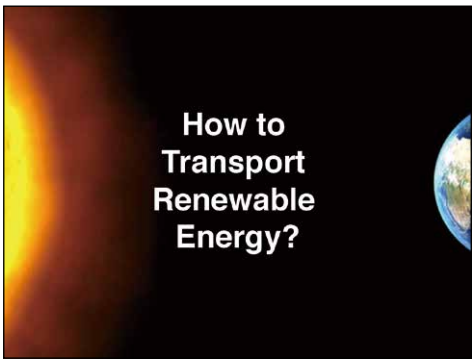




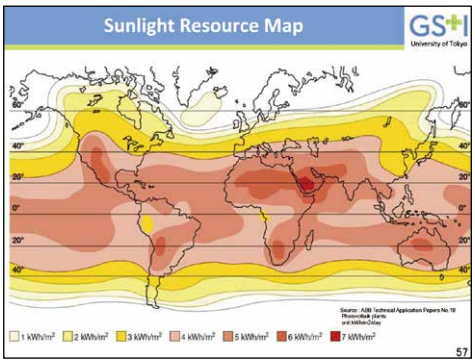




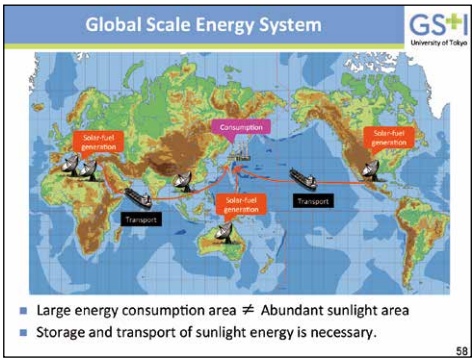
So, how to transport renewable energy?



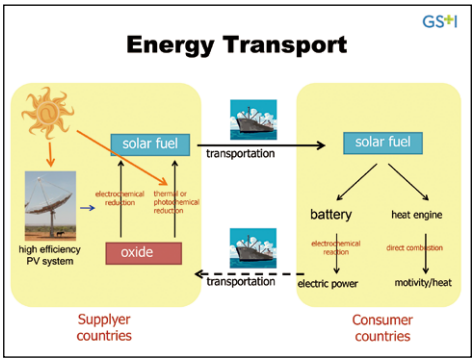
This is a map, the resource map of the solar energy. We need to transport solar energy from under the equator to the remote region like North Europe, Japan.

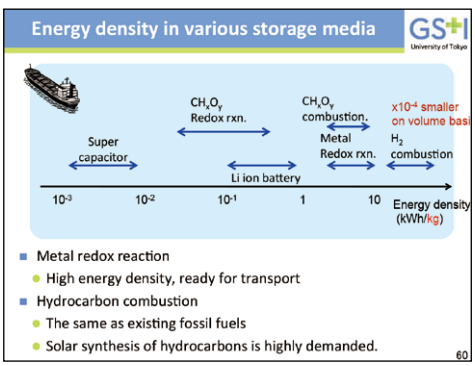


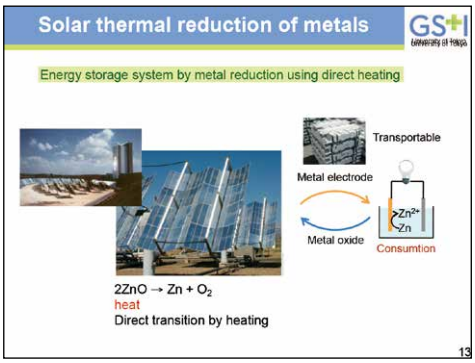
Then we want to transport the renewable energy by very inexpensive way like ocean transportation.



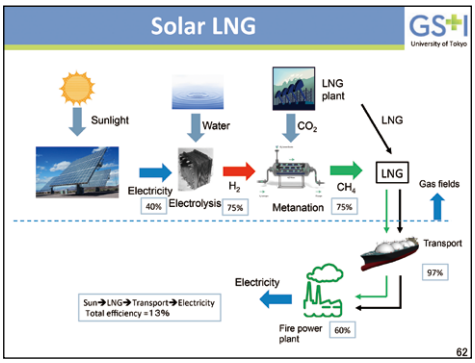
We can do that in this way, charging under the strong sunshine, then transport, use, and send the remaining material back and make the recycling paths like this one.



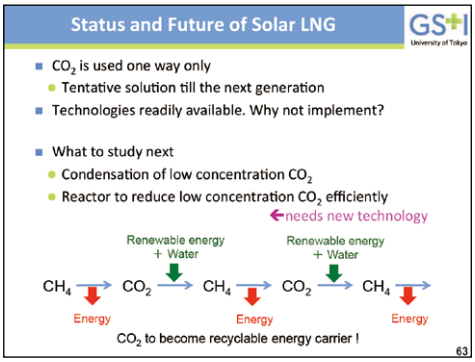


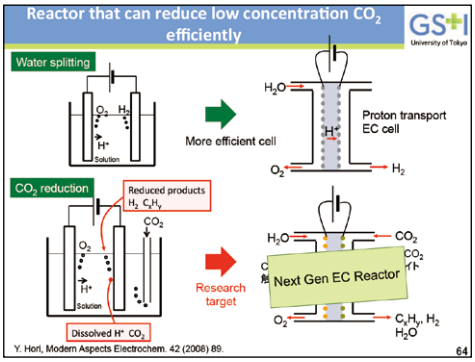


We have many different options to do this. But one simple thing is to convert the sunlight generated hydrogen into methane. This could be called as a renewable natural gas. And this renewable natural gas could be shipped with the fossil natural gas, in the form of liquid natural gas. Then use them as a usual natural gas. Thereby we can change the percentage of the natural gas used. For example, in Japan, from 100% non-green to 10% green, 20% green, 30% green, gradually.

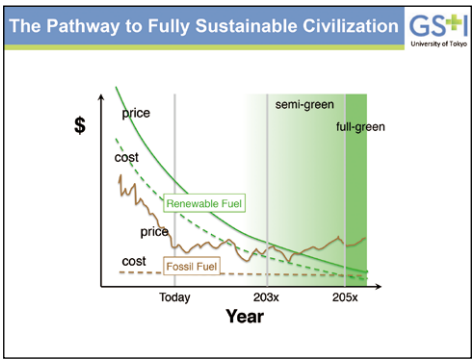


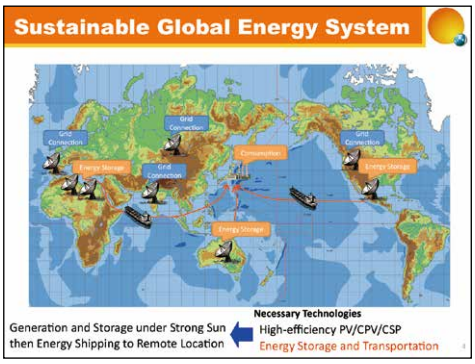
If we think about that sort of recyclable global energy system, the carbon dioxide is going to be no longer a very bad guy. The carbon dioxide will make hydrogen transportable. With the help of the carbon dioxide, we can ship the renewable energy over very long distance. The final goal is of course to reduce carbon dioxide directly. That would become available in a few years.



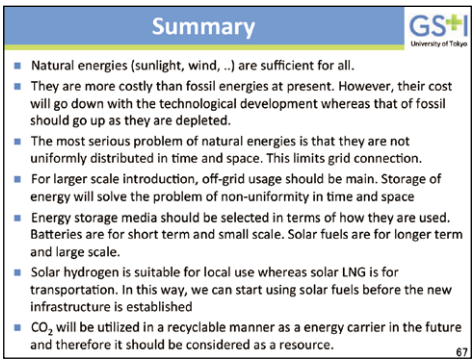


So, this is the final slide. At this moment, the cost of the renewable fuel like renewable hydrogen or renewable methane is higher than the fossil fuel. But as time goes by, they will go down because the technology advances. Whereas the fossil one, they stay almost the same. It goes up and goes down because of the policy or the political situation. Within some years, the cost and the price will become almost comparable between renewable fuel and the fossil fuel.





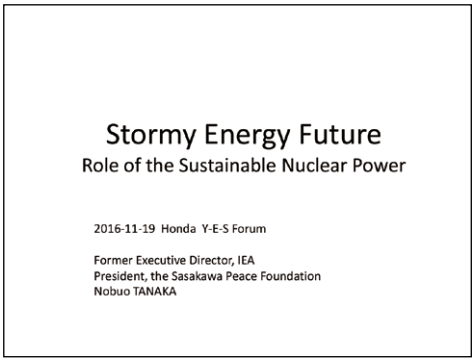
From that point, the renewable fuel will be selected and the fossil fuel will be abandoned. And from this point, the cost of the renewable fuel will become lower than the cost of the fossil fuel. From that point, we will become fully green. We will become free from the global warming, free from the depletion of fossil energy. Thank you very much for your attention.

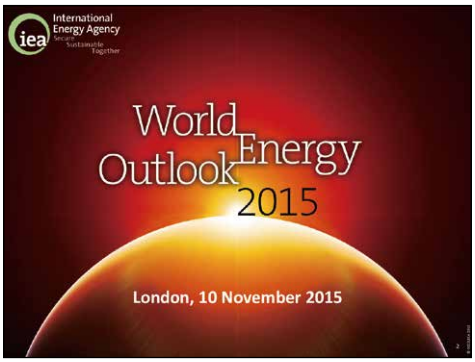


Mr. Nobuo Tanaka
President,
The Sasakawa Peace Foundation

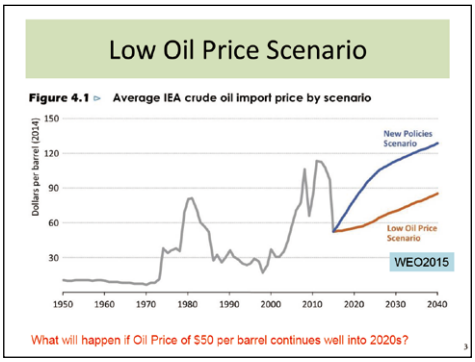
Stormy Energy Future and Sustainable Nuclear Power

Hi everybody, I'm very much delighted to come here. As the subject for today is certainly energy security that is achievable by the ecological technology so to speak, will nuclear play a role? This is interesting question. As I was the former Executive Director of the IEA, maybe you may have heard about the IEA, International Energy Agency, headquartered in Paris. It's an international body and its publication is called World Energy Outlook. The newest version came the day before yesterday, so I have not yet fully covered it so I use the old one but there's not much difference. The new one is much more focused by the way on the renewable energy so the new Executive Director who succeeded me came in next week to talk about the new renewables more than what he did last year.



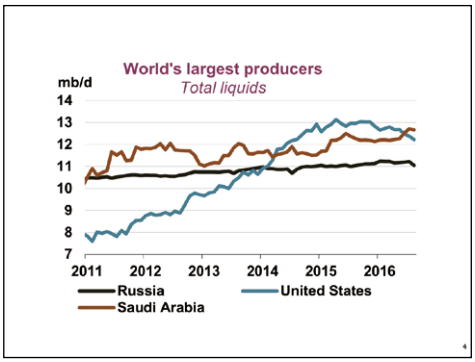


The current energy focus, as you may know, is the price of oil. Price of oil is always the issue for those engaged in the oil industry, gas industry. The history shows that IEA was created in here, 1974 at the first oil shock with Arab embargo of oil. The consumer countries fell into the panic and created the IEA to enhance security by creating the collective stockpile of petroleum. So, to use its strategic release, and to stabilize the price was the purpose of this security, but in a couple of years later, the second oil crisis happened because of the Iranian Revolution. Of course, after that, oil price collapsed because the very high price induced, increase of production in other than the Middle East, such as Russia, Mexico, North Sea, etcetera, etcetera. Also consumer countries did a huge exercise of energy conservation, so supply exceeded demand and price collapsed. Same thing is happening now.



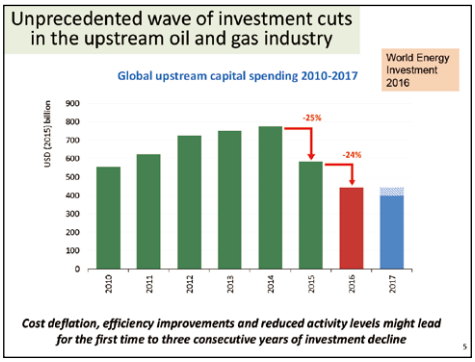
That is the very interesting story. Because of the very strong growth of China, it went very high to $147 per barrel in 2008. Lehman crash made the price down but still went up, and in the autumn of 2014, Saudi Arabia changed its oil policy by not accepting the repetition of the mistake they did in 1990s. So rather than giving up the share of the oil and revenue, they simply maintained the production and that caused a huge drop of the price. Will this low price continue as it did from 1990s to 2000, or will it go back to the high price? This is a very interesting question. If I know the answer, I will be a millionaire so I don't know, but this shows something interesting.

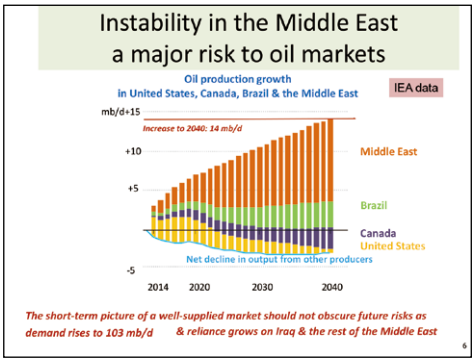
This is the three major oil producers and the level of their production in the recent years. Blue is United States and you can easily imagine why this big increase happens. Yes, it's shale oil, the famous story of their innovation of producing oil from shale. Black is Russia. Russia was very steady. Even with the price crash in 2014, it maintains because revenue is guaranteed because Ruble, the Russian currency, deteriorate substantially while the price of oil goes down. So, internal revenue in terms of Ruble maintained so Russia is very sustained. Because of share keeping policy by Saudi Arabia, United States production of shale will stagnate and decline so now the Saudi is the number one producer of oil.



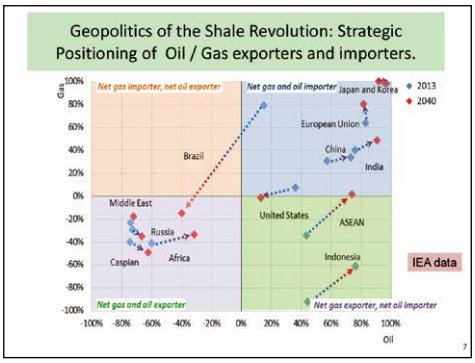
So, this is the kind of geopolitical rivalry of three major countries in the energy sector. The problem of the low price is in the future because investment is collapsing. In two years and the three years again, the reduction of the investment may happen, means future capacity will be definitely in short of possible demand raise in developing economies in Asia, India, and China.

The problem is here. This is the Middle East, and the United States' shale revolution will not continue forever. Maybe it's only decades. Canadian oil sand will continue and Brazilian offshore will continue but majority should come from Middle East because its cheap and huge capacity potential is in Iraq, Iran and Saudi Arabia. The risk is low price of oil, means much less revenue for the Middle East, means Middle Eastern stability of politics will definitely be undermined. While production capacity of these high cost countries will decline, the global community especially Asian growing economy must depend more and more on Middle Eastern countries, which will be less and less politically stable. This is the risk of the low price of oil. Low price is good thing for economy but increasing huge risk of geopolitical nature of the oil. US is lucky because of energy independence by the shale at least for decades.



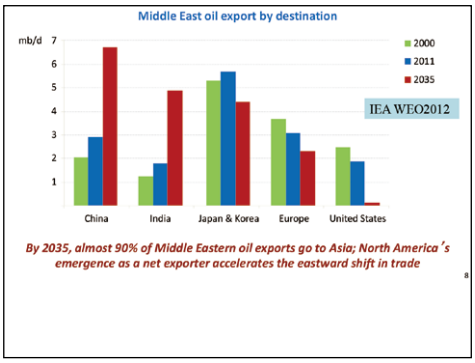


This is the vertical axis of import dependency to gas. Horizontal axis is the import dependency of oil. So, US import of oil declines while US becomes the exporter of gas in the future. Yes, this is China and this is India, it's getting deteriorating. China will import 80% of oil and about 40% of gas in the future. Japan and Korea are stuck here because we are already 100% importer of gas and oil and we cannot be worse, right? We depend on 40% of gas from ASEAN countries but ASEAN will no longer export gas for us in the future. Myanmar delegation said "yes, we need gas for domestic use", and Indonesia too.

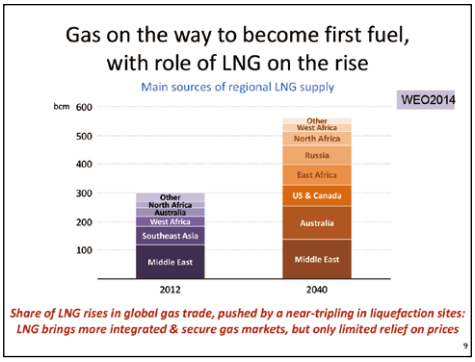


Where can we buy gas? Maybe part of the United States and somewhere here, there's Australia, yes but expensive. So, these countries in purple area will be our target. But to reduce dependency from Middle East, we have to get gas from Russia, maybe from East Africa or Caspian. Russia is definitely important player for us. Now, Prime Minister Abe and Mr. Putin will meet each other next month and try to do some political deal in the Northern territory if possible and our reliance on all of these countries certainly needs Russia in the future. United States no longer need Russia. United States no longer need Middle East.

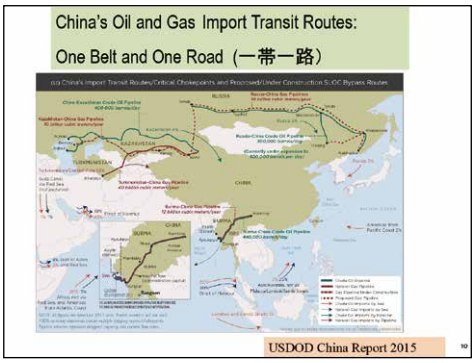
See this chart. The Middle East oil will go to Asia 90% in 2035; China, India, Japan, Korea and other ASEAN countries definitely need oil from the Middle East. The United States, no. Will United States protect free navigation in the Strait of Hormuz or continue to commit the Middle East peace? Now, the indication of the new president elect, Mr. Trump, isolationism certainly worries me.



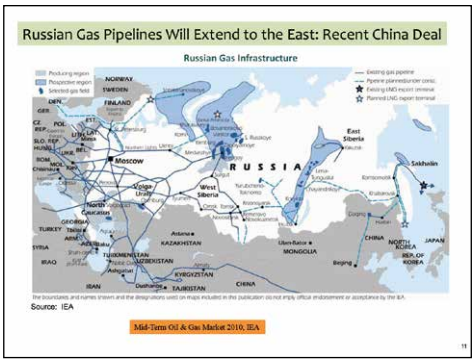
Probably Japan, Korea, China, India and other ASEAN countries should work closely together to maintain the peace and free navigation in the Strait of Hormuz in the future, maybe together with the United States but who knows. Japan is ready to send maritime minesweepers in case of emergency by changing the legislation. Will Asian countries do the same with us? This is the geopolitical security question. Gas is okay. Lots of different sources, so for the security purposes as well, because its clean source for the sustainability sake. Gas is getting more and more important, so the golden age of gas is coming.

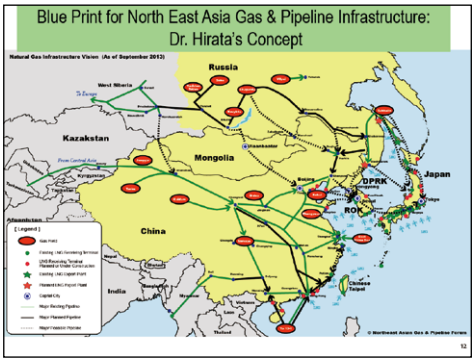


China is preparing for the security by lots of pipelines because China believes pipeline is much more secure than sea lane. Myanmar, Turkmenistan, Kazakhstan and Russia provides gas and oil by pipeline. Yes, sea lane continued to be important but assertiveness of Chinese action worries neighbors, Vietnam, Philippines, Indonesia, and Malaysia but not only these countries but the United States. This chart is from the US Department of Defense China report last year. Every year, this chart is getting much more in detail. This shows the American concern about the Chinese Energy Policy as a national security issue.

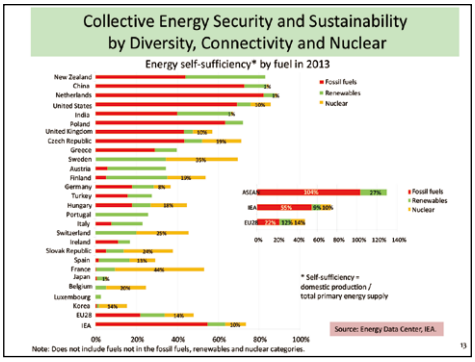


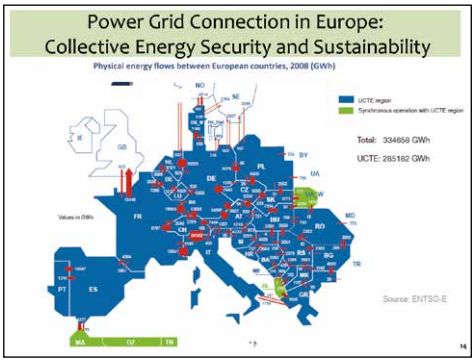
Russia is moving from west to east because of the shortage of gas sources in the Western Siberia and moving to the Eastern Siberia, and there are much bigger users; China, Pacific countries or Japan and Korea rather than Europe. And of course, the issue of Ukraine sanction causes Russian move as geopolitics. Mr. Trump will be a very good friend of Mr. Putin and what will happen of this change to China, Japan, and Europe and other Asian countries? We don't know but this is very important for the energy security of everybody. China is using pipelines. We are not really using it enough but collective energy security, say pipeline is important.



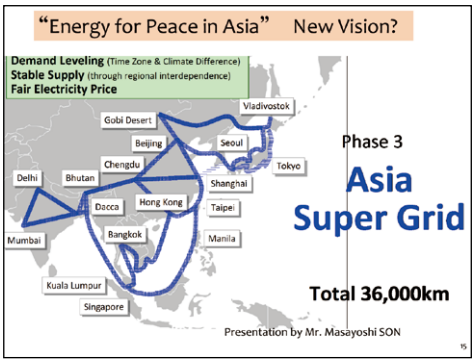


This chart shows the self-sufficiency of different countries by ranking; red is fossil fuel and green is renewable. There are many countries who is above 100% exporters of fossil fuel, like Russia, Canada, Australia and Norway but we started only less than 100% countries. The Europe as EU28 is by average about 50% self-sufficient with well-balanced between fossil fuel, renewables and nuclear. Yellow is nuclear. Those countries with less fossil fuel and renewables use nuclear as supplement; France, Belgium, Korea, and Japan, these are the countries. The European case is interesting. Europe is average here but each has different portfolio of mix but combining them by grid line connections like this. Germany can phase out nuclear because they can import power. Electricity from France is generated by nuclear or from Czech generated by coal and using wind in Denmark and Baltic Sea by using big market. So, absorbing the volatility of the renewables, like wind and solar.

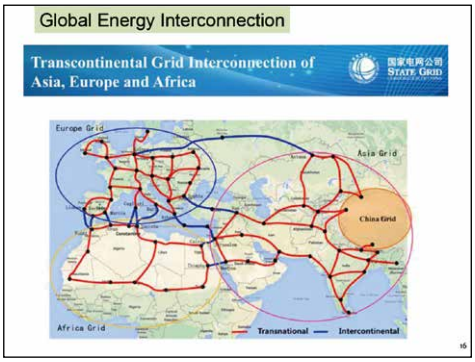


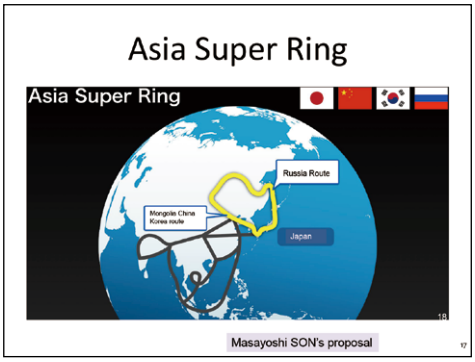


Can Japan and Korea without any connection to the other countries survive without nuclear power? This is the really serious question for us. Asian Super Grid, this is the vision for the CEO of SoftBank, Mr. Son. His idea is connecting grid line from China, Korea to Japan. Chinese has another strategic connectivity at state grid, and just recently in Vladivostok, Russian president supported this concept of Asian Super Ring of these four countries with Mr. Masayoshi Son's proposal. So, this kind of thing should be considered as collective energy security starting in Asia. ASEAN countries are doing the connectivity of power line as well as pipeline so they are already starting to that direction.

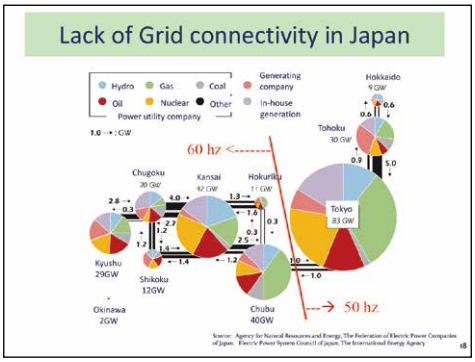


Energy security cannot be achieved by only one country. It should be dealt by the collective or group of the countries. I saw many of your presentations this morning, but what would happen if Mekong River is blocked by the dam in Laos, can Thailand suffer? Or if there's plenty of energy sources, electricity in Myanmar, why not export it through the grid connection to Thailand or as farther into Indonesia? So, collective thinking is necessary to think about energy security in the region. Not only one country can solve the security by itself. This must be the lesson for everybody today.

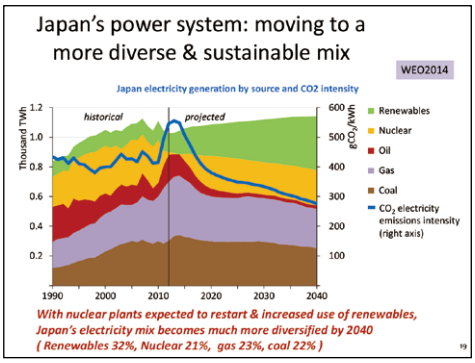


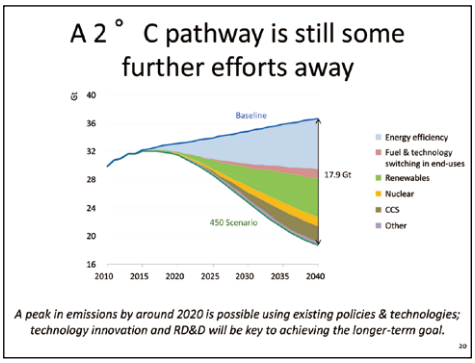


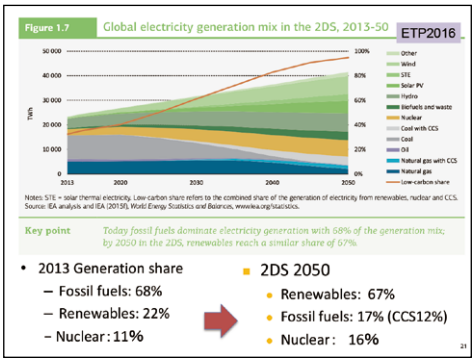
Japan has a problem. We have two different blocks of electricity market because frequency is different by east and west. After March 11, TEPCO lost all of the nuclear power, but connectivity between East and West was so weak, and even with access capacity in the West, power cannot be transmitted to the East, and caused blackout. IEA, International Energy Agency, warned this could happen sometime before 20 years. The government of Japan never listened to us and learned a very severe lesson in March 11, unfortunately. So, this kind of connectivity is very important for the sake of security but also for the use of volatile renewable energy as European lesson told us.



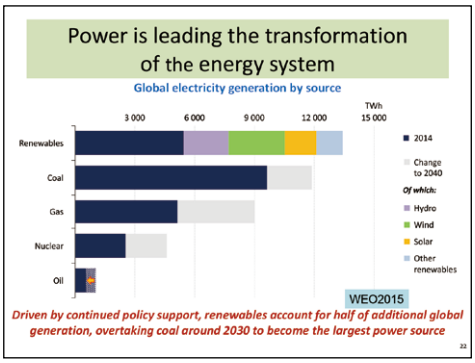
This is the Japanese best mix potential. Hopefully nuclear comes back by 20% nuclear, 30% renewables and gas and coal, but as everybody talked about this CO2 emission reduction, we need everything; energy efficiency, fuel switching, renewables, nuclear and CCS (Carbon Capture and Storage). All of this technology must be deployed to achieve 2°C pathway. Power sector must be zero carbon with all of these huge renewables and quite big amount of nuclear. This nuclear means very big. In fact, 20 more Gigawatts every year from now to 2050, can we do that? This is difficult.



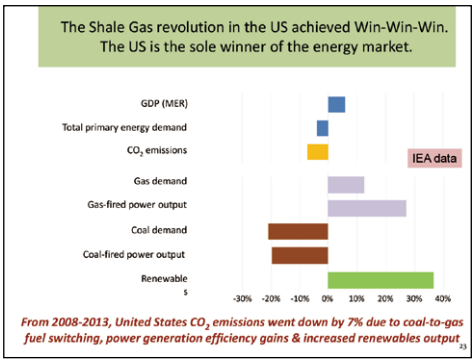




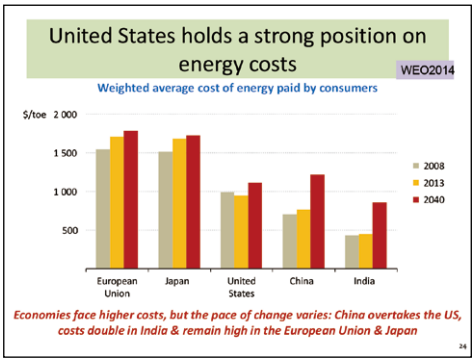
Renewables will be the major source of power. Yes, we have to learn the technology and deployment. Yes, renewable is getting most important. I can fully agree with that.



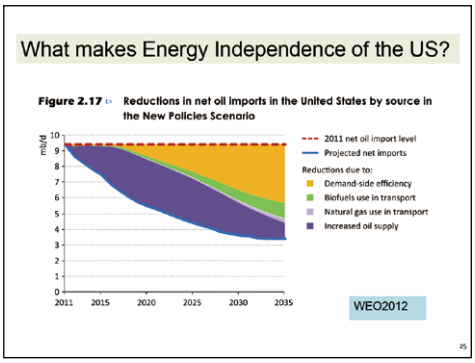
US made a good case because of very cheap gas by the shale gas revolution replacing coal and with new renewables, reducing CO2 emission and energy import and achieving economic growth : this is triple win. It was possible for US because of shale revolution but shale revolution cannot happen everywhere so it was very lucky for them, and energy cost for US is very low compared to Europe, Japan and even with China in 2040. So, industrial competitiveness is so good in the US, so United States is the single or sole winner of the energy market.



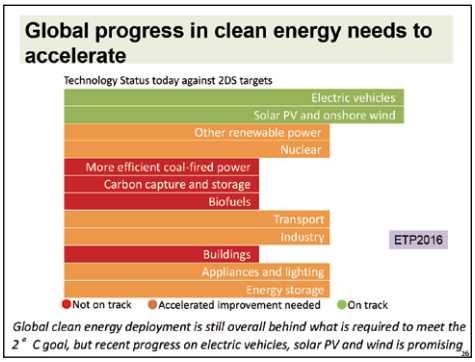
How can Mr. Trump promote isolationism even with the sole winner of the energy market? This is nonsense and protectionism in the trade by the strongest player in the world makes other part of the world very poor. So, this kind of concern should be shared by everybody and we should tell the United States, "Hey guys, you should not go to the isolationism, it suffers us so much".



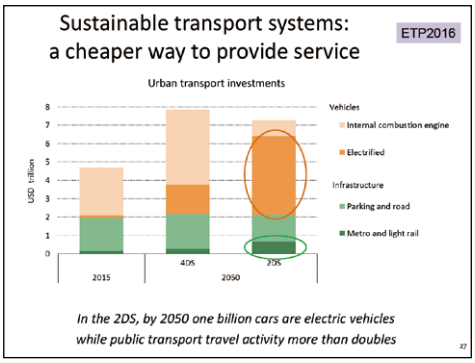
This clearly shows US makes a big reduction of oil by shale revolution but also demand side efficiency.

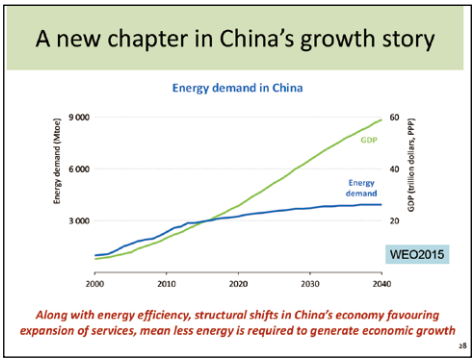


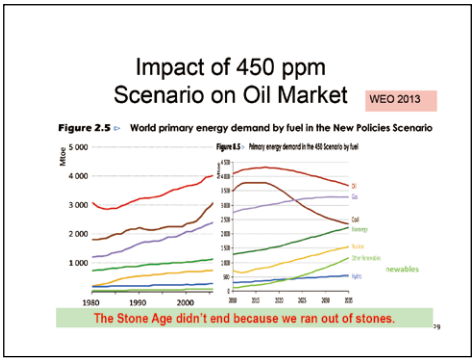
This is car, automobile, efficiency fuel standards of automobile. So, energy independence is not only shale revolution but technology and energy efficiency in the auto sector. This is very important. This means recent move in the IEA shows that electric vehicle and solar wind, these are the very successful two technologies, now moving.



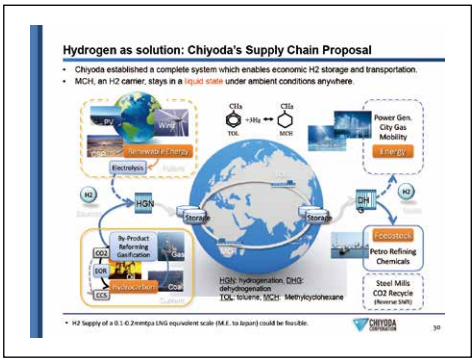
Yes, this is electric vehicle and public transportation made a huge decarbonization in the transportation sector in addition to the decarbonization of the power sector. This is the big challenge for everybody. Saudi Aramco is very concerned about peak demand of oil because of this energy technology, electricity technology. Electric vehicle makes a big difference for Saudi Arabia. This is a famous quote of Saudi Oil Minister, Zaki Yamani, "The Stone Age didn't end because we ran out of stones." "The Oil Age doesn't end because we ran out of oil." This is the implication. Climate change mitigation is a very strong measure to enhance energy security. That is what Saudi Arabia is very much worried about.



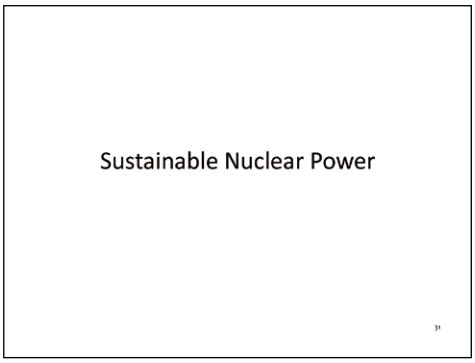


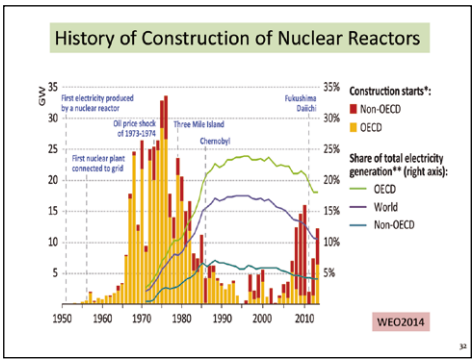


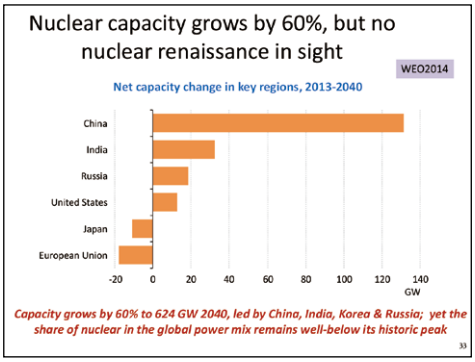
Hydrogen, we talked a lot so I omit it.



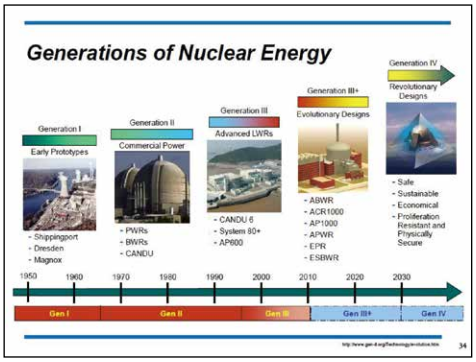
Just five minutes, I'll tell you what sustainable nuclear power is. Nuclear is important for CO2 emission reduction. For the energy security, yes, but majority of Japanese public do not accept only because of the Fukushima accident. We can build more than 20 reactors, we did build 20 reactors in '70s but can we do it now? This is very difficult question. This is old traditional light-water reactor but they should be decommissioning very soon in 2030. Quite number of decommissioning must happen while China, India, developing economy must rely on nuclear, but this nuclear technology must be safe. That is the lesson we learned from Fukushima accident; otherwise, we suffer.

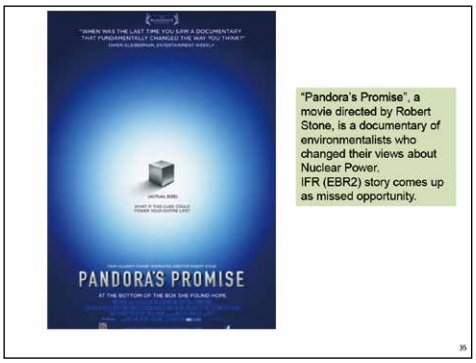


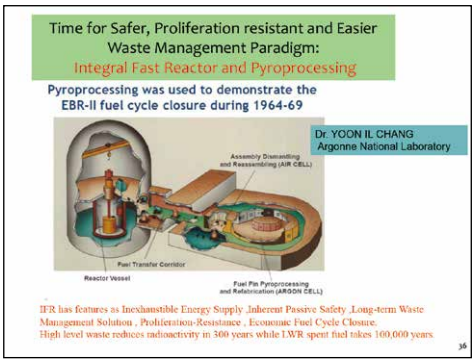


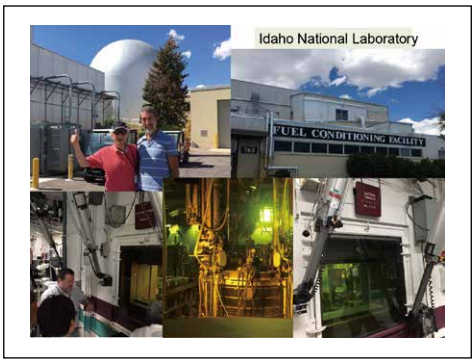


So, my proposal is, let's go to more advanced reactors like Generation IV, not in the third generation. This is the sustainable technology which I call it. This movie gives you one example so called Integral Fast Reactor(IFR), which is passive safety proven and this is a reactor system with reactor and pyroprocessing, reprocessing plant, put together integrated in the Argonne National Laboratory in Idaho. This proved the passive safety. I went to see the plant by the way just recently. It's still there even it started in 1960s, so it has already been experimented quite well and proven passive safe and easy waste management.

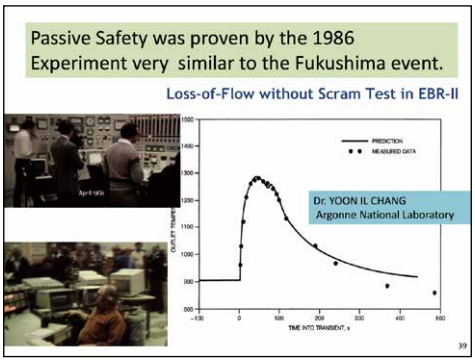




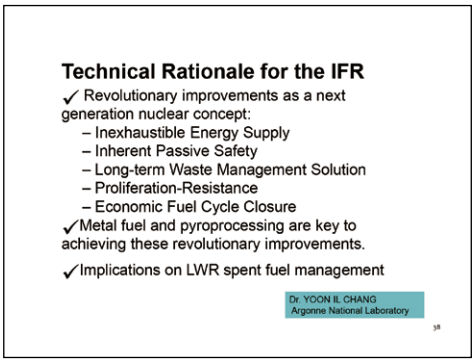


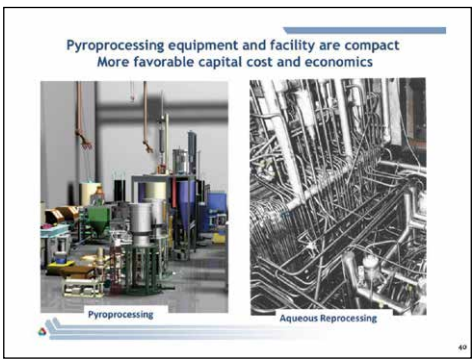


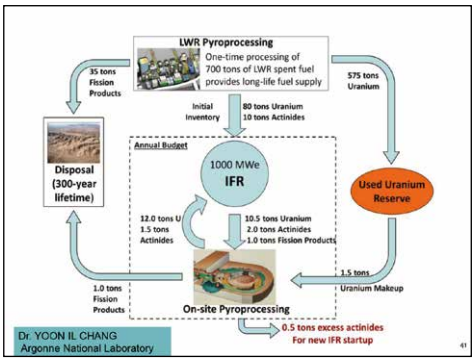
This is a safety experiment totally similar to the plant blackout of Fukushima.

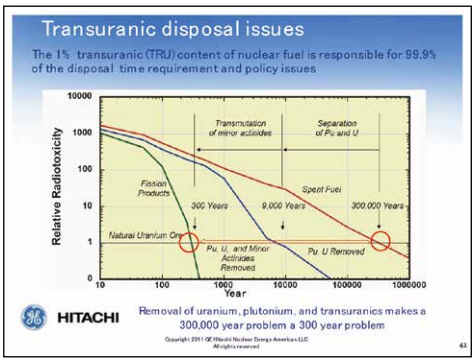


Suddenly, the temperature of the reactor moved up and came down automatically without any action. It is very cheap. Also, it's another big feature is easy radioactive waste management. If you dispose spent fuel, it takes 300,000 to 100,000 years to reduce radiotoxicity but if these technologies applied only 300 years, 300 is still long but very short relative to 300,000 years. So, is this better? Yes, definitely. But will this be acceptable to Japanese public? This is interesting, very important question.

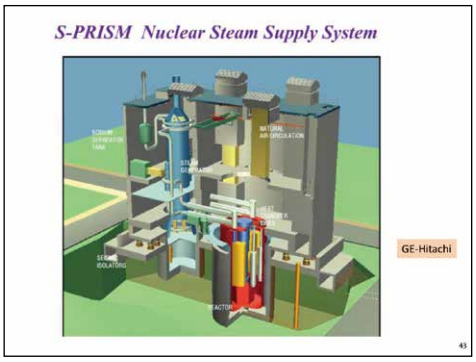


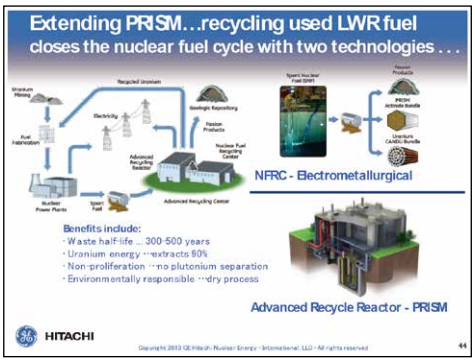


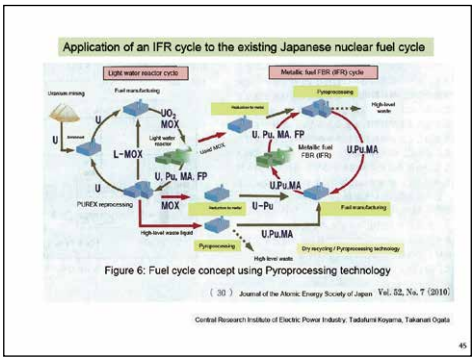


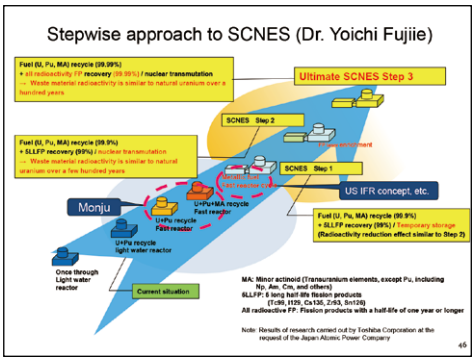


This is a commercial version, not yet built anywhere but GE Hitachi has the idea.



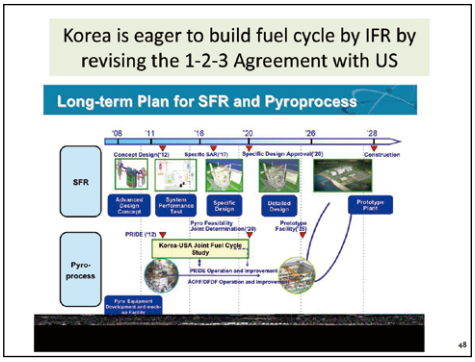


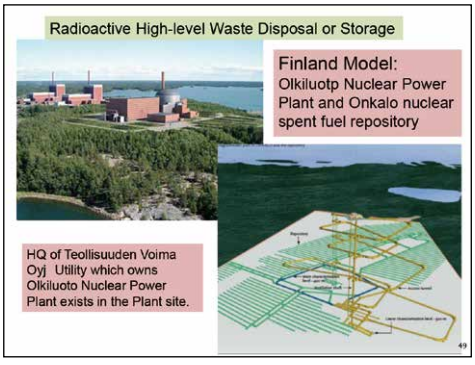




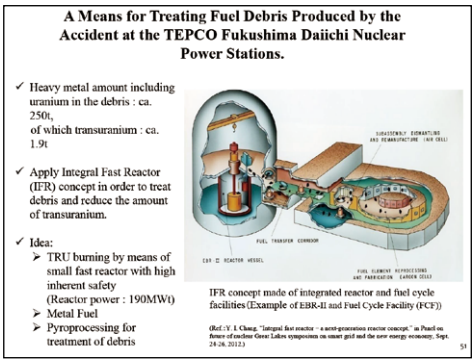
Of course, light-water reactor was developed for submarine. If it sank into the water, it stopped automatically because the coolant is water but if there is no water, it may melt down so it is passive safe in the water but not on shore. This is a lesson we learned. So, light-water reactor system was so successful. The change paradigm is very difficult.

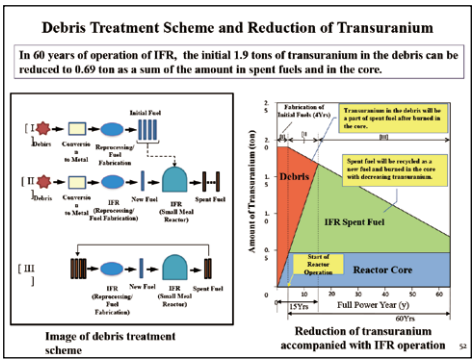
Korea is challenging it introducing sodium fast reactor with pyroprocessing, the technology of this integral fast reactor.





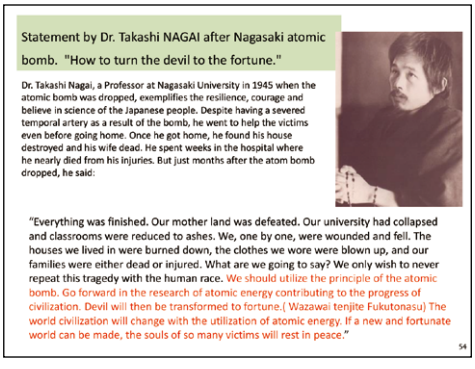
I am proposing, let's use this in Fukushima to reduce the melt down debris because this technology is very good for that, and not only that, but the spent fuel stored in the first, second, third unit of the Fukushima Daiichi which cannot be transported out of the prefecture, it should be treated there. We calculated in Sasakawa Peace Foundation, the cost and the duration of the possible timing.





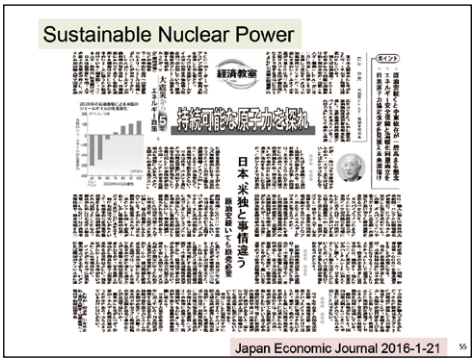
Fukushima used to be a beautiful place. This is a mail. I'm sorry this is Japanese but this is a mail from a lady who suffered the disease in muscle and she's from Fukushima and told me, "Mr. Tanaka, if this technology helps the recovery of Fukushima, why don't we try it? Utsukushima Fukushima, the Beautiful Fukushima should be transformed into Tsukusushima Fukushima, the contributor to the technology in the future and this is a way to turn the devil to the fortune."

The last slide is this. This is the statement of Dr. Nagai of Nagasaki University. He is a victim of the bomb. He mentioned in his report that it was a disaster, the Nagasaki atomic bomb. But we have to use this atomic bomb principle into the civilization and this is— "Wazawai tenjite Fukutonasu" means— the devil will then be transformed to fortune and the many people's victim can rest in peace.



I like this statement because we made a mistake, Japanese made a mistake in Fukushima. Serious mistake and we lost the confidence of global society, community in our technology especially in the nuclear technology. Can we recover the confidence of the people to us? Maybe only by our application of this technology in the Fukushima, and if Fukushima people can accept it, maybe that is the way we can contribute to the global community by the sustainable nuclear power.

Thank you very much.



Panel Discussion

Panel Discussion – Summary

1. Introduction

The panel discussion is one of the most expected agenda of the HONDA Y-E-S Forum 2016. The panel discussion was arranged after a short break following the keynote speeches and was an opportunity to have further discussion into the topic of the Forum. There were eight panelists, including six awardees from five countries (Vietnam, India, Laos, Cambodia and Myanmar), and the two keynote speakers, Dr. Yoshiaki Nakano and Mr. Nobuo Tanaka. This session was proceeded under the facilitation of Dr. Hirohisa Uchida, Professor, School of Engineering, Tokai University and Executive Director of Honda Foundation. The discussion highlights the key aspects to achieve the energy security through eco-technology of each countries and for all nations as a whole.

2. Content of Discussion

Before starting the panel discussion, Dr. Uchida delivered a short presentation to provide more understanding about the philosophy of the term "Eco-technology" which is defined by Honda Foundation: "Technology should be applied and used in harmony with nature and human environment". He also shared the story of Japan who experienced serious pollutions in the 50s to 70s but has step by step cleaned up their environment by the Reduce-reuse-recycle actions in using energy. He also emphasized that hydrogen is the energy of the future for Japan.

At the beginning of the discussion, Dr. Uchida asked the two keynote speakers to share their opinion about the issues raised by the Honda Y-E-S awardees. Dr. Nakano said each Asian country is facing the same main issues that energy demand is increasing and how to supply that demand. He also shared that each nation would be nicely supported by the natural energy resource, however, we probably could find a better solution on how to create a new era of making use of renewable energy in terms of cost and strengths in the future. Also, Mr. Tanaka added that besides the technology, the way of living of people is also an important element to reach the energy security and developing a green lifestyle should become a public purpose. Overusing of fossil fuel for economic growing should not be a model for developing countries and the country who succeeds in building a green development model will be the winner of the next generation, he emphasized. The Y-E-S Awardees expressed their appreciation to the two keynote speakers for their enlightening and highly informative sharing. Each representative came to the Forum with their country issues and searching for the solution to ensure their own country energy security. Now, they understand that one country cannot solve the problem itself and the energy security must be thought of at a global level.

To continue the discussion, the Y-E-S awardees discussed the problems in energy and environment of their countries and their idea of achieving energy security through ecotechnology. The representatives from Vietnam shared that their most serious problems are the negative impact of hydropower and the excessive consumption of energy. Vietnam currently depends 46% on hydropower. During the dry season, the dams caused drought to the river delta. During the rainy season, water discharged from hydropower escalated the flooding that has submerged thousands of houses in the area. Vietnam plans to decrease the dependency on hydropower but they had difficulty in meeting the excessive consumption of energy that is doubled every ten years. Moreover, the understanding of the society about global warming and eco-technology is poor. In Vietnam, it's hard to find a book that explains the climate change or similar problems in a simple way for children. Thus, they need to improve the understanding of eco-technology of the society

by having many books and programs, written by the experts to explain the problems to the public. The problem with India is the sheer magnitude because of the population which leads to the total consumption of energy being high. The means of power generation, which mainly includes conventional methods leads to heavy air pollution and land pollution, due to disposal of fly ash from coal based thermal power plants. The suggested approach to attain energy security of the country requires a mixed approach using appropriate proportions of renewable and conventional methods of power generation as no single source is sufficient and relieable to meet the complete demand of the country. The Government policy specially emphasises on increasing the use of solar, wind, and nuclear energy. India has recently initiated acquisition of nuclear power technology and higher efficiency clean coal technologies from Japan. The representative from Cambodia shared the security of electricity was not achieved due to knowledge and illegal activities of people at the slum side in the city. Some people from those areas were trying to connect wires from their house directly to the cabinet without technical support or skill, leading to many houses firing because of electrical issues in the slum area. Their suggestion of re-organizing house design in the slum area is not only for energy saving but also community development with sustainability. The representative from Laos mentioned that hydropower is the main source of energy in his country. However, dam construction can only be applied where have stream or river and energy deficiency still happen in the rural area. Laos is looking for renewable energy supply solutions such as biomass or wind power to support the energy system of the country. The representative from Myanmar talked about the sanitation requirement and energy especially electricity requirement. In the rural area of Myanmar, there are many areas which do not have toilets. She would like to make solar septic tanks with reasonable price which can also produce biogas. That biogas can also be used as electricity for cooking and other small uses. To add to the discussion of the awardees, Mr. Tanaka added a comment that one of the problems of utilizing green energy is the pricing. The low price of oil will cause difficulty to the exploitation of green energy. The renewable energy sources like solar or wind power are now considered too costly for industrial using. When there is no or low internal carbon price, using fossil fuel makes economic sense. But if we can set high enough internal carbon price, the corporation will consider reducing the consumption of fossil fuel and invest into green, energy, and eco-technology.

Also in the discussion, the representative from India raised a question to Mr. Tanaka about the status and scope of research on Nuclear fusion which was once seen as a clean and unending source of energy, but has not seen any significant breakthrough in more than 40 years. He sighted nuclear fusion as a single probable source of energy which could meet the energy demands of his country eliminating the need of a mix of multiple sources and technologies like coal, oil, solar and wind based power plants. Mr. Tanaka's comment on the question is that India, Japan, US, Europe, China, Korea, Russia have been investing heavily in the ITER (International Thermonuclear Experimental Reactor) project spending huge amount of dollars, unfortunately without any useful output. Nuclear fusion is presently a matter of scientific discovery rather than Government policy. ITER has a problem of international collaboration, and with big facilities, space and money being invested. However, there are many commercial fusion companies in North America and Canada using a very different types of technology. The Department of Energy and many venture capitalists are investing in these fusion companies. There is no information yet if these different approaches are working, but if they work it is going to be a huge breakthrough. The fact that venture capitalists are investing in these technologies is very interesting as it hints towards a fact that these ventures are equally a business as science. Mr. Tanaka mentioned in particular a setup named General Fusion in Vancouver which tries to ignite fusion for microseconds through intense pressure in a vortex of lead. The CEO of the company who was very confident about the approach predicted a breakthrough in 2 years, which has not yet been achieved. There are many such interesting trials going on. Sun is the source of all energy, but this fusion is creating sun on the ground.

The discussion facilitated by Dr. Uchida drew participation from the audience, evolving into a free exchange of views and productive discussion. One of the questions was how to collaborate between countries in solving energy problems? Mr. Tanaka answered that one way to get the collaboration between countries is contributing to the international organization. The engineers can work in the international bodies and try to find out the common issues and give recommendations to each government to make difference. Since many countries listen carefully to the reports and advice from the international organizations, we can use these recommendations as friendly pressure to the government. Mr. Tanaka strongly recommended the young, talented, capable people to be a staff or member of international organizations to work together toward the common goal of ensuring energy security and sustainable development.

Research Poster Contest

Research Poster Contest – Summary

Introduction & Purpose

As part of the Honda Y-E-S 2016 Forum a research poster contest was held on the theme of "Achieving Energy Security through Ecotechnology".

The objectives of holding the poster contest on the Forum day were as follows –

- To allow students and researchers to share their ideas and work
- To initiate a dialogue on innovative ideas and solutions to improve energy security
- To help students develop their technical skills by getting feedback on their work
- To enable networking and collaboration in order to strengthen the momentum of finding eco-friendly solutions

Competition Scheme

The competition started with a call for posters and submission of abstracts. The competition was made open for students in Japanese universities and graduate schools (including foreign students) enrolled as of August 2016. The team size was two people per team and there was no enrolment fee.

Received abstracts were evaluated on technical content along 5 dimensions – applicability (potential impact), contribution, problem structuring, methodology of research & innovation. After the initial shortlist, teams were invited to showcase their posters at the Forum and to participate under the judge's award or the audience award. For the Y-E-S 2016 Forum we shortlisted 10 teams for the judges award and 4 teams for the audience award. Each team shortlisted for the judge's award was provided an opportunity to give a three minute presentation about their poster at the Forum.

Final Results

Final presentations of the Posters were held at the Fukutake Hall at The University of Tokyo. The 10 posters shortlisted for the judge's prize were evaluated by an esteemed panel of senior researchers and directors at Honda Foundation. Visual representation of concepts, technical quality and response to questions were considered to select the winner. For the audience award, ballot papers were given to all participating members at the Forum and a final count was made.

The judge's prize worth 50,000 Yen was awarded jointly to the two teams from Kyushu University for their poster presentation on "A Novel approach for Modeling of Solid Oxide Fuel Cell Operated with Biogas" and "Flexible catalyst material to create a direct-hydrocarbon fuel cell". The second prize worth 30,000 Yen was given to the team from Hirosaki University for their research on "Weight Analysis under Carbothermal Reduction Process of Silica for Production of Solar-grade Silicon". The audience prize was given to the team from Kyoto University for their poster on "How BAGUS project benefit the benign fluid from beneath". All participating teams were given certificates of participation.

Entry List of Research Poster Contest

Finalist for 1st and 2nd Prize

Team	Abstract Title	Organization	Name (Leader)
A	An improvement to biodiesel production from rubber seed oil with a high content of free fatty acids using a co-solvent method	Osaka Prefecture University	Hanh Le
B	Weight Analysis under Carbothermal Reduction Process of Silica for Production of Solar-grade Silicon	North Japan Research Institute for Sustainable Energy	Benioub Rabie
C	A Novel Approach for the Modeling of Solid Oxide Fuel Cell Operated with Biogas	Kyushu University	Tran Dang Long
D	Hydrogen Energy for the Future: Generation and Storage	Yokohama National University	Bao Yun
E	Solar Hydrogen Production via Two-Step Overall Water-Splitting System Consisting of Stable Oxides	University of Yamanashi	Tanigawa Satoshi
F	Realization of High Performance Cu(In, Ga)Se2 solar cell by Interfacial Control	Tokyo Institute of Technology	Nishimura Takahito
G	Flexible catalyst material to create a direct-hydrocarbon fuel cell	Kyushu University	Nguyen Thi Giang Huong
H	Development of proton conductive SOFC electrolyte aiming to improve conductivity and power generation characteristics by changing composition ratio of SrPrAlO4	Tokyo Institute of Technology	Kurahashi Yusuke
I	Sonolytical cascade extraction of sugars, medicinal compounds, and oil from oil seeds	Osaka Prefecture University	Le Anh Bang
J	Energy Harvesting based VLC System for Indoor Smart Lighting	Waseda University	Khourn Khemry

Participation for Audience Award

Team	Abstract Title	Organization	Name (Leader)
K	Utilization of sweet sorghum bagasse as a waste of bioenergy procesing	Kyoto University	Kusumah Sukma Surya
L	Thermoelectric properties of Bi2SrsRh2Oy bulk materials	University of Yamanashi	Watanabe Takuya
M	Stable Supply of Powers in Introduction of Renewable Energy	Waseda University	Zuo Hu
N	How BAGUS project benefit the benign fluid from beneath	Kyoto University	Shoedarto Riostantieka Mayandari

1st Prize

A Novel Approach for the Modeling of Solid Oxide Fuel Cell Operated with Biogas

Tran Dang Long[1], Tran Quang Tuyen[2] and Yusuke Shiratori[1,2]

[1]Department of Hydrogen Energy Systems, Faculty of Engineering, KYUSHU University

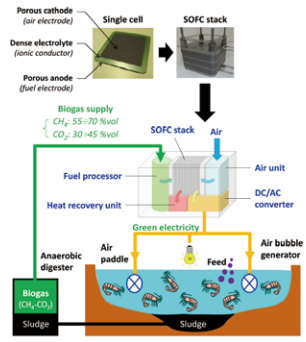
[2]International Research Center for Hydrogen Energy, KYUSHU University

Honda Y-E-S Forum 2016
Research Poster Contest
Nov. 19, 2016
The University of Tokyo
Japan

Conclusions

- **Solid Oxide Fuell Cell (SOFC)** operated with **biogas** (a biological CH_4-CO_2 mixture) is a promising **sustainable generator** for developing countries, where the construction of hydrogen infrastructure is unrealistic option.
- **CH_4 multiple-reforming (MMR)**, the direct H_2 production process from CH_4 within the SOFC anode under the **simultaneous contribution** of dry reforming and steam reforming, **MUST** be taken into consideration in the feed of **humidified biogas** (CH_4-CO_2-H_2O mixture) with **low** degree of humidification **(steam-to-carbon ratio (S/C))**, which is favorable to the highest overall system efficiency.
- **Artificial Neural Network(ANN)** & **Fuzzy Inference System (FIS)** were applied to **approximate** the complex reaction kinetics of MMR which has been unsolved so far.
- A **3-dimensional model of biogas-fuelled SOFC** coupled with the developed **ANN/FIS-based model of MMR** have been **successfully** verified with simulated biogas ($CH_4/CO_2 = 1$).
- By this achievement, we can build a **powerful numerical tool** for evaluating and optimizing biogas-fuelled SOFC systems far efficient than heat engine based technologies.

Introduction



Biogas-fuelled SOFC sustainable power system for a shrimp farm (Ben Tre Province, Vietnam / JICA/JST-SATREPS Project, 2015-2019).

SOFC Technology

- **One-step** energy conversion: Chemical energy of H_2 → Electricity
- **Direct internal reforming** (DIR) capability: $C_nH_y + CO_2$, $H_2O \rightarrow H_2 + CO$
- **Multi-fuel** capability: H_2, CO, CH_4, C_nH_y (fossil fuels, bio-fuels)
- Mechanical integrity

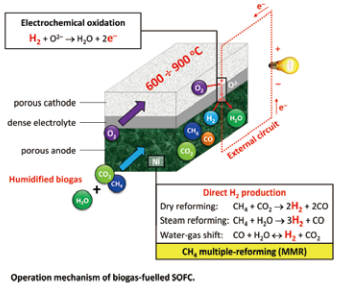
Biogas-fuelled SOFC technology

- **Simplified** fuel pre-processing compared to other types of fuel cell
- **High efficiency** (> 50%) compared to heat engine based systems (25-35%)
- Noiselessness, no harmful emissions
- Low maintenance

Background

Operating principle

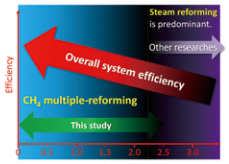
- Under high operating temperature of SOFC and the catalytic effect of Nickel in anode material, H_2 is internally produced through the **MMR** process.
- **Electricity** is generated through the electrochemical oxidation of H_2.
- **Humidified biogas** is effective for preventing coking in anode volume caused by CH_4 pyrolysis.



Operation mechanism of biogas-fuelled SOFC.

Technical challenges

- **Maximize** overall system efficiency
- The complex reaction kinetics model of **MMR** (which has been **unsolved** so far.)



Correlation illustration of overall system efficiency and MMR condition.

Table 1: Conventional reaction kinetics models of CH_4 steam reforming within SOFC anode adopted in other researches (the contribution of CH_4 dry reforming is neglected.)

The net consumption rate of CH_4 (r_{CH_4})	S/C	T / °C	Ref.
$k_0 p_{CH_4} \exp(-E_a/RT)$	3–15	650–800	[1]
$k_0 p_{CH_4}^{1.25} \exp(-E_a/RT)$	1.5–2.5	900–1000	[2]
$k_0 p_{CH_4} p_{H_2}^{-1.25} \exp(-E_a/RT)$	2–8	800–1000	[3]
$k_0 \frac{K_{CH_4} K_{H_2O} p_{CH_4} p_{H_2O}}{(1 + K_{CH_4} p_{CH_4} + K_{H_2O} p_{H_2O} + K_{CO} p_{CO})^2}$	3–7	700–1000	[4]

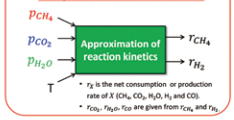
References:
[1] King et al., J. Catal., 258 (2008), 356–365
[2] Özkara-Aydınoğlu et al., Proc. Solid Oxide Fuel Cell 4, (1995), 810–819
[3] Lee et al., Ind. Eng. Chem. Res., 29 (1990), 766–773
[4] Peters et al., J. Power Sources, 106 (2002), 238–244

Research objectives

- The **empirical model** of MMR
- The **3D-CFD model of biogas-fuelled SOFC** coupling with the **MMR model** for numerical evaluation on cell behavior and performance.

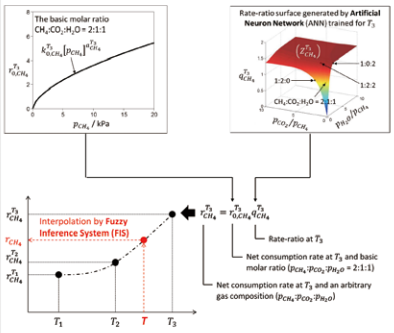
NOVEL APPROACH

ANN/FIS-based model of MMR

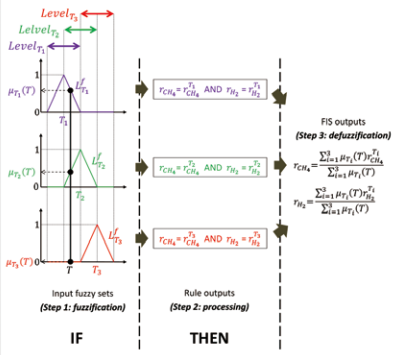


- r_X is the net consumption or production rate of X (CH_4, CO_2, H_2O, H_2 and CO).
- r_{CO_2}, r_{H_2O}, r_{CO} are given from r_{CH_4} and r_{H_2}.

ANN/FIS-based model



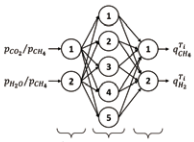
- **The calculation flow to obtain the net consumption rate of CH_4 (r_{CH_4}) at arbitrary temperature (T) and gas composition (CH_4-CO_2-H_2O-H_2-CO) in MMR.**



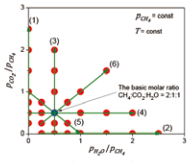
- **The interpolating process to determine the net consumption rate of CH_4 (r_{CH_4}) from the set of $[r_{CH_4}^{T_1}, r_{CH_4}^{T_2}, r_{CH_4}^{T_3}]$ and the net production rate of H_2 (r_{H_2}) from the set of $[r_{H_2}^{T_1}, r_{H_2}^{T_2}, r_{H_2}^{T_3}]$ at an arbitrary temperature (T) between T_1 and T_3 by FIS. $\mu_{T_i}(T)$ is considered as the temperature dependent coefficient of the interpolation.**

The empirical model of CH_4 multiple-reforming

- **Highly flexible** approximating techniques meets the nonlinearity of the reaction kinetics of MMR.
- Dependences on temperature and gas compositions can be treated **independently**.
- Only a **small number** of experiment is required.
- The applicable temperature range can be extended **easily**.

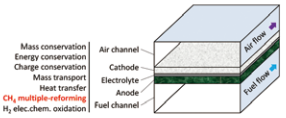


- **Schematic of the ANN trained for expressing the concurrent effect of CO_2 and H_2O in MMR at T_i.**



- **Experimental matrix with 6 testing programs to obtain kinetics data of MMR for training the ANN at T_i.**
  (1): dry reforming
  (2): steam reforming
  (3): MMR with increase of p_{CO_2}
  (4): MMR with increase of p_{H_2O}
  (5): MMR with shifting from dry to steam reforming
  (6): MMR with $p_{CO_2} = p_{H_2O} = p_{CH_4}/2$

Results & Discussion

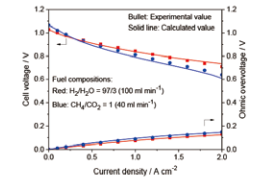


- **3D-CFD model of anode-supported SOFC applied in this study coupled with the developed ANN/FIS-based model of MMR.**

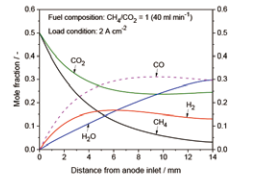
Table 2: Materials and dimensions of cell components

Cell component	Material	Thickness / μm	Porosity / %
Anode	Ni-8YSZ	890	35
Electrolyte	8YSZ	5	–
Cathode	LSCF-GDC	60	35

- Surface area: 14 mm x 14 mm
- Temperature: 800 °C
- Assumptions: laminar flow, ideal gas, isotropic
- Calculating code: COMSOL Multiphysics 5.1



- **Comparison between the predicted polarization curves and the measured results with different feeds of fuel composition.** Good matching between the calculated results and the observations is achieved, indicating that **the ANN/FIS-based approach for MMR is valid.** Distributions of gaseous species, temperature, current density and thermally-induced stresses within the cell can be estimated accurately and reliably.



- **Calculated distribution of mole fractions along the fuel channel with the feed of simulated biogas (CH_4/CO_2 = 1) at 2 A cm^{-2}.** The domination of dry reforming in H_2 production within the distance of 6 mm from anode inlet is apparent. In downstream, H_2 production is promoted through steam reforming and WGS reactions, as a result, the consumption rate of CO_2 is balanced by the production rate of CO_2.

Acknowledgements

This research was supported by JICA/JST, SATREPS program, and partially supported by AUN/SEED-Net.

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1st Prize

Flexible catalyst material to create a direct-hydrocarbon fuel cell

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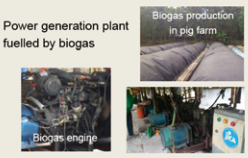
[a]Department of Mechanical Engineering, Faculty of Engineering, Kyushu University
[b]International Research Center for Hydrogen Energy, Kyushu University

Honda Y-E-S Forum 2016, Nov 19, 2016, The University of Tokyo, Tokyo, Japan

Electricity generation without burning is a key to increase efficiency !

Electricity generation by heat engine (Fuel combustion process)

Power generation plant fuelled by biogas

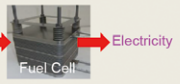


Multiple Energy Conversions

Chemical Energy ⇒ Thermal Energy ⇒ Kinetic Energy ⇒ Electrical Energy

- Electrical efficiency (20-25%)
- Efficiency further decreases with biogas due to its low calorie.

Electricity generation by fuel cell (Electrochemical process)



Direct Energy Conversion

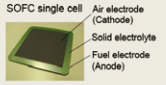
Chemical Energy ⇒ Electrical Energy

- Simple operation and compact design
- High electrical efficiency (45-50%)
- Same level efficiency even with biogas

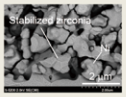
Solid Oxide Fuel Cell (SOFC)

High temperature operation: 600-900 °C

All solid state fuel cell



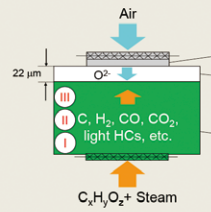
Anode microstructure



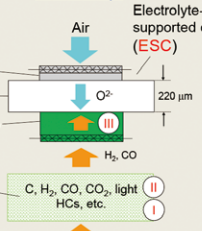
- SOFC is the most efficient device for direct conversion of a fuel into electricity.
- Reforming of hydrocarbons can proceed in the porous cermet anode to produce H_2 and CO, which electrochemically oxidized to generate electricity and heat. This operation is called direct internal reforming (DIR) operation.

Our concept of DIR-SOFC

Conventional anode-supported cell (ASC)



Our concept



(I) Thermal decomposition of heavy hydrocarbons
(II) Steam reforming of heavy and light hydrocarbons
(III) Electrochemical oxidation of H_2 and CO

- Carbon deposition (Coking) within the porous anode is crucial issue to be solved.
- By the application of a structured catalyst material, functions of reforming and electrochemical reaction sites can be well-separated without losses of both functions to have stable operation with lower risk of coking.

ASC

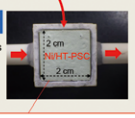
Anode-support	Ni-YSZ (8 mol% Y_2O_3-ZrO_2) (850 μm)
AFL	Ni-YSZ (10 μm)
Electrolyte	YSZ (5 μm)
Cathode	GDC ($Gd_{0.10}Ce_{0.90}O_{1.95}$)/ LSCF-GDC/LSCF

ESC

Anode-support	
AFL	Ni-ScSZ (20 μm)
Electrolyte	ScSZ (160 μm)
Cathode	GDC/LSCF-GDC/LSCF

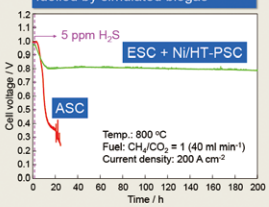
Ni/HT-PSC

Simulated biogas (CH_4/CO_2 = 1) with 5 ppm H_2S



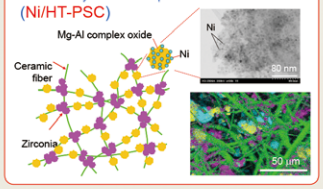
Porosity / %	pore size diameter / μm
89	16
Ni loading / wt%	Ni particle size / nm
8.6	32
BET SSA / m^2g^{-1}	Ni SSA / m^2g^{-1}
15.5	21

5 ppm H_2S poisoning test during DIR operation of SOFC at 800 °C fuelled by simulated biogas



- Ni/HT-PSC substantially improved the sulfur tolerance of DIR-SOFC.

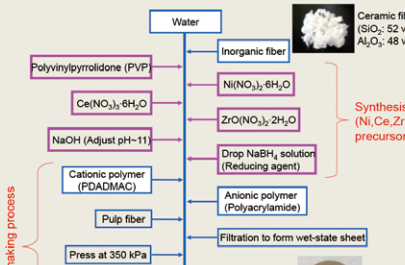
Ni-loaded hydrotalcite-dispersed PSC (Ni/HT-PSC)



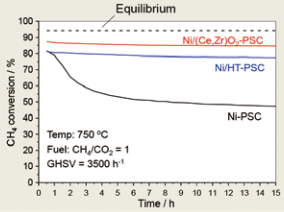
♦ Y. Shiratori, M. Sakamoto, T. Uchida, H. Le, T. Quang-Tuyen, K. Sasaki, "Hydrotalcite-dispersed paper-structured catalyst for the dry reforming of methane", Int. J. Hydrogen Energy 40 (2015) 10807-10815.
♦ Y. Shiratori, M. Sakamoto, "Performance improvement of direct internal reforming solid oxide fuel cell fuelled by H_2S-contaminated biogas with paper-structured catalyst technology", Journal of Power Sources 332 (2016) 170-179.

Coking tolerant PSC ($(Ce,Zr)O_2$-dispersed PSC)

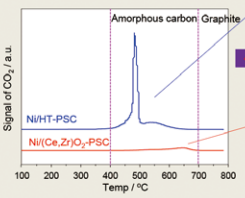
Paper-making process



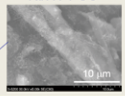
Dry reforming of methane at 750 °C for three types of PSCs



Temperature programmed oxidation (TPO) after the 15 h dry reforming

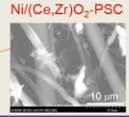


Ni/HT-PSC



- Whisker carbon was formed.

$Ni/(Ce,Zr)O_2$-PSC

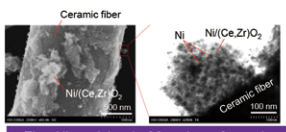


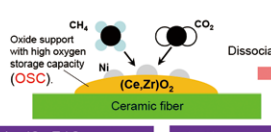
- Coking was prevented.

- $Ni/(Ce,Zr)O_2$-PSC exhibited higher catalytic activity than that of Ni/HT-PSC in spite of lower Ni loading.

	Ni loading / wt%	Ni (wt) : CeO_2 (wt)	Zr precursor	CeO_2 (wt) : ZrO_2 (wt)	Surface area** / m^2 g^{-1}
$Ni/(Ce,Zr)O_2$-PSC	5.95	2:1	$ZrO(NO_3)_2$	1:1	24.0
Ni/HT-PSC	8.60	--	Zr sol	--	15.5
Ni-PSC	5.15	--	Zr sol	--	22.7

- For the developed $Ni/(Ce,Zr)O_2$-PSC, coking was considerably suppressed compared to the conventional Ni/HT-PSC.
- By the application of $Ni/(Ce,Zr)O_2$-PSC on the anode material of SOFC, fuel cell breakdown caused by coking can be avoided.





- Fine Ni particles (~ 20 nm) are formed on the $(Ce,Zr)O_2$ support.
- Metal/oxide interface is well-developed.
- Lattice oxygen in $(Ce,Zr)O_2$ can effectively contribute to the removal of the carbonaceous species on the surface.

Conclusions

- Particles of CeO_2-ZrO_2 solid solution can be synthesized in the inorganic fiber network in paper-making process.
- CeO_2-ZrO_2 dispersed paper-structured catalyst ($Ni/(Ce,Zr)O_2$-PSC) exhibited higher catalytic performance and higher coking tolerance than the conventional PSCs.
- The PSC developed in this study is a promising support material realizing DIR-SOFC.

Acknowledgment: This study was supported by JST/JICA, SATREPS.

2nd Prize

HIROSAKI UNIVERSITY

2016 Honda Y-E-S Forum

Honda Y-E-S Forum 2016

November 19 (Sat)

NJRISE

Weight Analysis under Carbothermal Reduction Process of Silica for Production of Solar-grade Silicon

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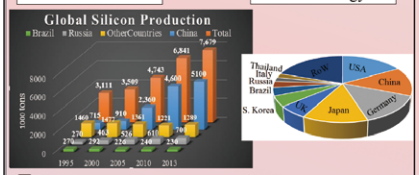
Background

78% of the solar cells market is based on crystalline silicon.

Solar Grade Silicon

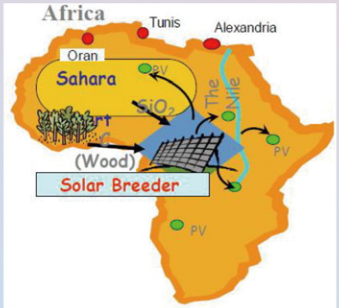
Solar Energy



❑ **Japan's consumption of silicon material represents 20% of worldwide consumption compared to its production.**

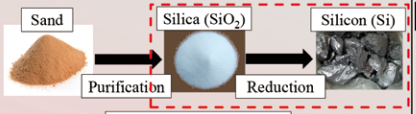
- 80% of Algeria's surface is a Saharan area while the country has a 97% oil-based economy.
- 70% of Sahara Sand is compose of silica (SiO_2), the raw material for production of silicon.

❑ **Algeria has a significant unexploited solar potential quite enough to satisfy worldwide needs in term of electricity and raw material (silica) for the production of silicon.**



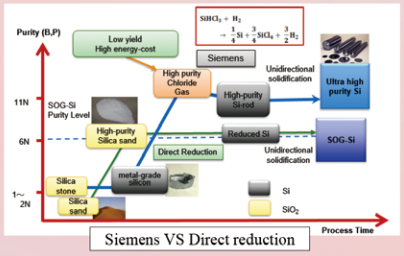
Sahara Solar Breeder (SSB) project employs the advanced technological level of Japan to exploit the Solar potential of Algerian Sahara in terms of solar energy (electricity and silicon production).

Objective



Silicon production process

❑ Our team is focusing on the second step of the process which is the reduction of silica.



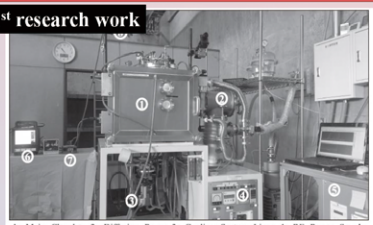
Siemens VS Direct reduction

❑ Siemens method is a costly and time consuming process compared to direct reduction.

Objective : Optimization of the carbothermal reduction process.

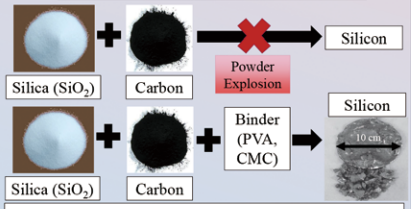
Experiments & Results

1st research work



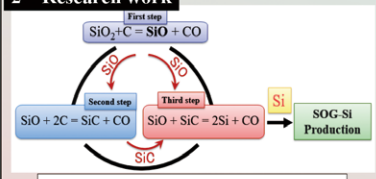
1: Main Chamber 2: Diffusion Pump 3: Cooling System Lines 4: RF Power Supply 5: Quadrupole Mass Spectrometry 6: Control System 7: Weight Change Indicator 8: Infrared Thermometer

Induction furnace used for reduction of silica



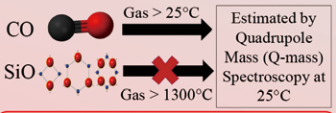
Highest reduction yield of 32.5% was achieved reducing granules of silica and carbon mixed with PVA binder, *Boucetta, Benioub et al*, Mater. Trans. JIM, 57, November (2016) 1936-1944.

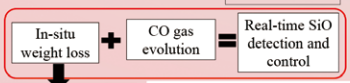
2nd Research work

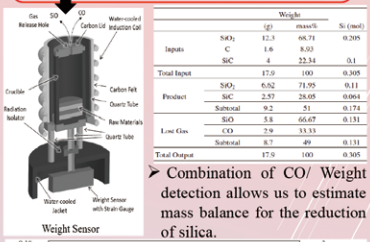


Carbothermal reduction process pathway

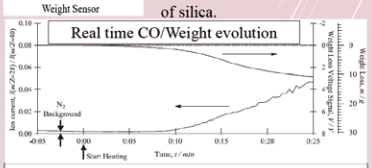
- Main by-product gas phase ➔ SiO and CO.
- Less SiO gas loss ➔ High reduction yield.
- SiO control ➔ Important.







- Combination of CO/ Weight detection allows us to estimate mass balance for the reduction of silica.



Real-time evolution of SiO gas was achieved using combined results from developed *in-situ* weight loss with Q-mass for CO gas, *Benioub et al*, Mater. Trans. JIM, 57, November (2016) 1930-1935

Conclusion

❑ **First step of SSB project was achieved by the successful production of 150 g of silicon per hour using carbothermal reduction process with a yield of 32.5%.**

❑ **Further optimization of the process was exploited by development of real-time analysis of the main by-product (SiO gas).**

Graduate School of Science and Technology
Hirosaki University

大学院理工学研究科
弘前大学

Audience Award

Honda Y-E-S Forum 2016

How BAGUS project benefit the benign fluid from beneath

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Shoedarto, R.M.[1], Kubo, T.[1], Kashiwaya, K.[1], Tada Y.[1], Koike, K.[1], Sakurai, S.[2], Iskandar, I.[3], Heriawan, M.N.[3], Notosiswoyo, S.[3], and Malik, D.[4]

Where does it start?

Of all of the natural sources, geothermal stands out as Indonesia's best opportunity for utilizing renewable energy, it has **40%** of world's geothermal potential.

However, this archipelagic state **suffers from fossil fuel and electricity subsidy** which drained the government's budget and hinders energy conservation campaigns.

This situation puts Indonesia to take no other options except **shifting energy** consumption to renewables one.

Indonesia is currently using only 1.6 GW out of 29 GW of its total geothermal capacity, adding up only 7% to its energy mix along with 7 GW from hydropower, 500 MW from biomass, 22.4 MW from solar power, and 2 MW from wind energy (Mulyana, 2016).

What is benign fluid from beneath?

Have you heard about geothermal energy?
Geothermal power is generated by tapping the heat of the fluid from under the Earth's surface to extract steam and turn power plant turbines.

That kind of fluid in this paper poster, we call it benign fluid from beneath.

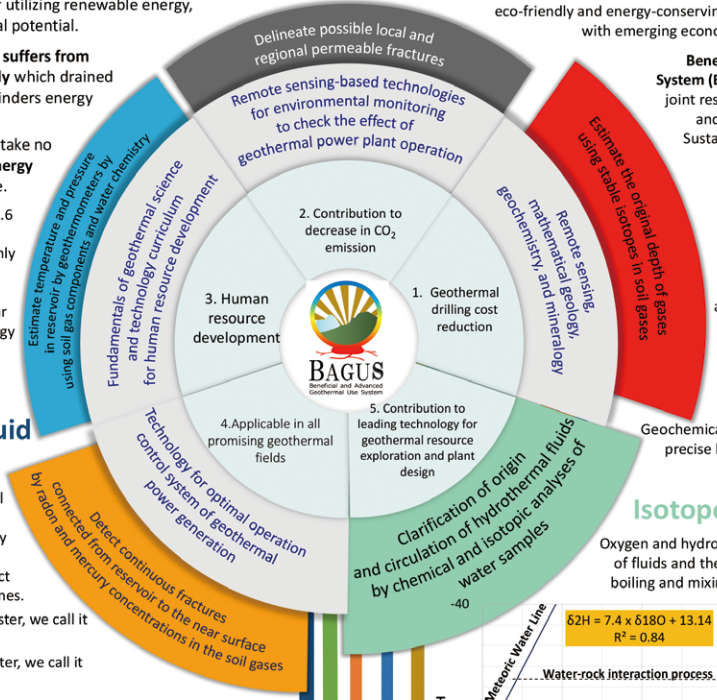
That kind of fluid in this paper poster, we call it benign fluid from beneath.

BAGUS Project?

Japan has been the leader in **reducing GHG emissions** and has done real implementation of the emission reduction targets to achieve its 2050 goal.

In furtherance of balancing the paces, Japan also proactively brings out eco-friendly and energy-conserving technologies through **joint projects** with emerging economies as well as developing countries.

Beneficial and Advanced Geothermal Use System (BAGUS) project is one of international joint research programs promoted by Science and Technology Research Partnership for Sustainable Development (SATREPS) under supervision of JIST and JICA.



How benefit?

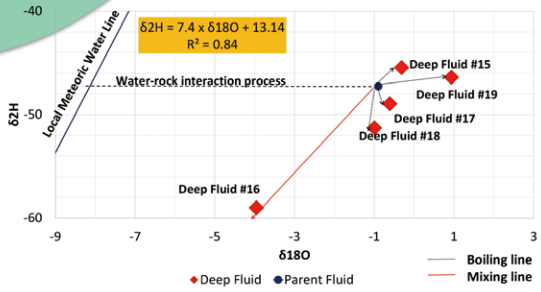
This green project has particular objective to obtain subsurface characteristics of reservoir fluids in order to design drilling target area as accurate as it can be, **and to minimize the drilling risk** which can cost up to 40% of the total investment cost.

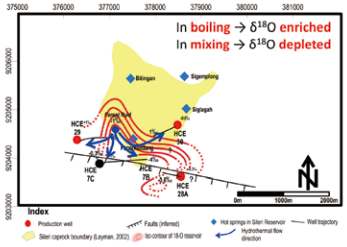
How does it work?

Geochemical methods help us to determine the precise location of before we tap the energy from beneath by drilling process.

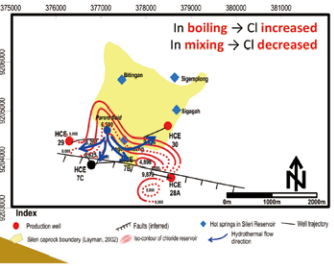
Isotopes Analysis

Oxygen and hydrogen isotopes to indicate the sources of fluids and the nature of subsurface processes like boiling and mixing processes in geothermal systems.





The iso-contour of reservoir chloride and $\delta^{18}O$ contents can infer the hydrothermal flow pattern. In the upflow zone, Cl content is typically lower than in the outflow zone (Nicholson, 1993).



Geochemistry Gas

- Rn-222 can serve as **reservoir temperature indicator** as the solubility coefficient for radon is become lesser in higher temperature.
- Rn-222 is soluble in water in which it may be carried for great distances (upflow zone of geothermal system).

- H_2S is the second most plentiful gas besides CO_2 in a geothermal steam.
- Radon is product of natural radioactive decay of uranium and thorium, has half-life 3.8 days
- Appearance at shallow depth is usually related to high gas flows or anomalies of shallow thermal indicator.
- The younger the age of lava, the larger amount of parent radionuclide, the higher the Rn-222 values.

Fumarole	Associated with Mount	K-Ar Dating (Ma) from fresh lava*	Trace Elements (ppm)*		222Rn (Bq/m^3)
			U	Th	
Burung	Puncak Besar	0.23 ± 0.03	1.2	6.0	2.490
Wayang	Wayang	0.49 ± 0.01	1.4	6.4	4.130
Windu	Windu	0.10 ± 0.02	1.5	7.0	7.950

Boogie and Mackenzie (1998)

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Acknowledgements

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Closing Remarks

Mr. Akira Kojima

Advisor, Japan Center for Economic Reseach

Director Kojima announced the winners of the Y-E-S award and gave the final remarks for the day's events at the forum. After a difficult discussion, the selection committee made the surprising decision to award the first prize jointly to Teams C and G, two teams from Kyushu University who both worked on the subject of research on fuel cells, with second prize being awarded to Team B.

Director Kojima went on to praise all of the participants for their passion, energy, and sense of mission, encouraging them to continue striving toward achieving the focuses of their research, through connectivity, collective approaches, collaboration, and cooperation, to achieve CO2 reduction and a sustainable balance between economic growth and energy pressure. He drew parallels to the 1972 report "The Limit of Growth" from the Club of Rome, noting that the United Nations has also since talked as well about the importance of decoupling economic growth from energy pressure.

Much as how Honda Motor's founder Soichiro Honda was motivated by "The Power of Dreams," the director noted the importance of the participants following their dreams to continue their work in the field of Ecotechnology and use new technologies like fuel cells to ease the burden on the environment as society develops, furthering not only their individual careers, but also working toward the ultimate goal of helping to protect and preserve the environment for the sake of the future of humanity.

Sumeet Sanjay Gattewar
2008 Honda Y-E-S Awardee in India

It has been a great time for all of us today – being in the presence of some of the great thinkers and innovators in the field of ecotechnology.

The Y-E-S forum 2016 what a wonderful platform it has proved to know, learn and share information on almost everything concerning the field of energy security at local and global levels and eco-technology in general. From futuristic electric vehicles to advances in nuclear energy to state of the art solar panels, methods of hydrogen generation and storage and transportation. From $44 wind mill to a $5,000 energy saving house. We discussed it all.

Furthermore, the enlightening presentations from our keynote speakers truly elevated this forum from a local to a global level holistically discussing the technological advancements in sustainable energy as well as the importance of collaborative thinking and policies of government under various geopolitical combinations.

Rome was not built in a day they say – and so is not going to be a green and sustainable future. It was, however, a great experience to know so many brilliant minds contributing their share towards building the Rome of today - and feeling myself to be a part of it.

I would like to most sincerely thank Honda Foundation for creating such a great platform and providing us with an opportunity to be a part of it. I wish that its vision bring the brightest minds together and call their attention to some of the biggest questions faced today by human civilization soon bears fruits.

I would like to conclude here by extending the deepest heartfelt thanks to all the dignitaries, participants, officials and my colleagues in making this event a great success and wishing the best for the upcoming editions of this forum.

Thank you.

The Way Forward

Honda Y-E-S forum has been designed to engage young scientists and engineers from Japan and other Asian countries, including the Honda Y-E-S awardees, in discussion with experts in various fields, on issues in modern society examined from the perspective of young scientists and engineers for ecotechnology into action. To achieve this mission, three key factors should be considered and improved through Forums, as follows:

Network development

We should build a strong Y-E-S Forum participant alumni network of scientists, engineers, researchers, and potential students by sharing ideas and opportunities for ecotechnology into action. A mailing list of the network should be created to establish connections. In addition, Y-E-S awardees who are currently working on in areas related to ecotechnology both in research and development, should be supported from Honda Foundation to pursue their career. Beside the Forum, a journal of ecotechnology should be took in account to encourage people to share their works both in research and development.

Skill development

Firstly, a skill set for organizing the Forum (planning, writing, presentation, etc) should be carefully annotated and documented for new PCMs. Moreover, organizing team of the Forum should create a student section where experts could teach ecotechnological lectures and students could learn useful skills such as “Ecotechnology at a glance”, “Skills you need to become a researcher” or “How to build your startup”.

Ecotechnology into action

To raise consciousness of issues in the region and proposed solutions from ecotechnology perspective, PCM country teams should write a report about their study to publish in local newspapers, journals after finishing the Forum each year. In addition, the focus should be on promoting the event to young scientists and engineers who will make technological breakthroughs. In the future, the event could be held in different locations of the world to expand the student and research community involved in the Forum. Each PCM should be an ambassador to promote Honda Y-E-S forum in their local countries.

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