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Energy systems comparison and clean high tech evolution

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Energy investment decisions must be based on the full costing principle, including the external social cost and risks. The graph below shows the comparison of presently known energy systems. It is evident that conventional power plants cannot compete with clean, sustainable ones anymore.

Depending on the size, type and location of the energy system there is an operational cost range from the light blue minimum to the darker blue maximum. The green external cost comprise health cost due to pollution and damages to the environment and climate, whereby the cost of flooded islands and coastal regions from rising ocean levels due to global warming can hardly be quantified, as well as killed people by weather disasters or cancers from nuclear radiation. Affected agricultures and bio diversity by acid rains and draughts or noise are also external cost.

The risk factor of power plants is also part of the cost equation. No insurance company is covering the full risk of nuclear power, because of the infinite damages, accidents at such plants could cause, as was the case at Chernobyl with millions of contaminated people and biospheres. USA Professor Sternglass proved with official Department of Health statistics that around all nuclear power plants much higher health cancer rates were observed – see facts on www.radiation.org.

Based on the international standard ISO 13602-1 for energy systems analyses the true, total energy cost including all by-products, side effects and risks of energy systems can be calculated.

The oldest clean energies are the sun, biomass, wind and hydropower, complemented by ocean waves, tides and OTEC. They depend on varying weather conditions and seasonal cycles but are more and more competitive with non-renewable systems thanks to lower external cost and less dependency on the speculative fuels coal, petroleum, gas and uranium with their increasing cost.

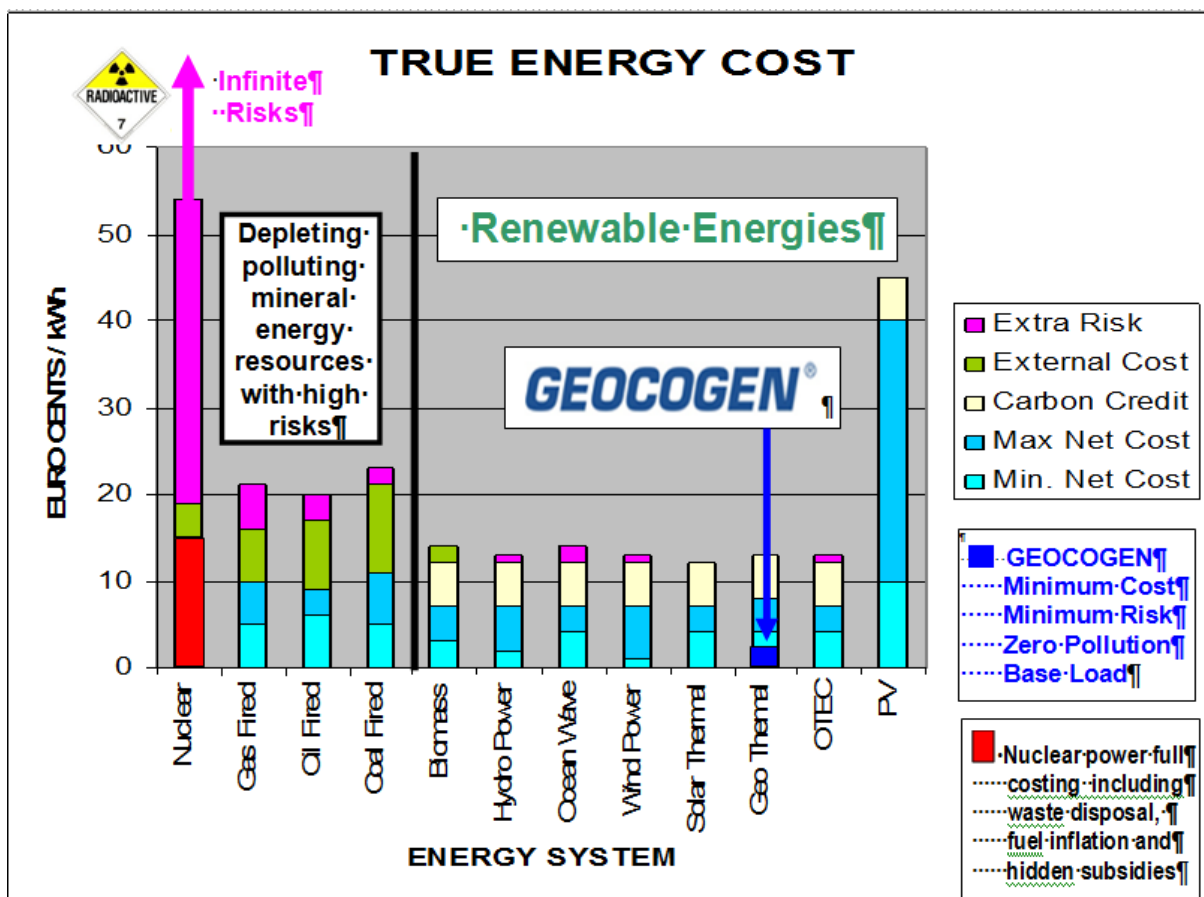


Fig. 1.

The world economy needs thousands of Giga Watt base load power in view of the modernization of life and a rapidly increasing number of electric vehicles which have to be recharged overnight.

Unlimited GW base load energy systems are the space-based solar power **SBSP** (space based solar power) transmitted to energy consumption areas on Earth and the 4th generation deep-well hot rock **GEOCOGEN** (geothermal co-generation). Both can be built safely where energy is used, thus avoiding high transmission cost and losses from remote locations. International ISO-IEC standards are indispensable to implement energy systems.

Energy History

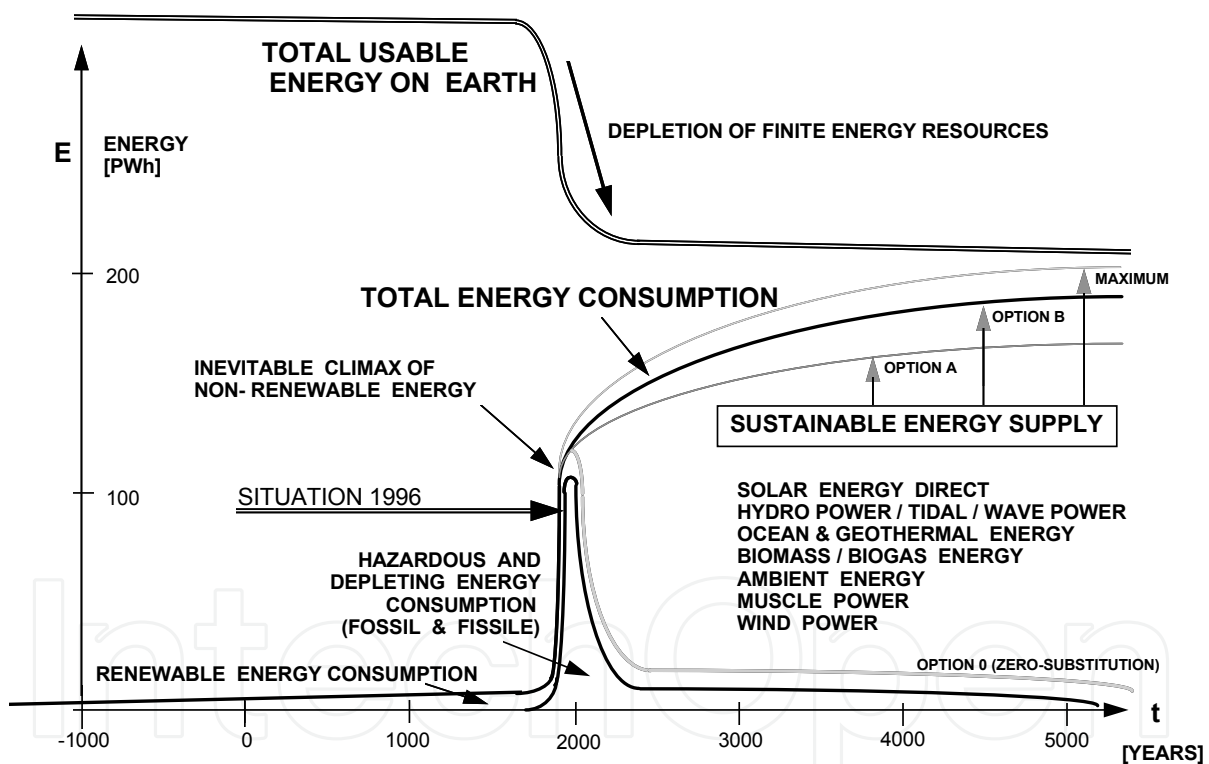
Cosmic nebula consist of overabundant energy. Our Earth and Moon sparked off in the solar system by immense power, full of geothermal energy, apparent by volcanic eruptions since millions of years. All life on Earth thrives from the solar energy, which is radiated into the atmosphere causing plants to grow, water to evaporate, wind and waves to move. The moon cycles drive the tidal movements, supplying abundant ocean energy onto the sea shores.

Energy and genius enabled the emergence of the human evolution in prehistoric times, which started off with the use of human muscle power for hiking, running, rowing, hunting and plant harvesting for food, using also dried biomass and dung for cooking and heating -

thanks to the discovery of fire. But also geothermal springs and primitive solar food drying and heating were applied. Food was the source of this natural human bio-energy.

In ancient times man started to apply wind energy for sailing, pumping and milling, and made use of animal muscle power for farming, transport and other mechanical work. The “horsepower” (hp) denominated mechanical performance since the industrial revolution, which evolved from the bio, geo, wind and hydro energies to mineral energy sources, having started with the coal discovery for combustion in fire places, steam boilers and central heating systems.

The harnessing of petroleum reservoirs in the 20th century started the modern age with its incessantly rising mobility, industrialization, building comfort and communication technologies. The concept of combustion engines and thermal power plants culminated in modern nuclear technology - again using finite mineral resources, resulting in the peak phenomena within the millennium fraction of human technical history, as dramatically illustrated by following graph.



SOURCE : ICEC / CMDC-WSEC

Fig. 2. Energy history and forecast

The fatal crux of the majority of energy systems over the last two centuries is the finite nature of their mineral sources and their catastrophic impacts on human health and on the natural climatic and biosphere cycles and balances, with incalculable risks in the case of nuclear fission and fusion energy, which insanely absorbed public and private funds of trillions of dollars.

The calamity with most systems using finite energy resources is the fact, that engineers, physicists and chemists did not care about the holistic assessment of all side and after effects of their inventions. They did neither care about the environmental and health impacts of their use, nor about the resource depletion, nor about the consequences of the waste and safety hazards of such systems. The gasoline and Diesel engines are one typical example of such blindness – they would be prohibited by modern environmental and occupational health and safety laws – not to mention the heavy metal particle emissions by modern cars. Nuclear power, which originated from the development of weapons for mass destruction, is another shocking example, where neither material failures and human risks, nor the safe waste disposal, nor the wasteful Uranium mining with fossil fuel driven engines were put into a total cost and fallacy assessment.

Geologist Dr. Colin Campbell, publisher of the monthly ASPO reports about the world-wide oil and gas resource depletion, calls this fatal period in history the “The Age of Hydrocarbon Man” and foresees a collapse of the industrial age and the environment, if not enough is done fast enough to substitute mineral energy concepts by benign, sustainable energy systems.

Future Energy Needs of Humanity

All we need in future are energy services for better comfort, mobility, communication, work and leisure, which do not jeopardize our life basis with radiation risks, hazardous pollution, global warming, rising oceans, melting glaciers and further biosphere and ocean life deteriorations.

How can such clean energy services be provided to everybody in a sustainable manner – also to the billions of underprivileged people in the world, who could not enjoy the convenience of electricity, health care, hygienic habitat, basic education and modern mobility up to now ?

The answer is simple: there is so much renewable energy available on Earth for thousands of years, that we can stop squandering mineral resources and conserve them for the chemical industry for many centuries, which would otherwise be depleted within one or two generations.

This future scenario is illustrated by the following graph, showing the gradual reduction of finite energy resource use to zero while increasing the renewable energy production drastically in order to satisfy development needs of the whole world, reflected in the 2 % annual increase.

However, an annual energy consumption growth of merely 2 % is only possible, if all conceivable energy efficiency measures are applied world-wide, which means the prohibition of all wasteful incandescent and halogen lamps, the substitution of all low-efficiency thermal engines in cars and power plants and the much better insulation of buildings and refrigerators.

The transition to a sustainable energy economy means in monetary terms the re-channelling of annually over one trillion USD from harmful subsidies and mineral energy investments to clean, sustainable energy systems. Another trillion could be re-channelled from exaggerated military budgets, since oil wars and other mineral resource disputes will be made superfluous.

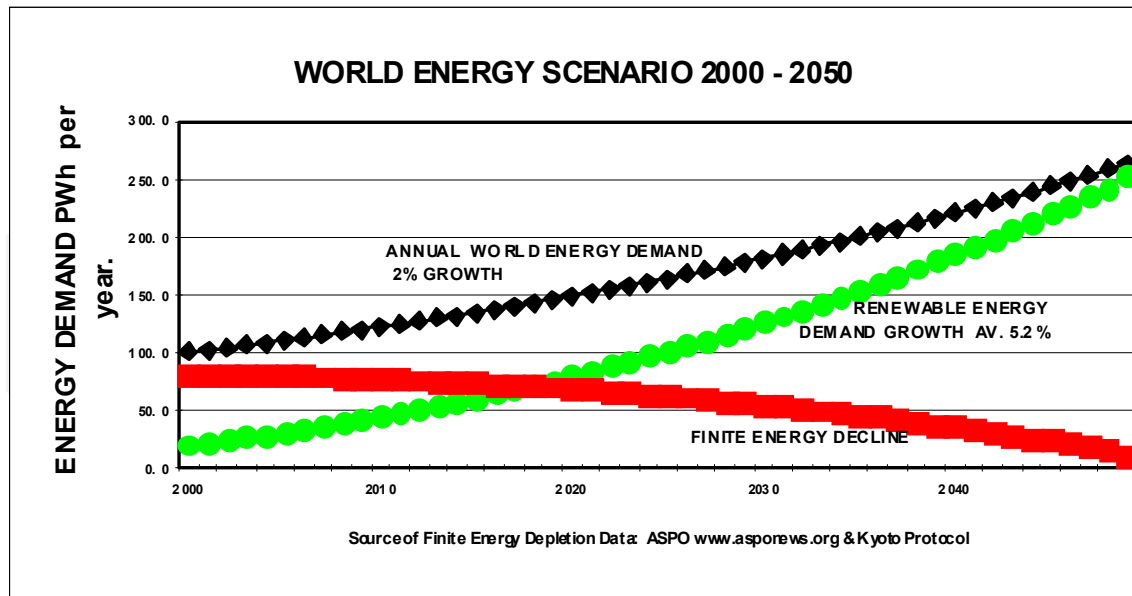


Fig. 3.

Some pessimists keep saying that energy consumption has to be reduced to less than half in industrialized nations, in order to allow the less developed countries an energy consumption increase. The term convergence is often used in this context: less for the affluent society and more for the poor, which sounds socially fair. The awkward term “2000 Watt Society” was coined for this austerity concept by somebody who confused the power unit kW with the legal energy units kWh or Joule, thus suggesting that there is not enough “power” available for the growing world population. With this utterly misleading terminology non-technical citizens get the wrong impression that merely 2 kW would be allocated to each of them, while their car and indispensable heating and cooking stoves have a multiple of this performance. What is really meant by this credo, is that all citizens on this planet shall limit their annual energy consumption to $2000 \text{ W} \times 8760 \text{ hours} = 17'520 \text{ kWh}$ and thus must choose their preference and priorities whether to use this allocation for more comfort, mobility or for energy at their work.

Such pessimists are right in their conviction that too much energy is wasted nowadays with badly insulated houses and fridges, too heavy vehicles, inefficient combustion engines and light sources. But they are totally wrong in their believe that energy from mineral resources could be stretched forever merely by increased efficiency and that average people would forego some of the modern mobility pleasures, leisure gadgets, work aids, travel joys and living comforts. They grossly misjudge human nature with its desires and the temptations from modern technology !

What is absolutely right, is that energy emission impacts cannot any longer be paid by the victims in human society in terms of health cost, loss of environmental quality - resulting in a reduced quality of life, genetic damages from radiation, noise from inappropriate transport modes etc. - and that a more efficient use of energy is surely easing energy emission hazards.

To make the polluters pay, total cost accounting must be enforced to make them accountable for the damage to the impaired. This is only possible with a world-wide tax reform, which re-directs hazard costs to cleaner, quieter and less risky energy systems. The technical committee ISO/TC203 (International Standards Organization in Geneva) has issued standard Nr. 13602-1, which allows the calculation of the total energy cost - including all external, social cost - by making all inputs and outputs of energy systems quantifiable in legal SI units. Thus all energy systems become economically and ecologically comparable, which have to be reflected in complete energy statistics and a better energy forecasting methodology, as also tackled by ISO.

The Future Energy Solutions

There is no lack of sustainable energy on Earth, making finite, polluting energy resources totally superfluous ! The former Saudi Minister of Petroleum Sheikh Zaki Yamani has put it quite simple in saying that *"the stone age did not come to an end, because of the lack of stones"* and that similarly *"the petroleum age will not be ended because of the lack of fossil fuels"*.

The sun is radiating daily about 10'000 times more solar energy to the surface of the Earth, than the total world energy consumption. The solar-induced bio-energy in nature and from energy crops could cover more than all present energy needs, if properly managed and utilized. The very economical hydro- and wind power electricity production can still be multiplied around the world to satisfy all electricity needs, complemented by geothermal energy and ocean energy, which are so abundant that they alone could again satisfy all energy demand, plus the direct solar energy on billions of roofs and along roads for electricity and heat which is able to grow by over 30 % per annum, if economically mass produced and further optimised by more research. Space based solar power (SBSP) could be another modern base load electricity source in the GW class.

Hence, there is more sustainable energy available than humans ever need, which leads to the logic conclusion that all polluting energy systems can be replaced and no more such systems should be produced at all. They shall even be prohibited by international law and the United Nations to the benefit of a healthier, happier survival of life on planet Earth.

The energy supply infrastructure is undergoing a similar change like the computer technology:

from expensive central units to a decentralized, economic mix of interconnected small systems like solar panels and wind generators on the roofs, heat pumps and fuel cells in the basements and cogeneration units fuelled by local biomass instead of imported minerals. Evidently, the energy multinationals and large power producers do not like this trend, which makes them gradually lose their monopolistic grip on the energy business, the control over electricity grids and the fuel supply chains, when consumers will be covering their energy needs themselves.

To accelerate this overdue world-wide transition to the "Post-Mineral Energy Age, the International Sustainable Energy Organization ISEO was initiated by Swiss parliamentarians of all political parties in 2002 and got legally established in March 2003 in

Geneva, the birthplace of the League of Nations, the Red Cross and the United Nations with its many economic and social council bodies, cooperating closely with relevant NGOs like ISO, to accomplish this global survival task of historic dimensions, thus allowing all nations and their people to develop their civilizations in a sustainable manner with equitable, clean and benign energy systems.

ISEO promotes the “Blueprint for the Clean, Sustainable Energy Age” with its “Geneva Declaration” as implementation guide for governments, academia and the private sector. Its web portal www.uniseo.org contains all necessary technical, legislative, educational and financial implementation tools, based on the heuristic “Global Energy Charter for Sustainable Development”. Consequently oil wars will become superfluous and most nations can become energy self-sufficient without wasting their foreign exchange on hazardous energy imports, bringing drastically down health cost and environmental rehabilitation expenses in future.

Mobility of the Future

Mobility is one of the four main urges of human beings. It was kept in environmentally acceptable proportions, as long as only boots, horses, sledge dogs and sail ships were used. The steam engines with their coal firing did not make much leeway either, except for railway locomotives and ships until coal was replaced by the more convenient liquid fossil fuels.

The discovery and refining of crude oil, combined with combustion engines, changed the whole mobility concept, when modern vehicles and aeroplanes were developed and mass produced in the 20th century. This mobility drive due to scattered habitats with more and more remote work places, food sources and holidays changed human habits fundamentally, to degenerate into one of the main nuisances to people and nature with its increasing pollution and noise.

The curse was the cheap fossil fuel supply and the low engine efficiency, which caused the depletion of over half of the economically viable energy resources within one century with now over one billion vehicles in service world-wide. The enormous expansion of air traffic for leisure, work and defence with its impact on the sensitive atmospheric strata worsened the situation.

Hydrogen seemed to be the clean answer to the dilemma of substituting about one third of the fossil energy consumption wasted in transport. Among the hydrogen drive concepts fuel cells look more promising than combustion engines, because of their much higher efficiency and silence. However, the clean production and storage of hydrogen is expensive and the fuel cell merely produces electricity, which necessitates finally an electric drive system to turn the wheels.

By comparing the composite cost of hydrogen vehicles with the cost of electric vehicles with advanced batteries, one must conclude that the ultimate mobility solution are pure electric vehicles with safe high-density batteries, which are emerging now from intensive research and development. This ultimate concept costs less than half of any fuel solution and does neither cause emissions, nor engine noise, and does not necessitate an expensive fuel supply chain with its energy losses in transport and storage, and thus will satisfy people's expectations for their future individual mobility - similar to electric trains and buses for public transport.

Healthy Energy Job Creation and Avoided Uprooting

All hazardous jobs in coal and uranium mines, on remote oil fields and offshore platforms and in hazardous mineral resource transportation with their too frequent disasters and oil spills will be eliminated by the clean, sustainable energy system production, requiring a multiple of workers compared with the resource intensive conventional energy jobs. The shift from concentrated, finite resource-intensive concepts to labour-intensive decentralized energy system production will provide enough jobs for everybody in their own countries, without necessitating migrations.

The danger of population displacements due to lost coastal zones and islands will also be banned as soon as the cause of rising oceans – manmade global warming - will slow down thanks to clean, sustainable energy systems.

And last but not least - the hitherto strangling health and accident insurance cost will be drastically reduced by the elimination of emissions from fossil energy combustion, minerals transport hazards, and nuclear radiation damages ! There will also occur fewer sacrificed lives and less casualties and material losses from river floods, disastrous storms, land slides and rising oceans, as more and more frequently experienced in the last few decades of the fossil fuel frenzy, resulting in the unprecedented steep rise of man-made global warming and dramatic oil spills !

Conclusions and Future Outlook

Humanity can be confident to survive on planet Earth in good livelihood, because

- 1 - there is enough clean, sustainable energy available for centuries to come
- 2 - these clean, sustainable energy systems are competitive with finite polluting systems
- 3 - decentralized, clean sustainable energy conversion will be growing world-wide
- 4 - environmental impacts can be avoided with clean, sustainable energy systems
- 5 - mineral resources can be conserved for future generations and must not be burnt any more
- 6 - this huge historic task can be financed if governments and investors re-direct their money
- 7 - wars become totally superfluous and a gun-free global society can blossom peacefully
- 8 - the work can and must be done without further excuses and procrastinating conferences

Artist's View of the Clean Energy Age by Hans Erni

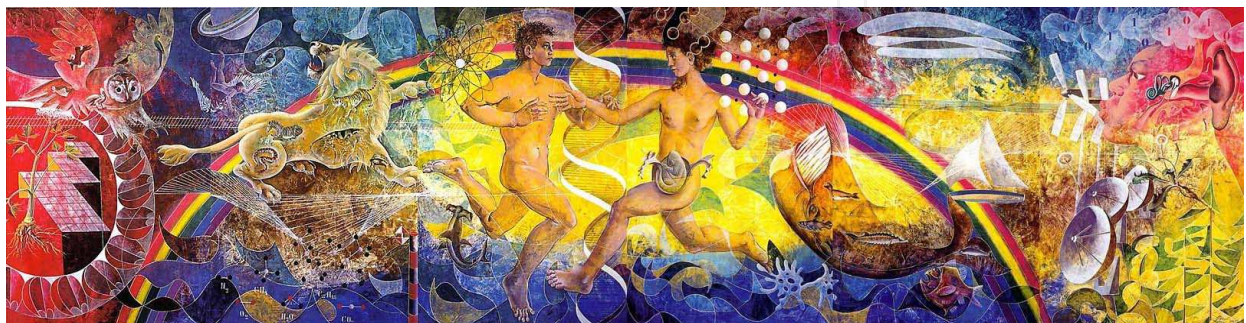


Fig. 4.

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Clean Energy Systems and Experiences

Edited by Kei Eguchi

ISBN 978-953-307-147-3

Hard cover, 178 pages

Publisher Sciyo

Published online 05, October, 2010

Published in print edition October, 2010

This book reports the latest developments and trends in "clean energy systems and experiences". The contributors to each chapter are energy scientists and engineers with strong expertise in their respective fields. This book offers a forum for exchanging state of the art scientific information and knowledge. As a whole, the studies presented here reveal important new directions toward the realization of a sustainable society.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Gustav Grob (2010). Energy Systems Comparison and Clean High Tech Evolution, Clean Energy Systems and Experiences, Kei Eguchi (Ed.), ISBN: 978-953-307-147-3, InTech, Available from:

<http://www.intechopen.com/books/clean-energy-systems-and-experiences/energy-systems-comparison-and-clean-high-tech-evolution>

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