IEA PVPS TASK 8: VERY LARGE SCALE PHOTOVOLTAIC POWER GENERATION (VLS-PV) SYSTEMS IN DESERTS

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The objective of IEA PVPS Task 8 is to examine and evaluate the potential of Very Large Scale Photovoltaic Power Generation (VLS-PV) Systems in desert areas, which have capacities ranging from several megawatts to gigawatts, and to develop practical project proposals for demonstrative research toward realizing VLS-PV Systems in the future. Stakeholders targeted to will be policy makers, investors and project developers including PV industries, as well as researchers and engineers in the field of solar cells and PV system technology. Through the activities, Task 8 will give recommendations to stakeholders and for world brightness future.

Keywords: solar energy, photovoltaics, VLS-PV, desert

INTRODUCTION

The objective of IEA PVPS Task8 is to examine and evaluate the potential of Very Large Scale Photovoltaic Power Generation (VLS-PV) Systems on desert areas, which have capacities ranging from several megawatts to gigawatts, and to develop practical project proposals for demonstrative research toward realizing VLS-PV Systems in the future.

We started the Task8 in 1999. In 1st-Phase (1999-2002), key factors that enable VLS-PV systems feasibility were identified and the benefits of this system's applications for neighbouring regions were clarified as well as the potential contribution of system application to global environment protection and renewable energy utilization in the long term was clarified. Mid- and long- term scenario options for making VLS-PV systems feasible in some given areas were also proposed [1]. Based on the scenario options of 1st-Phase, in 2nd-Phase (2003-2005), case studies on VLS-PV systems were carried out in depth and practical proposals for demonstrative research projects on pilot PV systems suitable for selected regions, which would enable sustainable growth into VLS-PV Systems in the future, were discussed [2]. To develop these results toward an implementation of VLS-PV systems, we've started 3rd-phase activity. In 3rd-Phase (2006-2008), specific case studies from viewpoints of local, regional and global aspect are carried out, and financial and institutional scenarios and a general instruction for practical project proposals are developed. Also, considerable future technical options implementing VLS-PV system are analysed.

In this paper, the lessons learned from 2nd-phase activity will be shown.

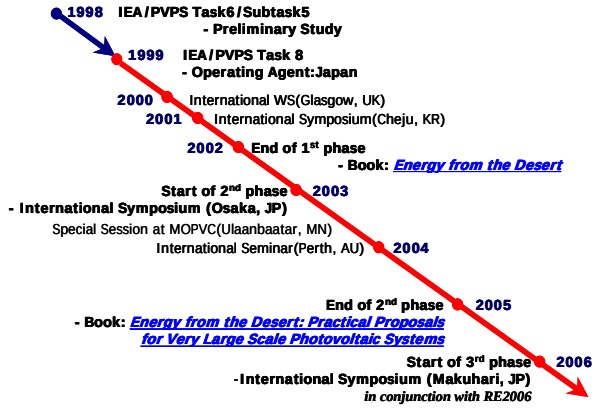

Fig. 1. History of IEA PVPS Task 8 activity

LESSONS LEARNED FROM 2ND-PHASE ACTIVITY: PRACTICAL PROPOSALS FOR VLS-PV SYSTEMS

Practical proposals for VLS-PV systems

It is apparent that VLS-PV systems can contribute substantially to global energy needs, become economically and technologically feasible, and contribute considerably to the environment and socio-economic development. Securing these contributions and deploying the actions for implementing VLS-PV in the

future, we developed proposals of practical projects suitable for selected regions.

Considering sustainable growth of VLS-PV systems, project proposals for these regions, the Mediterranean region, the Middle East region, Asian region (China and Mongolia) and Oceania region were selected. The Mediterranean project performed case studies of Spain, Portugal, Tunisia, from viewpoints of irradiation and general condition. A "Top-Down" approach is developed to introduce VLS-PV System into the Middle East. By the cooperation of Japan, Korea and Mongolia, a case of locations along railway, where infrastructures, local community and power transmission already exist in Mongolia, was selected and studied. Also, 8MW PV Project is planed in China. It can be considered as a preliminary stage or first stage for future VLS-PV. Further, in Oceania region, to build mega-watt class PV system at the Western Australia was discussed. It also have possibility to be a preliminary stage.

Followings are conclusions and recommendations that have been learned from the activity.

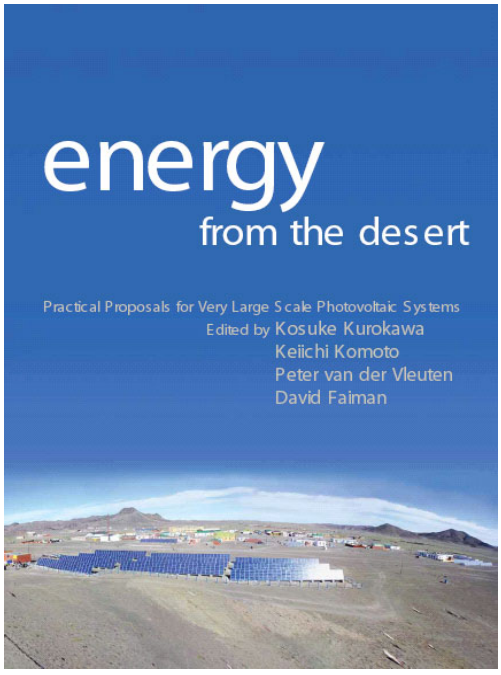

Fig. 2. 'Energy from the Desert: Practical Proposals for Very Large Scale Photovoltaic Systems' [2]

General conclusions

Thinking about a practical project proposal for VLS-PV development, finding the best sustainable solution toward VLS-PV is a common objective. System capacity for suitable development depends upon each specific site, corresponding to application needs, available infrastructure, available human resources, available financial resources, and other factors.

Background

-There may be high possibility that world energy demand and supply will become very tight due to trends in world population and economic growth in the 21st century. For saving conventional energy supply and for supporting a growth of economic activity, especially, of developing countries, new energy resources and related technologies have to be prepared.

-The potential amount of world solar energy resources is sufficient for people's life in the 21st century. It is forecasted that photovoltaic technology shows promise as a major energy resource for the future.

-Much potential exists in desert areas around the world. If appropriate approaches are found, they might provide solutions to the energy problem of countries surrounded by deserts.

Technical aspects

-Various types of PV systems already proven can be applied for VLS-PV. It is thought that PV technologies have reached the necessary performance and reliability levels for examining the feasibility of VLS-PV.

-To clarify the technical reliability and sustainability, a step-by-step approach will be required to achieve GW-scale. This approach is also necessary for the sustainable funding scheme.

-Technology innovation will make VLS-PV in desert areas economically feasible in the near future.

-Global energy systems like hydrogen production and high-temperature super conducting technology will make VLS-PV projects more attractive, as well as the higher conversion efficiency of PV cells and modules.

Economic aspects

-The economic boundary conditions for VLS-PV are still non-satisfactory at present PV system prices without supporting schemes, so that lowering the investment barrier, additional support, and/or higher feed-in tariffs for large systems are required.

-VLS-PV using flat-plate PV modules or CPV modules produced using mass production technologies are expected to be an economically feasible option for installation of large central solar electric generation plants in or adjacent to desert areas in the future as a replacement for central fossil fueled generating plants.

-Intelligent financing schemes like higher feed-in-tariffs in developed countries, and international collaboration schemes for promoting large-scale PV or renewable energy in developing countries will make VLS-PV economically feasible.

-For the sustainable development of VLS-PV, initial financial support programmes should be sufficiently to completely finance the continued annual construction of VLS-PV plants and the replacement of old VLS-PV plants with new ones, eliminating the need for any further investment after the initial financing is repaid.

Social aspects

-Renewable energy development is a promising way for social development and one of the most important policies in developing countries.

-VLS-PV projects can provide a pathway to setting up PV industry in the region, while the existence of a traditional and strong PV industry will provides an additional factor contributing to the economic and political environment favouring the application of PV.

-VLS-PV projects in developing countries will be led to success by international collaboration and by institutional and organisational support scheme.

-Development of VLS-PV will become the most attractive project there is, making the region and/or country a leading country/region in the world.

-When we think about construction of VLS-PV, you should be careful about social sustainability of the region, for instance, co-existing with agriculture and desert community development.

Environmental aspects

-In view of the basic global environmental problem, there is a logical necessity for renewable energy, and it is expected to be an important option for the mid 21st century.

-A proper green area coupled with VLS-PV would positively impact on convective rainfall rather than the negative impact due to rise in sensible and surface heat flux and would decrease dust storms, as well as reduce and mitigate CO_2 emissions.

Recommendations

It is strongly indicated that VLS-PV could directly compete with fossil fuel as the principal source of electricity and with existing technology for any country that has desert areas. This could be accomplished by finding an investment scheme and by getting institutional and organizational support for its implementation. Further the technology innovations on PV and global energy systems in the future will make VLS-PV economically and technologically attractive and feasible.

The following are recommended to realise a project enabling the sustainable growth of VLS-PV in the near future:

- Discussing and evaluating future technical options for VLS-PV, including electricity network, storage, and grid management issues as well as global renewable energy systems.
- Analysing local, regional, and global environmental and socio-economic effects induced by VLS-PV system from a viewpoint of the whole life cycle.
- Clarifying successful and un-successful factors for VLS-PV project, on both technical and non-technical aspects, based on experts' experiences in the field of PV and large-scale renewable technology including industry, project developers, investors, and policy-makers.
- Developing available financial, institutional, and organisational scenarios, and general instruction for practical project proposals to realize VLS-PV systems.
- The IEA PVPS community continues Task 8 activity for performing the above items. Experts from grid planning and operation, desert, agriculture, finance and investment should be involved.
- The IEA PVPS community welcomes non-member countries for the opportunity to discuss the possibility of international collaboration project in IEA PVPS activities.

FUTURE PESPECTIVE

From a viewpoint valuing the technological aspect, starting with the R&D stage or the pilot stage might be important considering overall desert development. Aiming at commercial operation, an initial project to be proposed should not be the R&D stage, but the pilot or demonstration stage. Further on, the technology innovations on PV and global energy systems in the future will make VLS-PV economically and technologically attractive and feasible.

We've started the 3rd-Phase activity (2006-2008). Specific case studies from viewpoints of local, regional and global aspect will be carried out, and financial and institutional scenarios and a general instruction for practical project proposals are developed. Also, considerable future technical options implementing VLS-PV system will be analysed.

Toward implementation of VLS-PV system, stakeholders targeted to will be policy makers, investors and project developers including PV industries, which enable to make a plan and concrete vision to realize VLS-PV from a viewpoint of global energy and environmental issues, as well as researchers and engineers in the field of solar cells and PV system technology. Through the activities, Task 8 will give recommendations to stakeholders and for world brightness future.

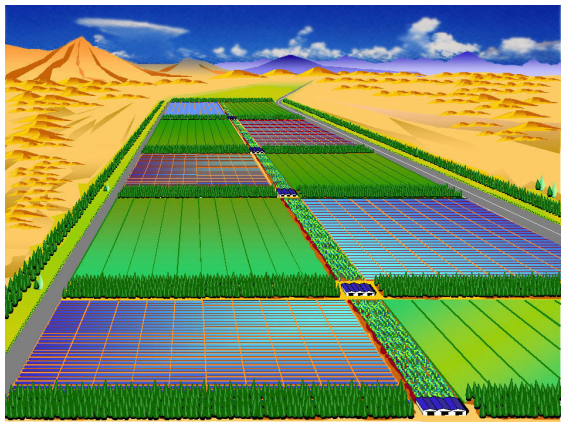

Fig. 3. Image of a VLS-PV system in a desert area

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[1] Kosuke Kurokawa, “Energy from the Desert: Feasibility of Very Large Scale Photovoltaic Power Generation (VLS-PV) Systems”, James & James Ltd., London, 2003

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Task 8. Study on very large scale photovoltaic power generation systems. It is already known that the worldâ€™s very large deserts present a substantial amount of energy-supplying potential. Given the demands on world energy in the 21st century, and when considering global environmental issues, the potential for harnessing this energy is of huge import and has formed the backbone and motive for this Task8. The objectives of the Task 8 are to examine and evaluate the potential of very large scale photovoltaic power generation (VLS-PV) systems, which have a capacity ranging from several megawatts