A novel solar CPV/CSP hybrid system proposed

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In concentrating photovoltaic (CPV) systems only a small part of the incident solar energy can be converted into electricity and the majority of the incident energy is dissipated as waste heat. Although the waste heat could be utilized in conventional CPV/thermal systems, the applications are seriously limited due to the low temperature accompanying the waste heat.

Professor Xu Chao and his group from North China Electric Power University (NCEPU) present a novel CPV/concentrating solar power (CSP) hybrid system. The dissipated heat is used to produce superheated vapor of refrigerant which is effective to generate power through an organic Rankine cycle (ORC), and thus the solar-to-electricity efficiency of the system can be significantly improved. This work was published in *Science Bulletin* 2015 No.4 issue.

Recently CPV has achieved worldwide attentions due to the features of more cost-effective and more efficient in energy harvesting than PV with no concentrators. However, redundant low grade heat is accompanying the CPV systems, because on one hand the majority of the incident solar energy is converted into heat, and on the other hand the temperatures of solar cell modules have to be restricted to a proper range (usually less than 100 C). To make full utilization of the massive dissipated heat, CPV/thermal (CPV/T) hybrid systems were developed in the past decades. However, the dissipated heat is usually used to heat a coolant to a higher temperature for space heating, absorptive cooling and so on in conventional CPV/T systems. The applications of the CPV/T

systems are actually seriously limited due to the possible mismatch between the demand for power and heat and the required complicated energy management system. On the other hand, only the core region of the energy flux density generated by the concentrators with high and relatively uniform local concentration ratios is suitable for CPV modules, and the peripheral radiation with low concentration ratios is usually discarded.

To make better use of both the dissipated heat from solar cells and the peripheral low-concentration radiation, Professor Chao Xu and his colleagues proposed a novel CPV/CSP hybrid system, which is mainly composed of CPV modules and its evaporative cooling subsystem on the back side, a solar thermal receiver surrounding the CPV module, and the equipments forming an ORC. The solar cells facing the core region of the concentrated radiation generate electricity directly, and the refrigerant becomes saturated vapor after absorbing the dissipated heat from solar cells. Then the saturated vapor is fed into the receiver tubes, and after being heated by the peripheral solar radiation it becomes superheated vapor which is used to generate power through the ORC. As thus the hybrid system has a combined electricity generation, which could avoid the problem that market of conventional CPV/T is limited because of the combined heat and power (CHP) generation. Professor Chao Xu et al. also established a steady-state physical model for the hybrid system and carried out the energy analysis. The results show that the useful peripheral low-concentration radiation that can be used to get a high-temperature superheated vapor could be rather considerable, and the overall solar-to-electricity efficiency can be significantly improved by the hybrid system. For example, the overall efficiency can be increased from 28.4% for the conventional CPV system to as high as 44% for the hybrid system with 500 suns. Therefore, the proposed CPV/CSP hybrid system provides a viable way for high-efficient solar power generation.

More information: Xue Han, Chao Xu, Xing Ju, Xiaoze Du, Yongping Yang. Energy analysis of a hybrid solar concentrating photovoltaic/concentrating solar power (CPV/CSP) system. *Science Bulletin*, 2015, 60(4): 460-469. link.springer.com/article/10.1007%2Fs11434-015-0738-7

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