EPRI | ELECTRIC POWER RESEARCH INSTITUTE

# TECHNOLOGY INSIGHTS

*A Report from EPRI's Innovation Scouts*

# PHOTOVOLTAICS – TENKSOLAR RAIS WAVE

## *High Output Commercial Flat Roof PV System*

**THE TECHNOLOGY**

*RAIS Wave Concentrated Solar Photovoltaics*

**THE VALUE**

*Potential to increase electricity production per unit of area, greater reliability and use on flat roofs and similar structures*

**EPRI'S FOCUS**

*Engage developers to participate in project(s) to evaluate the technology*

## TECHNOLOGY OVERVIEW

The RAIS Wave technology is reported by its manufacturer to offer roof mounted solar with a unique electrical interconnection design using a reflector built into the balance of system. The system utilizes conventional cell technology that in what tenKsolar characterizes as a unique "cell optimizing architecture" that allows it to absorb roughly 1.5x incident sunlight. This concentration of light increases the rated capacity of the modules and the system.

*Image: tenKsolar RAIS Wave technology - view of module and paired reflector; Source: tenKsolar*

Concentrated photovoltaics (CPV) to date has been less cost effective compared to conventional photovoltaic modules. By modifying the module construction and the internal connections to the cells in addition to building the concentrator into the balance of systems, tenKsolar reports that it has created a technology that will yield additional kilowatt-hours (kWh) compared to conventional systems. This solution cannot readily be integrated with other manufacturer's modules due to the impacts of "non-uniform cell illumination," concentration and the corresponding higher module operating temperature. "Non-uniform cell illumination" refers to how different cells within the module will receive varying degrees of concentrated sunlight due to the fixed tilt nature of the system and varying position of the sun. Additional reported benefits of the system design are full redundancy through the entire system to eliminate all single-points-of-failure (from cell-to-grid redundancy), a novel DC/AC interconnection architecture, low voltage for safety, minimization of the effects of partial shading, and no required roof penetration for construction.

### BASIC SCIENCE

The RAIS (Redundant Array of Integrated Solar) Wave system utilizes propietary modules that can reportedly optimize the additional light being reflected from the built in reflector, mounted at a choice of angles based on the latitude on the back of the corresponding module. The reflector is based on 3M Cool Mirror Film Technology.

The manufacturer claims that modules rated at 410 W under one sun can achieve a rated output of 500 W+ through the additional light incident on the module from the reflector. This improves the energy density of the system. Additional benefits claimed include no necessary roof penetration and minimal ballast requirements due to the wave like structure. The electrical design in the RAIS Wave technology consists of redundant integrated devices in the module, allowing it to continue to operate in the event of an internal failure. This is enabled by redundant connections on

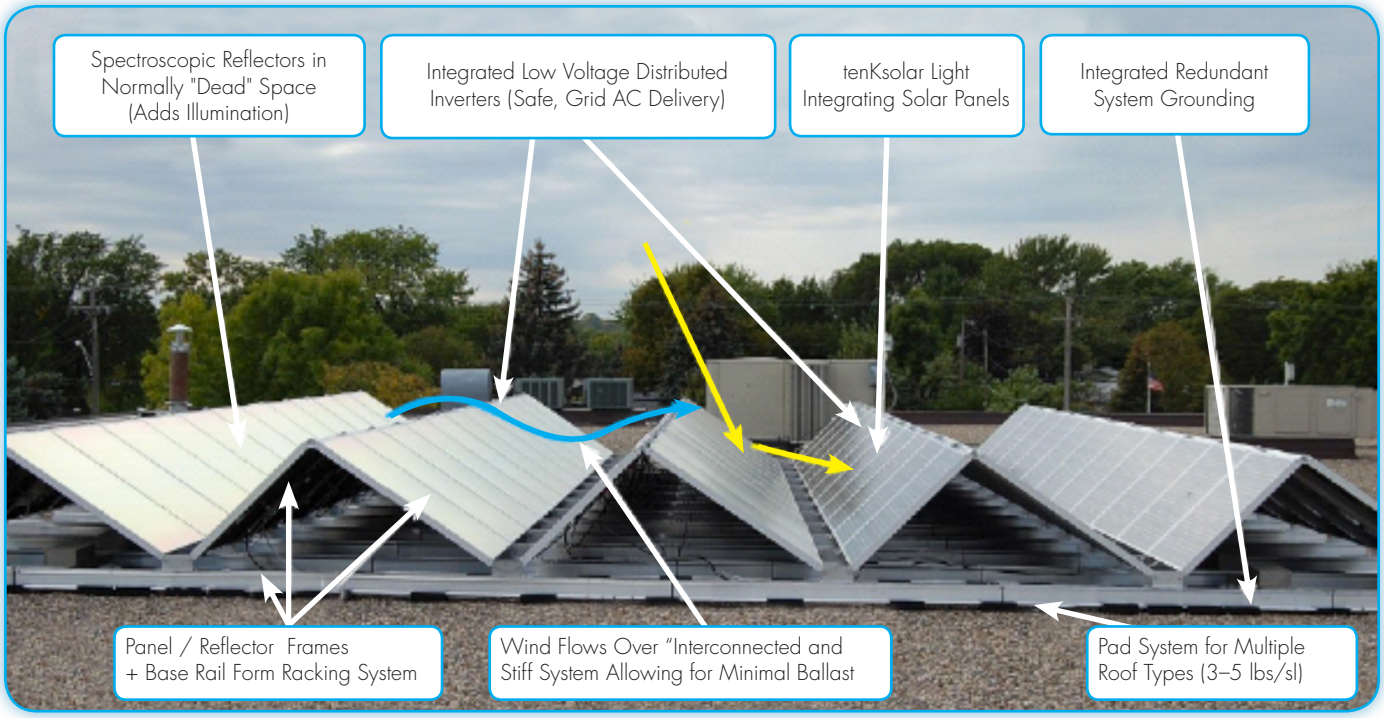


*Image: Profile view of rooftop mounted tenKsolar system; Source: tenKsolar*

the DC side to multiple single phase DC:AC converter boxes, which are wired into 277 VAC three phase interconnections. The converter boxes can be actively managed to vary the amount of energy delivered to each electrical phase.

### BREAKTHROUGH POTENTIAL

This type of technology may be well suited for flat roof, large commercial or small utility-scale photovoltaic systems. In applications that use available roof space with localized demand, system developers claim that it could offer more output per unit of area, offering one of the highest rated energy density systems available. According to the manufacturer, the system offers added fire and user safety through its low voltage design (10 VDC max).

## VALUE TO THE INDUSTRY

The RAIS WAVE system may provide solar power at a levelized cost of electricity less than other systems comprising available photovoltaic modules without the reflector. Even allowing for higher initial capital cost due to the enhanced balance of systems, a lower levelized cost of electricity could correspond to improved project economics and a higher rate of return. This could benefit utilities and developers installing large rooftop systems.

If cost competitive, the technology could increase its market share, assuming future generation will be built on a cost competitive basis. tenKsolar reports that systems are being shipped, with a few MWs of capacity already installed.

## STATE OF THE TECHNOLOGY

The RAIS WAVE technology is currently in Technology Readiness Level 8. While a number of systems have been deployed, the technology is still relatively new to industry, and not yet widely deployed. Production and uptake is increasing. This technology has been developed in tandem with 3M, and TenKsolar holds several key patents including the basic electrical design, module design and system architecture.

### PUBLIC LITERATURE

tenKsolar data sheets for both mono- and poly-silicon wafer based modules and the RAIS WAVE technology are accessible on their website, listed below. In addition, tenKsolar has commissioned a third party bankability study, the summary of which is available for download on their website.

*http://www.tenksolar.com/*

### NEXT MILESTONE

The next milestone for the RAIS WAVE system would be widespread deployment and use. While that may occur without any additional effort, participation in a study such as SolarTAC[1] could help gain utility and investor confidence and expedite deployment.

## INDEPENDENT ASSESSMENTS

A bankability study was performed by SAIC, formerly RW Beck. These results can be accessed through the execution of a mutual NDA with

1. The Solar Technology Acceleration Center (SolarTAC) is a demonstration facility located near Denver, CO that EPRI and other organizations utilise to evaluate the performance of new solar technologies.

tenKsolar. Additional on- site testing is underway. Specific protocols are unknown.

## COLLABORATION

### CURRENT COLLABORATORS

The initial collaborator was 3M, through which the 3M Cool Mirror Film Technology was developed. Significant interest in the technology has been demonstrated, but information on additional collaborators is limited.

### EPRI ENGAGEMENT

EPRI is engaged in a conversation aimed at securing tenKsolar's participation in the upcoming SolarTAC project or a similar project that would facilitate product evaluation. If this goes forward, the demonstration would provide data needed in order to support utility confidence.

## REFERENCES


1. *Personal Conversation with Jim Losleben, VP of Business Development for tenKsolar, Solar Power International, 10/18/11*
2. *RAIS Wave PS203-6-EN. tenKsolar, Minneapolis, MN: 2011. Technical Data Sheet.*
3. *RAIS PV Module 190W-M. tenKsolar, Minneapolis, MN: 2011. Technical Data Sheet.*
4. *RAIS PV Module 180W-P. tenKsolar, Minneapolis, MN: 2011. Technical Data Sheet.*
5. *tenKsolar website: http://www.tenksolar.com/index.html; accessed 11/6/11.*



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**Electric Power Research Institute**
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com



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