



Inside:

EDITORIAL

Energy provisioning in the developing world

ENERGY SECTOR ANALYSIS

Understanding corrosion of flexible pipes at subsea oil and gas wells

REGIONAL INITIATIVE

Renewable energy in Kazakhstan rises in the shadow of fossil fuels

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MRS Bulletin

“The proper use of science is not to conquer nature but to live in it.”

Barry Commoner, American cellular biologist, professor, and politician

Energy provisioning in the developing world

Those using Nature’s elements and Earth’s resources for energy during the last few millennia have developed enduring traditions of respect for the elements and the Earth, and, in turn, they have become integral parts of many cultures and religious beliefs. Organizations engaged in enhancing energy availability in the developing world have become increasingly aware that it is extremely important to understand how regional cultures perceive various means of energy production and use. For example, efforts to install photovoltaic panels in some tribal communities were stalled because of the offense these structures represented to the “spirits.” The issues were resolved when the organization talked to the elders in the tribe, convinced them of the advantages, and the elders, in turn, included that discussion in their evening storytelling to convey the message to the tribespeople and secure their acceptance.

These organizations also need to have substantial knowledge of local energy resources, availability of materials, and human resources. Adequate knowledge of “proven” technologies for energy is necessary if the intervening (albeit altruistic) organizations are interested in deploying solutions, allowing them to take root and become sustainable with local support. Energy production technologies that we take for granted may need innovative modifications for successful adoption under local circumstances. For example, photovoltaic panels and components corrosion is dependent on the composition of the air-polluting species introduced by local industry and needs customized corrosion protection solutions. The accompanying article on oil and gas pipeline degradation in Kazakhstan covers similar issues.

Unequal growth in different parts of the world has resulted in many developing countries striving to emulate the developed world and also utilize energy at a significantly faster rate. Providing low-cost energy that is produced by environmentally aware and sustainable technologies customized for growth has been challenging. Such efforts require specialized hybrid technical solutions and in-depth knowledge of local economies. For example, Senegal already has small-scale solar photovoltaics to charge cell phones, solar lamps instead of kerosene, small solar ovens as cooking alternatives, and micro-hydro electricity generation in regions more abundant in water resources, all driven by materials development for energy conversion.

Efficient, distributed energy storage is a key challenge to drive projects to eventual success and sustainability. It is here that most of the innovations will have to focus, whether they be photovoltaics with low-cost high energy density batteries, or concentrating solar thermal with thermal energy storage and high-efficiency Stirling engines that produce a few hundred kilowatts throughout the day as well as into the night. Similarly, heat-pump-driven cooling systems could also be implemented where needed.

In efforts to bring energy sources to developing regions, practitioners with a deep knowledge of materials science are key. Their insights, developed through materials training, research, problem solving, manufacturing, and outreach, if leveraged intelligently, will ameliorate issues associated with initial adoption. Introduction of early, labor-intensive, environmentally conscious and local resource-rich technologies with a path to higher volume and low-cost production to launch sustainable and profitable business ventures will lead to responsible practices and growing communities. This exemplifies a balanced approach to energy efficiency and responsible consumption.

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