Shaping the Future

Generation Clean

Now Is the Time to Develop and Test Technologies for Producing Cleaner Energy

By Chris Warren

Can a crowded, energy-hungry world be clean?

Yes, but it will require sustained investment and innovation across the gamut of electric generation and other advanced energy production technologies.

With the world's population growing and urbanizing rapidly, EPRI's Integrated Energy Network outlines a pathway to meet growing demand for energy services without sacrificing the clean water and air that are essential to human health and a high quality of life. A critical part of this pathway is producing cleaner, affordable energy through more efficient, environmentally sustainable, and flexible generation.

While nuclear, fossil fuel, and renewable electricity generation have great potential to help achieve this goal, each faces significant challenges. Wind and solar capacity have soared over the past decade but still represent just 3% of global electricity supply, and their hour-to-hour, day-to-day, and seasonal variability place fundamentally new requirements on the electric system.

While deploying rapidly in some regions of the world, reliable, zero-emissions nuclear power faces an uncertain future in many countries with an aging fleet, difficult financing for new construction in the United States and Europe, and economic challenges in competitive markets with low natural gas prices and significant supply of renewables.

In recent years, abundant natural gas has been essential in creating a cleaner energy system in the United States and other regions. To achieve even tighter environmental standards, carbon capture, utilization, and storage are critical to cutting emissions from fossil generation. However, technology demonstrations have been very limited, and investment has lagged because of a lack of viable business models and policy frameworks that could help drive their introduction.

Non-electric technologies will likely play a key role in providing some energy services in a cleaner energy future. Key challenges for clean hydrogen are cost, safety, and delivery while key questions for biomass and biofuels are cost and sustainable fuel supply.

In addition to producing cleaner energy, all energy sources will have the opportunity to improve economics and enhance system flexibility by providing new products. For example, fossil and nuclear plants can produce steam and heat for certain applications, while wind and solar plants can provide grid balancing services.

To help address these challenges, EPRI identified key R&D needs for producing cleaner energy:

- Develop next-generation renewable technologies that can respond to grid and market conditions more rapidly and reliably.
- Anticipate and address environmental issues associated with renewable technologies.
- Advance forecasting tools, communications and controls, diverse energy storage options, demand response, and market mechanisms to sustain the system's efficient, reliable operation as variable renewable resources are added.

- Demonstrate low-emission fossil power cycles, carbon capture and storage, and develop the policies, business models, and regulations required to support them.
- Develop new nuclear designs, along with the policies, market reforms, and business models needed to support both new and existing plants.
- Address challenges related to bioenergy (such as production, controls, and fuel supplies) to advance its deployment with carbon capture, utilization, and storage.
- Advance the role of hydrogen as a clean carrier of energy, including clean hydrogen production, safety, and business models for developing a hydrogen infrastructure.
- Advance flexible operation of all generation technologies, including fast ramping, advanced inverters, and long-term storage.

The Three Pillars of the Integrated Energy Network

The Integrated Energy Network provides EPRI's perspective on the future of energy. Research needs are identified for each of three supporting pillars:

- **Using affordable, cleaner energy through efficiency and electrification:** focuses on the opportunities and challenges—both technical and institutional—involved with scaling the use of cleaner energy sources.
- **Producing cleaner energy:** details the potential of cleaner electric generation technologies—renewable energy, nuclear power, and fossil-fueled generation with carbon capture—along with promising non-electric technologies.
- **Integrating energy resources:** examines how new technologies and markets must be tapped to better integrate the electricity, gas, water, and transportation systems.

EPRI invites you to share your ideas and approaches for addressing each of the three pillars.