

In today's energy sector, digitalization is fundamentally reshaping energy management systems for renewable energy. This has resulted in the fast-track evolution for designing new sustainable and efficient transformer technologies. And for IR? New opportunities to be a powerful voice for shaping a more resilient, efficient and eco-friendly future. Page 5 -



Art and Renewable Energy: Inspiring Sustainability.

The coming together of renewable energy and art is imagining a future where sustainability and creativity seamlessly blend. Both fields are being transformed by technological advances, environmental consciousness and a growing emphasis on sustainable innovation. Learn how art is helping to raise awareness planet-wide.

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GREETINGS!

As we step into the warmer months, I hope everyone is taking the time to prepare for the changing seasons, both personally and professionally. Spring and summer bring renewed energy and growth, a fitting parallel to the constant evolution we see in our industry. Just as nature transitions, so does the Investment Recovery field, presenting us with new opportunities to maximize value, embrace sustainability and adapt to emerging technologies.

This month's feature on new trends in electric transformers is particularly relevant to our work. As IR professionals, we are not only tasked with managing the end-of-life cycle of assets but also with staying ahead of industry advancements that shape their value and disposition. With transformer technology evolving toward smarter, more sustainable designs, our role becomes even more critical in ensuring these assets are recovered, repurposed and reintegrated in ways that align with both economic and environmental goals.

Building on this theme of innovation, another fascinating intersection of technology and sustainability is the rise of renewable energy art. While we often view renewable energy as a means to power industry and infrastructure, artists are now using it as a medium for creativity and awareness. From solar-powered sculptures to wind-driven kinetic art, these installations do more than beautify public spaces—they serve as a testament to how sustainable practices can seamlessly integrate into everyday life.

This shift presents both an opportunity and a challenge for Investment Recovery professionals. As cities and businesses adopt creative ways to repurpose old infrastructure—like transforming transformer boxes into vibrant works of art—there's a growing need for IR experts to facilitate these transitions. The same principles we apply to maximize asset value and sustainability can be extended to these projects, ensuring that decommissioned equipment finds new life in ways that benefit communities and the environment alike.

As we continue to navigate the evolving landscape of Investment Recovery, it's clear that innovation, sustainability and creativity are shaping the future of our industry. Whether we're managing the latest advancements in transformer technology or supporting the transformation of outdated infrastructure into inspiring works of art, our role remains vital in maximizing value and promoting responsible resource use. These trends reinforce the importance of staying informed, connected, and proactive in our work. I encourage you to join us at our annual conference from **September 21-24 in Westminster, Colorado**. It's an opportunity to engage with industry leaders, share best practices, and discover new strategies to help us all continue to drive progress in Investment Recovery.

I look forward to seeing you there!

-George Rheubottom Investment Recovery Association President and Manager of Investment Recovery Santee Cooper

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MORE POWER TO YA! New Trends in Electric Transformers

When it comes to electric transformers, IR professionals know 'a thing or two' about their life cycles— especially their end-of-life disposition. But as investment recovery becomes more integrated with sustainability and renewable energy, the more they need to be informed about how the latest design and technology trends are shaping the future trajectory of transformers.

Fast-changing evolution

As we all know too well, the energy

sector is rapidly changing in terms of sustainability and efficiency. So, as we transition into a brave new world of renewable energy, transformers play a critical role in managing the electricity generated from sources such as solar, wind and hydro power. Transformers ensure the efficient transfer of this energy from production sites to consumption areas, minimizing energy losses

Digitalization is not only transforming how businesses operate but also fundamentally reshaping energy management systems for renewable energy. and maximizing output. Their ability to handle varying loads and voltages makes them indispensable in modern energy grids, especially as the demand for renewable, sustainable energy solutions grows.

And of course, the real driver for this evolution is the dramatic increase in energy demand. This in turn, is forcing major technological changes as the electrical power industry develops to satisfy the rising needs for efficiency, dependability, and sustainability.

Evolution is 'green' lit

The design and technology of electric transformers are evolving with advancements in materials, productivity, digital integration and environmental impact. 'Green' designs prioritize the use of recyclable and sustainably derived materials in both main and winding construction. In line with regulations such as the Restriction of Hazardous Substances (RoHS) Directive, efforts also aim to reduce the use of dangerous chemicals in manufacturing processes.

Key trends include:

1. Environmentally Focused and Sustainable Transformers

Vegetable-Based and Biodegradable Insulating Oils: Adoption of biodegradable insulating oils is among the most important and safer options in newer transformer designs. Traditional mineral oil for insulation and cooling presented risks due to potential leakage and pollution.

Recyclable and Low-Carbon Materials: Sulfur hexafluoride (SF6) has been used in high-voltage transformers and switchgear for its excellent insulating qualities but is a formidable greenhouse gas emitter. Substitutes for SF6, such as dry air, nitrogen or CO2 blends can help reduce the carbon footprint of the electricity sector.

Noise Reduction: Environmental sustainability also includes a lessening of noise levels. Designed to run more silently than conventional types, environmentally friendly transformers reduce their effect on nearby wildlife and communities. Strategies include carefully positioning cooling systems, noise-dampening materials and optimizing core and coil layouts.

2. High-Efficiency Transformer Designs:

Amorphous Core Transformers: Amorphous metal alloys don't have a crystal structure like other metals, which helps transformers retain energy. This reduces energy loss and makes transformers more eco-friendly.

Superconducting Transformers: These high-temperature transformers have been called 'game-changing' with major advantages over conventional ones. Superconductors offer greater power density, lower weight and smaller size.

3. Smart and Digital Transformers

Smart Transformers: The new generation of smart transformers have sophisticated electronics and

communication technologies that can independently monitor and control power distribution in real-time.

Digital Transformers: Powered by advanced algorithms and Al integration, they can provide data analysis, predictive maintenance and automated adjustments that go beyond smart transformer capabilities.

IoT-Enabled Monitoring: Sensors and IoT technology provide real-time data on temperature, load and performance for predictive maintenance.

Al and Machine Learning Integration: Al-driven analytics help optimize transformer operation and prevent failures.

Self-Healing and Adaptive Transformers:

Embedded AI and automation can detect issues and adjust operational parameters dynamically.



4. Compact and Lightweight Designs

Solid-State Transformers (SSTs): SSTs are used in modern electrical systems to improve power quality, manage dynamic loads and integrate renewable energy sources.

Modular Transformers: Designed for flexibility and scalability, modular transformers are easier to transport, install and replace.

5. Enhanced Safety and Resilience

Fire-Resistant and Explosion-Proof Designs: Improved insulation materials and cooling systems not only prevent accidents but also improve reliability and sustainability.

Fire barriers are another trend to contain fires within a limited area.

EMP-Resilient Design: Research has focused on modeling high-voltage transformers to understand their responses to fast-rise time voltages characteristic of EMPs – aiding in designing transformers that can withstand such disturbances.

Cyber Threat Resilient Design:

As transformers become more

interconnected through smart grid technologies, they are increasingly susceptible to cyber threats. Recent trends to enhance cybersecurity include the integration of cybersecurity with risk management, the adoption of cybersecurity-as-a-service (SaaS) and the implementation of advanced monitoring systems.

Zero Trust Architecture: With AI being integrated into transformer design, cyber vulnerabilities can be exposed. A "zero trust architecture" when applied to AI protection, means that no AI system or component is inherently trusted. This would require strict verification and access controls for every interaction to monitor for a potential breach or suspicious activity.

6. Integration with Renewable Energy

Transformers for Smart Grids: Designed to handle variable power inputs from solar and wind energy sources.

Bidirectional Power Flow Capability: Enables energy storage and distribution flexibility, essential for decentralized energy grids.

But what about the initial investment?

Change comes at a price. But to date, businesses are reporting positive outcomes by implementing the latest transformer technology. Their upfront costs have quickly provided fast ROI with the aforementioned list. They also cited longer lifespan, stronger alignment with evolving grid demands and regulatory/market incentives as additional benefits to growth and innovation.



More power to investment recovery

The new trends in electric transformer design and technology can significantly benefit the end-of-life stage (EOL) of transformers by enabling better recycling, reducing environmental impact and potentially extending the lifespan of older units through refurbishment and upgrades. All of this is leading to more efficient and cost-effective management of retired transformers. Instead of end-of-life disposition, IR can be a powerful voice in future-proofing assets in several ways:

Recyclable materials: Using more readily recyclable materials like specialized polymers and environmentally friendly insulation can simplify the recycling process and increase the value of recovered components.

Advanced alloys: Development of new alloys with higher magnetic permeability can improve transformer efficiency and reduce material usage, potentially leading to less waste at EOL.

Predictive maintenance: Real-time monitoring systems with sensors can identify potential issues early, allowing for timely repairs and extending the lifespan of transformers before reaching EOL.

Condition assessment: Data from monitoring systems can be used to assess the health of aging transformers, enabling better decision-making regarding refurbishment or replacement.

Modular design: Breaking down transformers into easily separable components can facilitate efficient dismantling and recycling at EOL.

Retrofitting capabilities: Designing transformers with the ability to upgrade components like cooling systems or insulation can extend their lifespan through refurbishment.

Optimized recycling processes: Developing new technologies to efficiently separate and recover valuable materials like copper and steel from old transformers.

Closed-loop recycling: Reusing recycled materials to manufacture new transformers, minimizing the need for virgin materials.

Solid-state transformers: These newer designs may offer improved efficiency and longer lifespan compared to traditional oil-filled transformers, potentially impacting EOL management.

Smart grids integration: Integrating transformers with smart grid technology can enable better load management and optimize their performance, potentially extending their operational life.

Power opportunities

In today's energy sector, digitalization is not only transforming how businesses operate but also fundamentally reshaping energy management systems for renewable energy. This has resulted in the fast-track evolution for designing new sustainable and efficient transformer technologies. And for IR? New opportunities to be a powerful voice for shaping a more resilient, efficient and eco-friendly future.

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Closeup of 3-phase distribution transformer bushings with porcelain insulator.

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Art & Renewable Energy: Inspiring Sustainability

Renewable energy is considered essential

for saving the planet. It has inspired individuals, communities and governments alike to take action to lessen our dependence on fossil fuels. But as an inspiration to create art? Really? Most of us value renewable energy for its sustainable functionality, not its aesthetic potential. But that is changing.

And here's the thing: You can develop all kinds of forwardthinking renewable energy solutions and innovations. But here's the other thing: How do you get people excited enough to actually support and adopt them? To meet that challenge, researchers and designers have been creating art installations to engage the public and grow interest in renewable energy – as in solar-powered art installations...and more.

Solar-powered art

Anything an artist can do with paint and other materials, they can now do in solar!

With the start of solar panel customization, eye-popping art is showing up in public places. These sun-powered artworks are more than enhancements to an urban landscape. This fusion of art and renewable energy forces us to consider how creativity is shaping sustainability solutions while providing creative inspiration to artists. Artists are now bridging the gap between science and art by adding solar panels, LED lights and other sustainable technology into their works. Solar-powered art in turn, will hopefully spark discussions and create awareness about everyone's role in protecting the planet.

A win-win situation.

In addition, these projects reduce dependency on traditional energy sources, because they produce their own energy thus lowering the carbon footprint associated with non-solar public art installations. They also show businesses the value of renewable energy while serving as a model for artists to embrace sustainable practices.

Nothing new under the Sun

The evolution of solar energy and its integration with art goes way back in time. Throughout history, artists have incorporated solar energy into their works, while exploring its potential as a sustainable energy source. These early experiments paved the way for future artistic practices that utilize solar energy.

Early Greek and Roman civilizations recognized the potential of solar energy in art and architecture, utilizing sunlight to enhance aesthetic appeal and functionality.

But it wasn't until photovoltaics or solar panels became more accessible that solar art took shape during the 1960s-1980s.

In 1976, Nancy Holt created *Sun Tunnels* in Utah. Composed of four concrete cylinders, 18 feet in length and 9 feet in diameter, Sun Tunnels is arranged and aligned to frame the Sun on the horizon during the summer and winter solstices. The 90s saw more artists integrating solar panels into public spaces. Large-scale solar art started appearing in the early 2000s. More solar-powered works included the following:



Greetings to the Sun in Zadar, Croatia. Photo credit: Keith McNabb

In 2008, the permanent artwork, *Greetings to the Sun*, by Nikola Bašić was installed in Croatia. It consists of three hundred colored glass plates of encased solar cells that absorb sunlight during the day. At night, the glass plates produce a dazzling, animated light show similar to a 70's disco floor. Energy absorbed by the panels also provides power to the local area for a third of the cost.



Solar "trees" provide extra light to parks and walkways. Photo credit iStock

In 2010, solar-powered streetlights designed to look like trees started sprouting up all over. Many of these "trees" provide more than light to passersby, including USB outlets, drinking fountains and Wi-Fi connectivity.

In 2012, the artist Olafur Eliasson and solar engineer Frederik Ottesen created a small, solar-powered LED light called, *Little Sun*. Only 8 inches in diameter and shaped like a sunflower, *Little Sun* is providing solar-powered light to off-grid, often poverty-stricken communities. When the sun sets and no light is available, work, medical care and studying for school children become compromised with toxic-fumed kerosene as the only option. *Little Sun* can now provide safe, reliable light at a fraction of the cost.



Solar-powered Little Sun, Photo Credit: Alamy

In 2014, Artist Daan Roosegaarde paid tribute to Vincent Van Gogh's painting *Starry Night* by creating an illuminated bike path in Van Gogh's hometown. The Van Gogh Path is made of thousands of sparkling stones that charge during the day and twinkle at night. The path celebrates the famed artist's legacy while connecting with modern technology and providing a safe lane for nighttime bike-riders.



Shifting Topographies by artist Dan Corson, commissioned by the City of Oakland Public Art Program

Also, in 2014, Seattle-based artist and sculptor Dan Corson, was commissioned to create a unique installation for the city of Oakland...more specifically for the walls of the *BART* tunnel station. The art was inspired by the surrounding landscape, capturing both the rolling hills and the bay area. The piece reacts to the sun giving viewers an iridescent and changing pattern throughout the day and night. In 2017, the *Solar Egg* made big news in Sweden. Created by the artists Bigert and Bergström, this egg-shaped sauna is powered by solar panels that convert sunlight into electricity. The Solar Egg is a fully functional sauna which also serves as a piece of art.

And the latest?

EDP Art Reef: 2023 welcomed Portugal's first underwater art exhibit comprised of 13 sculptures. The artist Vhils used materials from EDP's (Energias de Portugal) decommissioned power station materials. In time, Mother Nature will transform these sculptures into a new artificial reef, creating a habitat for marine life.

Prismatic Cloud: Los Angeles, USA: The *Prismatic Cloud* by artist Sarah Hall is an awe-inspiring piece in Los Angeles. Constructed of over 1,000 solar-powered prisms on a framework, it was designed to be an interactive experience where changing colors and patterns react to human movements in an awesome display as the refracted sunlight hits the prisms.

Dataland: Coming in 2025, famed AI artist, Refik Anado, will be creating quite a stir in the art world with his AI-driven art museum in Los Angeles named Dataland. The museum will feature digital sculptures obtained from extensive datasets, including 3D scans of the Amazon rainforest. Most importantly, this project will focus on raising environmental consciousness through data-driven art.

Solarpunk: This is an up-and-coming literary and artistic movement which focuses on a more positive future influenced by sustainability and renewable energy. Solarpunk leverages the art of storytelling through multimedia channels such as literature, movies, architecture urban development and art/fashion.

Renewable Energy Art and Design at Penn State: Researchers at Penn State University have developed projects that meld art with renewable energy education. Funded by the Institutes of Energy and the Environment (IEE) Seed Grant, researchers and designers created several pieces that were exhibited at the Woskob Family Gallery in State College, PA. The exhibition also featured interactive educational experiences that focused on sustainability and climate change.

And the future?

We can expect to see:

More Solar-Powered Art Installations: Public sculptures and digital art displays powered by solar energy will become common in cities.

More Kinetic and Wind Energy Art: Art pieces that generate their own electricity using wind or movement will be used in urban landscapes.

Sustainable Digital Art Studios: Artists will use eco-friendly energy solutions to power studios, exhibitions and creative spaces.

Eco-Conscious Festivals & Exhibitions: Large-scale art and music festivals will prioritize renewable energy sources, setting new standards for sustainability in entertainment.

The coming together of renewable energy and art is imagining a future where sustainability and creativity seamlessly blend. Both fields are being transformed by technological advances, environmental consciousness and a growing emphasis on sustainable innovation.

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