LTIMindtree

Report

Energy Transition & Sustainability Trends

2025

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Foreword

The energy sector has been in a state of flux as organizations attune themselves to low carbon expectations and a volatile market landscape. Transition is underway with energy companies intensifying their investments in renewables and exploring opportunities involving new technologies and processes.

As the world marches towards net zero, the energy transition is poised to go through a major overhaul to prevail over the hurdles and align its goals with the Paris Agreement. Ensuring rapid adoption of low-carbon energy technologies and minimizing emissions is critical in driving the energy transition. By 2035, it is expected that electric power, synthetic fuels, hydrogen, and other alternatives will make up about 32% of the global energy mix, increasing to 50% by 2050.

LTIMindtree's technology visionaries and industry experts are closely tracking the transformations within the energy transition and are convinced that digitization and technology innovation will act as a major linchpin for the recent advancements. AI is set to take centre stage and will be the major strategic enabler for cleaner energy deployments with sustained fuel-driven activities; nevertheless, the potential of AI will produce insights like never before. Leveraging the power of AI, energy companies can predict energy demand, optimize grid operations, and integrate renewable energy sources to minimize GHG emissions and advance low-emission energy solutions. The convergence of drones, robotics, and continuous workflow optimization is revolutionizing the green energy industry, providing unmatched abilities for monitoring, maintenance, and optimizing operations in both renewable energy infrastructure and fossil fuel facilities. Big Data and analytics, on the other hand, are well-positioned to help organizations reduce costs and minimize the environmental impact.

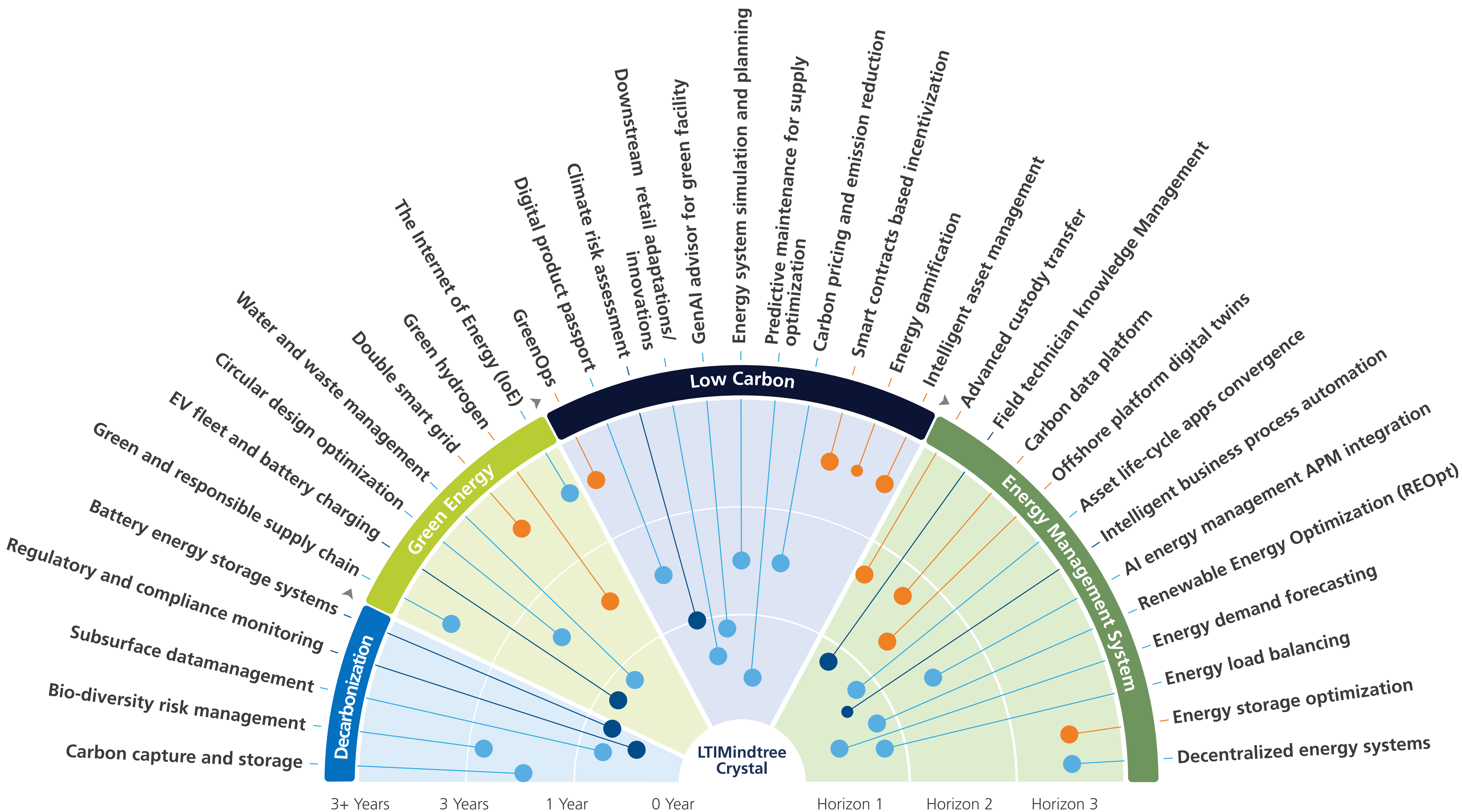
Translating new technologies into scalable solutions remains a critical part of the energy transition. Rapid implementation of renewable energy technologies will become essential for combating climate change and pave the way for a sustainable future. However, despite technology driving the green energy transition, obstacles such as cost barriers, complexities in grid integration, intermittent challenges, and the ongoing need for technological advancements persist. To tackle the ongoing bottlenecks, energy companies can capitalize on novel solutions and create robust strategies to catapult towards a resilient energy future.

LTIMindtree's Crystal - Energy Transition and Sustainability Trends Radar 2025 Report is a first-of-its-kind edition that provides a comprehensive view of evolving technological trends set to disrupt the Energy transition ecosystem from a software services perspective. This report is an output of collaboration between our Global Technology Office and the Energy Council at LTIMindtree. Our team of experts has thoroughly analysed the future technological trends that we believe will become widespread in the Energy Transition & Sustainability fields.

Access our report now and harness the potential of cutting-edge technologies and trends to drive your organization's growth!

Parsh Ramanathan
Global Delivery Head,
Energy & Utilities, LTIMindtree

Energy Transition & Sustainability Trends Radar



Horizon	
Horizon 1	Technology will be in the market within 0-1 year
Horizon 2	Technology will be in the marketplace within 1 - 3 years
Horizon 3	Technology will be in the marketplace after 3+ years

Adoption Phase	
Emerging	Trend is still under R&D
Improving	Trend creates hype and promotes innovation
Mature	Trend is accepted by the masses

Market Potential	
Low	Market potential indicates the expected revenue opportunity from the technology trend
Medium	
High	

Navigation Page

The trends listed below are arranged according to their corresponding horizon and grouped by their segments.

	Decarbonization	Green Energy	Low Carbon	Energy Management System
Horizon 1	• Subsurface data management • Battery energy storage systems • Regulatory compliance monitoring	• EV fleet battery charging • Water and waste management	• Gen AI advisor for green facility • Downstream retail adaptations • Climate risk assessment • Predictive maintainence for supply optimization	• Field Technician knowledge management • Asset life cycle apps convergence • Intelligent business process automation • Renewable energy optimization (REOpt) • Energy demand forecasting • Energy load balancing
Horizon 2	• Carbon capture and storage • Biodiversity risk management	• Circular Design Optimization • Green Hydrogen	• Digital product passport • Carbon pricing emission and reduction • Energy system simulation and planning	• Carbon Data Platform • AI energy management APM integration • Advanced Custody Transfer • Offshore platform digital twins
Horizon 3		• Double Smart Grid • The internet of energy (IoE) • Green and responsible supply chain	• Green Ops • Intelligent asset management • Smart contract based incentivization • Energy gamification	• Energy storage optimization • Decentralized energy systems

Energy Transition & Sustainability Value Chain Mapping

- Energy Storage and Transformation
- Policy and Regulation
- R&D
- Energy Efficiency & Demand-side Management
- Clean Industry
- Energy Services and Solution
- Energy Generation
- Transmission and Distribution
- Operations and Supply Chain
- Customer Experience
- Downstream
- Electrification of Transportation
- Energy Management-as-a-Service
- Financing & Investment

Segment 1

Decarbonization

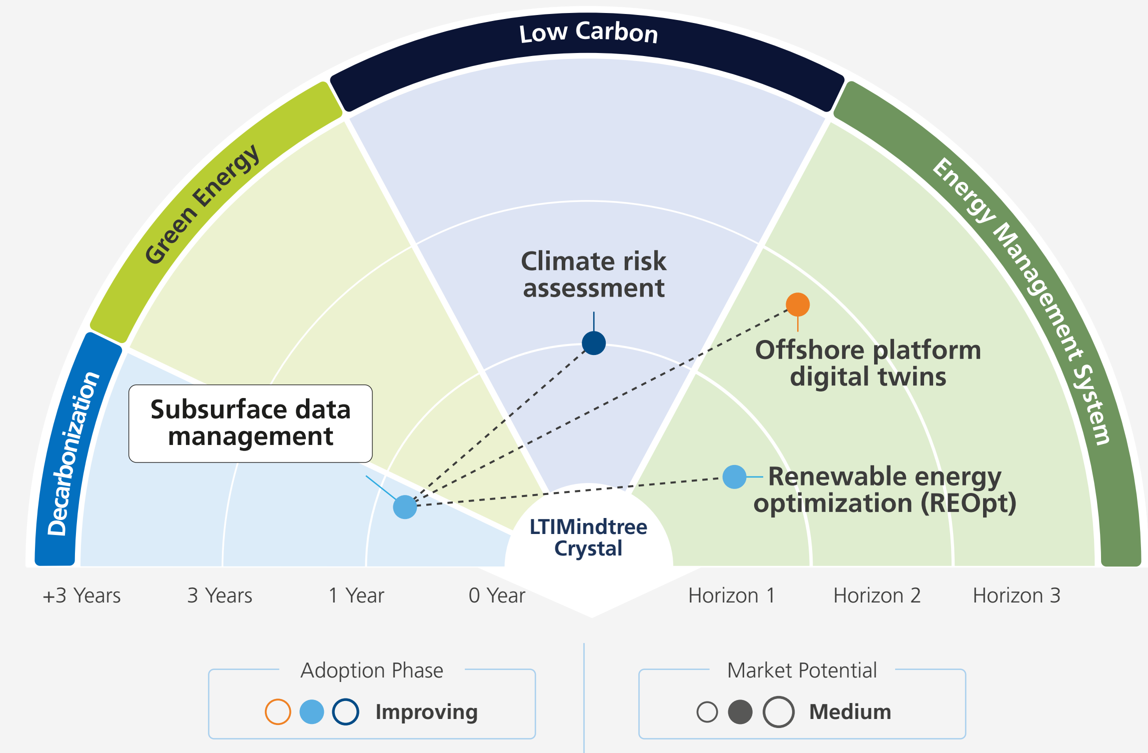
Subsurface Data Management

Subsurface data management is vital in the exploration and production phases of energy transition. It encompasses acquiring, organizing, storing, and analyzing geological and geophysical data. Essential for renewable energy development, it identifies locations for geothermal plants, assesses conditions for underground energy storage, and optimizes heat or stored energy extraction, ensuring efficient and effective resource utilization.

Highlights

Understanding the subsurface is essential for hydrocarbon, geothermal, and offshore wind projects, as well as carbon capture and storage initiatives. The energy industry has leveraged digital transformation to maximize subsurface data value. Knowledge management systems combine various data sources to improve decision-making and safety. Advances in tech and projects like the Open Subsurface Data Universe (OSDU) make it easier to integrate old systems. AI helps make operations more efficient and cost-effective, boosting sustainability. Tools like SAP Joule offer useful insights for better operation. Key trends, including AI, cloud technology, and digitalization, are essential for managing subsurface data and supporting the energy transition.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Enhancing drilling and reservoir performance using real-time surface datathe equipment.

Energy & Utilities:
Balancing grid load with insights and renewable energy management.

Key Technologies

Sensor technology
Detects pollutants and hazards, providing real-time data for emission standards compliance

Hybrid cloud
Scalable and centralized compliance tracking and reporting, ensure operational alignment

Edge AI:
Enables real-time data processing at the source, such as CCS facilities

Generative Artificial Intelligence
Gen AI can help engineers develop innovative solutions that maximize CO2 capture and storage efficiency

Featured Story

A UK-based O&G company uses the OSDU platform to standardize subsurface data management, integrating diverse data sources for improved exploration and production. This open-source framework enhances data accessibility and interoperability, enabling faster, data-driven decision-making and optimizing resource extraction. In addition, it leverages cloud-native services, including ML and Natural Language Processing (NLP) from leading cloud providers, to streamline subsurface data management and drive agile, innovative solutions.

Key Takeaway

The future of subsurface data management will leverage AI and cloud platforms like OSDU to improve data integration and accessibility, enabling scalable, efficient solutions for the energy transition and sustainability.

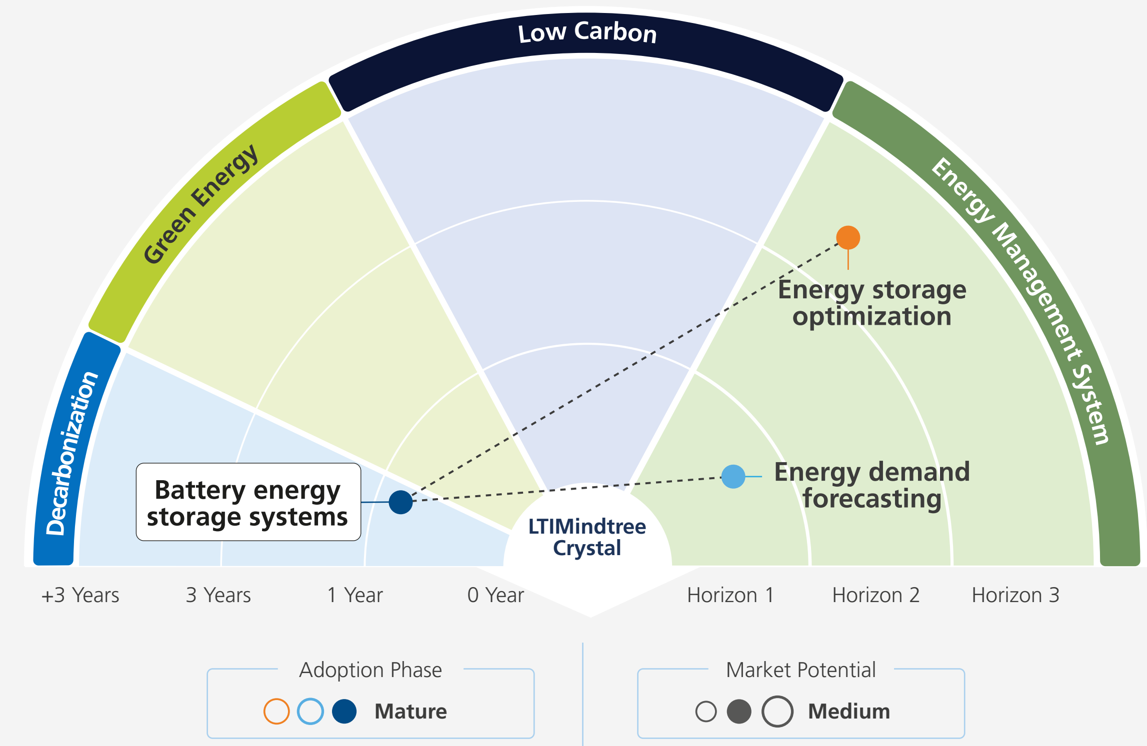
Battery Energy Storage Systems

Battery Energy Storage Systems (BESS) are a crucial component in the transition toward sustainable energy. They play a vital role in storing energy generated from renewable sources like solar and wind, enabling electricity supply to meet peak demand periods and providing rapid compensation during sudden dips or surges in electricity supply.

Highlights

The versatility of BESS in storing and dispatching energy makes them invaluable to modern energy management. Enhanced with advanced software, BESS integrates energy storage with intelligent management, leveraging AI, ML, and data-driven solutions to optimize consumption patterns. This boosts energy efficiency and supports renewable integration into the grid. McKinsey forecasts that the global BESS market is expected to reach USD 120-150 billion by 2030. Most US utility-scale BESSs use lithium-ion batteries, known for high-cycle efficiency and fast response times, ideal for grid support. Projects reported to the U.S. Energy Information Administration (EIA) plan to add 22,255 MW of capacity from 2023 to 2026, with 13,881 MW co-located with solar photovoltaic generators.

Radar View & Related Trends



Industry Use Case

Energy & Utilities:
Maintaining power supply by storing surplus solar and wind farm energy

Key Technologies

Sensor tech
Real-time monitoring and optimization of BESS

Applied AI
Intelligent systems for optimizing energy storage and distribution in BESS

Edge AI
Real-time local data processing and decision-making in BESS

Sustainable technology
Enhancing energy efficiency and reducing carbon footprint in BESS

Featured Story

One of the world's leading companies serving the energy sector highlights the Green Hydrogen Plant with 800 kW electrolyzer capacity, powered by a 990 kW rooftop solar plant and a 500 kWh BESS. The plant produces 15 TPA (tonnes per annum) of high-purity hydrogen blended with natural gas for captive use. This supports the company's carbon neutrality goals. The plant utilizes advanced safety systems and a command-and-control center with integrated data analytics for optimized operations.

Key Takeaway

Business should focus on enabling seamless integration of renewable sources with BESS, thus ensuring grid stability and optimizing energy consumption with AI-driven insights to be at the forefront of innovation.

Regulatory and Compliance Monitoring

Regulatory and legal aspects are crucial to energy transition and sustainability. Monitoring carbon emissions helps organizations track their environmental, social, and governance KPIs toward adopting clean and sustainable energy. Monitoring also helps to track progress, identify areas for improvement, and maintain transparency and accountability within the industry.

Highlights

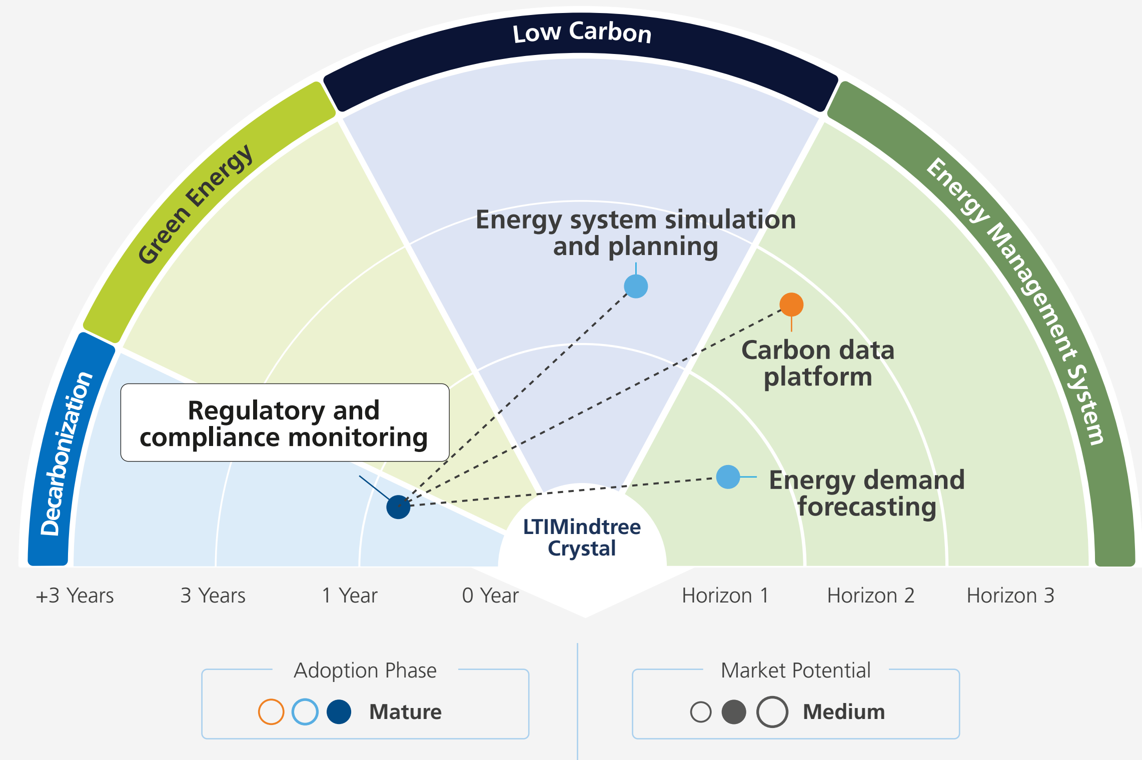
Regulatory and compliance monitoring is vital to energy transition initiatives involving renewable energy adoption and natural resource governance. Efficient regulation is a dynamic process that allows governments and organizations to reach their growth and social targets. Simultaneously, they can improve their performance, assess the results obtained, and eventually modify the structure. Regular inspection and monitoring of energy systems ensure regulatory compliance and that companies contribute to the established goals. Regulatory bodies like the Organization for Economic Co-operation and Development (OECD) advise governments about the roles, functions, and responsibilities required to encourage new innovations in the energy industries. Clarifying roles and mandates in regulation can support the effective execution of regulatory tasks and prevent overlaps or gaps in mandates.

Industry Use Case

Oil & Gas:
AI-driven monitoring ensures adherence to environmental regulations.

Energy & Utilities:
Inspection software helps identify compliance gaps by undertaking an automated regulation audit.

Radar View & Related Trends



Key Technologies

Edge AI
Processes subsurface data in real time at the source, cutting latency and speeding up decisions

Sensor Tech
Capture high-resolution seismic data, which is crucial for accurate subsurface mapping

Decision Intelligence
Estimate the quantity and quality of subsurface resources, aiding in efficient resource management

Generative Artificial Intelligence
Provide scalable storage solutions for vast amounts of subsurface data, ensuring easy access and integration

Featured Story

A UK-based multinational O&G company implemented an AI-driven compliance system to support energy transition and sustainability. By leveraging big data analytics, it ensured regulatory adherence, optimized resource use, and minimized carbon emissions. This led to successful renewable energy integration, operational efficiency improvement, and significant carbon footprint reductions, aligning with global sustainability targets.

Key Takeaway

By prioritizing decarbonization in their decision-making processes, regulators can drive significant progress towards net-zero emissions. This involves updating legal frameworks, enhancing collaboration between government and regulatory bodies, and adopting innovative approaches to regulatory processes.

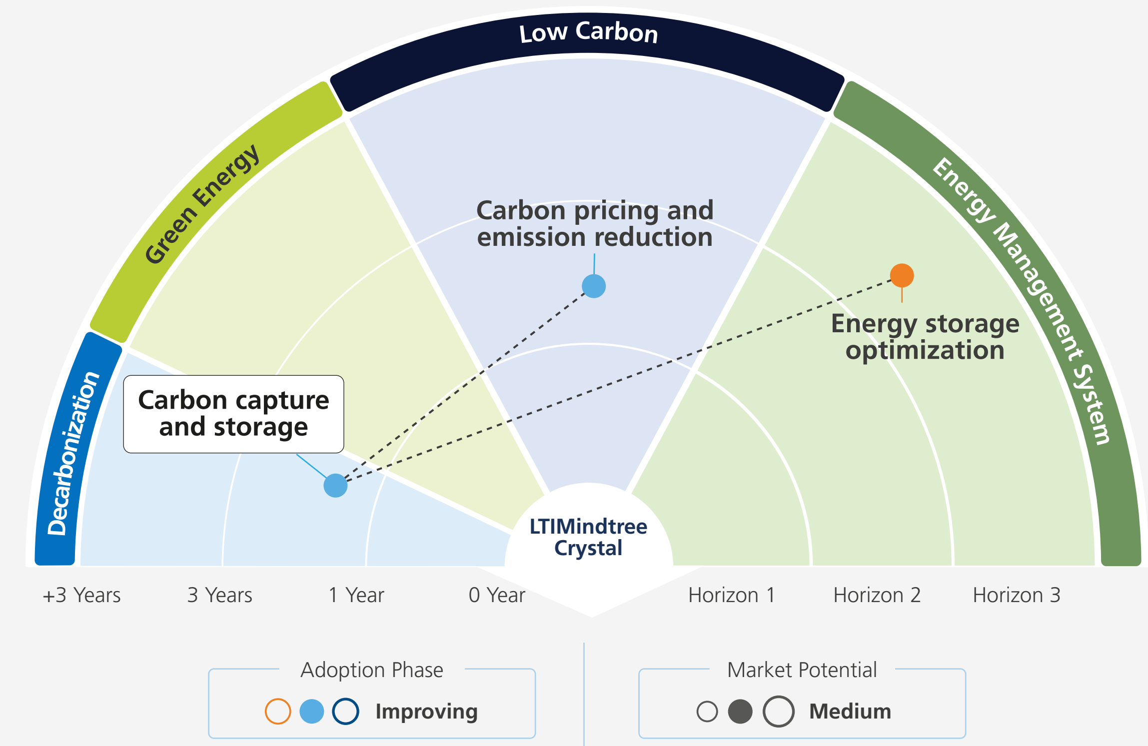
Carbon Capture and Storage

Carbon Capture and Storage (CCS) refers to a collection of techniques used to extract Carbon Dioxide (CO2) from the atmosphere. It helps reduce CO2 emissions from significant sources, including refineries, power plants, and other industrial sites. The process involves three distinct stages: collecting the CO2 released from the manufacturing plant, transporting the collected CO2, and securely storing it in an underground storage facility.

Highlights

CCS technology plays a crucial role in global climate action, with significant advancements aimed at reducing costs in power generation. Notably, the UK's Net Zero Teesside Power, which is expected to be operational in 2027, could become one of the first commercial-scale gas-fired plants to implement Carbon Capture Utilization & Storage (CCUS). According to International Energy Agency (IEA), carbon capture, utilization and storage accounts for nearly 15% of the cumulative reduction in emissions in the Sustainable Development Scenario. The momentum for CCS has increased, with over 700 projects in various stages of development across the CCUS value chain. The 2021 Infrastructure Investment and Jobs Act in the U.S. allocated USD 1.7 billion for carbon capture demonstration projects and USD 1.2 billion for Direct Air Capture (DAC) facilities.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Reducing the carbon footprint of operations, making fossil fuel use more sustainable.

Energy & Utilities:
Producing low-carbon hydrogen for power generation and transportation

Key Technologies

Blockchain
Tokenized carbon credits facilitate easy trading and verification of emissions reductions

Machine Learning (ML)
Analyze CCS data to optimize capture, predict maintenance, and enhance performance of the system

Edge computing
Enables real-time data processing at the source, such as CCS facilities

Generative Artificial Intelligence
Gen AI can help engineers develop innovative solutions that maximize CO2 capture and storage efficiency

Featured Story

The Northern Lights project in Norway—a collaboration between an energy company, an O&G firm, and an integrated energy and petroleum organization—aims to develop a full-scale CCS value chain in Europe. The project involves capturing CO2 from industrial sources and transporting it to a secure offshore storage facility. It commenced its carbon transport and storage activities in 2024.

Key Takeaway

Advancements in technology and potential policy incentives could enhance the feasibility and adoption of CCS in the coming years. CCS is poised to become an integral part of global strategies to achieve net-zero emissions, especially for industries that are difficult to decarbonize.

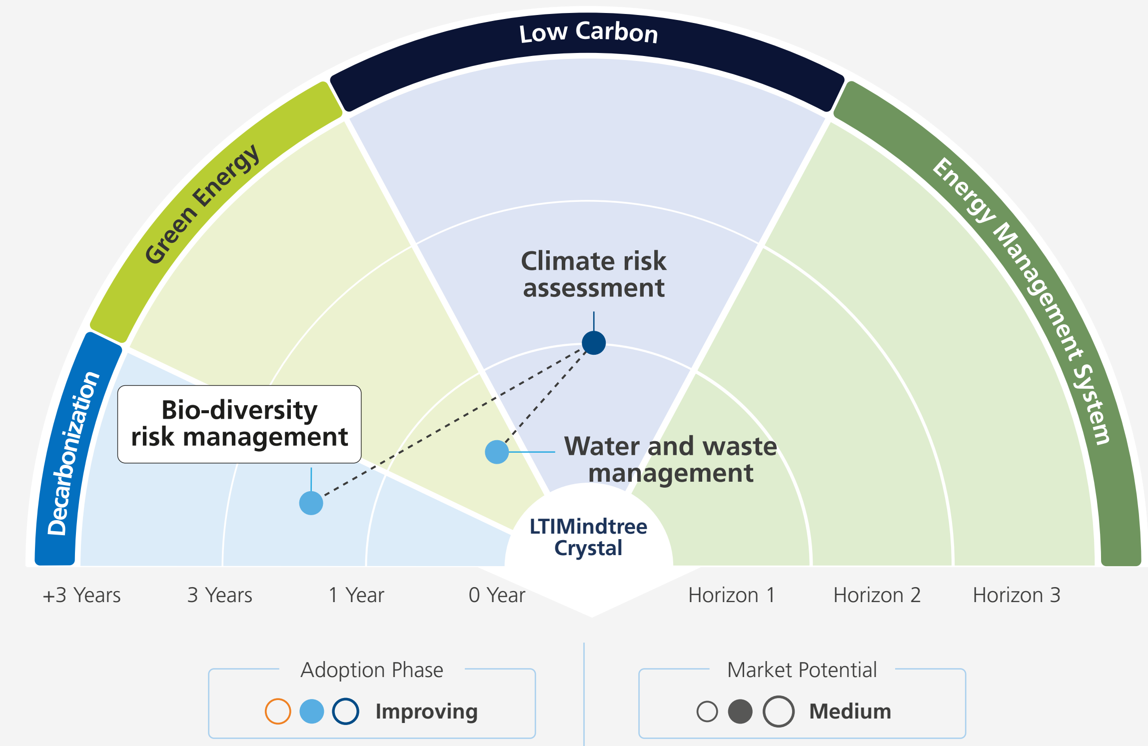
Bio-diversity Risk Management

In the context of energy transition and sustainability, biodiversity risk management entails strategies and practices to minimize negative impacts on ecosystems and promote the conservation of biological diversity while transitioning from fossil fuels to renewable energy sources. Bio-diversity risk management can handle the energy transition in a way that supports both the shift to renewable energy and the conservation of biodiversity, ensuring a more sustainable future.

Highlights

Investing in biodiversity risk management can improve reputation and access to finance compared to activities that cause pollution. Protecting nature and increasing biodiversity could generate business opportunities worth USD 10 trillion annually and create nearly 400 million new jobs. The biodiversity risk filter assists companies in making informed decisions that enhance business resilience and contribute to a sustainable future. A free online tool from the World Wide Fund (WWF) for nature, WWF Biodiversity Risk Filter (BRF), assists companies and financial institutions in understanding, assessing, and responding to their biodiversity-related risks. Technologies such as blockchain, environmental DNA (eDNA), regenerative agriculture, and other technologies will be used to incorporate cutting-edge techniques into animal monitoring and community-driven conservation efforts.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Conducting thorough EIAs before starting new projects helps identify potential impacts on local biodiversity.

Energy & Utilities:
Advanced monitoring tools enable utilities to track their impact on ecosystems and make decisions to reduce harm.

Key Technologies

Edge AI
Process data from sensors and cameras in real-time to monitor biodiversity in and around energy projects

Quantum computing
Optimize resource allocation and management strategies to balance energy production with biodiversity conservation

Digital twins
Track the lifecycle of energy infrastructure and its interactions with the environment

AI-powered hyperautomation
Streamline the process of environmental impact assessments by automating data collection, analysis, and reporting

Featured Story

A British multinational O&G corporation that operates through a subsidiary in Nigeria acknowledged the Niger Delta's biodiversity-rich environment and decided to establish a biodiversity management plan between 2022 and 2023 to assist in offsetting the environmental effect of its activities in the region. As a result, the company improved the health of mangrove ecosystems, strengthened biodiversity monitoring capacities, and built more informed decision-making procedures.

Key Takeaway

Biodiversity risk management will use technology, policy, and collaboration to conserve and promote biodiversity and support sustainable development. Implementing effective risk management strategies will preserve ecosystems, species, and natural resources for future generations.

Segment 2
Green Energy

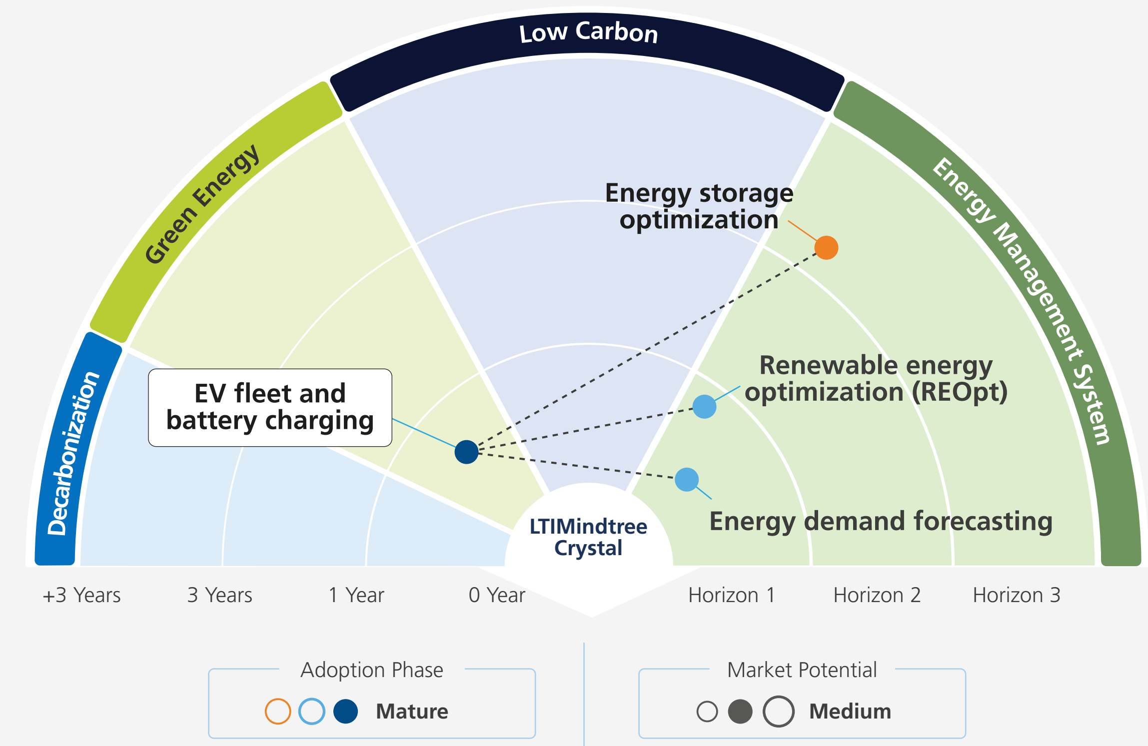
EV Fleet and Battery Charging

Electric Vehicle (EV) fleet and battery charging refers to the infrastructure and systems involved in operating and managing a fleet of EVs, including their battery charging requirement. This technology allows EVs to return stored energy to the grid, supporting grid stability and integrating renewable energy sources.

Highlights

As battery cost decreases, EVs become more affordable for fleet operators. The growth of charging stations and networks supports EV fleet deployment. Governments and businesses are increasingly setting emissions reduction targets and implementing incentives to drive the transition to zero-emission fleets. Integrating EV fleets with distributed energy resources can create virtual power plants that provide valuable grid services like frequency regulation and load balancing. The continued improvements in battery energy density and charging speeds make EVs more cost-effective for a broader range of fleet applications. Innovative charging solutions like battery swapping and modular charging can enhance the flexibility of fleet charging infrastructure. Transitioning to EVs can give fleet operators a competitive edge by demonstrating environmental

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Companies are creating extensive EV charging networks with fast-charging stations at fuel sites to offer convenient EV charging.

Energy & Utilities:
Integrating battery storage with EV charging stations and storing renewable energy can enhance grid stability

Key Technologies

ML
Enhance charging schedules, forecast maintenance requirements, and boost overall fleet efficiency

Blockchain
Guarantees secure, transparent energy trading and peer-to-peer exchanges, boosting supply chain traceability and trust

Decentralized AI
Process real-time data from various sources to enhance charging schedules, lower energy costs, and prevent grid overloads

Edge AI
Processes Internet of Things (IoT) data from EVs and chargers for real-time monitoring of battery health

Featured Story

The city of Los Angeles, California, partnered with automakers and fleet management companies to acquire and manage its growing EV fleet. Its EV charging infrastructure is integrated with the local utility's smart grid system, enabling the coordination of charging schedules and optimizing energy consumption. The city also implemented a program to incentivize the installation of private charging stations in residential and commercial properties.

Key Takeaway

The EV industry is focusing on electrifying fleets to become more sustainable. Strategically developing charging infrastructure is crucial for operational efficiency, cost-effectiveness, and the broader adoption of electric vehicles.

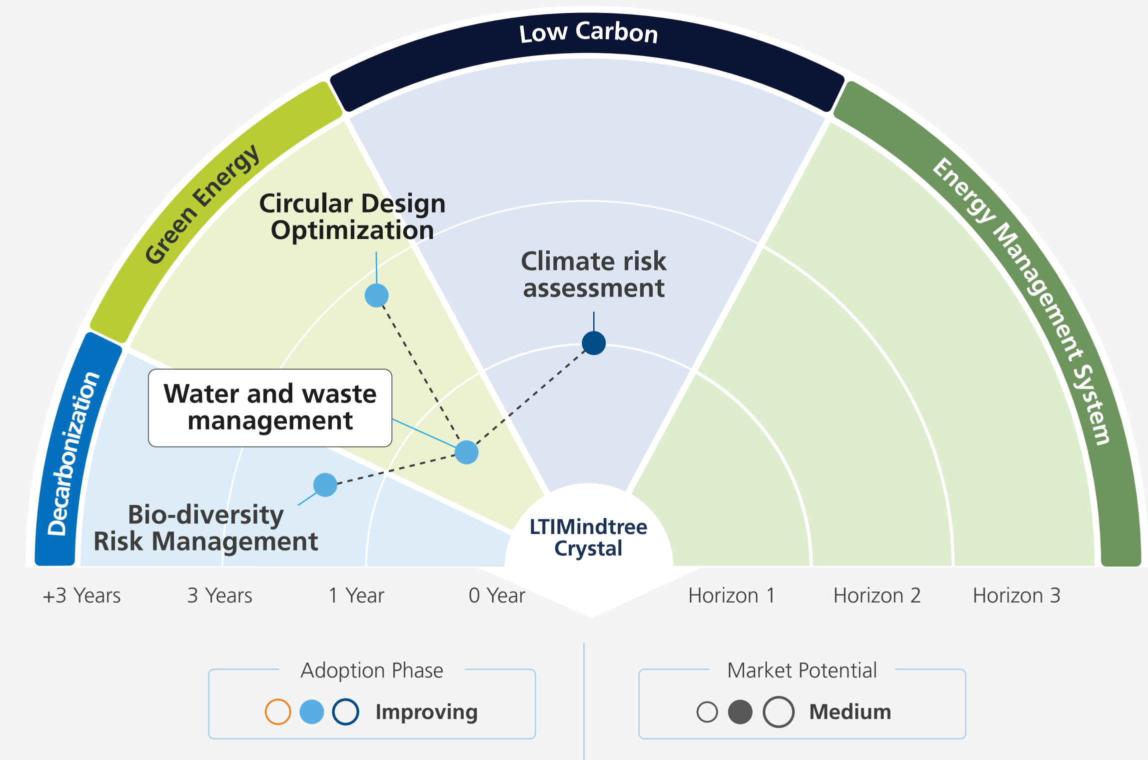
Water and Waste Management

Water and waste management is the strategic planning, development, distribution, and use of water resources to facilitate the transition to more sustainable energy systems. It also collects, transports, processes, recycles, and disposes waste materials created during energy generation. Its goals are to reduce the environmental effects of waste, increase resource recovery, and ensure the transition to sustainable energy systems is clean and efficient.

Highlights

Water and waste management are critical components of sustainable growth; thus, inventive solutions are even more important. Initiatives such as the US' Clean Water Act and India's Swachh Bharat Mission demonstrate a commitment to improving water and waste management practices using technical solutions. UpLink, a World Economic Forum program, sponsored the Zero Water Waste Challenge by selecting 10 'Aquapreneurs'. These entrepreneurs are tasked with developing innovative solutions to reduce water waste and improve water management practices. Companies can achieve a more sustainable future by supporting and promoting these initiatives. Technology businesses are developing various applications and ground-breaking solutions for sustainable water management. They include wastewater recycling, source reduction, waste management through product recovery, and waste minimization.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Remove oils and suspended particles from wastewater for further treatment .

Energy & Utilities:
Power plants use desalination to provide a reliable water supply for cooling.

Key Technologies

Connected enterprise
Monitor the health of critical infrastructure, such as pumps and valves, predicting failures before they occur

Edge computing
Edge devices can predict equipment failures and maintenance needs, reducing operational costs

Zero Trust
Ensures that all data transmitted between devices and systems in water and waste management is authenticated and encrypted

Agentic AI
AI-powered robots and systems can sort waste more accurately and efficiently, improving recycling rates

Featured Story

A US-based O&G company has implemented innovative water management strategies in the Permian Basin, a region known for its significant oil production and water scarcity issues. The company has invested in facilities that treat and recycle produced water. Additionally, it employs digital technologies, including IoT sensors and data analytics, to monitor water quality and manage water resources efficiently.

Key Takeaway

Future water and waste management will leverage smart technology, recycling, decentralized systems, sustainable infrastructure, and public-private partnerships driven by environmental concerns, regulatory pressures, and climate change adaptation.

Circular Design Optimization

Circular Design Optimization (CDO) is a holistic approach that aims to minimize waste and maximize resource utilization throughout the design, production, and consumption of products and services. It requires rethinking the traditional linear model to develop innovative solutions that fulfill present needs without compromising future generations. The key principle includes establishing supply chains where waste from one process becomes input for another.

Highlights

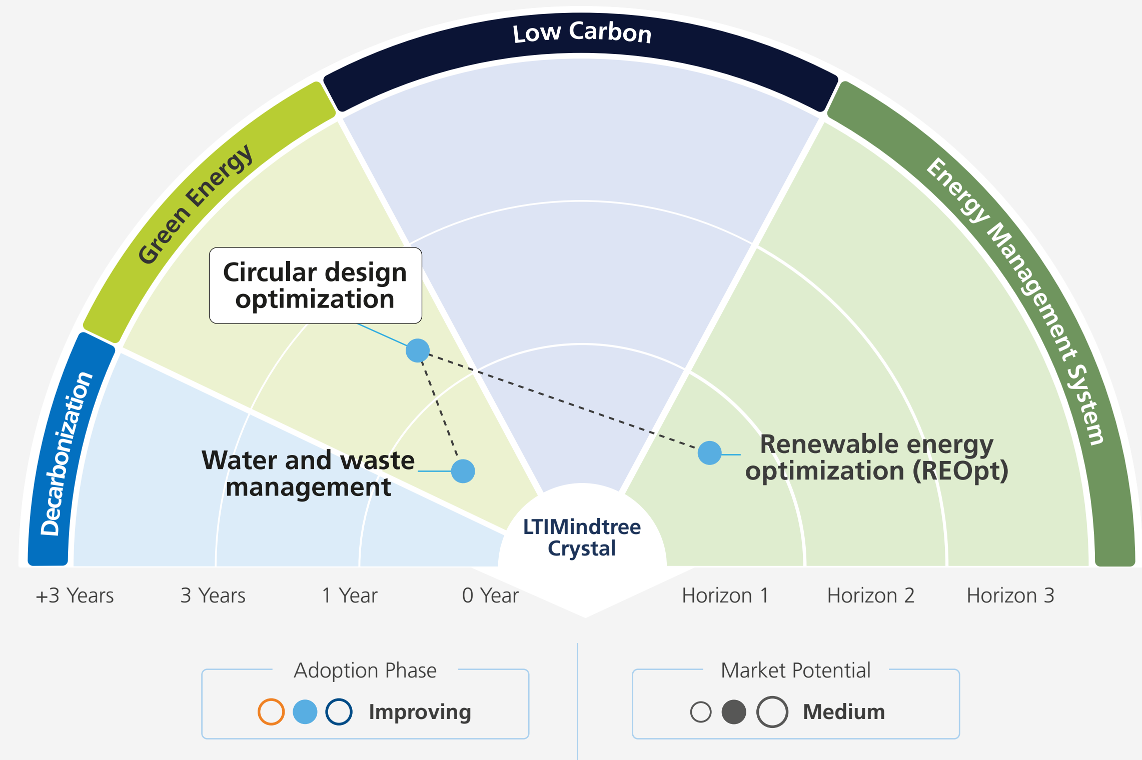
The circular economy could generate a net economic benefit of USD 4.5 trillion by 2030 through reduced costs and new revenue streams. The adoption of CDO is influenced by several key factors driving organizations to rethink their production and consumption models. Product design is the cornerstone of CDO, focusing on durability, reparability, and recyclability to minimize waste and extend product life cycles. Achieving scalability in CDO requires transforming the entire ecosystem, including supply chains, business models, and consumer behavior. The greatest source of value in CDO lies between a product's end-use and recycling, which includes opportunities for repair, maintenance, and refurbishment. It streamlines operations, improves efficiency, and reduces unnecessary resource use.

Industry Use Case

Oil & Gas:
Treated Produced Water (PW) can be reused for irrigation, industrial purposes, or underground reinjection.

Energy & Utilities:
Organic waste from sewage treatment plants can be transformed into biogas and used as a renewable energy source

Radar View & Related Trends



Key Technologies

Blockchain
Verifies sustainability of materials and processes by ensuring transparency and traceability in supply chains

Edge computing
Lowers latency and energy use while enhancing the efficiency of circular systems

Zero Trust
Continuous monitoring and verification of devices and users ensures real-time anomaly detection

Agentic AI
Autonomous overseeing and control of resources promotes efficient use and reduces waste

Featured Story

A global integrated energy company leverages an advanced circular economy by implementing closed-loop systems to reduce waste and promote resource reuse. In its refining operations, the company recovers valuable byproducts like sulfur and CO_2, which are later repurposed for industrial use. This initiative demonstrates how circular economy practices can generate economic value while enhancing environmental sustainability.

Key Takeaway

Adopting circular design optimization is crucial for industries to achieve sustainability goals and stay competitive. Increasing carbon emission regulations push companies to adopt circular practices, minimize waste, and promote recycling.

Green Hydrogen

Green Hydrogen (GH2) is produced via water electrolysis using renewable electricity, emitting fewer greenhouse gases than grey hydrogen sourced from fossil fuels and emitting greenhouse gases. GH2 production is considered environmentally friendly and sustainable because it produces zero carbon emissions when generated using renewable energy. It helps reduce emissions in difficult to decarbonize sectors like transport, chemicals, and steel.

Highlights

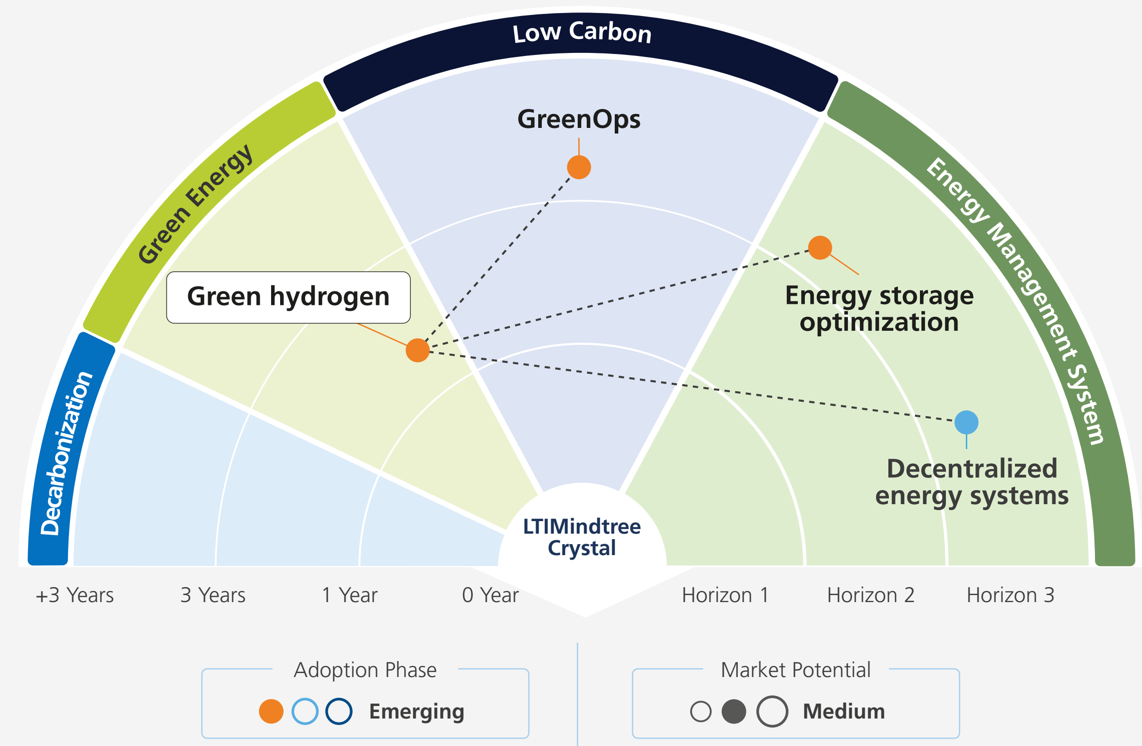
GH2 adoption is driven by key factors such as stringent emission regulations and the urgent need to decarbonize all sectors. For instance, the Indian government mandates that GH2 must not have emissions exceeding 2 kg of CO2 equivalent per kg of H2. According to the International Renewable Energy Agency (IRENA, 2023c), GH2 is expected to significantly contribute to the energy transition towards the 1.5°C climate goal by 2050. GH2 utilization offers substantial value by enhancing air quality, promoting energy security, and facilitating renewable energy integration. However, challenges include high production costs compared to grey hydrogen from fossil fuels. Despite the challenges, projections from IRENA's World Energy Transitions Outlook 2023 indicate significant GH2 production growth to 492 million tons by 2050.

Industry Use Case

Energy & Utilities:
Store excess renewable energy for later use by converting it back to electricity through fuel cells or turbines when demand increases, thus enabling grid flexibility and stability.

Oil & Gas:
Replace fossil fuels in processes like ammonia production, methanol synthesis, and steelmaking, reducing carbon emissions

Radar View & Related Trends



Key Technologies

Edge AI
Real-time processing of sensor data for optimizing hydrogen production processes

Quantum computing
Discovery of efficient catalysts and materials for electrolysis

Digital Twins
Simulate and optimize hydrogen production processes

AI-powered hyperautomation
Real-time decision-making in hydrogen production operations

Featured Story

One of the world's leading companies serving the energy sector has marked a milestone in clean energy by commissioning its first indigenously manufactured electrolyzer in Hazira, Gujarat. The 1 MW capacity electrolyzer, expandable to 2 MW, produces 200 Nm3/Hr hydrogen. Designed to international standards, it highlights the company's commitment to sustainable energy solutions and local manufacturing prowess, driving the Make in India initiative.

Key Takeaway

Low renewable energy prices and electrolysis advancements will boost green hydrogen adoption in energy and utilities companies. The UAE aims for a 25% global market share by 2030, while Japan invests $100 million to convert fossil-fired plants to ammonia and hydrogen-based plants.

Double Smart Grid

A double smart grid typically refers to an advanced power grid system incorporating two layers of smart grid technologies. It combines smart electricity systems like advanced metering, distributed energy resources, and demand response with commercial smart grids. This holistic approach maximizes renewable energy utilization, reduces emissions, and enhances grid reliability, representing a significant advancement in sustainable energy management.

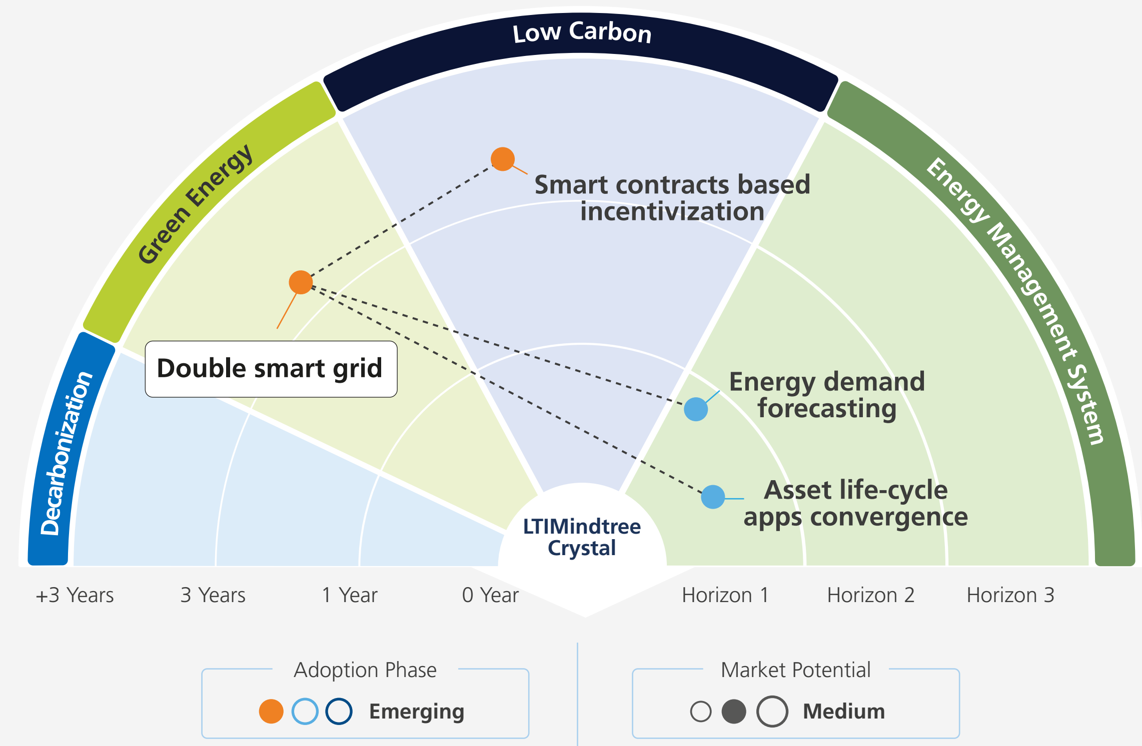
Highlights

Double smart grids represent a cutting-edge technology trend, leveraging doubly intelligent networks to enable a shared energy storage framework. This innovative solution optimizes cost savings among multiple users in demand response systems by minimizing peer-to-peer energy-sharing losses within a network of interconnected microgrids. Through real-time digital communication, energy production seamlessly adapts to consumption patterns. Households are connected to the main grid and a shared battery for renewable energy storage. The system orchestrates efficient energy distribution and manages consumer demands, dynamically allocating shared renewable energy to ensure fairness and efficiency. This approach maximizes renewable energy use, enhances energy efficiency, and supports sustainable living by integrating advanced digital and energy management technologies.

Industry Use Case

Energy & Utilities:
Resilient microgrids that can operate independently or in conjunction with the main grid to enhance reliabilit.

Radar View & Related Trends



Key Technologies

Digital twins
Real-time monitoring and optimization of grid components

AI-As-A-Service (AIaaS
Predictive maintenance and demand forecasting for grids

Edge AI
Local data processing and real-time decision-making in grids

Data fabric
Unified data management and integration across grid systems

Featured Story

In Nanterre, France, a smart building project has been implemented to optimize energy consumption through advanced environmental technologies. This initiative integrates smart thermal and electric systems, leveraging geothermal, aerothermal, biomass, and waste heat recovery for heating, hot water, and air conditioning. The project has achieved a significant milestone with 60% renewable energy usage.

Key Takeaway

The double smart grid has a transformative potential to enhance grid efficiency and resilience by integrating advanced digital technologies and renewable energy sources. This dual-layered approach optimizes energy distribution and consumption, ensuring a stable and sustainable energy supply.

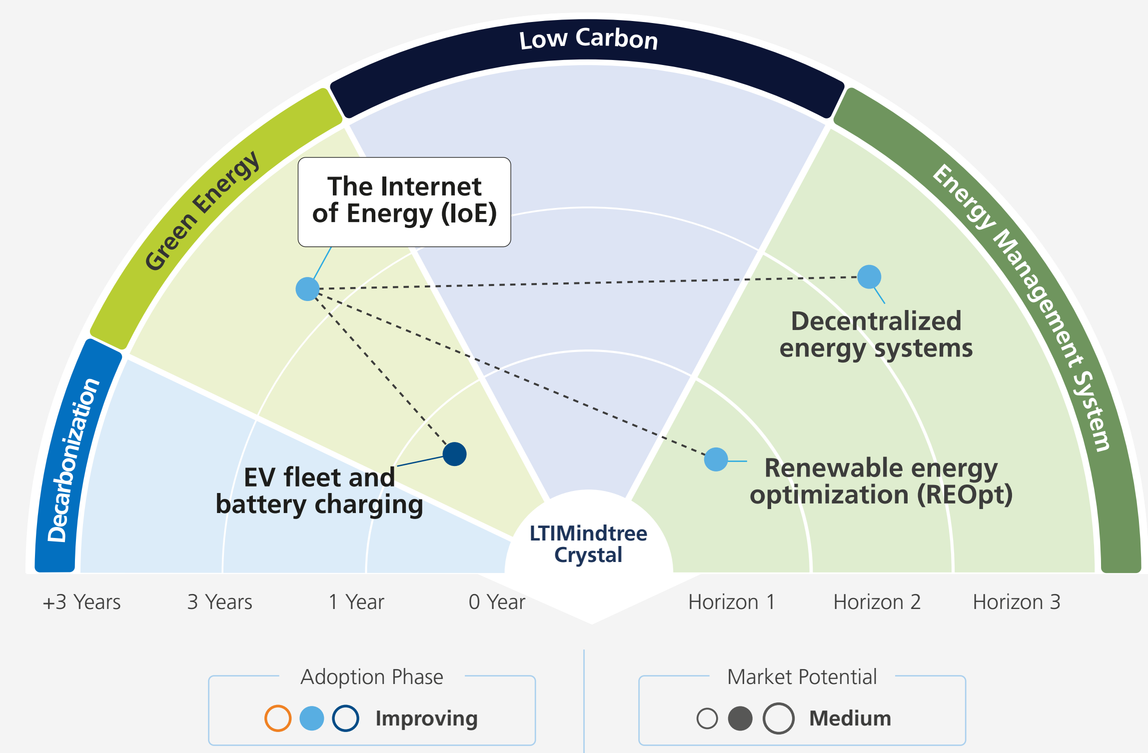
The Internet of Energy (IoE)

The Internet of Energy (IoE) refers to the automation of electricity infrastructures for energy producers, allowing energy to flow more efficiently. By integrating IoT technology into distributed energy systems, IoE optimizes energy infrastructure efficiency and reduces wastage. The objective is to enhance energy production and distribution and make consumers more energy efficient.

Highlights

The continuous enhancement of smart meters, sensors, communication protocols, and renewable energy generation is necessary for an intelligent energy grid. As these technologies become more advanced and cost-effective, it leads to the wider adoption of the IoE. This technology can improve grid stability and enhance outage management while facilitating the integration of distributed energy resources. The sensor networks, advanced analytics, and automated control systems within IoE can help detect and respond to grid disturbances, reducing the frequency and duration of power outages. It can also enable self-healing capabilities in the grid, allowing for faster restoration of services. The emergence of prosumers is also facilitated by IoE, allowing them to better monitor and optimize their energy generation and consumption.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Enhance the efficiency of O&G transportation logistics, ensuring prompt deliveries and minimizing fuel usage

Energy & Utilities:
IoT smart grids enable two-way communication between utilities and consumers, optimizing energy use and reducing outages

Key Technologies

Edge AI
Real-time processing of sensor data for optimizing hydrogen production processes

Quantum computing
Discovery of efficient catalysts and materials for electrolysis

Digital Twins
Simulate and optimize hydrogen production processes

AI-powered hyperautomation
Real-time decision-making in hydrogen production operations

Featured Story

The city of Fujisawa launched the Fujisawa Sustainable Smart Town (FSST) project in 2014, which aimed to create a sustainable and energy-efficient community. The project involved developing a smart grid system that integrated renewable energy sources, energy storage, and smart home technologies. The town installed a large-scale solar Photovoltaic (PV) system, such as batteries, to ensure a reliable energy supply.

Key Takeaway

IoE involves smart grid technology, allowing users to integrate communication systems, control power flow, monitor system health, and automate power management. It can improve grid resilience, achieve significant cost savings, and reduce energy wastage.

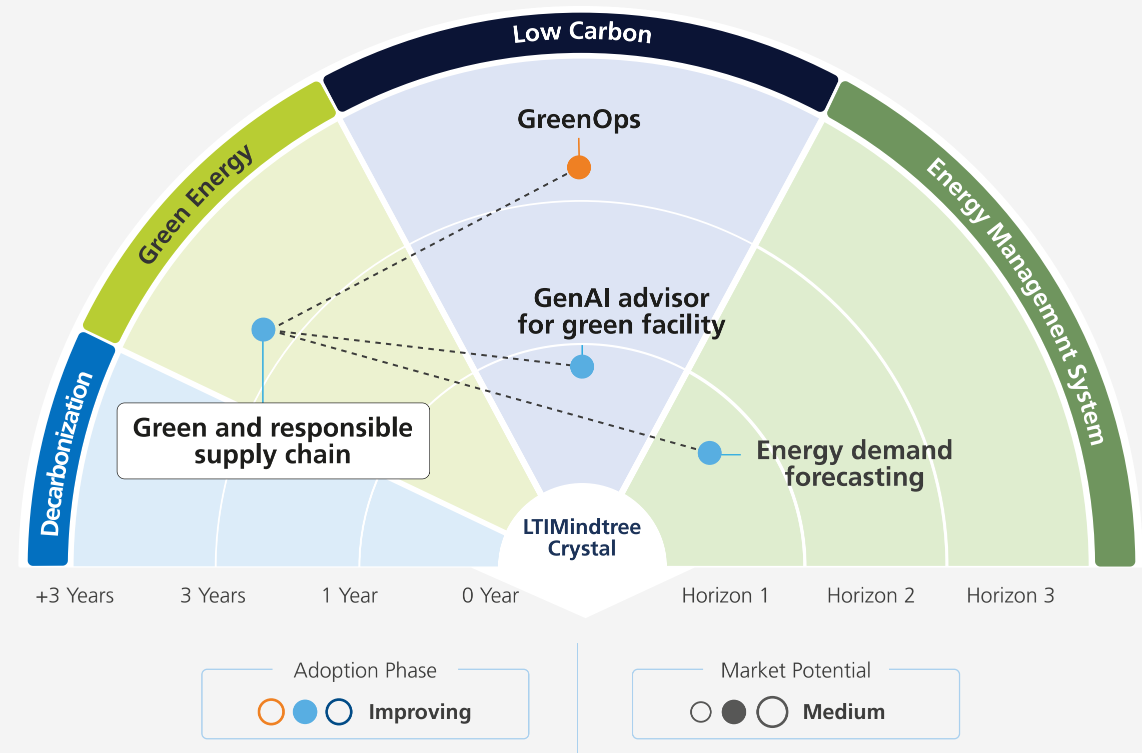
Green and Responsible Supply Chain

Green and responsible supply chain management strategically integrates ethical and environmentally sustainable practices across the supply chain. It emphasizes end-to-end transparency, from raw materials sourcing and last-mile logistics to product returns and recycling processes. This approach minimizes the ecological footprint at every stage, including product conception, manufacturing, distribution, and disposal.

Highlights

Companies adopting green and responsible supply chain practices can differentiate themselves from competitors, enhance their brand reputation, and attract eco-conscious customers and investors. Innovations in renewable energy, smart logistics, and circular economy models are making it easier and more cost-effective for companies to implement green supply chain practices. Applying lean, green, and circular economy principles can lead to efficient logistics, inventory management, and production processes. This results in higher productivity and responsiveness. Supply chains are responsible for a staggering 90% of the industry's environmental impact, and therefore, the actions taken within the supply chains can significantly reduce this impact. Only 23% of companies engage vendors on sustainability, making supplier collaboration vital for greener supply chains.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Comprehensive waste management program focusing on waste reduction and responsible disposal of hazardous material.

Energy & Utilities:
Optimizing logistics for transporting renewable energy components reduces carbon emissions and enhances cost efficiency.

Key Technologies

Edge AI
Real-time processing of sensor data for optimizing hydrogen production processes

Quantum computing
Discovery of efficient catalysts and materials for electrolysis

Digital Twins
Simulate and optimize hydrogen production processes

AI-powered hyperautomation
Real-time decision-making in hydrogen production operations

Featured Story

In 2023, a major American O&G corporation based in Spring, Texas, partnered with the largest U.S. steel producer and top North American scrap recycler to capture, transport, and store up to 800,000 metric tons of CO2 annually from the vendor's Louisiana site. This deal helped boost their supply chain and capital efficiency, demonstrating economies of scale.

Key Takeaway

Companies are integrating sustainable practices in their supply chains, responsibly sourcing materials, and optimizing logistics to minimize emissions. They balance profitability with environmental responsibility, investing in Carbon Capture Utili Storage and hydrogen production to lower their carbon footprint.

Segment 3

Low Carbon

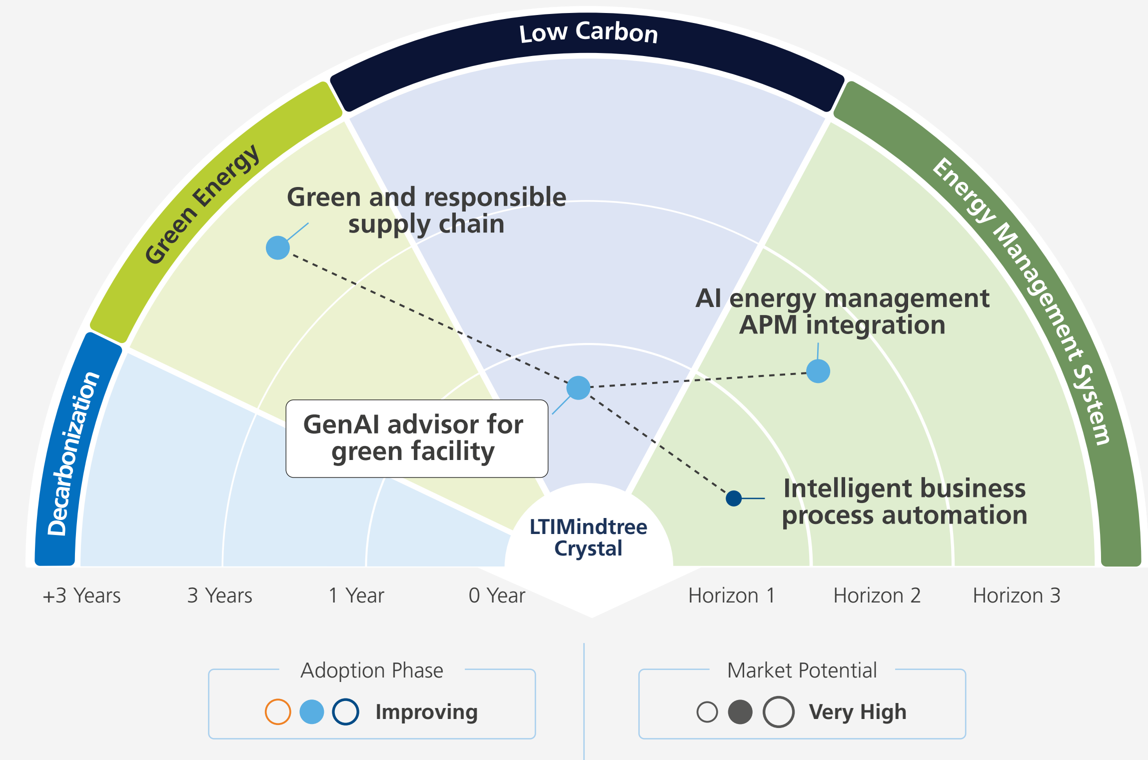
Gen AI Advisor for Green Facility

Gen AI advisor for green facilities is a concept that intersects AI and sustainability within the context of facilities management. Gen AI can optimize energy use, significantly cutting costs by dynamically adjusting to a building's behavior, utility data, occupancy rates, and environmental conditions. This results in a smarter, more sustainable approach to energy management that aligns with global sustainability goals.

Highlights

McKinsey's global survey on AI reveals that 65% of respondents regularly use Gen AI. This surge in interest is global, with adoption reaching 72% across various industries and business functions. Gen AI empowers Facility Managers (FM) by providing proactive insights, suggestions, and actions without constant human intervention. It can detect anomalies in building processes and automatically assign inspections to prevent equipment malfunctions. By optimizing space utilization, predicting maintenance needs, and recommending real estate strategies, it enhances FM's decision-making, contributes to cost savings, reduces occupant disruption, and supports sustainability initiatives. Gen AI-enabled workplace management solutions yield high-performing workplaces by analyzing patterns, predicting behavior, and enhancing the overall workplace experience

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Analyzes energy use patterns and suggests optimizations to reduce consumption and improve efficiency.

Energy & Utilities:
Installing energy-efficient lighting, Heating Ventilation & Air Conditioning (HVAC) systems, and smart technologies to reduce energy use and emissions.

Key Technologies

Edge computing
Enables data processing at the source, reducing latency and enhancing Gen AI application responsiveness

Digital twins
Generates virtual models of facilities, allowing Gen AI to simulate and optimise risk-free operations

Synthetic data generation
Improve facility management, boost sustainability practices, and ensure adherence to privacy regulations

AI governance
Implement strong data privacy and security measures to safeguard sensitive information and meet regulations

Featured Story

In August 2023, a large corporate office building with 200,000 square feet of space implemented a generative AI system to assist with various facilities management workflows. The Gen AI system used building occupancy data, weather forecasts, and historical energy usage to adjust HVAC and lighting to minimize energy consumption dynamically. The system used computer vision and occupancy sensors to identify underutilized spaces and optimize floor plans.

Key Takeaway

Gen AI is revolutionizing facilities management by making operations smarter, more efficient, and sustainable. Companies are integrating Gen AI into energy and sustainability tools to streamline tasks, optimize resource allocation, and boost operational efficiency.

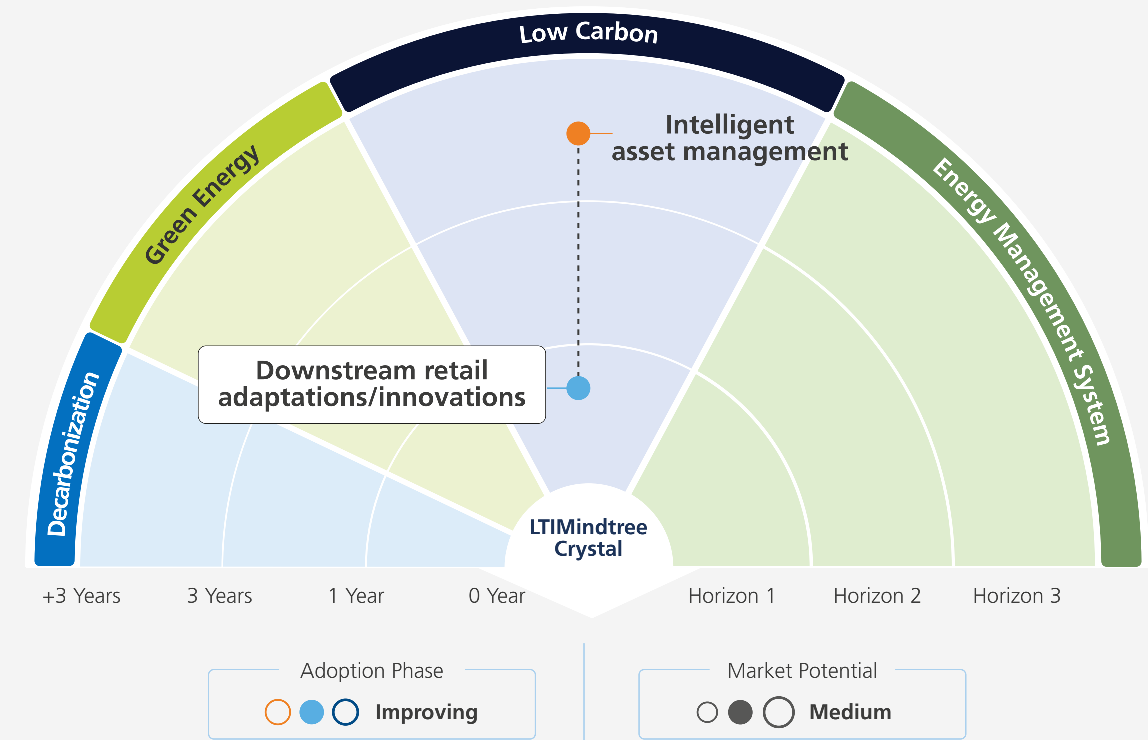
Downstream Retail Adaptations/Innovations

Downstream retailers use numerous sales channels, AI-driven customization, and eco-friendly sustainability methods to increase consumer loyalty and company success. Retailers may use technologies and tactics to collect data on customer preferences and behavior to adapt their products and marketing efforts. Prioritizing sustainability practices not only appeals to environmentally conscious consumers but also establishes a positive brand image, fosters customer trust, and sets businesses apart from competitors.

Highlights

Downstream retail innovations prioritize improving customer experience, optimizing processes, and harnessing technology to stay ahead of the competition. Downstream companies prioritize environmental sustainability by lowering carbon emissions, increasing energy efficiency, and promoting eco-friendly goods. Energy downstream companies increasingly use digital tools such as mobile applications and smart meters to boost consumer interaction and manage operations. There is an increasing focus on supply chain transparency and sustainable practices. Consumers are becoming more concerned about the source and environmental effects of the items they purchase, causing businesses to implement more open and sustainable supply chain policies. Finally, downstream firms that adapt their strategies to changing demand patterns and emphasize supply chain security may find success in energy transition.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Investing in on-site renewable energy generation, such as solar panels and wind turbines.

Energy & Utilities:
Mobile apps providing real-time alerts, energy-saving advice, and outage notifications.

Key Technologies

Digital twins
Create virtual models of supply chains, allowing retailers to optimize logistics and inventory management

AI-As-A-Service (AIaaS):
Deploy predictive analytics to forecast demand, optimize stock levels, and reduce waste

Edge AI
Enable real-time surveillance and anomaly detection, ensuring safe and efficient store operations

Data fabric
Aggregate customer data from various touchpoints, providing deeper insights into customer behavior

Featured Story

A London-based global O&G corporation with a flagship service station in Fulham represents the future of energy retail. It has numerous ultra-fast chargers that can fully charge an EV in under 30 minutes after being plugged in. This corporation is committed to sustainability and reducing carbon emissions by offering a convenient and efficient alternative to traditional gasoline-powered vehicles.

Key Takeaway

Companies may integrate Virtual Reality (VR) technology to enhance customers' shopping experience. Additionally, they are exploring partnerships with sustainable brands to offer more eco-friendly products in their stores.

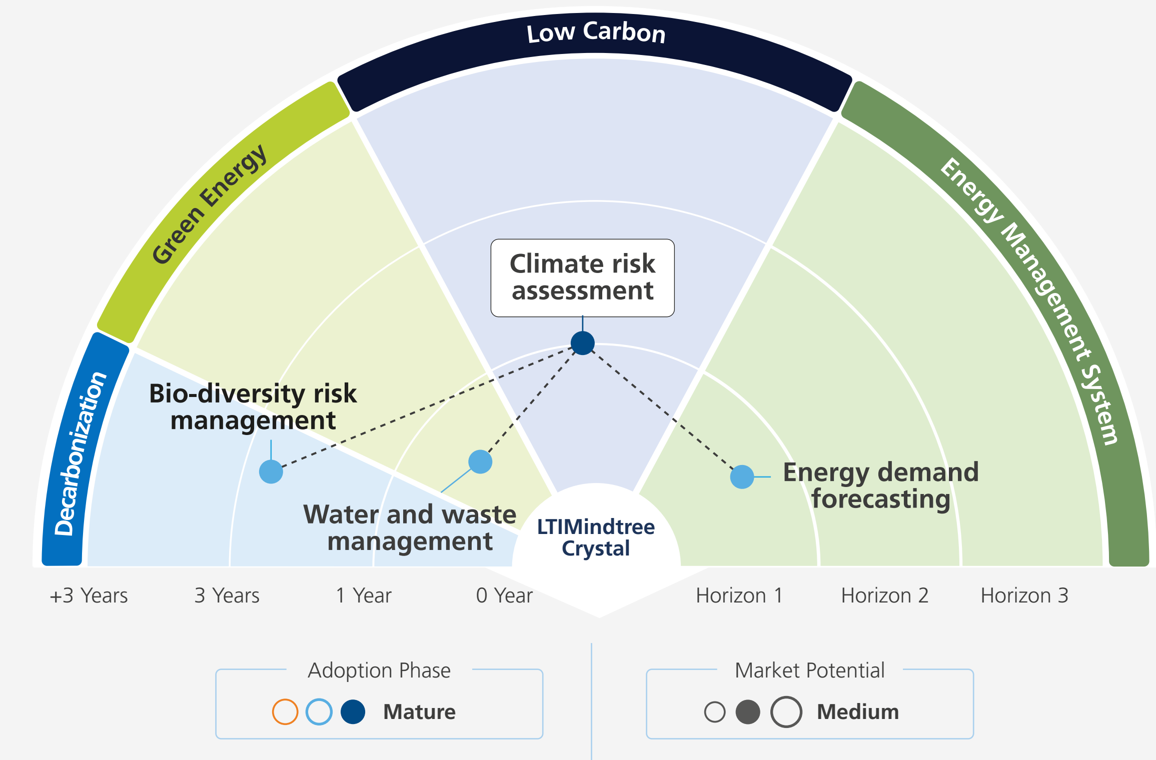
Climate Risk Assessment

Climate risk assessment is the process of evaluating the potential impact of climate change on energy systems and identifying opportunities for sustainable practices. It involves identifying and quantifying the impacts of climate change, including physical climate hazards (such as extreme weather events and changing climate patterns) and transition risks associated with shifting to a low-carbon economy.

Highlights

Climate risk assessment provides comprehensive data and analysis to support policymakers and stakeholders in making informed decisions regarding climate adaptation and mitigation. It aids in the identification of potential climate-related hazards such as floods, droughts, storms, and heatwaves. It also assesses the susceptibility of communities, ecosystems, and infrastructure to climate hazards. In January 2024, the European Environment Agency (EEA) conducted comprehensive climate risk assessments to evaluate and address the impacts of climate change across Europe. The EEA's climate risk assessments provide critical insights into the varied and significant impacts of climate change. Advances in technology, increased data availability, and evolving methodologies will likely influence climate risk assessment. AI, ML, big data, and analytics will enhance predictive capabilities and pattern recognition for better risk forecasting.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
O&G companies develop continuity plans to maintain operations during and after extreme weather events.

Energy & Utilities:
Assess climate risks to protect power plants and systems from extreme weather conditions.

Key Technologies

Edge computing
By processing data locally, edge computing reduces latency and bandwidth usage

Digital twins
Develop virtual models of physical assets to simulate and analyze climate risks

Synthetic data generation
Creating synthetic data helps test different climate scenarios and understand potential risks

AI governance
Helps in identifying and mitigating risks associated with AI deployment, such as biases in data or decision-making processes

Featured Story

A leading German O&G solutions provider partnered with a consulting firm to conduct a comprehensive climate risk assessment. The goal was to identify potential climate-related risks and develop strategies to mitigate these risks, ensuring sustainable operations and compliance with environmental regulations. The climate risk assessment led to significant improvements in the company's sustainability practices.

Key Takeaway

Quantitative data and expert evaluations are necessary to assess existing and future climate risk levels, which are currently underestimated. Advanced technologies like renewable energy and smart infrastructure may minimize GHG emissions and improve adaptation.

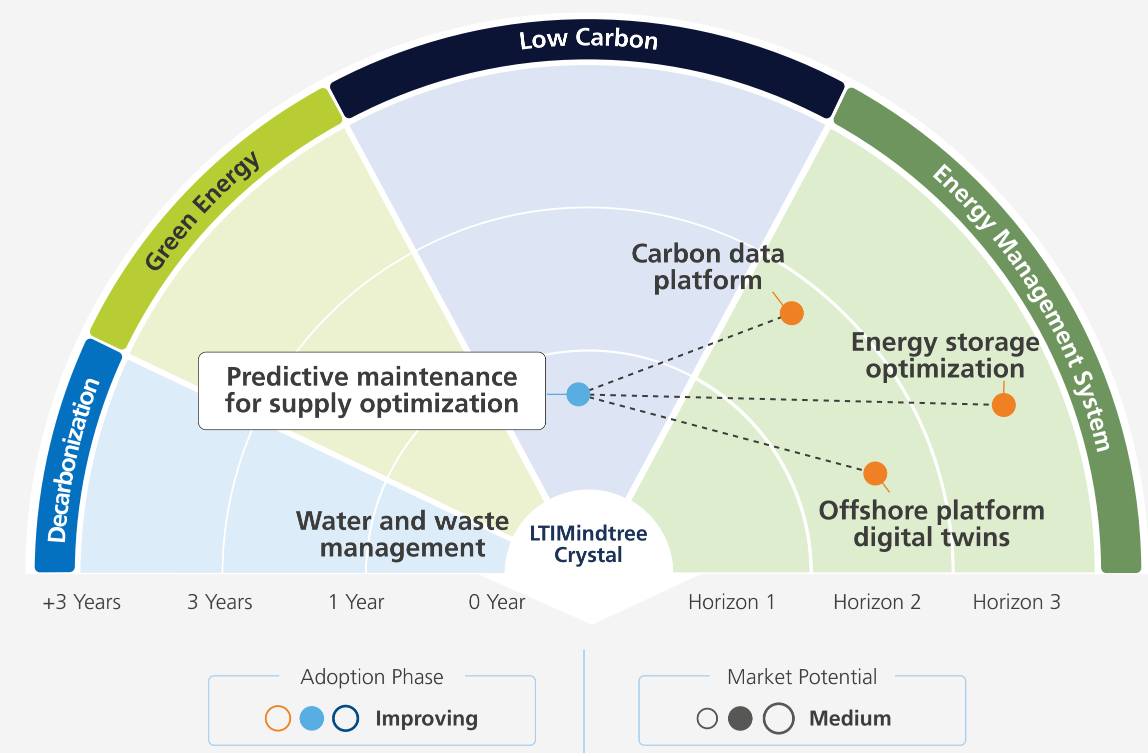
Predictive Maintenance for Supply Optimization

Predictive maintenance plays a critical role in the energy transition value chain. It contributes to improving the overall performance and reliability of energy systems. By integrating predictive maintenance into the energy transition value chain, energy systems can operate more efficiently, reducing environmental impact. These measures support optimizing and managing energy assets and enhance the deployment of renewable energy technologies.

Highlights

Predictive maintenance in the energy supply chain uses advanced technologies like data analytics, ML, and AI to identify patterns and relationships and predict disruptions in the energy supply. It also uses real-time data, which is combined with historical data to create predictive models that anticipate the near-future maintenance needs of equipment or any other vital component of the energy supply. Predictive maintenance helps energy companies mitigate minor glitches before they become major breakdowns or blackouts by monitoring the machine in real time and detecting minute changes in regular performance. Thus, predictive maintenance benefits energy companies by reducing equipment downtime, resulting in a consistent energy supply, minimizing unnecessary maintenance costs, and enhancing equipment lifespan.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Ensure uninterrupted energy supply by proactively eliminating downtime.

Energy & Utilities:
Undertake smart meter data analysis to anticipate potential systems overloads

Key Technologies

Adaptive AI
Recalibrate predictions and recommendations based on real-time scenarios

Blockchain
Ensure secure and traceable data sharing across supply chain stakeholders

Sensor tech
Gain precise data on equipment health and environmental conditions

Edge AI
Reduce latency in decision-making with real-time fault detection in remote areas

Featured Story

An Australian multinational mining and petroleum company operating across various industrial assets faced challenges like monitoring equipment performance, higher plant downtime, and inaccurate failure analyzer. LTIMindtree developed a predictive maintenance application leveraging the latest technologies like Industrial IoT (IIoT) and hi-tech sensors for gas compression that drastically reduced unplanned downtime and a robust predictive maintenance system for alerts/repairs/replacements.

Key Takeaway

Predictive maintenance forms a building block of energy supply optimization. Advanced technologies like AI, ML, and IoT are vital in bolstering predictive maintenance to deliver top-notch performance.

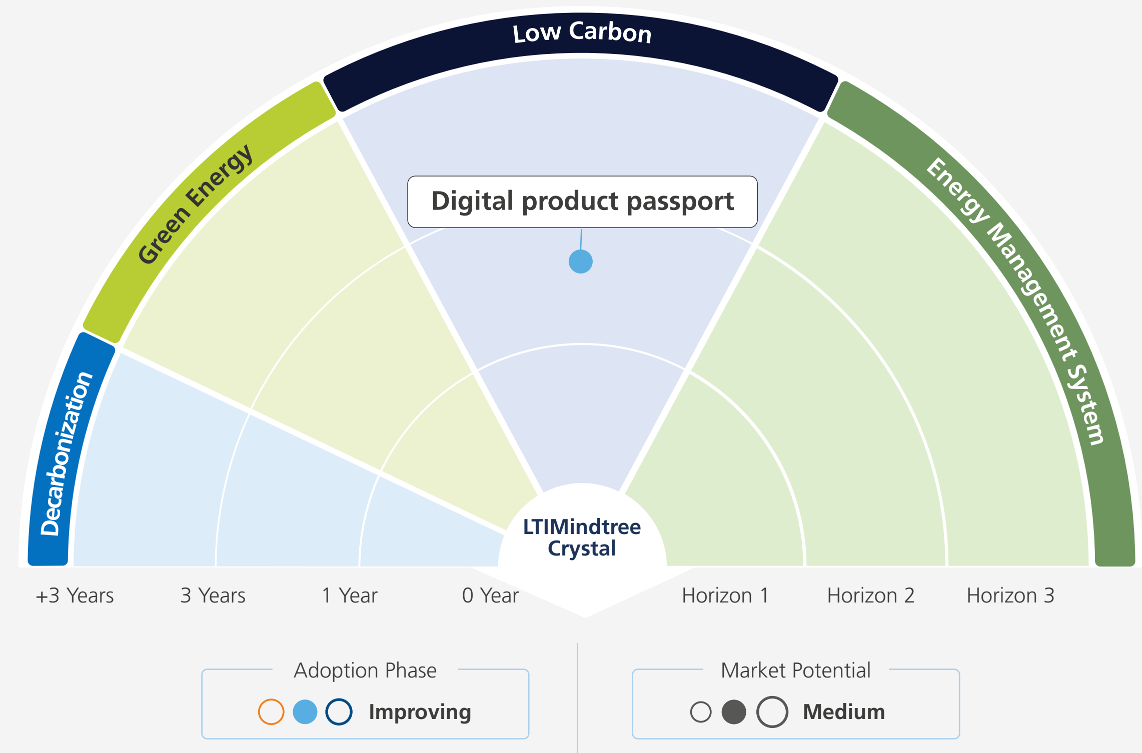
Digital Product Passport

A Digital Product Passport (DPP) is a developing tool designed to improve transparency, traceability, and sustainability over the lifespan of goods. Within the energy transition and sustainability framework, DPPs have a pivotal function in providing comprehensive data on a product's materials, manufacturing methods, use, and disposal. DPPs provide lifetime environmental impact information to assist customers and make informed selections.

Highlights

DPPs are gaining popularity in the O&G and utilities sector due to increased regulatory requirements, customer desire for more transparency, and initiatives to foster a circular economy. The European Union is leading in promoting DPPs via its circular economy action plan. Consumers' growing awareness of environmental issues is driving demand for things made using sustainable processes and transparent supply chains. Firms must build dependable mechanisms for exchanging data with other parties to protect privacy and proprietary information. Global DPP standards are necessary to ensure compatibility and interoperability across sectors and countries. Technologies such as blockchain and IoT are being leveraged to create robust DPP systems.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Improve supply chain visibility for stakeholders to verify product sustainability

Energy & Utilities:
DPPs detail material composition and origin, helping utilities manage resources better, reduce waste, and enhance recycling.

Key Technologies

Zero Trust
Ensures compliance with environmental and sustainability regulations by protecting sensitive information

Decision intelligence
Optimizes product lifecycle with advanced analytics and AI to ensure sustainability

Digital twin
Generates virtual replicas of physical products to monitor performance and environmental impact in real time

Blockchain
Provides a tamper-proof ledger for tracking the origin, manufacturing process, and lifecycle of products

Featured Story

An American automotive and clean energy company recently initiated a pilot program for Battery Digital Passports. This is a key part of the Global Battery Alliance's (GBA's) effort to improve transparency and sustainability within the battery supply chain. These digital passports function as virtual counterparts to physical batteries, providing comprehensive details about their origin, composition, material flows, and manufacturing history.

Key Takeaway

Digital product passports will improve transparency, sustainability, and the transition to a circular economy in industries. The passports provide detailed information on products' environmental impact throughout their lifecycle, helping consumers make more informed purchasing decisions.

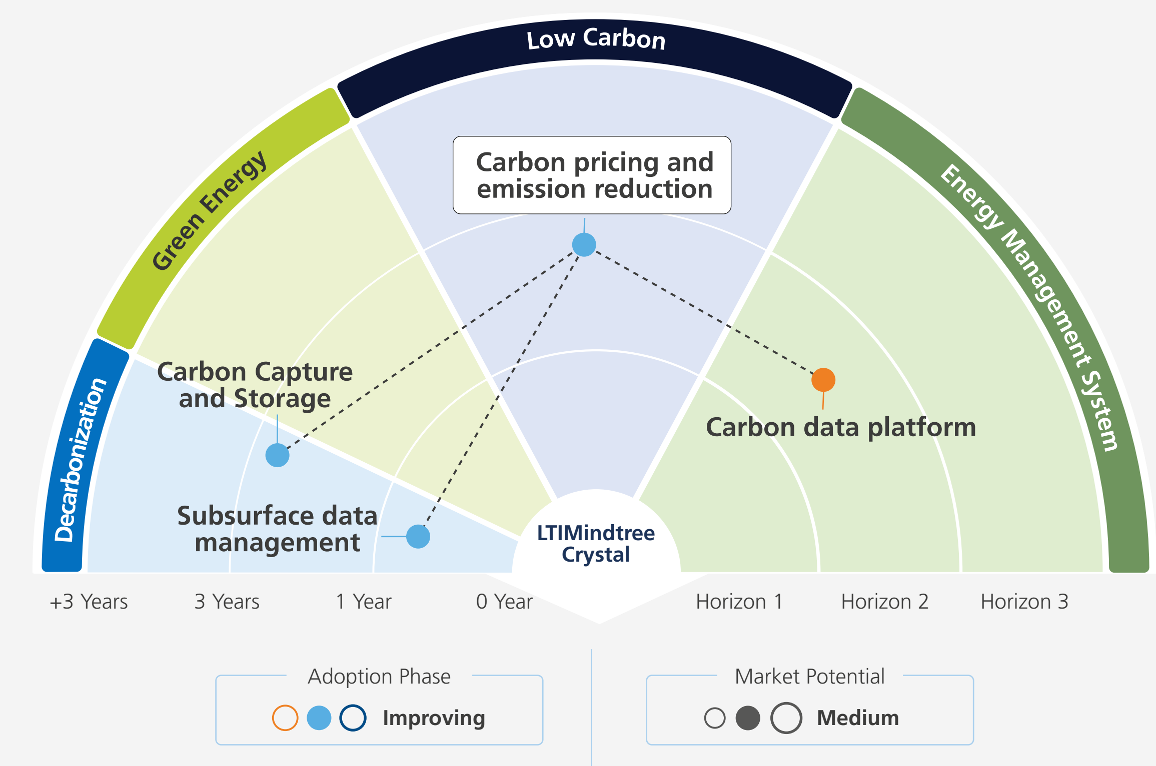
Carbon Pricing and Emission Reduction

Carbon pricing is a strategy to reduce GHG emissions by assigning a monetary value to CO2 emissions. The carbon price provides an economic signal to emitters and allows them to decide whether to transform their activities and lower their emissions or continue emitting and paying high prices for their emissions.

Highlights

Carbon pricing is one of the key initiatives to reduce carbonization in energy systems. It provides economic incentives for emission reductions, while emission reduction efforts contribute to the overall success of carbon pricing by reducing the need for emissions allowances or carbon tax payments. While traditional sectors like power and industry continue to dominate, carbon pricing is increasingly being considered in new areas such as aviation, shipping, and waste. Automation and complete digitalization have made collecting, processing, and analyzing massive amounts of emissions data much easier. Technology has also made it possible to identify emissions hotspots, develop data-driven decarbonization pathways, and automate sustainability reporting. Thus, it spurs investment and innovation in clean technology by increasing the relative cost of using carbon-intensive technology.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Companies can track their carbon footprints and align with carbon neutrality goals.

Energy & Utilities:
Minimize emissions from upstream and downstream operations to comply with global carbon regulation.

Key Technologies

Edge AI
Real-time carbon cost analysis to drive immediate emission reduction actions

Blockchain
Secure and transparent tracking of carbon credits and emission data

Digital Twins
Simulate carbon capture plant operations to enhance system design and minimize energy loss

Adaptive AI
Optimizes carbon reduction strategies by identifying the cost-effective measures to reduce emissions

Featured Story

A British multinational energy company aimed to reduce GHG emissions. To achieve this, it implemented carbon pricing mechanisms, including CCUS systems. Post-implementation, the company reported a significant decrease in methane emissions from its operations and established itself as a leader in the energy transition, with a clear strategy to balance profitability and sustainability.

Key Takeaway

Transparent carbon pricing and emission reduction aids in decision-making and minimizes carbon leakage. Emission standards can lead to financial benefits through rebates and reduced fees, incentivizing organizations to cut Green House Gas (GHG) emissions.

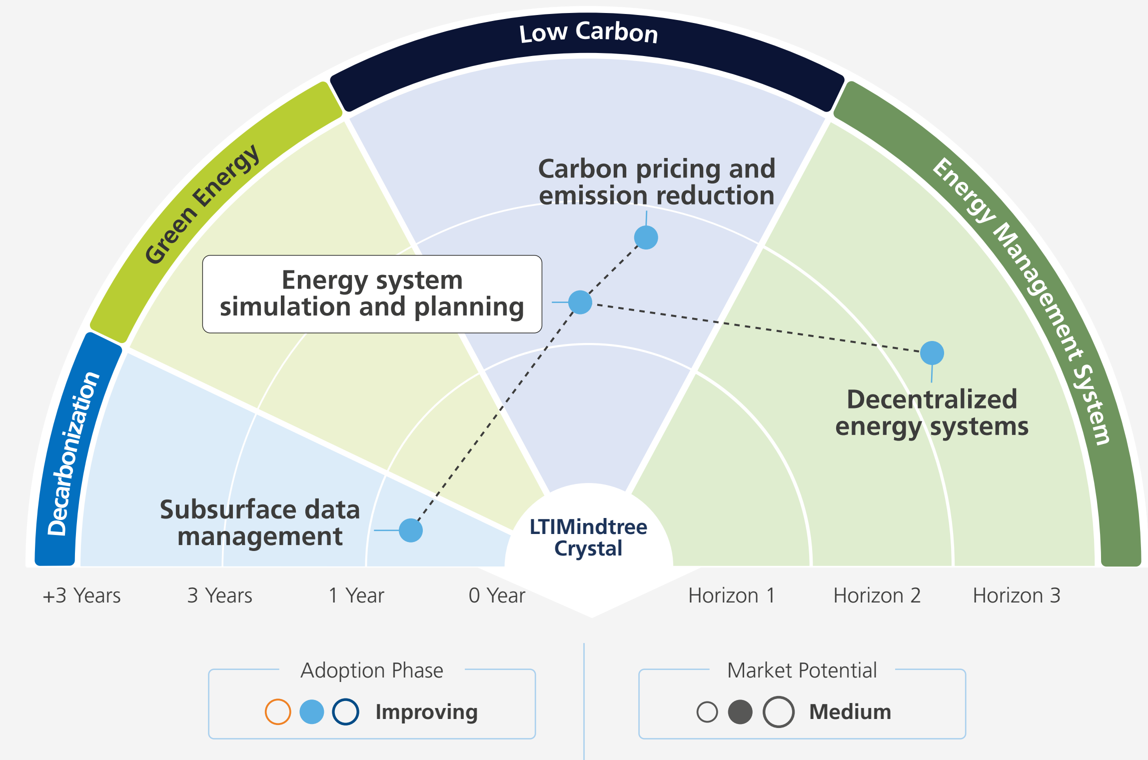
Energy System Simulation and Planning

Energy system simulation and planning involves computer-based modeling to assess a building's energy performance. Designers and building owners use it to identify potential improvements and enhance energy efficiency by suggesting design modifications before construction begins. It is designed to help system engineers, policymakers, and utilities in the energy sector make better decisions about their facilities' longevity and economic impact.

Highlights

Energy system simulation or modeling is crucial for businesses, governments, and individuals to forecast, analyze, and enhance energy usage. It entails constructing a virtual representation of energy systems, identifying factors influencing consumption, and estimating energy usage across various scenarios. Sophisticated software and complex methods enable energy modeling to predict real-world energy performance. Assessors gain deeper insights into how buildings retain heat or regulate air quality by considering various parameters and performing elaborate calculations, including methods like the Simplified Building Energy Model (SBEM) and simulation programming. These tools also support accurate sustainability design to meet green building requirements. This enables optimization of system configuration, sizing, and element placement (e.g., transformers, lines, capacitors). Additionally, they evaluate integrating renewables, energy storage, and smart grid tech.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Determine the best carrying capacity, total fleet capacity, and fleet configuration.

Energy & Utilities:
Identify the optimal size and operation schedule for battery storage in an integrated energy system

Key Technologies

GenAI
Analyze large datasets and predict future demand and supply patterns

Deception Technology
Deploying decoys and monitoring interactions with threats enhances energy systems' resilience and security

Edge AI
Analyze sensor data to detect anomalies and predict equipment failures

Sensor Tech
Continuously monitor temperature, pressure and create simulations to improve planning and compliance

Featured Story

A US-based State Energy Research and Development Authority undertook an energy system simulation and plans to achieve a zero-emission electricity system target by 2040. It also proposed generating 70% renewable energy by 2030. The primary purpose is to provide recommendations to the Public Service Commission (PSC) for planning the investments in the New York electric system needed to meet Climate Leadership and Community Protection Act (CLCPA) goals

Key Takeaway

Energy system simulation and planning go beyond cost savings and environmental impact reduction. aAs these energy-saving approaches gain popularity, power companies can increasingly benefit by conserving energy and reducing costs.

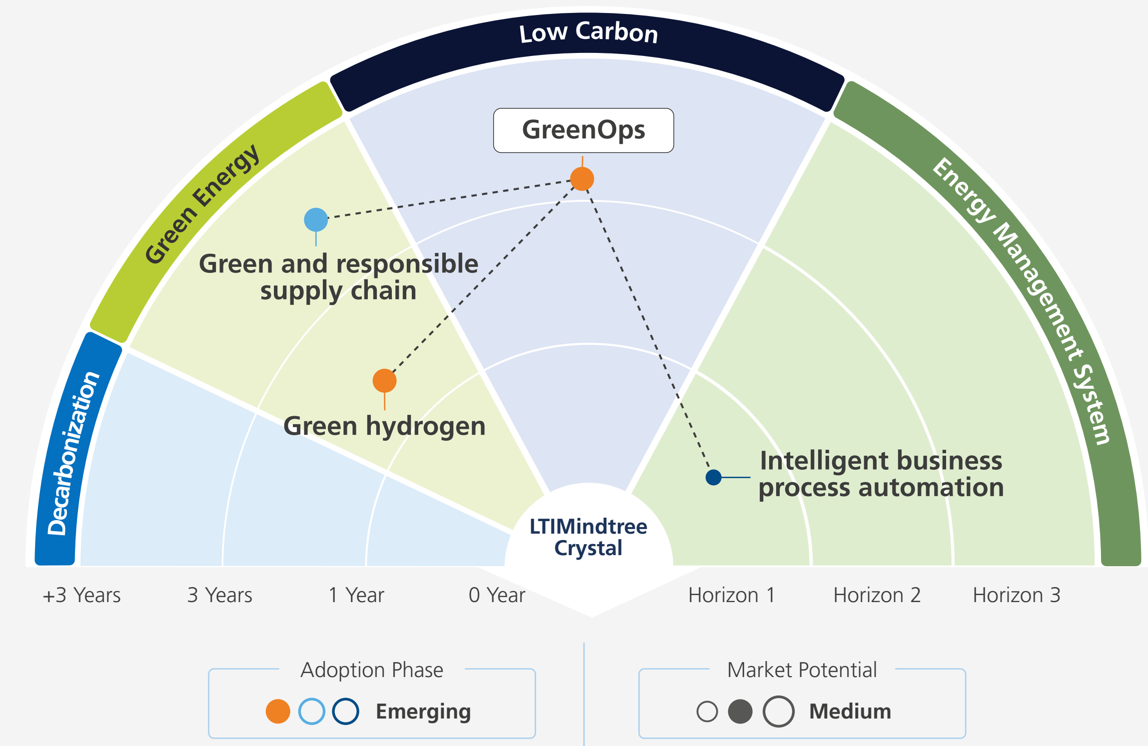
GreenOps

GreenOps encompasses the practices and principles designed to minimize the environmental impact of IT operations while maintaining efficiency and cost-effectiveness. It serves as a cloud operating model that emphasizes the responsible management of digital resources and technologies from creation to retirement.

Highlights

Integrating sustainability into IT operations is a strategic initiative that benefits the company's bottom line and long-term success. GreenOps seeks to optimize existing IT environments both environmentally and financially, with Financial Operations (FinOps) as a key pillar in the IT sustainability strategy. Sustainable IT practices can lead to cost savings through energy efficiency improvements, reduced resource consumption, and lower operational expenses. For instance, shutting down unused virtual machines and monitoring resource usage more effectively can decrease costs and environmental impact. As many regions have implemented regulations and standards related to environmental sustainability, GreenOps ensures compliance with environmental standards and regulations. It focuses on rightsizing virtual machines, using auto-scaling effectively, and minimizing idle resources. Companies are also exploring serverless computing to reduce resource waste.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Leverage CCS to capture and store CO2 emissions underground, reducing GHG.

Energy & Utilities:
Use smart grids to optimize energy distribution, reduce losses, and integrate renewables.

Key Technologies

ML
Predict maintenance needs, reducing downtime and extending equipment lifespan

IoT
Sensors enable real-time monitoring of environmental parameters and operational efficiency

Generative AI
Design and optimize CCS systems, improving their efficiency in capturing and storing carbon emissions

AI-powered hyperautomation
Predict and manage energy demand, balancing the grid and reducing additional power plant needs

Featured Story

One of India's leading O&G companies aimed to achieve operational excellence and sustainability through digital transformation. Partnering with a consulting firm, they developed a digital strategy for all business segments, including natural gas and petrochemicals. Investments in solar and wind projects diversified their energy portfolio, reducing emissions. Enhanced cybersecurity, data management, and cloud technology supported these initiatives.

Key Takeaway

According to a leading global market intelligence company, Sustainability (37%) and FinOps (31%) are the top investment areas for organizations to optimize their cloud operations. GreenOps and FinOps tracks financial and environmental metrics, identifying inefficiencies, and driving improvements.

Intelligent Asset Management

Intelligent Asset Management (IAM) in the context of energy transition refers to the strategic use of advanced technologies and data analytics to optimize the lifecycle of energy assets such as power plants, renewable energy installations, grids, and storage facilities. Efficient energy asset management contributes to overall sustainability goals by reducing carbon emissions, improving resource utilization, and promoting the adoption of cleaner energy sources.

Highlights

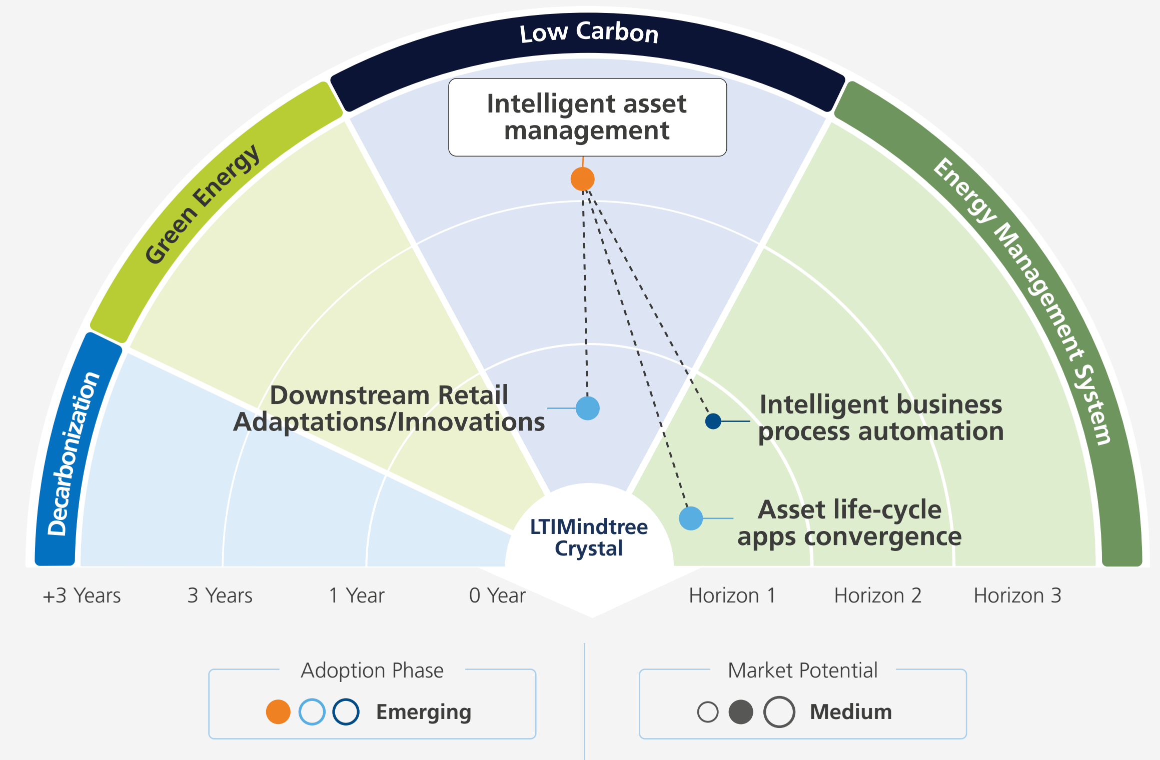
As the energy transition accelerates, asset-intensive industries face mounting challenges. With renewable energy systems expanding daily, managing assets becomes increasingly intricate. Connecting more assets to the grid heightens the complexity of deployment, tracking, and maintenance. Intelligent asset management is pivotal for oil, gas, and manufacturing sectors, leveraging digital technologies to optimize global operations. The market for remote monitoring solutions in renewable energy assets is projected to grow from USD 1.3 billion in 2020 to USD 3.2 billion by 2026. This surge reflects a heightened board-level focus on formalizing and executing Environmental, Social, and Governance (ESG) strategies. Maintenance operations must now prioritize decarbonization, new supply chain standards, and other complexities associated with the energy transition and enhanced environmental stewardship efforts.

Industry Use Case

Energy & Utilities:
Monitors and analyzes the performance of assets in real-time and ensures that assets are operating at peak efficiency.

Oil & Gas:
Integrating IAM with supply chain management ensures timely availability of parts and materials, reducing delays and boosting efficiency.

Radar View & Related Trends



Key Technologies

Sensor tech
Collect real-time data on the performance and condition of energy assets, enabling continuous monitoring

Decision intelligence
Optimize energy production, distribution, and consumption to improve overall efficiency

Blockchain
Maintain an immutable record of asset ownership and maintenance history, improving accountability and traceability

Smart spaces
Enable demand response strategies, adjusting energy consumption based on supply conditions to balance the grid

Featured Story

LTIMindtree's XmerIOT is an IoT-based transformer monitoring solution that ensures reliability by proactively monitoring critical transformer assets, analyzing data in real time, and diagnosing issues to prevent failures and minimize downtime. Built on best practices and Institute of Electrical and Electronics Engineers (IEEE) guidelines, it supports all distribution transformer ranges. State-of-the-art dashboards offer insights into primary and secondary parameters such as voltage, current, power analysis, and temperature, enhancing operational efficiency.

Key Takeaway

Effective IAM is crucial for smart grid activities. Poor asset management risks isolated modernization, hindering reliable, sustainable, and adaptable services.

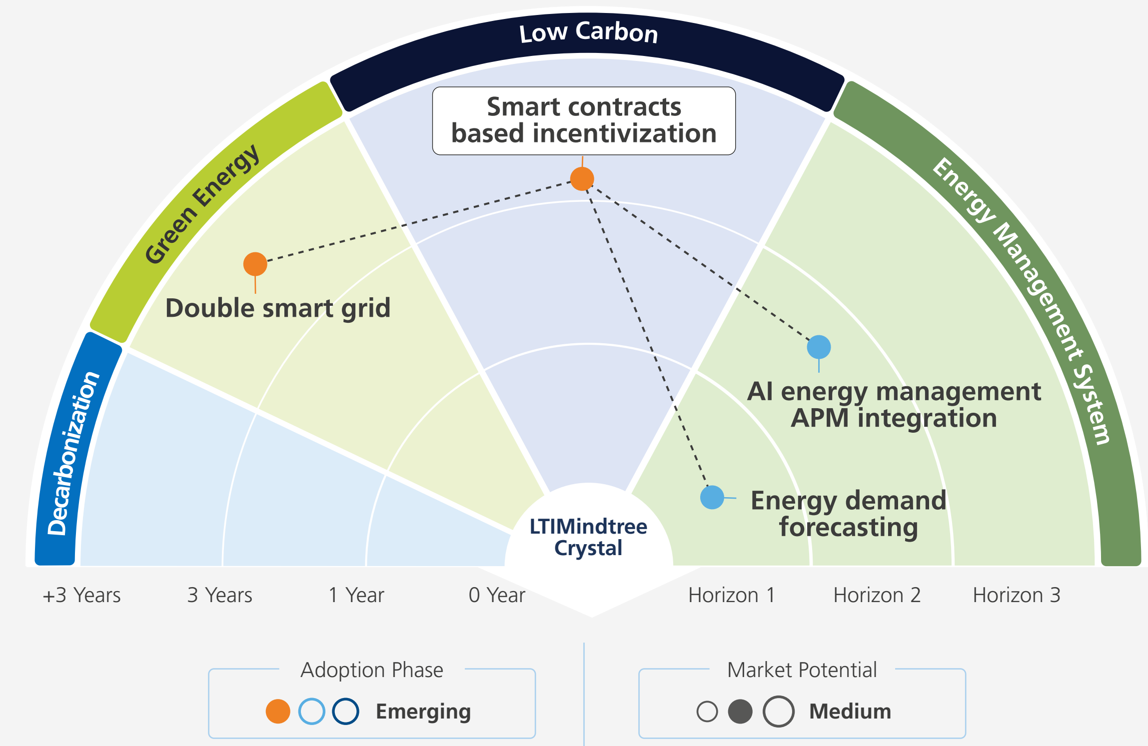
Smart Contracts-based Incentivization

Smart contracts based on blockchain technology offer a new, decentralized mechanism for entering and fulfilling transactions of contracts in energy markets. Energy transactions and smart contracts go hand in hand to improve operators' reliability, efficiency, and pitfalls. Smart contracts help enable transactive energy by addressing challenges like cost and security

Highlights

Clean energy technology and blockchain are becoming crucial to the energy sector. Blockchain creates a strong foundation for more secure and decentralized systems. Peer-to-peer energy (P2P) systems and smart grids are emerging as leading smart contract technologies. P2P and smart grids have several advantages over traditional energy systems, such as better availability, improved reliability, and lower costs. This makes them highly capable of meeting consumers' current and future energy needs. Smart contracts can also ensure a stable energy supply irrespective of the generation source as they leverage a decentralized grid leveraging renewable energy sources. As blockchain is still developing, legislators and the judiciary do not recognize smart contracts, but we hope they will soon be fully recognized with amendments in the law.

Radar View & Related Trends



Industry Use Case

Energy & Utilities:
Smart contracts can track energy usage via IoT-enabled smart meters and disburse tokens for meeting predefined thresholds.

Oil & Gas:
Smart contracts automate the issuance and tracking of carbon credits.

Key Technologies

Blockchain
Foundation for secure, immutable, and transparent smart contracts, ensures trust and eliminates intermediaries

Distributed cloud
Facilitates scalable storage and processing of large energy datasets and integrates blockchain and IoT systems

Edge AI
Processes energy data closer to IoT to reduce latency and uses AI to enable real-time contract execution and incentivization

Digital twins
Provide real-time data from physical assets, ensuring accurate and timely information for smart contracts

Featured Story

An Australian blockchain company facilitates a direct connection between green energy providers and buyers, enabling them to buy energy in advance at discounted rates. To achieve this, the firm has created Ethereum Smart Energy tokens that are traded through its e-commerce platform. The tokens regularize renewable energy and allow businesses to buy the exact amount as required while also being able to sell the excess capacity.

Key Takeaway

Blockchain-based smart contracts form a robust foundation for next-generation energy transactions. Smart contracts can potentially transform the energy sector by providing a secure, transparent, and efficient platform for energy transactions.

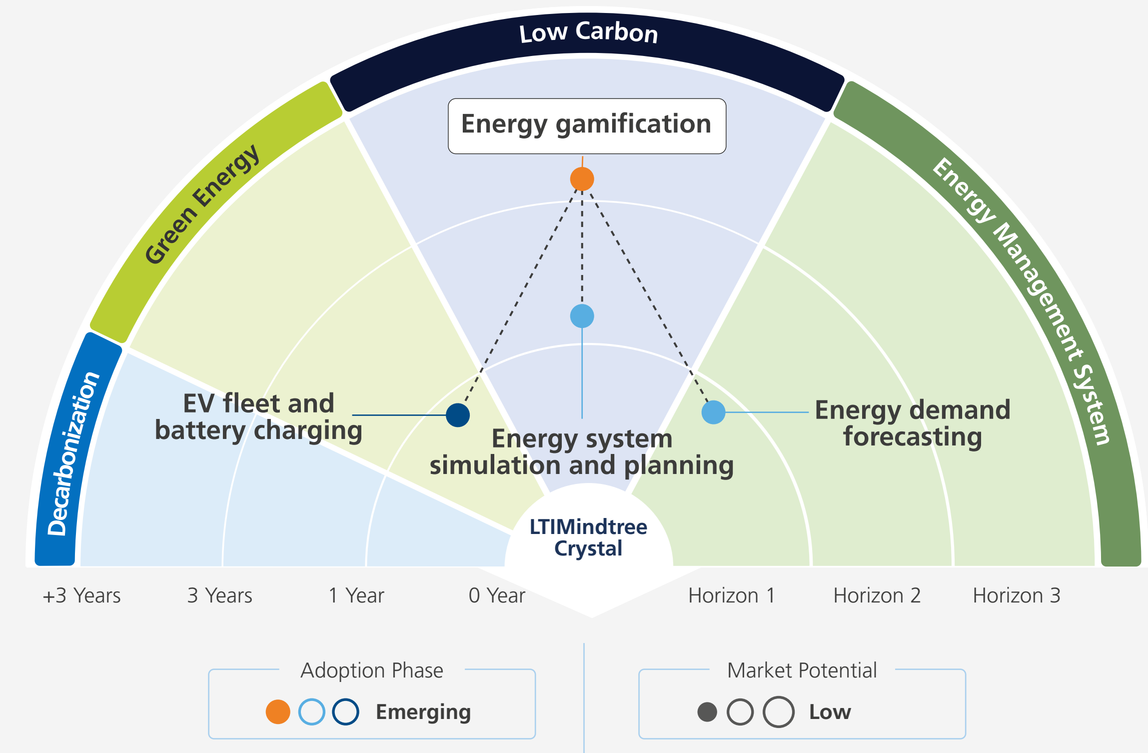
Energy Gamification

Gamification is a term that describes the application of game theory, concepts, and rules in a non-gaming environment. In the energy sector, game elements and game design techniques aim to improve customer participation in demand management programs by competing or collaborating with others and improving past performance.

Highlights

In today's technologically advanced era, games have become more accessible to everyone. Gamification can also benefit energy-related industries. It focuses on studying how people or groups interact with each other when they play games related to energy consumption, strategies, etc. In energy management, gamification aims to determine the best strategy for handling specific situations or conflicts. In the context of energy consumption, this can help design strategies that optimize energy use. These strategies align with goals such as reducing energy costs, achieving zero carbon emissions, creating sustainable buildings, and complying with energy efficiency and decarbonization regulations. Gamification techniques play a pivotal role in smart energy meters, suggesting a promising future for their integration.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Gamified training modules for safety drills and equipment handling.

Energy & Utilities:
Gamified mobile apps track energy usage consumption, reducing energy wastage and improving demand management.

Key Technologies

Decision intelligence
Analyze real-time energy consumption to provide actionable insights to users

Augmented Reality (AR)
AR-powered simulations visualize energy usage and create immersive trainings for energy conservation and safety

Digital twins
Simulate energy systems to predict the impact of gamified energy-saving strategies

Blockchain
Implement secure and transparent token-based reward system, peer-to-peer energy trading platforms

Featured Story

The government of Thailand conducted an innovative program to optimize and save energy consumption, especially in the public sector, including government agencies, schools etc. Gamification techniques were used in the schools, and a game called "Power School" was played by 150+ students. This data was collected using live videos and questionnaires. The results from this experiment highlighted how gamification has a significant positive effect on a student's energy-saving behavior at 95% confidence.

Key Takeaway

Gamification has a huge impact on the energy industry and could drive the energy transition by transforming customer behavior, upskilling sector employees, and improving the safety of the equipment.

Segment 4

Energy Management System

Field Technician Knowledge Management

Effective Knowledge Management (KM) for field technicians in the energy transition and utilities sector is crucial. It enables just-in-time knowledge sharing, hands-free information access, and accurate task debriefing. AI-driven systems automatically manage and distribute data, making processes more efficient and cost-effective. They also support eco-friendly practices and help overcome challenges related to physical distances.

Highlights

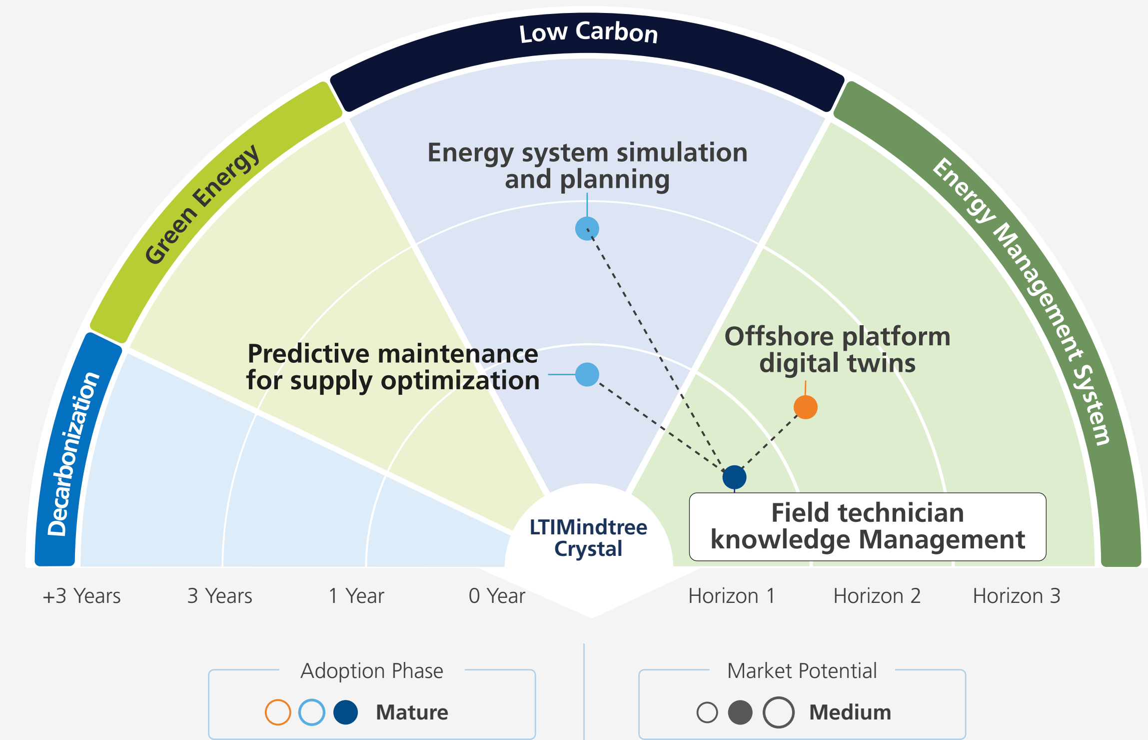
According to Power Magazine, 50% of the workforce in the utilities sector is expected to retire soon, creating a significant knowledge retention challenge. Proper KM is crucial to prevent the loss of tacit knowledge from senior workers. The rise of smart homes and grids require adaptive Knowledge Management Systems (KMS) to enhance consumer confidence and operational efficiency. Innovative technologies like AR and AI are essential for bridging the gap between retiring and incoming talent. AR can deliver real-time information via smart devices, while AI optimizes just-in-time data delivery. These technologies ensure KM is intuitive, automated, and interactive, supporting crisis preparedness, efficient energy use, and seamless transitions in the workforce.

Industry Use Case

Oil & Gas:
Provide digital access to checklists and standards for pipeline and rig inspections.

Energy & Utilities:
Enable knowledge sharing for troubleshooting and maintaining power lines and managing and upgrading smart grid infrastructure.

Radar View & Related Trends



Key Technologies

Augmented reality
Assists with remote expert guidance and visualization of complex equipment

Cloud
Offer centralized access to technical documents, manuals, and guides from anywhere

Wearable technology
Hands-free access to safety information and remote instructions

Machine learning
Analyze historical data for optimized solutions and insights

Featured Story

A US-based electric utility company uses an AR platform to assist field technicians. The AR system provides real-time visual instructions, overlays schematics on physical equipment, and enables remote expert consultations. The data collected is fed into a business intelligence system to optimize performance and training programs. This has helped the company to reduce human errors and make workers safer, faster, and smarter.

Key Takeaway

Field technician KM in O&G and utilities industries enhances efficiency by leveraging mobile apps, analytics-driven Business Intelligence (BI), and fostering communication for effective knowledge sharing in field service operations.

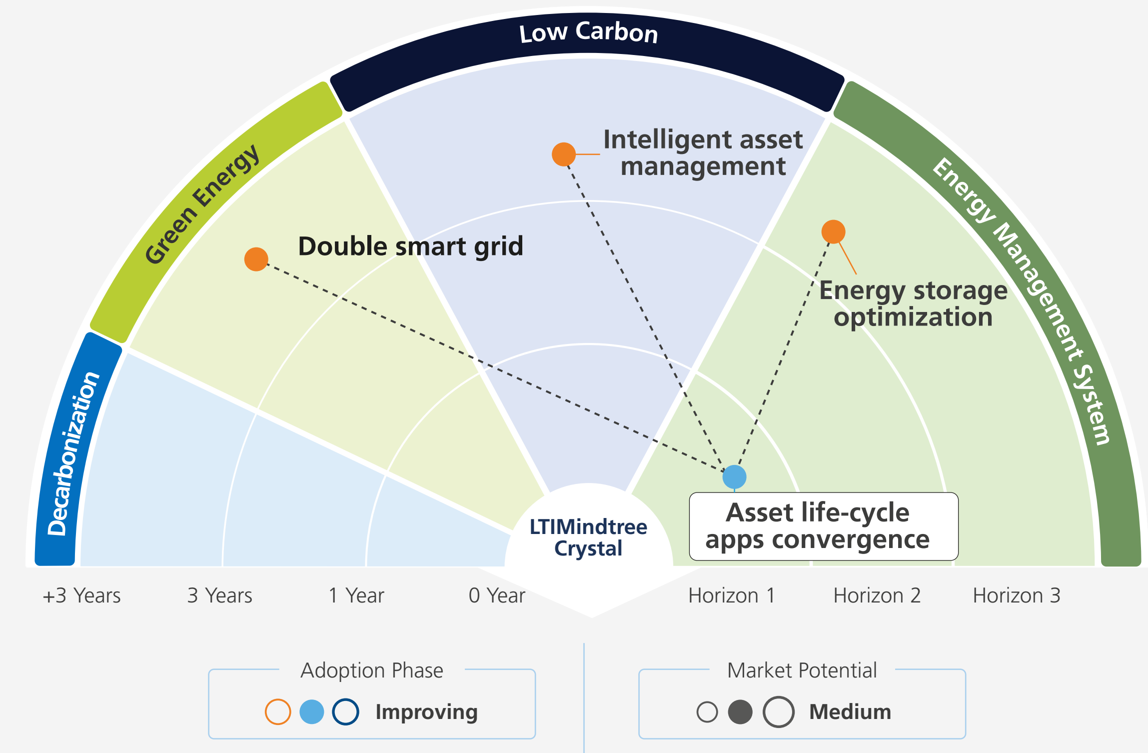
Asset Lifecycle Apps Convergence

Asset lifecycle apps integrate into the energy transition, focusing on digitalization and optimization. They manage renewable energy, grid infrastructure, and storage systems throughout their lifecycles. This shift prioritizes sustainability, efficiency, and cleaner energy sources in the energy sector's generation, distribution, and consumption. Asset lifecycle applications manage energy assets, including grid infrastructure, ESSs, and renewable energy installations.

Highlights

There's a notable trend toward converging technology assets with operational assets in energy and related industries. This integration enhances efficiency and decision-making by linking IT and Operational Technology (OT) systems. Key examples include Supervisory Control and Data Acquisition (SCADA), Geographic Information System (GIS), Enterprise Resource Planning (ERP), and cybersecurity systems, which are vital for managing energy infrastructure. OT encompasses physical devices like sensors and controllers that automate and optimize operations. The emergence of digital oilfields leverages analytics and real-time data from OT and IT to predict and optimize asset performance. Incorporating Engineering Technology (ET) further enhances this convergence by integrating digital models with asset data, facilitating efficient modifications and predictive maintenance. Ultimately, these advancements aim to reduce downtime, cut maintenance costs, and improve operational efficiency across the energy sector.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Centralize inspection, maintenance schedules, and repair data to maximize asset uptime and minimize failure.

Energy & Utilities:
Monitor and extend the life of renewable energy assets like wind turbines and solar panels.

Key Technologies

Sensor tech
Real-time data from sensors allows for better decision-making regarding asset management

Digital twin
Simulating assets for lifecycle analysis and performance tracking

Decision intelligence
Proactively managing asset health and performance

Zero trust architecture
Safeguard data integrity and operational reliability across connected systems

Featured Story

A US-based energy equipment manufacturer's solution has integrated remote transformer monitoring and advanced inspection tools into an enterprise asset management platform. This approach reduced emergency interventions by 50%, minimized offshore visits for condition assessments, and optimized maintenance planning, ensuring efficient operation despite challenging weather conditions and safety constraints.

Key Takeaway

Asset lifecycle app convergence is crucial for environmental sustainability and accountability. Centralized orchestration using AI/ML and common platforms enables rapid innovation and operational excellence in energy and utilities.

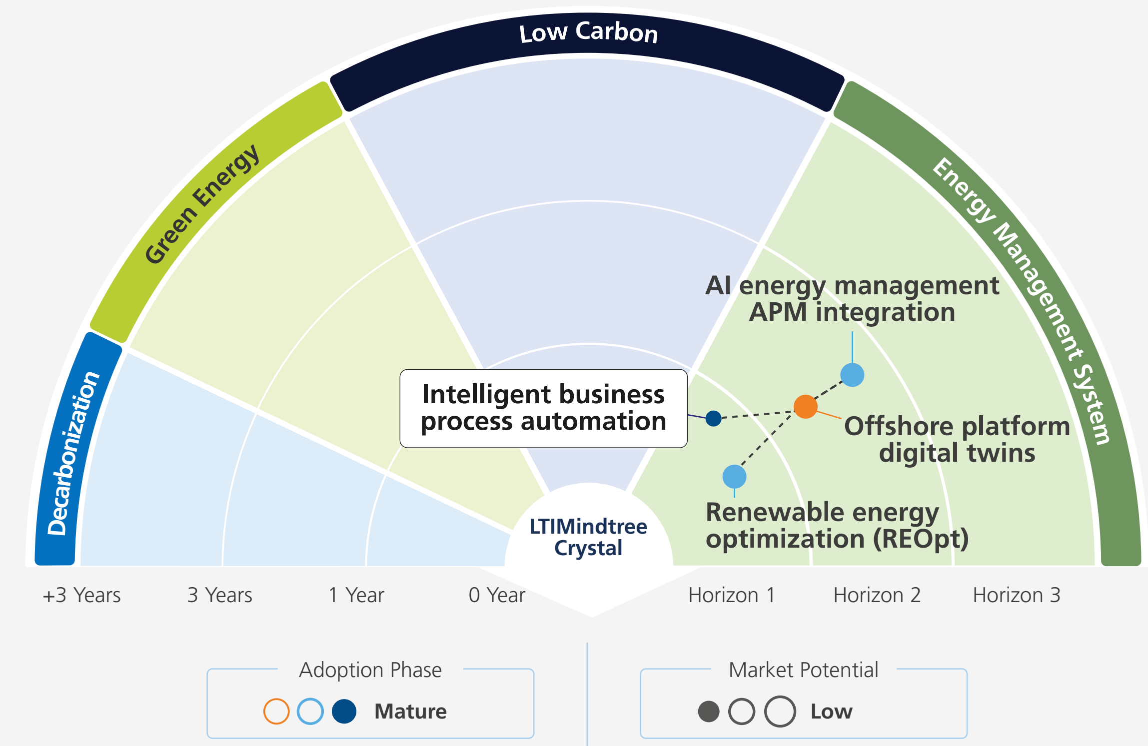
Intelligent Business Process Automation

Intelligent Business Process Automation (BPA) is revolutionizing oil, gas, and utilities by enhancing efficiency, optimizing processes, and supporting data-driven decisions. Key advancements like Intelligent Process Automation (IPA) and low-code tools enable scalable solutions for carbon capture, hydrogen infrastructure, lithium mining, battery production, and biofuels. Thus improving energy efficiency and reducing emissions across the value chain.

Highlights

BPA in the energy sector is rapidly evolving, driven by advancements in AI, ML, and IoT. These technologies enable predictive maintenance, reducing costs by 25%-30% and minimizing unplanned outages by up to 75%. Digital twins are enhancing operational efficiency and decreasing downtime. Automated Demand Response (ADR) systems optimize energy consumption, achieving peak load reductions of up to 15% and lowering carbon emissions significantly. Automation also facilitates the seamless integration of solar and wind energy into the grid, supporting renewable energy growth. Strategic adoption of AI technologies like ChatGPT and Microsoft CoPilot, alongside automation tools like Figma and HubSpot, is pivotal in driving sustainability and efficiency across the energy industry, poised to meet future renewable energy targets.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Improves supply chain management by automating inventory tracking, procurement, and logistics

Energy & Utilities:
Automate load balancing for stable energy distribution, simplifying billing processes for accurate and timely invoices

Key Technologies

Machine learning
Predictive analytics for maintenance, production, and demand forecasting

Hyperautomation
Streamlining repetitive tasks like reporting and billing

Gen AI
Simplify workflow automation and application developments

Edge AI
Enable real-time fault detection and load balancing of the edge devices to maintain optimal performance

Featured Story

An intelligent automation and consulting company integrated Router PWI and PGNIG E-BOK systems with their CRM to streamline business processes for Swiss power producers. This automation facilitated supplier changes, automated prosumer settlements, streamlined invoice issuance, enhanced partner communication, and updated CRM prices. This significantly improved operational efficiency and response times to energy price changes.

Key Takeaway

Intelligent automation supports in integrating renewable energy sources, boosting sustainability. Automated systems offer real-time energy usage data for quick optimization, while AI-driven predictive maintenance extends equipment lifespan.

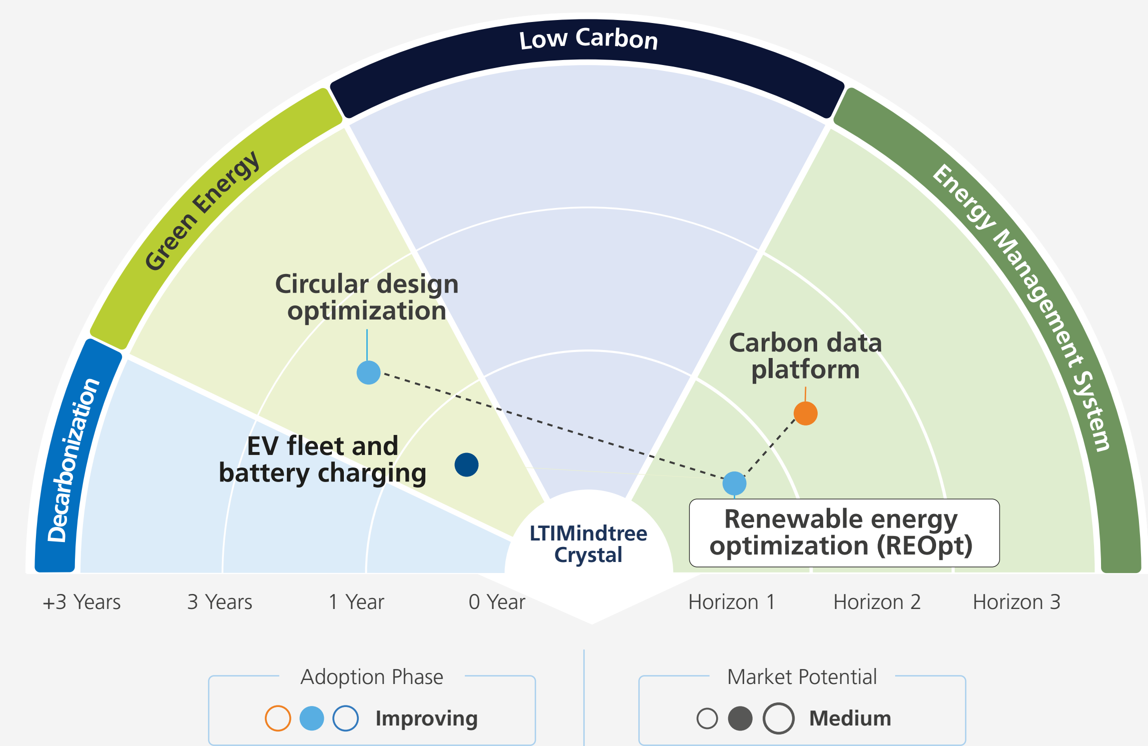
Renewable Energy Optimization (REOpt)

The process of optimizing renewable energy systems, such as solar, wind, hydro, and biomass, to maximize their efficiency, performance, and sustainability is known as renewable energy optimization. It focuses on maximizing the value and effectiveness of energy storage systems through system design, dispatch strategies, grid integration, and market participation. It drives a decrease in Greenhouse Gas (GHG) emissions and energy costs while it increases reliability and energy security.

Highlights

Renewable energy is prone to variability and intermittency due to changing weather conditions. Power companies usually implement optimization techniques such as smart grid integration, advanced forecasting, and Energy Storage Systems (ESS) to undermine the effects and provide a stable and reliable power supply. Re-optimizing renewable energy makes it competitive and cheaper than fossil-based power sources. Further advancements in technology, such as data-driven decision-making and intelligent monitoring systems, enable real-time optimization of renewable energy systems. ESSs are increasingly used to store excess power for lean periods. This plays a crucial role in enabling and promoting REOpt while fully utilizing the potential of renewable energy sources.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Enhance efficiency to lower carbon emissions and shift to sustainable energy.

Energy & Utilities:
Store intermittent power from renewable sources to be used during high-demand cycles

Key Technologies

Gen AI
Analyze usage data to optimize production and storage costs

Sensor tech
Continuously monitor renewable energy for better optimization

Industry cloud platforms
Facilitate real-time data analysis, predictive modeling, and remote monitoring

Edge AI
Enhance grid stability and optimize renewable ESSs

Featured Story

LTIMindtree created a "Map Library" for a geoscience tech company, enabling visualization of geographical data (satellite, constraints, wells, wind suitability, solar suitability). The library also included an optimized site selection tool with zones for wind, solar, forests, and water. The company now benefits from automated site selection that is aligned with investor needs and supports carbon schemes and renewable investments.

Key Takeaway

Optimizing energy production and distribution significantly lowers renewable energy costs, enhancing competitiveness with traditional sources. Techniques ensure solar and wind are fully utilized, reducing waste and boosting overall efficiency.

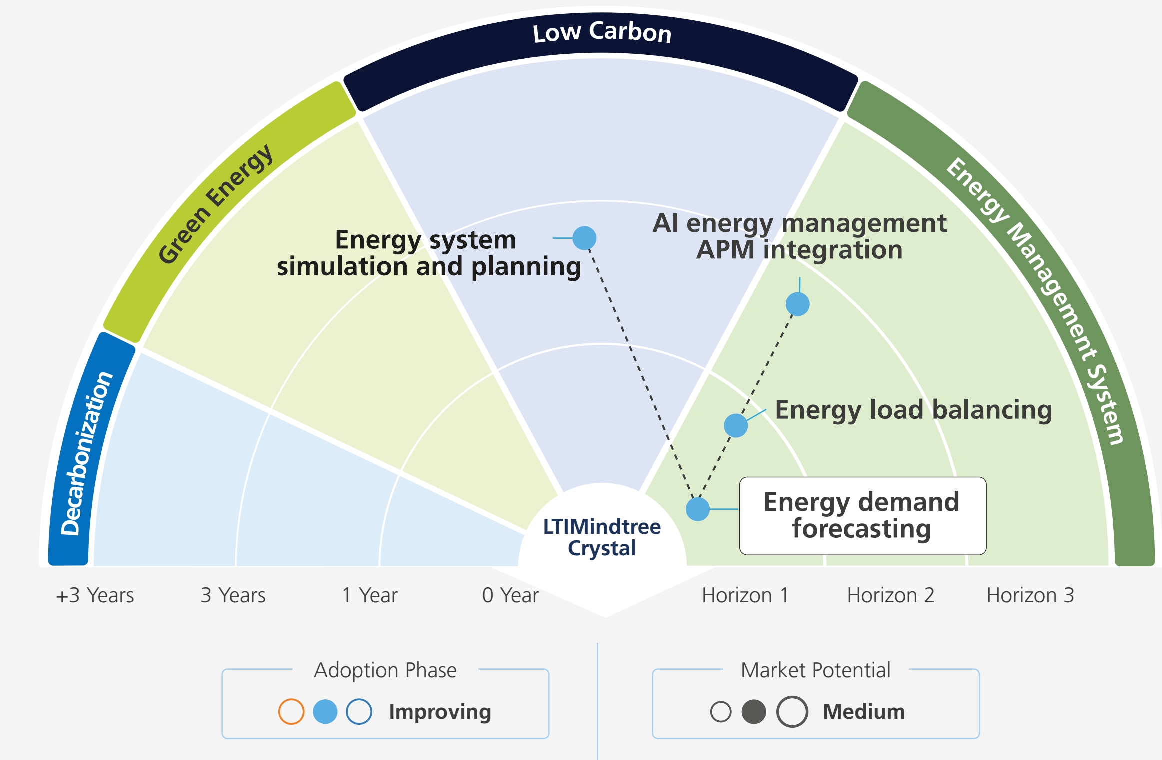
Energy Demand Forecasting

Energy demand forecasting plays a crucial role in predicting the future energy requirements for households, industries, and regions. It considers factors like weather patterns, economic activities, population trends, and technological advancements. Accurate forecasting empowers energy providers to allocate resources efficiently, plan infrastructure, mitigate risks, and optimize costs. However, traditional methods often struggle due to the intricate and variable nature of energy consumption patterns.

Highlights

Energy demand forecasting becomes an essential part of the generation process since it gives an appropriate estimate of required power demand at any given time. This reduces the over-generation of power, maintains the balance and stability of the grid, and helps in complying with sustainability goals. With stability and greater reliability, it leads to greater efficiency and cost savings. Energy demand forecasting is an enabling factor to incentivize consumers to reduce power use at peak demand periods. It helps in strategic planning decisions such as infrastructure development, maintenance scheduling, capacity planning, etc. Energy demand forecasting can be done on a short, medium, and long-term basis. It has its limitations, making it difficult to forecast power from renewable energy sources due to its nature.

Radar View & Related Trends



Industry Use Case

Energy & Utilities:
Optimize energy generation as per demand to avoid excess production and save costs.

Oil & Gas:
Optimize production to minimize the difficulties in storage and supply of natural gas.

Key Technologies

Machine learning
Analyze data to forecast energy use by recognizing patterns and correlations

Internet of Thinking
Provide real-time data for predicting future demand more accurately

Distributed cloud
Leveraging distributed cloud's computational power enables the deployment of advanced ML models for more accurate energy demand predictions

Gen AI
Analyze consumption patterns and environmental factors to predict precise demand forecasting

Featured Story

An Indian electric utility company enhanced its distribution services by implementing AI and ML tools to monitor demand. They adopted Auto Transfer Schemes (ATS), LoRa IoT solutions, and Feeder Remote Terminal Units (FRTU) in Distribution Sub-Stations (DSS) and Customer Service Stations (CSS). Regular network monitoring included thermal scanning of transformers, feeder pillars, and cables.

Key Takeaway

Energy demand forecasting with high accuracy is a critical mechanism that helps maintain the grid's balance and stability. These systems are not new but the advent of newer ML models for forecasting has transformed this field.

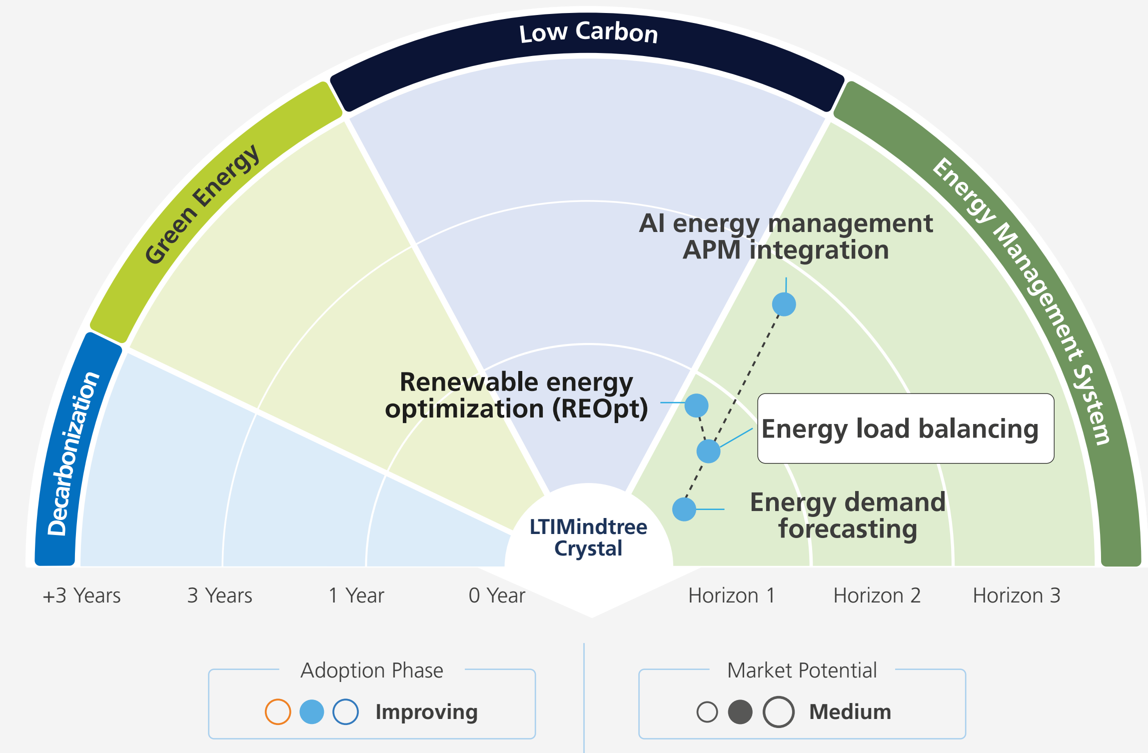
Energy Load Balancing

Energy load balancing refers to the process of integrating the supply and demand of renewable electricity in real-time using various techniques. The primary aim is to maintain the system's voltage stability and frequency by storing and releasing excess power during high demand and vice versa. It plays a crucial role in ensuring the reliable and efficient integration of renewable energy sources and optimizing the overall energy system.

Highlights

As more and more sectors are electrified, including vehicles, the demand for electricity is rising. Producing electricity from renewable sources poses its own challenges due to its intermittent nature driven by weather conditions. These factors make energy load balancing crucial for managing fluctuations and maintaining overall grid stability. Implementing energy load balancing enables efficient energy distribution, avoids wastage, helps conserve energy, and contributes towards reducing carbon emissions. The energy load balancing system draws electricity from the grid by continuously monitoring available capacity and demand. It promotes integration and EV adoption as excess electricity can be easily stored and used during peak demand. Consumers benefit greatly since they can consume more electricity at reduced prices during non-peak hours.

Radar View & Related Trends



Industry Use Case

Energy & Utilities:
Effectively manage power distribution and excess loads.

Oil & Gas:
Manage natural gas supply and demand for stable, efficient distribution.

Key Technologies

Machine learning
Allocate resources, predict demand, and manage workloads efficiently to reduce waste

Edge AI
Locally processes data, minimizing latency and allowing instant adjustments to energy distribution

Sensor tech
Collect real-time usage information for data analysis and grid stabilization

Ambient computing
Seamlessly integrate computing devices and sensors for load balancing

Featured Story

One of Europe's largest utility provider faced challenges such as load spikes due to mass EV charging and needed to manage congestion with Charging Station Operators (CSOs). They needed to study load consumption patterns across multiple CSOs with a single solution. By implementing an energy load balancing solution, they efficiently controlled the power supply and were able to study load consumption in a secured solution.

Key Takeaway

Energy load balancing is a key enabler for a clean, sustainable, and resilient future. As increased amounts of renewable energy are added to the grid, it is expected to play a major role in maintaining efficiency.

Carbon Data Platform

A carbon data platform within the ESG framework aids businesses in monitoring and controlling their carbon footprint and greenhouse gas emissions. This essential data supports companies in establishing reduction goals and formulating effective strategies to minimize their environmental impact. The growing adoption of such tools since the UN introduced ESG mandates underscores the demand for standardized methods to assess and enhance carbon emission reduction initiatives.

Highlights

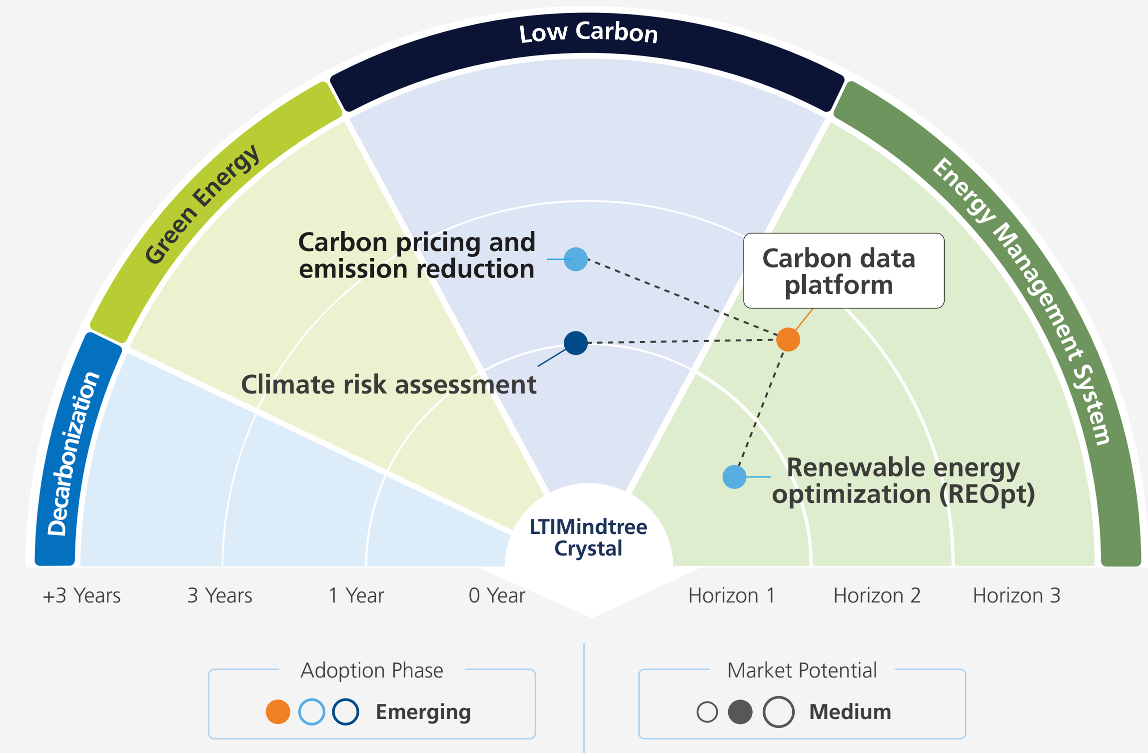
The demand for carbon accounting has surged alongside the global sustainability agenda. Regulatory requirements and stakeholder expectations for transparency have heightened, influencing investment decisions and consumer choices. Initiatives like the Global Reporting Initiative (GRI), Carbon Disclosure Project (CDP), and Science-Based Targets Initiative (SBTI) emphasize robust carbon accounting systems. Modern carbon data platforms integrate AI and ML to enhance accuracy and efficiency, automating measurement, management, and emissions reporting across sectors. Regional policies and economic priorities drive adoption, with China's investments and the EU's regulatory directives shaping global implementation trends Accurate carbon emission data helps energy companies reduce emissions faster, plan better, and track results. This is essential for reaching net zero by improving efficiency and using more renewable energy.

Industry Use Case

Oil & Gas:
Conduct real-time tracking of GHG emissions to ensure regulatory compliance and optimize operations.

Energy & Utilities:
Manage grid load by forecasting renewable energy production and demand fluctuations.

Radar View & Related Trends



Key Technologies

Sensor tech
AI algorithms use sensor data to predict future emission trends and identify areas for improvement

Machine learning
Analyze patterns in emission data to generate actionable insights

Cloud
Facilitates real-time carbon monitoring, integrating data to optimize energy and sustainability

Blockchain
Enable transparent carbon credit tracking and trading

Featured Story

A US-based gas company partnered with a tech provider to deploy a carbon data platform. The platform tracked and verified emissions for precise low-carbon product certification, supporting the company’s net zero targets by 2025. Utilizing advanced analytics and blockchain, the company scaled emissions mitigation, validated reductions, and generated data-backed carbon credits, enhancing its decarbonization strategy.

Key Takeaway

Carbon data platforms evolve with technology and regulations, enabling companies to lead in sustainability with transparency and sector-specific solutions, navigating challenges and seizing opportunities in a low-carbon future.

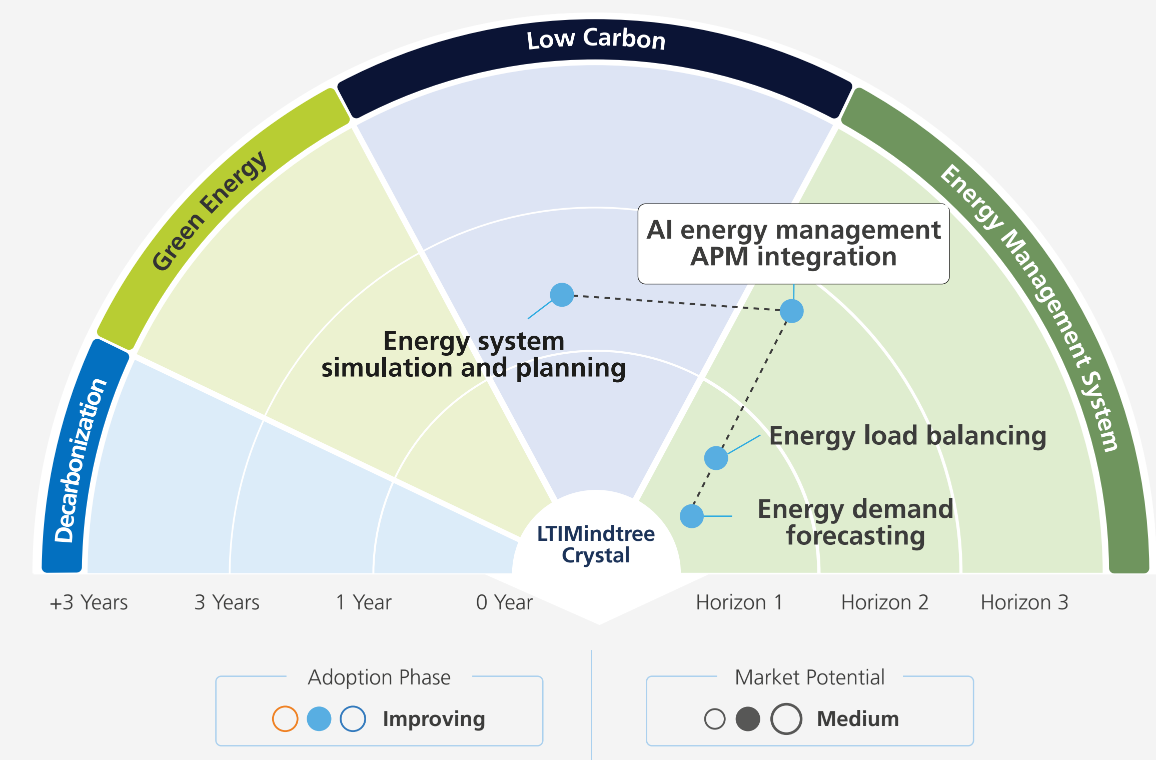
AI Energy Management APM Integration

AI and Asset Performance Management (APM) integration in energy management optimizes energy operations by combining AI-driven predictive maintenance with APM. The key features include real-time monitoring, anomaly detection, efficient resource allocation, and enhanced decision-making. This integration improves reliability, reduces operational costs, and supports the seamless integration of renewable energy sources.

Highlights

The global shift toward renewable energy sources is accelerating, with a growing emphasis on cleaner alternatives. Traditional energy management systems lack adaptability and are not equipped to handle the intermittent nature of renewable energy. Leveraging AI in energy management leads to improved overall performance of renewable power systems, improved decision-making, and enhanced grid integration. Factors such as grid modernization, rising electricity demand, and focus on sustainability and digitalization are increasing the focus on AI integration. AI-integrated energy systems can swiftly identify grid disruptions and respond in real time to fluctuations in energy demand. Moreover, AI significantly enhances the efficiency of CCUS processes by optimizing the capture of CO2 from the atmosphere or emission sources.

Radar View & Related Trends



Industry Use Case

Oil & Gas:
Detect and reduce methane emissions while optimizing energy usage in operations

Energy & Utilities:
Increase efficiency through demand forecasting, predictive maintenance, grid management, etc.

Key Technologies

Gen AI
Process data to predict and respond to energy demand

ML
Analyze energy consumption based on trends to optimize usage and improve efficiency

Decision intelligence
Automate the collection and analysis of data required for sustainability reporting

Sensor tech
Monitor real-time temperature, pressure, vibration, and energy data to ensure asset health

Featured Story

A prominent French energy provider operating in Israel implemented an AI and ML platform. This system analyzes energy meter data from solar farms, enhancing energy trading decisions. It automates electricity generation and consumption forecasts for utilities, Independent Power Producers (IPPs), and grid planners. Additionally, it conducts profit analyses based on predicted and actual revenues from end customers, integrating with billing systems for consumption data and invoicing.

Key Takeaway

AI is a game-changer in renewable energy and grid management. It provides innovative solutions to address critical challenges and empowers energy management by leveraging data-driven insights, optimizing resource usage, and supporting the transition toward cleaner energy sources.

Advanced Custody Transfer

Advanced custody transfer involves tracking and overseeing the supply needed for energy generation and other activities if required. The objective of advanced custody transfer is to ensure a consistent flow of materials and components needed for energy production, especially renewable energy. By maintaining a resilient supply chain, organizations can support the uninterrupted progress of the energy transition and sustainability.

Highlights

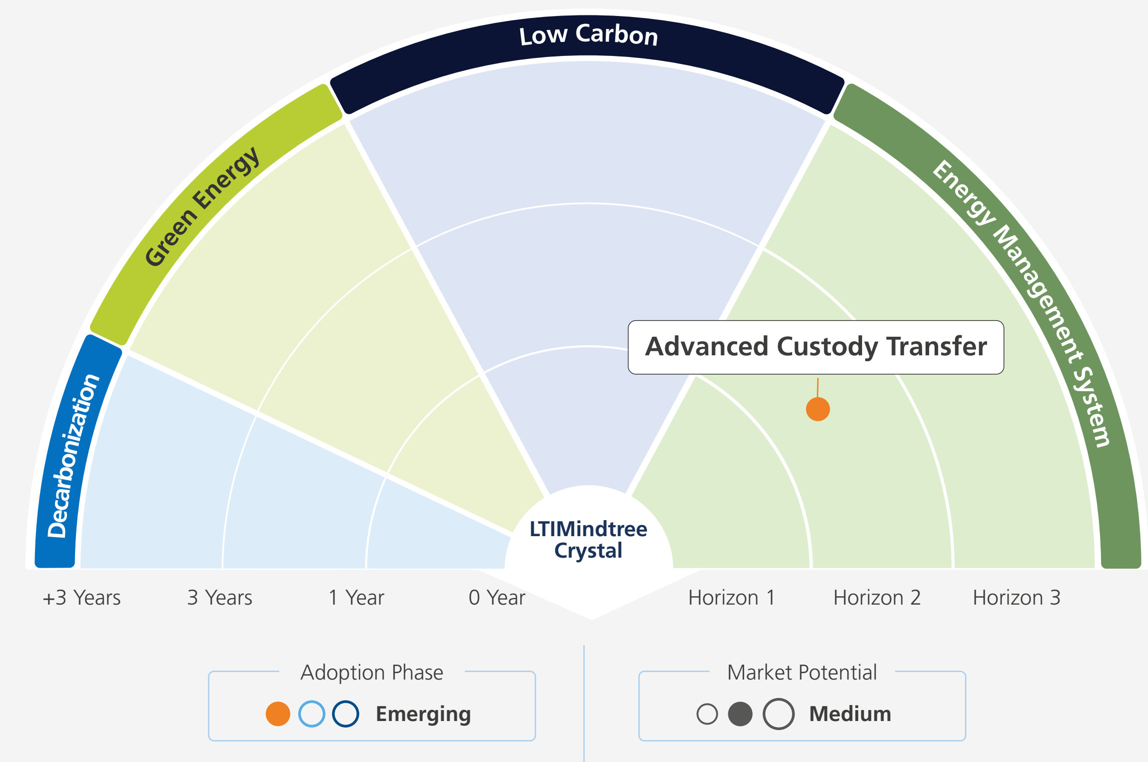
Raw materials play a critical role in the energy transition lifecycle. Diversifying energy sources is the first step toward a shockproof energy transition. This involves evaluating factors such as climate, transportation, geo-political vulnerability, technologies, etc. Organizations must diversify and localize the supply chains for critical raw materials, invest in recycling and R&D around substitute materials, explore opportunities for vertical integration, and decrease price volatility. For better custody transfer, companies can increase the use of blockchain technology for transparency, real-time tracking of carbon emissions, and the integration of AI for predictive analytics. These advancements are helping companies better manage their environmental impact and make more informed decisions regarding their supply chain practices.

Industry Use Case

Oil & Gas:
Encourages diversification by eliminating single-source dependency on supply.

Energy & Utilities:
Use high-precision flow meters and sensors to accurately measure transferred commodities, reducing discrepancies and financial losses.

Radar View & Related Trends



Key Technologies

Edge computing
Enable data processing near the source for faster decision-making

Distributed cloud
Scale to accommodate increasing data volumes and transaction loads

Sensor tech
Real-time monitoring of supply chain in transit logistics to identify anomalies quickly

Decision intelligence
Enable enhanced decision-making abilities based on the real-time data

Featured Story

An American multinational energy corporation has set up supply monitoring stations across its operating countries. These nerve centers are enabled with advanced automation and IoT devices that monitor the supply of O&G to the refineries 24/7. This monitoring has helped the corporation ensure an uninterrupted supply of materials to the oil refineries, generating the desired output in all weather conditions.

Key Takeaway

Advanced custody transfer for hydrogen ensures accurate and reliable measurement during ownership changes. Key aspects include using ultrasonic and Coriolis meters for high accuracy in varying conditions, and leveraging Cloud and AI for precise flow measurement.

Offshore Platform Digital Twins

Offshore platform digital twins, essential in the operational and maintenance phase of the energy transition, enhance efficiency, safety, and sustainability for offshore wind farms. These virtual replicas simulate real-time behavior using sensor data and monitoring systems. Digital twins allow operators to monitor, analyze, and optimize offshore platforms, ensuring dynamic and comprehensive asset management in renewable energy generation.

Highlights

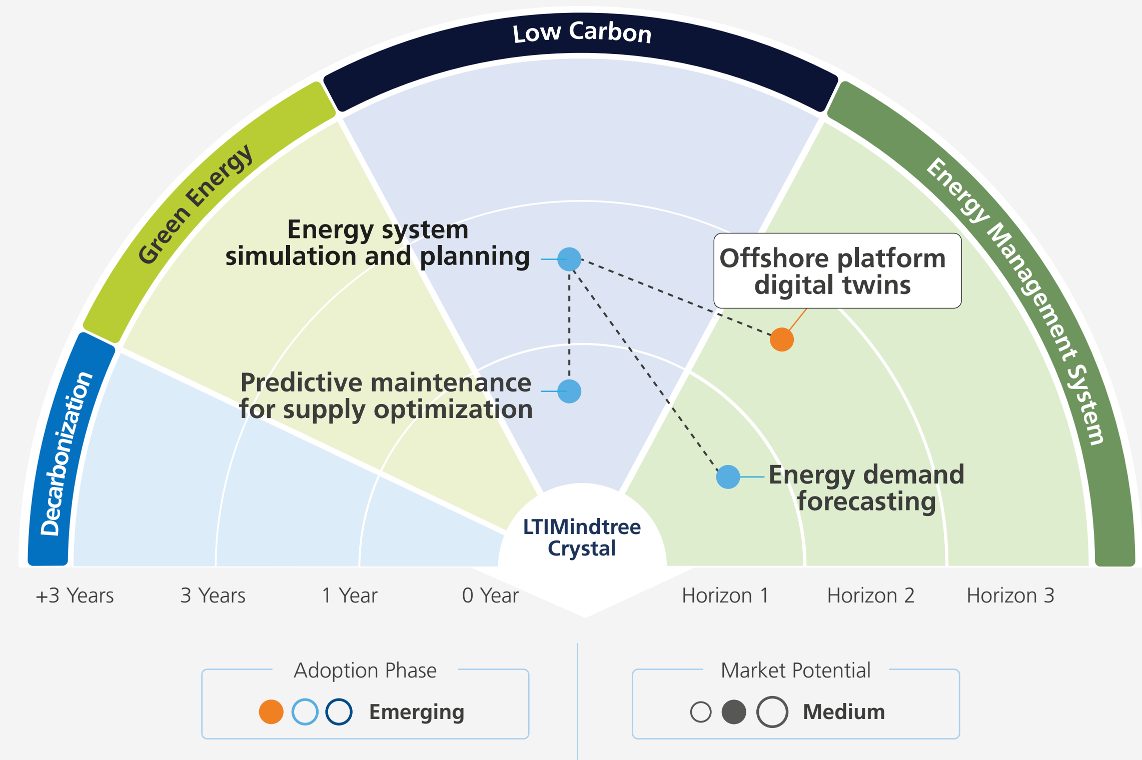
Digital twins in offshore applications leverage AI and real-time analytics to enhance asset performance and safety while reducing carbon footprints. Initially used in O&G facilities, digital twins now optimize operations across pipelines, refineries, and petrochemical complexes. They enable remote monitoring, predictive maintenance, and dynamic modeling. Stats show significant cost savings; for instance, implementing digital twins saved over 2 million euros in North Sea projects. They predict 9% to 15% savings in decommissioning costs. Gartner predicts widespread adoption, enhancing operational effectiveness by 10%. Digital twins also improve workplace safety through smart wearables and real-time monitoring, enhancing productivity and safety in offshore environments.

Industry Use Case

Oil & Gas:
Identify potential equipment failures to minimize downtime and costs

Energy & Utilities:
Stabilize offshore platforms and impart trainings with virtual simulations for hazardous environments.

Radar View & Related Trends



Key Technologies

Virtual Reality
Provides immersive 3D visualizations of offshore platforms, enabling engineers to interact with digital twins realistically

Digital twin
Create virtual models for real-time asset monitoring and analysis

Sensor tech
Collect real-time data from offshore equipment and infrastructure

Machine learning
Predictive analytics for maintenance and optimization leveraging real-time data to enhances the efficiency and reliability of offshore operations

Featured Story

A leading UK-based fuel provider utilizes cutting-edge digital twin software, like APEX System, to enhance operations. Deployed globally, APEX maps production cycles, optimizes processes, and predicts scenarios. For instance, APEX on platform Argos increased production by 30,000 barrels in the Gulf of Mexico. This comprehensive simulation tool accelerated engineering tasks, enabling rapid production simulations and efficiency gains across its operations.

Key Takeaway

Digital twins in energy transition enhances operational efficiency, minimizes costs and boosts safety. Real-time simulation enables proactive decision-making, preventing downtime and optimizing resource use for increased profitability and sustainability.

Energy Storage Optimization

Energy storage optimization is a key component of the energy transition value chain, falling under the domain of energy management and grid operations. The trend focuses on maximizing the value and effectiveness of energy storage systems through system design, dispatch strategies, grid integration, and market participation. Optimizing energy storage operations contributes to the efficient integration of renewable energy, grid stability, and economic viability of the energy system.

Highlights

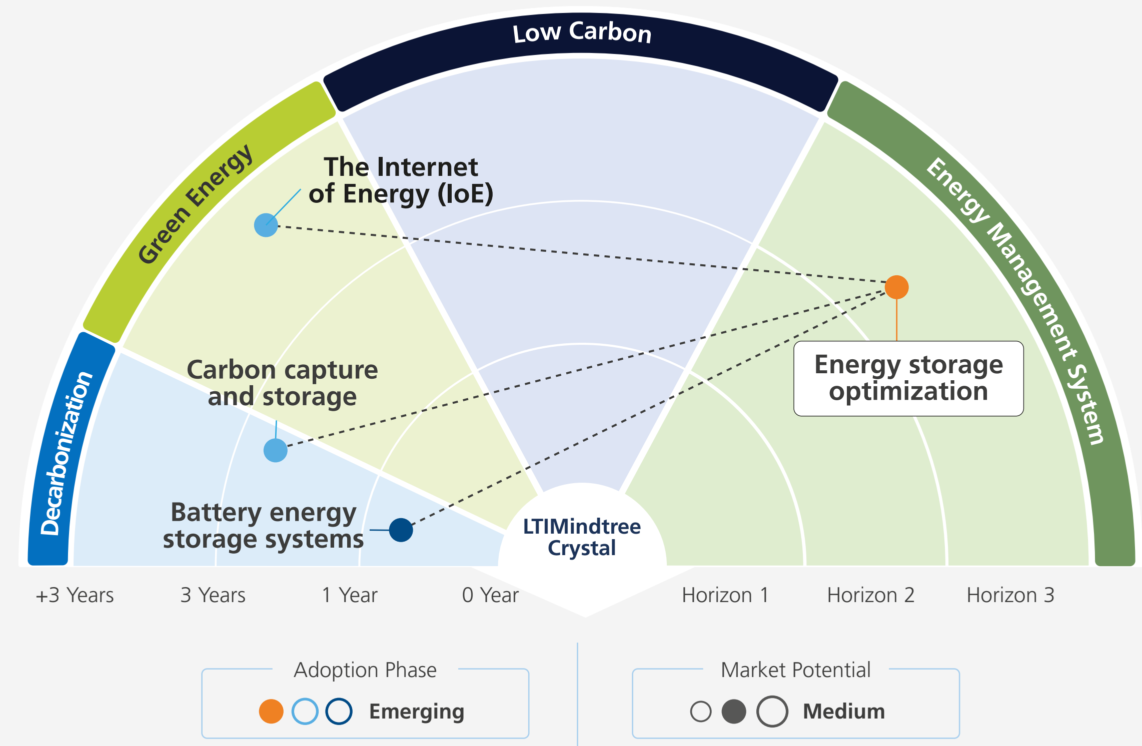
The energy ecosystem is experiencing a spike in electrical storage systems. It ensures on-demand availability and ensures grid stability. Energy optimization and storage stabilize ever-changing energy demands. Energy storage systems have many use cases in remote areas where electricity supply remains staggered. They offer greater opportunities and flexibility in operations. The decreasing cost of batteries remains the primary factor in the increased usage of optimized ESSs, coupled with factors such as increased efficiency, reliability, and affordability. Sodium-ion batteries are slowly being developed as an alternative to lithium-ion batteries, widely adopted for grid-oriented rechargeable electrochemical BESS. McKinsey expects the global BESS market to be valued at around USD 150 billion by 2030, more than double its size from 2023.

Industry Use Case

Energy & Utilities:
Store excess power produced and supply during peak demand cycles.

Oil & Gas:
Integrate hybrid power for effective and reliable gas operations.

Radar View & Related Trends



Key Technologies

Gen AI
Optimize battery efficiency and lifespan by predicting ideal charge times

Decision intelligence
Improve battery efficiency, ensuring battery charging at optimal times

Distributed Infrastructure
Distributed batteries store excess renewable energy and release it as needed, balancing supply-demand

Low-power, wide-area network (LPWAN)
Enables efficient communication and data management for optimizing efficient storage systems

Featured Story

A Finnish food manufacturer implemented a 10 MWh Thermal Energy Storage (TES) system to decarbonize steam production. This TES system supplies 3,000 MWh of steam annually, eliminating emissions from process heating and cutting energy costs by USD 140,000. The Energy-as-a-Service (EaaS) model reduces upfront expenses and financial risks while ensuring stable energy costs and grid demand response participation.

Key Takeaway

Energy storage and optimization is gaining prominence for addressing market challenges such as power supply during high-demand periods and maintaining grid instability caused by integrating renewable sources into the main grid.

Decentralized Energy Systems

Decentralized Energy (DE) systems reduce transmission losses by locating energy production facilities near energy consumption centers. These systems efficiently use renewable energy sources like solar, wind, and biomass. These systems can incorporate renewable energy sources tailored to local resources and needs. This ensures a resilient and reliable energy supply, reducing reliance on fossil fuels and enhancing eco-efficiency.

Highlights

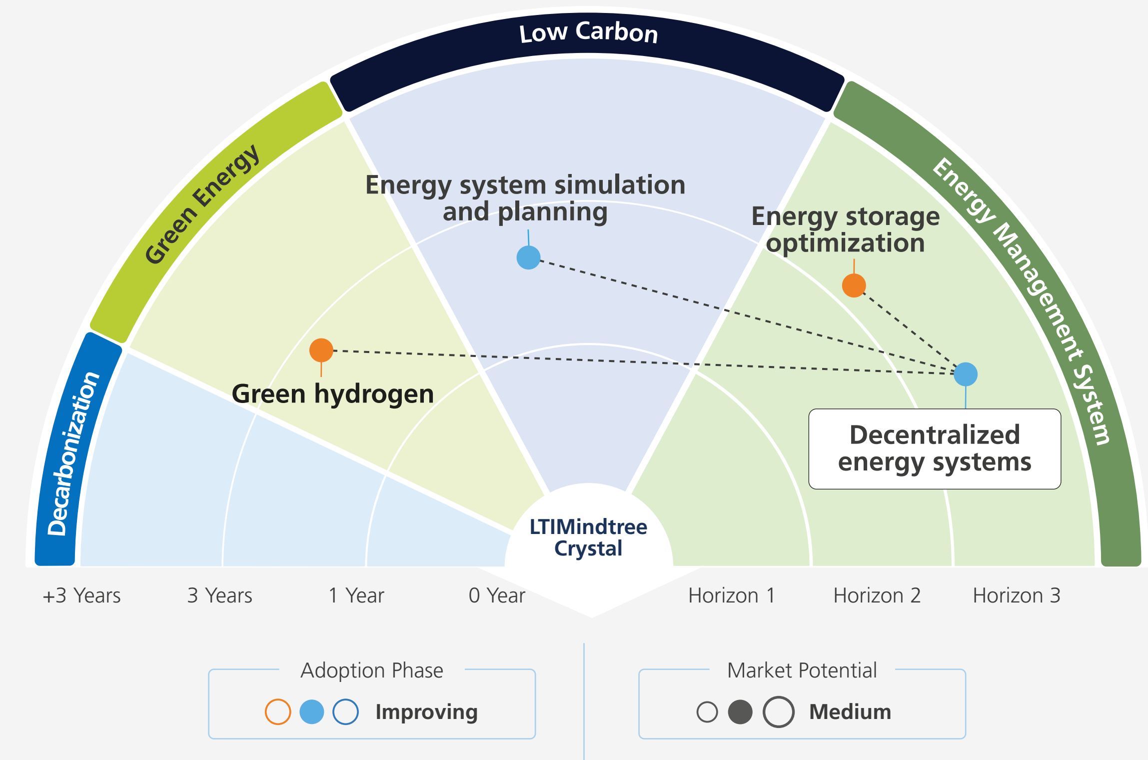
DE systems are key to the global energy transition, moving from fossil fuels to sustainable, renewable sources. Compared to large power grids, decentralized systems are more reliable and cost-effective, as they are less prone to failures and inefficiencies. Worldwide, countries are exploring DE systems to tackle energy challenges, especially in low- and middle-income regions. DE systems, such as mini-grids and stand-alone setups, can extend electricity access to remote and underserved communities, promoting social and economic development. Developing localized power systems to meet energy demands is a global effort. To get the most out of DE systems, it's important to address environmental issues by managing old PV installations and batteries effectively while also improving technology and supporting policies.

Industry Use Case

Energy & Utilities:
Minimize the energy lost during transmission over long distances.

Oil & Gas:
Use decentralized energy systems to reduce GHG emissions.

Radar View & Related Trends



Key Technologies

Satellite internet
Allows for the remote management of energy assets, reducing the need for on-site personnel

Machine Learning
Enhances the efficiency of Distributed Energy Resources, including solar panels, wind turbines, and energy storage

Sensor tech
Enable connected devices and systems for real-time monitoring and control of energy use

Decision intelligence
Adjust energy consumption based on supply conditions to balance the grid

Featured Story

Rural Kenya has long struggled with unreliable electricity access. In 2018, a DE project was launched, installing solar-powered microgrids in several rural communities. This initiative provided a reliable and sustainable electricity source to over 5,000 households, schools, and small businesses, significantly enhancing their quality of life. The project marked a pivotal step towards addressing the region's energy challenges and promoting sustainable development.

Key Takeaway

Off-grid areas in Africa and Asia are crucial to future energy decentralization. It will take USD 11 billion to connect all homes by 2030 and would be mostly driven by technologies such as smart grids and microgrids.

Acknowledgement

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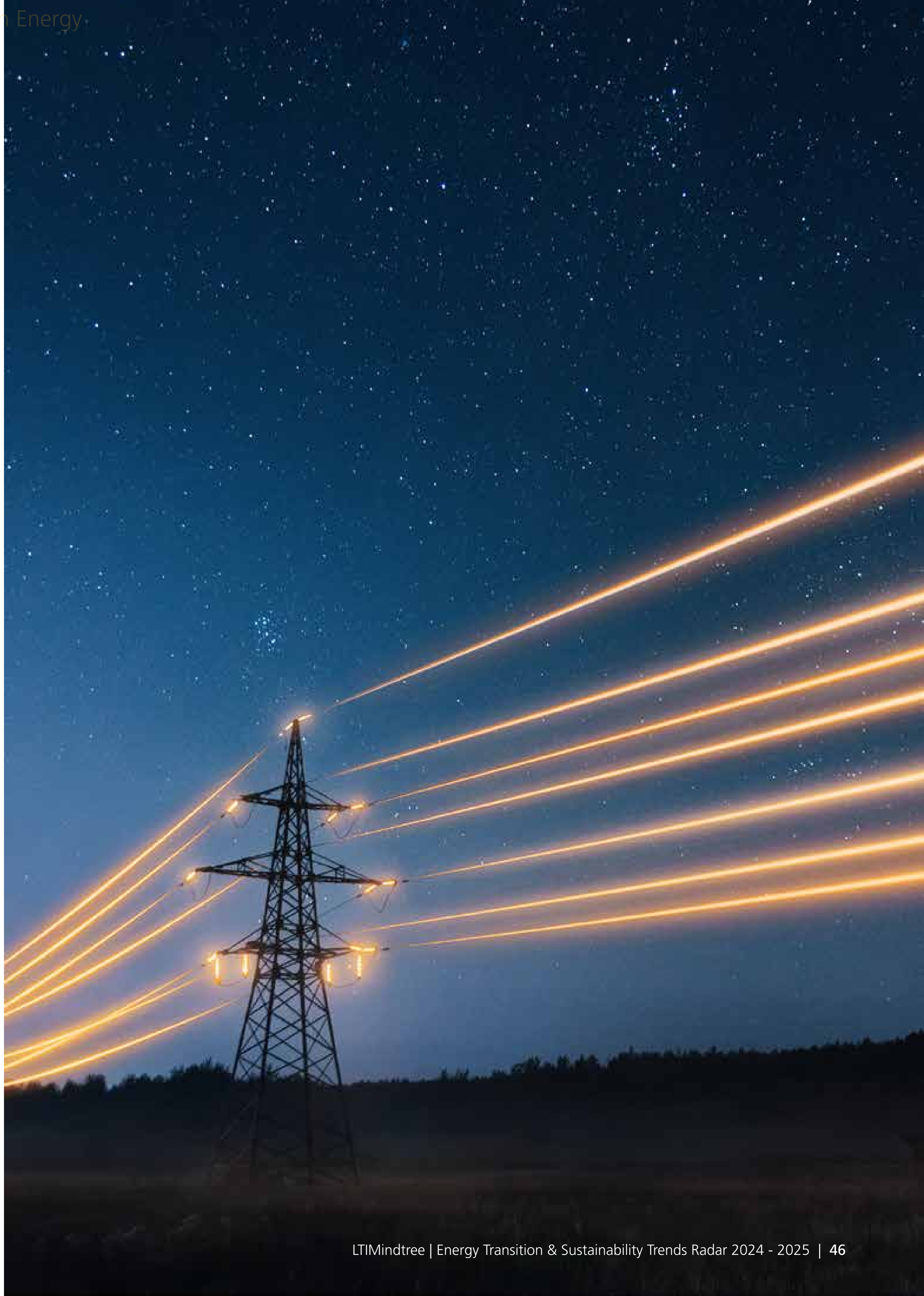
Glossary

BESS	Battery Energy Storage System
EIA	Energy Information Administration
TPA	Tons per annum
BRF	Biodiversity Risk filter
CCS	Carbon Capture and Storage
IEA	International Energy Agency
OECD	Organization for Economic Co-operation and Development
OSDU	Open Subsurface Data Universe
NLP	Natural Language Processing
PW	Produced Water
GH2	Green Hydrogen
DPP	Digital Product Passport
EEA	European Environmental Agency
SBEM	Simplified Building Energy Model
CLCPA	Climate Leadership and Community Protection Act
GIS	Geographic Information System
DE	Decentralized Energy



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