BROCHURE

Advance the energy transition

LET'S GO

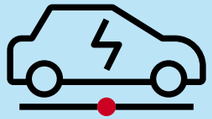
UL Solutions

Safety. Science. Transformation.™

The debate is over. And the time for rapid energy transition is now.

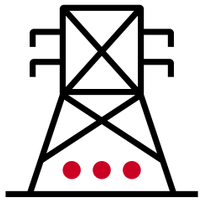
Decarbonization of power generation

Decarbonization of transportation



Safer, more sustainable energy storage

Grid resilience



Built environment

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Table of contents

Introduction

As the effects of climate change grow more obvious, the momentum behind the transition to clean energy is accelerating rapidly.

New and emerging technology is making the transition to clean energy possible. Many consumers, investors and industry players are agitating for this change, and governments around the world are making heavy investments toward decarbonization.

In fact, a decarbonized future is so bright that the potential is almost overwhelming. However, setting strategy, making smart investments and measuring progress are often challenging, particularly as technological innovation outpaces new standards. This gap between innovation and standards development, while predictable, creates uncertainty for all stakeholders, from regulators to manufacturers and beyond.

UL Solutions brings calm to this complexity, with independent guidance that helps organizations make confident choices for a greener tomorrow. We offer customers our encyclopedic knowledge of current and emerging standards plus cutting-edge services and software, all to speed energy transition activities and help safeguard safety, security and sustainability.

From anticipation to action

How understanding core challenges helps customers make real progress

During times of change, we must step back and examine the issues that hold back progress and address them directly.

Innovations driving rapid technological change, by their very nature, go beyond the remit of existing standards. Manufacturers understand the important role their products play in advancing the transition and addressing the climate crisis; 94% of executives agree — safety is pivotal to a successful energy transition. When existing safety standards do not address the new features or capabilities, Outlines of Investigation offer a path to addressing safety concerns based on sound science and demonstrating compliance.

Outlines of Investigation enable our customers to build confidence in the safety of their innovations while meeting the demand for rapid deployment of new technologies. They also serve as an early pathway to standardization as Outlines of Investigation often inform standards that regulators ultimately adopt into codes and directives. In addition, our energy transition experts actively participate in hundreds of relevant standards panels and industry working groups. Our professionals help build consensus between manufacturers and regulators to achieve necessary accord between these disparate stakeholders and empower much-needed standards harmonization.

In-house regulatory knowledge and capabilities

Rapidly evolving sectors like green energy have a regulatory environment that varies in maturity by market — even by state or municipality. For example, bidirectional energy flow from EV charging cables and microgrid systems rely on IoT connectivity that opens the door to cybersecurity and interoperability challenges. Devices and systems must demonstrate compliance, and assets must be secure.

Staying on top of these changes requires constant vigilance to monitor the regulatory landscape and pivot manufacturing, design and compliance activities. UL Solutions has teams of professionals dedicated to investigating regulatory updates and communicating portfolio impact.

Automotive-specific services that empower new mobility

Advanced safety and cybersecurity are growing more integral as autonomy, connectivity, electrification and shared mobility transform logistics and personal transportation. As competition and innovation increase, EV providers must strike a balance between ultra-fast development cycles and demonstrating compliance in a more complex technical landscape. UL Solutions connects the entire automotive industry — and new mobility, too — with services that support innovation and the guidance of safety science leaders to unlock opportunity.

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Manufacturer testing, modeling and assessment capabilities

Consider products that feature lithium-ion batteries, from the power pack in a mobile phone to a rapidly charging EV system. These items are so energy dense that they can pose significant safety risks, but conducting testing requires specialized facilities designed to handle intense heat and dangerous off-gassing, and subsequent fire and explosion hazards. Manufacturers rarely invest in this kind of in-house testing.

Learn more about our new UL Solutions EV and industrial battery testing lab in Auburn Hills, Michigan, on the following page.

To obtain financing for power generation projects, advanced modeling and analysis may be required throughout the project using granular and custom insights. UL Solutions accesses proprietary and public data, plus our own software and professional guidance, to perform feasibility studies, site assessments, performance analysis and more.

Supply chain headaches

In an increasingly complex global supply chain, problems happen. It's just inevitable. However, renewable energy production, use and storage projects are critical to making society run. As we move toward decarbonization in these areas, businesses must gain insight into all suppliers, form contingency plans and understand how the regulatory environment will impact substitutions. Our deep reserve of regulatory insight and subscription-based data sets can help boost resilience along the supply chain.

New North America Advanced Battery Lab

With batteries and other energy storage systems so critical to the success and pace of energy transition, manufacturers must demonstrate compliance with safety and performance requirements around the world.

In 2024, UL Solutions will open an advanced battery testing laboratory located in Auburn Hills, Michigan. This facility will feature cutting-edge battery testing equipment and methodologies to deliver comprehensive safety testing and performance services for the EV and industrial battery markets — all under one roof.

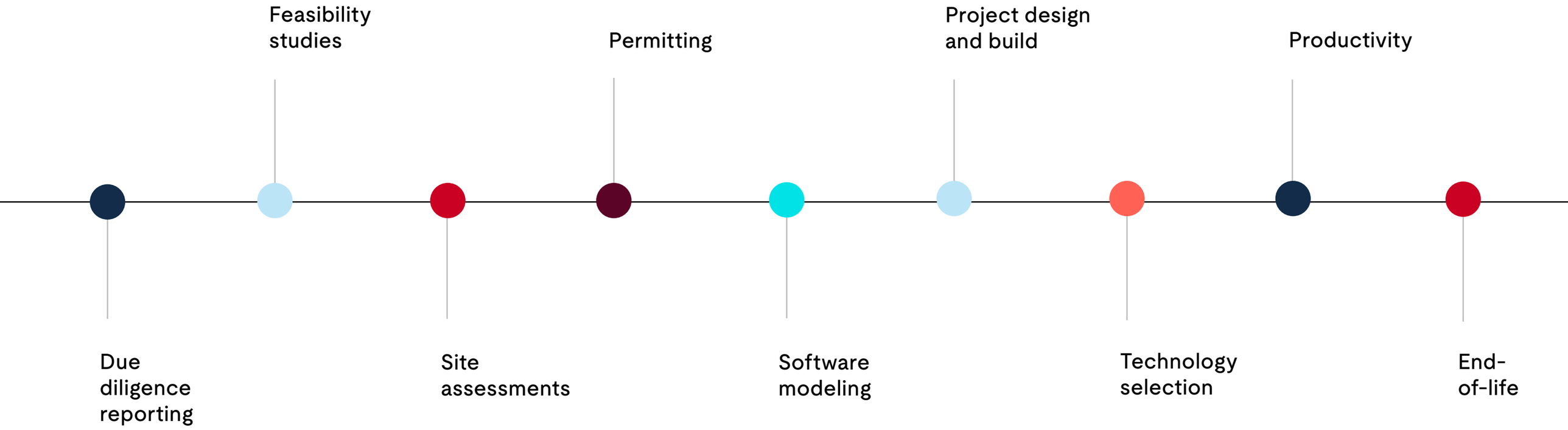
- Testing capability at the battery cell, module and pack level
- Fire testing
- Design verification and product validation
- Electrical, mechanical, abuse and environmental testing based on various UL Standards

This new laboratory complements our worldwide laboratory footprint, with advanced battery testing facilities in Asia and Europe. For the rapidly evolving industrial battery industry, this easier access to safety science expertise will enable shorter development cycles and faster time to market.

SECTION 1

Renewable power project development

Renewable power project development



Green power generation takes off

According to the International Energy Agency (IEA), in 2023 global annual renewable capacity surged by almost 50% to 510 gigawatts (GW). This is the fastest growth rate in the past two decades. China, Europe, the United States and Brazil have achieved all-time renewable capacity levels through significant investments in solar and wind capacity.

This exponential growth, powered by significant public and private investment, is good news for the green energy transition. In the race toward a greener future, power producers must carefully plan projects to help ensure financial viability, productivity and operational safety.

From design to build and beyond

UL Solutions works closely with power producers during the entire lifecycle of a renewables project, offering services ranging from product or project certification, early-stage feasibility and design, project development and financing, managing operational wind and solar projects, and end-of-life issues.

Our professionals have assessed more than 300 GW of renewable energy projects around the world, in all climates and continents. Every project is different, and every setting unique. UL Solutions provides independent, third-party certification, testing and inspection services that help customers create, install and operate renewable power projects that are guided by a balance of goals, tapping into regulatory, engineering and economic information.

By 2028, global renewable capacity is set to reach 7,300 GW.

Source: IEA, https://www.iea.org/reports/renewables-2023/executive-summary

01

Financing research

Feasibility studies and bankability reports are required to gain financing by demonstrating the viability of a site, exploring technology options and output predictions.

What we offer

- Software modeling
- Field assessments
- Feasibility studies
- Offshore/onshore wind site screening
- Solar site screening
- Permitting efficiencies

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02

Optimize design and assess performance

Right from the start, modeling software and granular site-centric data can guide efficient design and tech selection, and then provide transparent analysis during operations.

What we offer

- Early-stage assessments
- Software products for modeling, design and optimization of microgrids and DERs
- Operational wind and solar energy production reports
- Bankable production reports

02

Selecting certified components and technology

Manufacturers of green technology may be required to have products tested, inspected or certified, or seek these qualifiers to build trust with power producers.

What we offer

- Distributed energy resources certification and assessment
- Grid code assessment, compliance and certification
- Medium- and high-voltage cable systems testing
- Photovoltaic (PV) polymeric materials testing
- PV frames testing and certification
- Stationary engine generator, turbines and controls testing and certification

03

Planning for aging renewable energy projects

As projects mature, power producers need data to make decisions to repower, decommission or conduct life extension to maintain safety and profitability.

What we offer

- Remaining useful life analyses and lifetime extensions
- Wind turbine component evaluations
- Production reports
- Portfolio benchmarking and benefit analyses

SECTION 2

Grid resilience and integration

Democratizing power production for greater stability and security

More and more of us are becoming power producers. Whether through a few solar panels on a home or a full array on a factory campus, today's centralized power grid is rapidly changing via technologies like microgrids and on-site battery storage.

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What is gained from a decentralized approach to power generation?

More efficient
Less power is lost through shorter transmission distances and on-site storage.

Cost effective
Government incentives help defray setup costs, and power producers can realize significant savings on energy bills. Additionally, the advantageous levelized cost of energy for a renewable project must be considered.

Improved resilience
Weather woes and cyberattacks can knock out traditional power grids, but microgrids can minimize disruption.

Advancing change
Many consumers and organizations want to participate in a green-energy future. Early adopters advance goals — including energy equity, environmental justice and energy independence — and drive down costs.

At UL Solutions, we are excited to play an active role in helping the energy infrastructure of tomorrow become the reality for today through continual investment in research, laboratory technology, conformity assessment programs and testing protocols. These efforts empower us to help customers uncover interoperability, fire safety, data protection and other challenges that must be addressed in a decentralized grid system.

Manufacturers and power plant developers can increase energy sustainability while maintaining power resiliency through streamlined certification activities.

For DER units and components

Utilities are striving to boost resilience through DERs, while still ensuring the safety of users, workers and property. Every country defines its own grid connection requirements differently. This fragmented regulatory environment means that manufacturers of DER units and components struggle to demonstrate compliance with codes and access those customers in need of these key grid resilience products.

UL Solutions simplifies market access efforts for manufacturers of renewable energy generating systems, units and components. Demonstrate compliance for more than 60 grid code standards more efficiently by bundling certifications through one provider.

Our engineers test products at manufacturing facilities or in the field and evaluate:

- Power versus frequency
- Active power control
- Reactive power capabilities and response
- Voltage and frequency protection (ROCOF and fault-ride-through)

For power plant generators

Utility-scale renewable generation and DER systems must satisfy the local grid codes and demonstrate performance before connecting to the grid. Region-specific codes govern installations such as solar power parks, wind installations, energy storage systems, microgrid and DER systems.

With a global network of testing facilities and comprehensive regulatory knowledge, UL Solutions offers engineering services including static and dynamic plant modeling, varied voltage simulation, and field-based inspections to analyze factors such as:

- Power quality
- Short circuiting
- Protection coordination
- Electrical losses
- Load flow
- And more

SECTION 3

Decarbonization of the built environment

How the built environment must adapt

The built environment includes the structures where we live, work, shop, play, study, etc. — and where we will generate, store and manage energy.

These energy-related activities introduce new, more severe fire safety, interoperability and data protection challenges. In the quest for total built environment decarbonization, asset owners and site managers will need to proactively identify areas of concern and take decisive measures to protect structures, occupants and data.

Here's how UL Solutions helps the built environment industry identify, reduce and optimize green electrification and reduce emissions:

Build consensus around built environment standards
Our engineers participate in standards panels and industry working groups to shape the future of safety in the built environment.

Demonstrate compliance with confidence
Testing, inspection and certification services empower safer energy transition in the built environment.

Safety guidance that supports innovation
Helping customers identify vulnerabilities in the built environment and focus on safety and sustainability.

Tools for new and existing structures
Software used by asset owners and building managers to optimize the built environment, from construction through operation.

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Shaping the standards, driving greater resilience

It is an understatement to say that UL Solutions has a significant track record in supporting electrical and fire safety. Indeed, it is why we were founded in 1894. Today, our safety experts work tirelessly to drive consensus among disparate stakeholders and develop standards relevant to renewable energy generation, including microgrids, charging stations, cables and other related products.

UL Solutions helps customers demonstrate compliance with safety, security and sustainability standards through testing, inspection and field evaluation programs that address unique product needs, installations and product makeup.

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Spotlight on emerging standards

UL Solutions professionals sit on more than 1,300 standards panels and working groups, trying to build consensus among industry and government and research bodies such as the Department of Energy and National Renewable Energy Laboratory.

With a strategic imperative to advance cybersecurity for distributed energy resources (DER) inverters, we are working actively to develop assessment requirements via **UL 2941**, currently classified as an Outline of Investigation.

UL 3001 is a consensus standard that is being developed with deep engagement with industry players, regulators and other stakeholders across five working groups with the overall aim of improving microgrid safety.

UL 1741 SC is a new standard development initiative to create requirements for bi-directional electric vehicle supply equipment (BEVSE) and interconnection systems equipment (ISE) for electric vehicles (EVs) with bidirectional onboard inverters.

When these requirements go into and proliferate across the marketplace, it is expected that manufacturers can rapidly scale up, as these products can be evaluated for safety, security and sustainability using independent, science-based targets.

UL Solutions can help you with:

- Field testing, evaluation and inspection
- Functional safety assessments, audits and training
- Grid simulation service
- Grid code connection and compliance testing, inspection and certification
- Renewable energy system integration services

SECTION 4

Safer battery storage

Providing testing and certification services for energy storage supplies:

- Battery chargers
- Battery modules
- Battery packs
- EV chargers, including bi-directional chargers

Supporting the energy storage industry with supply chain services

- Process audit certification
- Software for compliance and communication

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Safer, more sustainable storage

Energy transition: it all comes down to batteries
Without enhanced battery technology, we simply cannot realize the full benefits of decarbonized, decentralized power generation and transmission. The sun sets, winds die down — but societies and economies do not stop.

With new Battery Energy Storage Systems (BESS), power from renewable sources can be more effectively managed to maximize the impact of clean energy sources and optimize energy usage at any time.

But with all these new and notable technologies, stakeholders must join together to tackle interoperability, security and sustainability challenges. Safety challenges for BESS are magnified due to issues inherent in batteries, such as uncontrolled thermal runway which can lead to fire, explosion and gas evolution. With the intense energy capacity in lithium-ion and other battery chemistries, uncontrolled thermal runaway has led to high-profile incidents that have led to deaths and property destruction.

When these requirements go into and proliferate across the marketplace, it is expected that manufacturers can rapidly scale up, as these products can be evaluated for safety, security and sustainability using independent, science-based targets.

Fire safety standards
UL Solutions was instrumental in the introduction of UL 9540A, ANSI/CAN/UL Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems. This test method helps manufacturers demonstrate compliance with the evolving regulations. Leveraging our long practice of contributing to standards development with our vast experience in the battery, energy storage and fire industries, we worked with regulators to understand their concerns and deliver a viable test method to accelerate the adoption of this innovative technology.

SECTION 5

Decarbonization of transportation

Supporting safer transportation today — through full decarbonization

As a safety science leader, we understand that today's vehicle transportation cannot be considered sustainable when core challenges of safety and security are not addressed. Cycles of innovation grow ever tighter, and risks grow more significant. We help the industry meet these challenges and select quality supply-chain partners, challenge conventional thinking and support a culture of safety that extends worldwide.

Our customers include OEMs and suppliers working to overcome challenges in the rapidly evolving personal and industrial vehicle landscape — including both EV and legacy vehicles. UL Solutions services, software and guidance help the sustainable transportation industry accelerate technologies including EV vehicles, batteries, infrastructure and other next-generation approaches.

Common concerns from our automotive industry customers

- How do we continuously improve our processes to embrace emerging technologies (including AI), exceed customer expectations and fulfill business objectives?
- How do we stay on top of ever-evolving automotive and commercial vehicle standards and showcase our commitment to safety, performance, sustainability and more?
- How do we tackle safety challenges inherent in EV batteries and components and plan for responsible end-of-life?

UL Solutions meets these challenges — and many more — with opportunities for faster, safer innovation that advance possibilities throughout the automotive industry, including development in the new mobility sector.

Comprehensive automotive services, software and support for legacy and EV leaders

Certification, testing, verification and assessment for the evolving automotive industry

Cybersecurity:
Our hardware and software testing services for automotive components and systems help identify products' exploitation risk and validate security measures.

Electric vehicle battery enclosure safety:
Using the Battery Enclosure Material Screening (BEMS) suite of tests developed by UL Solutions, we help automotive original equipment manufacturers (OEMs) and their suppliers choose the most suitable EV battery enclosure materials.

Electromagnetic compatibility:
To meet consumer demand for safety, security and high performance, we offer a full range of EMC and wireless automotive testing services.

Interoperability:
Our deep expertise with consumer electronics, we can help OEMs ensure that their systems work with other devices and products as expected, confirm conformity to the IoT and connectivity technology platform standards, maintain product quality, and enhance brand reputation.

Validation and reliability:
These services assess how systems and components may perform under expected and unusual use, including environmental simulation, vibration and shock testing, electrical testing, and vehicle thermal management systems.

Software, consulting and training informed by the latest safety science

Our customers consider us a trusted partner supporting their goals in automotive megatrends such as autonomy, connectivity, electrification and shared mobility (ACES).

Functional safety

We offer comprehensive ISO 26262 training and consulting services for real-world automotive programs, informed by the latest in safety science guidance.

Automotive SPICE®

Through training and consulting, UL Solutions helps manufacturers build a process framework to map ASPICE requirements to development processes.

Stages software

This innovative software supports automotive process innovation that speeds up the adoption of the latest engineering work practices. Processes built in Stages can be mapped to multiple automotive standards to understand overlaps and avoid developing processes in silos.

Deep automotive and standards expertise from engineering experts

We are true partners, working with the industry to develop guidelines, understand current and future challenges, and deliver services that solve business needs. Our scientists and engineers sit on 1,300+ standards panels and other technical committees, including those relevant to legacy and new mobility, and have helped develop thousands of standards around the world that define safety, quality, security and sustainability.

Hydrogen: an emerging fuel source with unique storage needs

For the transportation and municipal fleet markets, hydrogen is gaining traction as an alternative fuel source that burns far cleaner than fossil fuels. Government investment in research and development is spurring advances in technology required to safely create, transport and store hydrogen fuel, but the regulatory environment is also growing more complex due to the low-temperature storage requirements of hydrogen.

Our significant background in fossil fuel technology and constant investment in emerging fuel sources means that UL Solutions can help manufacturers and suppliers understand new code requirements, identify and mitigate risks and evaluate certified products relevant for hydrogen fueling.

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Advancing your organization’s energy transition strategy

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UL Solutions has the heritage and history — plus a future-looking philosophy — needed to help you make a swifter, safer transition to an all-electric tomorrow.

Rapidly, the world is shifting away from fossil fuels to new technologies that promise more efficiency and sustainability. And while these developments are exciting, the energy transition comes with some inherent risks that must be mitigated so a cleaner, safer future can be embraced by all.

UL Solutions works closely with organizations as they seek to build and manage renewable projects, realize the benefits of new grid technology, and ensure a stable energy supply for all users.

Together, we’re working for a safer, more secure and sustainable world.

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