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Question: What are the **expectations** of electric power utilities from the virtual and augmented reality technologies? Are they going to be **used** only for engineering staff training or there are other promising applications?

The energy and utility sectors are usually slow adopters of advanced technologies due to the reliance on traditional methods to carry out work procedures. Also, the implementation of any technology involves a large sum of capital investment, which may not be feasible for every utility company. The increasing demand for electricity in the rapidly developing countries and the increasing cost pressure are causing this industry to rethink the traditional business models it uses. Augmented and virtual realities are an innovate technologies that can transform this sector.

VR technology enables the user to immerse themselves in an artificially created environment and enables them to interact with the virtual world. VR applications typically require specific devices, such as a head mounted display (HMD) and haptic controllers, that allow the user to experience the imaginary world and manipulate virtual objects. While Augmented Reality (AR) refers to a real environment, which is supplemented by various digital objects such as sounds, videos and graphics that extend over the physical environment. In contrast to VR headsets, AR devices do not block the view of the real environment like VR helmets. AR is mainly used in smartphones and smart glasses and does not require any additional equipment such as helmets.

Essentially, the main difference between AR and VR is that AR complements reality with software embedded in different devices. While VR devices offer an artificially created environment, AR devices complement reality and enable the user to manipulate, move and perform operational processes without obstacles that exist in real work.

The energy and utilities industry faces a number of challenges today that arise from an outdated infrastructure, the rising retirement pension of highly qualified workers, the modernization of the networks and government regulations. All of this puts great pressure on utilities that want to remain competitive in the market.

There are 2 major issues that are related:

- o The biggest problem in the utilities sector is the aging of the workforce, which leads to the loss of institutional knowledge.
- o Aging power generation and distribution systems is another major challenge for the utilities sector.

How AR technology can help the energy and utilities meet these challenges.

- o **Accelerated process of plant maintenance**. AR technology can force a 3D model on a device in real time, so a number of problems can be solved faster and more efficiently. Field service technicians who are equipped with mobile AR devices or smart glasses have immediate access to the operating documentation and can thus view the system type, the maintenance history or the exchange conditions. In the event of equipment damage, a line judge can respond immediately by ordering a replacement or consulting a technician to

resolve the problem. The introduction of AR applications in the energy and utilities industry significantly speeds up operational processes, reduces costs and saves time.

- **Effective remote support- e**nables business experts to lead inexperienced sales representatives in real time, thereby significantly reducing the costs for technical experts (SMEs). If necessary, SMEs can use AR equipment to guide young workers and this application enables employers to keep very experienced retired or aging employees in the workforce by giving them the opportunity to work remotely.
- **Faster training for skilled workers**.
- **Data generation** :Various sources provide data to AR systems, that are analyzed to provide a better work environment for employees and consumers. Consumers can help notify the utility company of an accident through videos and photos.
- **AR enhanced with AI:** by overlaying virtual content over actual locations and objects advances in computer vision, that analyzes, identifies, and labels visual content can be used.
- **AR equipment inspection:** there are many equipment in substations, data centers and other places. By wearing an AR industrial intelligent helmet, inspectors can check the equipment status according to the inspection sequence based on the registration tracking technology of SLAM (Simulation Localization and Mapping).
- **AR equipment installation**: in the case of complex connection between devices, the installation personnel often need to spend a lot of time looking for the corresponding interface. Using AR technology, the virtual information such as interface mode and connection relationship are tracked and located on the equipment.
- **AR visual safety operation**: electronic fence can be used for safety warning in electric poer operation site, and SLAM is used for visual warning of dangers in high voltage and high-altitude operation sites, so that operators wearing industrial intelligent helmets can always keep vigilance.
- **VR power engineering design**: -to carry out in-depth and intuitive communication on a design by wearing intelligent glasses and other terminal devices and using gesture recognition interaction mode, replace and adjust working mode.
- **Utility systems expand and evolve because of many factors.** Climate change and the move to renewable energy sources, population growth, and the adoption of electric vehicles have and will put new demands upon transmission and distribution systems. Utilities operators are not inclined to update asset records within an asset lifespan. At the point at which it has expanded to most of the system, then the real benefits of AR and VR should start to flow.

Thus Expectations:

- ➢ Utilities view AR solutions as having potential to provide value as a complementary tool for enhancing the functions involved in electricity delivery.
- ➢ Worker performance opportunities build on applications being advocated for manufacturing floor environments and take those out into the field where the electric distribution infrastructure is found. Broad field visualization of underground and aerial plants can accelerate installation and repair times.
- ➢ AR is increasingly being considered by utilities for use in operations, maintenance optimization, predictive maintenance, and as a means to connect field personnel to centralized experts for support.
- ➢ how well existing safety standards for similar electronics are applicable or whether new and modified standards will be needed to meet industry expectations
- ➢ will the existing wireless communications standards apply directly, enabling utilities to maintain consistency with existing infrastructure?
- ➢ Will AR solutions coexist in a utility communications environment?

- ➤ Will interference issues need to be addressed? These issues will all need to be addressed in driving adoption of AR/VR/XR.
- ➤ device physical connection standards and power management- Hardware ruggedness for sometimes harsh field conditions to move towards plug and play interoperability to assure seamless integration of AR solutions into the utility environment. Beyond the traditional realm of standards, there is also a critical need to address internal utility process standards (e.g., work instructions, work flows) and compatibility with the Common Information Model (CIM) used in the utility industry.
- ➤ Augmented reality solutions clearly have potential benefits for application in the utility environment. However, many issues remain to be addressed to build the business case, as well as to gain the acceptance and adoption by the utility community.