

Vietnam National Power Transmission Corporation

Application of State-Of-Art Technology for Operation and Maintenance

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The population of Vietnam: about 96.5 million

GDP: US\$ 261 billion, in 2019

EVNNPT is managing the 220kV-500kV transmission system in Vietnam, operating under the model of a one-member limited liability company under the Vietnam Electricity Group (EVN).

EVNNPT has 4 Power Transmission Companies operating in four regions of Vietnam.

EVNNPT has about 7,800 staff

Energy Transmitted in 2020: 203.85 billion kWh

Length of 500 kV T/L: 11,862 km

Length of 220 kV T/L: 24,824 km

Number of 500 kV substation: 28

Number of 220 kV substation: 114

Total capacity of transformers: 107,450,438 MVA



12.10.2017

EVNNPT set a goal to become a Digital Utility and one of 10 leading power transmission utilities in Asia by 2030.

The application of State-of-Art in EVNNPT can be grouped into three following groups:

Group1: *Real-time monitoring*: the applications which help the operators to real-time monitor the core equipment such as camera system, online oil monitoring, fault location

Group 2: *Enhancing Supervision*: the applications which help the operators to supervise, monitor, and check working condition of the core equipment, such as UAV, LIDA

Group 3: *Digital Technology*: Applications of this group are based on the platform of high integration of digital technology, such as Asset Management, Augmented Reality, AI



Control Room of PTC2 in Danang

Monitoring Camera system

The application helps to:

- i. improve the efficiency of remote monitoring transmission lines, substation construction Sites
- ii. Quickly view and assess the situation in the flooded area;
- iii. Zoom in for a clear view of lines, accessories, and towers bars;
- iv. Store and retrieve the image for investigation, and analysis of abnormalities of the lines;
- v. Record lightning strikes near the line;
- vi. Detect incidents that potentially affect the safe operation of the line
- vii. monitor all the activities on the construction sites, and supplies in/out of warehouses



Camera installed in T/L towers

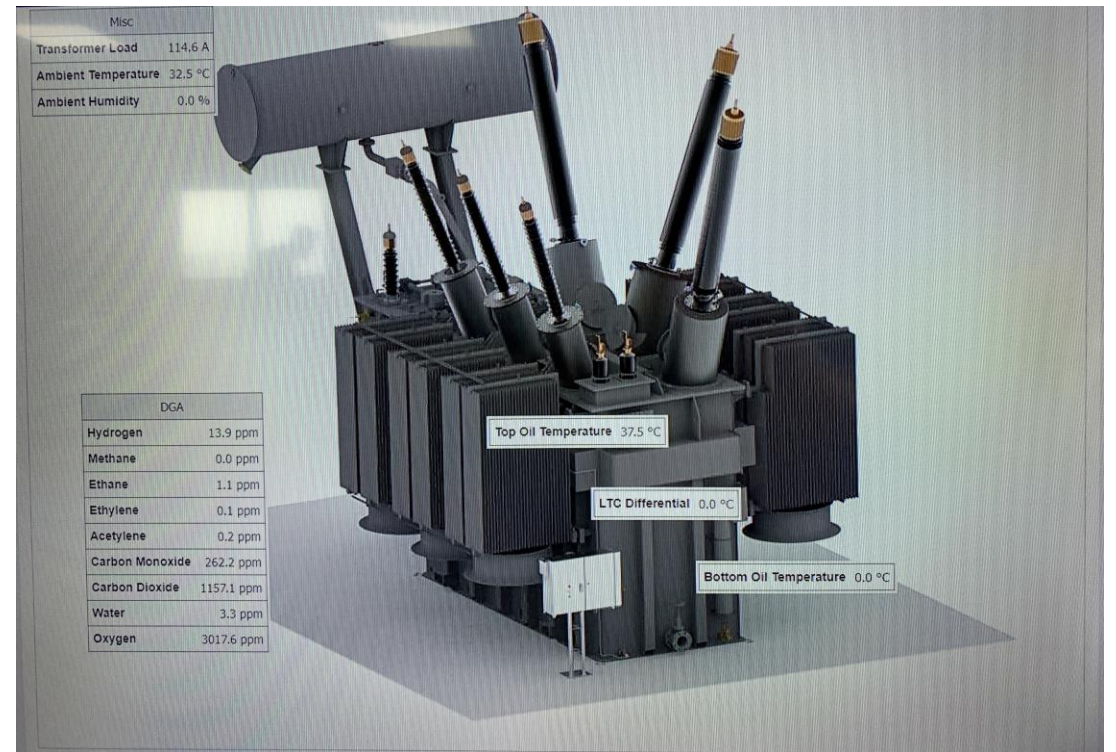
(viii) monitor substations, transformer equipment inspection, and security monitoring; (ix) monitor changes in terrain, residential activities, activities

Online oil monitoring equipment

Dissolved gas analysis (DGA) in power transformers and reactors

The application helps to:

- i. Early detection of transformer problems, reduction of economic risks, as well as possible notify activities based on financial management strategies;
- ii. Online monitoring and measuring different gases and dissolved humidity individually, and the equipment can also make online diagnoses and probe diagnoses; measuring these gases allows users to detect and diagnose a wide range of transformer defects;
- iii. Monitor the content of combustible gas and water in the power transformer.



Transformer overall monitoring system

- *The application helps:*
 - i. Support operators to automatically record the operating parameters such as voltage, over current, and short-circuit current;
 - ii. Monitor the transformer cooling system and assist the operator in deciding on the mode of overloading operation in case the cooling system fails;
 - iii. Monitor the operating status of the OLTC set (steps, number of times, working time of the engine, power of the engine,...); allow the operator to expect the maintenance and repair regime of the OLTC set;
 - iv. Monitor the capacitance 500 kV porcelain's tolerance in real-time operation without cutting power for testing. The function is essential in operation to minimize the duration of power cut to measure the capacitance of 500 kV bushing.
 - v. For a 220kV transformers, a movable online monitoring device should be used can for different transformers at different places



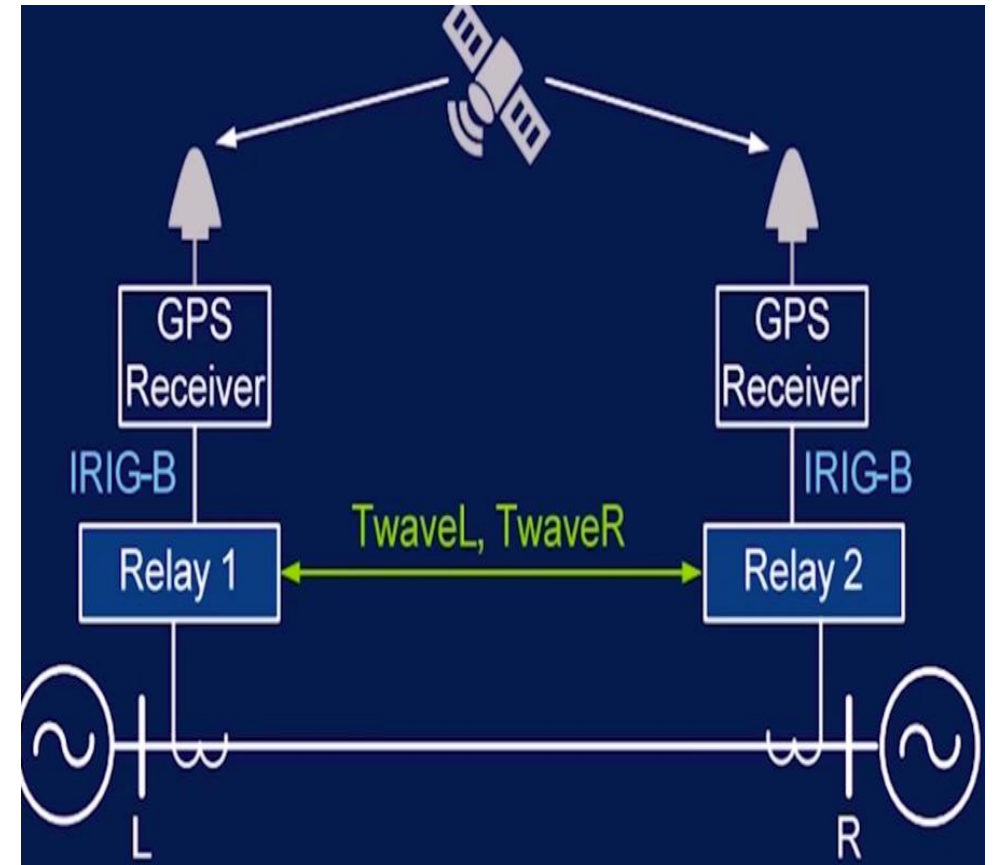
Monitoring system installed in
500kV Transformer

Fault location in lines

In 2018 EVNNPT completed the equipment of FL for 69 of 500, 220kV lines of large length and passing through the areas with complex terrain.

Some of FL benefits are:

- i. Reducing time searching and troubleshooting,
- ii. Improving safe and continuous transmission capacity,
- iii. Reducing the cost of line patrol workers,
- iv. Reducing the cost of maintaining system safety during power outages,
- v. Reducing the prescribed penalty cost due to power outages.

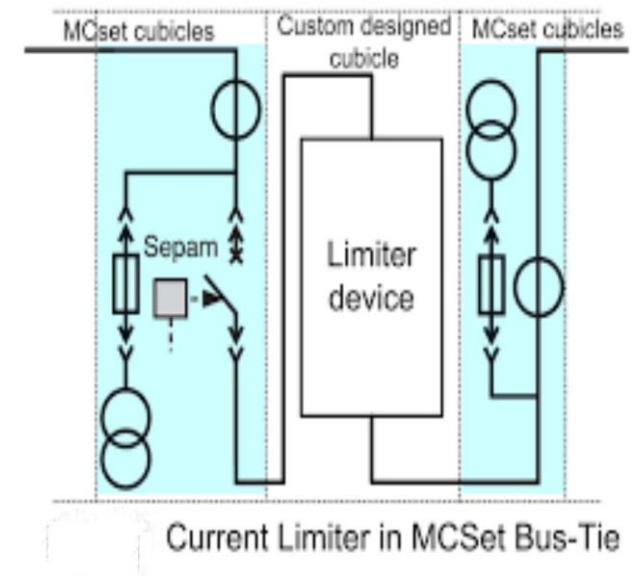


Fault Current Limiter

A fault current limiter (FCL) limits the amount of current flowing through the system and allows for the continuous uninterrupted operation of the electrical system

Reactors can be installed anywhere in the distribution circuit in order to limit the fault current.

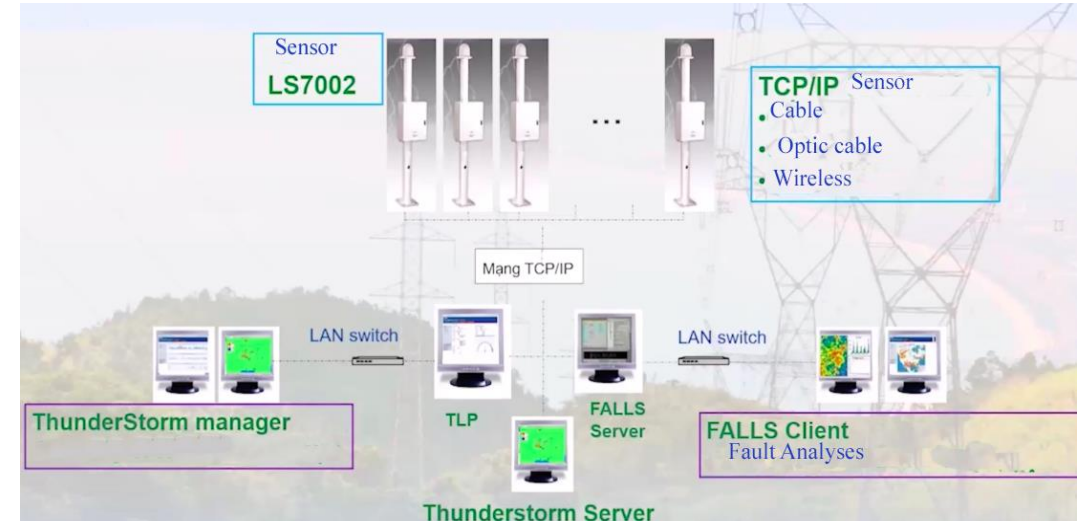
EVNNPT assigned PTC4 to install short-circuit limited-flow equipment at 06 stations: Song May, Cat Lai, Nha Be, Long Binh, Thu Duc, Binh Chanh. Currently, all substations have completed the installation.



Real time lightning detection

EVNNPT has installed lightning detection and warning collection systems, helping to quickly identify lightning incidents and analyze the cause of incidents provides a database for:

- i. Early warning of the development process of thunderstorms for timely taking countermeasures
- ii. Providing statistics on lightning such as the intensity and density of lightning by territory over time,
- iii. Quickly finding the 'problem point' of the lightning-induced incident,
- iv. Applying a lightning monitoring system, in combination with software to analyze lightning-induced incidents, proposing solutions for incidents caused by lightning.



Currently, EVNNPT has completed deployment of the system for the Northern and North Central regions and it is expected that by the end of 2021, EVNNPT will equip lightning detection in the South Central and Southern regions

UAV

The application helps to:

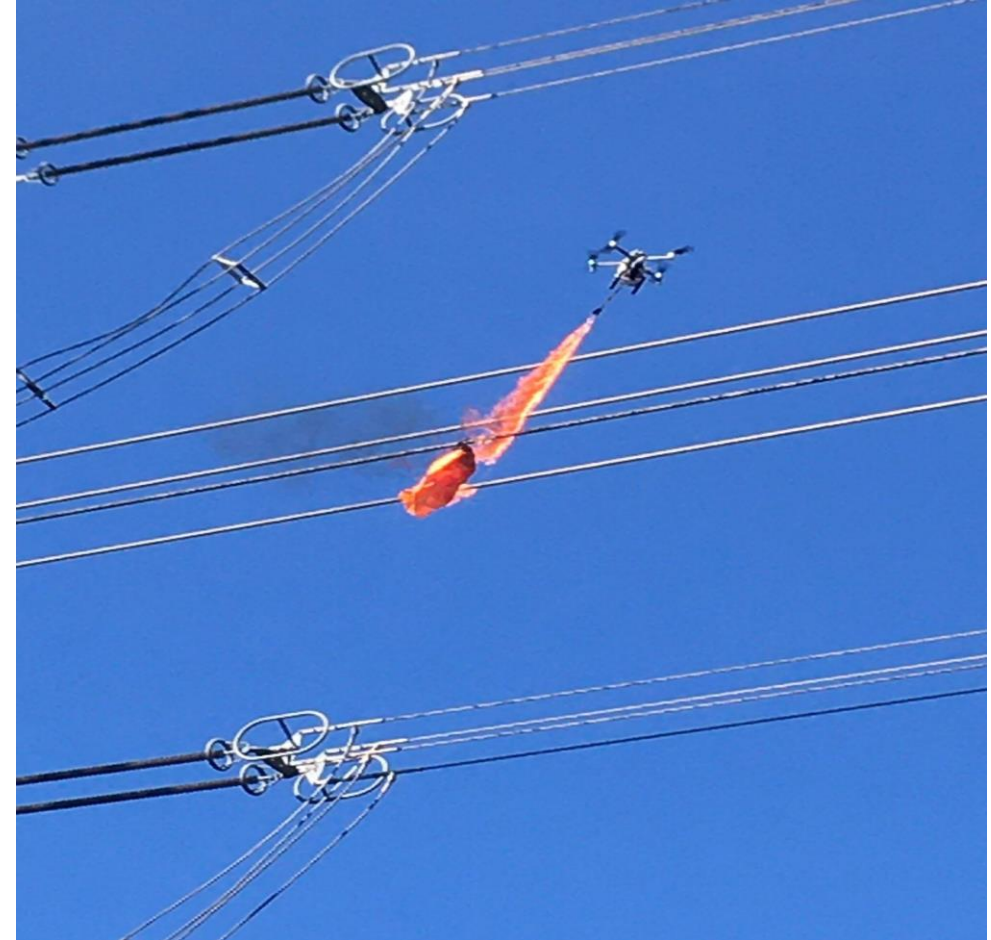
- i. Reduce the level of hard work, improve safety
- ii. Improve the productivity, and efficiency by quick access to difficult locations and do not require power cuts,
- iii. Closely check the technical condition of the power grid from above and in places where the naked eye cannot see (or is difficult to see,
- iv. Support the construction supervision of power transmission works to inspect, and supervise the acceptance conductors



NPT's Worker uses UAV to check 500kV

UAV –continued

- v. Quickly access and detect damage on conductors, lightning-resistant wires, fiber optic cables, and line equipment without the need to cut power lines. Record the actual status quo with images, videos ...
- vi. Use UAV to clear objects stuck in lines like paper kites.
- vii. Increasingly use the AI to analyze the images captured by UAV
- viii. The application of UAV is particularly useful during the Covid-19 time when traveling is limited

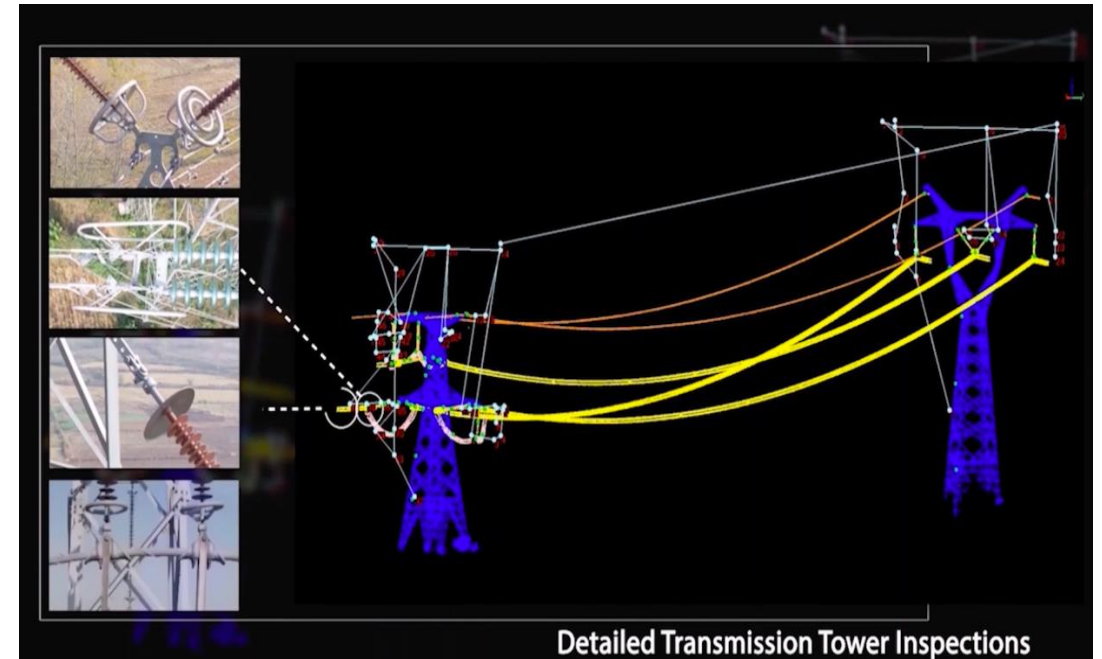


PTC2 uses UAV to clear kite stuck in conductors

Light Detection and Ranging (LIDAR) Technology

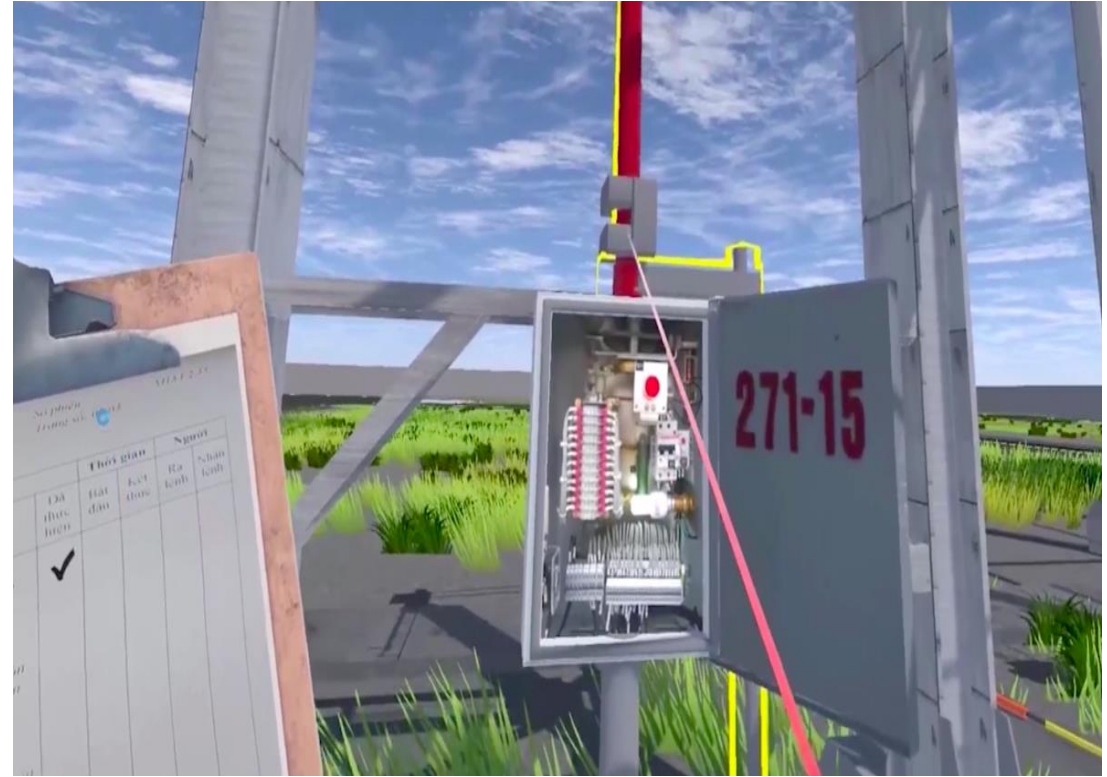
Another application of UAV equipped with the Light Detection and Ranging (LIDA) device, a LIDA device mainly consists of a laser, a scanner and a dedicated GPS receiver mounted in UAV.

- Measure the distance from any point of the structure/conductor to the ground surface
- Detecting trees inside and outside of corridors in violation of grid corridor's safety
- Warning of dangerous areas, unsecured phase-wall distance
- Forecast of tree growth in violation of grid corridor's safety
- Simulation of conductor sag/hammock test under different load conditions
- Shake Wire Test Simulation



Augmented reality

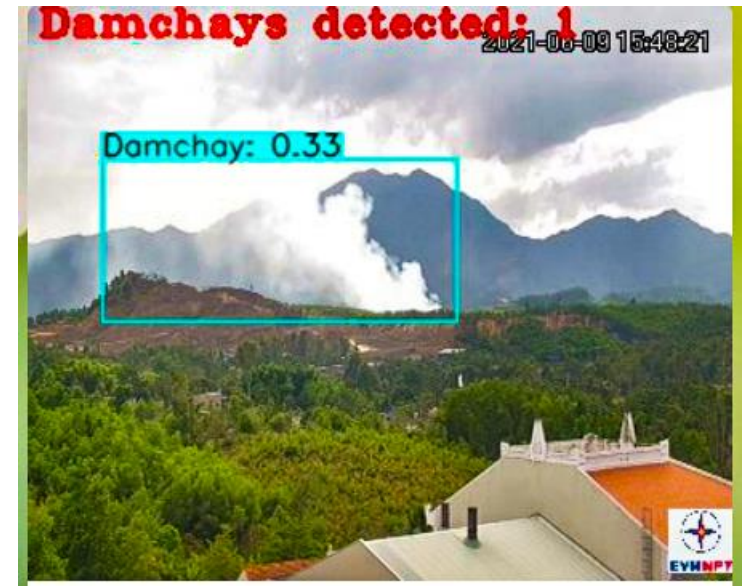
Augmented Reality (AR) allows people to observe things in the real world through an electronic device. Then, in addition to what the naked eye sees, the electronic device VR completely replaces reality with a simulated world, AR only adds details to the real world. With a software program installed on the smartphone device, users can experience and interact with the equipment in a virtual environment as if viewing a real device. AR helps users interact with digital content in reality such as touching objects, grafting objects, and viewing objects in 3D, with only a tablet or a smartphone.



PTC1 of EVNNPT developed the VR program to train the staff

Artificial Intelligence

- EVNNPT realized that AI is 'a must' for digital transformation and state-of-art technology applications.
- AI helps to: analyze automatically available data such as oil monitoring data online, tele measurement data, integrated incident positioning, automatic incident reporting, fire near transmission lines, and violation of the line corridor. AI also immediately reviews the images, and data collected by UAVs and gives the warning signal to the operation staff.
- AI needs to be trained before use.



AI detected a fire



AI identifies accessories on the line

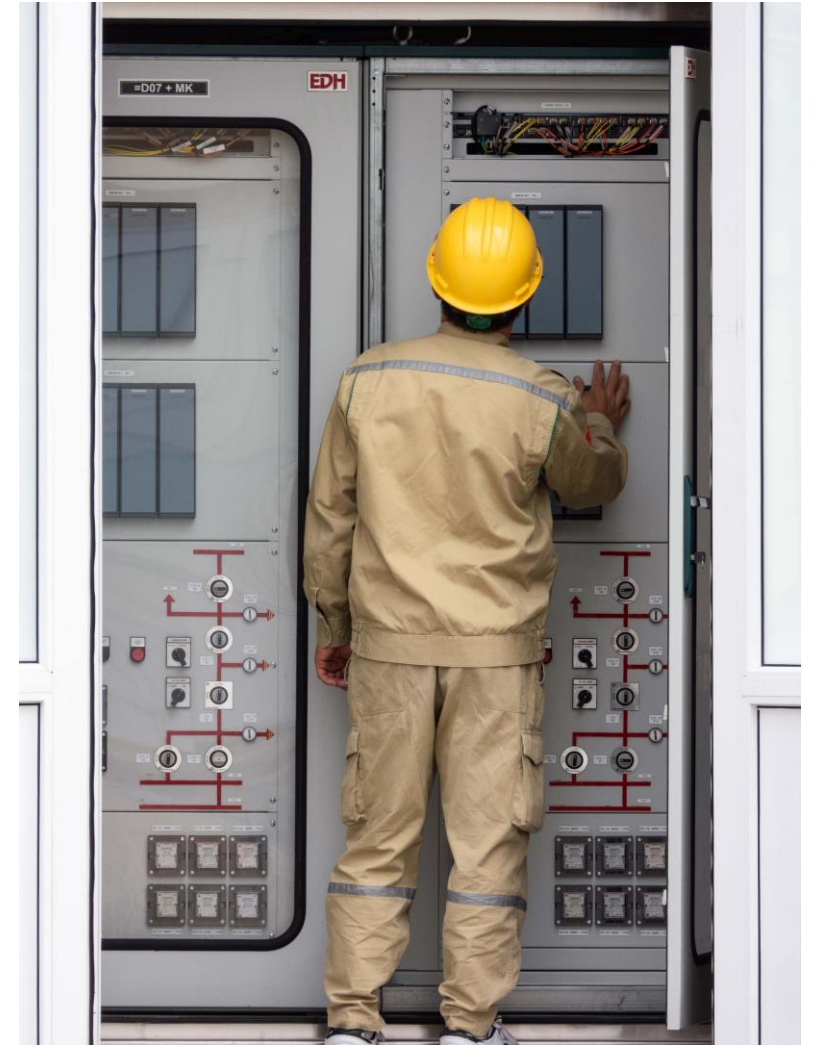
Condition-based maintenance (CBM) of core equipment

EVN decided that CBM will be applied in the transmission and distribution sector, including EVNNPT, the generation companies are following the Reliability-Centered Maintenance (RCM).

CBM monitors the actual condition of an asset to deciding what maintenance needs to be done.

CBM dictates that maintenance should only be performed when certain indicators of the Condition Health Index show signs of decreasing performance or upcoming failure.

CBM will be widely put into operation from 2022.



PTC1 Staff checking substation equipment

Digital substations

220 kV Thuy Nguyen substation in Hai Phong City, the first Digital substation, as a pilot one, has been put into operation on 18 April 2021.

Pros: (i) Reduce copper cable and trench by using fiber optic cable
(ii) circuit checking by logic checking from a computer; (iii) Allow better device monitoring

Cons: (i) The cost of the secondary equipment increased by about 20%, but this cost is a small portion of the total cost of substations; (ii) Because it is a new technology, the process of organizing the implementation of projects, construction, acceptance, and operation organization is still difficult; (iii) Difficulties in pairing new bays and devices due to new technology, (iv) Replacing faulted Merging Unit could be difficult due to manufacturers' constraints, limited suppliers, no backup equipment.

EVNNPT proposed to continue monitoring the operation of the 220kV Thuy Nguyen substation to conduct an assessment of the pros and cons of the technology in the coming time.



Thuy Nguyen the first Digital Substation
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Digital Workforce System

- A digital workforce (DWF) is a team of software, robots that work alongside with employees to undertake manual processes and allow humans to focus on value-adding tasks
- DWF can Increase Flexibility; Reduce Operational Costs; Improve Productivity and Efficiency; Increase Revenue; Enhance Communication and Innovation; Heighten Employee Experience; Increase Performance; Facilitate mobility; Improve communication; improve management of human resources
- EVNNPT Target: 100% of field staff use smart mobile applications for tasks such as: Receiving tasks; carrying out inspection, repair, calibration testing, and safety monitoring

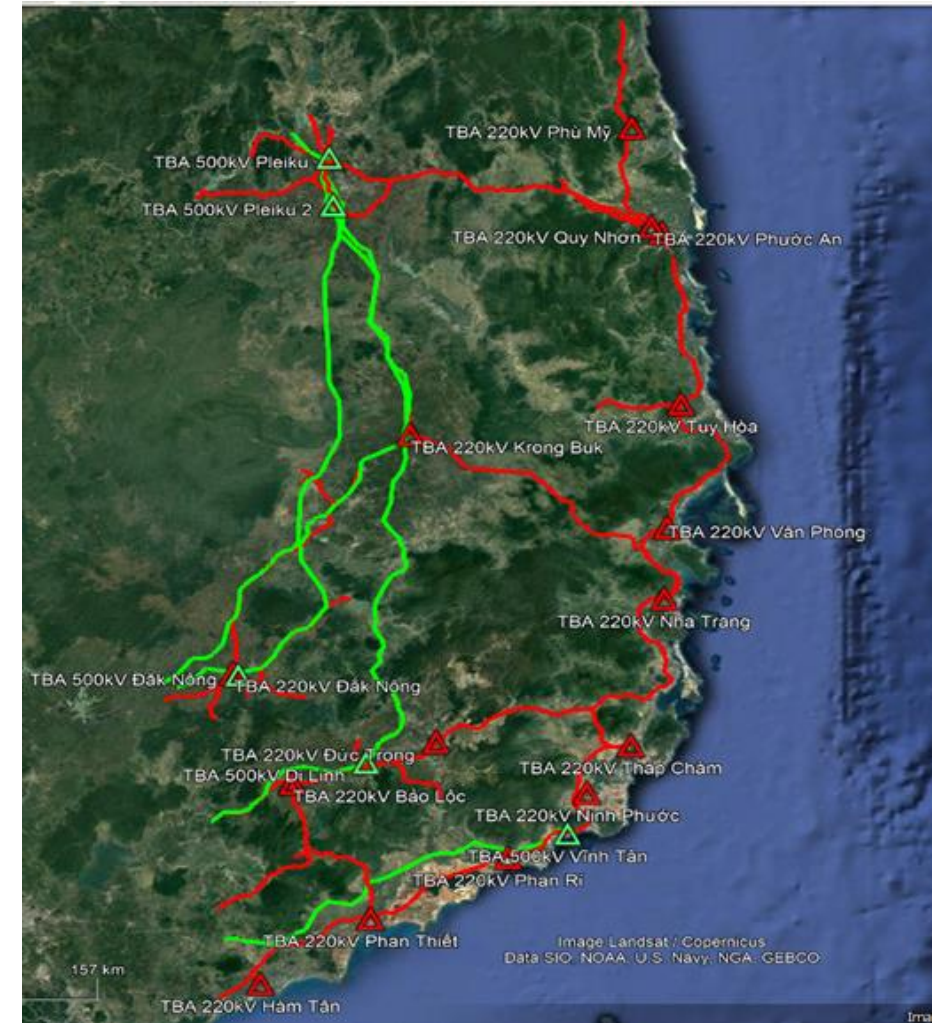


PTC2 staff use drone for inspection of Transmission line

Geographic Information System (GIS)

GIS is an important condition for the successful AM, for most of application for O&M of a large Corporation like EVNNPT. GIS application helps:

- Manage the power grid, substation equipment, transmission lines, visual information equipment on the background of geographical terrain, administrative, satellite and according to 500kV, 220kV diagram layers; manage equipment parameters, document images, operational history, real-time operation status on geographic information maps.
- Help minimize the time to find a location to reach the area where the problem occurred
- It is expected that EVNNPT will complete the incorporation of the GIS in 2021



GIS map of Transmission system of PTC3

Conclusion

The promotion of the application of science and technology has brought:

- Efficiency in technical management,
- Reducing incidents, power losses of transmission power grid, power cut off time
- Ensuring the transmission system operates safely, reliably and stably,
- improving labor productivity in the context of average transmission output growth of 11-12% per year.



500 kV system

Thank you
for
your attention