Question: "A general question to utilities: Which is the expected maintenance interval extension by applying condition-based approach in comparison to a time-based one?"

Answer: Circuit Breaker Monitoring for predictive maintenance: Return on experience

There is no simple answer to this question. Indeed, the maintenance interval extension which could occur thanks to the condition-based maintenance is highly dependent to the application, as a result, the features of the monitoring solution should be adapted accordingly.

Therefore, if we look at current references which use effectively the monitoring of circuit breaker to adapt the maintenance interval, one of the common application is the Pump Storage Power Plant.

For this specific case, the particularity of the application is the clearance of variable current more than once a day. Because of such intensive use of the circuit breaker, the traditional time-based maintenance is obsolete and the condition-based one is more accurate.

However, to achieve a correct monitoring of the circuit breaker, based on our 25 years of experience multiple sensors are required:

- Digital gas sensor, they monitor the pressure and temperature of all type of gases (SF_6 & C4-FN mixtures) and give a smart density control: Leak rate computation, etc.
- Mechanical strokes and timings are monitoring the mechanical ageing of the apparatus
- Interrupted current sensors which enable the monitoring of the breaking chamber ageing based on the electrical wear computing
- Coil current sensors are able to monitor the control circuit for either the health and the wear of the coils depending on the selected features
- Finally, the monitoring system is also ensuring a health self-check to alert in case of any fault occuring it

In addition to the offline monitoring, the device is recording COMTRADES for each operation. These records when transmitted to our expertise center can benefit from the most recent and adapted methodologies of electrical wear calculation independently of the device release date. Then, based on the results, reliable and custom recommendations can be given to users to integrate them inside their overall maintenance plan of the power plant.

Depending on the situation, recommendations can be given up to 2 years ahead of maintenance. An example of data processing is presented in the figures below:
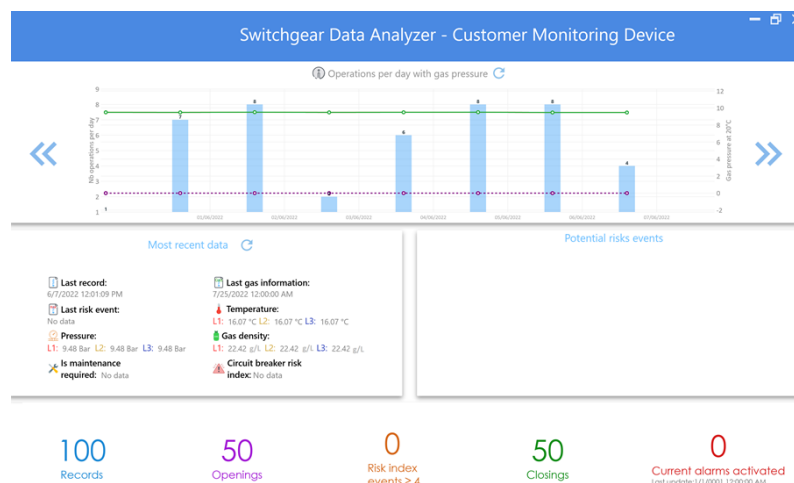

Figure 1 : Overview of processed data inside the software for analysis

Such active monitoring is a strong advantage for utilities which are using circuit breakers intensively and cannot apply a simple time-based maintenance. As a result, in our case, for Generator Circuit Breaker (GCB), monitoring is now considered as a part of the overall product. And, from the experience earned with these applications, the methodology could be extended to other critical applications on the grid network based on laboratories results and various on-site REX.

Finally, having a modular solution is bringing great adaptation to the application needs with a correct sizing of the product based on its available features.

In conclusion, to give a straight answer to the question. The opportunity to extend the periods between maintenance phases based on predictive models varies mostly in function of the circuit breaker application intensity and the overall maintenance strategy and organization of the user. Each case is different and interval extension will not be the same from one case to another, however, the efficiency of the maintenance actions will be increased as the condition of the circuit breaker is better known prior to the operation.