FASIT, THE NORWEGIAN RELIABILITY DATA COLLECTION SYSTEM – EXPERIENCES AND UTILITARIAN VALUES

Arnt Ove EGGEN
SINTEF Energy Research – Norway
arnt.o.eggen@sintef.no

Jørn HEGGSET
Statnett SF – Norway
jorn.heggset@statnett.no

Ketil SAGEN
Fornybar Norge – Norway
ketil.sagen@fornybarnorge.no

Camilla AABAKKEN
NVE-RME – Norway
caa@nve.no

Bjørn Tore HJARTSJØ
Lede AS – Norway
bjorn.tore.hjartsjo@lede.no

Egil Arne ØSTINGSEN
Elmea AS – Norway
egil.ostingsen@elmea.no

Svein Olav GJERSTAD
Nettselskapet AS – Norway
svein.gjerstad@nettselskapet.as

ABSTRACT

FASIT has been in operation since 1995 and has since then been regularly updated. A major revision and update with an information model based on CIM and utilizing the MADES/ECP communication technology resulted in a new version put into operation from 2019. All messages and grid incident reports are exchanged encrypted machine-to-machine, thus reducing manual work, and securing data consistency between the different modules in the system. The paper focuses on the areas of use, the applications, and the utilitarian values for the NRA and the TSO in their supervision and control, for the DNOs in using the collected data to improve their own performance, and as a source for input data for various reliability calculations and simulations. The main source of information is each DNO's inhouse FASIT database, together with the nationwide PQ Portal, which is a fault and interruption statistics generation tool where users can select/filter data from the national database to get statistics best suited for the analysis at hand, or to benchmark their own company towards comparable companies or the Norwegian average.

INTRODUCTION

The Norwegian national reliability data collection system, denoted FASIT (Fault and Supply Interruption information Tool), has been in operation since 1995 [1]. FASIT has since then been regularly updated according to changing regulations and new user needs. Ever since the beginning the development of the system has been done in close cooperation with the national regulatory authority (NRA), transmission system operator (TSO), distribution network operators (DNOs), and Fornybar Norge[1]. This cooperation has been essential and is formalized through a reference group consisting of representatives from different types of stakeholders, and this group has among other tasks the responsibility for developing the FASIT system. The authors of this paper are the members of this reference group.

FASIT – a short summary

FASIT is the Norwegian standardised system for collecting, recording, calculating, and reporting of reliability data in the electric power network. The core of the FASIT system is a software requirement specification, supported by definitions, guidelines, and illustrative examples for registration of faults and interruptions. The reporting scheme is divided into low voltage (< 1 kV), medium voltage (1–33 kV) and high voltage (≥ 33 kV), with reduced requirements (less required data fields) for low voltage incidents and increased requirements (more required data fields) for high voltage incidents.

All planned outages causing end-user interruption and all grid disturbances on all voltage levels must be recorded and individually reported. For each incident, parameters such as number of affected end-users, duration of interruption, interrupted power, energy not supplied (ENS), and cost of energy not supplied (CENS) are calculated, summed for each customer group, and reported to the national database. For grid disturbances, failure data are recorded on the component level, e.g., overhead line, cable, transformer, breaker. Standardised indices are also calculated and reported, e.g., system average interruption frequency (SAIFI) and duration (SAIDI) index.

Four vendors offer software that fulfils the FASIT requirement specification, and FASIT software is used by all the DNOs on all voltage levels in Norway for the mandatory reporting of end-user interruptions to the NRA and grid disturbances to the TSO.

Locally, the FASIT system can provide useful information and statistics, e.g., the number of planned outages vs. grid disturbances, CENS caused by different network levels or voltage levels, failure rates on different components, and dominant failure causes, enabling the DNOs to focus their maintenance and reinforcement to the most important/critical parts of their network.

[1] Fornybar Norge is a non-profit industry organization representing about 300 companies involved in the production, distribution, and trading of electricity in Norway.

FASIT – the new version

After a major revision and update a new version was put into operation from 2019 [2]. Improvements in data quality are achieved by formalizing the FASIT information model, which is based on the Common Information Model (CIM) [3] and extended to fulfil specific FASIT requirements. Improvements in the reporting process efficiency are achieved by utilizing the MADES/ECP [4] (Market Data Exchange Standard / Energy Communication Platform) communication technology for connecting TSO and DNOs. Figure 1 shows the modules of the FASIT system, and the stakeholders involved.

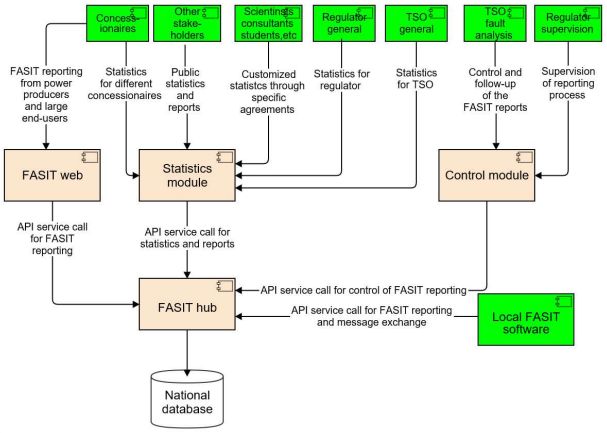

Figure 1: FASIT modules and stakeholders [2]

All incident reports are sent to FASIThub, where they are automatically validated and stored in the national database or rejected in case of any data or format error. Also, all messages are sent through FASIThub, where each message is logged, and the content is validated before it is forwarded to the receiver. FASIThub also publishes downloadable reference sets with valid values for all drop-down lists in the software, and connection sets specifying approved combinations, e.g., valid failure causes for an already selected component at a given network level. These reference sets enable flexibility and a possibility to add or remove predefined valid values and combinations whenever needed without changing the software, i.e., data driven / list driven software. The predefined values and combinations also ensure consistent registration resulting in improved data quality.

REPORTING STATUS AFTER FOUR YEARS OF OPERATION

Approximately 100 DNOs nationwide with a total of approximately 3 250 000 end-users are connected through the ECP platform. The system handles approximately 40 000 incident reports per year, from all network levels including low voltage, and a number of other messages exchanged between DNOs and between the TSO and DNOs. The annual number of incident reports and messages are presented in Table 1 and Table 2.

Table 1: Number of incident reports per incident type, and number of messages to and from FASIThub

Year	Incident reports		Messages	
	Planned outages	Grid disturb-ances	In-coming	Out-going
2019	24 172	15 477	48 333	62 723
2020	25 359	18 005	113 597[2]	62 204
2021	25 124	16 153	52 314	54 796
2022	23 629	15 485	45 803	48 881

[2] The high number of incoming messages in 2020 was due to a software failure where duplicates of one specific incident report were resent numerous times.

Table 2: Number of incident reports per network level

Year	LV	MV	HV	EHV
2019	14 514	24 472	411	252
2020	17 223	25 387	493	261
2021	16 719	23 954	444	160
2022	15 830	22 655	402	227

It is expected that the number of low voltage incidents should at least be of the same magnitude as the number of medium voltage incidents. Hence, it is assumed that there is some underreporting of low voltage incidents. In the time ahead special attention will be paid to this issue by the NRA and TSO.

FAULT AND INTERRUPTION STATISTICS

The TSO is responsible for the national collection of data for all voltage levels, and as a part of the implementation of the new FASIT system the TSO has developed the PQ Portal (Power Quality Portal). This portal contains data from voltage quality instruments in the Norwegian network and a fault and interruption statistics generation tool. The tool provides data based directly on the incident reports from all DNOs, large production companies, and large end-users in Norway, and are made available to the NRA, TSO and DNOs. Other actors such as researchers and students may also get access to the portal.

Data in the previous national database from 2009 onwards have also been migrated into the new format and the current database now constitutes a searchable data history of 14 years with more than 400 000 incidents. Prior to 2019 the data was limited to voltage levels above 1 kV, but from 2019 incidents in the low voltage network are included as well. It should be noted that failure analysis and reporting of failure data is not required for low voltage incidents.

Figure 2 shows the development in the number of incidents from 2009, i.e., planned outages and grid disturbances, where the inclusion of incidents < 1 kV from 2019 can be clearly seen.

Figure 2: Number of incident reports 2009–2022

The portal is continuously updated with new approved incidents reports, and hence gives a relatively 'live' presentation of the status in the network.

The statistics module has a very user-friendly graphical interface, where various filters can be used to pinpoint what the user is looking for. For the time being the filters consist of the following data types:

- Date (from – to)
- Network company
- Voltage level
- Component
- Internal and external failure cause
- Fault type
- Fault character (temporary, permanent)

The diagrams can show:

- Number of faults
- Failure rates (for some selected components)
- Energy not supplied (ENS)
- Cost of energy not supplied (CENS)

The interface enables a user to generate fault statistics with the appropriate level of details needed, and where the user can study trends over several years. The portal can also be used for benchmarking, e.g., for one DNO to benchmark itself with other comparable DNOs or the average of all DNOs.

The user can also choose several graphical options, like lines or columns, individual or stacked values, values ordered chronologically or in increasing/decreasing order. In addition, the user can also download the selected data to Excel for further analysis and local presentations.

Figure 3 shows an example of what a user-adapted statistics may look like. In this figure the period is from *2009* to *2022*, the selected component is *overhead line*, and the selected external failure cause is *environment*. The figure shows the *failure rate per year*, distributed on the fault characters *temporary* and *permanent* faults.

In addition, the portal can show information about various incident types (grid disturbances, planned interruptions, etc.), reporting status (compared with deadlines given by the NRA), and voltage quality (information from voltage quality instruments). All information can be shown company-wise or as a sum of selected or all companies.

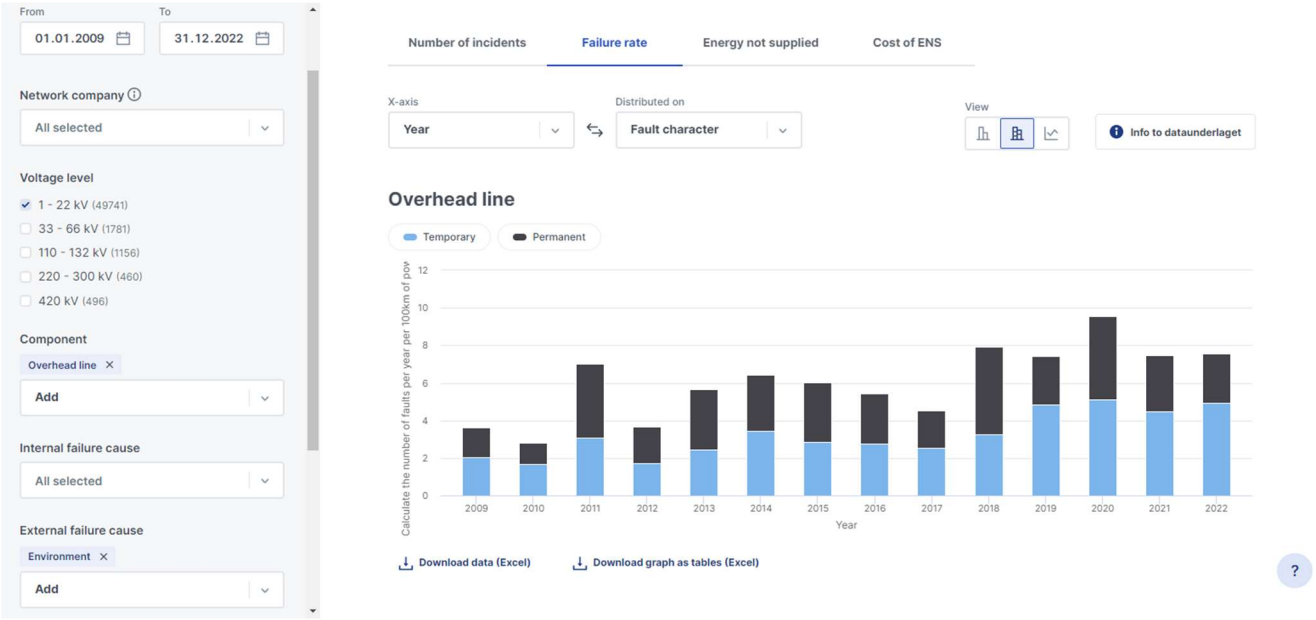

Figure 3: Example showing the user interface of the PQ Portal

UTILITARIAN VALUES – USE OF DATA

The National Regulatory Authority (NRA)

The Norwegian Energy Regulatory Authority (NVE-RME) has experienced a number of benefits with the new FASIT system:

- Continuously submission of fault and interruption data enables NRA to follow up the DNOs during the year, compared with annual reporting prior to 2019.
- It is possible to follow the development of the continuity of supply of the DNOs, the TSO and in Norway as a whole.
- Deadlines for the DNOs and TSO for reporting of fault and interruption data are given in the regulation, both exchange of data between the stakeholders after incidents involving more than one DNO and for reporting to the TSO. The PQ Portal enables NRA to control whether the DNOs and the TSO comply with the deadlines.
- NRA receives annual reports of continuity of supply from DNOs and the TSO via the MADES/ECP communication platform. This has simplified and reduced the need of manual processes when the reports are imported into the NRA's local database.

Transmission System Operator (TSO)

Statnett, as TSO, has several tasks related to the reporting process in Norway:

- coordination of grid disturbances involving more than one company.
- control, follow-up, and verification of incident reports from networks above 33 kV.
- follow-up on deadlines on incident reports and message exchange between the companies, sending automatic reminders when needed.
- make fault and interruption statistics available for the stakeholders.
- reporting of grid disturbances in the Norwegian network above 100 kV to ENTSO-E.

The new FASIT system has numerous advantages over the old version with respect to each of the points listed above. These can be summarized as:

- More formal message exchange and reporting, with the use of the MADES/ECP communication platform. This has several advantages, e.g., strong encryption as well as authentication schemes used for all communication between parties.
- Automatic control of consistency between the local and national database.
- Information contained in the Outage messages as well as the Interruption messages represent financial responsibilities for the involved DNOs, and this information must therefore be considered legal documents requiring 'non-repudiation' and digital signatures by the respective parties.
- Reduced need for manual processes, such as exchanging information by email or other informal channels, e.g., phone and Teams.
- Open and updated information about the reporting status for all companies, compared with the deadlines set by the NRA.
- User-friendly website for generation of fault and interruption statistics, always based on updated data.
- Less resource-intensive reporting of grid disturbance data to ENTSO-E.

All in all, the TSO finds that the new FASIT system requires less resources used to follow-up the reporting from the companies, thus more time can be spent on activities that increase the useful value of the data application.

Distribution Network Operators (DNOs)

For DNOs there is an increasing need for reliable fault and interruption data as a basis for the calculation of key performance indicators, and for the planning, operation, and maintenance of the power network. For DNOs the new FASIT system has the following main advantages compared to previous versions:

- Automated acquisition of temperature data from approved weather stations for the calculation of load profiles, interrupted power and energy not supplied.
- More digitized flow in managing the incident report from the start of the interruption to the completed approved report.
- Predefined templates reduce the time used for registration and improves the consistency of the registration of similar incidents.
- Continuous registration and reporting of incidents to FASIThub, compared to annual reporting, provides higher quality of each incident report.
- Improved quality and availability of failure statistics.
- Possibility of periodic (monthly, quarterly) benchmarking towards other DNOs for interruption indices, by simplified solutions in the PQ Portal (standardized tables between companies, groups of companies for each index grouped by voltage level or distribution/transmission power network).
- Simplified annual reporting to NRA and TSO on the secure IT solution ECP.

FURTHER IMPROVEMENTS

Through experiences from operation of the new FASIT version, the reference group has identified new improvements to increase observability of the reliability of supply for the NRA and improved possibility for benchmarking of DNOs.

Increased observability

The number of counties and municipalities have been reduced over the last years. There is also an ongoing restructuring in the electricity distribution industry towards fewer DNOs covering larger geographical areas and more customers. Hence, the existing performance indicators for reliability of supply as an average per DNO and per county will have a coarse geographical resolution. In addition, the NRA needs to know how the reliability of supply differs within a DNO's distribution area. Zip codes or other geographical data will increase the resolution. Average, maximum, and minimum reliability indicators may be reported for each area.

Improved benchmarking

In the existing version of FASIT, the reliability indices are reported on an annual basis. Several of the indices are calculated by using the annual energy supplied and number of customers, which must be manually entered into FASIT by each DNO. The energy supplied may be derived from the DNO's settlement system or the national hub for electricity meter values (Elhub). The easiest way to collect accumulated energy supplied during a year, is for the TSO to derive it automatically from the Elhub, with the meter IBAN-no. as the key. The IBAN-no. must then be included in the reports to TSO. The PQ Portal must be continuously updated with reliability indices for each DNO.

The reference group is considering the costs/benefit of the different improvements.

CONCLUSIONS

The FASIT system is a useful tool for collecting, recording, and reporting grid disturbances and end-user interruptions. FASIT data are used in numerous statistics for planning, operation, and maintenance of the electric power network. In addition, FASIT provides the NRA with key figures for the monopoly control of the DNOs.

The main improvements and benefits of the new FASIT system are:

- downloadable reference sets and connection sets with predefined valid values for all drop-down lists.
- encrypted machine-to-machine exchange of incident reports and various messages.
- automatic validation of the content in all messages and incident reports before forwarding or storing them in the national database.
- continuous updating of the data basis for fault and interruption statistics.

During the first few months of 2019 there were some challenges with the new message exchange function. This was probably related to lack of training of the users of the new local FASIT software. However, after TSO's direct contact with DNOs offering support and guidance, and implementation of improved validation rules in FASIThub, these problems were solved and have now been almost eliminated.

Now, after four years of operation, the experiences have been satisfying, and the overall conclusion is that the expectations of the new system have been met.

The focus for the coming years will be continuous improvements of the PQ Portal with user-friendly functions and possibilities for statistics generation, e.g., for benchmarking of the DNOs, and more flexible division in geographical areas for better comparison and monopoly control.

REFERENCES

[1] G.H. Kjølle, H.M. Vefsnmo, and J. Heggset, "Reliability Data Management by Means of the Standardised FASIT System for Data Collection and Reporting", presented at the 23rd International Conference on Electricity Distribution, Lyon, France, 2015.

[2] J. Heggset, K. Johannessen, A.O. Eggen, and K. Sagen, 2019, "National Reporting of Faults and Interruptions Using CIM and MADES-ECP", Proc. of the 25th International Conference on Electricity Distribution (CIRED 2019), Madrid, 3–6 June 2019, AIM, doi: dx.doi.org/10.34890/790

[3] Common Information Model (CIM), https://www.entsoe.eu/data/cim/

[4] MADES Communication Standard, version 1.1, ENTSO-E, 20 June 2014 https://eepublicdownloads.entsoe.eu/clean-documents/EDI/Library/depreciated/503_mades-v1r1.pdf