

PRINCIPLES OF HOURLY METERING

2010

These instructions are a translation of the corresponding instructions in Finnish. In any cases of ambiguity in interpretation, the Finnish-language instructions shall be complied with.

Committee for Electricity Supply & Trading, Finnish Energy Industries
Committee for Electric Networks, Finnish Energy Industries

FINNISH ENERGY INDUSTRIES

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APPENDICES

- Determining total metering error (Appendix 1, 2 pages)
- Taking the instrument transformer load into account (Appendix 2, 3 pages)
- Indicative design of current transformers at low voltage (Appendix 3, 1 page)
- Methods of estimating missing hourly data (Appendix 4, 2 pages)

Introduction

This recommendation provides guidelines for the implementation of hourly metering, which is required by the electricity market legislation. The recommendation examines the legislative requirements and provides more detailed instructions and recommendations on the implementation of hourly metering and the processing and transmission of hourly data. The recommendation aims to harmonise industry practices with respect to hourly metering and transmission of hourly data. The recommendations on the characteristics of equipment and systems should be taken into account when the equipment and systems are acquired or the next time they are upgraded.

This recommendation mainly applies to the distribution network, unless otherwise mentioned.

This recommendation supersedes the previous corresponding recommendation 'Sähkökaupan mittaus ja tiedonvälitys' (Metering and data transmission in the electricity trade) from 2005.

Unlike the previous version, this recommendation does not deal with the metering or data transmission of sites that are part of the load curve procedure. This has been covered separately in the Finnish Energy Industries' practical guidelines for the electricity market and in the calculation instructions for the type curve procedure, drawn up by Enease Oy for the Finnish Energy Industries.

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Definitions

Time stamp	Time reference entry for metering data, indicating the time period of data provided.
UN/EDIFACT	Electronic Data Interchange for Administration, Commerce and Transport: Collection of ISO standards on the message formats in electronic data transmission, maintained by the UN.
EDIEL	The electricity industry's message and information interchange specification, developed by the Nordic Ediel Forum (http://www.ediel.org). Its operation is continued by ebIX (http://www.ebix.org).
Cumulative reading	A continuously growing value of a metered quantity.
Reading system	A system for gathering metering readings and maintaining the settings of the metering device.
Metering device	A general term for a meter at a metering site, used for hourly energy metering.
Metering equipment	An entity consisting of the metering device and the data transmission connection.
Metering circuit	The amount of energy consumed/produced through separate metering circuits is metered and transmitted to be registered by the metering device.
Metering point	A point in the electricity network, to which the current transformer or meter of the metering equipment at the delivery point is connected.
Reading according to the distribution product	A reading in accordance with the customer's distribution product, shown on the display of the customer's metering device. The reading in accordance with the distribution product used in billing and data transmission may be a reading read directly from the meter or a reading calculated on the basis of hourly loads. If the reading is calculated from the hourly data, it must be ensured that it matches with the readings displayed on the meter.
Metering data management system	A system used in the recording and processing of data gathered from the metering device. Inspection of metering data, correction of statuses and forwarding of hourly data take place in the metering data management system.
Electricity market participant	Electricity vendor for the delivery point, vendor with a delivery obligation, system operator, or balance responsible party for one of the above.
Balance window	Period from the delivery of electricity to the closing of the balances of the distribution network. The balance window is 1 month from delivery until the end of 2010 and 14 days from delivery as from 2011.
Data transmission protocol	A set of rules, which the devices must comply with to enable data transmission (data transmission frame).
Delivery point	A point in the electricity network where electric energy is transmitted from one party to another.

Hourly reading	Cumulative reading metered and registered by the metering device for each full hour, not taking into account, e.g. two separate readings of two-rate products.
Hourly metering	Hourly metering of the amount of electricity and the registration of this metering data in the memory of the metering equipment.
Hourly metering equipment	Metering equipment for metering and registering of electricity consumption or feed to the network in the memory of the equipment. The data registered by this equipment may be read from the memory of the equipment via the data transmission network.
Hourly load	Average hourly load for each hour. This may be calculated as a difference of two consecutive hourly readings.
Hourly data	A general term meaning either hourly load or hourly reading.
Status of hourly data	The status recorded for the hourly data indicates the reliability of the data to the recipient of the data.
Official time	The current local time in Finland. The time is determined with respect to the Coordinated Universal Time (UTC). Finnish winter time (= standard time) is two hours ahead of this, i.e. UTC+2, and summer time is three hours ahead, i.e. UTC+3.

1. On metering in general

This recommendation is primarily meant for distribution system operators and personnel responsible for metering operations, but also for other parties related to metering and the processing, transmission and reception of metering data. As a rule, the recommendation only deals with metering on the distribution network.

The recommendation discusses the principles and procedures of metering and the processing and transmission of metering data. The document examines the legislative requirements of hourly metering and provides recommendations for the characteristics of metering devices and systems.

The actors should take into account the recommendations on devices and systems at least at the stage when considering next acquisitions or upgrades to the devices or systems. Procedures on the transmission of hourly data should be introduced as soon as possible, at the beginning of 2012 at the latest, unless otherwise mentioned in the guidelines. The actors, system operators and vendors must develop their systems concurrently with meter replacements so that the hourly data obtained from the meters can be effectively and reliably utilised as quickly as possible and in stages. The objective of this is to avoid situations where a considerable number of metering points are transferred to hourly reading at the same time at the beginning of 2012.

1.1 Legislative obligations for metering

1.1.1 Electricity Market Act (386/1995 with amendments)

According to Section 10 of the Electricity Market Act, the system operator shall organise the metering of the electricity supplied in an appropriate manner, as provided in more detail by a Government decree.

Section 16 c of the Electricity Market Act gives a brief statement of balance settlement: it shall be based on electricity metering, or on a combination of metering and type-loading curves, and on supply reports, and further provisions are given by a separate Government decree.

The Section also states that balance settlement services must be offered on equitable and non-discriminatory terms to the electricity market participants. The balance settlement services offered may not include any conditions or limitations that are unfounded or that obviously restrict competition.

1.1.2 Valtioneuvoston asetus sähkötoimituksen selvityksestä ja mittaamisesta (Government decree on determination of electricity supply and metering) (66/2009)

The most important decree concerning metering is the Government decree on the determination of electricity supply and metering (metering decree) issued by virtue of the Electricity Market Act, which entered into force at the beginning of March 2009.

According to the decree, the system operator must arrange for the metering as the basis for balance settlement and billing, as well as for the registration and reporting of metering data to the electricity market participants. The metering data required in billing must be reported to the electricity supplier for each electricity consumption site or metering. The system operator is also responsible for the metering devices and data transmission connections installed at the electricity consumption and production sites. An exception to this until the end of 2013 will be made with customers who have their own metering equipment acquired during the validity of the previous decree.

The objective of the decree is that, in future, hourly metering will be adopted in almost all cases. Therefore, the decree obliges that 80% of all metering sites of the system operator will be brought within the scope of hourly metering by the end of 2013. All metering sites and production sites of over 3x63A must be brought within the scope of hourly metering no later than the end of 2010. The metering requirements are presented in further detail in chapters 1.2 and 1.3.

The minimum obligations regarding the characteristics of the metering equipment and obligations to store metering data are also laid down in the metering decree. These are discussed in further detail in chapters 1.6 and 6.8.

Balance settlement must be based on hourly metering when the site has the equipment for hourly metering in compliance with the decree. Otherwise, a combination of a traditional metering method and a type load curve may be applied with respect to other than vendors with a delivery obligation.

The metering decree also sets obligations on the transmission of metering data. This matter is also laid down in the decree by the Ministry of Employment and the Economy on data interchange related to the settlement of electricity deliveries (työ- ja elinkeinoministeriön asetus sähköntoimitusten selvitykseen liittyvästä tiedonvaihdosta), which is dealt with in further detail in the next chapter. Data interchange is dealt with in further detail in chapter 7.

The data gathered by the hourly metering equipment must be provided for the customer's use not later than at the same time as it is transferred or completed for transfer to the customer's electricity supplier, i.e. the day after delivery, not later than at the beginning of 2014.

1.1.3 Työ- ja elinkeinoministeriön asetus sähköntoimituksen selvitykseen liittyvästä tiedonvaihdosta (Decree of the Ministry of Employment and the Economy on data interchange related to the determination of electricity supply) (809/2008)

In addition to the metering decree, the decree of the Ministry of Employment and the Economy on data interchange related to the determination of electricity supply (message traffic decree) has also been issued by virtue of the Electricity Market Act.

The system operator must provide the balance power unit with a preliminary report on the summed information of deliveries arriving at or leaving the network of the electricity market participants on the next working day following the electricity supply. Final reports of the summed information on deliveries must be made within one month, and from the beginning of 2011 within 14 days of the delivery date.

The distribution system operator must also provide the electricity suppliers with a preliminary report on the deliveries concerning the electricity market participants, calculated in connection with the balance settlement, for meeting the balance responsibility and billing on the next working day following the electricity delivery or within a time period agreed with the electricity supplier. Final reports on the electricity deliveries must be made within one month, and from the beginning of 2011 within 14 days of the delivery date. The message traffic between actors is described in further detail in Message Traffic Procedural Instructions, Practical Procedural Instructions for the Electricity Market, and in Ediel Messaging: General Application Instructions by the Finnish Energy Industries.

In connection with supplier switching, the system operator must report the meter readings to the customer's new and current suppliers within 10 working days of the beginning and ending of delivery.

1.1.4 EMV:n määräys sähköenergiaa ja sähkön siirtoa koskevien laskujen erittelystä (Energy Market Authority's regulation on itemisation of bills concerning electric energy and electricity transmission) (367/441/2006)

The Energy Market Authority's regulation on itemisation of bills concerning electric energy and electricity transmission (electricity bill regulation) must also be taken into account when determining the principles related to hourly metering. Section 5 of the regulation also states e.g. that meter readings must be reported in the reading-based and balancing bill or its appendix, if these readings are available.

1.1.5 Measuring Instruments Directive and the national obligations by virtue of the directive (2004/22/EC)

The Measuring Instruments Directive (MID) entered into force in spring 2004. The directive applies to a wide scale of measuring instruments, including fuel meters, taximeters, and water, gas and electrical energy meters. The member states should have implemented the statutes within two years, but in Finland the measuring instruments legislation based on the directive is still under preparation at the time of drawing up this recommendation. However, it is known that final legislation will correspond with the contents of the directive. On the other hand, measuring instruments that meet the requirements in force before the application of the directive could be introduced on the market until 2016.

The purpose of the Measuring Instruments Directive and the Measuring Instruments Act under preparation is to safeguard the reliability of operation, metering methods and metering results of the measurement instruments. The statutes provide instructions on e.g. the errors, operating conditions and display of results of measuring instruments, as well as the inspection of measuring instruments before and during introduction.

It is extremely likely that separate decrees will be drawn up on the characteristics and inspections of metering devices, although there is not much information about more detailed contents of these at the time of drawing up this recommendation. In other words, there are no statutes in force concerning the inspection of metering devices during use at the time of drawing up this recommendation.

Inspections taking place before commissioning

According to the directive and draft law, a measuring instrument must not be taken into use before its conformity with the requirements is proved and its reliability is ensured. The directive states in general, e.g. that the measuring instrument's manufacturer or authorised representative, the party placing it on the market, its importer, distributor, entrepreneur or the person taking the measuring instrument into use must ensure and prove that the instrument complies with this law.

The reliability of the measuring instrument is verified by a body or inspection body notified before the instrument is taken into use. *The instrument manufacturer may verify the reliability of the instrument if the manufacturer has a procedure corresponding with its impacts, which is approved and supervised by the notified body or inspection body.*

The act will provide the Safety Technology Authority (TUKES) with a task of approving the lawful inspection bodies. Verification of the reliability of the measuring instrument before it is taken into use includes inspection of the structure and operation of the instrument, as well as comparison of measurement results in an applicable way within the maximum permissible errors.

Inspections during use

According to the directive, the entrepreneur is responsible for the fact that the measuring instrument in use is suitable for its intended use and environment, that it functions reliably at all times, and its use meets the legal requirements, and the verification is carried out at prescribed intervals and whenever necessary. Therefore, the entrepreneur must ensure that the reliability of the measuring instrument in use is verified periodically. However, so far there is no separate regulation on the inspection of electricity meters during use, and the decree concerning this may be provided at a later date, if necessary, by virtue of the Measuring Instruments Act.

Reliable operation of a serviced measuring instrument must be verified before taking it into use at a later date. The verification may also be carried out by a service company approved by the Safety Technology Authority.

If the entrepreneur neglects the verification of the measuring instrument during use or the measuring instrument does not otherwise meet the requirements, the supervisory authority may ban or restrict the use of the instrument.

1.1.6 Laki energiamarkkinoilla toimivien yritysten energiatehokkuuspalveluista (Act on the energy efficiency services of companies operating in the energy market)

The purpose of the act on the energy efficiency of companies operating in the energy market (energy services act), which entered into force at the beginning of 2010, is to promote efficient and frugal energy use of the customers of companies operating in the energy market, e.g. by obliging the energy sector to provide customers with more detailed information about electricity consumption and with energy saving advisory services.

In relation to electricity metering and the transmission of metering data, the act has hardly anything to add to the obligations issued by virtue of the Electricity Market Act. However, it must be noted with respect to the opportunities of utilising the metering data that, according to the energy services act, electricity retailers must provide their customers with a report on the customer's energy use once a year. The report must include information about the end user's energy consumption for the period of the report and the previous three years, however, for a maximum of the duration of the customer relationship with the vendor. Furthermore, the report must include reference data on the end user's energy consumption in comparison with other corresponding end users. The report must be given to the customer for the first time in 2011 and it does not have to include information about the period before 2010. The system operator must provide the necessary information on electric energy consumption to the electricity vendor for the report free of charge.

1.2 Metering of electricity consumption

According to the metering decree, the system operator must arrange for hourly metering in at least 80% of all its metering points by the end of 2013. It is only possible to leave outside hourly metering mainly sites with a size of a maximum of 3x25A. Larger sites may be left outside hourly metering only if their annual use does not exceed 5,000 kWh and they are not subject to competitive tendering.

Large metering points of over 3x63A must be equipped with hourly metering by the end of 2010. Completely new metering points of over 3x63A must be equipped with hourly-metering equipment in connection with first metering. However, it is possible to leave outside hourly metering any hourly metering sites whose annual use does not exceed 5,000 kWh and which are not subject to competitive tendering.

Metering points remaining outside hourly metering must be read three times a year. The system operator is responsible for acquiring one reading each year, and the customer is responsible for supplying two further readings at the system operator's request. The system operator need not acquire these readings separately if the customer does not supply them despite receiving requests to do so.

1.3 Metering of production

Generation sites from where electricity is also transmitted to the public distribution network must be equipped with hourly metering by the end of 2010 at the latest. New generation sites must be equipped with hourly metering with immediate effect.

Network output must be metered hourly at the generation sites. If the site also has consumption, network input must also be metered separately by the hour. Network input and output must not be netted, but the metering device must have separate registers for these.

If the generation site is located in a metering point of over 3x63A with both network input and output, consumption of own generation must be metered hourly in addition to metering the network input and output at the site. Consumption of own generation is obtained by deducting from the generated electricity the production plant's electricity for own use and the electricity fed into the network (network output). Electricity for own use is electricity consumed by the production plant system itself. Further information about the metering of generation is available in

the Energy Industries' network recommendation YA9:9 Connection of micro-generation to the public distribution network.

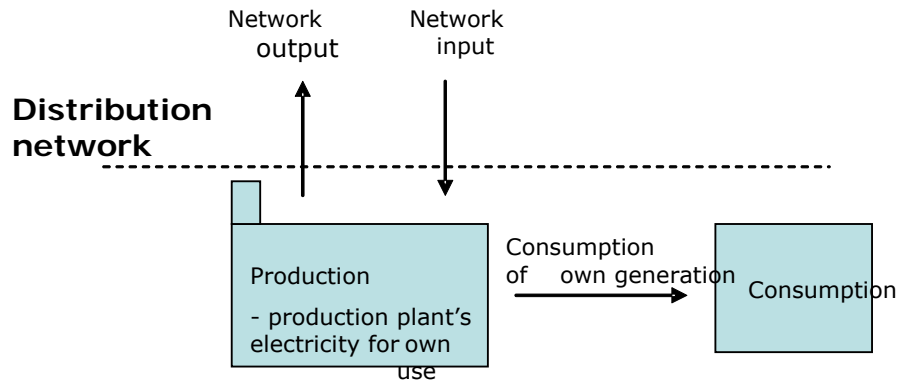


Figure 1. An example of metering of production

The producer himself is responsible for arranging for the metering of his own generation if the system operator does not require this information to fulfil its own tasks. If the system operator uses consumption of own generation as the basis for network service fees, the system operator shall arrange for the metering, in which case the system operator is also entitled to charge reasonable metering fees for metering the consumption of own generation. The system operators normally use consumption of own generation as one of the bases for the network service fees only for sites of over 1 MVA due to the principles of grid fees.

A generation network is established of sites with more than 1 MVA of generation. Metering of generation networks and transmission of the metering data are not dealt with separately in this recommendation.

1.4 Metering of real estate systems

According to the metering decree, separate living and business quarters of a new building must be equipped with metering devices even if the electricity is sold through a real estate system. Apartment-specific metering must also be arranged when the electricity system inside the real estate is altered so that electricity is sold through the real estate system after the alteration.

Metering shall be arranged so that apartment-specific consumption can easily be added to the real estate's consumption or separated from it if the electricity user wants to switch vendors.

The holder of the real estate system is responsible for the necessary alterations to the system to enable apartment-specific metering.

In addition, in accordance with section 25 d of the Electricity Market Act, if the user of electricity has purchased his electricity through the system inside the real estate, he shall pay back the costs arising from the changes related to the metering of electricity to the of the real estate system operator when starting to purchase his electricity through the distribution system of a distribution system operator.

1.5 Responsibilities related to metering

1.5.1 System operator's responsibilities

The distribution system operator is responsible for arranging for metering, reading the metering data, verifying the validity of the data, transmission and reporting of metering data as required by the legislation on the electricity market. The system operator is also responsible for the metering equipment, including its data transmission connections. According to previous electricity market

legislation, customers were entitled to acquire their own hourly metering equipment. This is dealt with in further detail in section 1.5.6.

The system operator may manage these tasks itself or purchase them as a service. When outsourcing metering operations, the responsibility for the metering devices and metering remains with the system operator, which must be taken into account when drawing up contracts with the service provider.

The system operator is also responsible for the data protection related to meter reading and the recording and transmission of metering data. Hourly data must be handled in the same way as personal information all the way from the metering device. The customer and the body authorised by the customer are entitled to have access to the metering data. The electricity market participants are given the information they need, e.g. for meeting the balance responsibility and for billing.

From chapter 2 onwards, the recommendation deals with tasks that are the responsibility of the distribution system operator, unless otherwise mentioned.

1.5.2 Electricity vendor's responsibilities

The electricity vendor's responsibility in the metering of electricity deliveries is mainly related to the reception of metering data and its use in billing, as well as to transmission of information having an impact on metering to the system operator.

The vendor must be able to receive the metering data sent by the system operator in accordance with the legislation and the procedural instructions. The vendor is not responsible for the correctness of this information, but the responsibility lies with the system operator. However, the vendor must ensure that even corrected data sent by the system operator is recorded in the correct systems. Moreover, the vendor shall notify the system operator of any errors it has detected in the data it receives.

In accordance with the message traffic procedural instructions, the vendor must notify the system operator of any contractual changes having an impact on metering and the transmission of metering data, such as the starting and termination of the contract and changes to the contract number.

Furthermore, the energy services act obliges electricity vendors to provide customers with a report on the customer's electricity use once a year.

1.5.3 Electricity user's responsibilities

A customer with a contractual relationship with a system operator or a vendor with a delivery obligation, i.e. the electricity user, is responsible for keeping his own electricity devices and equipment in the condition required by the statutes and provisions. The electricity user must ensure that the low-voltage switchboard is in the condition required by metering. The electricity user is primarily responsible for the instrument transformers required by indirect metering. If it so wishes, the system operator may take over the responsibility for instrument transformers.

If the electricity user and system operator have agreed on the load control, for example, directing night-time loads, the electricity user is responsible for the related connections and wiring of the low-voltage switchboard. The connections made to the meter may only be implemented by the system operator.

1.5.4 Electricity producer's responsibilities

The electricity producer has the same responsibilities related to metering as electricity users in accordance with the previous section.

Moreover, the electricity producer himself is responsible for arranging for metering that the system operator does not need in order to meet its own obligations, but which may be required, e.g. for tax reasons. If the producer must meter the consumption of its own generation according

to the tax legislation and the system operator does not need this metering data, the electricity producer himself will arrange for this metering. The electricity producer shall always notify the tax administration, in practice the customs administration, the information required for tax purposes.

The customer is always under obligation to notify the system operator of electricity generation to be connected to the electricity consumption site so that the system operator can ensure the safety and operational reliability of network use and to organise metering for the site in accordance with the electricity market legislation.

1.5.5 Responsibilities of the real estate system operator

The real estate system operator is responsible for arranging for metering inside the real estate system in accordance with section 1.4.

1.5.6 Metering equipment owned by the customer

According to previous electricity market legislation, the electricity user and/or producer (customer) was entitled to acquire himself the hourly-metering equipment that meets the system operator's technical requirements or the related data transmission connection. This kind of equipment owned by the customer is mainly installed at sites of over 3x63A. According to the Government decree on determination of electricity supply and metering, which entered into force at the beginning of March 2009, customers no longer have this right, but the system operator will install meters in all sites.

Customers that are already in possession of their own hourly-metering devices or related data transmission connections are entitled to keep this equipment in their possession until the end of 2013. This requires that the hourly data can be read remotely from the meter in a reliable way within the periods of time issued by legislation. If the customer's metering system does not meet these requirements or if the customer and the system operator agree on replacing the meter at an earlier date, the system operator is entitled to replace the meter before the end of 2013.

In the above-mentioned case, the customer will be responsible for the metering device and data transmission connections in his possession. The customer is also responsible for their maintenance and inspection. The customer must notify the system operator without delay of any faults detected in the equipment or any modifications to be made to the equipment. For example, a change of the data transmission connection number must be reported to the system operator without delay.

If a metering device owned by the customer develops a fault, the system operator is entitled to demand that the customer repairs the fault or arranges for its repair *within the next three working days from the notification*. After that, the system operator is entitled to carry out the repairs itself or replace the system operator's metering device and data transmission connection at the site. The costs arisen from this may be charged for the modification.

If the data transmission connection owned by the customer develops a fault, the system operator is entitled to demand that the customer repairs the fault with immediate effect. If the fault has not been repaired *within one week* of the notification, the system operator is entitled to charge for reading to be carried out on site. If the data transmission connection is not repaired within reasonable time, the system operator is entitled to replace the metering device and data transmission connection with equipment owned by the system operator. In such a case, the system operator is also entitled to charge the costs arisen from the replacement.

1.5.7 Responsibilities related to separate inspection of the metering equipment

In addition to inspections related to standard maintenance measures, the customer may demand the system operator to have the metering equipment inspected. If the metering device is owned by the customer in accordance with section 1.5.6, the system operator, in turn, is entitled to demand for an inspection of the metering equipment.

If the inspection proves to be unfounded, the inspection will be paid by the party that requested it. Otherwise, it shall be paid by the owner of the inspected metering equipment. The amount of any rectification will be determined or estimated on the basis of available metering data or, if necessary, with the aid of an impartial expert statement in accordance with the Terms of Network Service.

According to the Measuring Instruments Directive, the metering equipment may only be inspected by an approved inspection body. After the metering equipment act, which is under preparation concurrently with this recommendation, has entered into force, the Safety Technology Authority will approve the inspection bodies in accordance with the directive.

1.6 Requirements for hourly metering equipment set out in the metering decree

According to the metering decree, hourly metering equipment refers to equipment or a combination of equipment that meters and registers electricity consumption or feed into the network into the memory of the equipment on an hourly basis. The data registered by this equipment may be read from the memory of the equipment via the data transmission network.

According to the metering decree, the data system handling the metering data of the hourly-metering equipment and the system operator must include at least the requirements presented in the following. The requirements apply to hourly-metering equipment ordered after the decree has entered into force.

- It must be possible to read the data registered by the metering equipment from the memory of the equipment via the data transmission network (remote reading facility).
- The metering equipment must register the start and end times of de-energised time of over three minutes
- The metering equipment must be able to receive load control commands sent via the data network, and it must have at least one control device available for load control, and this control device may not be reserved for any other use
- Metering data and the data concerning de-energised time must be recorded in the data system processing the metering data of the system operator. In the data system, the metering data must be stored for at least six years and the data concerning de-energised time for at least two years
- The data protection of the metering equipment and the data system processing the system operator' metering data must be verified in an appropriate way.
- Moreover, the system operator must offer hourly-metering equipment for the use of its customer at the customer's separate request, including a standardised connection for real-time monitoring of electricity consumption.

1.6.1 Energy Market Authority's interpretation of hourly-metering equipment

According to the Energy Market Authority's policy, hourly-metering equipment is deemed to mean that

1. there is a metering device (=hourly meter) capable of hourly registering at the site, and
2. the hourly meter has a data transmission connection for daily transmission of hourly data, and
3. the reading system is in such a condition that, if necessary, it can be used on a daily basis for reading the hourly data of all sites equipped with an hourly meter.

Therefore, it is not sufficient with respect to the reading system that e.g. a system meant for the reading of sites of over 3x63A can be used for reading some smaller sites. The definition of hourly-metering equipment does not include the readiness of the metering data management system for processing hourly metering data.

1.7 Metering and data transmission chain

Figure 2 presents the metering and data transmission chain of hourly reading, starting from the collection device and ending with the parties requiring the data.

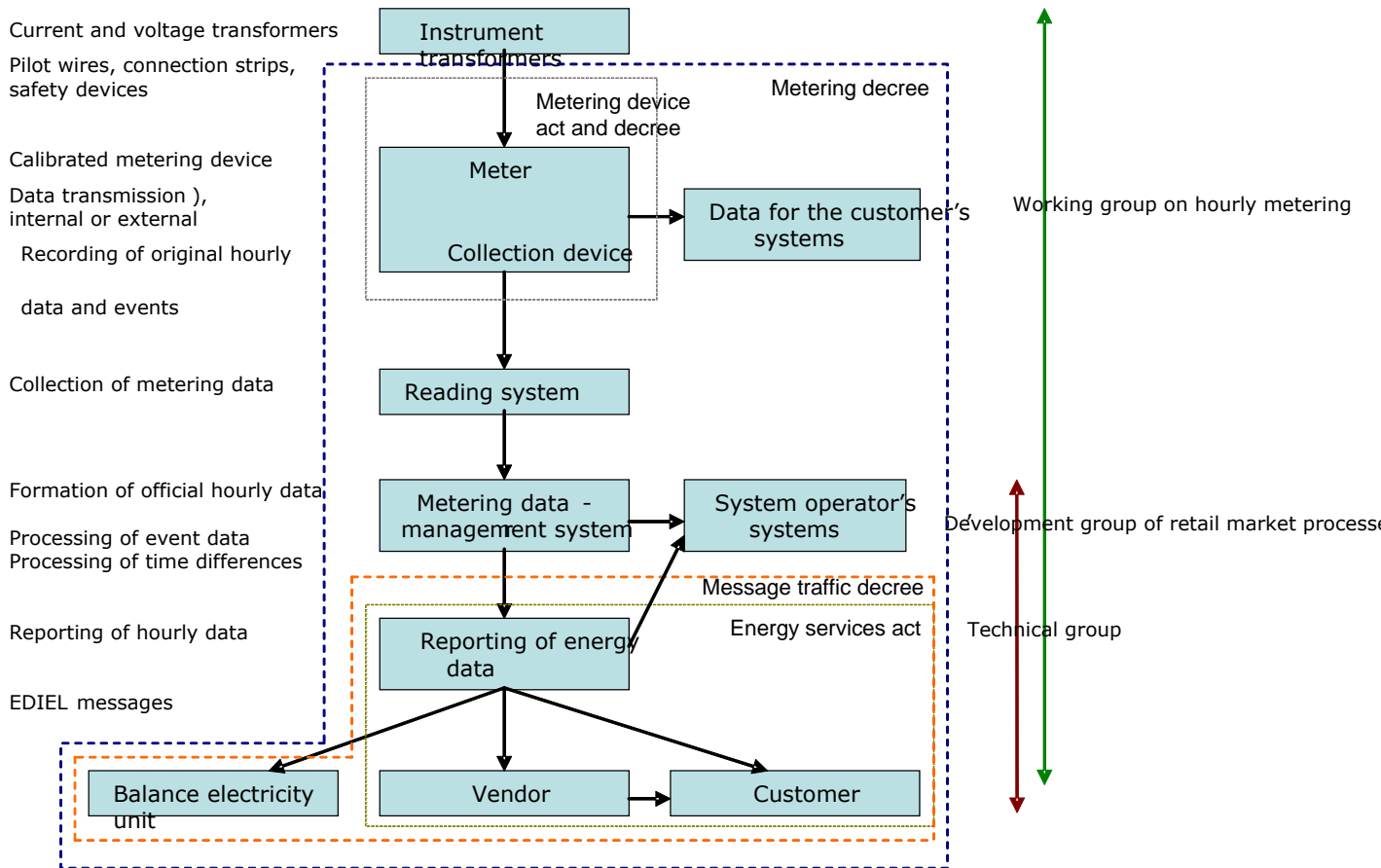


Figure 2. Metering and data transmission chain

The obligations of the acts and the decree referred to above and the sections of the metering and data transmission chain they apply to are marked in the figure. The figure also demonstrates that the work of the Development Group of Retail Market Processes of Finnish Energy Industries focuses mainly on the procedures used in the transmission of metering data. Therefore, the Hourly Metering Working Group, which has prepared the recommendation, has dealt with the data transmission between participants only to the necessary extent. Many of the definitions in the first part of the chain also have an impact on the contents of messages to be transmitted. These include the Hourly Metering Working Group's recommendations on periods of time and the statuses of hourly data.

2. Characteristics and connection of metering devices

In this recommendation, metering equipment refers to hourly-metering equipment that measures active energy and possibly also reactive energy, as well as certain qualities of electricity. The characteristics of the metering and registering of hourly data and readings are dealt with in sections 2.2 – 2.3. The metering and registering of characteristics related to the quality of electricity are dealt with in chapter 3.

The recommendations apply to new and renovated permanent metering sites.

The metering decree, the metering equipment act and the decrees issued by virtue of it (the act is in its preparation stage at the time of drawing up the recommendation) provide the minimum requirements for metering equipment. The minimum requirements of the metering decree are dealt with e.g. in section 1.6.

2.1 Accuracy requirements and operating limits of the metering equipment

The accuracy requirements for electrical energy meters intended for residential, commercial and light industrial use are listed in Annex MI-003 of the Measuring Instruments Directive. These requirements are presented in the following table (meter classes A, B, C). The requirements apply to the metering of active energy. The accuracy requirements only apply to electrical energy meters, not instrument transformers. The meter requirements complying with the directive are dealt with in further detail in standards EN 50470-1, EN 50470-2 and EN 50470-3.

Table 1. Maximum permissible errors in percentages when the meter is operating under varying-load current.

MPEs in percent at rated operating conditions and defined load current levels and operating temperature

	Operating temperatures			Operating temperatures			Operating temperatures			Operating temperatures		
	+ 5 °C ... + 30 °C			- 10 °C ... + 5 °C or + 30 °C ... + 40 °C			- 25 °C ... - 10 °C or + 40 °C ... + 55 °C			- 40 °C ... - 25 °C or + 55 °C ... + 70 °C		
Meter class	A	B	C	A	B	C	A	B	C	A	B	C
Single phase meter; polyphase meter if operating with balanced loads												
$I_{\min} \leq I < I_{tr}$	3,5	2	1	5	2,5	1,3	7	3,5	1,7	9	4	2
$I_{tr} \leq I \leq I_{\max}$	3,5	2	0,7	4,5	2,5	1	7	3,5	1,3	9	4	1,5
Polyphase meter if operating with single phase load												
$I_{tr} \leq I \leq I_{\max}$, see exception below	4	2,5	1	5	3	1,3	7	4	1,7	9	4,5	2

For electromechanical polyphase meters the current range for single-phase load is limited to $5I_{tr} \leq I \leq I_{\max}$

When a meter operates in different temperature ranges the relevant MPE values shall apply.

I = the electrical current flowing through the meter

I_{\min} = the value of I above which the error lies within maximum permissible errors (MPEs) (polyphase meters with balanced load)

I_{tr} = the value of I above which the error lies within the smallest MPE corresponding to the class index of the meter

I_{\max} = the maximum value of I for which the error lies within the MPEs

U = the voltage of the electricity supplied to the meter

U_n = the specified reference voltage

f = the frequency of the voltage supplied to the meter

f_n = the specified reference frequency

The requirements concerning the maximum permissible errors defined in the table are in force in the voltage range $0.9xU_n \leq U \leq 1,1xU_n$ and in the frequency range $0.98xf_n \leq f \leq 1.02xf_n$. The power factor range must be at least from $\cos\varphi = 0.5$ inductive to $\cos\varphi = 0.8$ capacitive.

Below the rated operating voltage, the positive error of the meter shall not exceed 10%.

The recommendations for accuracy classes apply to new and renovated permanent metering connections. Less accurate measurements may be used temporarily, e.g. in maintenance situations or similar.

According to the directive, a member state must allow class A meters in residential use. For specified purposes, a member state may require any class B meter. It is recommended that a meter located outdoors or in a cold room is at least of accuracy class B.

In commercial and/or light industrial use, a member state must allow metering with class B meters. For specified purposes, a member state may require any class C meter.

System operators should pay attention to the fact that the accuracy requirements for meters in accordance with the directive are less strict than the accuracy requirements for meters traditionally used at these sites (meter classes 1 and 2), which are specified in standards IEC 62052-11 and IEC 62053-21. In order to ensure the reliability of metering, the system operator may acquire more accurate meters than those in the accuracy requirement of the directive.

Metering of active power in accordance with standard SFS-EN 62053-22 (classes 0,2S and 0,5S) is still used for the metering of larger sites. The accuracy of the metering of reactive power is specified in standard EN 62053-23. The required accuracy of both direct and indirect metering of reactive power is accuracy class 2 in accordance with the standard.

The total error is crucial with respect to the correct measurement; total error is affected by e.g. the selected instrument transformers and testing wires, which are dealt with in further detail in section 2.17. Appendix 1 includes practical instructions for establishing the total error at the installation site.

2.2 Hourly data metered and registered by the metering device

With respect to the energy data, the metering device must *meter and register cumulative readings (hourly reading) or average hourly loads (hourly load)* every hour into the memory of the metering device. These are read further into the reading system. It is recommended that specifically cumulative hourly readings and not average hourly loads are registered especially at sites of up to 3x63A.

Cumulative reading registered every hour, i.e. the hourly reading, is one uninterrupted total reading that does not take account of, e.g., the two separate readings of two-rate products. Therefore, it deviates from the cumulative readings according to the customer's distribution product at least in cases where the distribution product has a two-rate tariff. The hourly-registered total reading usually, but not always, corresponds with the reading in accordance with the single-rate product, which can be seen on the metering device.

Hourly energy data means the reading or power data registered every hour on the hour, 1:00, 2:00, 3:00 etc.

In the case of indirect hourly metering, the metering coefficient is recommended to be recorded in the metering device, in which case it is possible to record already multiplied values in the meter.

2.3 Readings metered and registered by the metering device in accordance with the distribution product

In addition to section 2.2, at least in the case of a consumer customer, the metering device must *meter* the cumulative readings divided in accordance with the customer's distribution product

because, according to the Measuring Instruments Directive, the customers' metering device must show the cumulative readings in accordance with the distribution product at any given time.

For reasons of simplicity, it is recommended that all metering devices meant for sites of up to 3x63A will measure cumulative readings in accordance with the distribution product, and these readings are shown on the metering device's display.

Of the readings in accordance with the distribution product, it is possible to *register* in the metering device's memory, e.g. readings at the turn of the month or the turn of the 24-hour period. This is recommended especially with respect to sites of up to 3x63A. If the customer has a general time-of-day product, the reading according to the distribution product and the total cumulative reading are usually the same, in which case there is no need for separate registering of the distribution product.

If the metering device does not register hourly cumulative readings, but it registers average hourly loads, it is particularly recommended to register readings at the turn of the month or the 24-hour period in accordance with the distribution product.

Readings according to the distribution product, which are shown on the display of some metering devices, are reset to zero, e.g. in connection with updates. This non-recommended feature must be observed especially when new metering devices are acquired. According to the metering equipment legislation currently under preparation, it must not be possible to reset to zero the total amount shown on the metering device during use. However, the lifetime total reading of metering devices is not usually reset to zero even in connection with updates.

The metering device may also be equipped with a multi-rate feature, in which case the meter simultaneously measures readings according to different distribution products. The readings of a meter equipped with a multi-rate feature are not reset to zero even when the distribution product changes.

2.4 Registering of network input and output

The metering device must register network input and output separately. The metering device must not add up network input and output taking place during a single hour (netting), but network input and output taking place during one hour must be registered in different registers.

Simultaneous network input and output may be netted, i.e. if one stage is feeding 100W into the network and two other stages are taking a total of 60W from the network at any given moment, these can be added up, i.e. at the moment in question there is 40W of network output.

2.5 Accuracy requirements and rounding off of hourly data

Hourly data must be recorded with an accuracy of at least 10Wh at sites of up to 3x63A. Data for sites larger than this are recorded with an accuracy of at least 1 kWh. When rounding off the hourly data, truncating rounding is used, and the remaining energy is transferred to the next hour.

2.6 Time stamps and statuses of metering data

The metering device must furnish the hourly data (hourly readings or hourly power), and any other readings registered by the metering device, with time stamps. Moreover, the hourly data is furnished with statuses, which can be used for detecting any factors of uncertainty having an impact on the validity of the data.

With cumulative hourly readings (hourly reading), the time stamp is the moment of registering. Hourly powers, on the other hand, are usually furnished with the time stamp of the starting moment of the hour in question. The meanings of the time stamps must be taken into account when forming time series for the hourly power for each 24-hour period in the metering data management system.

The metering device must enter statuses for the hourly data to indicate whether the data is reliable or whether it is connected to some possibility of an error. The statuses entered for the hourly data of metering devices on the market vary by metering device. These statuses are mainly information meant for the use of the system operator for monitoring the operation of the metering equipment. The statuses of hourly data are converted to a commonly agreed form in the metering data management before the data is transmitted to other market participants. This is dealt with in further detail in sections 6.3 and 7.6.

2.7 Recording capacity of the metering device

The memory of the metering device must accommodate the energy data at least for the period of the balance window (1 month / 14 days). Other data measured by the metering device (especially interruptions lasting longer than 3 minutes) must be saved for at least one week.

It is worth noting that when the remote reading connection is out of order, the memory must retain the recorded data at least for a period long enough to have time to seek the data from the meter and, if necessary, to replace the meter.

2.8 Operation of the metering device during a power failure

The clock of the metering device must be kept in time during a power failure, and the data in the memory of the meter must remain correctly in the memory. The program and metering data of the metering device should remain in the metering device even for years without power. According to the Measuring Instruments Directive, in the event of loss of electricity in the circuit, the amounts of electrical energy measured shall remain available for reading during a period of at least four months.

It is recommended that the clock of the metering devices keeps time for at least 7 days.

The metering devices must be able to register the start and end time of a long interruption in accordance with section 3.1.

2.9 The clock of the metering device and testing of clock accuracy

The clock of the metering device is tested against the time of the reading system in connection with the daily reading. The clock of the metering device must be reset to the correct time, if necessary. If the time of the reading system deviates from the time of the metering device by a maximum of 36 seconds, the clock is reset to the correct time, but the statuses of hourly data need not be entered as uncertain. If the difference is more than 36 seconds, the time of the clock is reset and the hourly data since the previous reading will be stamped with a status specific for the metering device manufacturer, describing the inaccuracy of time. The system operator may set another time limit, if so desired.

Resetting of the clock must be available as a remote function.

The time of the clock shown on the display is dealt with in further detail in the following section.

2.10 Display of the metering device

According to the Measuring Instruments Directive, the display must be clear and unambiguous. Easy reading of the presented result shall be permitted under normal conditions of use. Whether or not a metering device intended for utility measurement purposes can be remotely read it shall in any case be equipped with a metrologically controlled display accessible without tools to the *consumer*. The reading of this display is the measurement result that serves as the basis for the price to be paid.

Therefore, according to the Measuring Instruments Directive, the display of the customer's metering device must show at least the readings divided according to the distribution product. It is recommended that the metering devices of all sites of up to 3x63A are equipped with this feature. It is not necessary to be able to browse the reading data backwards in time on the display.

At the system operator's discretion, the total cumulative reading, gathered as hourly data and registered by the metering device, may also be wished to be shown on the display of the metering device. The cumulative reading deviates from the readings according to the distribution products at least in cases where the customer has a two-rate distribution product.

If so desired, the display of the metering device can also be programmed so that the customer can browse the readings according to different distribution products on the display (multi-tariff feature).

The electrical energy measured shall be displayed in accordance with the Measuring Instruments Directive either in kilowatt-hours or in megawatt-hours, depending on the size of the site.

It is recommended that the display of the metering device shows the date and time. The clock shown on the display must be in official Finnish time, i.e. complying with winter and summer time, from the beginning of 2014 at the latest. If the official time is deviated from, the customer must be notified of this separately, for example, with a sign or sticker attached to the meter case or device, or in the meter reading instructions.

2.11 Programming facilities of the metering device

It must be possible to program the metering device, and the programming shall be able to be primarily carried out as a remote function. The system operator is responsible for the programming, and programming is only permitted to be carried out by the system operator or a body authorised by the system operator. It must not be possible to change the settings without sufficient safety measures through the data transmission connection.

It must be possible to control the distribution product in use at any given time via the remote connection. At the same time, the display of the metering device must be directed to show the reading according to the selected distribution product.

Similarly, it must be possible to programme the clock of the metering device via the remote connection. Furthermore, it must be able to remotely programme the control delays of night loads, control times and any control functions serving flexible demand.

In the case of indirect metering, it is recommended that it is possible to programme a metering coefficient for the metering device, in which case the metering device will record the final multiplied values.

2.12 Remote disconnection and reconnection facility

It is advisable to fit the metering device with a remote disconnection and reconnection function, especially if the metering device is at a site with typically a high number of contractual amendments. It is possible to install a remote disconnection device to some of the metering devices at a later date.

System operators must take into account that the remote connection device must not be used as a disconnecting device when the electricity is cut off due to electrical works. The remote connection device does not have an air gap in accordance with the electrical safety regulations, nor does it have a visible locking of the 'on' position.

The metering device can also be equipped with so-called approval button. By pressing this button, the customer can reconnect the electricity to the site after the system operator has first carried out remote connection. However, in this respect, the system operator must pay attention to sites where the customer has no access to the meter. With some metering devices, the approval button can be bypassed.

2.13 Reading of metering data during a connection failure

It must also be possible to read the metering device locally via a data transmission connection if the remote reading of the metering device is not successful for some reason.

2.14 Inputs and outputs of the metering device, and data transmission to other systems

The metering devices may have other inputs and outputs, but they must not have an impact on the reliability, hourly registering and data transmission of the metering for invoicing.

According to the Measuring Instruments Directive, the system operator must offer hourly metering equipment for the customer's use, including a standardised connection selected by the system operator for real-time monitoring of electrical energy consumption, if the customer places a separate order for such equipment. If the existing meter has to be replaced as a result, the system operator is entitled to charge the customer for the installation and deployment of the meter.

Metering data can be transferred to the customer's equipment e.g. in pulse format (potential free contact). Other standardised methods independent of the metering device manufacturers are not known at the time of finalising this recommendation. When metering data is transferred in pulse format, a pulse/relay output is used for transferring the metering data. The metering device may have another than a pulse-format solution for transmitting real-time data to the customer's systems.

Other technologies independent of the meter, which the customer can use for obtaining real-time information on his energy use for utilisation, e.g. in domestic automation, are entering the market in addition to the meters. Customer's automation equipment utilising real-time data transfer is currently being developed to a significant extent.

2.15 Load control characteristics of the metering device

The metering systems should be built so that the load control characteristics enable site-specific load control. This should be taken into account especially when building and renovating multimeter distribution boards.

2.15.1 Controls tied to the tariff

In this connection, controls tied to the tariff refer to e.g. night-time load control tied to the night-time/daytime tariff.

Tariff-based load control should not be tied to the start time of tariff control, i.e. night-time load may only be switched on at a later time after the start of night-time tariff period. Fingrid has provided instructions for the distribution system operators to have staggered switch-on of their customers' night-time loads in order to be able to moderate the power peak at 22.00 hours. It is recommended that the staggering takes place over a sufficiently long period, for at least one hour. The system operator may determine the method of implementing the control delay, i.e. the delay may be either occasional or standard, depending on the metering site.

The customer may also control his own loads to be switched on or off with his own automation equipment or timer switch, unless otherwise agreed with the customer.

2.15.2 Demand flexibility and power shedding controls

According to the metering decree, the metering device must be able to receive and transmit load control commands. The purpose of the decree paragraph is to promote e.g. introduction of demand flexibility controls and management of power shortages.

The decree does not impose obligations to the technical implementation of controls.

It is also possible to implement load control without separate relays via the interfaces of the metering device or fully independently of the meter, for example, utilising building automation systems.

2.15.3 Recommendation on the control features of the metering device

It is recommended that the metering devices of electrically heated sites with both direct and storage heating are equipped with two relays reserved for control purposes (or with other alternative technology that can be used for implementing two controls). One of the relays is reserved for night-time load control and the other for any demand flexibility and load shedding controls. At sites with only storage heating, one control relay or another corresponding alternative technology will be enough. Similarly, at sites with no tariff control, only one control relay or another alternative technology would be needed.

It is recommended that system operators maintain the control possibilities (e.g. load shedding, night-time load) in connection with meter replacements.

2.16 Location of the metering point

Primarily, efforts are made to locate the metering point at the energy delivery point. In some special cases, the metering point and delivery point differ from one another (e.g. instrument transformers and the delivery point are on different sides of the distribution substation). In practice, this may become an issue when, for example, the metering of a medium-voltage connection is located on the low-voltage side of a transformer substation. In these cases, the system operator shall calculate the losses using a formula derived from the electrical values of the cables and transformer, as well as the metered data. Metering data can be corrected on the basis of the calculated loss data. This can be carried out on the metering data management side. On the market, there are also metering devices with an opportunity for internal calculation in order to take transformer losses into account. The use of this function will naturally require programming of the correct parameters in the metering device.

The system operator should also take into account the location of reactive power metering in view of the compensation.

2.17 Metering connections

When connecting an hourly-metering device, it is essential to take into account whether the data transmission connection to the device is working after electricity has been switched off from the main switch of the low-voltage switchboard. The devices used in the metering must be selected and installed so that they operate and withstand the environmental conditions of the place of installation.

2.17.1 Size of the metering device and structure of the low-voltage switchboard

The system operator must ensure that the metering device fits into the structures of the low-voltage switchboard in accordance with the effective standards. This matter is dealt with e.g. in standard SFS 5601 Space for electrical energy meters. Also in other respects, it is worthwhile for the system operator to choose the size of the metering device so that it will fit into the majority of low-voltage switchboards in the metering sites of its network area.

The size and the structure of the customer's low-voltage switchboard must comply with the standards.

2.17.2 Connection of the metering device in the low-voltage switchboard

The metering device must be installed between the main fuses and the main switch whenever possible. Thus, the metering device must be equipped with appropriate warning signs indicating that the voltage of the metering device is not disconnected from the main switch. New low-voltage switchboards are built according to this principle, but the modification of old ones may be difficult. When the metering device cannot be installed in the above-mentioned way, it is worth finding out whether it is possible to arrange auxiliary power supply for the metering device before the main switch. The auxiliary voltage feed must be protected with labelled and sealable over-current protection.

If it is decided that the connections of old centres are modified so that the metering device is located between the main fuses and the main switch, or if auxiliary voltage is connected to the metering device, this must be recorded in the document concerning the technical requirements of the system operator's metering or in the design instructions. The customer will not be charged separately for the modifications.

Centre structures are dealt with in Sähköinfo's ST cards and the valid standards regarding metering centres.

2.17.3 Connections of indirect metering

The cross section of metering wires must be at least 2.5 mm². When using thicker cross sections, especially the load of the current transformers must be taken into account. The design of instrument transformers is dealt with in further detail in Appendices 2 and 3.

In indirect measurements, connection strips with a switching facility and equipped with plug cases must be installed in both the voltage and circuit as close to the instrument transformers and meters as possible. Separate secondary cabling, protected with a fuse or residual current circuit breaker, is recommended for the metering voltages used for invoicing. The connection strips must be installed in a space that can be sealed, or the connection strips must be sealable.

2.17.4 Instrument transformers

The characteristics of instrument transformers are defined in standard SFS 3381 Metering of alternating current energy, metering equipment. On the other hand, this standard conflicts with the accuracy requirements of meters in the Measuring Instruments Directive, and therefore the standard will probably be updated when the meter accuracy requirements in accordance with the Measuring Instruments Directive are introduced in the national legislation.

According to standard SFS 3381, current transformers conforming to standard IEC 60044-1 shall be used as instrument transformers, as well as voltage transformers conforming to standard IEC 60186 and combined current and voltage transformers conforming to standard SFS 4925.

According to standard SFS 3381, the accuracy class requirement of current transformers is 0.2S and that of voltage transformers is 0.2, covering all capacity ranges.

Instrument transformers are installed in all phases. The secondary current recommendation for current transformers is 5A. The current transformer should correspond with the actual operating area as far as possible. The current transformer must be selected so that the metered current corresponds with 5–120% of the rated current of the primary of the current transformer. All phases must have their individual return current.

It is recommended that only voltage transformers with single-pole insulation be used. The secondary voltage of a voltage transformer is 58 V.

For the instrument transformers to keep within their accuracy class, the devices and wires in the secondary circuit must be selected so that they form a load, which is 25-100% of the rated load of the secondary of the instrument transformers.

This must be taken into account especially in the circuit of the current transformer when using static meters (also when changing the induction meter into a static one). The problem is emphasised when the secondary current of instrument transformers is below 5 A or when the load of the current transformers is high (often with old current transformers). If necessary, the instrument transformers are replaced with ones with a smaller rated load or extra load is installed in the secondary circuit (e.g. separate return wires and/or a necessary length of 2.5 mm² extra wire).

The calculation examples of taking account of the instrument transformer load and a table of the design of current transformers in a low-voltage network are presented in Appendices 2 and 3.

2.18 Data transmission features of the metering device

It is not recommended for the metering devices to be tied to only a single data transmission technology. It is advisable to consider the life expectancy of the data transmission technology to be used.

If the network company wants to receive automatic alarms from the metering device, e.g. in relation to interruptions, the metering device must be able to send the alarms without excitation from the reading system.

3. Metering features of outage data and quality of voltage

According to the metering decree, an hourly-metering device should register outages lasting more than three minutes. Moreover, the hourly-metering devices can be utilised, e.g. in the monitoring of voltage quality. However, the hourly-metering devices are not comprehensive electricity quality meters, but they can be used for obtaining information in support of network operation.

Metering of the voltage with an hourly-metering device is not "watertight", and the frequencies of sampling of the voltage vary between meters. Therefore, hourly-metering devices provide only indicative information about the voltage and short outages.

3.1 Characteristics of outage registration

According to the metering decree, hourly-metering equipment must register outages lasting more than three minutes. It is advisable to use metering devices for registering short outages in addition to long ones. However, it must be observed with respect to short outages that all short outages are not necessarily registered in the device due to the fairly infrequent sampling of the metering devices.

The following characteristics must be taken into account when examining the outage data registered by the metering device:

- Sampling frequency: are all voltage dips and short outages registered?
- Long outages: registers the start and end time of the outage or the duration and ending time of the outage
- Short outages: registers the numbers and possibly the times
- Set value of the outage: the results are affected by the setting of the residual voltage ($10\% \cdot U_n$ / $5\% \cdot U_n$).

3.2 Characteristics of voltage-level metering

The metering devices have different ways of metering and registering voltage. The voltage data obtained from the meters may be the root-mean-square value or the average root-mean-square value for a certain period, e.g. 1, 3 or 10 minutes. From the viewpoint of the quality of electricity, the average root-mean-square value for 10 minutes is interesting because, according to the power quality standards (EN 50160, EN 61000-4-30), slow voltage variations are examined specifically over a 10-minute metering period. In addition, it would be beneficial to obtain information about a few highest and lowest root-mean-square values over a period of the past week.

It is recommended that all of the voltages for all phases are metered.

It is also recommended that the over- and undervoltage limits could be determined by the user.

3.3 Operative functions

It should be possible to program the metering device to indicate and raise the alarm as a result of outages and voltage variations according to the adjustable limit values.

In terms of alarms/indications, the following operating categories should be available to choose from: 1) out of use, 2) recording into the event log, and 3) recording into the event log and alarm.

There should be prioritisation/locking possibilities between various alarms, in which case only the most important data is sent to control in case of several simultaneous indications.

It should be possible to freely set the indications and alarm limits, e.g. $U_n - X\%$ for a certain duration. The limits should be determined at least for over- and undervoltage. With suitable limit values of over- and undervoltage, it is also possible to detect a zero fault, phase discontinuity, lack of one phase in the low-voltage network, lack of two phases in the low-voltage network.

In practice, it is enough that the alarm functions are taken into use from behind the transformer only from one or two metering devices. Three-phase faults are usually faults in the medium-voltage network, and therefore they do not necessarily need an alarm.

The meter must keep an event log of the alarms and indications with respect to each matter: e.g. of the last five events including their time stamps.

It would be beneficial to be able to examine the voltage data for the metering site in real time with the remote connection.

3.4 Recording of outages and voltage quality data

The decree obliges operators to record outage data for a minimum period of two years. For this period, the data must be recorded in an appropriate system of the system operator. The data can be recorded in the reading system if it has sufficient capacity. The data can also be recorded on the side of the metering data management system or in a separate power outage/quality data system of the system operator. It is essential that the data is available in the calculation system where the outage statistics and any monitoring of long outages take place. This can be a network operation support application.

Meter recording ability and registered events

It must be possible to record outages and any data related to voltage quality in the meter for a minimum period of one week. It must be possible to read the outage data and voltage quality data, along with the energy data, locally directly from the meter if remote reading is not successful.

In terms of the registering ability, it is advisable to establish the number of registered events for various quantities and whether the metering device has a common or separate registers for different quantities.

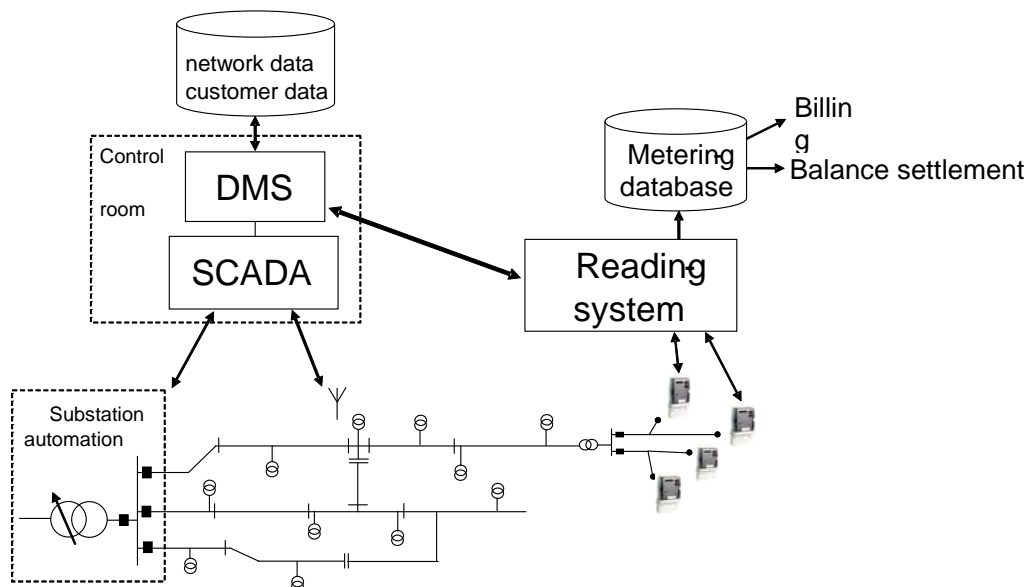


Figure 3. Recording of quality data in the systems (Source: Tampere University of Technology, Department of Electrical Energy Engineering)

4. Inspection of the metering equipment

This chapter deals with the inspection of metering devices and related connections and data transmission connections. Chapters 5.6, 6.9 and 7.10, on the other hand, deal with the inspection of metering data. Obligations concerning the inspection of metering devices will probably be issued at a later date by virtue of the metering device act currently under preparation, and chapter 1.1.5 deals with this in further detail.

4.1 Inspections during the installation phase

In the installation phase, the following matters are usually inspected:

- Validity of metering connections; e.g. correct connection of phases, i.e. incoming and outgoing wires are connected in the correct way
- Correct direction of rotation of the electrical field in the case of reactive power metering
- Functioning of the data transmission connection; for example, the intensity of the GSM field at the time of installation, which can be used for estimating the need for extra antennae
- Sealings
- The energy and power readings of the meter (e.g. validity of the magnitude of power)
- Meter data (incl. pulse data)
- Operating couplings

Moreover, the fitter should report the condition of the main switch for later reference as regards to the reason why the reading may not be successful.

4.2 Further inspections of indirect metering sites

After installation, the following can be inspected in addition to the previous section:

- Total metering error
- Condition, functioning and conversion ratio of current and voltage transformers
- Integrity and load of the secondary circuit
- Meter accuracy
- Phase-specific currents, voltages and loads of the secondary side

The calculation examples of taking account of the instrument transformer load and a table of the dimensioning⁰ of current transformers in a low-voltage network are presented in Appendices 2 and 3.

5. The reading system and data transmission connection

The requirements for data transmission and the reading system are described in the following. It should also be taken into account that the same requirements for functionality, availability and data protection also apply to the reading service purchased by the system operator.

Some data transmission alternatives from the meter to the reading system are presented in the following figure.

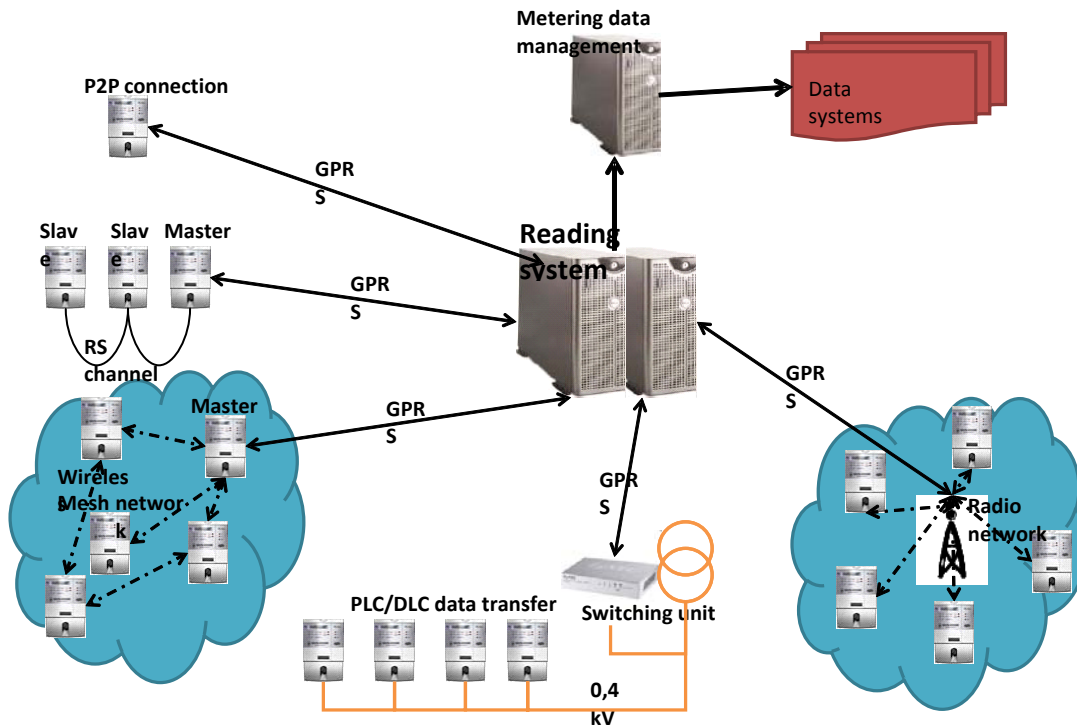


Figure 4. Principles of the data transmission of energy meters.

5.1 Characteristics required of the data transmission connection

The data transmission connection must be a two-way system. It must be able to transmit at least the data defined in this recommendation.

It is recommended that the data transmission connection of a metering device is selected so that data transmission is successful at all times of the day and night. The system operator must be able to read the data registered by the metering device at any moment.

Moreover, it should be taken into account in the selection of data transmission connections and systems that the meter is capable of transmitting, e.g. alarms to the system operator's system and controls from the system operator's system to the metering device with the desired response time.

The system operator should set a minimum level for successful reading. The requirements may be set separately for data transmission and the reading system. In terms of data transmission, any technical restrictions related to the selected data transmission technology and the life cycle of the data transmission channel should be taken into account. The prerequisites and requirements for data transmission should be carefully written into any contracts to be signed with co-operation partners.

5.2 Data transmission protocol

The data transmission protocol must be based on a public standard (e.g. DLMS/COSEM). Openness should be a requirement for the systems so that metering devices of different suppliers can be matched to the same systems. On the other hand, with respect to the transmission and recording of metering data, it must be ensured that access to the data by unauthorised persons is prevented.

The data transmission protocol must ensure that no data will be altered in data transmission without it being detected in the reading system. This error detection method must be public.

5.3 Characteristics required of the reading system

The metering device, data transmission connection and reading system should be selected so that the data registered by the meter can be read by both separate command and automatically. The metering device can also automatically send data to the reading system.

It must be possible to verify the individual code of the metering device and the time of the clock in the metering device through the data transmission connection, and it must also be possible to individualise every metering device in the reading system.

The reading of the metering device must not destroy or alter the metering or event data of the metering device.

The reading system must find any errors and unsuccessful readings detected from the data transmission and to report these.

It is recommended that the system operator should empirically determine the longest time during which a temporary fault in the connection should correct itself. Outages longer than this time will launch remedial actions in order to restore the connection.

The system operator should set a minimum level for successful reading. The requirements may be set separately for data transmission and for the availability of the reading system. The requirements may be set separately for first reading and for re-reading taking place after a certain length of time, for example, 3 days.

5.4 Reading data in the reading system and recording the data

The reading system must read from the meter new and missing data registered by the meter, including time stamps and the status given by the meter, at least once every 24 hours. The data to be read is dealt with in further detail in chapters 2.2-2.4 and outage data is discussed in chapter 3.

The reading system must read the hourly data for the previous 24 hours on a daily basis so that it is possible to send to the market participants the hourly data for the previous 24 hours for the entire 24-hour period. This is dealt with in further detail in the next chapter.

The reading system must store the reading data, including the recording times, for at least one month.

5.5 The time base of the reading system and verification of the meter clock

The time base of the reading system is not restricted, nor is the time base of the time stamps for hourly data. However, in terms of the time spent, it is important to take account of the obligations related to the use of the official Finnish time (summer/wintertime). In terms of reading, it must be ensured that the system operator is capable of sending each day the hourly time series for the

previous 24 hours to the vendors as whole 24-hour periods in accordance with the official time, i.e. the current local time. Other metering data is also always transmitted according to the official time. For example, readings related to the starting and ending of contracts must be readings taken at the turn of the 24-hour period in accordance with the official time. Moreover, the display of the metering device and the invoicing registers must operate in the official time from the beginning of 2014 at the latest.

The time of the reading system may differ from the correct time by a maximum of +/- 2 s (at the time of setting the time of the metering devices).

The clock of the metering device is tested against the time of the reading system in connection with every reading and, when necessary, the clock of the metering device must be set to the correct time after reading. This is dealt with in further detail in section 2.9.

5.6 Inspections when connecting the metering device to the reading system

When using the GSM network, the system should verify the meter identification data and the SIM card identifier, and compare whether they correspond with the data established in the database. If the data of the metering device and the SIM card do not match, no connection is usually made to the meter.

In terms of the current transformer measurements, it is also advisable to check the current transformer coefficient if it has been set for the meter. This can usually be made as remote reading from the meter register.

5.7 Information security

The remote reading system must have comprehensive information security. Information security consists of e.g. personnel security, document security (backup and safe copying), physical security, hardware security, software security, telecommunications security and operating security (malware protection). Further information about information security is available e.g. in the general guidelines on information security work by a state authority (valtion viranomaisen tietoturvaluustuustyön yleisohje).

From information security point of view, data transmission should also be based on a well-known data transmission protocol (e.g. DLMS/COSEM). With respect to the transmission and recording of metering data, it must be ensured that access to the data by unauthorised persons is blocked. Remote reading and programming of the metering device should only be possible by the system operator or a body authorised by the system operator.

The reading system must detect errors that have taken place in data transmission.

The system operator should also take account of storage of data and data security in situations where the reading system develops a fault.

If remote reading is purchased as a service, the management of and responsibilities for information security must be agreed on in the service contracts.

6. Management of metering data

This chapter deals with the energy data recorded in the metering data management system and the measures required for verifying its validity.

The metering data management system is the distribution system operator's official place of recording metering data, from where it is ready to be distributed for the use of the market after the recording systems, inspections and any necessary processing described in this chapter (= hourly loads equipped with general statuses).

6.1 Calculation of hourly loads from the hourly readings

When reading cumulative hourly readings from the metering device, they are used for calculating the hourly energies, i.e. hourly loads, which are transmitted to the vendors in the metering data management system and used in balance calculation. When calculating hourly loads from cumulative hourly readings, particular attention should be paid for the fact that the time stamps for hourly data are recorded correctly. The meters record the time of registering as the time stamp for cumulative hourly readings, while the meter usually stamps the hourly loads with the time stamp of the starting moment of the hour in question.

6.2 Recording of hourly data

Hourly data must be recorded in the metering data management system so that the original and any modified data with their statuses can be traced at a later date.

The storage times for hourly load data and hourly reading data are dealt with in further detail in chapter 6.8. In practice, the hourly load time series and cumulative reading time series may be distributed between various metering data management systems (arranged by both the system operator and the service provider).

In the metering data management system, the hourly data for sites of up to 3x63A is recorded with an accuracy of 10Wh and for sites of over 3x63A with a minimum accuracy of 1 kWh, however, with a maximum accuracy of 10 Wh. If it is necessary to round off the data obtained from the metering device, mathematical rounding should be used in the metering data management system. The accuracy of metering data must remain unchanged from the metering data management system to the invoicing system.

In the metering data management system, network input (consumption) and network output (production) must be separated.

6.3 Hourly data statuses

The statuses entered for the hourly data of metering devices on the market vary by metering device. These statuses are mainly meant for the use of the system operator. When hourly load data is calculated from the cumulative hourly readings, the statuses of hourly load data are changed to industry-specific general statuses. *The general statuses presented in the following must be taken into use from the beginning of 2012 at the latest.*

Statuses complying with the EDIFACT standard are used **as the general statuses for industry-specific metering data:**

- Z03 Missing
- Z02 Uncertain
- 99 Estimated
- 136 OK (FG: metered)
- Z01 Corrected-OK (FG: manually set)

The MISSING status is used for preliminary hourly data if the data is not obtained from the meter and the preliminary data is transmitted as zero use. Data marked with a Missing status must always be replaced within 5 days either with metered or estimated data.

UNCERTAIN status is used when it can be assumed that the data may be specified or changed at a later date. The most typical occasion to use the Uncertain status is when the missing hourly data has to be estimated, but it is assumed that the metered data will be obtained at a later date. Data indicated with the Uncertain status must always be replaced with data supplied with either the OK status or the Estimated status.

The ESTIMATED status is used when the hourly data has to be estimated and it is known that metered or more accurate data will not be obtained even at a later date.

The OK status is used for hourly data obtained from the meter if there is no particular reason to assume that the value obtained from the meter is incorrect.

CORRECTED OK status is used, however, when it is necessary to correct hourly data previously transmitted with an OK or Estimated status.

Further information about the use of statuses is presented in sections 7.6 and 7.7.

It is possible to provide more detailed information about the use of statuses in separate industry guidelines concerning the correction of balance errors.

6.4 Processing of missing hourly data

The need for estimating missing hourly data depends on the situation causing the lack of data. If it is a question of a connection problem and it is assumed that the values will be obtained within a couple of days, there is no need to estimate the missing hourly data. If, however, it is a question of a telecommunications fault (permanently weak fields, faulty telecommunications module), it may take so long to obtain the hourly data that the missing data must be estimated. If it is a question of a fault in the metering device, which has resulted in metering errors or non-registration of data, the hourly data must always be estimated. The estimating methods are dealt with in further detail in the following section.

If it is not possible to obtain metered data from the meter, the missing data must be estimated within 5 days at the latest. The status to be entered for this data:

- ***Uncertain*** if it can be assumed that the missing data will be obtained from the meter at a later date. In the most typical case, hourly data is not obtained due to temporary connection problems, and the hourly data that is estimated in such a case will expressly be supplied with the Uncertain status because the metered data will be obtained once the connection has been restored.
- ***Estimated*** if it is known that the missing data will not be obtained at all. A fault in the meter is the most common reason for obtaining no hourly data at all.

Transmission of missing data is dealt with in further detail in chapter 7.7.

6.5 Methods of estimating missing hourly data

When estimating missing hourly data, any available cumulative readings must always be utilised. The missing use is entered for the gap hours on the basis of the previous consumption profile for the site. The estimate is based on consumption during similar periods, taking weekdays and holidays into account.

In the estimate, any power peaks are removed and any temperature impacts will be taken into account, i.e., for example, estimates for a site with electrical heating will not be made directly on the basis of consumption during a colder period.

When consumption for only one or two hours is missing, the gap may be filled on the basis of hourly values on either side of the gap. Even here, primarily the cumulative readings will be

utilised. Even an isolated gap must be estimated with discretion especially if no cumulative readings are available so that e.g. the consumption during tariff-change periods in two-rate tariff sites will be correctly estimated.

If there is no data available for the previous consumption behaviour of the site, the hours of a longer outage may be estimated using the load curve method.

The system operator should pay attention to sites where the main switch is switched on from time to time (summer cottages). The lacking hourly data for these sites should be estimated as zero. Therefore, the system operator will forward the lacking data for a site known to be a main switch site as zero hourly data with an Estimated status.

The methods of estimating missing readings are dealt with in further detail in Appendix 4.

6.6 Permanent problems in obtaining data

If there are permanent problems in the reading of hourly data of a certain hourly meter, it can be considered for the site to be transferred to the load curve method if the legislation allows the handling of the site in question as a load curve site. Here, it must be observed e.g. that starting from 2014 all sites of over 3x25A with an annual electricity consumption of over 5,000 kWh must have hourly metering. Moreover, in 2014 at least 80% of all metering sites of the system operator must have hourly metering.

If it is necessary to transfer the site from hourly metering back to the load curve method, the site's vendor must be notified of the change.

6.7 Readings according to the distribution product

It is recommended that readings in accordance with the distribution product are also recorded at sites of up to 3x63A. These readings will be utilised e.g. in customer billing.

Readings in accordance with the distribution product may be read directly from the metering device if the device registers this data. Readings in accordance with the distribution product may also be calculated on the basis of hourly data if the system operator knows the initial readings in accordance with the distribution product, which were shown on the metering device. If the readings are calculated on the basis of hourly data, particular attention must be paid to the fact that the calculated readings correspond as accurately as possible with the readings shown on the customer's metering device.

It is noteworthy that some of the acquired systems are incapable of obtaining readings in accordance with the distribution products or calculating readings on the basis of hourly data. In such a case, readings in accordance with the distribution product are not used e.g. on bills or in metering data messages transmitted to the vendors. The electricity bill regulation of the Energy Market Authority obliges showing of the readings on the bill only if the readings are available.

6.8 Storage time for metering data

In accordance with the metering decree, hourly data (hourly loads and/or hourly readings) must be stored for at least 6 years. If only the hourly load data is stored, it is recommended that the available cumulative readings are stored for at least the period required by the inspection of metering data.

Invoicing data must be stored for 6 years as laid down in the Accounting Act.

When considering the storage time for hourly and invoicing data, it should be remembered that, according to the terms of contract, the contracting parties may, in principle, present a claim for their receivables based on billing, metering and meter reading errors for a period of three years, but the

consumer may present a claim for his receivables for a maximum of 10 years if it is possible to afterwards verify the time when the error developed and the impact of the error on billing.

6.9 Inspection of metering data

It is the responsibility of the system operator to ensure the validity of metering data. However, the vendor must notify the system operator of any errors detected in the data received. Inspections of metering data can be made either in the metering data management system or the reading system.

As average hourly loads are transmitted to the electricity market, the inspection of expressly the hourly load series will be focused on in the following. The inspection of hourly loads aims to produce an uninterrupted time series for the electricity market, equipped with the correct time stamps and values and approved statuses. The measures described in the following may also be adapted to the cumulative hourly reading series.

Determination of missing hourly data

Metering data management must have procedures for detecting missing data from the time series. Based on the detected faults, measures must be launched in order to establish the missing values, as presented in sections 6.4 and 6.5.

Inspection of excessively high hourly loads

As the impact of even one hourly value on total consumption may be significant, metering data management must have procedures for the inspection of excessively high hourly loads. The main fuse of the metering site is meant to function as overload protection and, that way, to set a limit for the maximum value of hourly electricity consumption. However, in the cold conditions of Finland, the fuse transmission coefficient in extreme conditions may be 2-2.5 times the rated current.

Inspection of average hourly loads based on fuses can, therefore, be carried out with a simple maximum inspection based on the maximum value of the fuse size permitted for the metering site, taking the above coefficient into account. If the maximum value is exceeded, the system operator must inspect and, if necessary, correct the hourly data. Before inspection, an oversized value may not be transmitted further.

Inspection of negative values

As the calculation of average hourly loads is based on the difference of cumulative hourly readings, it is possible that the average hourly load obtained will be a negative figure. This situation may arise from a metering error, but it is also possible in connection with meter replacement.

Metering data management must have procedures for the inspection and correction of negative hourly loads. A negative value may not be transmitted onward by the system operator.

Inspection of statuses

Metering data management must have procedures for detecting the metering values, for which the meter has entered an error status. Based on the detected errors, measures must be launched in order to restore the statuses to approved ones in accordance with section 6.3.

Long series of zero values

A zero value for consumption is possible as such, but is usually an abnormal situation especially if the zero series is longer-lasting. As a result, it is recommended to implement observation of long zero series (e.g. 7 days).

However, as the zero value is possible, there is no reason to automatically change the statuses for the time series to Uncertain before the situation has been inspected at the metering site or the log data of the meter has been examined.

It is also possible to use a deduction mechanism on the nature of the metering site (e.g. summer cottage in the winter), on the basis of which it is possible to accept even longer zero series.

Inspection of the level of vendor-specific summed curve

If the inspection of excessively high hourly loads is not successful for some reason, it is recommended that the level of the vendor-specific summed curve be inspected, e.g. visually, on a daily basis. Under normal circumstances, it may not have significantly higher values.

Inspection of total consumption

The objective of the inspection carried out on the basis of the annual consumption estimate for the metering point is to reveal a systematic metering error. This may arise, for example, from a coefficient error of indirect meterings or an undetected fault in the metering device.

It is recommended that this kind of an inspection is carried out on the measurements at least once a year. This inspection is particularly necessary if changes have been made to the metering procedure.

7. Transmission of metering data to electricity market participants

This chapter deals with the transmission of metering data to vendors and to the balance electricity unit for billing and balance settlement purposes.

Procedures on the transmission of data should be introduced as soon as possible, at the beginning of 2012 at the latest, unless otherwise separately mentioned.

7.1 Transmission of hourly-metered metering data to vendors

Hourly data must be transmitted in accordance with the message traffic decree and the industry guidelines. Hourly data must be delivered preliminarily for the electricity vendors on the next working day after the electricity delivery. Final reports must be made within one month, and from the beginning of 2011 within 14 days of the delivery date (=balance window).

The message traffic between actors is described in further detail in Message Traffic Procedural Instructions, Practical Procedural Instructions for the Electricity Market, and Ediel Messaging: General Application Instructions by the Finnish Energy Industries.

According to the metering decree, until the end of 2011, the system operator may implement the balance settlement of hourly-metered sites of up to 3x63A, for which no electricity is purchased in the form of an hourly-based electricity product, as a sum of hourly data of hourly-metered sites. In such a case, metering site-specific monthly readings and, on the next working day, from the electricity delivery, a summed profile meant only for hourly metering created from the summed information of hourly-metered sites will be transmitted to the electricity vendor.

In accordance with the decree, as from the beginning of 2012, the balance settlement of all hourly-metered sites must be made in accordance with the hourly-based procedure, in which case the metering site-specific hourly series will be sent to the vendor on the next working day after the electricity delivery.

It should be mentioned in this context that the metering decree obliges actors to send only the invoicing readings of sites with remote reading equipment, but of which no hourly data read on a daily basis is available. According to the decree, this kind of metering equipment is other than hourly-metering equipment. However, according to the industry guidelines, monthly readings should be transmitted of these sites if they are available.

The next sections focus expressly on the transmission of metering site-specific hourly series and the related procedures.

The system operator must notify the vendors of the moment when transmission of hourly data from site of up to 3x63A starts with at least 1 month's notice. It is not absolutely necessary to report the starting time separately for each metering site, but it is enough to notify the time when transmission of hourly metering data is started as and when hourly data is received from the sites. The vendor receives the metering site-specific data from the PRODAT

message (Z10[7]) concerning the change in the metering device or metering method. It must be noted that metering site-specific PRODAT messages concerning a change in the metering method must always be sent, despite an advance notice.

If transmission of hourly data is started simultaneously *en masse*, it is recommended that an Excel list of these metering sites is sent as an enclosure with the advance notice.

7.2 Transmission of metering site-specific hourly data

The system operator will transmit the hourly load series and the missing or corrected data for a previous period on the next working following the electricity delivery. The hourly load data is entered with jointly agreed statuses. The statuses and their use are presented in further detail in chapters 7.6 and 7.7.

Only new and changed data is transmitted

The basic principle is that only new and changed data is transmitted to the vendor on a daily basis. However, the data is always transmitted for whole 24-hour periods even if individual data for the 24-hour period were new or changed.

Hourly series are transmitted according to the official Finnish time

The official Finnish time is observed in the transmission of hourly series. The system operator sends the hourly series for the full 24-hour period according to the official Finnish time. At the turn of the winter/summertime, the hourly series has 23 values, and at the turn of the summer/wintertime it has 25 values. At the finalisation of this recommendation, some of the systems are unable to observe summertime. It is recommended that the system change is to be ordered in connection with any other following system update. The systems should be able to operate according to the official time at the beginning of 2012 at the latest.

Operating in the official time has no impact on the UTC offsets reported in the messages. It is possible to use any UTC offset in the time stamps as long as the system is able to correctly interpret the offsets and send the readings for the correct time in the winter and in the summer.

The same notified time zone is used in all time stamps in a single message.

7.3 Transmission of billing data for the network from hourly-metered sites

The transmission of billing data of hourly-metered sites in accordance with this section is started as soon as possible, and not later than 1 March 2011.

With respect to sites of up to 3x63A, in addition to the site-specific hourly data, the metered consumption data according to the network billing are transmitted to the vendors with a PRODAT message (Z11[5]) in accordance with the message traffic procedural instructions. In practice, this means that, of the network billing event, the vendor is sent the billing period, as well as the start and end readings and consumption divided according to the distribution product.

If the system operator has no reading data according to the distribution product at his disposal (see 6.7), only the consumption used as the basis for billing will be transmitted (see further PRODAT inhouse definitions and reason codes).

7.4 Notification of network input and output

When transmitting hourly data, the sign rules for balance notices in the electricity trade in accordance with the valid Ediel messaging: general application instructions shall be used. The received energy is marked as positive (+) and the released energy as negative (-).

Therefore, the system operator shall always enter network input (consumption) as negative and network output (production) as positive. This matter is described in further detail in the Ediel messaging: general application instructions (www.energia.fi/fi/sahko/sahkokauppa/ediel-sivut).

These rules concern both vendors and the hourly data transmitted to the balance electricity unit. Here, it should be noted that the method of transmitting limiting point metering data deviates from this, i.e. it is transmitted without the signs.

If the site has production and consumption, separate hourly time series will be drawn up for network output and network input. If the open vendor of the site also purchases the electricity transmitted to the network, the vendor will be supplied with two separate hourly time series, one for production and one for consumption. However, if the production is purchased by an electricity market participant other than the open vendor of the site, they will be supplied only the hourly time series concerning their contract.

7.5 Accuracy of hourly data and rounding-off rules

Hourly data is delivered to all parties with the same accuracy. Hourly series are transmitted between the actors as MWh in five decimals and as kWh in two decimals, i.e. with 10Wh accuracy.

The accuracy of the data must remain unchanged from the system operator's metering data management system to the vendor's billing system, i.e. no rounding-off is permitted in the transmission of data. On the bill, consumption is rounded off, e.g. to kWh with mathematical rounding off.

The actors must pay particular attention to the fact that the quality unit is also attached to the messages especially when the data is delivered with the unit of kWh/h. If the quality unit is missing altogether, the recipient's system will interpret Mwh/h as the unit in accordance with the standards on data transmission.

7.6 Use and transmission of metering data

The principles of the following table are applied in the use of statuses.

Table 2. The principles of the use of statuses

Term	FG ediel codes	When used	Correction
Missing	Z03	<ul style="list-style-type: none"> When there is no hourly data, preliminary data can be sent as zero use with the Missing status. 	To be corrected with data provided with an Uncertain, Estimated or OK status.
Uncertain	Z02	<ul style="list-style-type: none"> When it is suspected that incorrect data has been received from the meter, and it is assumed that more accurate data will be received at a later date. When the missing data is estimated (within 5 days of transmission of preliminary data at the latest) and it is assumed that more accurate data will be received at a later date. 	To be corrected with data provided with an Estimated or OK status.
Estimated	99	<ul style="list-style-type: none"> When the hourly data is estimated and it is known that no other data will be obtained. 	<p>No need to correct.</p> <p>If necessary, can be corrected with data provided with a Corrected OK status.</p>
OK	136	<ul style="list-style-type: none"> When the data has been metered (is reliable). When the data transmitted with a Missing or Uncertain status is corrected with the metered reading. 	<p>No need to correct.</p> <p>If necessary, can be corrected with data provided with a Corrected OK status.</p>
Corrected OK	Z01	<ul style="list-style-type: none"> When it is necessary to correct data transmitted with an OK or Estimated status. Can also be used when it is necessary to correct data sent with a Corrected OK status. <p>(Cannot be used as the 1st status!)</p>	No need to correct.

Hourly data, which the system operator can assume to be incorrect and which can be corrected at a later date, are marked with an **Uncertain status**. The most common occasion to use the Uncertain status is when the system operator estimates the missing data and assumes that the estimated data can be replaced with metered data at a later date.

Once the meter has recorded a reading as uncertain, the system operator can transmit this data to the vendor with the OK status if it is assumed that the data will not be specified at a later date.

If the system operator sends the vendor hourly data marked with the Uncertain status, it must always be replaced with data marked with either the OK status or the Estimated status. (In relation to this, a time limit may be set at a later date in a separate instruction concerning the correction of balance errors.)

Corrected OK status is used when it is necessary to correct hourly data marked with an OK status or an Estimated status. Sometimes, it may be necessary to correct the hourly data more often than once. For these events, it is not possible to specify their own statuses within the EDIFACT standard. Therefore, the vendor must be able to notice if the reading is received more often than once with the Corrected OK status.

It is possible to provide more detailed information about the use of statuses in separate industry guidelines concerning the correction of balance errors.

The actors will decide whether to also allow the customers to view the statuses.

7.7 Processing and transmission of missing hourly data

Missing data may be of such a nature that it may never be received or it may be received at a later date. The latter is usually the result of a temporary fault in the connection.

If no hourly data is obtained from the meter, it is possible to send *zero hourly loads with a Missing status* as preliminary data on the next working day following the delivery.

Missing data must be replaced by either metered data or estimated data within 5 days of transmitting the preliminary data at the latest:

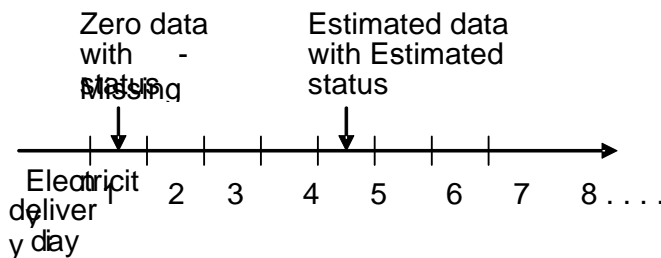
- 1) If metered data is received within this time limit, it will be sent in the normal way with an OK status.
- 2) If, on the other hand, it is necessary to estimate the missing hourly data at that time, the estimated hourly data is marked with an *Uncertain status* if it is assumed that the missing data will be obtained from the meter at a later date.
- 3) If, on the other hand, it is known that the missing data will not be received at all, the estimated data is marked with an *Estimated status*. In such a case, the recipient will no longer wait for corrected data.

Estimated hourly load can be sent with an Uncertain or Estimated status immediately on the next working day following the delivery as preliminary data instead of the missing zero data.

The system operator may send the missing data of a site known to be a main switch site (summer cottages) as zero hourly data with the Estimated status because, when the data is missing, it is probable that the customer has switched off the power feed of the site from the main switch and therefore there is no consumption at the site.

In the following, there are a few examples of the use of statuses when some of the data is missing.

- 1) The data is missing due to a fault in the meter, i.e. the data will not be received at all.



- 2) The data is missing due to a fault in connection. Metered data will be received at a later date.

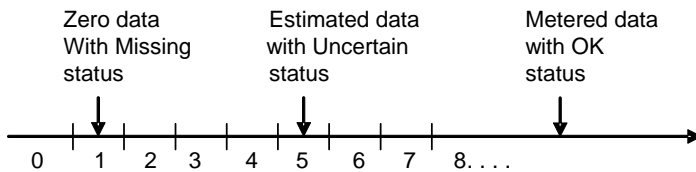


Figure 5. Examples of data transmission and the use of statuses.

It will be at the discretion of the actor whether to use the hourly loads marked with the Uncertain status in its billing. Hourly data marked with the Estimated status should be taken into account in billing because it is presumed that these will not be specified at a later date.

7.8 Transmission of metering data after the closing of the balances

When the metering data changes after the balances have closed, the balances are corrected with a special procedure, for which separate industry guidelines will be provided. In spite of this, corrections made to the metering data must be transmitted to the vendors by virtue of the energy services act.

In order to avoid billing mistakes, the system operator must notify the vendor when corrected metering data that has been previously sent with an Estimated, OK or Corrected OK status is transmitted after the balance window has closed.

7.9 Transmission of metering data to the balance power unit

The system operator will send the balance power unit a preliminary report on the summed information (new and changed) of deliveries by the electricity market parties on the next working day following the electricity delivery for balance settlement. Final reports of the summed information of deliveries must be made within one month, and from the beginning of 2011 within 14 days of the delivery date. It is the task of the balance power unit to transmit the summed data further to the balance responsible party of the electricity market parties. In practice, the data is transmitted to the vendors and the balance power unit simultaneously and for the same period. *This principle should be complied with as soon as possible and by 1 January 2011 at the latest.*

The hourly series are also transmitted to the balance power unit as MWh with five decimals or as kWh with two decimals, i.e. with 10Wh accuracy.

The same statuses are used in the data transmitted to the balance power unit as in the hourly data transmitted to the vendors. The summed data for each hour is entered on the basis of the weakest status for the individual hourly loads for each hour. The statuses from the weakest to the most certain are: missing, uncertain, estimated, OK, corrected OK.

7.10 Verification of the validity of metering data transmission

When sending metering data, it must be taken into account that the transmitter of the message, i.e. the system operator, is responsible for the arrival of the message until he receives an acknowledgement of the message he has sent. If an acknowledgement is not received or if it is negative, i.e. the recipient's system has been unable to receive the message into its system due to the erroneous nature of the message, the sender must correct the message and resend it.

A CONTRL acknowledgement request should be attached to MSONC messages containing metering data as this way it can be ensured that the message has gone through the message translator. It is also possible to request for an APERAK acknowledgement. Concurrent use of both acknowledgements should be avoided. An acknowledgement request must always be responded to.

When transmitting data with PRODACT messages, the sender must ensure that the message always has an APERAK acknowledgement request.

Message transmission and the use of acknowledgement messages are dealt with in further detail in the recommendations Message Traffic Procedural Instructions and Ediel Messaging, General Application Instructions.

8. Reporting of hourly metering data to customers

Obligations on reporting of metering data to customers are laid down in the Government decree on the determination of electricity supply and metering (metering decree) and the energy services act.

According to the metering decree, electricity consumption data gathered by the hourly metering equipment must be provided for the customer's use not later than at the same time as it is transferred or completed for transfer to the customer's electricity supplier, i.e. the day after delivery, from the beginning of 2014 at the latest. The data is transferred to the customer using a method generally complied with by the industry and the system operator. In practice, the customers will probably be provided with the data via online services. For major customers, hourly data can also be delivered with EDI messages. When transmitting hourly data to the customer with EDI messages (MSCONS), the customer must have an unambiguous party ID for data exchange. In practice, the customer's party ID for data exchange is determined by the customer's operator in a jointly agreed way. Once the customer and the system operator have agreed on the transmission of hourly data with EDI messages, the system operator will notify its own EDI operator of the customer ID and the address the messages are to be sent to. In the case of other than an official electricity market participant, no official party ID granted by Fingrid is required.

Moreover, according to the metering decree, the system operator is obliged to offer hourly-metering equipment for the use of the customer to the customer's separate order, including a standardised connection for real-time monitoring of electricity consumption. Metering data can be transferred to the customer's equipment, e.g. in pulse format. Other standardised methods independent of the metering device manufacturer are not known at the time of finalising this recommendation. This is dealt with in further detail in section 2.14.

According to the energy service act, the vendor must provide its customers with a report on the customer's energy use once a year. The report must include e.g. information about the end user's energy consumption for the period of the report and the previous three years, however, for a maximum of the duration of the customer relationship with the vendor. Furthermore, the report must include reference data on the end user's energy consumption in comparison with other corresponding end users. The report must be given to the customer for the first time in 2011. It is not necessary to include data prior to 2010 in the report. The system operator must provide the necessary information on electric energy consumption to the electricity vendor for the report free of charge.

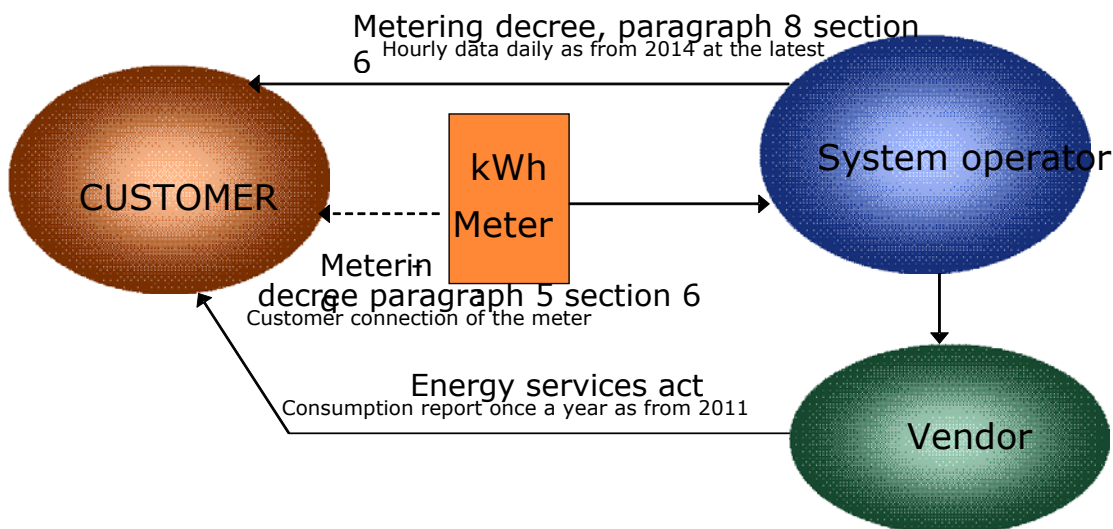


Figure 6. Transfer of electricity consumption data to the customer.

APPENDIX 1

DETERMINING TOTAL METERING ERROR

When determining total metering error, the following error factors are taken into account:

- Error of the energy meter
- Ratio errors in instrument transformers, i.e. current and voltage error
- Angle errors of instrument transformers
- Voltage reduction caused by secondary wiring in the voltage transformer (cabling and the transition resistances of auxiliary contacts of connectors, circuit breakers, throw-over relays or disconnectors).
- Angle error caused by voltage cabling (the impact is low)

Total error definition at the installation place is carried out as follows:

Measuring at the installation place is carried out either in a normal operating situation or with power supply devices. The measuring devices used must be calibrated.

1. An error in the energy meter is measured with a portable inspection device.
2. In order to define the operating points of the current transformers, the terminal voltages and secondary currents of the measuring windings are measured.
3. When measuring with a voltage transformer connection (measurement groups 3-5), in order to define the operating points of transformers, the terminal voltages and secondary currents of the measuring windings, as well as the secondary load, are measured.
4. If the energy metering has separate voltage cabling, the currents and secondary load of the measuring circuits are also measured.
5. The voltage reduction of voltage cabling is measured, when necessary, with a coaxial cable.
6. Errors in the operating points caused by instrument transformers are defined with error curves drawn on the basis of the transformer manufacturer's testing records.
7. The total error is calculated with the formula presented on the next page.

The total error of active energy metering is calculated on the basis of the measurement results as follows:

- $F_{\text{kok}} = f_{\text{mitt}} + f_{\text{vm}} + f_{\text{jm}} + f_{\text{uh}} + k (\delta_{\text{vm}} - \delta_{\text{jm}} - \delta_{\text{uh}}) \tan \varphi$
- The errors are inserted into the formula with their signs. The errors of instrument transformers are the averages of the components in different phases. The angle is entered as an absolute value.
- F_{kok} = total error
- f_{mitt} = meter error [%]
- **f_{vm} = ratio error of the current transformer [%] (THE MOST SIGNIFICANT FACTOR)**
- f_{jm} = ratio error of the voltage transformer [%]
- f_{uh} = ratio error due to the wiring of the voltage circuit
- δ_{vm} = angle error of the current transformer [min]
- δ_{jm} = angle error of the voltage transformer [min]
- δ_{uh} = angle error due to the wiring of the voltage circuit
- φ = phase angle
- $k = \rho / (180^\circ 60') \quad 100\% \approx 0.0291$

As the most significant error factor especially in measurement groups 2-4 is the ratio error resulting from the incorrect design of the current transformers, an example of ensuring the operating load of the current transformer is presented in Appendix 2.

In measurement groups 3-5, the compatibility of the voltage transformers and the loads of the meters used must also be checked.

APPENDIX 2

TAKING THE INSTRUMENT TRANSFORMER LOAD INTO ACCOUNT

Example 1. Replacing an induction meter with a static meter. Is the load suitable? Current transformer 200/5A, rated load 5 VA

Method 1: By calculating

	1. Induction meter + wire 2 x 2.5 m	2. Static meter + wire 2 x 2.5 m	3. Static meter + wire 2 x 3.4 m
Meter load	0.500 VA	0.010 VA	0.010 VA
Connections	0.075 VA	0.075 VA	0.075 VA
Wire (separate, 2.5 mm ² Cu) load	0.875 VA	0.875 VA	1.190 VA
Load in total	1.450 VA	0.960 VA	1.275 VA
Load % of the rated load of the current transformer	29%	19%	25.5%
Is it within the permitted limits (25-100%)	Valid	Not valid	Valid

The meter load is stated in the technical specifications of the meter.

The value 0.075 VA can be used as the load of the connections

The load of the wire can be calculated or estimated with formula 1. The calculation formula is:

$$S = I_{SN}^2 \times \rho \times l/A = 5^2 \times 0.0175 \times 5/2.5 = 0.875 \text{ VA, where}$$

S = Load of the wire (VA)

I_{SN} = Rated secondary current (A)

ρ = Resistivity of the wire (Ω /mm²/m), which with copper is 0.175 Ω /mm²/m

l = Wire length (m)

A = Cross-section of the wire (mm²)

In such a case, changing the meter from inductive to static alone would not be possible, but load should be added to the secondary of the circuit, **e.g. according to column 3 of the table**, or the instrument transformers should be changed to ones with a smaller rated load.

Method 2: With the diagram and auxiliary table

The load of the wire is estimated on the basis of diagram 1. According to the diagram, the load is 0.9 VA.

The circuit of the current transformer:

Rated load of the current transformer 5.00	VA	x	Minimum load (%) 25%	VA	=	+ 1.25	VA	
Meter load 0.01	VA	+	Wire load (VA) 0.90	VA	=	- Load in total - 0.91	VA	
						=	+ 0.34	VA

Need for further load if the value is positive

If the value is positive, change into cross-section 2.5 mm² or

install separate return wires or extra wire (2,5 mm² Cu) as extra load:

+

2,5 mm ² Cu wire 0.175	VA/m	x	Length of extra wire (m) 2.0	m	=	- Extra load (VA) - 0.35	VA
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Therefore, 2 m of extra wire, i.e. 1 m for either direction, is needed as extra load.

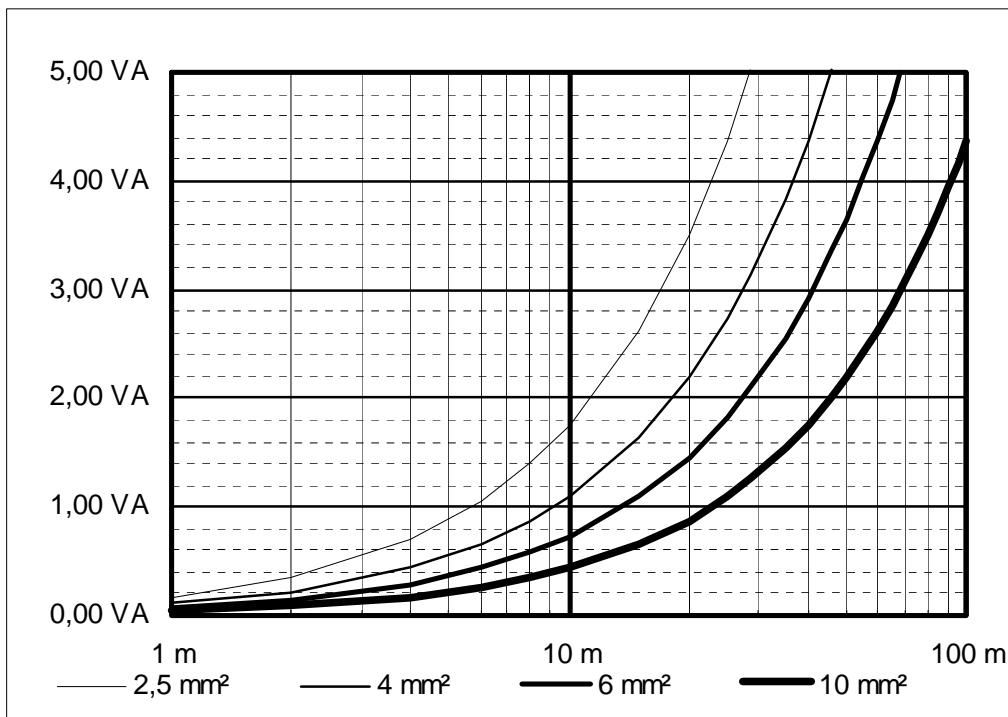


Diagram 1. Load of the copper wire in a 5 A rated secondary circuit at different cross-sections (If a common return wire, distance only in one direction)

Inspection record: Carried out by: _____ Time: _____

The circuit of the current transformer:

Rated load of the current transformer	VA	x	Minimum load (%) 25%	VA	=	Minimum load (VA)	VA
Meter load (current side)	VA	+	Wire load (VA)	VA	=	Load in total	VA
Need for further load if the value is positive						=	

If the value is positive, change into cross-section 2.5 mm² or

install separate return wires or extra wire (2,5 mm² Cu) as extra load:

+

2.5 mm ² Cu wire 0.175	VA/m	x	Length of extra wire (m)	m	=	Extra load (VA)	VA
						=	

The circuit of the voltage transformer:

Load of the voltage transformer	VA	x	Minimum load (%) 25%	VA	=	Minimum load (VA)	VA
Meter load (voltage side)	VA	+	Load of other devices (VA)	VA	=	Load of devices in total	VA
Change the voltage transformers or meter, if positive						=	

APPENDIX 3

INDICATIVE DESIGN FOR CURRENT TRANSFORMERS AT LOW VOLTAGE

Pre-fuse A for metering	Transformation ratio alternatives A/A	Primary punctures	Connected transformation ratio A/A	Coefficient
3 x 50	50/5	1	50/5	10
3 x 63	75/5	1	75/5	15
or	150/5	2	75/5	15
3 x 80	300/5	4	75/5	15
3 x 100	100/5	1	100/5	20
	200/5	2	100/5	20
	300/5	3	100/5	20
3 x 125	125/5	1	125/5	25
	250/5	2	125/5	25
3 x 160	150/5	1	150/5	30
	300/5	2	150/5	30
3 x 200	200/5	1	200/5	40
	400/5	2	200/5	40
3 x 250	250/5	1	250/5	50
3 x 315	300/5	1	300/5	60
3 x 400	400/5	1	400/5	80
3 x 500	500/5	1	500/5	100
3 x 630	600/5	1	600/5	120
3 x 750	800/5	1	800/5	160
3 x 800	800/5	1	800/5	160
3 x 945	1000/5	1	1000/5	200
3 x 1000	1000/5	1	1000/5	200
3 x 1250	1200/5	1	1200/5	240

Accuracy class	0.2S
Load	2.5 VA, the volt ampere amounts can be deviated from if it is indicated with an imputed value that the load is in the region of 0.25-1.0 of the rated load. If the total length of the secondary wiring between the metering device and the instrument transformer (supply+return wire) is over 6m, the design is established separately in each case.
Voltage circuits	2.5 mm ²
Circuit wires	2.5 mm ²
Connection strips	In accordance with SFS 2529, connection to be tightened with screws
Voltage fuses	3 x 10 A plug fuse or residual current circuit breaker
Fuse of the control device	1 x 10 A plug fuse or residual current circuit breaker

APPENDIX 4

METHODS OF ESTIMATING MISSING HOURLY DATA

It is the system operator's task to estimate the missing data. The vendor may not estimate data for the use of the customer processes (e.g. billing, reporting).

The need for estimating missing hourly data depends on the reason that causes the lack of the data. Therefore, the network reading process should be able to provide metering data management with the reasons for missing data (connection problem, telecommunications fault, fault in the metering device).

If it is a question of a connection problem and it is assumed that the values will be obtained within a couple of days, there is no need to estimate the missing hourly data. If, however, it is a question of a telecommunications fault (permanently weak fields, broken telecommunications module), it may take so long to obtain the hourly data that the missing data must be estimated. If it is a question of a fault in the metering device, which has resulted in metering errors or non-registration of data, the hourly data must always be estimated.

If it is not possible to obtain metered data, the missing data must be estimated within 5 days at the latest. The status entered for estimated data will be Uncertain if it can be assumed that the missing data will be obtained from the meter at a later date (a typical situation). If, on the other hand, it is known that the missing data will not be received at all (more unusual), the estimated data is marked with an Estimated status.

The general principles and examples of the methods of estimating missing readings are described in the following.

Estimating methods:

- **Cumulative readings are utilised** whenever they are available.
 - When the metering device measures hourly cumulative readings, missing use is obtained directly on the basis of cumulative readings on either side of the gap.
 - If, on the other hand, cumulative readings are recorded less frequently, e.g. on a daily basis, the missing energy is obtained by deducting the hourly energies registered from the difference of the readings available on both sides of the gap for the period in question.
 - The missing use determined on the basis of cumulative readings is entered for the gap hours on the basis of the previous consumption profile for the site (utilisation of history data).
- **History data is utilised** if possible. When using history data, they usually give a more accurate estimate than when using the curve method.
 - When utilising history data, a comparison day method is used, i.e. the electricity use of the site is modelled on the basis of the history data, taking Saturdays and holidays into account.
 - *If the missing data is known*, it is divided for the missing hours according to the profile calculated on the basis of history data for the electricity use of the site. The profile should be based on at least three similar periods. In other words, if e.g. some data are missing from Monday to Friday, the hourly use of the period in question is modelled on the basis of use in a corresponding period in the previous three weeks. It is observed that no weekday holidays are used in the modelling if they are not present in the period in question.
 - *If the missing use is not known*, a corresponding time and date is obtained from the history data (taking holidays into account) and the hourly averages for the missing hours are calculated on the basis of this data. This means that if one of the missing hours is the hour starting at 12 o'clock on Monday, the corresponding hours for at least three previous Mondays are obtained, and their average is used. If one of these Mondays is a holiday, it will not be used.

- If history data is not available, the hourly loads can be estimated using the load curve method.
- Any temperature impact is taken into account, i.e., for example, estimates for a site with electrical heating will not be made directly on the basis of consumption during a colder period. This is emphasised especially when it is not possible to define the missing energy on the basis of cumulative readings.
- The estimating may not cause a peak load. Any excess peak loads (also reactive power) are removed.
- Basically, both large and small sites are dealt with in the same way. If it is a question of a large site and consumption during the missing time is considerable, discretion must be used in the estimation in addition to the general methods of estimation (e.g. comparison day). Thus, further information about electricity use for the period of missing data should be requested from the customer, and this information should be used when estimating the missing hourly data.

Short periods (a maximum of five hours):

- It is recommended that the above-described modelling method is also applied when data for a short period is missing.
- However, alternatively it is possible to use the following, lighter method:
 - If the missing energy is known:
 - If the missing use can be calculated on the basis of cumulative readings, the gap is filled with this energy.
 - If the gap is longer than one hour, the missing energy can be divided equally for the gap hours. However, any load controls must be noted here.
 - If the missing energy is not known:
 - The values are estimated by using history data. The missing hours are copied from the previous day (if the previous day is Monday-Thursday) or from the previous week from the day corresponding to the missing day. The peaks may not take place in the period in question.
 - A gap of up to two hours may be filled on the basis of the hourly values surrounding the gap. Any load controls are taken into account in the estimation.