

Your Power

Traction energy 2018



Table of content

1. Introduction	3
2. What is traction energy?	3
2.1 From producer to train	3
2.2 Advantages	3
2.3 Energy, voltage or current	4
2.4 Transport and distribution of traction current	4
2.5 Supply of traction current	4
3. Can you choose your own energy supplier?	5
3.1 Basic conditions	5
3.2 What else must you do?	5
3.3 Infrabel as energy supplier	5
4. How is your consumption determined?	6
4.1 Energy meters	6
4.2 Train information	6
4.3 Estimation	8
4.4 Degree days	8
4.5 Validation	8
4.6 Where is consumption determined?	8
5. How much do you have to pay?	9
5.1 Rate periods	9
5.2 Rates	9
5.3 How are the rates set?	9
5.4 Invoices	9
5.5 Erex user interface	10
6. How does Infrabel acquire traction current?	11
6.1 What is acquired?	11
6.2 Purchasing method	11
6.3 Unit prices	12
6.4 Renewable energy	12
7. How are the rates set?	13
7.1 Transport and distribution	13
7.2 Supply	13
8. Do you need an energy meter?	14
8.1 Why?	14
8.2 What requirements must an energy meter fulfil?	14
9. Definitions and abbreviations	15

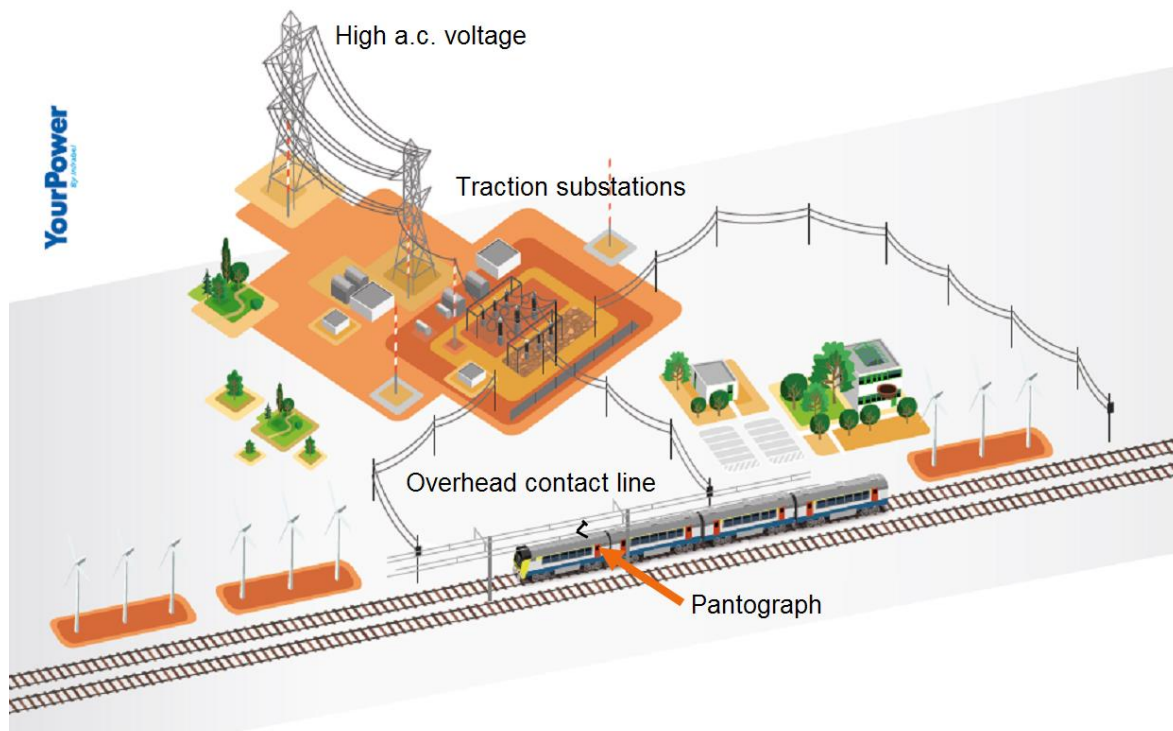
1. Introduction

This leaflet is dedicated to all railway undertakings that run with electrical locomotives on the Belgian railway network, but also to those intending to do this.

2. What is traction energy?

2.1 From producer to train

Producers generate electricity in nuclear power plants, with classic thermal power plants (using e.g. natural gas) or via renewable energy (e.g. wind).



The electricity is transported at high a.c. voltage to Infrabel's traction substations.

Infrabel transforms the voltage and distributes it via the overhead contact line. Pantographs permit you to take the required energy.

You can use this energy to power:

- your electric locomotives and/or electrical multiple units;
- comfort services for passenger trains such as heating, lighting and air conditioning.

2.2 Advantages

Running with electric traction is more efficient than running with diesel traction because less primary energy is used. The fact that less CO₂ is emitted also makes it better for the environment.

Electric locomotives are also more suitable for transporting large, heavy freight loads.

Transporting 1000 tonnes of cargo over a distance of 100 km costs around 115 euro of electrical energy. Energy efficient driving with a locomotive equipped with an energy meter can result in 15% energy savings.

2.3 Energy, voltage or current

The supply of energy involves the provision of a quantity of current at a specific voltage for a specific period. Infrabel provides as a “minimal service” voltage via the overhead contact line. The “additional service” relates to the element of current.

The service Your Power comprises these two elements:

- transport and distribution of traction current (minimal service);
- supply of traction current (additional service).

These elements are explained hereafter.

2.4 Transport and distribution of traction current

Infrabel is solely responsible for the transport and distribution of electricity on its network, irrespective of whether the railway undertaking uses this supply of traction current via Infrabel or another supplier of their choice.

The element "transport and distribution of traction current" of the service Your Power is therefore mandatory for each railway undertaking that uses electric traction.

Transport and distribution of traction current encompasses:

- all costs for connections from the Elia substations and other distribution system operators (full network costs);
- network losses in substations and on the overhead contact lines;
- administrative costs for measuring and correctly allocating the energy to the railway undertakings and corresponding supplier;
- taxes and levies withheld by system operators.

2.5 Supply of traction current

Infrabel delivers traction current to the railway undertakings requesting this service.

The supply of traction current encompasses:

- energy costs;
- costs in the context of balancing injection and offtake by the supplier within the Belgian control area;
- taxes and levies withheld by the supplier;
- costs of green certificates and cogeneration certificates;
- CO₂ emission rights.

A railway undertaking can also choose its own energy supplier (see chapter 3).

3. Can you choose your own energy supplier?

3.1 Basic conditions

Following the transposition of Directive 2009/72/EC¹ into Belgian law, we made the necessary agreements with bodies such as public system operators in the electricity market.



In case you intend to choose your own energy supplier, you shall have energy meters in your trains. This is a basic condition in the electricity market. This condition was also included in a study conducted by ERA, the European railway agency. Commission Regulation 1302/2014² requires energy meters on all new, renewed and upgraded rolling stock.

3.2 What else must you do?

You must find an energy supplier. The energy supplier must possess a valid supply licence. You must also appoint a balance responsible party (e.g. your energy supplier).

The balance responsible party:

- reports every day to Elia how much energy you will use;
- compensates for energy losses on the Elia transmission grid;
- pays costs for imbalances to Elia.

You must notify us of your supplier and balance responsible party (in Belgium this is also known as the access responsible party) at least three months in advance. Any change will be implemented on the first of the month and will run for a period of at least three months.

No railway undertaking has yet requested to use its right to choose its own supplier. Please consider that applying this principle a first time will take the time needed for implementing some processes (like e.g. the export of data towards system operators and other market parties).

3.3 Infrabel as energy supplier

If you do not choose your own energy supplier, you can opt for the element “supply of traction current” of the service Your Power.

Infrabel will ask the larger railway undertakings sufficiently in advance if they will be using this service. This will enable Infrabel to start purchasing in advance. As a result, the security of supply will improve and the financial risks will be spread as effectively as possible.

¹ Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC.

² Commission Regulation (EU) No 1302/2014 of 18 November 2014 concerning a technical specification for interoperability relating to the ‘rolling stock — locomotives and passenger rolling stock’ subsystem of the rail system in the European Union Text with EEA relevance.

4. How is your consumption determined?

4.1 Energy meters

If you have energy meters on your trains, the measurement data from these will be used to determine your trains' consumption.

Your energy meter is mounted on a locomotive or an electrical multiple unit. It measures both the energy that is supplied via the overhead contact line and the braking energy that is recuperated. GPS coordinates and date time stamp are also stored.

Measurement values are transmitted at least once a day.

You must choose one infrastructure manager which can receive your raw measurement data. This infrastructure manager will check the country in which the consumption took place and then pass on the measurement data to the appropriate infrastructure manager in that particular country (in line with UIC leaflet 930). Infrabel offers this service free of charge.

Annex E.3 from the network statement contains the requirements for energy meters and also other methods for sending the data. This document can be found on Infrabel's website under the section "professionals" followed by "rail operators".

4.2 Train information

There must be a facility to connect the measurement data to your trains. If this connection cannot be made, we cannot assign the data to the right train journey. That is why you have to notify us of the composition of all your trains.

4.2.1 Fill In

The composition of freight trains with wagons can be sent via "Fill In", an application on the Business Corner. The European vehicle number is used as a unique reference: e.g. 918801302301.

This application can't be used to report:

- the composition of empty train runs (without wagons);
- changes of traction units during a train-run;
- for the composition of passenger trains.

Instead of using the "Fill In" application on the Business Corner, you can also use the spreadsheet below.

At cell A17 and thereafter, you can enter the European vehicle number for your locomotives. All information on this sheet and the "Fill In" application can be found on the Business Corner. Feel free to contact us should you have any further questions.

Fill In xml_v1_432.xls										
A	B	C	D	E	F	G	H	I		
4	v.1.4.3									
Train/Journey Information										
6	Transporter	ICTRA			Trajet	Date time (DD/MM/YYYY hh:mm)				
7	Train reference	80020			Scheduled departure	05/05/2010 18:37				
8	Wagons quantity	10			Scheduled arrival	05/05/2010 23:01				
9	Total weight	726								
10	Total length	155								
11	Brake rate	G90								
12	End runner	yes			Reference train				copy from traject	
13	Number of hazardous cargoes	15			Train reference	80020				
14					Scheduled departure	05/05/2010 18:37				
Traction units										
16	Traction unit service nr.	mode of deployment								
17	918801302301	train locomotive								
18										
19										
20										
21										
22										
Wagons details										
24	position	number	brutto weight (kg)	netto weight (kg)	length (dm)	max. speed	# containers	nr.container	RID nr.	U
25	1	338579330303	75100	49700	155	90	1	2356		

4.2.2 Train Traction

Train Traction is also available on the Business Corner. It can be used to announce the traction composition for freight trains and for passenger trains. It also allows for the communication of traction unit changes during a train-run.

It is not possible to declare the composition of freight wagons with this application.

Train Traction is available as XML-generator. The application generates an XML-file in the correct format. It is also possible to exchange automatically this data via such an XML-file between your application and the application Train Traction of Infrabel.

A	B	C	D	E	F	G	H	I	
1									Generate XML
2	Train Traction								
3	ver. 1.6 For help, please check the "howto" tab.								
4	Train			Traject			Tractions		
5	PAV	Train nr.	Discr.	Dep.Date	Dep.PTCAR	Arr.PTCAR	Weight	Traction num.	EVN
6									
7									
8									

4.2.3 General rule

If the European vehicle number for the traction unit is not entered correctly or promptly, we will not be able to check the traction method provided and diesel trains may be confused with electric trains. It is possible to amend the information regarding train composition in Fill In up to 4 days after the departure of the train (before D+4 at 16.00). The same rule applies for Train Traction.

The mass of the train is also entered into our system. We register the passage of your train at various locations. Using all these data, we can calculate the ton-km per train journey and per rate period.

4.3 Estimation

Missing measurement data will be estimated on the basis of average specific consumption (kWh/ton-km) per category (passengers, freight or high speed).

Infrabel is using the following formulas in 2018:

passengers:	$(33 + 0,63 * D1 + 0,63 * D2)$ Wh/ton-km
high-speed:	$(41 + 0,63 * D1 + 0,63 * D2)$ Wh/ton-km
freight:	4 kWh/km + 12 Wh/ton-km

These formulas may change slightly each year. The formulas have also been included in the network statement. The formula for the estimation of freight trains is changed in 2018. The estimated consumption will increase for empty train runs, but will decrease for heavy trains. This new formula will divert less from the real consumption.

4.4 Degree days

A significant share of the consumption by passenger trains is used for heating or cooling purposes. This consumption depends on the outdoor temperature.

The above formulas use D1 and D2 for degree days based on the average temperature measured by the weather stations of Infrabel.

In order to determine D1, every degree under 16.5°C is counted as one degree day. A day with an average daytime temperature of 10°C therefore equates to 6.5 degree days. In order to determine D2, every degree above 20°C is counted as one degree day. The values D1 and D2 are defined on a daily basis.

4.5 Validation

Measurement data is compared with estimated values. If measurement data is likely incorrect, an alarm is given and estimated consumption will be used. The validation rules are part of annex F.2 of the network statement.

4.6 Where is consumption determined?

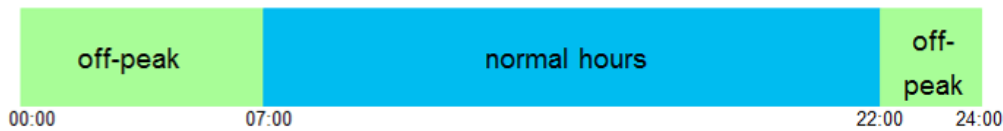
Infrabel settles the energy consumption at the level of the pantograph.

An energetic reconciliation will take place at the end of each month. The total of metered and estimated consumption is compared with the measurement of the consumption injected in the overhead contact line. We consider 5% of transport losses (purchased by Infrabel). The difference will be distributed. This method allocates an advantage of at least 2% to the metered consumptions and supports thus the installation of on-board meters. The cost for purchasing the losses will be regarded as part of “transport and distribution of traction current”.

5. How much do you have to pay?

5.1 Rate periods

Infrabel has two rate periods:



On Saturdays, Sundays and Bank Holidays, the off-peak rate will apply.

5.2 Rates

The rates have also been included in the network statement. These are split up per rate period and for the elements “supply of traction current” and “transport and distribution of traction current”.

In 2018, the following rates are used:

	transport and distribution of traction current	supply of traction current
normal hours	23 EUR/MWh	56 EUR/MWh
off-peak	23 EUR/MWh	42 EUR/MWh

5.3 How are the rates set?

Infrabel makes an initial estimate of rates in the summer of Year-2. These will appear in the network statement. The definitive rates will then be set one year later and adapted in the same document.

This means that a first estimation of the tariffs 2018 was made in the summer of 2016 and published in the network statement 2018. During the summer of 2017, these tariffs for 2018 were definitely fixed. This adaptation of the network statement was published at the end of 2017.

5.4 Invoices

At the end of October in Year-1, Infrabel draws up a table of monthly advances that must be paid by each railway undertaking. This table will be included in the user agreement. The invoice for these advances will be provided at the beginning of the consumption month.

After each consumption month, another invoice will be made on the basis of measured and/or estimated consumption according to the published rates.

A settlement invoice will be made together with the last invoice of the year. Deviations between costs and income from Infrabel in the “charge for the transport and distribution of traction current” and in the “charge for the supply of traction current” will be tweaked on the basis of the total invoice amount per railway undertaking in the current financial year.

All invoices are to be paid within 30 days.

5.5 Erex user interface

Erex is the system that Infrabel uses to determine consumption for each train journey.

In order to remain transparent for our customers, we provide a user interface. This user interface can be used to monitor consumption (both measured and estimated) in detail.

The screenshot shows the Erex web application interface. On the left, there are navigation tabs for 'Status', 'Processes', 'Queries', 'Report', and 'Administration'. Below these are sections for 'Queries' and 'Search Parameters'. The main area is divided into two panes: a map on the right showing a train route with red and blue markers, and a data table on the left listing various time series metrics. The data table includes columns for 'Time', 'End time', 'Value', 'Value quality', 'Lat', 'Lon', 'Lat', 'Lon', 'Position quality', 'Created on', and 'Created by'.

For more information about the possibilities offered by this interface, and to receive a log-in code, please contact yourpower@infrabel.be.

You will receive each month a Settlement Report. This report contains all information needed in order to create the monthly invoice.

You can request to receive each month also a Train Run Report and a Mass and Distance Report. These reports can be requested at yourpower@infrabel.be.

The Train Run Report gives for each train run: the applied categories, the coordinates of the begin and end point and the measured or estimated consumption.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Train#	OperatingDay	Part start at	Part end at	start latitu	start longi	end latitu	end longit	Net consu	Combine result	Segment value	TractionUnitSet	TrafficCati
2	22120	25/11/2017	25/11/2017 07:24	25/11/2017 12:48	51,06773	3,7426	51,06372	3,7403	2529,2	Metered	Metered	918871862150	Cargo
3	22170	08/11/2017	08/11/2017 17:24	08/11/2017 17:26	51,28842	4,38972	51,28775	4,41353	10,34	Estimated	Estimated	empty	Cargo

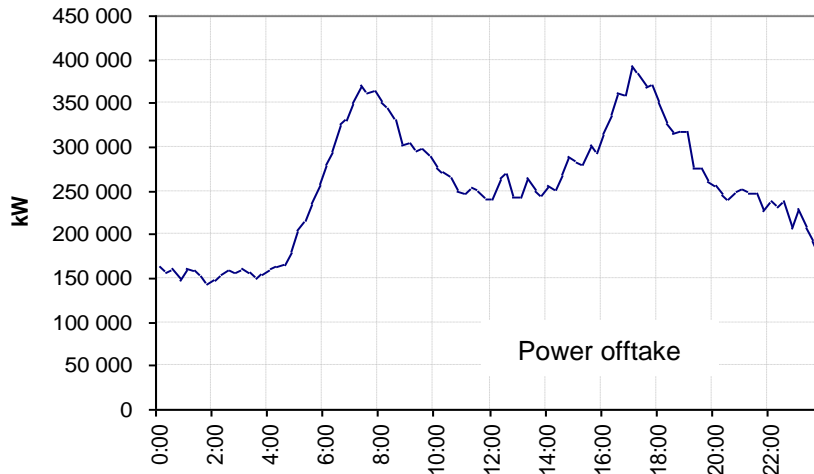
The Mass and Distance Report gives additionally for each train run the tonne-km, the mass and the distance of the train run. This extra information will be added in the course of 2018 to the Train Run Report.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Train#	Part start at	Part end at	start latitu	start longi	end latitu	end longit	Traffic catego	Traction u	Tonnes	Distance (TonneKm	
2	108	04/12/2016 09:58	04/12/2016 10:11	50,62548	5,56521	50,54034	5,57349	Passengers	empty	90	13,774	1239,66
3	119	07/12/2016 20:08	07/12/2016 20:40	50,62548	5,56521	50,47301	5,67248	Passengers	empty	90	30,229	2720,61

6. How does Infrabel acquire traction current?

6.1 What is acquired?

The total volume of energy for trains amounts to around 1,400 million kWh each year. This is an enormous volume.



The offtake follows a very specific profile. The graph above shows the offtake on a winter day. This irregular profile complicates the purchase of electricity on the energy market. Extra production units must be employed temporarily for peaks and, as a result, production costs rise significantly compared to those of a wholesale user with a smooth offtake profile. The profile also makes it difficult to retain balance between injection and offtake. This also leads to higher costs.

6.2 Purchasing method

Infrabel organises European tenders in order to purchase energy. Infrabel starts purchasing electricity three to four years in advance. The purchasing strategy is based on the following goals:

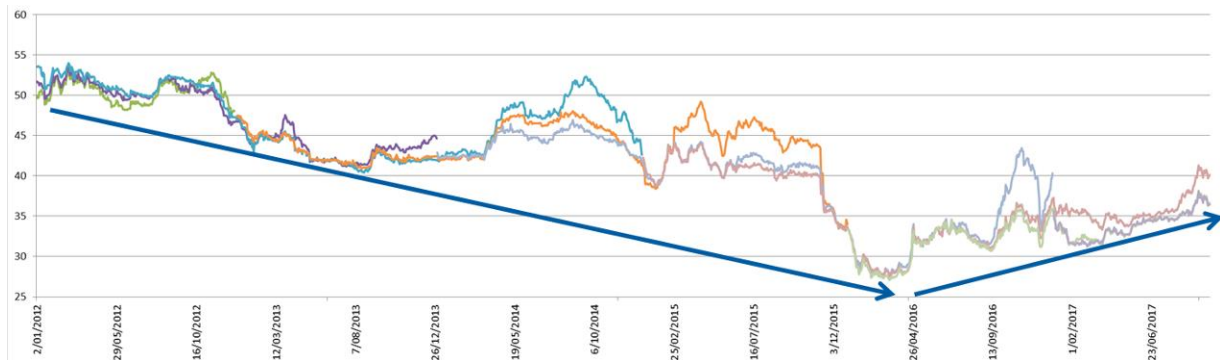
- ensure the energy supply;
- avoid sudden price fluctuations;
- enable the railway undertakings to estimate the prices in advance;
- obtain the lowest possible price.

In order to obtain these goals the energy price is fixed during a period of four years. The energy price is fixed as follows:

The price is fixed ...	For energy consumption in ...				
	2016	2017	2018	2019	2020
three year in advance	30%	25%			25%
two year in advance	25%	25%	40%	40%	25%
one year in advance	25%	25%	30%	30%	25%
in the year of delivery	20%	25%	30%	30%	25%

Infrabel applies pricing formulas in the purchasing contract with an electricity supplier. The price for the part fixed more than one year in advance, is based on the baseload price for Belgium as defined on Ice-Endex. The price for the part fixed in the year of delivery, is based on the average of day-ahead prices for Belgium as defined on Epex Spot.

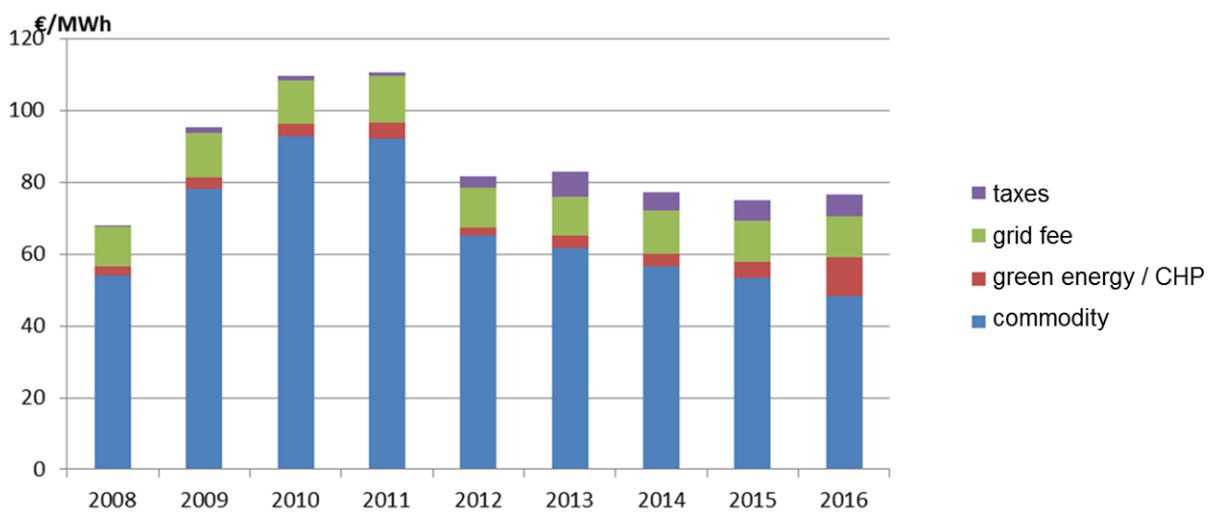
Evolution of forward prices for commodity from the beginning of 2012 to the end of 2017:



Electricity prices are going up due to mounting gas, coal and CO₂ prices.

6.3 Unit prices

The diagram below shows unit prices (in EUR/MWh) for purchasing traction energy for the period 2008 to 2016.



6.4 Renewable energy

Infrabel has decided (after discussions with the railway undertakings) to introduce no requirements regarding renewable energy in the purchasing procedure for traction current. Railway undertakings wanting to use green energy, can purchase guarantees of origin and ask the competent authorities to destroy them.

7. How are the rates set?

7.1 Transport and distribution

Infrabel pays the connection costs of the traction substations on the public high-voltage grids (Elia and the distribution system operators). These costs are linked to the physical connection of our traction substations with the public grid and the costs of transporting energy through the public grid. The invoices from the public system operators also contain a number of taxes and levies that are withheld via the system operators.

We suppose that 5% of energy is lost between connection to the public grid and the pantograph. Infrabel buys energy itself to cover this.

In order to be able to measure and allocate energy, we have numerous IT applications. Costs for improving, managing and maintaining these applications will be taken into account.

For a number of crucial tasks concerning information processing, we work together within Eress, a European cooperation with numerous railway infrastructure managers. This allows us to share knowledge and also save on investment costs.

7.2 Supply

The price for actual energy supply is based on the results of the European tender and the evolution of the energy indexes for the supply period (see chapter 6).

Railway undertakings having more than 2.5% of the total estimated electricity consumption, can choose to perform some price clicks for a part of their consumption. This part of their consumption will be invoiced at the by the railway undertaking clicked prices. The remaining part will be invoiced at the prices from the network statement. The railway undertaking will indicate its choice when giving a mandate to Infrabel to purchase the electricity for a specific period for them.

8. Do you need an energy meter?

8.1 Why?

Every electricity consumer has an energy meter. Trains consume huge amounts of electricity. If a railway undertaking would like to choose its own energy supplier, Infrabel must have access to actual energy consumption data. Therefore an energy meter is vital.



An energy meter also ensures that you are only charged for your actual consumption. A railway undertaking that uses less energy will also pay less. Countries such as Norway and Germany have made savings of 10 to 20% in a five year period. A group of train drivers has reached similar results on our network. These drivers try to avoid unplanned stops and try to regenerate during braking as much energy as possible towards the overhead contact line.

8.2 What requirements must an energy meter fulfil?

The railway sector has set out requirements that all energy meters placed on trains must fulfil. These have been approved by the European Commission. The basic requirements are set out in appendix D of the TSI on rolling stock (published via Commission Regulation 1302/2014).

More detailed requirements can be found in a European standard, namely EN 50463. Products that fulfil this norm will also fulfil the basic requirements from the TSI.

A new version of EN 50463 is published in 2017. This version includes a standard protocol for the exchange of data. Erex will be able to receive this measurement data from 2019 without passing by a server of a third party.

All requirements for the energy meter are summarised in appendix E.3 of the network statement.

9. Definitions and abbreviations

Business Corner	Secure B2B-website, reserved for railway undertakings Railway undertakings can use a range of applications to reserve their routes online, download rules and administrative documents, consult transport and invoice data, enter the composition and tonnage of trains, ...
Elia	Manager of the Belgian transmission grid Elia manages the 30 kV to 380 kV electricity grids. All large power stations and connections with neighbouring countries are at this voltage. Most traction substations are connected to Elia's grid. Electricity cannot be stockpiled. Elia also ensures that there is a balance between the supplied or produced energy on one side and the offtake or consumed energy on the other at all times. Elia invoices these services to the party that has caused the imbalance.
ERA	European Union Agency for Railways The body that sets out legal and practical agreements for the railway sector on behalf of the European Commission. They are responsible for setting up TSIs, among other things.
Eress	European Railway Energy Settlement System European cooperative partnership, involving numerous railway infrastructure managers, with the aim of offering railway companies collective solutions with regard to the measurement and allocation of energy consumptions by trains.
Network statement	The network statement is the document that provides, in detail, a description of the network, general traffic rules, periods, procedures and criteria in connection to charging rules and the allocation of railway infrastructure capacity. It also contains all other information that is necessary to submit a demand for railway infrastructure capacity. The network statement is drawn up on behalf of railway undertakings and other parties that have interest in railway transport. The document can be consulted on www.infrabel.be .
TSI	Technical Specification of Interoperability There are multiple TSIs. A TSI contains the basic requirements for a particular subsystem, e.g. rolling stock or infrastructure. All new trains in Europe must fulfil the TSI for rolling stock. These TSIs can be found on www.era.europa.eu .

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Energy Management

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