Periodic Review 2013: Network Rail consultation on traction electricity & electrification asset usage charges in CP5

September 2012

CONTENTS

1. EXECUTIVE SUMMARY

Around 50% of the traffic operated on the GB network is electrically powered. Traction electricity charges recover the costs of electricity supplied by us to train operators for their use of traction electricity. This electricity is supplied through the overhead lines for AC (alternating current) and the 'third rail' for the DC (direct current) network which is in the southern region and Merseyside. In 2010/11 we recovered £223million through traction electricity charges income, and £8million through electrification asset usage charge income.

Most electric train operators are charged on the basis of modelled consumption rates, which are multiplied by electrified mileage and the electricity price to give the modelled traction electricity charge for each period. At the end of each year, we carry out two reconciliations. The first is the volume wash-up. This reconciles modelled consumption and actual consumption in each electricity supply tariff area (ESTA), and results in either a payment to or from the train operator to us. The second is the cost wash-up which reconciles the difference in prices charges each period, and the actual prices we paid for that electricity, and results in a payment to or from the train operator to us.

During CP5 some operators opted-in their trains to metered billing. These operators are now charged on the basis of metered consumption multiplied by electrified mileage and the electricity price to give a metered traction electricity charge each period. Metered train operators participate in the cost wash-up as above, but they do not participate in the volume wash-up.

Scope of this consultation

ORR has stated its intention to use traction electricity charges as a way to offer incentives to operators and us to use energy efficiently. Specific proposals it has made for doing this are:

(a) to recover electrical losses based on a losses mark-up which reflects a "challenging by achievable level of losses";

(b) for the year-end volume wash-up to be allocated between unmetered operators and used to reflect our ability to manage the risk; and

(c) to apply an uplift to modelled consumption rates to incentivise operators to move to on-train metering.

While we have set out some options for (c), we have not included any suggestions in relation to (a) and (b). It is our understanding that ORR will be consulting in these areas in November 2012. This document consults possible approaches for CP5 for modelled EC4T consumption rates, regenerative braking, electrical losses (AC), electricity prices, the contractual framework and electrification asset usage charges.

Modelled consumption rates

We have assessed the possibility of adjusting the consumption rates so as to reduce the large volume wash-ups each year, and our evidence suggests that on average consumption rates are around 10% too high. However, due to the large variability of the volume wash-up from year to year, we are reserved about the extent to which a highly averaged adjustment across all consumption rates will reduce the volume wash-ups.

For this reason we are proposing to retain the current modelled EC4T consumption rates in CP5. Further to this, we are proposing to continue using the same methodology as was used in CP4 to calculate modelled consumption rates for new vehicles in CP5.

We fully support incentives to increase on-train metering. At ORR's request we discuss options for doing this, and suggest applying a 10% surcharge to modelled consumption to provide an incentive for modelled operators to move to metered billing. We consider that the proceeds of this surcharge should be excluded from the volume wash-up and instead paid back to both metered and modelled operators in proportion to their final EC4T bills.

Regenerative braking

We have assessed the validity of the current regenerative braking discounts offered to modelled train operators, using a very small sample of data from London Midland, Southern and Virgin Trains, we consider the discounts to be broadly appropriate. However, we discuss the option for the possible removal of the regenerative braking discounts from the start of CP6. This is because the availability of regenerative braking systems is uncertain, especially in winter and leaf-fall seasons. This may result in distortions in the volume wash-up.

We suggest amending the way we reflect regenerated energy in metered EC4T bills. Currently the losses mark-up is applied to net energy consumption, however we are proposing to apply a separate losses factor to regenerated energy to reflect the losses associated with this energy. We are estimating losses at 1% for regenerated energy, and we are suggesting that there is an option to reopen this estimate after two years from the beginning of CP5, capping any adjustment to no higher than 2.5%.

Electrical losses (AC)

We have carried out substantial work this year to quantify the level of actual electrical loses on our AC network, and we are proposing that this is recovered by way of a losses mark-up of 4.82% for CP5. We discuss options for reopening this estimate after two years from the beginning of CP5 to reflect changes in electrification and the availability of more metered data.

We do not propose disaggregating the losses mark-up by ESTA, this is because ESTA boundaries are likely to change substantially in CP5.

Electricity prices

We are proposing the freight operators are charged on the basis of actual prices, this means that they will participate in the cost wash-up with passenger operators, and means the complete removal of the current modelled prices used by freight.

We also propose that delivery charges are levied in a more cost reflective way.

Contractual framework

We are proposing that the current EC4T Metering Rules document, which sets out various provisions associated with metered billing, is widened and renamed the traction electricity rules, which will include all EC4T drafting. This will result in the removal of all EC4T provisions from schedule 7 to the track access agreements.

We also propose adjustments to the cost wash-up drafting to disaggregate it by ESTA and to allow operators to benefit from direct price setting arrangements.

Electrification asset usage charge

We have set out our assumptions on variability of the costs of electrification assets. We are proposing that EAU cost estimates are based on a more long-run average approach from CP5 to CP11. We are proposing a total EAU cost estimate of £21.3million.

Industry engagement

We are proposing to continue using the monthly traction electricity steering group (TESG) meetings to discuss EC4T and EAU charges issues with the industry. We plan to conclude on this consultation in December 2012, and will submit draft modelled consumption rates, regenerative braking discounts and losses mark-ups / factors in March 2013.

Conclusion

A summary of our key proposals are:

- to retain current modelled consumption rates for CP5;
- to apply a separate losses factor to regenerated energy of 0.9899 (based on assumption that 1% of regenerated energy is lost) from the start of CP5 ;
- to retain a single losses mark-up for AC at 4.82% for CP5;
- not to geographically disaggregate the losses mark-up for AC;
- for freight to pay actual electricity prices for all usage from the start of CP5;
- to create a new set of rules called the traction electricity rules (to include all multilateral EC4T arrangements); and
- to use updated cost variability assumptions and use long-run average cost estimates for the electricity asset usage charge.

Areas in which we are keen to hear your thoughts and / or suggestions are:

- whether to apply a 10% uplift to modelled consumption rates to incentivise modelled operators to move to on-train metering;
- whether to remove existing regenerative braking discounts for modelled usage in CP5 or CP6, because of the conditional use of the functionality which means operators may be under-billed;
- whether to revisit the regenerative braking losses factor during CP5, albeit capped so the losses estimate rises from 1% to no more than 2.5%; and

- whether to have the option to revisit the losses mark-up in light of new information during CP5.

In conclusion, we consider the proposals we have made represent a sensible way forward for the traction electricity and electrification asset usage charging framework in CP5. We are keen to hear your thoughts on our proposals.

As set out above, there are a number of areas where we have not made firm proposals. However, we are interested to understand what your thoughts and / or suggestions may be for dealing with these issues.

Responding to this consultation

All the consultation questions are set out in Appendix A. We welcome responses to these questions, as well as comments on any other aspect of the traction electricity and electrification asset usage charges work programme as part of PR13. The closing date for this consultation is **Friday 12 October 2012**. This provides just under six weeks for consultation.

We intend to make responses public, including sharing them with ORR and publishing them on our website. Please indicate if you wish all or part of your response to remain confidential.

Please address any responses and / or queries to:

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This consultation can also be downloaded from our website here: http://www.networkrail.co.uk/PeriodicReview2013.aspx.

2. INTRODUCTION & BACKGROUND

Around 50% of the traffic operated on the GB network is electrically powered. Traction electricity charges recover the costs of electricity supplied by us to train operators for their use of traction electricity, this is also known as EC4T (Electric Current for Traction). This electricity is supplied through the overhead lines for AC (alternating current) and the 'third rail' for the DC (direct current) network which is in the southern region and Merseyside.

In 2010/11 we recovered £223million through traction electricity charges income, and £8million through electrification asset usage charge income.

2.1. Purpose of this document

At each periodic review, we review the charges we levy to our customers[1]. All final charges are set in consultation with the industry, and are audited and approved by ORR as part of its periodic review. Any changes to charges are usually implemented at the start of the next control period, which is CP5[2].

This document sets out a proposed approach to developing the EC4T and electrification asset usage charging framework for implementation from the start of CP5, and seeks views from the industry on this approach.

2.2. Structure of this document and scope

While we are responsible for developing the proposals for existing charges and the general technical implementation of charges, ORR is responsible for developing any new aspects of charging, including any additional incentive based elements.

As such, this document focuses on three key areas, namely:

- modelled consumption rates;
- regenerative braking discounts;
- electrical losses mark-ups.

In May 2012, ORR published its decision on various aspect of the financial and incentive framework for Network Rail in CP5, this included its decision on other aspects of the EC4T charging framework, including setting a challenging but achievable level of losses and increasing Network Rail's share of the volume wash-up[3]. We do not intend to cover any of those areas in this consultation.

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[1] In Appendix to Annex F of its first PR13 consultation, ORR proposed that for PR13, Network Rail should retain its current responsibility for developing proposals for existing charges and the general technical implementation of charges.

[2] Control period 5; this is the period from 1 April 2014 – 31 March 2019.

[3] ORR (May 2012), '2013 Periodic Review: Financial and Incentive Framework', paragraph 5.123.

2.3. Background

All train operators who draw electricity from the network are charged to recover the cost of electricity itself and the costs of distribution and transmission. This charge is based on electricity consumption multiplied by the electricity price.

For most operators, the electricity consumed is based on published modelled consumption rates. For those that have opted-in to on-train metering (OTM), charges are based on metered electricity consumption, which now accounts for around 25% of all traction electricity.

The price paid by franchised passenger operators is based on electricity purchased at Network Rail's actual cost. Some passenger operators have fixed their prices up until 2014. Freight operators are charged a modelled price. The price is based on the equivalent costs in 1999/00 which is then indexed each year by the MLUI[4].

At the end of each financial year, a volume reconciliation (volume wash-up) and a cost reconciliation (cost wash-up) is carried out. This process reconciles operators' bills based on the actual final bills we receive at the end of each year.

2.4. 2008 periodic review and CP4

As part of the 2008 periodic review, it was determined that some changes would be made to the EC4T charging policy for CP4[5]. The key changes were:

- the revision of the consumption rates;
- the introduction of the option for operators to move to metered billing;
- the inclusion of freight in the annual volume wash-up; and
- the basis for freight tariffs.

ORR was keen for the modelled consumption rates to be recalculated for CP4. We developed and consulted on a new model which estimated traction electricity consumption rates. This model used a performance modelling tool called Railsys. However, there were significant concerns with the model, and ORR determined that the CP3 consumption rates would continue to apply.

ORR also determined that train operators should be able to opt-in for on-train metering at the start of each year from 1 April 2010.

2.5. On-train metering and losses

Virgin Trains was the first operator to opt-in for metered billing, using the train management system on its full fleet of Pendolinos from 1 April 2010. In 2011, London Midland also opted-in its full fleet of trains. This resulted in substantial metering on the West Coast Main Line.

[4] Moderately large users' index, this is published quarterly by Department of Energy and Climate Change, accessible here: http://www.decc.gov.uk/en/content/cms/statistics/publications/prices/prices.aspx.

[5] Control period 4, this is the period from 1 April 2009 – 31 March 2014.

This move to metered billing brought about a number of issues which needed to be discussed, consulted on and agreed. The key issue was in relation to the level of energy losses, which were to be recovered through an additional charge known as the losses mark-up. The losses mark-ups were eventually agreed in 2011 and metered operators' charges were backdated to 2010 to reflect this.

Concerns were also raised by the industry as to the risk to non-metered operators as a result of others moving to metering, as metered operators were no longer included in the volume wash-up. In response to this, Network Rail introduced a Transitional Risk Sharing Mechanism (TRSM). The TRSM protects operators against any rise in their post volume wash-up consumption rate above 7.5%. This mechanism is time-limited, and expires at the end of CP4.

There were also technical issues around the billing of data and the handling of missing data. Provisions were agreed and set out in the newly created EC4T Metering Rules to deal with these issues.

Since then, further work has been carried out to further refine our billing system, and to agree provisions to be used for the possible opt-in of freight operators to metered billing.

2.6. How are charges calculated now?

At the end of each period, all electric train operators are charged a traction electricity charge. For modelled passenger operators this is calculated as follows:

Modelled passenger Traction electricity charge = total modelled consumption rate x price x mileage

For modelled freight operators, their modelled traction electricity charge is calculated as follows:

Modelled freight traction electricity charge = total modelled price x 1000 gross tonne miles

At the end of each year, two supplementary amounts are calculated for each modelled electric train operator. These supplementary amounts (also known as S1 and S2) represent the volume and cost wash-up, respectively. These amounts are either payable by or to the train operator. S1 is calculated for each train operator in each Electricity Supply Tariff Area (ESTA) as follows:

S1 = total modelled traction electricity charges x (actual consumption – modelled consumption) / modelled consumption

S2 is calculated for each train operator as follows:

S2 = (total modelled traction electricity charges + S1) x (Network Rail's actual costs for traction electricity – (total modelled traction electricity charges + S1) / (total modelled traction electricity charges + S1)

Metered traction electricity charge bills are calculated as follows:

Metered Traction electricity charge = (Metered consumption x power factor correction factor x price) – (regenerated consumption x power factor correction x price) x (1+ tolerance factor) + (Metered consumption x power factor correction factor x price) – (regenerated consumption x power factor correction x price) x (1+ tolerance factor) x (relevant losses mark-up)

Metered operators do not take part in the volume wash-up, therefore an S1 amount is not calculated, unless more than 90% of the consumption in an ESTA is metered, in which case the metered consumption including the losses mark-up are included in the annual volume wash-up.

2.7. 2013 Periodic Review

ORR has set out its view that the efficient use of traction electricity should be incentivised, and that traction electricity charges are an effective way to provide these incentives. In its May 2012 document[6] ORR set out its decision on the framework to do this:

(a) metered train services should be billed on the basis of consumption, with a mark-up based on a challenging but achievable level of losses (given that losses vary widely across the network, we expect this to vary by geography and / or service, balancing the benefits of greater cost-reflectivity against simplicity and transparency);

(b) the year-end volume wash-up will be allocated between unmetered services and Network Rail, to reflect their respective ability to manage the risk (primarily consumption and losses respectively). This will place an incentive on Network Rail to manage losses more effectively; and

(c) application of an uplift to modelled rates. This uplift would reflect internal and external cost differences such as the lower expected efficiency associated with vehicles that are unmetered; the associated revenue will not be included in the volume wash-up.

The policy for these decisions will be developed by ORR. However this provides a useful context for the work we will be doing in preparation for CP5.

[6] ORR (May 2012), '2013 Periodic Review: Financial and Incentive Framework', paragraph 5.123.

3. MODELLED CONSUMPTION RATES

Most operators' traction electricity charges are based on modelled consumption rates. These rates are set by service code and vehicle type, and are based on a system called TRATIM[7].

As expected, the modelled rates are not 100% 'correct'. We know this because some of the annual volume wash-ups are fairly large. Given the historic way in which the modelled rates have been set, it is difficult to unpick and recalibrate them.

Given the large volume wash-ups we have seen in previous years, we considered that there may be scope to adjust the modelled rates to reflect the outcomes of the last few years' volume wash-ups. However, adjusting rates across the network would be relatively complex to do because of the effect of adjustment across all of the ESTAs. This is explained in more detail, below.

The modelled consumption rates are computed for journeys which often extend across one or more ESTA boundaries. If the modelled consumption rates were adjusted according to the volume wash-up factor in one ESTA it would need to be similarly adjusted in all the ESTAs that the journey passes through. However, the volume wash-up factor in the first ESTA is likely to be different to the factor in the next ESTA and so other consumption rates would need to be adjusted to make up any differences. The following table uses a simplified example to illustrate this issue:

Assume ESTA A volume wash-up factor is -10% and ESTA B +5%

Table 1: Worked example of adjustment using volume wash-up factor

Row	Journey	Modelled Consumption Rate (kWh/km)	Corrected Rate as per ESTA A volume wash-up (kWh/km)	kWh used in ESTA A	kWh used in ESTA B
1	Pre volume wash-up position				
2	X	20		40	0
3	Y	30		60	60
4	Z	40		0	40
5	Total			100	100
6	Grid Consumption			90	105
7	Post volume wash-up position				
8	X	20	18	36	0
9	Y	30	27	54	54
10	Z	40	n/a		51
11	Total			90	105

Rows 1-5 show the consumption for 3 journeys across 2 ESTAs. Row 6 shows the actual consumption in the ESTA. Rows 7-11 show the position if the journey

[7] TRATIM is no longer in use

consumption rates are adjusted according to the volume wash-up in ESTA A but only for the journeys that operate in ESTA A (i.e. journeys X & Y). In ESTA B, if journey Y is adjusted according to the ESTA A volume wash-up then its consumption reduces to 54 kWh which then means that journey Z has consumed 105 – 54 = 51 kWh. Its modelled consumption was 40 kWh so it has seen an 11/40 or 27.5% increase. This is a very significant difference from the ESTA volume wash-up factor of +5%.

In conclusion, when the real situation of multiple journeys, stock types and ESTAs is analysed then an enormous set of simultaneous equations would result which would take many months to set-up and solve. In fact, there may not be an available solution in many cases.

The only situation where consumption rates could be adjusted without undue knock-on effects is where all journeys start and finish within one ESTA. There is only one ESTA in which this happens and that is ESTA M – Merseyside. The volume wash-up factors for ESTA M over the last three years are shown in Table 2.

Table 2: Volume wash-up factors

Year	Volume wash-up factor (ESTA M)	Volume wash-up factor (ESTA O)
2009/10	+ 0.40%	- 6.69%
2010/11	- 1.83%	- 7.65%
2011/12	- 6.02%	- 10.09%
Average	**-2.48%**	**- 8.14%**

Source: Network Rail track access billing system (TABS)

Table 2 illustrates that, when using an average over the last three years, the modelled consumption rates for Merseyrail could be adjusted downwards by 2.48%. However, it is worth highlighting that the adjustment is relatively low, and as the last three years' volume wash-up factors illustrate, the volume wash-up factors themselves can be quite volatile and so it cannot be said for certain that any adjustment in the modelled consumption rate would necessarily reduce the magnitude of volume wash-up corrections.

We have also analysed the volume wash-up factors in ESTA O (London Tilbury & Southend), this is because there is just one passenger operator which runs services in this ESTA. However, there are freight operators in the area also, and we consider that it would be inappropriate to use this information to adjust c2c's consumption rates by the suggested 8.14% set out in Table 2. This is because it may have a substantial and adverse impact on freight operators' modelled bills. This risk is even more apparent in other ESTAs where there is more than one train operator running electrified services.

ESTAs M and O have been used as case studies to illustrate how an adjustment to consumption rates, using previous years' volume wash-ups, might look. These ESTAs were chosen because they can be considered to be relatively isolated parts of the electricity network, in which it might be easiest to apply this approach. These case studies have been helpful in illustrating that there is likely to be little benefit, and more likely substantial risk in adopting this approach.

Changing an operator's rates in one ESTA would introduce a relative benefit (or dis-benefit) to that operator. If all rates in one ESTA are adjusted then there would be knock-on effects to all other ESTAs and operators (except for one: ESTA M – Merseyside). The existing rates need to be preserved to maintain the existing relativities between operators, to prevent a situation where 'winners' and 'losers' are created by such an approach.

A simpler approach may be to make bespoke, train operator specific, adjustments based on their previous volume wash-ups, which is applied at each period bill and will reduce the year-end volume wash-up, however we would have significant concerns about implementing this approach which may be very resource intensive, and therefore may not represent value for money.

In 2011/12 and 2010/11, in 17 of 19 ESTAs, train operators received money back via the volume wash-up. However in 2009/10 the number fell to 14 of the 19 ESTAs. In any case, it is clear that the majority of train operators are paying money back to us via the volume wash-up – which suggests that their modelled consumption rates are too high. Ignoring the ESTAs where operators pay us via the volume wash-up, the volume wash-up factors themselves vary considerably between ESTAs, for example on average between 2009/10 and 2011/12 the money paid back ranged from around 1% to 37% of their modelled consumption. On average, each of the payments received by the operators at the end of the year represented around 13% of their modelled consumption.

Table 3: Average volume wash-up factors (ESTAs where we have over-billed only)[8]

	Average wash-up % (where we have under-billed only) – small number of ESTAs	Average wash-up factor (where we have over-billed only) – most ESTAs	Average wash-up factor (all ESTAs)
2006/07	9%	-9%	-5%
2007/08	5%	-11%	-5%
2008/09	5%	-10%	-6%
2009/10	6%	-11%	-6%
2010/11	7%	-16%	-13%
2011/12	12%	-13%	-11%
Average	**7%**	**-13%**	**-10%**

Source: Network Rail track access billing system (TABS)

Table 3 shows that, in theory, we could apply a downward adjustment on all passenger and freight consumption rates by around 10% which may reduce the large volume wash-ups for the majority of the ESTAs. This could improve some operators' cash flow during the year. However, in the two ESTAs we have identified in 2010/11 and 2011/12 where supplementary amounts were paid back to us, those operators will face larger payments to us at the end of the year.

3.1. Options for adjusting modelled consumption rates

We would like your views on an appropriate approach to this issue. The options for adjusting modelled consumption rates are:

[8] Please note that ESTA boundaries have changed during this time period, and so come changes may be due to this.

(a) adjust all individual passenger and freight consumption rates based on previous volume wash-ups using simultaneous equations to map ESTA wash-ups to individual consumption rates – this is likely to be considerably time-consuming, and is likely to yield little benefit and more likely increased risk;

(b) calculate bespoke additional charges per passenger or freight operator, based on previous volume wash-ups and apply to period bills;

(c) reduce all consumption rates by 10%, noting that the variability of the historic wash-ups mean that it may not necessarily reduce wash-ups, and for some operators it will increase money to pay back to us via the volume wash-up ; or

(d) continue with current arrangements of the annual volume wash-up leaving consumption rates unchanged.

Our suggested approach would be (d); however we would be keen to hear your views.

(A) Do you agree with our proposal to leave all modelled passenger and freight EC4T consumption rates unchanged for CP5?

(B) Do you have any other suggestions to make about modelled consumption rates in CP5?

3.2. Relationship between consumption rate and EMU length

Because of the aerodynamic drag of an electric multiple unit (EMU) which is not at the front of a train, the relationship between electricity consumption and train length is not linear. The current factors used are set out in Table 4, below:

Table 4: Consumption rate factors for EMUs

Consumption rate factors for EMUs (kWh / train mile)			
1 unit	2 units	3 units	4 units
100%	192%	285%	380%

Source: Network Rail track access billing system (TABS)

We propose to continue using these factors for modelled consumption rates. We would be keen to hear your views on this.

(C) Do you agree that it is appropriate to continue using the current uplift factors for electric multiple units?

3.3. New modelled consumption rates during CP5

During CP4, new consumption rates were calculated using a methodology which was agreed by the industry for use shortly after the conclusion of PR08[9]. We propose that this methodology is rolled forward for new vehicles for use in CP5 also. We are keen to hear your views on this approach.

The agreed methodology was developed to produce rates for new rolling stock coming onto the network during CP4. It was considered important that this methodology was broadly consistent with the TRATIM-based approach, which existing rates are based

[9] This methodology was agreed in May 2009.

on. This was considered a temporary solution given ongoing work to introduce on-train metering across the entire electric fleet during CP4 and CP5. The main principles underpinning the methodology are discussed below.

TRATIM approach

It is not possible to identify all of the assumptions that underpinned the original TRATIM modelling as the relevant information is not available. However, in general, the approach taken was to model ‘representative’ journeys and stopping patterns which were then used to generate rates (kWh per train mile) for each combination of train service code and train consist. The rates derived also included an element for auxiliary energy consumption and energy consumed during station dwell and terminal layovers. Distribution losses and energy consumed during stabling were not included and have historically been dealt with through the wash up. Similarly, energy reductions from regenerative braking were not included in the TRATIM approach.

New methodology

The methodology we proposed for new or re-routed stock was therefore an attempt to mirror the TRATIM approach as closely as possible, as requested by ORR, while avoiding some of the main problems identified in our original EC4T consultation for the 2008 periodic review. The key steps are set out in Table 5.

Table 5: Steps to calculate a new modelled consumption rate

Step	Action
1.	A service pattern is selected as ‘representative’ of the service code for which a new consumption rate is required. The service pattern is selected on the basis of it being the most frequent i.e. containing the most trains[10].
2.	The selected service pattern is modelled in Railsys[11] to derive mechanical energy at the wheels. This is derived using the following assumptions: • Trains modelled are based on the timetable period during which they are running; • Maximum braking rate of 1m/s^2[12]; • Trains are run flat out and weighting factors of 5% and 8% energy reduction are applied to AC and DC traction respectively to reduce the line energy consumption. (This is to take into account the effects of operational and engineering allowances etc.)[13]
3.	The mechanical energy is converted into electrical energy. In doing so, the auxiliary load while in traffic is calculated and added[14].
4.	To reflect energy consumed during station dwell time and terminal layovers the final numbers are uplifted by 10%[15].

[10] Where there is more than one service pattern in a service code with the same number of trains, an average of the most frequent service patterns is taken.

[11] This is a performance modelling tool.

[12] A braking rate of 1 m/s^2 is identified as appropriate as this value is commonly used as a standard maximum for new rolling stock types derived from Railway Group Standards. (It is understood this is slightly lower than some of the braking rates that were applied in TRATIM however it is regarded as being more representative of the likely maximum braking that would be applied in real-world operating conditions).

[13] This is consistent with the original approach followed under TRATIM.

[14] Data on the electrical characteristics of individual trains is taken from OSLO.

Distribution losses for both AC and DC operation are not included in the rates calculated. This is consistent with the existing TRATIM methodology. Transmission losses are, effectively, dealt with in the volume wash-up. Similarly the impact of regenerative braking is not included. However, a discount is offered to those operators which use regenerative braking.

From this process a consumption rate (kWh per train mile for multiple unit operation, kWh/gross tonne-mile for loco-hauled operation) can be derived for the following level of detail:

- Train operating company;
- train service code; and
- rolling stock type.

In addition, in line with the TRATIM methodology, rates can be derived for coupled multiple units (e.g. where two 4-car EMUs are operated together) by multiplying the single EMU rate by existing uplift factors.[16]

Comparison with TRATIM

While a comparison between the new rates and TRATIM rates cannot be used as a test of accuracy, it is useful as a means of demonstrating consistency between the two approaches. As such, a validation exercise was undertaken to compare the rates derived for selected types of rolling stock/route against the existing TRATIM rates. This validation exercise illustrated that, in most cases, the rates derived using the new methodology were within 5-6% of comparable TRATIM rates. It is therefore believed that the new rates are as consistent as reasonably possible with those derived using the original TRATIM approach.

We consider that it is suitable to continue using this methodology to calculate modelled consumption rates for new vehicles introduced during CP5. We would expect for most new stock introduced during CP5 to be fitted with on-train meters, and therefore opt for metered billing. For this reason, we would expect the use of this methodology to diminish over time. in fact to further incentivise this, we would suggest the option of applying an additional modelled rate of 5kWh per mile to all new rates, this is discussed further below.

(D) Do you agree that it is suitable to continue using the agreed methodology for calculating new modelled EC4T consumption rates, during CP5?

3.4. Incentive uplift

In its most recent document, ORR set the framework to incentivise efficient traction energy use. One of its decisions was to apply an uplift to modelled consumption rates. It said that the uplift should reflect internal and external cost differences such as the

[15] Note: TRATIM numbers were uplifted to take account of this consumption however there is no specific value identified in the assumptions. The 10% estimate is based on best available advice from Network Rail.

[16] Uplift factors are 192% for 2x1MU, 285% for 3x1MU and 380% for 4x1MU.

lower expected efficiency associated with vehicles that are unmetered. The aim of this uplift would be to provide a financial incentive to modelled operators to move to metered billing.

We support the strengthening of incentives for operators to move to metered billing. We understand that, in theory, applying an uplift to modelled consumption rates may be a good way to do this, however we have some observations about this approach. Firstly, we consider that basing the uplift on the approximate costs associated with the lower expected efficiency associated with vehicles that are unmetered seems sensible, but may be disproportionately difficult to quantify. Secondly, operators already experience a degree of financial uncertainty through the volume wash-ups, and because the volume wash-ups are generally quite large, overpayment each period results in adverse ‘cash flow’ for the operators during the year. It could, therefore, be argued that there is already an incentive for modelled operators to move to metered billing, because of the increase in certainty, and cash flow within the year.

In thinking about the possible application of an uplift incentive, there are questions about what is done with the associated funds collected from such a charge. We think that that any uplift should reflect the following principles:

- A single party (i.e. Network Rail) should not profit from the uplift;
- the funds collected should stay within the industry;
- the funds collected should not merely go back to the modelled operators – so there is still an incentive; and
- it should be simple.

We consider that it is important that any such uplift is consistent with the principles set out above. We would suggest an uplift on modelled consumption rates of 10%, the total of which could be paid back to both modelled and metered operators in proportion to their total traction electricity charge bill following the cost wash-up.

This arrangement would mirror those applied to metered operators where missing data is above the agreed threshold for missing metered data. This means that it would not be disproportionately complex to move modelled operators to this arrangement because there are already similar rules and processes in place to do this. Furthermore, we have seen that the 10% uplift incentive applied to missing metered data received support from the industry, and appears to drive incentives to keep missing metered data as low as possible.

Alternatively, the proceeds from the uplift collected could be set aside in a fund, which could be used to support on-train metering. However, we consider that the administrative effort needed to monitor a fund in this way is fairly high, and evidence from CP4 would suggest that the fund may not be fully used.

The extent to which an uplift on modelled consumption rates provides an incentive to franchised passenger operators is dependent on the application of the ‘no net loss / no net gain’ provision in franchise agreements, which would hold franchised operators neutral to changes in the consumption rates made during a periodic review. It is our understanding, however, that ORR has been discussing the possibility of relaxing this provision for CP5, with DfT.

Another option would be to charge this premium to new vehicles only, this may provide a strong incentive to install on-train meters on all new stock.

(E) **Do you have any views on our suggestion to uplift modelled consumption rates by 10%, consistent with the surcharge applied for missing metered data?**

(F) **Do you have any views on the use of the proceeds from an uplift to modelled consumption rates?**

(G) **Do you have any views on applying the uplift to modelled consumption rates to new vehicles only?**

4. REGENERATIVE BRAKING

Modern electric trains are commonly equipped with two types of braking system; conventional mechanical disc brakes and electric regenerative braking. The use of regenerative braking reduces the net energy consumed, and represents a cost saving for the train operators which use it. This cost saving is recognised through a regenerative braking discount, which is applied as a discount to the modelled traction electricity charge. The discounts available are set out in Table 6, below.

Table 6: Regenerative braking discounts in CP4

Type of infrastructure / service frequency	CP4 discount
AC, long distance (more than 10 miles between stations)	16%
AC, regional and outer suburban (less than or equal to 10 miles between stations)	18%
AC, local and commute (less than or equal to 2.1 miles between stations)	20%
DC	15%

Source: ORR, Periodic review 2008: determination of Network Rail's output and funding 2009-14

To understand the reasons for regenerative braking and how it works it is useful to compare a train to a bicycle. In both cases considerable effort is required when starting off and then when up to speed on level ground little effort is required to maintain speed. When accelerating or climbing a gradient, further energy is required. On downhill sections, negligible or zero energy is required and in fact it may be necessary to apply the brakes to avoid excessive speed. Applying the brakes reduces speed by creating friction and dissipating (wasting) the surplus energy as heat.

Many bicycles are equipped with dynamo lighting where a small generator is powered through the wheels to create electricity. Using the dynamo creates an extra load which requires extra energy to avoid the cycle slowing down. There are parallels in a train equipped with regenerative braking. When the train needs to reduce its speed, it is possible to reverse the operation of the electric motors so that instead of using power, they generate power similar to the bicycle dynamo. This power exported from the train reduces the momentum of the train to such an extent that it will bring the train to a halt.

A measure of the effectiveness of regenerative braking is that in slippery conditions, it is capable of causing the wheels to skid in the same way that over application of a mechanical brake will cause the wheels to lock and slide.

The electrical power exported from the train feeds back into the electricity traction network where it will either be used by another train nearby that is drawing power, or dissipated through network losses or, in the case of the AC network, fed back into the national grid system. As an alternative, it is also technically feasible to store some of this surplus energy either on board the train or line-side in batteries or fly wheels.

4.1. The regenerative braking discount

During the decades of relatively cheap energy there was little financial incentive to invest in regenerative braking. As energy prices have increased and environmental issues have taken on greater importance, the need to be more energy efficient has improved the viability of regenerative braking.

It was, however, still expensive for train operators to install regenerative braking on new trains. To reward the installation of regenerative braking, train operators were incentivised by a regenerative braking discount in the modelled traction electricity charges for trains equipped with regenerative braking in CP2. The regenerative braking discount varies according to route type assuming that as local commuter trains stop more frequently they would use their regenerative braking more than inter-city trains and hence return more power to the network.

The regenerative braking discounts were based on a number of assumptions which did not take account of the impact of the different variables which affect the amount of power regenerated. Historically this was not a major concern, as any imbalance due to these assumptions between the modelled and actual consumption was resolved through the annual volume wash-up.

However as more operators fit meters to their trains, it becomes even more important to revisit the way we incentivise the use of regenerative braking so that operators are fairly rewarded for regenerating energy. Information gathered from metered operators Virgin and London Midland demonstrate that the current AC regenerative braking discounts for modelled operators appear to be in approximately the right range. Similarly, a very small sample of metered data[17] from Southern Trains shows that the average regenerated energy, as an average percentage of the gross consumption the regenerated energy was between 16% and 20%. This suggests that the current 15% discount offered is broadly appropriate, we do not feel that this data is sufficiently robust to consider changing the current levels.

4.2. Factors affecting regeneration

Trains have a low rolling resistance which is an advantage when moving at speed, but a disadvantage when trying to stop a high speed train. Rail adhesion is a key factor in braking performance. For this reason, drivers can override the regenerative braking to avoid sliding in poor conditions such as ice or leaves. This manual intervention means there is no control or check that regenerative braking is in service even if installed.

The level of deceleration and hence regeneration varies according to train design, and the blending of mechanical braking with regenerative braking. Some train designs operate friction and electric braking in parallel, others only use friction to supplement the electric braking when the driver calls for increased retardation.

Table 7 sets out the factors which affect regeneration. We have found that these issues often result in a few days where no regenerative energy is being produced, and many days when the output is not maximised.

[17] This data was obtained from the on-train metering data used for billing.

Table 7: Factors affecting regeneration

Factors affecting regeneration	Influencing factors
The degree of timetable optimisation	A timetable that is optimised to reduce energy consumption by enabling trains to operate at a steady average speed with few signal stops will use less energy and also reduce regenerated brake energy.
Robustness of train operating service Passenger Performance Measures (PPM)	To maintain PPM a train operator may have to maintain a high average speed achievable only by aggressive driving. This will consume more energy but also due to reduced coasting create greater regenerative energy.
Number of electrically braked axles	The amount of regenerated power that a train can generate is partly dependent on the number of braked axles; the power that can be generated per axle is limited due to the wheel adhesion per axle.
Rail Adhesion / Weather	In poor conditions (leaves, ice) then regenerated power is reduced, often to zero.
Coasting policy	A coasting train is using no energy and is gradually reducing speed, braking and regenerated power when required to stop.
Train braking control logic	The braking of modern trains is determined by their software. The balance between mechanical and regenerative braking varies according to train class.
Driving style	An economical driving style avoids harsh braking and reduces regeneration energy.
Type of service	As indicated by the current range of regeneration discounts, the type of service influences the amount of regenerated energy.
Line design	A line with gradients, curves and junctions will require the train to brake and accelerate thereby increasing both the power consumption and power regeneration.

While we are keen for operators to exploit the full savings that can be made through regenerative braking, we consider that the first priority should be to improve efficiency through reducing gross energy consumption, which can be done through on-train metering itself. We believe the priority should be to incentivise and reward those savings ahead of the secondary recovery of energy through regeneration.

On-train meters measure regenerated energy as well as the gross energy consumption. Therefore, operators which use on-train metering are charged based on metered energy consumption net of any regenerated power returned to the rail network. This net consumption is then uplifted to take account of losses.

4.3. Regenerative braking and losses

AC network

If train A regenerates energy when there is another motoring train B nearby, train B will consume the regenerated power. Due to the short distance between the trains, the transfer of power will have little loss and in all probability much less loss than had train B been supplied by the normal feed.

On the other hand if train A regenerates energy and there is no other train to consume that energy, then the surplus energy will return to the National Grid through the normal grid supply point. Under this scenario, the train operator will not incur the cost of losses in supply and return for the regenerated energy. As a result, the cost of these losses will pass through to the volume wash-up and be shared by all parties in that ESTA who are subject to the year-end volume wash-up.

DC network

If train A regenerates energy when there is another motoring train B nearby, then train B will consume the regenerated power. Due to the short distance the transfer of power will have little loss and in all probability much less loss than had train B been supplied by the normal feed.

On the other hand, if train A regenerates energy and there is no other train to consume this energy, then the surplus energy cannot be returned to the National Grid through the normal grid supply point without the installation of prohibitively expensive inversion equipment. As a result the regenerated energy is lost through leakage and heat loss. Under this scenario, the train operator will not incur the cost of losses in supply and return for the regenerated energy. As a result, the cost of these losses will pass through to the volume wash-up and be shared by all parties in that ESTA, who are subject to the year-end volume wash-up.

On both the AC and DC networks, regenerative braking will reduce overall energy consumption, however it will increase the current flowing in the electrification system, and therefore increase electrification losses. Given the scenarios described above, it is apparent that losses differ between gross energy consumption and energy regenerated.

4.4. Options for reflecting regenerated energy in modelled bills

This section discusses the options for reviewing the regenerative braking allowances for both modelled and metered usage.

The options for reflecting regenerated energy in modelled bills are to:

(a) Retain existing regenerative braking discounts for CP5 – this would mean that operators may be incentivised to install but not necessarily to use or maintain regenerative braking systems (where operators are not using the functionality but claim the discount, they would pass this cost to other operators in that ESTA); or

(b) Remove regenerative braking discounts, given the level of variability, and possibility that the functionality is not working, or even switched off (this could be a tapered removal).

It has come to our attention the availability of regenerative braking functionality during the winter and leaf-fall seasons are uncertain. Regenerative braking functionality may not be used, to reduce the risk of wheel locking under braking and the consequent risk of overshooting signals and stations. Where this is happening, we may be under-recovering the consumption used. While this all ‘comes out in the wash’, the volume wash-up is in proportion to that operator’s modelled usage, which in these cases would be artificially low. This means that where discounts are granted despite the lower use of regenerative braking, the other operators in those ESTAs may be subject to higher bills. This issue presents a case to remove regenerative braking discounts altogether, and for regenerative braking benefits to be spread across the operators in proportion to the modelled gross consumption. Of course, the best way to benefit from an operator’s own use of regenerative braking is to install on-train meters. For this reason, we think that further consideration should be given to the eventual removal of the regenerative braking discounts, possibly from the start of CP6.

Despite the variability associated with regenerative braking, and the possibility that regenerative braking is not always switched on, a targeted incentive for each operator to use it is ideal. The current discounts do provide an incentive to operators to install the functionality. We consider that there should be some provisions in place which allow us to verify that regenerative braking is actually being used, if operators are to continue claiming a discount on modelled usage[18].

(H) Do you have any views on whether regenerative braking discounts for modelled usage should remain in CP5 or CP6?

(I) Do you have any views regarding provisions to allow us to verify that regenerative braking is being used correctly?

4.5. Options for reflecting regenerated energy in metered bills

As discussed above, some of the energy regenerated is lost. Under the current metered billing process these losses are not captured, this is because regenerated energy is netted-off the gross consumption before the losses mark-up is applied. Therefore we may be under-estimating actual consumption, this could result in the under-recovered amount being transferred to the volume wash-up. This is because metered train operators are credited with the full value of the power regenerated at the point where it leaves the train without taking into account any losses between the train location and the location where the regenerated energy is reused.

As already stated if all the regenerated energy was returned to the national grid then Network Rail would be credited with the value of the regenerated energy at the grid supply point which would be around 5% less than the value credited to the metered operator by the on-train meter due to electrical losses. However preliminary investigation has identified that only a small proportion of the total regenerated energy returns to the national grid with the majority of the regenerated energy being reused within the traction network either by other motoring trains, leakage or increased voltage gradients.

The current approach was introduced around the time that the first operators moved to metered billing, as a pragmatic way forward. Given that we now have more understanding about this issue, we consider that it should be considered from the start

[18] This is discussed further in the contractual framework chapter

of CP5. However, there are a number of options for reflecting regenerated energy in metered charges, they are:

(a) To retain the current approach – which is to apply a total losses mark-up to net energy consumption (i.e. gross consumption minus regenerated energy);

(b) to apply the losses mark-up to gross energy consumption only – and then net off the regenerated energy; or

(c) to apply separate loss factors to gross consumption and regenerated energy to reflect the different losses on both.

We consider option (c) to be the most appropriate option. We consider that this would be more accurate and fairer than the current approach. It may take time to estimate an appropriate losses factor for regenerated energy, but we consider it important that we set the principle from the start of CP5. We plan to carry out further work to understand what the losses factor for regenerated energy may be.

We would expect that the AC factor would be lower than the current losses mark-up to reflect the assumption that some energy goes back to the national grid, and some is used by another train. The DC factor will most likely be proportionally higher than the AC factor because all unused regenerated DC energy is lost.

Our emerging proposal for the AC regenerative braking losses factor is that around 1% of regenerated energy is lost. This translates to a regenerative braking factor of 0.9899[19]. We consider that this is a good starting point, but would like the option to revisit the 1% estimate during CP5, during which further investigation can be carried out to better understand the regenerated energy power flow and hence losses. To provide certainty to metered operators, we would be content to cap the estimate so it raises to no more than 2.5% i.e. a regenerative braking loss factor of no less than 0.9744[20]. We also propose that this rate be fixed for the first two years of CP5.

We plan to propose a DC regenerative braking losses factor as part of our wider consultation on DC losses, later this year.

We are keen to better our understanding of the actual regenerated energy being exported from trains to the traction electricity network. In reality, this can only be achieved by full on-train metering. We strongly support the installation of metering and regenerative braking to provide more information about how the industry can reduce overall electricity consumption.

[19] 1 - (1 / (1-1%)) = 0.9899

[20] 1 – (2.5 / (1-2.5%)) = 0.9744

(J)	**Do you agree with our proposal to apply a regenerative braking losses factor of 0.9899 (based on losses estimate of 1%) to metered AC regenerated energy?**
(K)	**Do you have any views on reopening the regenerative braking losses factor for AC after two years during CP5 to reflect emerging information, capped at no less than 0.9744 (losses estimate of 2.5%)?**
(L)	**Do you have any views on the other options for charging for metered regenerated energy?**

5. ELECTRICAL LOSSES (AC)

5.1. Background

Train operators opting in to on-train metering in CP4 are charged on the basis of their metered consumption plus a fixed percentage uplift to account for losses in the system on their power consumption net of regenerative power. As a result, it is our responsibility to model the network losses under normal timetable operation to determine the losses uplift that should be applied to the energy charge paid by the train operators.

Under our licence, we have a duty to manage the network in an "*efficient and economical manner*" and therefore an inherent duty to demonstrate that electrical losses occurring on the traction system are reduced where economically viable. This requirement also requires us to accurately quantify electrical losses.

Electrical losses consist of a combination of fixed and variable losses. The fixed losses are constant and occur all the time the network is energised. Variable losses occur when current is flowing, predominantly as a result of trains drawing traction energy.

We operate a number of computer models to calculate the energy consumed by trains operating on the AC system. These models are designed to take into account the many variables that influence this energy consumption (e.g. train design, driving style, weather, rail wear, etc) and the consequent variability of losses.

We have used cross industry support to progress further studies on this subject and to this end have commissioned a project[21], to carry out a series of on track measurements for comparison with modelled analysis of a similar network. To validate this modelling, we worked with a number of third parties to carry out similar modelling exercises.

In 2011, we completed studies which calculated the value of losses to be 5% for the AC network; expressed as an uplift percentage of the power used by the train. This report concluded that 5% is considered the best estimate for traction losses based on our understanding of loads and system configurations as applied to a 25 kV AC overhead electric system based on the following estimation.

Table 8: Estimation of Overall AC losses

Factor	Estimated Value
Resistive Losses	3%
Leakage	1.2%
Commercial	Up to 1.5%
Power Quality Equipment	0.53%
Adjustment for BT system	Up to 1.7%
Total	**4% to 6%**
AC losses mark-up set for CP4	**5%**

These mark-ups were introduced in June 2011, and ORR determined that the AC mark-up will be fixed at this level for the whole of CP4. In its most recent conclusions

[21] Project name: Measurement of Electrification System Losses

document, ORR decided that metered consumption should continue to be marked-up to reflect system losses by a fixed percentage. We support this decision.

We are committed to improving our understanding of the level of losses that occur on our network. Considerable work has been done during CP4 to further validate the losses estimates. We envisage that this work will be refined further to inform the review of the losses mark-ups from the start of CP6.

This document sets out our work on the refinement of the estimate of losses on the AC network. Our work on DC losses estimates will be consulted on later this year.

5.2. Quantification of total AC system losses

We have established that electrical losses are a combination of fixed and variable losses across the AC network.

Variable losses (I^2R) which are a multiple of the network impedance and the square of the load current have been modelled over a 24 hour period using the 2015 ECML timetable. The fixed losses on the AC network have been established using the annual 2011 energy consumption report.

5.3. Geographic disaggregation of total AC losses

It has been possible to establish a relationship between the energy used in megawatt hours (MWh) to the length of the feeding area single track kilometres (STK). This relationship enabled the summation of the variable and fixed losses to be extrapolated across the AC EC4T network in order to calculate the total AC losses. In extrapolating the total AC losses across the 18 ESTAs, the following key assumptions have been made:

- The train simulation modelling package (Vision / Oslo) has been validated. Due to the variable factors influencing losses it has always been difficult to align real-time data with modelled data and the report has assumed a 10% uplift on modelled results to actual results.
- No stabling loads in depots or sidings have been included in our modelling assumptions.
- We have assumed that the metering accuracy at the Network Rail grid supply points (GSPs) will all operate to the code of practice.
- All on- train metering data will be within the metering tolerances specified in EN 50463[22].
- The regenerative braking aspect with our simulation model has assumed a zero net impact on electrical losses.
- We have not accounted for any error with the on-train metering system errors.
- We have assumed all energy consumed with our models is related to traction power.

[22] Euro norm 50463 sets out European standards for on-train metering equipment.

- All booster transformers in the calculation are rated at 290kVA

- All autotransformers in the calculation are rated at 15MVA.

- In all areas we have assumed two insulators are housed on every support structure with a span length being every 40m. It is difficult to quantify the number of insulators across the network due to the different overhead line supports and feeding arrangements but we believe this assumption may be a conservative quantity.

- The ratio of installed polymeric against ceramic insulators is assumed to be 50%. In order to validate this, the local Route Asset Managers have been asked to confirm this ratio.

- The UK has a very changeable climate and over the 4 seasons the UK receives a considerable amount of rainfall and precipitation from fog and snow. We have demonstrated via our insulator studies the effects the wet conditions have on leakage losses. Using the data from various sources we have assumed a wet to dry annual ratio of 37% (i.e. In a 24 hour period the insulators will be wet 8.88 hours).

The electrical rail network is made up of a series of GSPs which are grouped into 20 ESTAs. Each ESTA is designated with an alphabetic code and each GSP feeds a section of railway which has a distance measured in STK, thus by grouping the GSPs to make up the ESTAs will give each ESTA an STK distance.

The 2011 electrical energy consumption for each GSP are captured via the Network Rail Traction Power Design Group. Using the 2011 information it has been possible to extrapolate an average daily load (kWh) (i.e. including weekend and midweek loads) for each GSP on the network.

Extrapolation of AC Variable (I^2R) losses

Modelling analysis has been carried out on the level of resistive losses (I^2R) and energy consumption based on the IEP 2015 timetable capacity over a 24-hour weekday period for each GSP that forms the east coast main line (ECML) electrical network.

The analysis demonstrated that resistive losses vary across a range of feeding areas and track configurations, electrification systems and load demands.

It was evident from the analysis that resistive losses predominately depend on the train service level and thus the load demand in order to support such a timetable service.

Early analysis suggests the following estimation of AC losses by ESTA as shown in Table 9.

Table 9: Indicative AC losses by ESTA

MWh per STK	AC ESTAs	I^2R energy loss range	Fixed energy loss range	Median energy loss	Losses mark-up
0 – 100	D,F	1.2% - 1.4%	4.08% - 4.68%	5.94%	6.32%
100 – 200	A,B,C,E,I,J,N,S	1.4% - 1.6%	1.99% - 4.72%	5.54%	5.86%
200 – 300	G,H,Q,V	1.6% - 1.8%	1.88% - 3.30%	4.63%	4.85%
300 – 400	O,P,R	1.8% - 2.0%	0.89% - 1.83%	3.64%	3.78%
400 – 500	T	2.0% - 2.2%	0.00% - 1.33%	3.19%	3.29%
Average					**4.82%**

Table 7 illustrates that the network could be split by MWh power demand, which could then be mapped to ESTAs. We are not proposing to set the losses mark-ups at an ESTA level, this is because ESTA boundaries are highly likely to change during CP5. These changes may be very significant given the level of expected new electrification. Also, ESTA level mark-ups may compromise the clear signals and simplicity that the current arrangements provide to those operators considering opting in for on-train metering.

We will continue, during CP5 to undertake work to improve understanding of the drivers of losses across the network.

5.4. Proposed AC losses mark-up for CP5

We are proposing to set a single national average AC losses mark-up of 4.82%. This figure is subject to further validation between now and the end of this year, this will include:

- validation using real time metered data; an
- reviewing current methodology for capturing dual voltage ESTAs (i.e. ESTAs P, R and T).

Traction electricity consumption is forecast to continue growing by 1.5% per annum. Due to the relationship between traction electricity and losses not being directly proportional, (I^2R), the losses will increase at a greater rate than compensated for by the additional loss uplift charges. It is estimated that this increase in loss will be in the order of a further 0.5% over CP5 which equates to an average year on year increase of 0.1%.

We consider that there may be merit in reviewing the AC losses mark-up during CP5 to reflect changes resulting from increased electrification and metering. We understand that certainty around charges are valuable to our customers, and as such we think that the losses mark-up could be fixed for two years with a possible reopener after this point by way of the traction electricity rules document (discussed further in chapter 7). In any case, we support a full review of the AC losses mark-up for CP6.

Clearly, any work that is undertaken to refine our losses estimate will be based on models, and therefore parts of the estimate will be highly subjective. The only way to increase the confidence and reliability of estimates is to use metered data. We are metering our own use of EC4T from the traction network, to try and remove that ambiguity. We plan to have c.85% of our non-traction usage on the GB network fully metered by the end of 2012. Similarly, we continue to fully support the introduction of strong incentives for operators to opt-in for on-train metering.

A more detailed losses report has been published alongside this consultation document.

(M) **Do you support the work that we have carried out to quantify AC system losses?**

(N) **Do you support further validation of the 4.82% likely to be proposed for CP5?**

(O) **Do you have any views on reopening the losses mark-up after two years during CP5 to reflect emerging information?**

(P) **Do you have any views on not geographically disaggregating the AC losses mark-up?**

(Q) **Do you have any comments on the AC losses report published alongside this consultation?**

6. ELECTRICITY PRICES

6.1. Background

Since April 2007, franchised passenger train operators have paid electricity prices set at the actual costs faced by Network Rail. This means that franchised passenger operators, as a whole, were able to influence the timing and duration of purchase.

Previous to this, all operators paid modelled electricity prices, which were rebased each year based on the moderately large users' index (MLUI) of average electricity prices.

Since the start of CP4, individual, or smaller groups of franchised passenger operators have been able to negotiate electricity prices separately, rather than acting as a whole. This reflects the fact that different operators may have a different attitude to risk related to the price of electricity.

6.2. EC4T delivery charges

The EC4T delivery charge recovers the cost of delivering electricity from the power station gate to the Network Rail boundary supply points. Part of the charge is paid to National Grid and the remainder to the distribution network operators. National Grid charges Network Rail according to Network Rail's consumption in three half-hour periods in the winter months. The periods are determined by the maximum demand on National Grid's system and are only known towards the end of March each year. An estimate of the charge is paid throughout the year and a reconciliation exercise is carried out in April. Charges vary geographically according to which distribution network each connection is located.

The introduction of on-train metering has resulted in better data quality, which includes location data. The location data would mean that it would not be too onerous to calculate an operator's demand in each charging area for the three half-hours.

We are proposing that metered operators pay their portion of the delivery charge in the three half-hour periods in the winter months, which is how Network Rail is charged. This disaggregation would reflect the way in which costs are incurred.

Since unmetered operators are still charged based on modelled consumption rates, they should continue to be charged as they are now, according to their consumption in the winter weekday peak charging period but subject to the volume wash-up.

We also propose to collect the estimated charge paid to National Grid throughout the year and then reconcile this to the actual costs in the annual cost wash-up (this also reflects how Network Rail pays the charge to National Grid via its supplier). This would remove the existing 'jump' in the delivery charge from 1 November each year.

(R)	**Do you support our proposal to adjust the way the EC4T delivery charge is levied?**

6.3. Freight prices

During the 2008 periodic review, freight operators decided that they did not want to move to these arrangements, therefore they still pay modelled electricity prices which are rebased each year based on the MLUI.

We are keen for all freight operators to move to similar pricing arrangement to those of passenger operators from the start of CP5. This would have the benefit of billing consistency. But also, more importantly; this approach would be far more accurate as it would reflect price differences across geography and time.

Given the recent developments during CP4 of on-train metering, there has been the requirement to review various aspects of the EC4T charging framework. In May 2012, the EC4T Metering Rules were amended to reflect the rules for freight operators, should they wish to opt-in for on-train metering. It was agreed that, should freight operators wish to opt-in for on-train metering; their prices for metered usage will be based on Network Rail's actual costs, to be consistent with passenger pricing arrangements. This would also mean that freight operators would be included in the cost wash-up arrangements. During this consultation, DB Schenker, Freightliner and ORR expressed their support for this approach. We are now keen to roll this approach out further to both modelled and metered traction electricity charges for freight operators in CP5.

(S)	**Do you support our proposal for all freight traction electricity charges to be based on actual electricity costs faced by Network Rail from the start of CP5?**

7. CONTRACTUAL FRAMEWORK

Traction electricity charges, like all the other track access charges, are governed by the contractual provisions for them which are set out in schedule 7 of the model passenger and freight track access agreements. In June 2011, the EC4T Metering Rules[23] were created. This document forms a multilateral agreement between train operators and Network Rail, and sets out arrangements for the following:

- Handling missing metered data;
- provisions for metering audits;
- publication of missing metered data;
- provisions for changes to the EC4T Metering Rules;
- provisions for the transitional risk sharing mechanism (expires at the end of CP4);
- template look-up tables;
- power factor correction factors;
- losses mark-ups; and
- meter tolerance factors.

The periodic review provides an opportunity to make changes to the track access agreements to reflect policy changes, but also to clarify, or ‘tidy-up’ unclear or redundant drafting.

The contractual provisions for traction electricity charges are very complex. This is mainly because of the wash-up provisions, which form a multi-lateral agreement between all electric train operators. The introduction of on-train metering and the exit of metered operators from the volume wash-up further complicated these arrangements.

This section of the consultation discusses options for amending or clarifying these provisions, where appropriate, so that they are fit for purpose. It will not set out specific legal drafting amendments. We do, however, expect it to form part of ORR’s more detailed consultation on Schedule 7 in 2013.

7.1. EC4T Metering Rules transfer to new Traction electricity rules

As mentioned above, the current EC4T Metering Rules set out the provisions for the use of metered data. However, we consider that there would be merit in widening the use of these rules to include the provisions set out in Table 10. We think that this wider document should be renamed the traction electricity rules.

[23] EC4T Metering Rules are accessible here: http://www.networkrail.co.uk/WorkArea/DownloadAsset.aspx?id=30064781316

Table 10: suggested changes to contractual provisions

Provision	Current location	New location	Additional
Volume reconciliation (volume wash-up)	Schedule 7	Traction electricity rules	These provisions should be brought in line with the new formulae set out in the schedule 7s of metered operators. This could also include provisions for Network Rail's non-traction use of traction power.
Cost reconciliation (cost wash-up	Schedule 7	Traction electricity rules	We would also like ORR and the industry to consider the 'tidying-up' of these provisions so that they are specific to each operator instead of the general application that applies now.
ESTAs definitions	Schedule 7	Traction electricity rules	This will allow ESTA boundary changes to be transparent, and provide flexibility for their movement as and when electrical feeding arrangements are changed.
Audit of regenerative braking systems	n/a	Traction electricity rules	This will allow us the opportunity to verify that where operators are claiming a regenerative braking discount, they are using the functionality correctly.

We propose that the new traction electricity rules document should include all of the provisions currently contained in the EC4T Metering Rules, plus the provisions listed in Table 8. This would mean that all modelled and metered traction electricity charging provisions will be contained in the new traction electricity rules document, and no longer in the Schedule 7 to the model track access agreement. We expect for the TRSM provisions to be removed for the start of CP5.

Naturally, moving provisions from the track access agreement to the traction electricity rules will mean corresponding amendments to model drafting in the passenger and freight schedule 7s.

(T) Do you support the reform of the EC4T Metering Rules to be widened and renamed the traction electricity rules?

(U) Are there any other areas which you consider should be included in the new traction electricity rules document?

7.2. Cost wash-up

The cost wash-up is designed to ensure that we remain financially neutral in terms of the costs we incur for supplying EC4T. This is done by reconciling the total actual cost of EC4T with the total billed cost to franchised passenger operators through the year[24]. Currently, as set out in the track access agreement (TAA), this difference is 'jam-

[24] As discussed earlier, currently freight operators do not participate in the cost wash-up

spread' across all franchised passenger operators in proportion to their post volume wash-up consumption. This approach presents two areas of concern:

The first issue is that transmission and distribution costs (typically of the order of £34million annually) vary across the country. Under the current model TAA drafting, any variation in these costs from the estimated costs are spread across all franchised passenger operators nationally in proportion to consumption. In order to be truly cost-reflective these costs ought to be washed up at a regional (ESTA) level to reflect the geographic variations.

Secondly, where one or more train operators have set prices for EC4T directly i.e. where prices for EC4T differ across train operators, the current drafting could lead to perverse cost wash up outcomes.

We have agreed a methodology for direct price setting with franchised passenger operators via ATOC. Under this methodology, in advance of the financial year in question, each train operator is allocated a percentage of the total contract consumption for which it can set the price. Under this methodology, if the year-end out-turn consumption is less than the allocation there would be no cost wash-up adjustment[25]. If the out-turn consumption is more than the allocation then the excess would be charged at a residual rate, which is a weighted average of the prices set by other franchised passenger operators. However, this methodology can only be applied if the model TAA is modified. Under the current drafting a train operator will face an additional cost wash-up adjustment (potentially positive or negative) regardless of whether it under- or over-consumes relative to its forecast share of volume.

To correct this issue we suggest that the cost wash-up drafting is amended:

(a) So that it is applied at ESTA level; and

(b) so that it reflects prices set by individual train operators.

Additionally, we consider that the drafting should be moved from the model track access agreements to the new traction electricity rules document. This will allow flexibility to amend the drafting more easily during control periods.

(V) Do you support the modification of the cost wash-up drafting to allow it to be more accurate and reflect direct price-setting arrangements?

[25] Albeit there may remain an S2 adjustment in relation to changes in transmission and distribution costs

8. ELECTRIFICATION ASSET USAGE CHARGE

8.1. Background

Our electrification assets are comprised of the AC and DC overhead lines and the DC conductor rail systems supported by their relevant distribution assets. These assets are used by trains to draw power from our electricity network into their traction packages. The electrification asset usage (EAU) charge is designed to recover the variable maintenance and renewal costs associated with electrification assets.

In 2010/11 we received £8million in EAU charges income, this represents 0.1% of our c.£6billion revenue requirement.

8.2. CP4 charges

Currently the charge is levied as a mark-up to the variable usage charge. The CP4 rates are:

Table 11: CP4 electrification asset usage charge (uplifted to 2011/12 prices)

Passenger		Freight	
DC (third rail) network (pence per electrified vehicle mile)	**OLE (AC) network (pence per electrified vehicle mile)**	**DC (third rail) network (£/kgtm)**	**OLE (AC) network (£/kgtm)**
0.45	1.18	0.0597	0.1120

Source: Network Rail, CP4 Charges – Track usage price list for CP4 www.networkrail.co.uk

As part of the 2008 periodic review (PR08), it was agreed that the EAU charge should be levied as a mark-up on the variable usage charge rather than a mark-up on the traction electricity charge (as was the case in CP3), reflecting the fact that costs are more closely related to vehicle miles than electricity consumption. It was also agreed that the CP4 charge should not recover costs associated with AC distribution systems (as was the case in CP3) because these renewals are driven by natural degradation such as weather and ageing, rather than traffic. This change was implemented.

The cost estimates for CP4 were calculated using a combination of our infrastructure cost model (ICM) and engineering judgement. The cost and variability assumptions for the CP4 charges were:

Table 12: CP4 variability assumptions (2011/12 prices and CP4 efficiency)

Activity	CP4 average cost (£million)	Variability (%)	Variable cost (£million)
OLE renewals	13.7	40%	5.5
OLE maintenance	21.9	10%	2.2
Conductor rail renewal	5.5	40%	2.2
Total			**9.8**[26]

[26] The total does not sum due to rounding

8.3. Initial cost estimates for CP5 charges

We have used broadly the same methodology as in CP4 to arrive at our initial CP5 cost estimates. We have, however, adopted a more detailed approach to assessing each cost category. We have also based our cost estimates on long-run (35 years) average costs, consistent with the approach used for the variable usage charge (VUC).

Table 13: CP5 initial estimate (2011/12 prices and CP4 efficiency)

	Activity	CP5 – CP11 average cost (£million)	Variability (%)	Variable cost (£million)
AC	Contact wire renewal	0.3	72%	0.2
	Mid-life refurbishment renewal	28.2	42%	11.9
	Component change renewal	1.9	10%	0.2
	OLE maintenance	25	12%	3
DC	Conductor rail renewal	9.1	54%	4.9
	Transformer/rectifier renewal	2.8	4%	0.1
	Electrical traction equipment maintenance	4.7	21%	1
	Total			**21.3**

Our emerging analysis indicates a significant increase in electrification asset usage costs for both the AC and DC systems. The reasons for this are set out below.

8.4. AC electrification asset usage costs

For the AC system, the costs have increased from approximately £8million to approximately £15million per annum. There are two key drivers for this increase:

- We are proposing to adopt a long-run average approach to estimating costs, moving from a 5-year (as used in CP4) to a 35-year horizon which has the advantage of smoothing out 'lumpy' renewal costs that would otherwise occur due to the age / condition profile of the overhead line equipment assets.
- The cost of the renewal activities has increased. This is due to higher unit cost rates, for example, due to higher metal prices.

Contact wire renewal

This is a stand alone renewal of the contact wire and associated components. Contact wire degrades due to the following factors:

- number of pantograph passages;
- contact force between pantograph and contact wire;
- train speed;
- traction current being drawn by the train;
- collector strip material; and

- contact wire material.

We consider that, a wear rate of 1mm^2 per 100,000 pantograph passages is a reasonable rate to be used for predicting contact wire lifetime[27]. This is supported by our own internal analysis which has also found a relationship between the number of pantograph passages and conductor wear.

We consider that the renewal costs of contact wire is 80% variable. This is based on the very strong link between an increase in traffic (pantographs) and asset degradation. If traffic increases we expect increased conductor wear, increased hard spots and increased faults which would lead to the need to renew the contact wire earlier. Factors other than pantograph passages also affect wear and tear and as such the variability is proposed at 90%.

Therefore we consider the total variability to be 72% for contact wire renewals (i.e. 80% x 90%).

Mid-life refurbishment renewal

Mid-life refurbishment of the overhead line equipment (OLE) system includes combinations of renewal of contact and catenary wires, droppers and jumpers, insulators and registration equipment. All of these components degrade, to varying degrees, as a direct result of traffic movements causing electrical and mechanical stresses on the components. We have identified a first generation of degradation relationships where the category of line affects the rate of change of the condition of the OLE system asset.

A significant proportion of the scope of works for a mid-life refurbishment is traffic related. It is estimated that, on average across the different refurbishment activities, 60% of the activity is affected by traffic. Of this, like contact wire, a large percentage of the cost varies with traffic – this has been estimated to be 70%.

Therefore we consider the total variability to be 42% for mid-life refurbishment renewals (i.e. 60% x 70%).

Component change renewal

The scope of this activity includes renewal of assets such as neutral sections, section insulators and other key OLE components. These are degraded, in part, by pan passages – most notably sectioning devices.

There are a number of other factors, such as obsolescence, that are impacting the renewal activities in this category, as such it is estimated that 25% of the activity is affected by traffic. Of this, it has been estimated that 40% of the cost varies. Therefore, we consider the total variability to be 10% for component change renewals (i.e. 25% x 40%).

[27] F Kieβling, R Puschmann and A Schmieder, Siemens (2001) 'Contact Lines for Electric Railways' 504-507.

OLE maintenance

Our electrical power asset policy[28] describes the degradation mechanisms for OLE systems. Utilisation is a key factor of degradation – as pantograph passages increase there is an increase in contact wear and frequency of contact forces on the OLE wire assets. This will cause additional mechanical and electrical fatigue which can contribute to the speed at which defects emerge on the system.

These defects are managed by reactive maintenance or as part of planned maintenance activities where access times allow. Our risk-based studies identified the need for a different inspection and maintenance regime based on two key parameters – pantograph passages and line speed. It follows then that as traffic increases OLE maintenance will increase both for planned and reactive activities. This is supported by the output from the OLE MACRO project which sets differentiated maintenance interventions for different categories of line to mitigate the impacts of usage on degradation. The output of the OLE MACRO project is summarised in NR/L2/ELP/21087[29].

The majority of OLE maintenance costs (inspections, intrusive maintenance and reactive works) are sensitive to traffic variations. This has been estimated as 80%, of this we estimate some 15% varies due to traffic. This is made up of 5% that is related to pan passage increases and the impact on planned maintenance works and 10% related to reactive works. The former has been assessed by looking at the impact of change of pantograph passages on the OLE line category and therefore maintenance costs while the latter has been assessed by considering the wire run reactive works cost percentages compared to the overall maintenance budget. Therefore, we consider the total variability to be 12% for OLE maintenance (i.e. 80% x 15%).

8.5. DC electrification asset usage costs

On the DC system, the costs have increased from approximately £2million to approximately £6million per annum. The key drivers of this increase are a material increase in unit cost rates and increasing renewal volumes due to asset age / condition peak. We are also proposing a higher variability assumption for conductor rail renewal (54% versus 40%) and the inclusion of DC maintenance costs.

Conductor rail renewal

The wear of conductor rail by collector shoes on electric trains is the primary cause of degradation for conductor rail. As a result of increased traffic volumes the wear rate will accelerate, which results in the need for earlier replacement of conductor rail. Factors which explain conductor rail degradation include:

- load creep (increase electrical loads and traffic volumes);
- wear / erosion (due to current collector shoes); and

[28] Network Rail (June 2011), 'Asset management policy for electrical power assets' section 5.2.1.

[29] OLE Line Categories are derived using a combination of line-speed and the number of pantograph passage which is described in more detail in Network Rail company standard NR/L2/ELP/21087 - Network Rail (March 2011), 'Specification of maintenance frequency and defect prioritisation of 25 kV overhead line electrification equipment'

- corrosion.

The 'web' of the conductor rail corrodes due to environmental conditions while the head of the rail degrades due to the passage of trains. There is a first generation linear degradation rate for conductor rail which varies by type of conductor rail from 0.27% per year through to 0.97% per year and these rates will increase linearly in proportion to traffic increases.

The scope of works for conductor rail renewal activity includes elements that are not directly affected by traffic, like, for example guard boards and insulators. As a result, we consider that the renewal activity affected by traffic is 60%, of which the element that varies due to traffic is considered to be 90%. Therefore, we consider the total variability to be 54% for conductor rail renewals (i.e. 60% x 90%).

Transformers / rectifier renewal

Our electrical power asset policy[30] describes how transformers degrade due, amongst other things, to loading / utilisation. Electrical power assets' useful or remaining life is affected by the utilisation / demands that are placed on them. As new electrical traffic is introduced, the assets work harder. Research has shown that there is a direct link between load (equated to transformer temperature) and remaining life such that remaining life doubles for every $6^{O}C$ below $98^{O}C$ i.e. the more load the less remaining life is available to the transformer. Transformer life is affected by load and there are standard models that cover this such as IEC 354-1991[31]. The IEC model requires a case-by-case assessment and detailed loading input data. In addition, traction rectifier transformers are subject to thermal stresses as a result of the high levels of fluctuating loads which further shorten remaining life.

It is estimated that 40% of the transformer renewal activity is affected by traffic but only a small percentage of the activity varies with organic growth. This is estimated at around 10%. Therefore we consider the total variability to be 4% for transformers / rectifiers renewals (i.e. 40% x 10%).

Electrical traction equipment maintenance

Our assessments of reactive costs for conductor rail, compared to the overall spend profile for electrical traction equipment maintenance is 40%. We consider the ratio of costs for activities that are sensitive to traffic increases against the overall expenditure for conductor rail reactive maintenance activities to be 52%. Therefore, we consider the total variability to be 21% for electrical traction equipment maintenance (i.e. 40% x 52%).

We are keen to hear your views on the variability assumptions and cost estimates we are proposing. We will be proposing EAU rates, based on this methodology, later this year.

[30] Network Rail (June 2011), 'Asset management policy for electrical power assets' section 5.4.2.

[31] British Standards Institution (1991), 'Guide to loading of oil-immersed power transformers'.

(W) Do you have any views on the cost activities we have included in our EAU cost estimates?

(X) Do you have any views on the variability assumption we have used in our EAU cost estimates?

(Y) Do you have any views on our proposal to use long-run cost estimates over 35 years instead of 5 years?

9. INDUSTRY ENGAGEMENT

Traction electricity charges (including the electrification asset usage charge) represent a significant cost for our customers. With many operators installing meters on their trains, the level of information and influence over this cost is increasing. This information has become a very valuable asset to the industry.

With franchised passenger operators usually able to retain any savings made as a result of moving to on-train metering, this charge receives notable engagement from the industry, which we welcome.

We understand the commercial implications that access charges have for our customers, and the complexities associated with the multi-lateral arrangements in place for annual wash-ups. For this reason, we are committed to working with the industry in developing a charging structure that is fully transparent, practicable to administer and accurately reflects the costs incurred, and that all parties to the multi-lateral arrangements are fully informed, and do not incur unreasonable levels of risk.

9.1. Our approach to industry engagement for PR13

We presented our latest thinking on traction electricity charges at the Traction Electricity Steering Group meeting on 5 March 2012, and on electrification asset usage charges on 24 July 2012.

However, we recognise that we need to continue our engagement with stakeholders to help ensure that the industry is fully informed on the progress being made in relation to both charges. Going forward, we will:

Table 14: milestones for the development of the EC4T and EAU charges

Date	Activity
September 2012	Seek views from stakeholders on the consultation questions and other issues presented in this consultation at the traction electricity steering group (TESG)
December 2012	Conclude on this consultation
March 2013	Submit draft modelled consumption rates, regenerative braking discounts and losses mark-ups / factors.

(Z) Do you have any views or suggestions about our approach to stakeholder engagement?

10. CONCLUSIONS

We consider that the traction electricity charging framework should be consistent with the following principles:

- Charges should, where possible, recover costs from those who cause them;
- be consistent with the charging objectives set by ORR;
- provide effective incentives for the efficient use of energy; and
- not be disproportionately complex.

As mentioned earlier, we strongly support initiatives to strengthen incentives for efficient energy use. We consider that a key enabler for this is full on-train metering across the electric network. Consistent with this, we have committed to meter as much of our own usage of traction electricity as is economically sensible to do.

A summary of our key proposals are:

- to retain current modelled consumption rates for CP5;
- to apply a separate losses factor to regenerated energy of 0.9899 (based on assumption that 1% of regenerated energy is lost) from the start of CP5 ;
- to retain a single losses mark-up for AC at 4.82% for CP5;
- not to geographically disaggregate the losses mark-up for AC;
- for freight to pay actual electricity prices for all usage from the start of CP5;
- to create a new set of rules called the traction electricity rules (to include all multilateral EC4T arrangements); and
- to use updated cost variability assumptions and use long-run average cost estimates for the electricity asset usage charge.

Areas in which we are keen to hear your thoughts and / or suggestions are:

- whether to apply a 10% uplift to modelled consumption rates to incentivise modelled operators to move to on-train metering;
- whether to remove existing regenerative braking discounts for modelled usage in CP5 or CP6, because of the conditional use of the functionality which means operators may be under-billed;
- whether to revisit the regenerative braking losses factor during CP5, albeit capped so the losses estimate rises from 1% to no more than 2.5%; and
- whether to have the option to revisit the losses mark-up in light of new information during CP5.

In conclusion, we consider the proposals made in this document represent a sensible way forward for the traction electricity charging framework in CP5. We believe that they are true to the principles set out above. We are keen to hear your thoughts on our proposals.

As discussed above, there are a number of areas where we have not made firm proposals. However, we are interested to understand what your thoughts and / or suggestions may be for dealing with these particular issues.

10.1. Responding to this consultation

This document sets out a number of specific consultation questions, which are summarised in Appendix A. We would welcome responses to these questions, as well as comments on any other aspect of the traction electricity charges work programme as part of PR13. The closing date for this consultation is **Friday 12 October 2012**. This provides just under six weeks for consultation.

We intend to make responses public, including sharing them with ORR and publishing them on our website. Please indicate if you wish all or part of your response to remain confidential.

Please address any responses and / or queries to:

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This consultation can also be downloaded from our website here: http://www.networkrail.co.uk/PeriodicReview2013.aspx.

APPENDIX A – CONSULTATION QUESTIONS

A list of the consultation questions is set out below:

(A) Do you agree with our proposal to leave all modelled passenger and freight EC4T consumption rates unchanged for CP5?

(B) Do you have any other suggestions to make about modelled consumption rates in CP5?

(C) Do you agree that it is appropriate to continue using the current uplift factors for electric multiple units?

(D) Do you agree that it is suitable to continue using the agreed methodology for calculating new modelled EC4T consumption rates, during CP5?

(E) Do you have any views on our suggestion to uplift modelled consumption rates by 10%, consistent with the surcharge applied for missing metered data?

(F) Do you have any views on the use of the proceeds from an uplift to modelled consumption rates?

(G) Do you have any views on applying the uplift to modelled consumption rates to new vehicles only?

(H) Do you have any views on whether regenerative braking discounts for modelled usage should remain in CP5 or CP6?

(I) Do you have any views regarding provisions to allow us to verify that regenerative braking is being used correctly?

(J) Do you agree with our proposal to apply a regenerative braking losses factor of 0.9899 (based on losses estimate of 1%) to metered AC regenerated energy?

(K) Do you have any views on reopening the regenerative braking losses factor for AC after two years during CP5 to reflect emerging information, capped at no less than 0.9744 (losses estimate of 2.5%)?

(L) Do you have any views on the other options for charging for metered regenerated energy?

(M) Do you support the work that we have carried out to quantify AC system losses?

(N) Do you support further validation of the 4.82% likely to be proposed for CP5?

(O) Do you have any views on reopening the losses mark-up after two years during CP5 to reflect emerging information?

(P) Do you have any views on not geographically disaggregating the AC losses mark-up?

(Q) Do you have any comments on the AC losses report published alongside this consultation?

(R) Do you support our proposal to adjust the way the EC4T delivery charge is levied?

(S) Do you support our proposal for all freight traction electricity charges to be based on actual electricity costs faced by Network Rail from the start of CP5?

(T) Do you support the reform of the EC4T Metering Rules to be widened and renamed the traction electricity rules?

(U) Are there any other areas which you consider should be included in the new traction electricity rules document?

(V) Do you support the modification of the cost wash-up drafting to allow it to be more accurate and reflect direct price-setting arrangements?

(W) Do you have any views on the cost activities we have included in our EAU cost estimates?

(X) Do you have any views on the variability assumption we have used in our EAU cost estimates?

(Y) Do you have any views on our proposal to use long-run cost estimates over 35 years instead of 5 years?

(Z) Do you have any views or suggestions about our approach to stakeholder engagement?

APPENDIX B – ACRONYMS AND ABBREVIATIONS

AC	Alternating current
ATOC	Association of train operating companies
CoP	Code of practice
CP4	Control period 4 (1 April 2009 – 31 March 2014)
CP5	Control period 5 (1 April 2014 – 31 March 2019)
CP6	Control period 6 (1 April 2019 – 31 March 2024)
CP11	Control period 11 (1 April 2044 – 31 March 2049)
DC	Direct current
DfT	Department for transport
EAU	Electrification asset usage
ECML	East coast main line
EC4T	Electric current for traction
EMU	Electric multiple unit
EN	European norm
ESTA	Electricity supply tariff area
GSP	Grid supply point
IEP	Intercity express programme
ICM	Infrastructure cost model
I^2R	$Current^2$ x resistance
KGTM	Thousand gross tonne miles
KGTKM	Thousand gross tonne kilometres
kVA	Kilovolt ampere
kWh	Kilowatt hour
MLUI	Moderately large users' index
MVA	Megavolt ampere
MWh	Megawatt hour
OLE	Overhead line electrification equipment
ORR	Office of rail regulation
PR08	Periodic Review 2008
PR13	Periodic Review 2013
TAA	Track access agreement
TESG	Traction electricity steering group
TOC	Train operating company
TRSM	Transitional risk sharing mechanism
STK	Single track kilometres
VUC	Variable usage charge