

Date: 24 February 2016

Item: International Benchmarking Report

This paper will be considered in public

1 Summary

- 1.1 This paper presents London Underground (LU) and Docklands Light Railway's (DLR) performance on a range of metrics in comparison with other metros who are members of the metro benchmarking groups CoMET (the Community of Metros) and Nova (Nova Group of Metros).
- 1.2 The analysis is attached at Appendix 1.
- 1.3 The Panel is asked to note the significant improving trends LU and DLR are making on key performance indicators for international metro benchmarking, particularly in covering operating costs, reducing maintenance unit costs and improving service reliability. LU and DLR are the highest performing Western European metros in terms of operating cost recovery trends.

2 Recommendation

- 2.1 **The Panel is asked to note the paper.**

3 Key messages

- 3.1 Over the last five years, LU and DLR have both improved at a faster rate than the average of all metros for the majority of lead metrics. They have also improved more rapidly than the average of other Western European and North American metros in the time period 2009/10 to 2014/15. This has been achieved through significant focus across the business on systematically improving reliability, driving down costs via the efficiency programme, whilst ensuring the highest levels of safety for our customers and staff.
- 3.2 **Operating cost recovery** – This is the fourth consecutive year that LU has covered operating costs from revenues, and the second consecutive year for DLR. DLR outperforms LU here due to its lower cost base. The faster pace of change for DLR reflects the introduction of the third car to trains, which has allowed ridership to increase very significantly for a similar operating cost. DLR's trend is undergoing one of the most significant improvements since 2009/10 at 40 per cent, whereas the average improvement across all other metros was two per cent.
- 3.3 **Total operating costs per car km** – LU and DLR have improved significantly, by 12 per cent and 29 per cent respectively, against an improvement rate of all other metros of just one per cent since 2009/10. DLR continues to reap the efficiency

benefits of the three car train deployment showing a general downward trend. LU has made significant progress in reducing its cost base since 2008/09 and Rail and Underground has an extensive efficiency programme in place with £1.95bn net operating cost reductions secured for the period 2015/16 to 2020/21.

- 3.4 **Maintenance costs per car km** – DLR’s maintenance unit costs are below the average of other metros and have improved significantly with the addition of the third car to trains. LU’s maintenance unit costs have decreased significantly and continuously, achieving a 15 per cent reduction since 2009/10. LU’s rolling stock maintenance cost per car km is also lower than average.
- 3.5 **Labour productivity per car km** – DLR is the third best metro in CoMET and Nova. LU has had an improving trend since 2009/10, mainly thanks to line modernisations and their consequent increases on frequencies. Continued investment in new technology and associated process improvements is further improving LU’s productivity.
- 3.6 **Reliability** – Since 2009/10, LU and DLR have been amongst the fastest improving metros in terms of reliability with 61 per cent and 186 per cent improvement respectively. The modernisation of the Victoria and Jubilee lines has enabled reliability improvements of 169 per cent and 156 per cent respectively on these lines since 2009/10, highlighting the value of these enhancements to customers. Currently, LU and DLR are similarly reliable and both perform better than the average North American and Western European metro. Equipment reliability has improved significantly for LU and DLR and this is expected to improve further as their networks are modernised.
- 3.7 **Environment** – Since 2009/10 LU and DLR have reduced CO₂ emissions per passenger km by 22 per cent and 17 per cent respectively, largely as a result of capacity increase and improvements to regenerative braking technologies. LU and DLR are the most energy efficient metros in consumption per car km and continue to embed sustainability considerations across processes and activities.
- 3.8 **Safety** – DLR’s staff safety has improved by 13 per cent since 2009/10 and is at a similar level than the average of Western European and North American metros. LU has improved by one per cent and remains 58 per cent better than the average of this peer group. LU and DLR also perform significantly better than average for customer safety related to accidents or illegal activity. In 2014/15 LU improved by three per cent and DLR again had no fatalities.

List of appendices to this report:

Appendix 1: International Metro Benchmarking – Final Report

List of Background Papers:

None

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International Metro Benchmarking

Final Report



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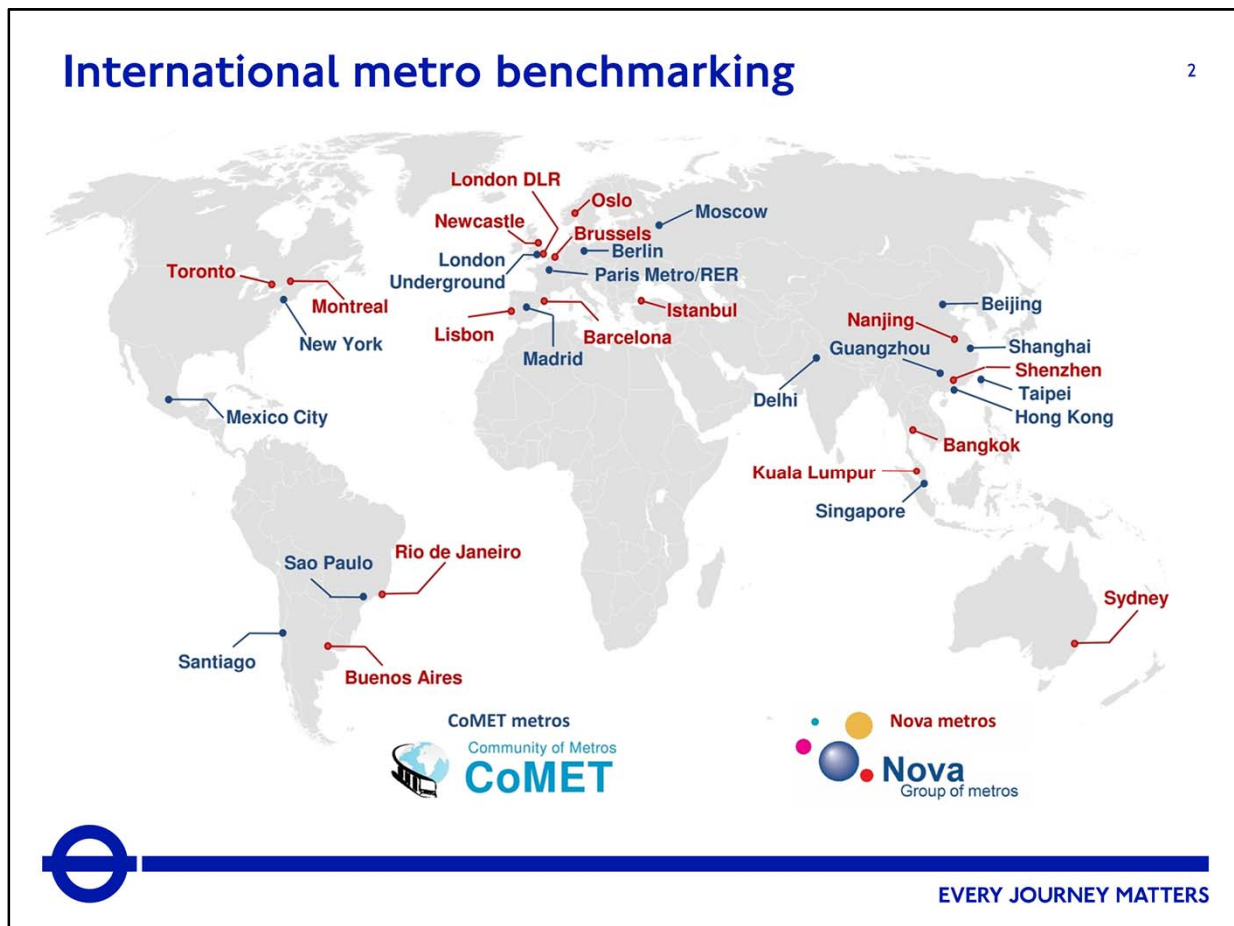
This report presents London Underground (LU) and Docklands Light Railway's (DLR) performance on a range of metrics in comparison with other metros who are members of the metro benchmarking groups CoMET (the Community of Metros) and Nova (Nova Group of Metros) over the last years. Performance is presented against eight key areas:

- Operating cost recovery ratio – a measure of the level of Government subsidy required by metros to cover the cost of operations;
- Total operating cost per car km – a measure of cost efficiency;
- Maintenance cost per car km – a measure of cost efficiency;
- Car km per total staff and contractor hours – a measure of labour productivity;
- Car km between incidents causing more than five minutes delay – a measure of reliability;
- Grams of CO₂ per million passenger km – a measure of environmental performance;
- Total energy consumption per car km – a measure of environmental performance; and
- Staff and customer safety – staff hours lost to accidents, which is a measure of the productivity impact of safety, and fatalities due to accidents or illegal activity per billion passenger journeys, which is a measure of customer safety.

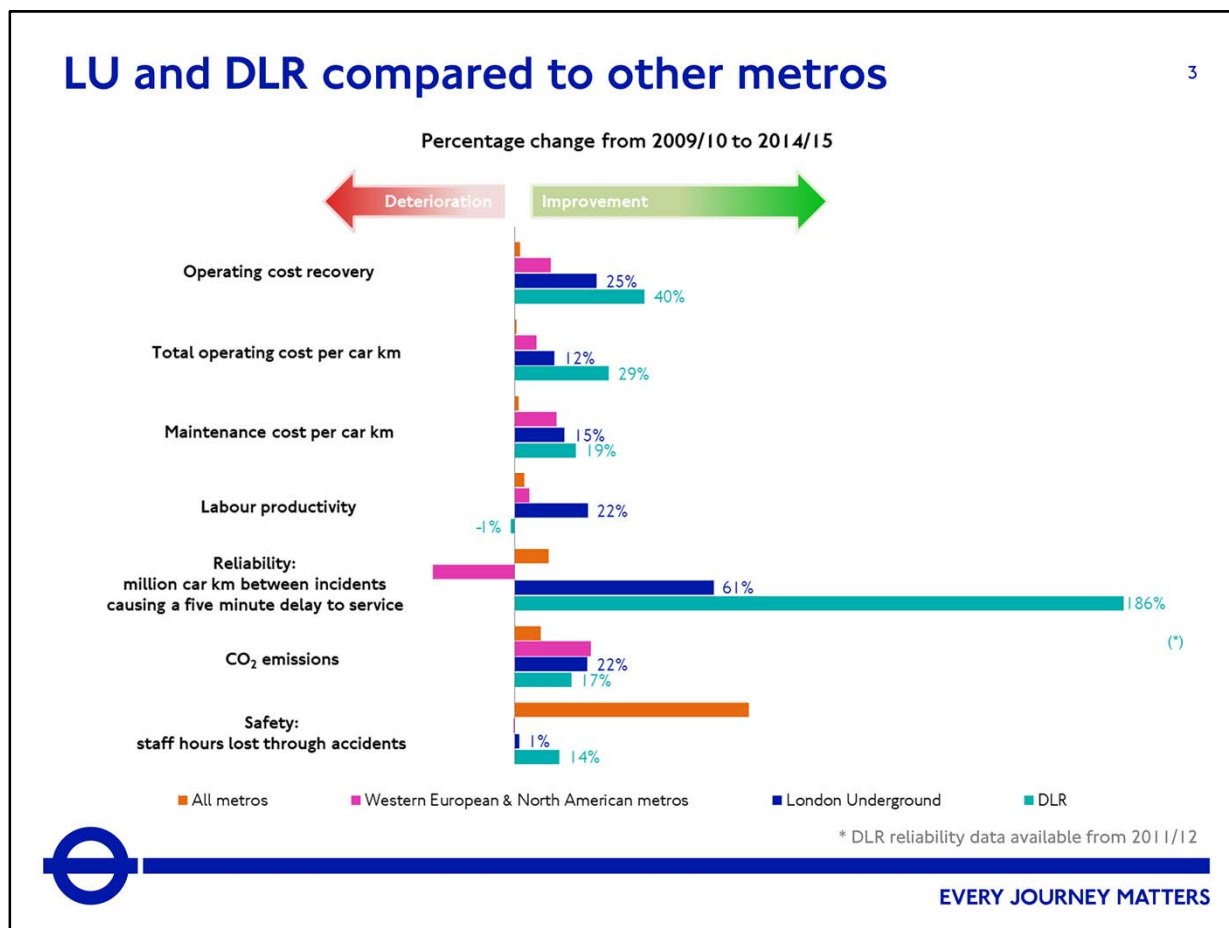
A high level explanation is provided as to why LU and DLR are performing relatively well or less well in specific areas, including contextual factors (for example, relative city wages or the impact of older assets).

The report also highlights the actions the business is taking to continuously improve its performance, learning from other metros internationally.

The information presented is a summary of the annual Key Performance Indicators (KPI) reported by the members of CoMET and Nova for the year 2014/15. The information is independently collated by Imperial College's Railway and Transport Strategy Centre.



- In 1994 the benchmarking consortium CoMET was formed, in which LU was a founding member. CoMET consists of 17 of the largest metros from around the world. The Nova Group of Metros was formed in 1998, following the success of CoMET. It is a group of 16 medium sized metros, in which DLR joined in 2013. The two groups work closely, with mutual sharing of data and best practices. In recent years several new metros have joined the CoMET and Nova groups, and the metros have improved their data collection processes, yielding a more mature, broader database.
- Before cost comparisons are undertaken, the cost data was normalised using Purchasing Power Parity (PPP) from the World Bank. The normalisation takes into account the different currencies and levels of purchasing power in each country, based upon a basket of comparable goods and services. It helps to minimize misleading international comparisons that can arise with the use of market exchange rates, since it equalises the purchasing power of different currencies, so that a unit of currency of one country will have the same purchasing power as another. However, it does not fully account for regional wage differences.
- One of the key principles of CoMET and Nova is that all activities are carried out within a framework of confidentiality, to ensure open and honest information exchange among the member metros. Any information that is released externally is therefore anonymized. Hence, when applicable the metro names have been replaced by codes according to their geographical location (“Am” for the Americas, “As” for Asia and “Eu” for Europe).
- A key benefit of LU’s and DLR’s membership of CoMET and Nova is access to diverse annually refreshed KPI data from member metros. This gives the opportunity to LU and DLR, which are unique in the UK, to make comparisons with international peers which yield valuable insight and support continual improvement.
- The process of preparing the International Report involves discussing aspects of performance with colleagues, who may not have encountered this international comparator data before. These discussions are useful to disseminate the benefits of LU’s and DLR’s membership of CoMET and Nova across the organisation, providing further impetus to improve performance.



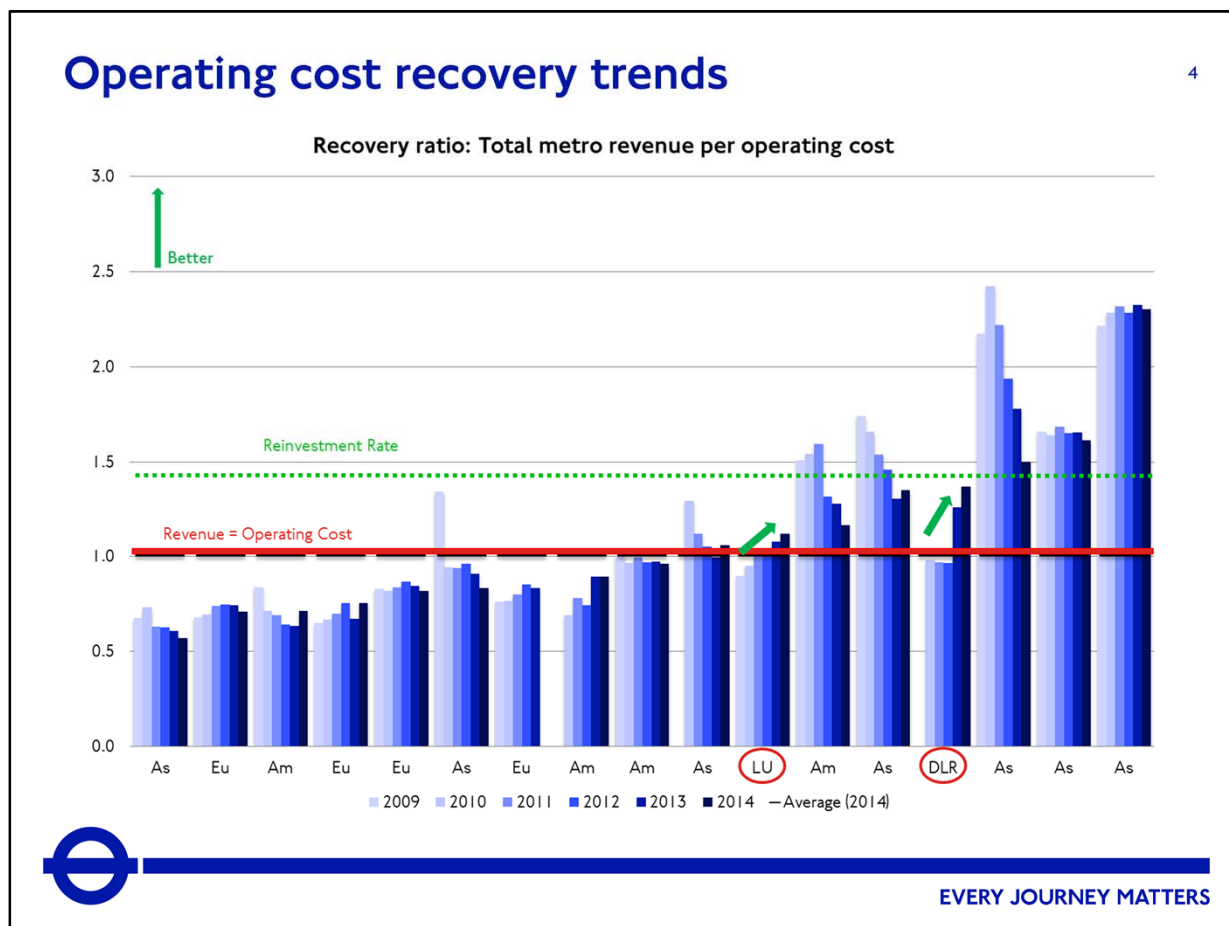
Over the last five years for the majority of lead metrics, LU and DLR have both made significant progress. Most of the times, they have improved at a faster rate than both average of all other metros and than the average of other Western European and North American metros.

DLR joined Nova in late 2013. Today's DLR is significantly different to the pre-2009 era with major expansion projects now operational; therefore its historical benchmarking data gathered starts from 2010/11. Hence, for comparability with LU and other metros this summary page presents the DLR changes from 2010/11 to 2014/15.

- **Operating cost recovery** – Total revenues for total operating cost. LU improved by 25% and DLR by 40% (on average, the other Western European and North American metros also improved by 11% and all metros improved by 2%).
- **Operating cost** – Total operating cost per car km (including service operations, maintenance, administration and other). LU improved by 12% and DLR by 29% (Western European and North American metros improved by 7% and all metros by 1%).
- **Maintenance cost** – Total maintenance cost per car km. LU improved by 15% and DLR by 19% (Western European and North American metros improved by 13% and all metros by 1%).
- **Labour productivity** – Car km per total staff and contractor hours. LU improved by 22%, while DLR deteriorated by 1% but remains third best in CoMET and Nova (Western European and North American metros improved by 5% and all metros by 3%).
- **Reliability** – Million car km between incidents causing a five-minute or more delay. LU improved by 61% and DLR by 186% (Western European and North American metros deteriorated by 25%, while all metros improved by 10%).
- **Environment** – Grams of CO₂ per million passenger km. LU improved by 22% and DLR by 17% (Western European and North American metros improved by 23% and all metros by 8%).
- **Safety** – Staff hours lost through accidents per thousand staff hours. LU improved by 1% and DLR by 14% (Western European and North American metros remained constant, while all metros improved by 71%).

Operating cost recovery trends

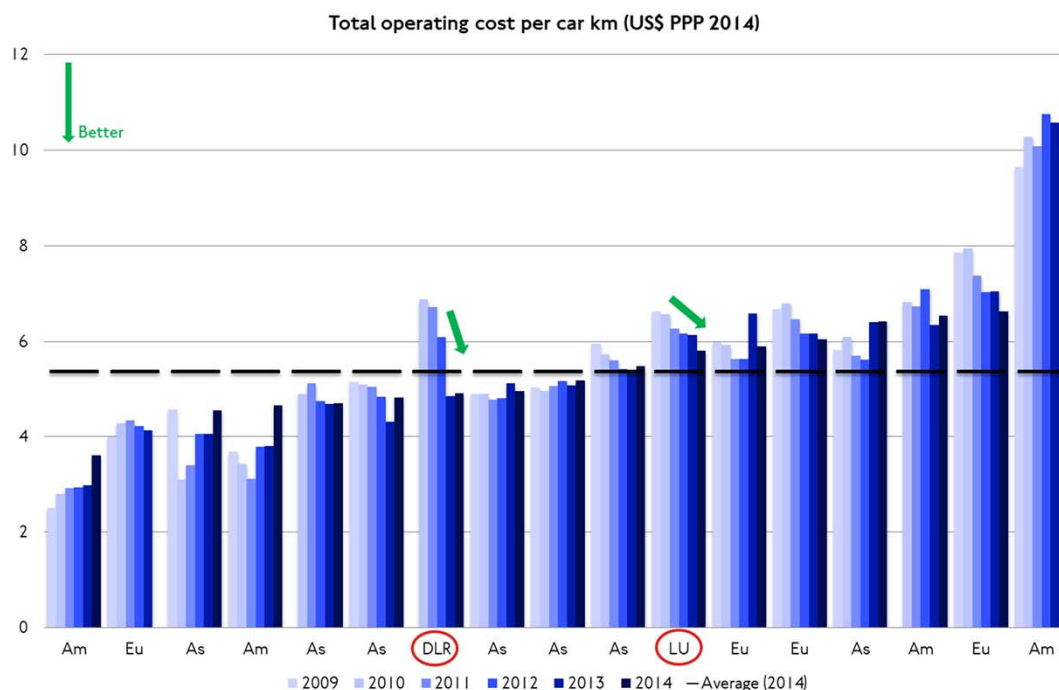
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- This graph indicates the operating cost recovery ratio of CoMET metros and DLR from 2009/10 to 2014/15. The ratio is the result of dividing total metro revenues by operating costs.
- This is the fourth consecutive year that LU's revenues have exceeded its operating costs, meaning that it has not needed government subsidy for non-capital operational activities. For DLR it is the second consecutive year that its revenues have exceeded its operating cost.
- Since 2009/10, LU has improved by 25% in this measure, while DLR has improved by 40% since 2010/11.
- For both metros, these improvements can be mainly attributed to increased ridership and non-fare revenues, such as advertising and retail.
- In 2014/15 LU's recovery ratio improved by 4%, whilst DLR improved by 9%.
- For DLR, bringing the responsibility for the development of advertising and retail opportunities in-house has contributed to increase non-fare revenues by 8%. In LU, these have increased also by 7% due to increased advertising and commercial property rent.
- For the remaining metros in CoMET, the average recovery ratio is 1.01. The current operating cost recovery ratios for LU and DLR are 1.12 and 1.37 respectively.
- Further improvement in operating cost would take both LU and DLR closer to the recovery ratio of 1.40, which is the level observed by Imperial College as the rate at which metros can, on average, also cover the cost of asset renewals. However, it is important to note that this is an indicative figure based on a diverse data set of metro investment levels over the past 20 years. It might not necessarily apply directly to metros where, for instance, there have been periods with a lack of reinvestment and the ensuing asset degradation.
- LU's fare revenues will continue to grow as a result of investments (mainly in rolling stock and signalling) to maximise capacity, as demand for services continues to rise. At the same time, LU continues the effort of achieving more cost reductions through various initiatives, such as improved contract terms, modernisation of maintenance regimes (moving towards a more predictive and preventative maintenance approach and taking advantage of major modernisation of lines and stations) and changes to station staffing models (Fit for the Future and Access Transformation programmes).
- Growth in DLR's fare revenue is expected to continue from further increase in ridership due to increasing urban density around the Docklands. Crossrail will alter the volume and profile of both LU and DLR's ridership when it starts operating in 2018/19.

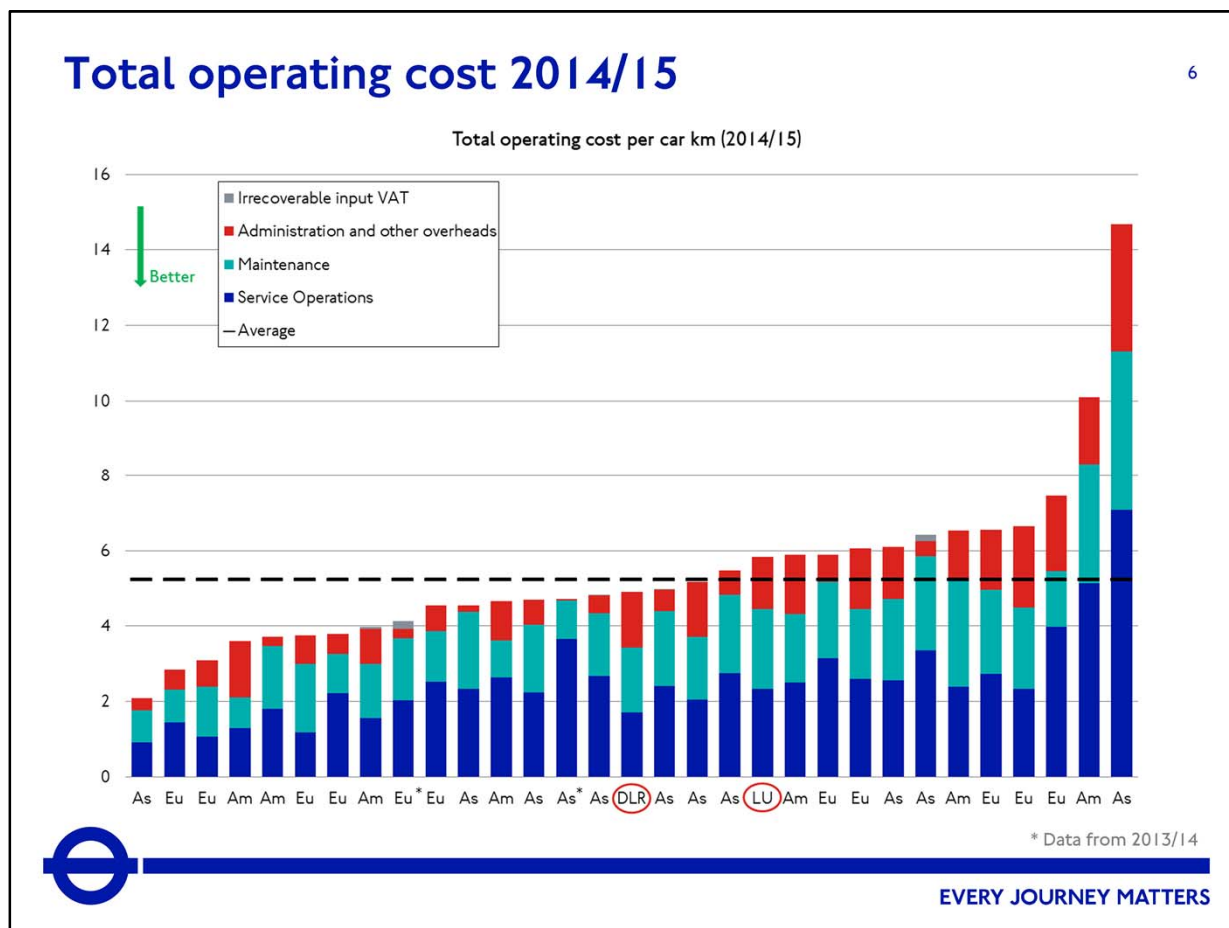
Total operating cost trends

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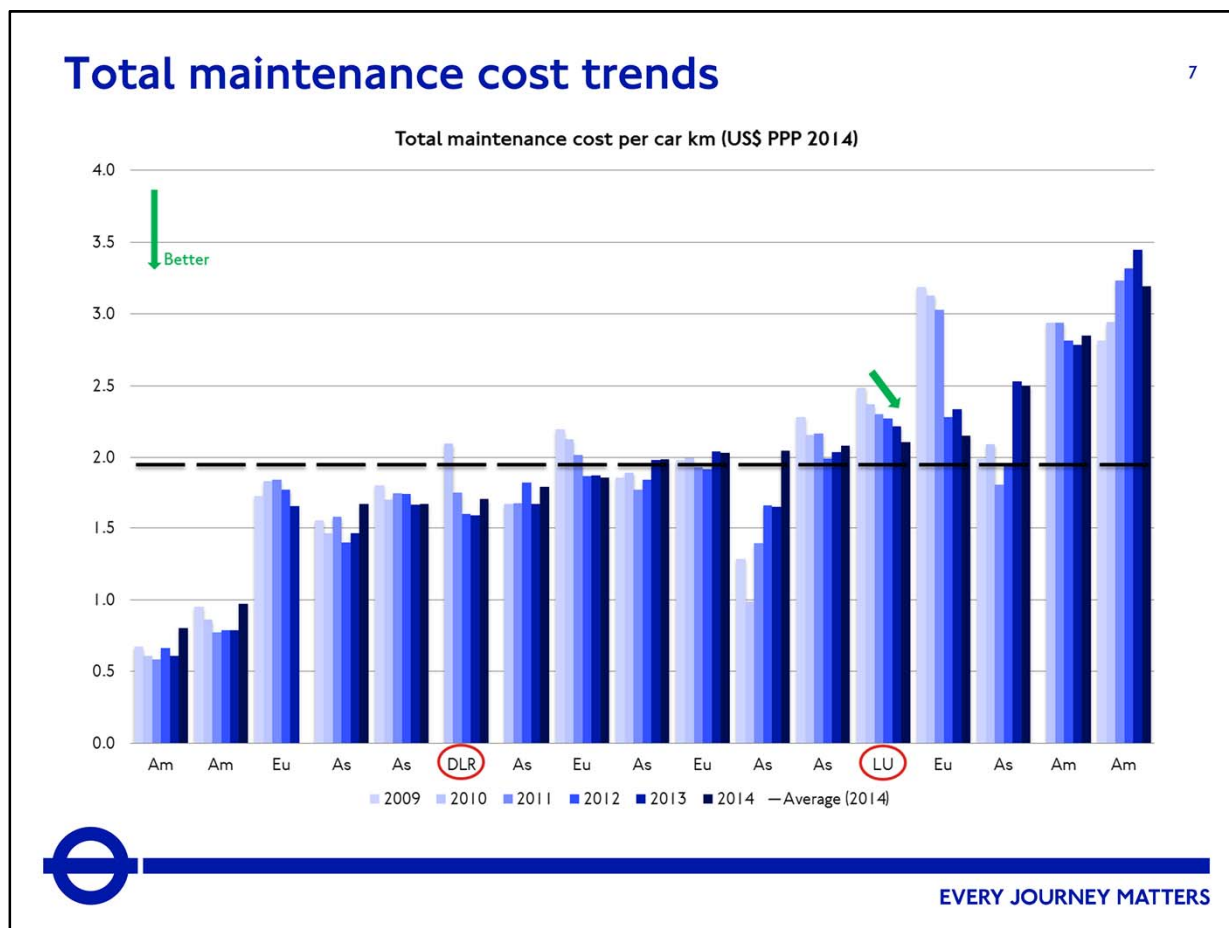


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- This chart shows the trend of operating cost per car km for the CoMET metros and DLR between 2009/10 and 2014/15. Operating cost includes the costs of service operation, maintenance, administration and other overheads. The costs of heavy renewals and capital investment are excluded.
- LU has reduced its operating cost per car km by 12% since 2009/10. It has accomplished this by delivering 17% more car km for only 3% more cost.
- Since 2010/11, DLR has improved in this metric by 29%, due to a 47% increase in car km for only 4.5% more cost. DLR continues to reap the efficiency of the three car deployment showing a consistent downward trend.
- In 2014/15, LU's operating unit cost improved by 5%, due to a 6% increase in car km, while increasing its cost by 0.12%. In order to keep up with growing passenger demand, service frequencies have increased thanks to line modernisations.
- DLR's operating unit cost increased by 1% in 2014/15. It provided 1% more car km through the introduction of a new base service plan, while its real cost increased by 2% mainly due to the resources required to deliver end of franchise obligations. The sharp reduction curve from 2011/12 to 2014/15 reflects moving back to normal operations after the resource intensive Olympics period.
- LU's unit cost remains 9% higher than the CoMET average, while DLR is 8% lower than average.
- LU has plans to keep delivering more for less, in line with the long term trend, as line upgrades deliver increased car km through longer and more frequent trains. In future, planned cost reductions across LU's operating cost, investment in technologies and improving works access will also enhance productivity. The Fit for the Future Stations programme will improve customer service whilst reducing costs. The Predict and Prevent programme will reduce maintenance frequency which will lead to lower maintenance cost and therefore lower operating cost.



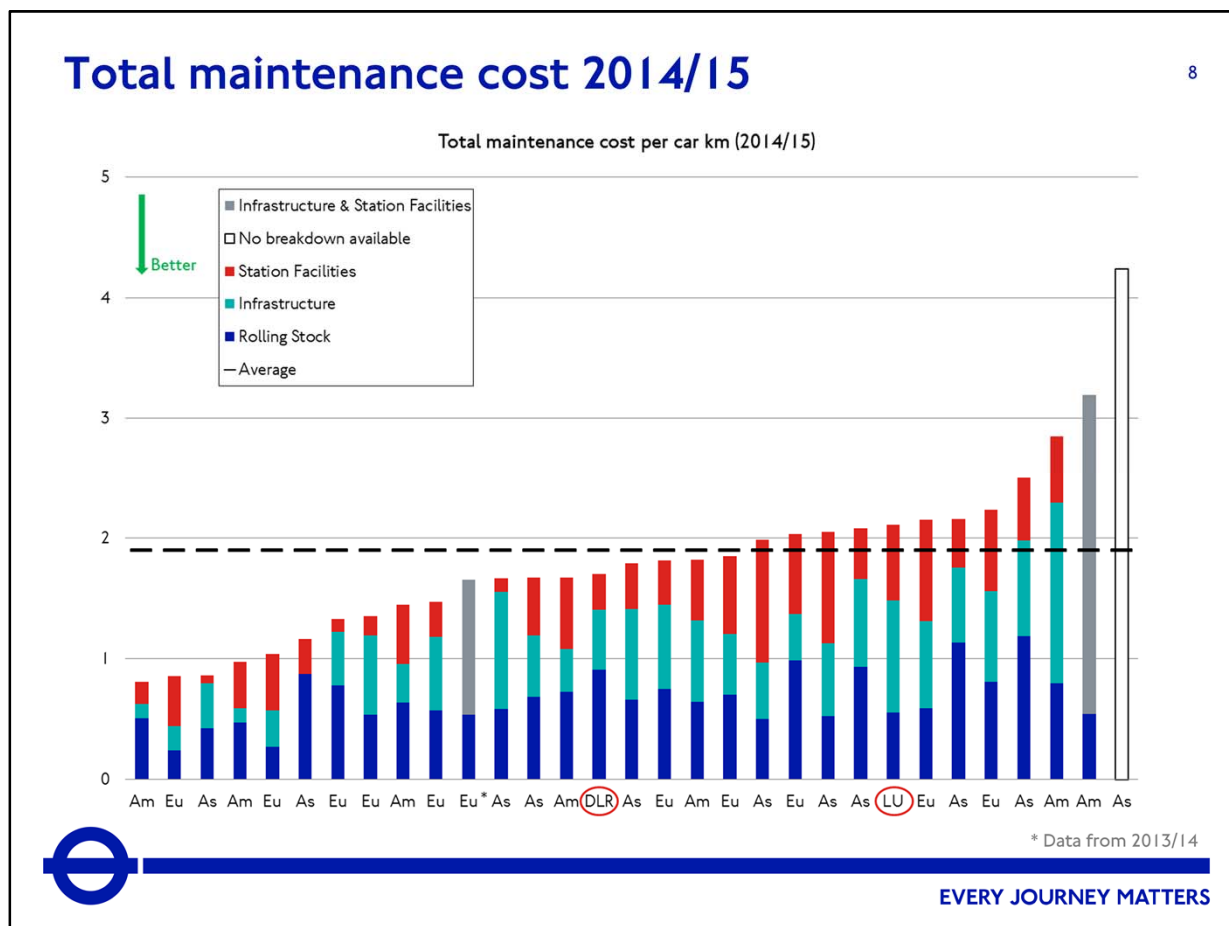
- This graph presents the breakdown of operating cost per car km in 2014/15 for all CoMET and Nova metros.
- Service operations and maintenance costs are the most significant operational expenses for both LU and DLR, as well as for the majority of CoMET and Nova metros.
- In 2014/15 LU's service operations cost per car km decreased by 2%. Its real cost increased by 3% due to additional recruitment (since more frequent services demand more operational staff) and higher electricity prices.
- In 2014/15 DLR's service operations unit cost reduced by 1% with its real cost decreasing by 0.3% as a result of a procurement saving in the new franchise for revenue protection, which is now provided by one supplier alongside cleaning services. DLR has a low staffing level, meaning that it keeps its service operations cost in particularly low levels.
- LU's maintenance unit cost decreased by 5%, whilst DLR's rose by 7% in 2014/15. A more detailed examination of maintenance unit cost is presented in the following pages.
- Both LU and DLR decreased their administration and other overheads unit cost by 11% and 2% respectively in 2014/15. Administration cost reduction of LU follows the integration of Tube Lines. DLR's improvement can be attributed mainly to efficiencies from the integration of some activities with TfL, such as commuter marketing.
- The outsourcing business model of DLR makes administration and other overheads costs higher, especially when compared to modern Asian metros. However, efficient operations, infrastructure and station facilities maintenance are achieved by using this model.
- Capital investment is also a driver of administration cost, as capital projects require for teams of people to plan and manage them. If we look at administration cost as a percentage of total cost of the metro (including capital investment), LU and DLR are only 7% and 18% higher than average of CoMET and Nova.
- The cost of administration and other overheads includes the cost of central services that are required to operate the metro. For example, LU and DLR's costs include the apportioned cost of pan-TfL services such as Human Resources and Information Management.



- This chart presents the maintenance unit cost per car km trends since 2009/10 for the CoMET metros and DLR. The measure used is maintenance cost per car km.
- Since 2009/10, LU's maintenance cost per car km has reduced by 15%. Over this period LU has followed the positive trend started in 2008/09, when TfL efficiency plans were drafted and Metronet was brought into TfL.
- DLR's maintenance cost per car km has decreased by 19% since 2010/11. The real maintenance cost has risen by 19%, but it is providing 47% more car km.
- In 2014/15, LU's maintenance unit cost reduced by 5%, continuing the improving trend from the previous years. Real maintenance cost increased by 1%. The increase of service frequencies had as a result higher track and signalling maintenance costs, and the accessibility improvements and station capacity upgrade programmes led to an increase in the number of lifts and escalators. However, this has been offset by offering 6% additional car km.
- DLR's maintenance unit cost increased by 7% in 2014/15, due to extra maintenance for the B92 fleet (which is reaching its end of life), an increased heavy exams schedule on the newer B2007 Stock and the costs of asset handback as part of the end of franchise obligations.
- LU's maintenance unit cost is 9% higher than the CoMET average. However, this cost has not been normalised for structural factors such as labour costs, asset condition and age. DLR's maintenance unit cost is 12% lower than the CoMET average.
- LU continues the effort to decrease its maintenance cost with various efficiency initiatives, such as the Predict and Prevent programme. Service affecting failures generally have non-service affecting pre-cursors. Identifying these pre-cursors gives the opportunity to detect abnormal asset behaviour and respond proactively, prior to the failure affecting passengers. As a result, maintenance activities will be transitioned from time-based to a more predictive regime, where repairs are only undertaken when necessary. Maintenance frequency will be reduced as a result, which leads to lower maintenance cost and therefore lower operating cost.

Total maintenance cost 2014/15

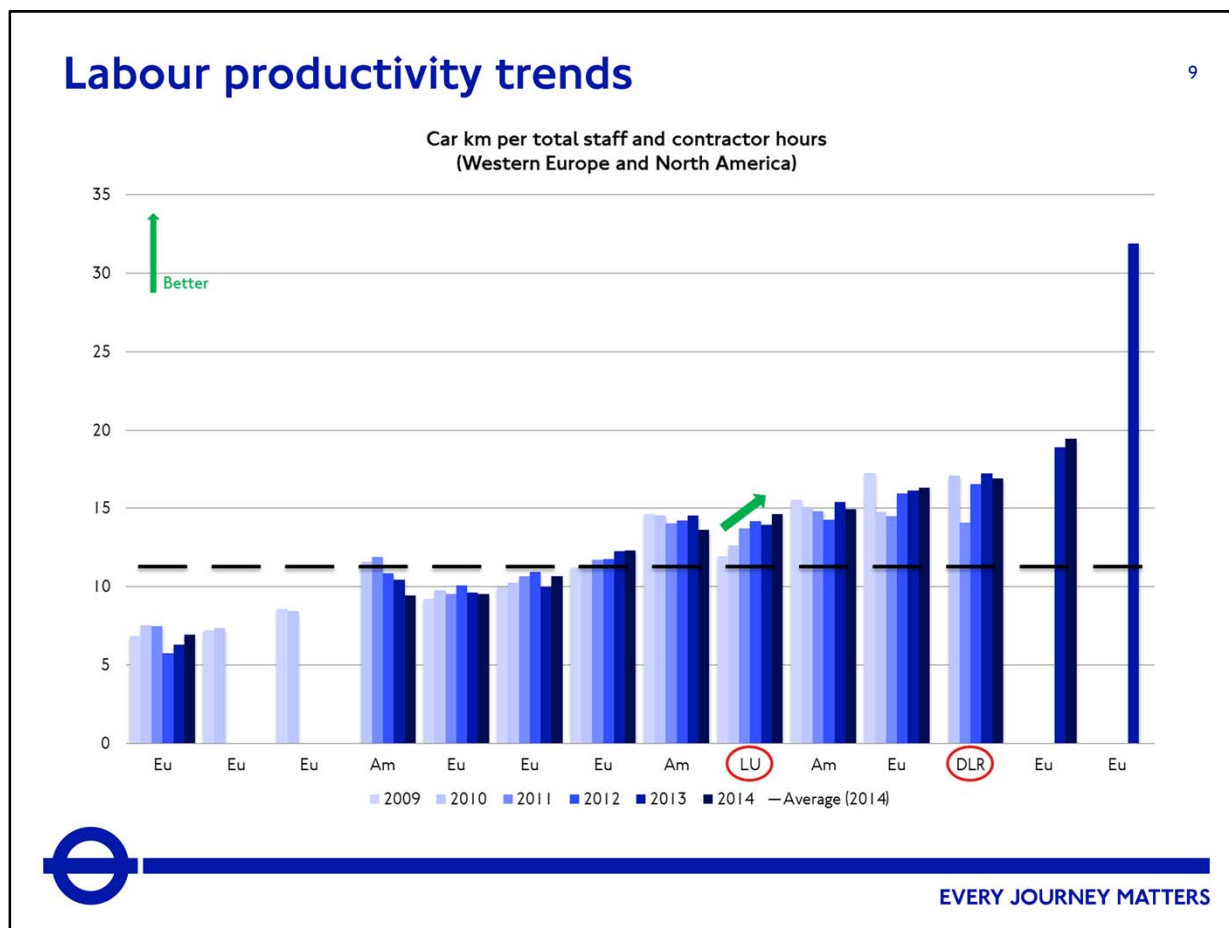
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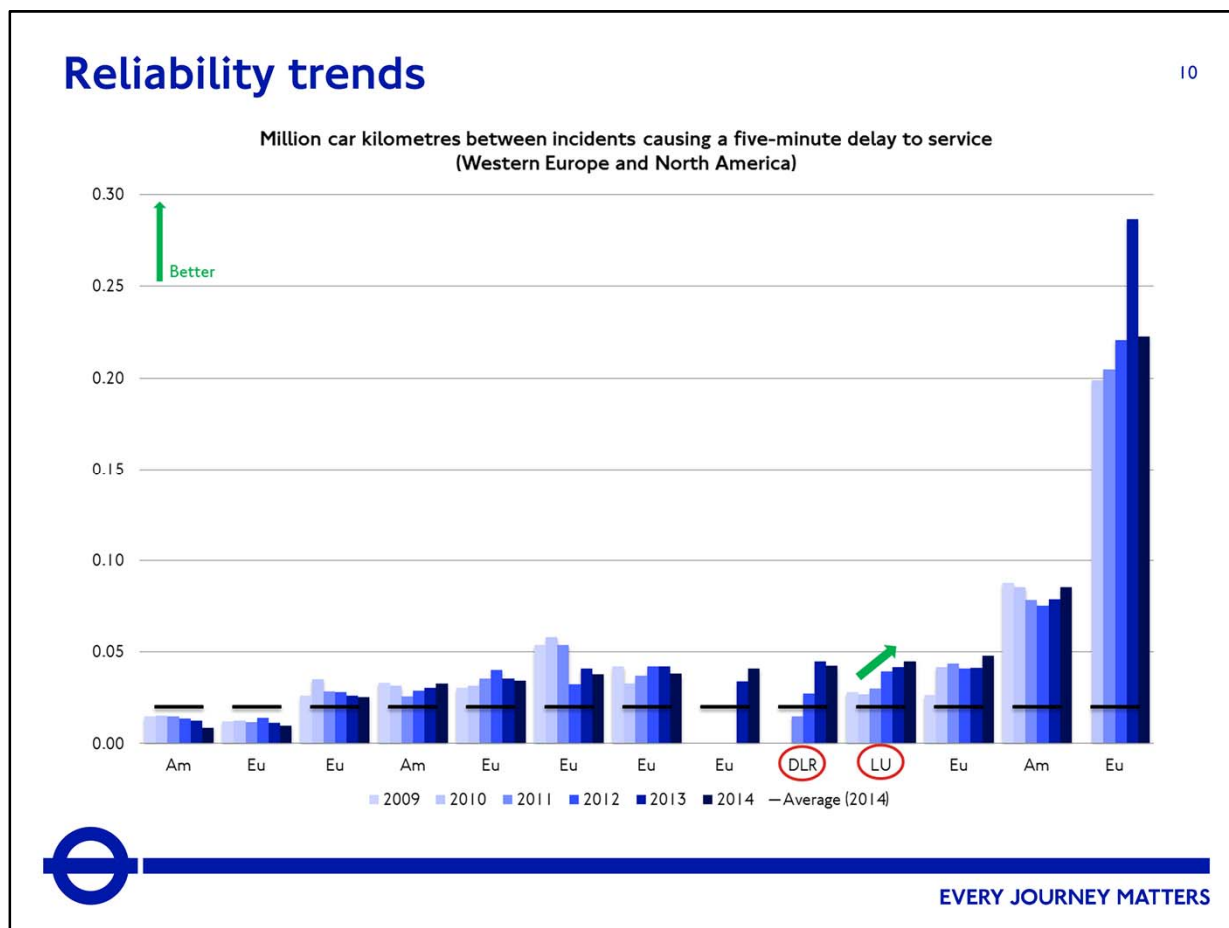
- This graph shows the breakdown of total maintenance cost per car km in 2014/15 for all CoMET and Nova metros. Maintenance unit cost is broken down by asset type where feasible, including rolling stock, infrastructure and station facilities.
- As the chart indicates, the distribution of LU's maintenance unit cost is different from the other CoMET and Nova metros. LU's station facilities and infrastructure maintenance unit costs are higher than the average of all metros. On the other hand, LU's rolling stock maintenance unit cost is lower than average. Research conducted by Imperial College indicates that this is in part due to structural factors such as network length and age.
- In 2014/15, LU's maintenance unit cost decreased across all categories. In particular, rolling stock and station facilities unit cost decreased by 3%, whilst infrastructure unit cost decreased by 7%.
- LU has been investing substantially to ensure that the existing asset base is kept in a safe and reliable condition. It is modernising the rolling stock and signalling in various lines, such as Circle, Hammersmith & City, District and Metropolitan line, and continuing the upgrades in already modernised lines, like Victoria, Jubilee and Northern line. In addition, major station modernisations are in delivery at Vauxhall, Tottenham Court Road, Bond Street, Victoria, Finsbury Park, Bank, Elephant & Castle and Holborn. It is expected that the stabilisation of the new assets into service will lead to a reduction of maintenance unit costs, since maintenance works will be come less frequent and increasingly mechanised.
- DLR's overall maintenance unit cost increased by 7% in 2014/15. Its rolling stock unit cost increased by 13%, remaining higher than average. This has arisen from increased maintenance for the B92 fleet, which is reaching the end of its design life, and the increased heavy exams schedule on the newer B2007 Stock. Its infrastructure unit cost increased by 5%, as a result of the end of franchise obligations relating to asset condition for hand back, and remains lower than the average. DLR's station facilities unit cost decreased by 5% and remains lower than the average. This reduction was achieved by incorporating the responsibility for maintenance of a part of the network previously maintained by a different concessionaire into the new franchise through the competitive tendering process.

Labour productivity trends

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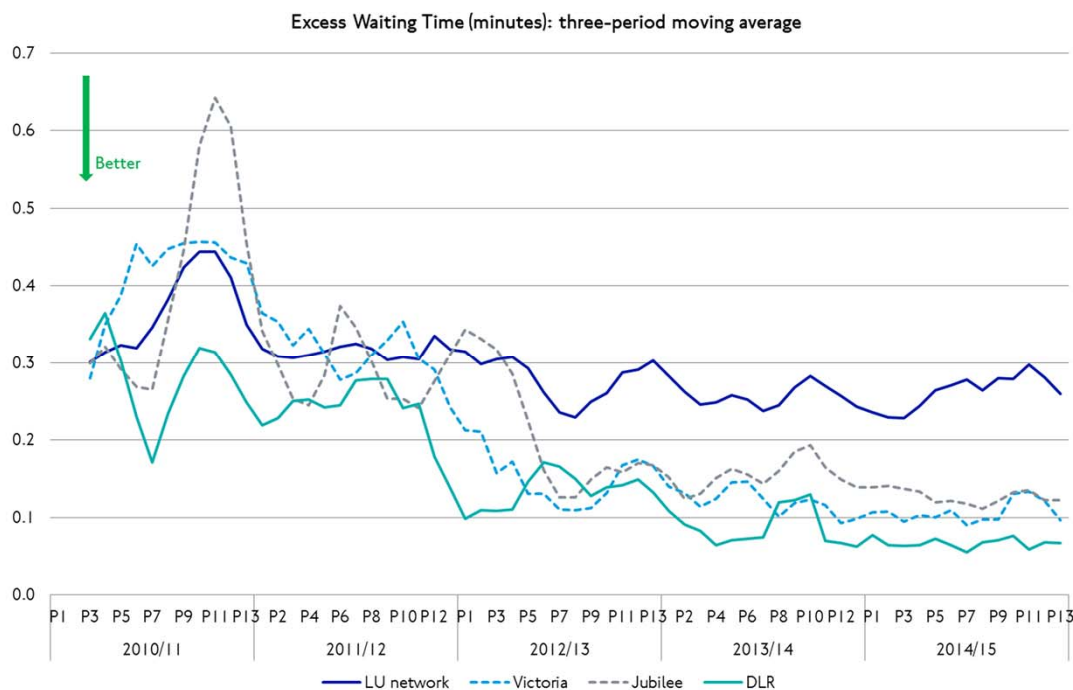
- This graph presents labour productivity of Western European and North American metros. The ratio is the result of dividing car km by total staff and contractor hours.
- Given their labour costs and levels of mechanisation, labour productivity tends to be higher for Western European and North American metros. This analysis therefore focuses on this peer group.
- Since 2009/10, LU has improved its labour productivity by 22%. It has accomplished this mainly due to growth in services by providing 17% more car km. Total staff and contractor hours have decreased by 4%.
- DLR's labour productivity has decreased by 1% since 2010/11. Car km have increased by 47%, while total staff and contractor hours have increased by 49%.
- On average, for the other Western European and North American metros, labour productivity has improved by 5% since 2009/10.
- In 2014/15, LU's labour productivity improved by 5%. Car km increased by 6%, whilst total staff and contractor hours increased by 1%.
- DLR's labour productivity decreased by 2% in 2014/15. Car km increased by 1%, whilst total staff and contractor hours increased by 3%. This was primarily due to the employment of additional staff to satisfy the increase in rolling stock exams, to undertake the new franchise procurement and mobilisation and to complete end of franchise asset hand back requirements.
- Both LU and DLR are above the average of Western European and North American metros in this productivity measure. DLR is the third best performing metro in this peer group.
- LU continues to make changes to how it operates, to improve overall service experience and to cope with rising customer demand. It is developing its station staffing model through the Fit for the Future Stations and Access Transformation programmes. The Fit for the Future Stations programme is designed to change the way LU meets customers' needs. Staff will be more available in ticket halls, helping customers to buy the right ticket, plan journeys and feel safe and secure as they travel. The Access Transformation programme aims to increase the use of engineering hours. The programme will deliver changes that will encourage increased work during traffic hours when safe and practical to do so, it will standardise station access times for works to take place, and improve safety when accessing the track during engineering hours.



- In general, Asian and South American metros are the most reliable in CoMET and Nova, with a significant gap when compared to metros in other continents. In addition to their structural differences in operating environment, these metros have built a majority of their lines in recent decades, meaning they have fewer legacy challenges than their older peers in Western Europe and North America.
- Hence, this chart analyses the reliability of Western European and North American Metros since 2009/10. The chosen metric is million car kilometres between incidents causing a delay of five minutes or more.
- LU's reliability has improved by 61% since 2009/10. DLR has improved by 186% since 2011/12.
- LU's improvement can be attributed to the modernisation of the Victoria and Jubilee lines, introduction of new rolling stock on the Sub-Surface lines and continued focus on reducing the number and impact of train service incidents.
- Among the 14 Western European & North American metros in CoMET and Nova, LU is the fourth best performing in this metric, while DLR is the fifth.
- In 2014/15, LU improved its reliability by 8%. This improvement can be attributed to increase in service frequencies and reduction of incidents by 2%.
- DLR's reliability decreased by 6% in 2014/15 as a result of an increase in rolling stock incidents, many of which have arisen due to the ageing B92 Stock. This older stock type, comprising of almost two-thirds of the entire fleet, is fast approaching its end of its life. Plans for the replacement of DLR's old fleet are already underway, with the introduction of the new fleet scheduled from 2020.
- Overall, LU and DLR perform better than the average of other Western European and North American metros. Particularly, LU and DLR's reliabilities are 129% and 115% higher than the average, respectively.

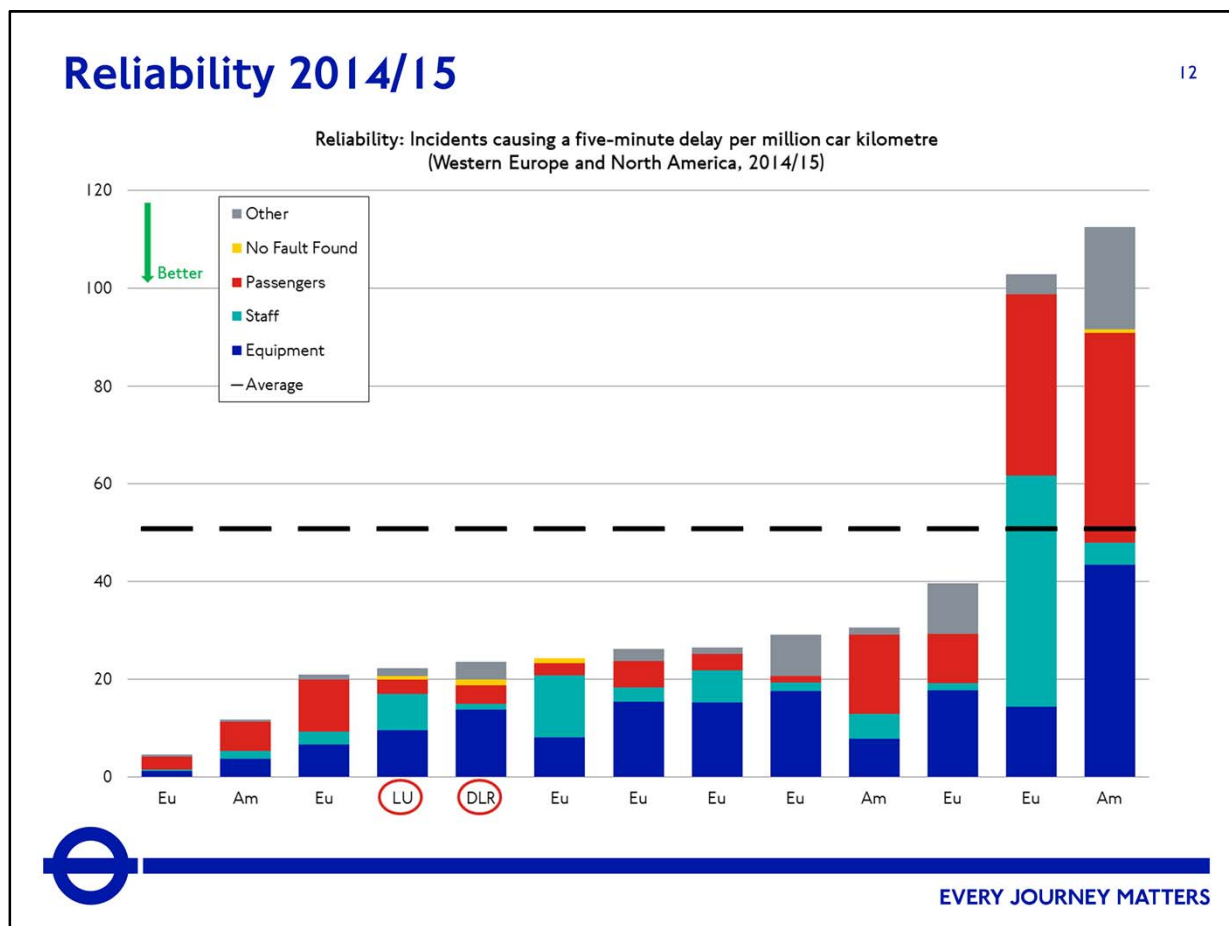
Alternative metrics for comparing reliability

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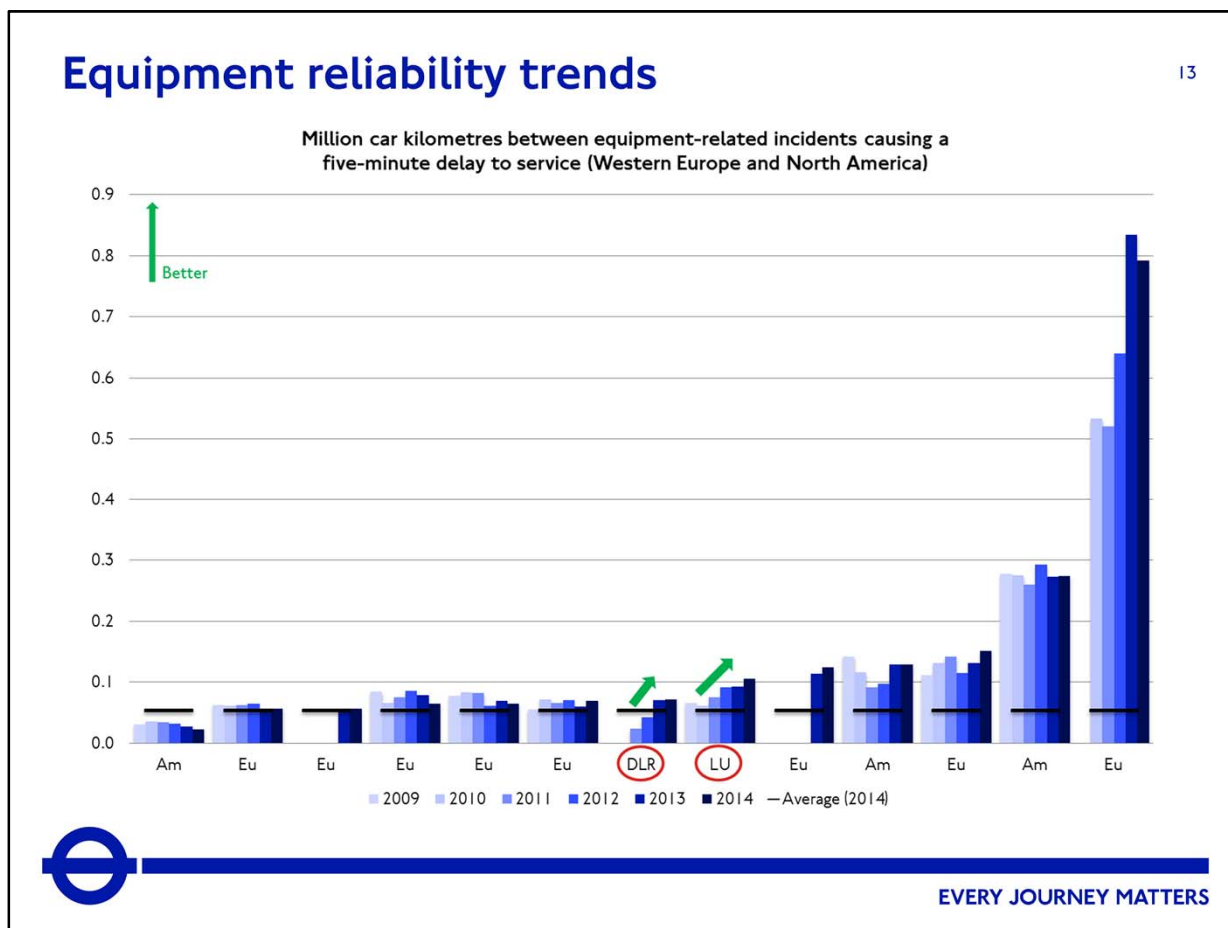


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- The KPIs available in the CoMET and Nova database consider delays of five minutes or more. On DLR only circa 15% of individual services operate on a headway of five minutes or less. Therefore, for 85% of DLR services any cancelled train is automatically a five-minute delay to customers. This metric is therefore more challenging for DLR than for those metros that operate with shorter headways on most of their network, such as LU.
- An alternative reliability metric is platform “excess waiting time”. This provides a weighted average of the length of time customers wait for a train versus how long they should wait according to the timetable; longer delays are weighted exponentially higher than shorter ones.
- LU and DLR both calculate excess waiting time, so it is possible to compare their reliability using this measure.
- The chart presented above shows the three-period moving average excess waiting time performance of DLR from 2010/11 to 2014/15 and compares it to the overall LU network as well as lines with similar signalling systems to DLR: the Jubilee and Victoria lines.
- The Victoria and Jubilee lines perform similarly to DLR. Both DLR and LU show an improving trend on this metric and the position of the LU network average relative to the Jubilee and Victoria lines underlines the value to passengers of installing modern signalling equipment that allows for higher levels of automation.
- The Victoria and Jubilee lines were modernised during this period and are now the most automated in LU. Against a backdrop of increased ridership, excess waiting time on these lines has reduced by more than 60% suggesting the high reliability value of this investment.



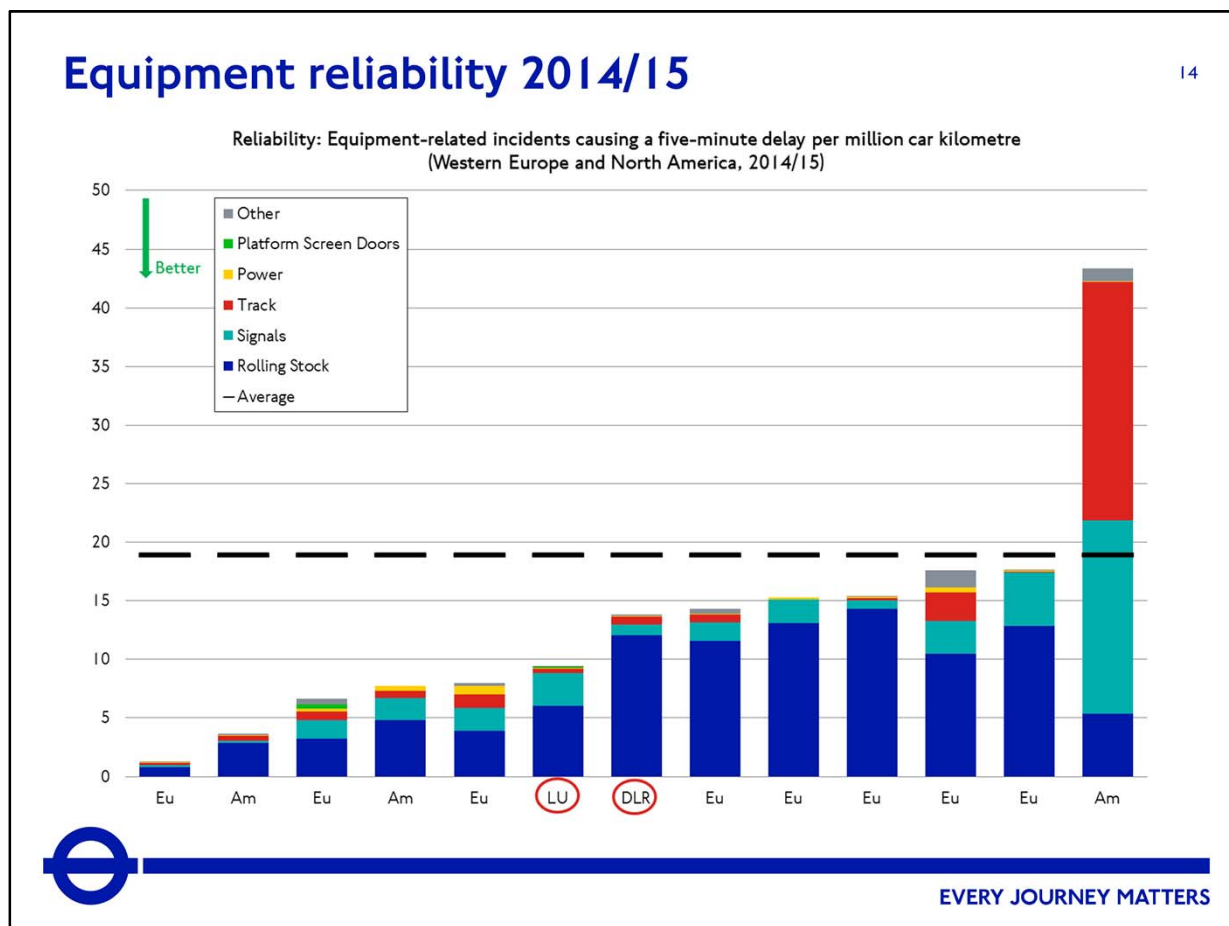
- This graph presents the breakdown of reliability according to incident cause: equipment, staff, passengers, no fault found and others. The metric used is incidents causing a delay of five minutes or more per million car kilometres.
- In 2014/15 LU's reliability improved across all categories for this metric. Particularly, equipment-related incidents per car km, which is the most significant category, improved by 12%. This category is analysed in further detail in the following pages.
- LU's staff-related incidents per car km improved by 1%, although they remained the third highest in this peer group. These incidents are primarily caused by non-availability and are a focus of LU's reliability programme. This metric has improved by 28% since 2009/10.
- LU performs better than average in terms of the volume of passenger-related incidents per car km and it improved by 4% on this metric in 2014/15. This is in part a result of an initiative, funded as part of the Reliability, Availability, Maintainability, Safety programme, that has allowed station staff to react quicker to this type of incident.
- In 2014/15, DLR's reliability decreased by 6%. Equipment-related incidents per car km improved by 2%. While staff-related and passenger-related incidents increased significantly in percentage terms, absolute numbers remain low (increasing from 18 in 2013/14 to 34 in 2014/15 and from 106 in 2013/14 to 118 in 2014/15 respectively).
- DLR's new franchise includes obligations to analyse all 15-minute delay incidents in greater detail to find the root cause and learn lessons. The new franchise also specifies the requirement of a robust Competence Management System for all staff.
- The most significant type of incident for both LU and DLR is equipment, which is analysed separately in the following pages.



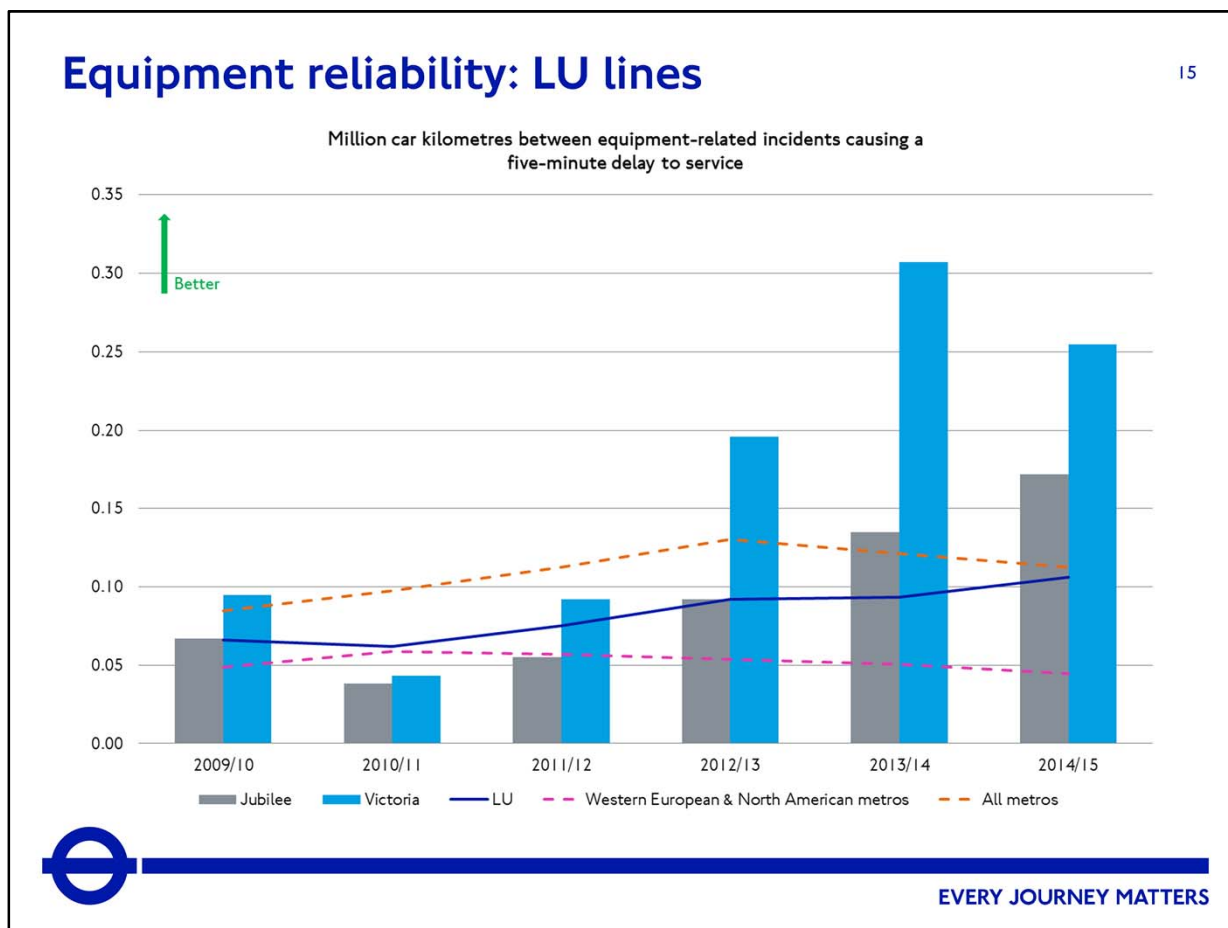
- This graph shows the equipment reliability trends since 2009/10. Reliability is measured in million car km between equipment-related incidents causing a delay of five minutes or more.
- LU's equipment reliability has improved by 60% since 2009/10. Since 2011/12, DLR's equipment reliability has improved by 207%.
- On average, for the other Western European and North American metros, equipment reliability has deteriorated by 17% since 2009/10.
- In 2014/15, LU improved its equipment reliability by 14%. It provided 6% more car km, whilst reducing the number of equipment-related incidents by 7%. This reduction of equipment-related incidents has been mainly due to various line modernisations, a shift of maintenance regimes to a more Predictive and Preventative approach, closer collaboration across departments and Reliability, Availability, Maintainability, Safety initiatives.
- In 2014/15, DLR improved its equipment reliability by 2%. It provided 1% more car km, while equipment-related incidents decreased by 1%. This reduction of equipment-related incidents has been primarily driven through the reduction of signalling, track and power incidents, thanks to process improvements on previous investments despite increase in rolling stock incidents which is explained in the next page.
- DLR has implemented operational measures to reduce five-minute delay incidents. The 'cut & run' programme (in which the network has been mapped to identify the nearest location to remove a train to in the event of a failure) successfully prevents failures from adversely affecting the service pattern and helps to quickly restore normal operation after any failure.
- Both, LU and DLR perform better than the average of Western European and North American metros. LU's equipment reliability is 100% higher than the average, whilst DLR's is 37% above average.

Equipment reliability 2014/15

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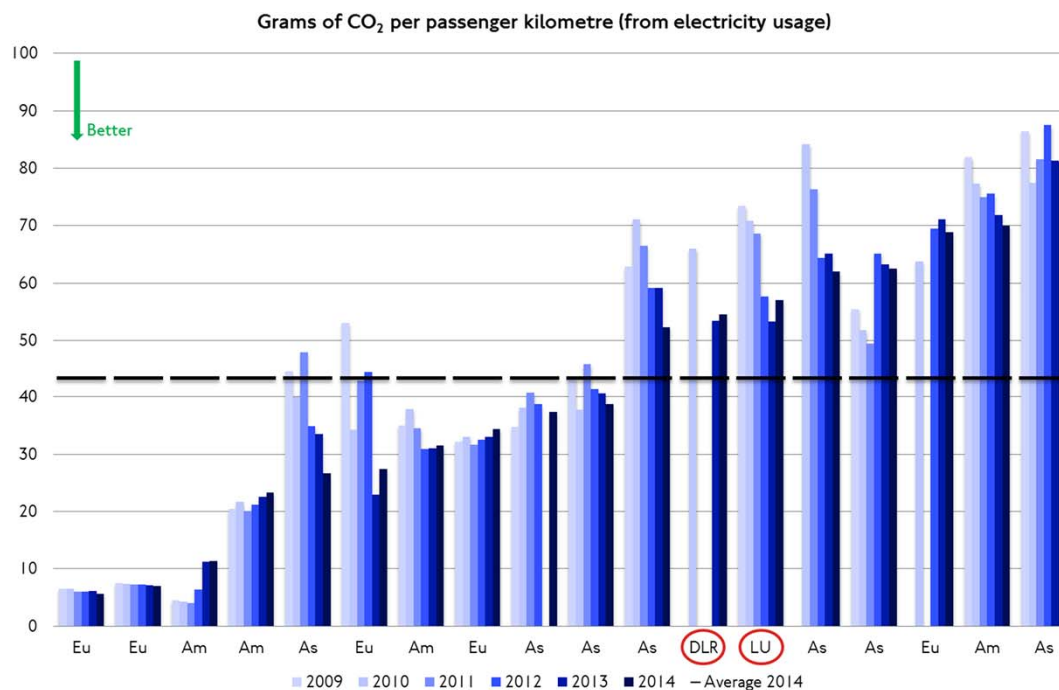
- This chart breaks down the 2014/15 equipment-related reliability figure according to incident cause: rolling stock, signals, track, power, platform screen doors and other. The metric used is equipment-related incidents causing a five-minute delay per million car km.
- In 2014/15 LU's equipment reliability improved by 12% in this metric, thanks to improvements on most of these categories.
- LU's rolling stock incidents per car km, the most significant category, reduced by 15%. The introduction of the new S Stock on the Circle and Hammersmith & City lines was a major contributing factor to this improvement.
- LU's signalling incidents per car km reduced by 5%. The completion of the Victoria, Jubilee and Northern line modernisations in the last few years has led to major improvements of signalling reliability on these lines.
- LU's track incidents per car km reduced by 22%, mainly due to the Rail Defect Reduction Programme, which focused on reducing reactive maintenance work and preventing defects.
- LU's platform screen doors incidents increased from 50 in 2013/14 to 69 in 2014/15. LU is working closely with the supplier to address the causes of these failures. However, platform screen doors reliability is now 26% better than it was in 2010/11.
- LU's power incidents per car km reduced by 8%.
- DLR's rolling stock-related incidents per car km increased by 3%, mainly due to the older B92 Stock, which constitutes two-thirds of the entire fleet and is approaching the end of its life. DLR has already planned its replacement, by introducing new fleet in the early 2020s.
- DLR's rolling stock-related failures per car km are high relatively in part due to DLR's system of recording information. All issues relating to train-borne signalling are categorised as rolling stock; this system replaces drivers and represents the interface between rolling stock and signalling. As such, higher failure rates here are not always 'traditional' rolling stock issues. In the ongoing CoMET/Nova KPI system review, we expect creation of a separate 'Train-Borne Signalling' category to improve clarity.
- DLR's signals-related incidents per car km improved by 22%. Well managed software upgrades, preventative maintenance and better use of remote condition monitoring were major contributing factors to this improvement.
- DLR's track and power-related incidents per car km improved by 26% and 75% respectively.



- This graph analyses equipment reliability trends since 2009/10. Reliability is measured in million car km between equipment-related incidents causing a delay of five minutes or more.
- The two recently modernised Victoria and Jubilee lines are compared with the average of all LU lines, the average of all Western European and North American metros and the average of all CoMET and Nova metros.
- LU's equipment reliability has improved by 60% since 2009/10, reaching the same level as the average of all CoMET and Nova metros and becoming 100% better than the average of Western European and North American metros.
- Since 2009/10, before the modernisation of the line, equipment reliability on the Victoria line has improved by 169%. This has been the result of new state-of-the-art signalling and brand new fleet of 09-TS trains. In 2014/15 some issues with the train-borne signalling equipment made Victoria's line equipment reliability reduce by 17%, although it was still the best of the LU network.
- On the Jubilee line equipment reliability has improved by 156% since 2009/10. This improvement has been achieved through the modernisation of the signalling system, a comprehensive package of Reliability, Availability, Maintainability, Safety initiatives, the replacement of obsolete electronic components and signalling initiatives such as "point of care".
- Currently Victoria and Jubilee lines' equipment reliabilities are respectively 126% and 52% higher than the average of all CoMET and Nova metros and 381% and 224% higher than the average of North American and Western European metros.
- Both lines will be improved further under the World Class Capacity programme, which will provide additional capacity beyond that delivered by the recent line modernisations. The programme focuses on train, signalling, power and cooling modifications. These improvements will get LU closer to the best performing metros in CoMET and Nova.

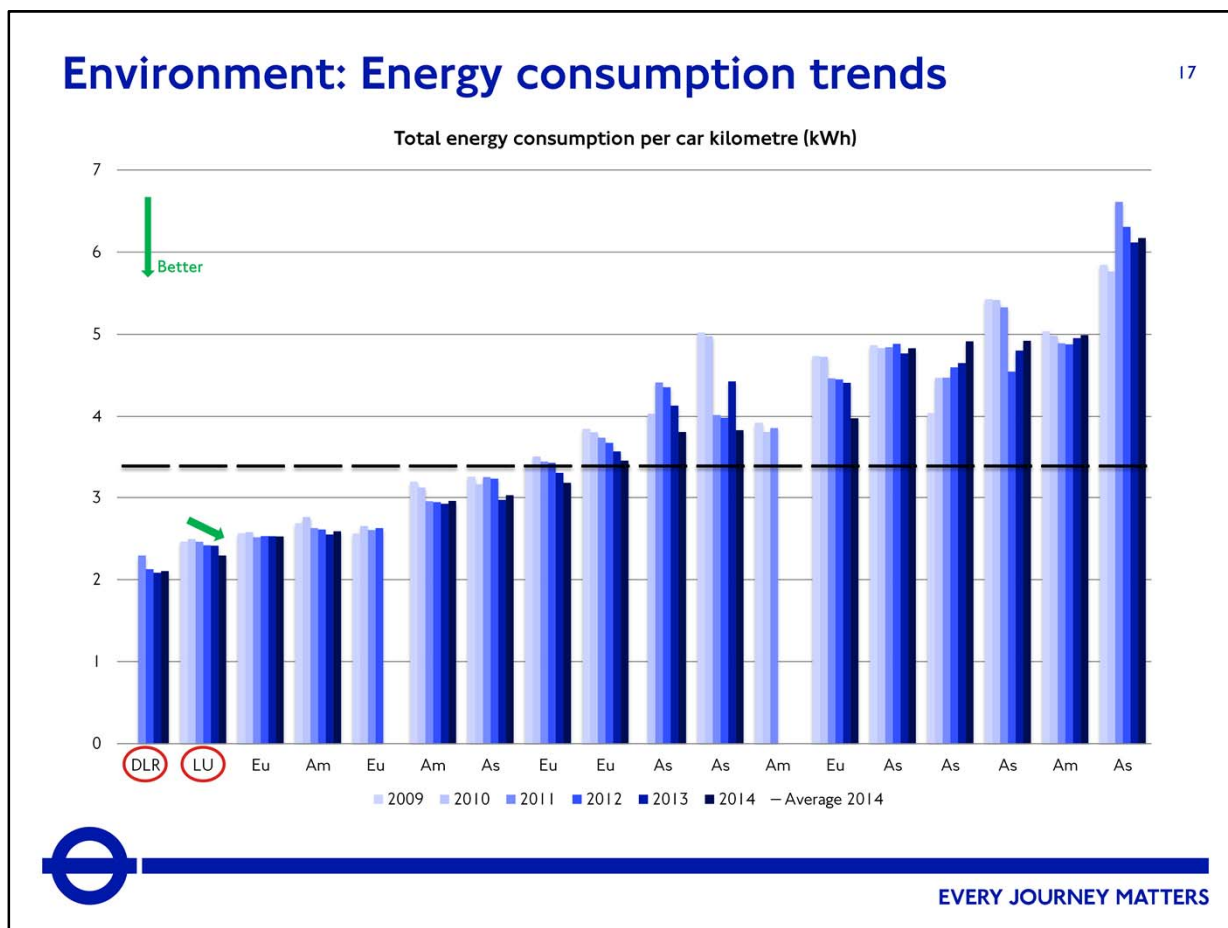
Environment: CO₂ emissions trends

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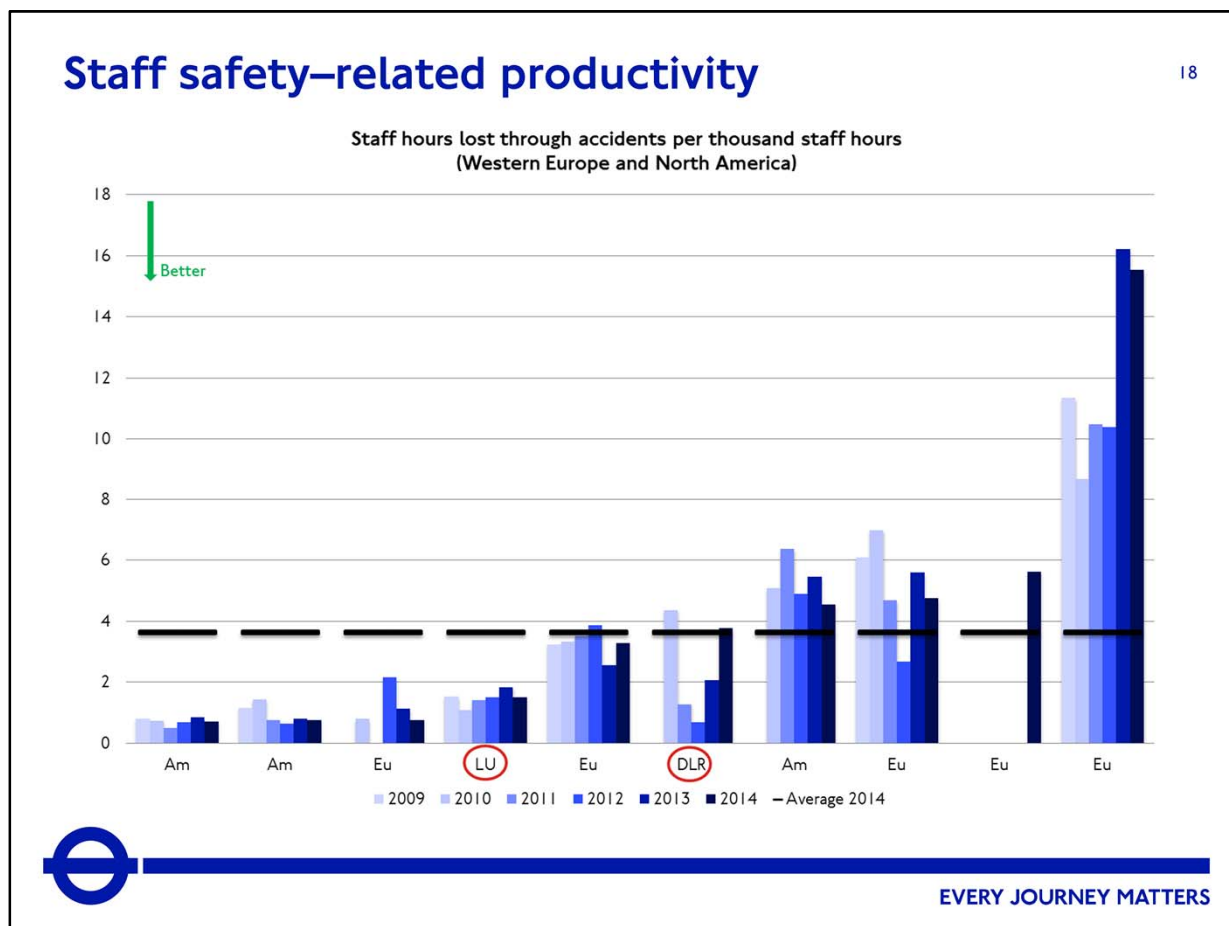
- This graph presents the environmental performance trends of CoMET metros and DLR in terms of CO₂ emissions per passenger km.
- Since 2009/10, LU's environmental performance has improved by 22%, whilst DLR by 17% since 2010/11.
- LU and DLR's performance in terms of CO₂ emissions per passenger km is lower compared to their international peers largely because of the UK's national grid mix.
- In 2014/15, CO₂ emissions per passenger km increased on both LU and DLR by 7% and 2% respectively, due to an increase in the UK grid emissions factor. This masks an improvement in energy efficiency in the year, as LU and DLR's total energy consumption increased at a slower rate than passenger km. In the following page energy consumption trends are examined.
- LU continues the effort to deliver efficiencies in carbon emissions, by reducing operational energy use and emissions associated with the delivery of capital projects, as well as optimising the sourcing of low carbon energy to LU. Energy efficiency initiatives such as the use of regenerative braking on over half of the network has helped to mitigate against this increase. In addition, innovative measures such as renewable energy, LED lighting, centralised cooling and heat recovery systems have been proven successful at various stations.
- LU continues to progress development work on the installation of additional power generation at Greenwich Power Station, its emergency supply. The gas-fired Combined Heat Power (CHP) system will provide a proportion of LU's electricity requirement from a lower carbon source than the national grid, improving performance in this metric.



- This chart shows the environmental performance trends of CoMET metros and DLR in terms of total energy consumption per car km.
- DLR and LU are the first and second best performing metros in this peer group, respectively, with energy consumptions per car km that are 38% and 32% lower than the average of CoMET metros respectively.
- Since 2009/10, LU has improved by 7% in this metric, whilst DLR has improved by 8% since 2011/12. Energy efficiency in both LU and DLR is achieved both through selecting more efficient equipment and by identifying and reducing instances where energy is wasted.
- In 2014/15, LU's energy consumption per car km reduced by 5%. It provided 6% more car km, with only 1% more energy consumed. The introduction of regenerative braking on Circle and Hammersmith & City lines at an interim level, the installation of LED lighting on Baker Street and Wimbledon Park stations and variable refrigeration flow equipment on Baker Street, South Kensington, Earls Court, Embankment and Paddington stations are contributing factors on this improvement.
- DLR's energy consumption per car km increased by 1% in 2014/15. DLR is currently conducting energy audits for the Energy Savings Opportunities Scheme, a UK legislation for large undertakings done every four years, for its buildings and trains. Other improvements in Building Management Control Systems are also investigated, as part of this workstream.
- LU will continue the effort to deliver efficiencies in total energy consumption by introducing a new technology on the Victoria line. The inverter improves the effectiveness of the line's regenerative braking by allowing recycled braking energy to provide energy for non-traction purposes as well as accelerating trains. Emerging results of the installation indicate additional savings of approximately 7 MWh per week, that is enough power to run a station like Holborn for more than two days a week.
- Green CBTC, an energy optimisation initiative which can potentially reduce traction energy consumption by up to 15%, is being considered by DLR's signalling team. Thales, the supplier, has now been commissioned to explore unlocking the possibilities by timetable optimisation to maximise use of regenerative braking, advanced coasting and adjustment of driving profile.

Staff safety-related productivity

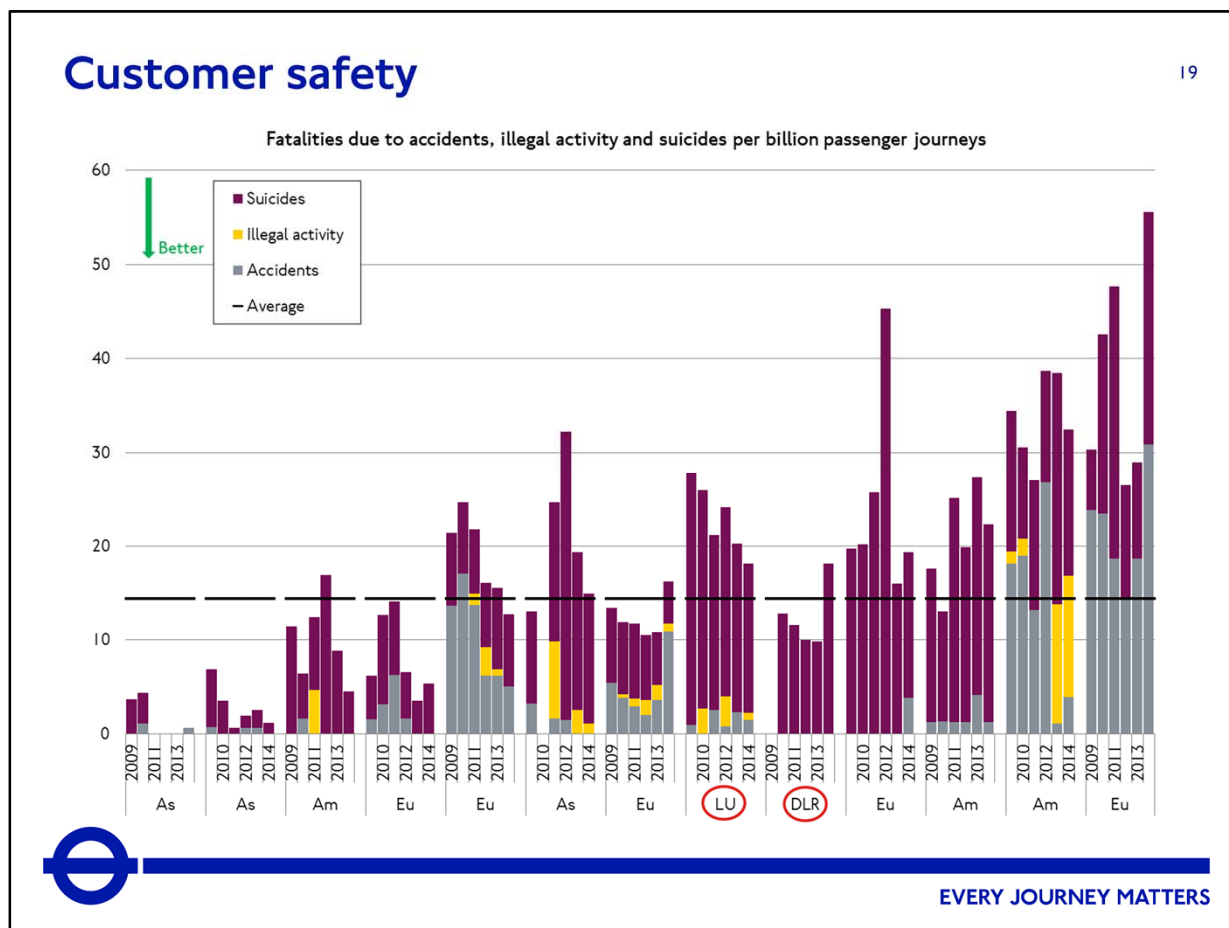
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- This chart shows the productivity impact of staff-related safety for Western European and North American metros. It is measured in terms of staff hours lost through accidents per staff hour. Therefore, it is not an absolute comparison of safety incidents.
- Since 2009/10 LU has improved by 1%. Whilst DLR has improved by 14% since 2010/11, it was worse in the last year despite having fewer accidents which resulted in long-term absence. The absolute number of accidents remains very low.
- In 2014/15 LU improved by 17% and became the fourth best performing metro in Western Europe and North America in this metric. While total staff hours increased by 1%, the time that staff lost through accidents decreased by 16%.
- In 2014/15 DLR increased by 83% for this metric. While total staff hours increased by 3%, staff time lost through accidents also increased by 89%. DLR has a relatively lower level of staffing, meaning that any changes in staff time lost can have a big impact in this metric. DLR aims to provide a safe working environment for its staff and via the Employee Safety Focus Group ensures effective health and safety performance across the organisation.
- LU performed 58% better than the average of Western European and North American metros in 2014/15, whilst DLR was 4% above average.
- It should be noted that this metric is complex, as it reflects the staff accident rate, severity of workplace accidents and employer policies on providing time off to staff following accidents. It is a top priority to have a low rate of staff accidents and especially of serious accidents. Generous leave provision may be desirable to staff welfare and provide long-term financial benefit through staff retention, though it is not clearly valued in this measure.
- It is LU's aim to provide a safe and healthy working environment for everyone who works on LU. All staff-related incidents are taken seriously and incident investigations focus on understanding causes to prevent recurrence. Staff who have had accidents at work and their managers are involved in this process to ensure that incidents are fully understood. This also demonstrates the organisation's commitment to safety, safety leadership by managers and highlights the seriousness of incidents. It is a collaborative approach to understand how accidents happen.
- LU discusses safety on a weekly basis at different levels and safety performance is continually monitored and reviewed with actions taken to improve. Safety briefings on relevant topics are issued on a weekly basis for employee engagement and further work on behavioural safety is also being taken forward.

Customer safety

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- This graph analyses customer safety trends for all CoMET metros and DLR, based on the number of fatalities due to accidents, illegal activity and suicides per billion passenger journeys.
- Since 2009/10 LU has improved significantly in this metric. LU's aim is to provide a safe travelling environment for its customers and work is ongoing to identify potential safety issues through specific workstreams relevant to each area.
- In DLR, despite the increasing number of passengers, between 2010/11 and 2013/14 suicide events remained constant at one per year. In 2014/15 there were two incidents.
- In 2014/15 both LU and DLR performed significantly better than the average of CoMET for fatalities due to accidents and fatalities due to illegal activities per billion passenger journeys.
- LU has customer safety strategy in place to reduce accidents at key locations including escalators, stairs and at the platform train interface. The majority of customer accidents occur in these areas. Physical improvements are being made to stairs and a number of new initiatives are being trialled on escalators to encourage customers to practice caution. Customer communications campaigns on safety issues run throughout the year via announcements, posters, the website and social media.
- In 2014/15 for both LU and DLR fatalities due to suicides per billion passenger journeys were higher than the average of CoMET.
- LU has launched a suicide reduction project to help address this issue which has been developed in partnership with the Samaritans. This has included a customer facing campaign and training for staff to equip them with the skills to identify vulnerable people and give them the confidence to intervene if necessary.
- On DLR, ongoing work with the British Transport Police, regular inspections of railway boundaries to ensure they are fit for purpose and training of on-board staff in mental health conditions awareness to identify passengers that might need additional support when travelling are some of the initiatives to reduce the number of incidents. DLR has recently launched the 'Back on Track' scheme which is a ground-breaking joint initiative with East London NHS Foundation Trust to promote social inclusion and help minimise mental health incidents on the railway.

Summary

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- This report presents the performance of LU and DLR over the last five years against the other international CoMET and Nova metros. The metrics used include financial, reliability, environmental and safety measures.
- For the majority of lead metrics, LU and DLR have made significant progress over this period. In most cases they have improved at a faster rate than the average of all metros and the average of Western European and North American metros.
- In financial terms, both LU and DLR have made significant improvements. 2014/15 was respectively the 4th and 2nd consecutive year that their commercial revenues exceeded their operating costs, meaning that they did not need government subsidy for non-capital operational activities. This has been achieved through increased ridership and non-fare revenues such as advertising and retail.
- Regarding reliability, LU and DLR have been amongst the most improving metros in CoMET and Nova. They are now significantly better than the average of Western European and North American metros.
- LU and DLR's CO2 emissions per passenger km have reduced over the last five years. They are also the most energy efficient metros in CoMET in consumption per car km.
- The security and safety of customers and staff is a top priority for LU and DLR. They have safety strategies in place to reduce accidents, illegal activity and suicides further, working closely with the British Transport Police and the Samaritans.



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