hale & twomey

26 May 2016

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ETS Operational Policy
Ministry for the Environment
PO Box 10-362
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[redacted]

RE: Emission Factor Annual Review

The Ministry for the Environment (MfE) engaged Hale & Twomey Limited (H&T) to analyse and review the default emission factors (DEF) for liquid fossil fuels in the Emissions Trading Scheme (ETS). The 2016 review analysed both the 2014 and 2015 product quality data and compared this with the quality data used to generate the DEFs[1].

H&T analysed Refining NZ product quality data provided by the Ministry of Business, Innovation and Employment (MBIE) using the process outlined in the *H&T Report Update of Default Emission Factors 2009*[2]. The review included obtaining information from Refining NZ, oil company import data and discussions with MfE. This letter presents a summary of the analysis completed and recommendations agreed.

2014-2015 Refining NZ quality data review

The last review was completed in 2014 (updating quality data to 2013). That review recommended the diesel DEF be updated, as the typical quality had moved outside the bands used for the original DEF calculation. The diesel DEF was updated in the regulations in 2014, so this review uses the new DEF for comparing current product quality.

Consistent with the review process, the energy content of products produced at Refining NZ were compared with the energy contents used to develop DEFs. This was done both for 2014 and 2015 annual average quality and the three year trend up to the year being analysed. The analysis assesses whether the energy content of the current products (as indicative of the emission factors) are still within 0.5% variation[3] from the data used to develop DEFs. Where a

[1] The DEF were developed in 2008 using 10 years refinery data (1998-2007) except for products where specifications changes had changed the quality (premium petrol used 2006/7 data and diesel used 2005-7)

[2] Ministry for the Environment: Updated of Default Emission Factors 2009, Hale & Twomey, July 2009

[3] The 0.5% limit is the allowance variance from base quality before a change in emission factor is considered.

default emission factor has been updated due to earlier reviews, the updated DEF has been used for the comparison. The results are shown in Tables 1 and 2 below.

Table 1: 2014 Refining NZ energy content data

Emission Source Category	Emission Source	Current Issue Energy content MJ/litre	2014 data Energy content MJ/litre	3 years (2012-2014) Energy content MJ/litre	% Difference 1 year MJ/litre	% Difference 3 year MJ/litre
Petrol	Premium (>= 95 RON)	35.24	35.28	35.22	-0.11%	0.05%
	Regular(< 95 RON)	34.81	35.09	35.05	-0.82%	-0.70%
Diesel	Automotive diesel	38.35	38.41	38.44	-0.15%	-0.24%
	Marine diesel	38.35	38.41	38.44	-0.15%	-0.24%
Aviation	Aviation gasoline	33.87				
	Jet fuel	37.10	37.15	37.19	-0.13%	-0.25%
Fuel Oil	Light fuel oil (< 85sct)	40.68	40.64	40.58	0.09%	0.24%
	Heavy fuel oil (>85 cst)	41.02	40.99	40.87	0.08%	0.36%

Table 2: 2015 Refining NZ energy content data

Emission Source Category	Emission Source	Current Issue Energy content MJ/litre	2015 data Energy content MJ/litre	3 years (2013-2015) Energy content MJ/litre	% Difference 1 year MJ/litre	% Difference 3 year MJ/litre
Petrol	Premium (>= 95 RON)	35.24	35.25	35.24	-0.02%	0.01%
	Regular(< 95 RON)	34.81	35.07	35.06	-0.75%	-0.71%
Diesel	Automotive diesel	38.35	38.48	38.43	-0.35%	-0.21%
	Marine diesel	38.35	38.48	38.43	-0.35%	-0.21%
Aviation	Aviation gasoline	33.87				
	Jet fuel	37.10	37.26	37.19	-0.44%	-0.23%
Fuel Oil	Light fuel oil (< 85sct)	40.68	40.68	40.59	-0.01%	0.23%
	Heavy fuel oil (>85 cst)	41.02	40.93	40.91	0.22%	0.27%

The percentage differences shown in red highlight where the energy data has more than a 0.5% variance from the quality data used to develop DEFs.

For both 2014 and 2015, all product qualities except regular petrol are within the accepted bounds for the single year and on a three year trend basis. Of particular note is that diesel quality is consistent with the new DEF set in 2014. The variance in fuel oil quality observed in earlier periods has been much reduced in the last two years.

As in the 2014 review, regular petrol produced at the refinery in 2014 and 2015 is outside the 0.5% variation allowed, both on an individual year and three year trend basis. This reflects fuel with a higher energy content (higher density) is being produced, which would result in a slightly higher emissions factor per litre of fuel. Fuel of this quality has now been produced consistently at the refinery for five years.

The regular petrol DEF has not been changed in previous reviews as it was found that imported petrol remained consistent with the product quality used to calculate the DEF, and when the quality of the total fuel pool was analysed (average of refinery production and imports) it was still consistent with that used to develop the DEF.

Import Quality

As the regular petrol qualities were outside the allowable variance for average Refining NZ quality, the quality data for imported regular was evaluated to see what effect this had on the country's total product pool (as regular data was collected, import data was collected for all

major import grades for future reference). Imports still make up a significant portion of New Zealand's petrol pool as shown in Table 3 (about 40-45% of the total pool). Imports are expected to reduce as a proportion of the pool from 2016 following the commissioning of a new CCR[4] unit at Refining NZ late in 2015.

Table 3: Import percentage

Fuel	Petrol RMS	Petrol PMS	Jet Fuel	Diesel
2009	42.5%	37.9%	17.1%	31.0%
2010	41.1%	35.8%	4.5%	24.3%
2011	40.0%	48.3%	1.4%	27.9%
2012	44.3%	46.3%	1.4%	19.0%
2013	46.6%	42.6%	6.8%	24.9%
2014	44.3%	48.6%	12.8%	29.1%
2015	40.9%	44.0%	5.3%	26.6%
2013-2015 Average	43.9%	45.1%	8.3%	26.9%

Source: Ministry of Business, Innovation and Employment Energy Data

In the analysis used when setting DEFs, the import product qualities were similar to Refining NZ product quality so it was deemed acceptable to use refinery quality data as the average for the product pool.

For import quality, only the density is easily available; however this gives an indication of the likely energy content and emissions factor. Table 4 shows the 2014 and 2015 average import density, along with import quality in earlier years and the density used for Refining NZ products when calculating the initial DEFs.

Table 4: Import quality (density)

Fuel	Petrol - RMS	Petrol - PMS	Jet Fuel	Diesel
Refining NZ average used for DEF calc	0.7387	0.7503	0.8002	0.8328
2006/7 import average	0.7366	0.7454		0.8304
2010 import average	0.7327	0.7455	0.7974	0.8314
2012 import average	0.7359	0.7398	0.7975	0.8331
2013 import average	0.7352	0.7403	0.7966	0.8326
2014 import average	0.7318	0.7359	0.7948	0.8321
2015 import average	0.7342	0.7414	0.7958	0.8348

The quality of imports in 2014 and 2015 has stayed relatively consistent with earlier years, with a slightly lower density for regular petrol. This means that for regular petrol the imports continue to be significantly less dense than refinery produced regular petrol, offsetting the trend seen in refinery product quality. Given this, the average pool quality was assessed to see if it was still within a 0.5% variation of the quality used for the DEFs.

[4] CCR is a continuous catalytic reformer. This unit increases petrol make and improves refinery efficiency.

Overall product pool quality change assessment

The impact of the import quality on the overall product quality pool was assessed by averaging the product qualities using the volumes of each source (Refining NZ/imports). As the data for all imported products was provided, we analysed all products even though only regular petrol was a concern. Similar calculations as used for refinery product are used to derive the energy contents for imported product from its density.

Table 5: 2014 New Zealand's total product pool energy content

Emission Source Category	Emission Source	Current Issue Energy content MJ/litre	2014 data with imports Energy content MJ/litre	3 years (2012 - 2014) Energy content MJ/litre	% Difference 1 year MJ/litre	% Difference 3 year MJ/litre
Petrol	Premium (>= 95 RON)	35.24	34.97	35.02	0.77%	0.61%
	Regular(< 95 RON)	34.81	34.86	34.87	-0.15%	-0.17%
Diesel	Automotive diesel	38.35	38.32	38.37	0.07%	-0.06%
	Marine diesel	38.35	38.32	38.37	0.07%	-0.06%
Aviation	Aviation gasoline	33.87				
	Jet fuel	37.10	37.10	37.17	-0.01%	-0.19%

Table 6: 2015 New Zealand's total product pool energy content

Emission Source Category	Emission Source	Current Issue Energy content MJ/litre	2015 data with imports Energy content MJ/litre	3 years (2013-2015) Energy content MJ/litre	% Difference 1 year MJ/litre	% Difference 3 year MJ/litre
Petrol	Premium (>= 95 RON)	35.24	35.09	35.04	0.41%	0.58%
	Regular(< 95 RON)	34.81	34.89	34.86	-0.22%	-0.15%
Diesel	Automotive diesel	38.35	38.41	38.36	-0.17%	-0.02%
	Marine diesel	38.35	38.41	38.36	-0.17%	-0.02%
Aviation	Aviation gasoline	33.87				
	Jet fuel	37.10	37.24	37.16	-0.38%	-0.16%

As regular petrol imports are less dense, the average energy content of the total pool is lower than for Refining NZ product separately. This means the average pool quality is well within the 0.5% range for 2014 and 2015 and the three year average period. Therefore the DEF is still representative of the average quality of the regular petrol pool and no change is required.

The analysis of the pool quality data also shows that while refinery quality premium is still in line with the DEF, on a pool basis the quality is outside the 0.5% limit at times (particularly 2014) as the import quality has a lower energy content. We don't consider the low pool average premium petrol energy content needs to be addressed as 2014 was an outlier with high import quantities and particularly low density. In addition if we averaged both petrol grades (market is approximately 21% premium, 79% regular), the quality is almost exactly in line with the average quality used for the DEF calculation (the lower energy content premium is offset by the higher regular).

A further consideration is with the commissioning of the CCR at the end of 2015, the petrol import quantities are expected to reduce. The new unit may also change the quality of refinery produced petrol. Even if a change in petrol DEF were recommended, it would not be sensible to change these prior to seeing the impact from the new unit. If there is a change in petrol qualities due to the new unit or the balance of refinery production and imports, it will be addressed in the next (2018) emission factor review.

It is worth noting that the change in the diesel DEF in 2014 now means the DEF is very well aligned with both refinery and total pool product quality.

Review process change

The current process reviews refinery data and then only collects and analyses import and total pool quality data should refinery qualities vary by over 0.5% from that used to calculate DEFs. For consistency of data collection and overall trend analysis we think it is worth collecting import data with every review so there are no gaps in the data trends (all import data since 2012 has been collected).

Recommendation summary

The review of quality data for 2014 and 2015 has shown that the average pool quality for all products is within a 0.5% variation from the quality used to calculate the DEFs (with all petrol grades treated as a pool). While the refinery produced regular petrol is outside the allowed variation band, once imported product is taken into account the total pool is well within the band.

The new default emission factor for diesel adopted in 2014 has corrected the previous issue with diesel quality variation. The diesel DEF now accurately reflects both refinery and pool diesel quality.

Kind regards

Ian Twomey
Hale & Twomey Limited