Multiplication Factor Calculations

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Provided by:

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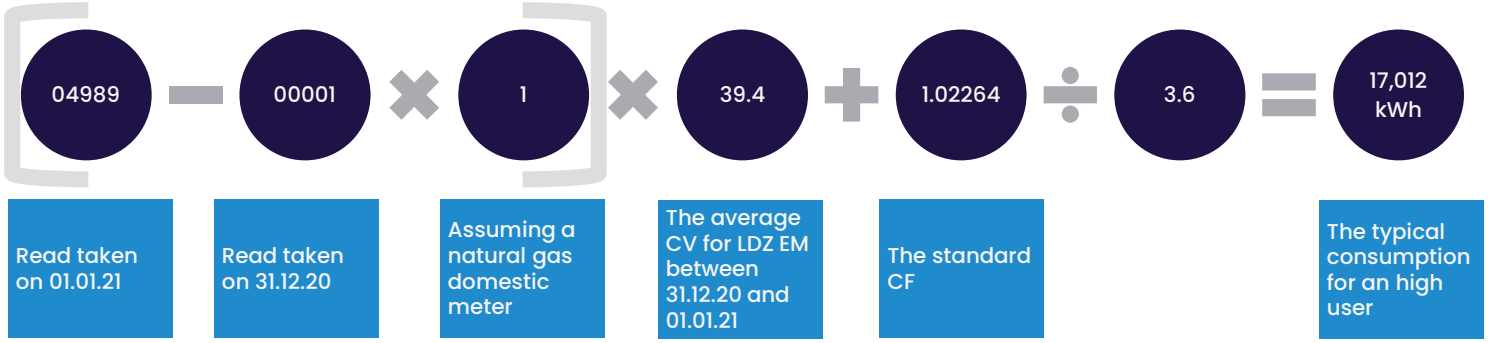
Energy Calculation

In order for us to ensure that Shippers, Suppliers and end consumers are not negatively impacted by taking part in 100% hydrogen demonstrations a number of options were discussed. One of these options was to use the multiplication factor (MF) which is used in the calculation of energy. The full calculation (based on a metric meter) is

Units (recent meter read – previous meter read * Multiplication Factor) * Calorific Value * Conversion Factor / 3.6 = kWh

- **Units:** These are readings taken from the meter (manually or through equipment like smart meters)
- **Multiplication Factor:** This is set by the meter manufacturer. For most metric domestic sized meters this is set as 1
- **Calorific Value:** This is determined at a Local Distribution Zone (LDZ) level using the Flow Weighted Average Calorific Value (FWACV) process. As this is set per day, when calculating energy the average CV is taken across the days between the dates of the readings
- **Conversion Factor (CF):** This is determined by how much energy will be used in an annual period. The standard Conversion Factor, for any MPRN with an Annual Quantity less than 732,000 kWh is set at 1.02264 (as set out in The Gas (Calculation of Thermal Energy) Regulations

An example of this calculation is as follows



Multiplication Factor Information

The long term aspiration is that the hydrogen CV (approx. 12) would be used in the calculation of energy. However due a number of reasons, including that hydrogen has not yet been proven as an alternative to natural gas, it has been agreed that in the interim the MF could be used to allow demonstrations of 100% hydrogen to be undertaken until the long term aspiration can be met.

A multiplication factor is set for a meter and is a static figure whereas the FWACV for natural gas varies day to day therefore we need the value of the MF to calculate the kWh as close to (but not exceeding) the equivalent natural gas kWh to ensure it will not result in customers paying more for hydrogen.

Its also important to note that;

- The allowable values for a MF is set out in the Retail Energy Code (REC) and is between 0.001 and 999.999
- Meter Manufacturers create and set the MF based on how many units the meter records per the amount of gas flowing through the meter. For example, to be able to limit the physical size of a meter the meter may be set to record less units than is actually flowing to the meter so a MF is applied to ensure the correct volume is calculated.
- MF is included in the Market Domain Data (MDD), governed by REC. Any agreed value would need to be added to MDD to allow industry parties to set and use the MF. (The hydrogen meter will also need to be added to MDD).
- A meter can only be set up with one MF although the same meter may have multiple entries (and multiple MFs) in the MDD table. Where there are multiple combinations available it is the responsibility of the MAM to notify the Supplier of the correct metering details. Suppliers then notify the Shipper who in turn notifies the CDSP.
- The multiplication factor is not shown on domestic bills and therefore domestic end consumers will need to be educated about this.

The following slides shows, in detail, what data has been used the calculate the MF and the different options available.

The data used to calculate the multiplication factors

Conversion Factor

The Conversion Factor (CF), also known as the Correction Factor, is set out in the Gas (Calculation of Thermal Energy) Regulations and is determined by how much energy will be used in an annual period.

A standard CF of 1.02264 is set for an MPRN with an Annual Quantity less than 732,000 kWh.

Where an MPRN uses more than 732,000 kWh per year a site specific CF is calculated. This is calculated using the formula set out in the regulations (temperature conversion factor x pressure conversion factor x compressibility conversion factor). This means that MPRNs using more than 732,000 kWh will have a unique CF.

A Corrector/Convertor is a physical device that accounts for the temperature, pressure and compressibility on site. Where this device is installed the CF is set as 1.

The standard CF (1.02264) has been throughout the analysis however the same Multiplication Factor can be used for all variants of the CF.

Annual hydrogen consumption

To calculate hydrogen annual consumption the current TDCV's (Typical Domestic Consumptions Values) which Ofgem published in 2020 has been used:

- Low = 8,000 kWh
- Medium = 12,000 kWh
- High = 17,000 kWh

Using the Calorific value of 12 the volume to energy calculation has been used to identify the amount of units that would registered by the meter for a typical domestic annual consumption.

By calculating the units this allows us to check that consumers will never be overcharged even if they are above or below the TDCV.

The expectation is that consumers will continue to need/use the same amount of kWh so whilst the units recorded will be different the kWh will remain the same.

Hydrogen Units	Hydrogen CV	Conversion Factor	Energy (kWh)
2,347	12	1.02264	8,000 (Actual figure: 8,000.45360)
3,521	12	1.02264	12,000 (Actual figure: 12,002.38480)
4,988	12	1.02264	17,000 (Actual figure: 17,003.09440)

All further analysis have used the highest annual consumption

Calorific Values

To ensure that end consumers are not charged more for hydrogen than natural gas the annual Calorific Values (CV) have been mapped for each LDZ.

The CVs from October 2016 to April 2021 have been used as this is the widest span of data available in National Grid MIPI.

LDZ	Lowest CV	Average CV	Highest CV
EA	38.2	39.2	40.1
EM	37	39.4	40.1
NE	37.1	40	40.7
NO	38.9	39.9	40.9
NT	38.6	39.3	40.1
NW	38.6	39.5	40.3
SC	37.9	39.4	40.4
SE	38.1	39.1	40
SO	37.8	39.3	40
SW	38	39.3	40
WM	37.7	39.3	40.1
WN	38.5	39.5	41.3
WS	38.2	39.2	40

All further calculations have used the highest CV values (static over a 12 month period) to determine the appropriate multiplication factor.

System Average Price

The System Average Price (SAP) is used to calculate Shipper charges per kWh whereas end consumers have their price per kWh set by the Supplier.

In order to identify the difference in cost between hydrogen and natural gas, for the purposes of this analysis, the System Average Price has been used.

To align with the CV data the SAP from October 2016 to April 2021 has been used.

	SAP (pence)
Lowest	0.2991
Average	1.4464
Highest	12.7162

All further analysis have used the highest SAP to demonstrate the highest cost difference between hydrogen and natural gas.

Please note that the actual calculation of charges will continue to use the actual SAP not the figures represented in this presentation.

Multiplication Factor calculations

The most accurate MF would be based on the CV however as the MF is set per meter and is a static value it has to be set for the highest CV to ensure that whenever a lower CV is recorded it does not result in hydrogen being charged more than natural gas.

To determine the appropriate MF, one has been calculated for every CV between 37 and 43 MJ/m3 (megajoule per cubic meter). This table shows what the MF would need to be for the highest CVs recorded per LDZ and for the highest possible CV value of 43 MJ/m3*.

*The highest possible CV is quoted with different values in multiple sources. The value of 43 MJ/m3 has been taken from National Grids website as this appears to be the most accurate based on the previous 4.5 years worth of data. (To note figures quoted elsewhere range from 40/41 MJ/m3 up to 44MJ/m3)

**Customers who have a site specific Conversion Factor or Converter installed will be able to use the same MF. Although the cost differences, shown in this presentation, will be different the result will still be an underpayment for hydrogen against natural gas.

The cost columns are the difference in annual cost from using hydrogen instead of natural gas. These costs are per MPRN, based on the highest SAP, standard Conversion Factor**, high TDCV and a static CV for the period.

LDZ	Lowest CV	Highest CV	MF	Cost (based on lowest CV)	Cost (based on highest CV)
EA	38.2	40.1	0.299	-£104.30	-£2.30
EM	37	40.1	0.299	-£169.19	-£2.30
NE	37.1	40.7	0.294	-£203.07	-£6.66
NO	38.9	40.9	0.293	-£108.92	-£3.72
NT	38.6	40.1	0.293	-£83.09	-£3.72
NW	38.6	40.3	0.297	-£97.00	-£6.64
SC	37.9	40.4	0.297	-£134.94	-£0.82
SE	38.1	40	0.300	-£104.05	-£0.87
SO	37.8	40	0.300	-£119.61	-£0.87
SW	38	40	0.300	-£109.26	-£0.87
WM	37.7	40.1	0.293	-£131.54	-£3.72
WN	38.5	41.3	0.290	-£150.86	-£5.19
WS	38.2	40	0.300	-£97.42	-£0.87
N/A	37	43	0.279	-£302.52	-£0.54

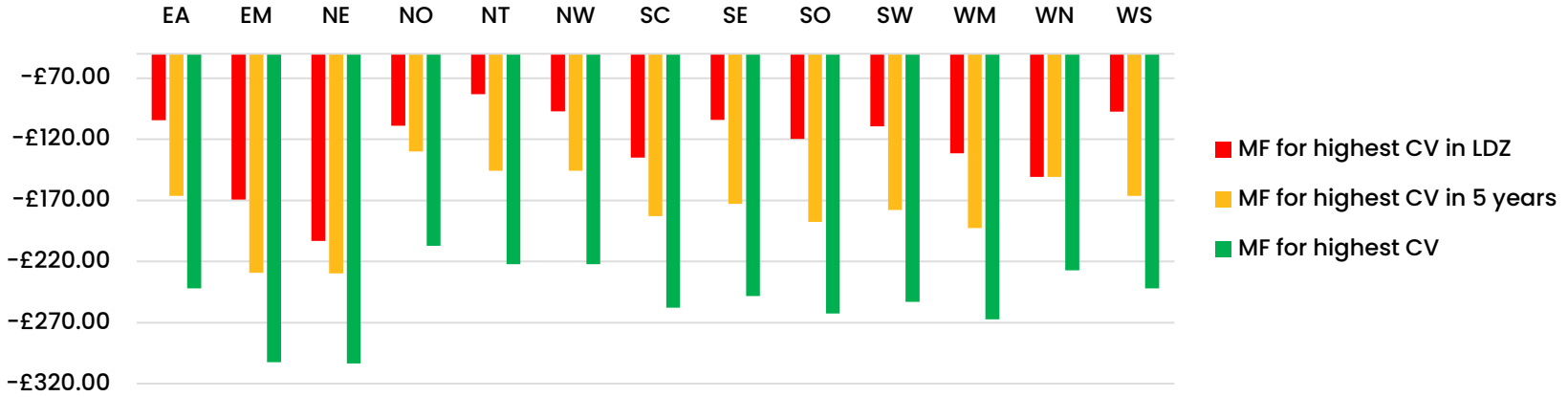
Options

Options for the Multiplication Factor value

Following analysis there are 3 different values which could be used as the MF. These are explored in the following slides.
The options are

1. Set the MF for the highest CV recorded in the LDZ (range of MF from 0.290 to 0.300)
2. Set the MF as 0.290 for the highest CV recorded in the past 5 years (41.3)
3. Set the MF as 0.279 for the highest possible CV (43)

This bar chart shows the annual difference, per MPRN, from natural gas unit cost based on the highest TDCV, highest SAP and lowest CV recorded for each LDZ. The CV is the FWACV recorded from October 2016 to April 2021.



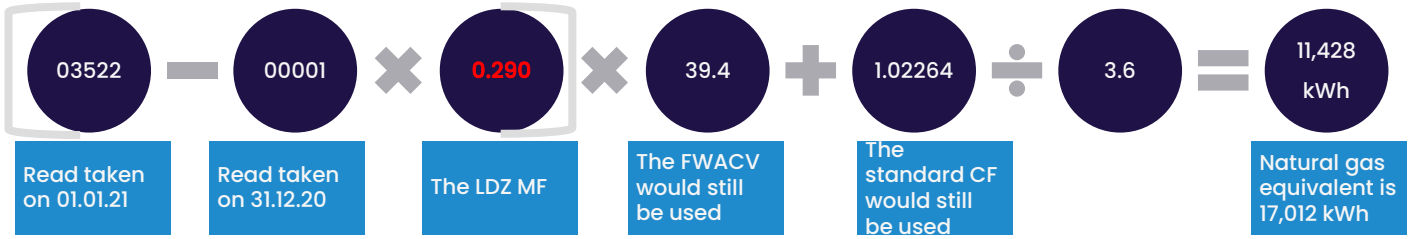
As the purpose of using the MF is to prevent end consumers paying more for hydrogen than natural gas using a value lower than the maximum CV has not been explored in detail. Whilst this could reduce the cost gap between natural gas and hydrogen for the overall demonstration period (resulting in an overall undercharge) there is an increasing likelihood that customers will be charged more in some billing periods. This would create an additional challenge if an end consumer 'opts out' before the overall charge is negative.

Consumption data using the different values

Each option would result in different annual hydrogen consumption being calculated. This kWh calculation is what Suppliers would apply to their unit rates to charge end consumers. These figures are based on a customer in the EM LDZ for a 12 month period.

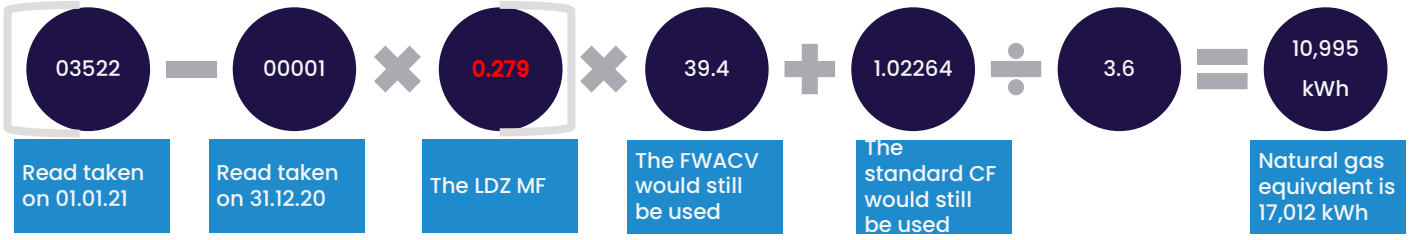
Option 1

Set the MF as 0.290 for the highest CV recorded in the past 5 years



Option 2

Set the MF as 0.279 for the highest possible CV (43)



Conclusion

The main challenges of each option and cost implications (based on the highest, lowest and average cost differences (from natural gas) per MPRN for a 12 month period) have been set out below. Potential end consumer challenges have been highlighted in red.

Option	Highest cost diff.	Lowest cost diff.	Average cost diff.	Challenges
1 - Set the MF for the highest CV recorded in the LDZ	-£203.07	-£0.82	-£63.42	• If the CV ever reached higher than currently recorded for the LDZ (40 for SO) the end consumer will be overcharged
2 - Set the MF for the highest CV recorded in the past 5 years (41.3) regardless of LDZ	-£229.81	-£5.19	-£115.94	• Some LDZs will be financially impacted more than others • If the CV ever reached higher than currently recorded the end consumer will be overcharged
3 - Set the MF for the highest possible CV (43)	-£303.34	-£87.05	-£193.59	• Every LDZ will be financially impacted greater than the other options.

Thank you