The European Association of Internal
Combustion Engine Manufacturers

EUROMOT POSITION

26 March 2014

Narrower specifications for natural gas than proposed by EASEE-gas/CEN TC 234 proposal is profitable and necessary for EU

EXECUTIVE SUMMARY

Under Mandate M 400, CEN is currently working on a standard for H-gas. The current draft proposal foresees a very broad gas quality range which basically accepts all Liquefied Natural Gas (LNG) compositions currently commercially available on the market. Switching the gas quality in Europe from the current narrow ranges will have a cost. Gas applications work best at a close to constant gas composition. It is highly probable that a situation of a very wide gas composition range ultimately leads to substantial negative effects for the gas users and for the European economy. An EU-wide acceptance of the wide draft CEN parameter range will require widespread renewal or adaptation of all gas-fuelled equipment and feedstock applications at a very high cost - one estimate [1] has shown that the costs of adapting the gas applications may exceed 178 billion Euro with limited benefit for customers.

This position paper shows that setting a narrow gas quality range and treating certain extremely rich LNG by removing higher hydrocarbons is a beneficial solution for society and environment and can even be profitable. Furthemore, investing into gas treatment facilities will help secure gas supply as many natural gas specifications even beyond the CEN H-gas proposal could be accepted after treatment, e.g. associated gases would become an available fuel source to the market.

1. Introduction

Natural gas is a versatile and relatively clean energy carrier that will play an important role in facilitating a large-scale integration of renewable energy sources. In order to keep Europe competitive with the rest of the world, EUROMOT, the organisation of engine manufacturers in Europe, strongly supports a reliable and affordable supply of natural gas.

Applications for natural gas perform best for a close to constant gas composition. Measurement and control theory clearly proves that minimum variations in process parameters result in optimum performance of processes. That applies for domestic heating appliances and cookers, engines and gas turbines as well as industrial burners. Optimum performance means highest possible fuel efficiency, stable power output, minimum emissions and maximum safety. Also industries using natural gas as feedstock for producing e.g. fertilisers and plastics benefit from a constant gas quality. Traditionally, natural gas is supplied to customers via pipelines from larger gas fields. That generally warrants a constant composition for the group of customers connected to a typical gas well. Gradually, pipeline networks expanded, integrated and interconnected wells, sometimes resulting in fluctuating gas compositions in certain areas. Gas companies traditionally took measures to keep gas quality within tight limits, by blending different gas streams, by removing higher hydrocarbons and by adding inert gases. Gas wells are as a standard equipped with treatment systems to remove components that would disturb gas use of the customers.

Due to a strongly increased use of natural gas coupled with depletion of local gas fields, gas companies have started to rely more on multiple sources. This trend was accelerated by the unbundling of integrated gas companies, resulting in gas transmission being separated from production and sales. Free trade of gases make that transmission system operators are obliged to transport gas from a producer to a customer irrespective of the composition. Transmission system operators are not (yet) responsible for the quality of the gas.

Policy makers in Europe aim to complete the internal market for commodities in Europe. The basic idea behind this is that competition will warrant low prices for the customers. Moreover, unlimited cross-border trade of natural gas would increase security of gas supply by facilitating imports from a wide range of suppliers. Unlimited cross-border trade of natural gas requires well defined specifications of the relevant gas properties in order to guarantee safety, efficiency and minimum emissions. However, EASEE-gas, a consortium of primarily gas suppliers, has unfortunately defined such a wide range for crucial gas parameters that **efficiency, emissions and safety are threatened to be jeopardised**. The EASEE-gas range, also proposed as a CEN standard, basically accepts all LNG compositions commercially available on the market. A narrow gas composition range needed for optimum performance of gas applications is seen as inconvenient by certain gas suppliers, since it may force them to carry out gas treatment with associated costs.

It is very clear already that a Europe-wide acceptance of the wide EASEE-gas parameter range will require widespread renewal or adaptation of all gas-fuelled equipment and feedstock applications. **An initial study [1] has shown that the costs of adapting the gas applications might exceed 178 billion Euro while a possible the benefit for European customers would only be 0.2 billion Euro per annum**. The final report also highlights that this cost needs further investigations [2].

It has to be emphasized, that even after adapting the gas appliances, performance and safety are reduced compared to a scenario with a narrow gas specification and that, performance of gas-fuelled equipment becomes variable and therefore less predictable (excerpt from table 2 "summary of benefits, costs and risks" of the final report /2/: "***appliance incompatibility high***"). This is unacceptable for e.g. applications ensuring the stability of the electricity grid. Reference [1] clearly showed that narrowing the gas parameter range by treating LNG is factors cheaper than the costs of the consequences of a wide gas parameter range. It should be remarked that reference [1] is only a preliminary study and some assumptions on possible benefits of a wide gas parameter range might be somewhat incorrect but associated uncertainties/risks seem to be big

Arguments by some stakeholders a wide Wobbe Index is common practice already in Spain appears to be incorrect. According to information from Sedigas, Madrid, the Spanish Wobbe Index varies between 50.2 and 53 MJ/m^3, with a mean value of 51.8 MJ/m^3. The composition of the gas is **quite stable locally**. Spain would experience substantial problems with its fleet of gas equipment if the Wobbe Index would suddenly have a value of 46.5 MJ/m^3.

EUROMOT is convinced the currently available data shows that treating LNG imports to within a more narrow range is more cost-effective and beneficial to gas users and the environment than adapting the whole European fleet of gas-using equipment.

This position paper shows that removing higher hydrocarbons from extremely rich LNG can even be profitable. It is highly probable that a situation of a very wide gas composition range ultimately leads to substantial negative effects for the gas users and for the European economy.

2. Gas quality range in the USA and a recent proposal by E·ON

About a decade ago, the USA initially expected to cover a large fraction of their natural gas needs with LNG imports from diverse sources in the world. Many terminals were constructed at both the East and West Coast. Concern was raised about the wide variation in composition of the LNGs to be imported. Meetings of the gas sector with equipment manufacturers and consumers, the so-called NGC+ group, resulted in a range of gas compositions acceptable for all stake holders [3, 6]. Figure 1 compares the US Wobbe Index range with the EASEE-gas range. The Wobbe Index is a parameter basically affecting the power output and air-to-fuel ratio of a gas appliance. Changes in power output and air-to-fuel negatively influence performance with respect to efficiency, safety and emissions. Gases with a high Wobbe Index generally have a low knock resistance which additionally affects stationary and mobile gas engines.

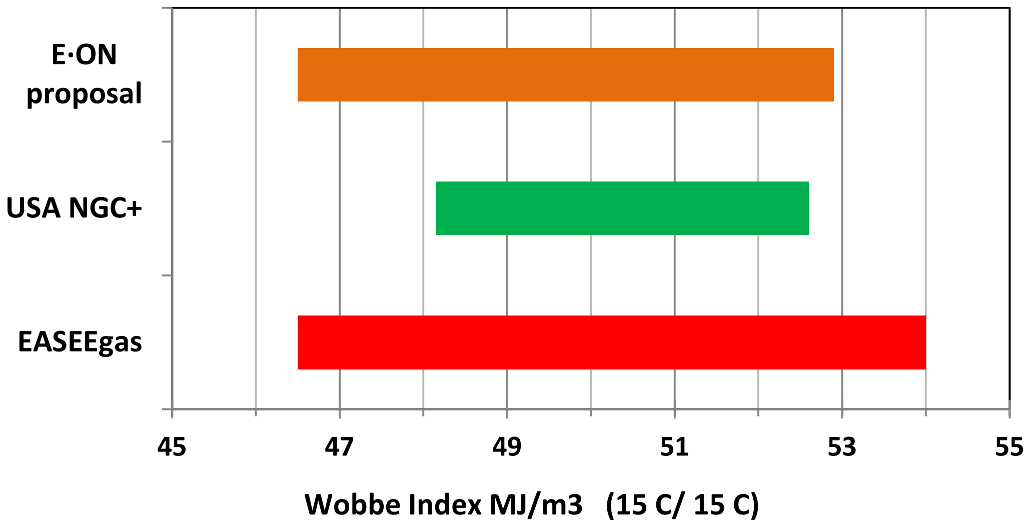


Figure 1: Comparison of the Wobbe Index range of EASEEgas, the USA NGC+ and the recent E·ON proposal [4]

Today, due to the substantial amounts of shale gas in the USA, LNG imports are no longer necessary. However, the NGC+ quality range set for LNG imports is still applied and is now used for shale gas. Shale gas can differ substantially in composition from location to location, even in case of the same basin. That means that shale gas has to be treated before it can be injected into the nationwide gas transmission system. Ultimately, the removal of higher hydrocarbons from the original shale gas streams appears to be quite profitable for the producers in the USA because of the high commercial value of these so-called natural gas liquids. The removed higher hydrocarbons can be sold at oil parity, which renders a higher price than selling them as natural gas. **The current low natural gas price in the USA is only sustainable thanks to the proceeds of these natural gas liquids**.

E·ON proposed /4/ a narrower Wobbe Index range, because the wide EASEE-gas range might give rise to unacceptably high CO emissions of a large number of domestic appliances.

3. Removing higher hydrocarbons for a narrower gas composition range

We will now use an example in which Libyan LNG is turned into a gas that fits within the more moderate NGC+ range. Libyan LNG is one of the gases in the upper Wobbe Index range of the LNGs to be imported in Europe. Figure 2 shows that only small amounts of this gas are expected to be imported. Accepting this extreme gas without treating it requires a wide Wobbe Index range that **results in substantial problems** and costs for European users.

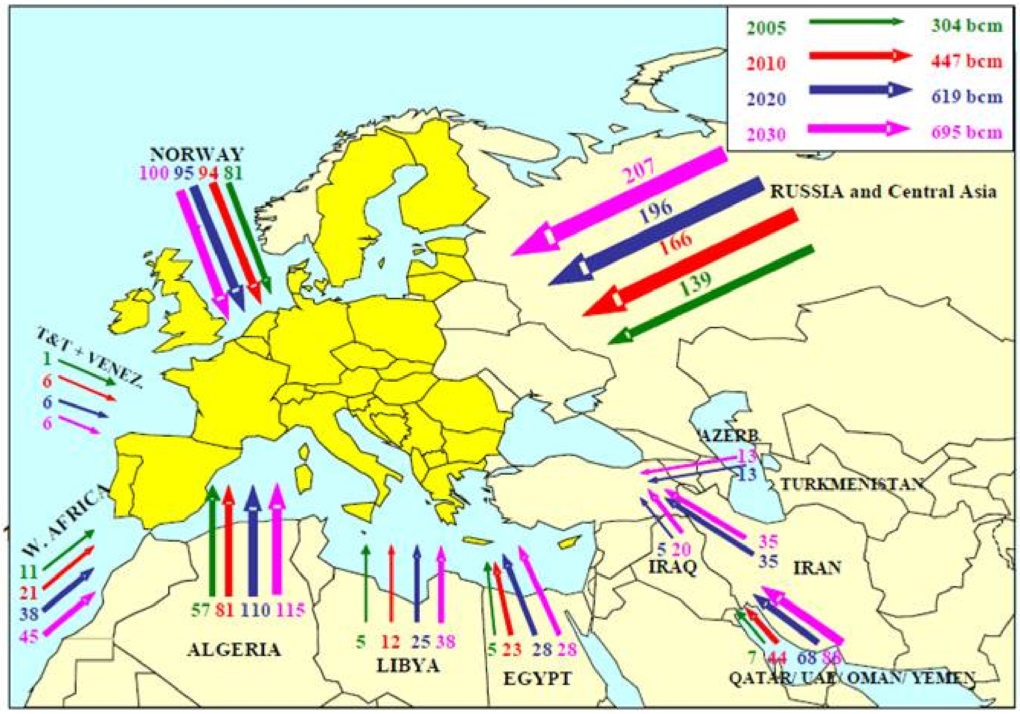


Figure 2: Expected sources of gas imports for Europe.

Removing higher hydrocarbons from gases with an excessively high Wobbe Index is common practice in the gas sector. Higher hydrocarbons can easily be separated by cooling the gas stream. LNG is transported cooled and the chill from the LNG can be used when evaporating, facilitating the process.

Figure 3 gives a schematic representation of the process.

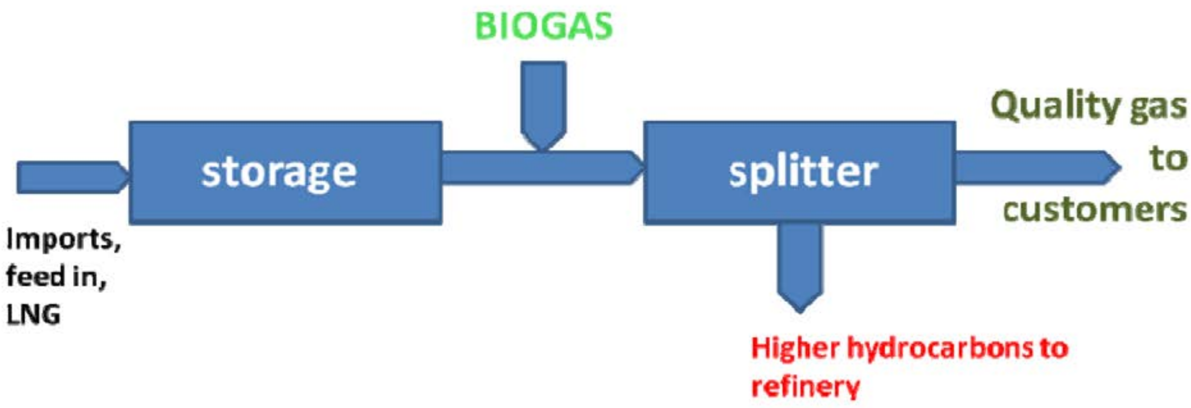


Figure 3: Schematic process for improving natural gas quality.

Table 1 shows the composition of the original Libyan LNG with a Wobbe Index of 53.97 MJ/m3 and the composition of the treated gas with a Wobbe Index equal to the USA NGC+

value. The table also give the composition of the resulting natural gas liquids (NGL). A methane number of 65, as found in Libyan "raw gas", would amongst all negatively affect engine performance

Table 1: Effect on the major gas properties of turning Libyan LNG into gas of NGC+ quality (conditions 15 °C/15 °C). The methane number is an indicator of the knock resistance of the fuel. (data based on Gasunie Fyscal)

component	unit	Libyan LNG	Treated gas	Removed NGL composition
Methane	Vol %	81.57	90	
Ethane	Vol %	13.38	7.45	69.0
Propane	Vol %	3.67	1.35	25.7
Butane	Vol %	0.69	0.2	5.3
Nitrogen	Vol %	0.69	1	
Upper calorific value	MJ/m3	44.00	41.23	77.17
Lower calorific value	MJ/m3	39.86	37.44	70.83
Wobbe Index	MJ/m3	53.79	52.61	69.58
Methane number		65	77	-

Turning the Libyan LNG into an NGC+ quality gas reduces the volume of the original gas stream by about 10%. Further, the calorific value of the new gas is 8 % lower than that of the Libyan LNG.

If natural gas sells at 7 €/GJ (upper calorific value) in Europe, one m^3 of untreated Libyan LNG could be sold for 30.8 €cts/m^3. We presume the 7 €/GJ as a typical sales price in EU. The treated gas sells then at 28.9 €cts /m^3 since it has a lower calorific value than the original gas. The treated gas has a volume which is 10% lower than that of the original Libyan gas, so one receives 4.8 €cts less per m^3 of the original gas. However, if the resulting natural gas liquids can be sold to refineries at 75% of a crude oil price of 12.5 €/GJ (≈ 100 US$/barrel), the natural gas liquids (NGL) can be sold for 72.3 €cts/m^3. Treating one m^3 of Libyan LNG brings about 0.1 m^3 of NGL, which renders NGL sales of 7.23 €cts per m^3 of Libyan LNG. **Converting the Libyan LNG into a more acceptable gas ultimately results in an additional gross profit of 7.23- 4.8 ≈ 2.46 €cts per m^3 of the original gas**.

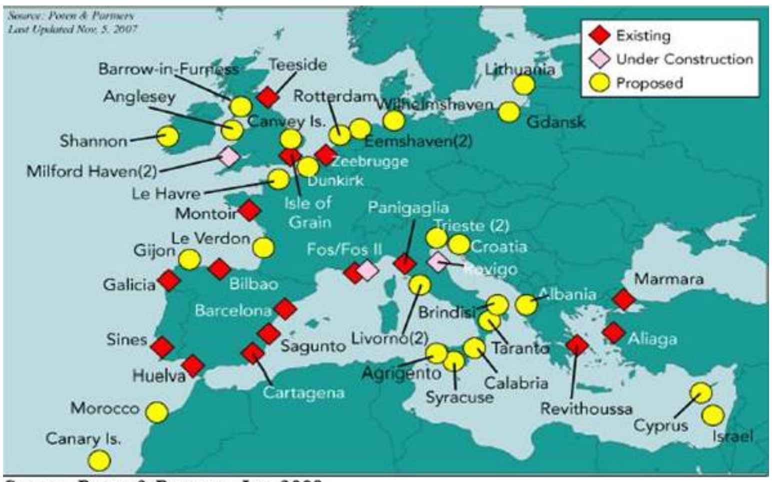
A presentation by Anne B. Keller from Midstream Energy Group during a workshop for the USA Energy Information Agency on June 6, 2012 [5] gives clear indications on the costs of the economics of the removal of ethane from a natural gas stream. Ethane is more difficult to remove from natural gas than propane and butane since it has a lower boiling point. Propane and butane are therefore even more easily removed from a gas stream than ethane resulting in lower costs. According to the Keller presentation, the capital and operational costs of removing 47 MJ of ethane from a gas stream are about 1 €ct. This equals about 21 €cts/GJ. If we use this figure to calculate the removing costs of 1 m^3 of NGL having a calorific value of 77.17 MJ/m^3, we end up with 1.6 €cts/m^3. Since the NGL are just 10% in volume of the original gas stream, the costs per m^3 to improve the original gas stream are 0.16 €cts/m^3. The **net profit** of removing the NGL from the Libyan LNG is then 2.46 – 0.16 **= 2.3 €cts/m^3**.

Even if the removal costs would double to 42 €cts/GJ, the profit of adapting the gas remains very clear. In the USA, where gas sells at about half the price in Europe, the relative profit of removing higher hydrocarbons is even higher.

Table 2: Overview of the costs/profits of removing natural gas liquids from the Libyan LNG to make a gas fitting into the NGC+ range

Presumed price of gas per unit of energy	€ 7/GJ
Resulting price of Libyan LNG	30.8 €cts/m3
Resulting price of treated gas	28.9 €cts/m3
Volume reduction of original gas	10%
Reduction in income from Libyan LNG	4.8 €cts/m3
Additional income from NGL per Libyan LNG m3	7.2 €cts/m3
Final additional income from Libyan LNG	2.46 €cts/m3
Estimated treatment costs Libyan LNG	0.16 €cts/m3
Additional income from Libyan LNG	**2.3 €cts/m3**

In practice, the treatment costs for removing the bulk of the natural gas liquids will depend also on the utilisation factor of the gas treatment equipment. A lower utilisation factor increases the specific capital costs. However, an easy solution would be to lead the extreme LNG compositions such as the Libyan LNG to a single reception terminal in Europe. Most LNG reception terminals are situated at ports with oil refineries, so transporting natural gas liquids to refineries is relatively easy.



Source: Poten & Partners, Inc. 2008.

Figure 4: LNG terminals in Europe.

4. Nitrogen ballasting of gas streams with high Wobbe Index from LNG terminals is not a good solution

In January EON/Ruhrgas, a major player in the European natural gas sector, published a paper [4] that the wide gas range as initially promoted by EASEE gas and later adopted by ENTSO-G and CEN will cause safety problems in a certain category of domestic appliances. Paper recommends the maximum Wobbe index for conditions 15 °C/15 °C should be reduced from 54 MJ/m^3 to 52.9 MJ/m^3. Retrofitting or replacing the relevant appliances is stated to be by far not an economic option, thus confirming the findings in [1]. Reference [4] suggested a solution by ballasting the original gas stream with nitrogen. Figure 5 shows that decreasing the Wobbe Index from 54 MJ/m^3 to a limit proposed by E·ON of 52.9 MJ/m^3 as requires an increase of 1.7% in nitrogen content.

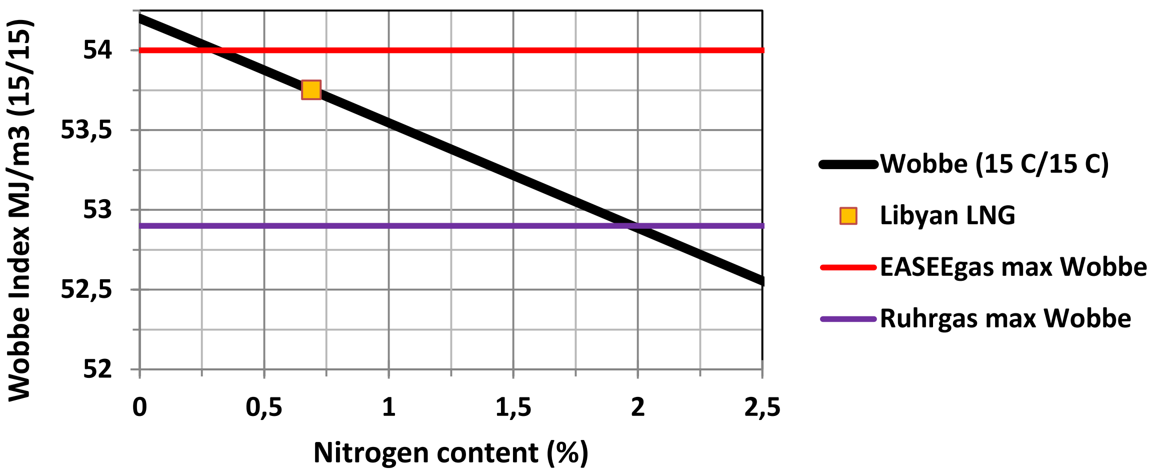


Figure 5: Lowering the Wobbe Index of natural gas by adding nitrogen

The required nitrogen has to be derived from ambient air. Different methods exist for such a process. The three common methods are:

- pressure swing adsorption;
- compression with molecular sieves;
- cryogenic distillation;

Costs estimates in the literature do not give substantially different values for the three methods of nitrogen production. Much will depend on the size of the installation and its utilisation factor. Reference [4] mentions a price of 0.3 €cts per m^3 of natural gas delivered as a maximum for decreasing the Wobbe Index to 52.9 MJ/m^3. This is almost a factor 2 higher than the costs of removing higher hydrocarbons of 0.16 €cts/m^3 to decrease a Wobbe index of 53.8 MJ/m^3 to the NGC+ limit of 52.6 MJ/m^3 as discussed earlier (Table 2). **Moreover, with nitrogen ballasting, the substantial profits to be made from selling higher hydrocarbons do not occur.**

5. Special remark for gas engine applications and other appliances

Flexible gas engines, often part of cogeneration units, will play an important role in balancing electricity supply and demand in future systems with a substantial fraction of wind and solar energy (see attachment 2). In addition, decentralized cogeneration of heat and electricity is accepted by the European Commission and the International Energy Agency as an effective method for reducing fuel consumption and decreasing greenhouse gas emissions (promoting EU 20-20-20 targets). The gas sector is in a process to approve a methodology for determining the knock resistance of natural gases via CEN TC 234. The knock resistance is an important quality parameter for the performance of gas engines. There is common agreement that gases with a high Wobbe Index have a poor knock resistance. A lower maximum in Wobbe Index is therefore welcomed, but adding nitrogen to a gas does not improve the knock resistance which is acknowledged by CEN. This is another reason to opt for removal of higher hydrocarbons rather than ballasting with nitrogen. See Euromot documents [6, 7] for more information.

Ultimately, choosing a narrower gas quality range than that initially proposed by EASEE-gas avoids substantial extra costs for the gas consumers for adapting their equipment and results in better performance (and higher safety) of all gas using equipment. This is apart from the lower fuel efficiency and higher emissions that the equipment would have with a wider gas quality range. The net benefit for Europe of opting for a narrower gas composition range by removal of higher hydrocarbons will therefore be substantial, both because of lower costs for the users and additional profits in the energy chain. Moreover, a narrower range results in higher safety. Harmonisation with the USA NGC+ Wobbe Index range is therefore highly recommended.

6. Other general remarks

I. The issue of the risk of incorrect adjustment of gas-fuelled appliances and installations in case of a wide Wobbe Index range is still insufficiently addressed by the gas industry. A technician carrying out periodic maintenance cannot be aware of the actual Wobbe Index during his actions. Gas appliances have to be adjusted at the average expected Wobbe Index in order to be able to accept a certain range. The Wobbe Index during the maintenance actions can be anywhere between high and low. If adjustment takes place when the Wobbe Index is low, a high Wobbe Index will cause overload and CO emissions. If adjustment takes place when the Wobbe Index is high, a lower Wobbe Index can cause flame blow off and loss of capacity.

II. Also the issue of problems arising from rapid changes in Wobbe Index and Methane Number have not properly been addressed in the EASEE-gas/ENTSOG and CEN work. According to the proposed standards, even plug flow, an instantaneous change in Wobbe Index, is allowed.

III. Sulphur content of natural gas is another issue that is insufficiently addressed in the current proposals. Sulphur compounds in natural gas **deteriorate emission reduction catalysts, cause corrosion of gas-fuelled equipment, increase undesired emissions,** result in undesired colouring in porcelain production and affect chemical processes [8,9]. Especially fuel cells deteriorate quickly from sulphur. Next to this, sulphur compounds tend to increase particulate emissions (PM 2.5 which is of the ambient air quality current/future main concerns in EU). The limits in sulphur contents in natural gas should therefore be drastically decreased.

7. Conclusions

I. Treating imported gases for Europe to fit into a narrower gas quality range than that initially proposed by EASEE-gas is profitable in case of selling the removed natural gas liquids as feedstock to refineries. By this also gases with a Wobbe Index beyond the proposed ide EASEE Gas specification such as associated gases from oil fields could be imported and used in the EU and thus open up new wider supply/business options. This is also of benefit for security of supply of liquid fuels in Europe. Proof of the profitable treatment of raw gases can be found in the USA.

II. Consumers of natural gas would benefit substantially from a narrower gas specification in terms of better fuel efficiency, lower emissions and avoiding costly replacement of installations. Moreover, the risk of issues with respect to safety will be substantially reduced.

III. Ballasting natural gas with nitrogen does not improve the poor knock resistance of gases with a high Wobbe Index and ultimately costs money instead of providing a profit option as in case of removing higher hydrocarbons. Also other gas applications such as the chemical industry prefer gas with less nitrogen content since they basically need a high methane fraction. Oxyfuel combustion, one of the methods for carbon capture and sequestration, will suffer from additional nitrogen in natural gas by producing substantially more oxides of nitrogen.

IV. Any legal barriers preventing gas transmission system operators to improve the quality of imported gases by removing and subsequently selling higher hydrocarbons should be removed for the sake of obtaining the optimum economic situation for Europe.

V. The risk that installations crucial for the European economy have to shut down occasionally because of an excessively wide gas composition range will also decrease by lowering the maximum allowed Wobbe Index via removal of higher hydrocarbons.

VI. Ultimately, the EU 20-20-20 targets will be better served by a narrower gas composition range.

EUROMOT – 2014-03-26

For more information please contact:

European Association of Internal Combustion Engine Manufacturers – EUROMOT
Paul Zepf, (+49 69) 6603-1752, paul.zepf@euromot.eu
EU Transparency Register ID number: 6284937371-73

REFERENCES

1. GL Noble Denton and Pöyry, '*Study on Interoperability -Gas Quality Harmonisation -Cost Benefit Analysis*', July 2011; at http://ec.europa.eu/energy/gas_electricity/consultations/doc/20110916_cost_benefit_analysis_report.pdf

2. GL Noble Denton and Pöyry, '*Gas Quality Harmonisation -Cost Benefit Analysis*'(Final Report), July 2012; at http://ec.europa.eu/energy/gas_electricity/studies/doc/gas/2012_gas_quality_harmonisation_cost_benefit_analysis_.pdf

3. Natural Gas Council, White Paper on Natural gas Interchangeability and Non-Combustion End Use, February 28, 2005.

4. Klaus Altfeld, Liaison Officer CEN TC 234, PC 408, TC 19, "*Harmonization of Wobbe Index in Europe – Rethinking Required*", January 2014

5. Anne B. Keller, "*NGL – The Basics*", abk@midstreamenergygroup.com, presentation June 6, 2012

6. Euromot Position paper "Gas Quality cost-benefit consultation US-rules", September 15th 2011 at http://www.euromot.org/download/5b335b91-c2a4-4146-b47b-1aad7eb423bf/GAS%20QUALITY_cost-benefit%20consultation_US%20rules%202011-09-15.doc

7. Euromot Position on Gas Quality, 2011; at http://www.euromot.org/download/bfa1d894-73d0-4b01-a3a0-90735b608fe2/GAS%20QUALITY%20euromot%20position%202011_05.pdf

8. Euromot Position on Sulphur levels in natural gas, 04.04.2012; at http://www.euromot.org/download/30e10106-5cca-4349-a337-91d1a9b804cf/GAS%20QUALITY_sulphur%20levels%20in%20natural%20gas%202012-04-04.pdf 9

9. Euromot Position on Sulphur, 30.08 2012; at http://www.euromot.org/download/d606ce6a-3b67-4c6e-8ed9-92db4aa964f8/GAS%20QUALITY_sulphur%202012-08-30.pdf

ATTACHEMENT - 1

The fraction of LNG with high Wobbe Index and low Methane number was very small in 2010 (The Wobbe Index in this diagram is for 25 °C/0 °C)

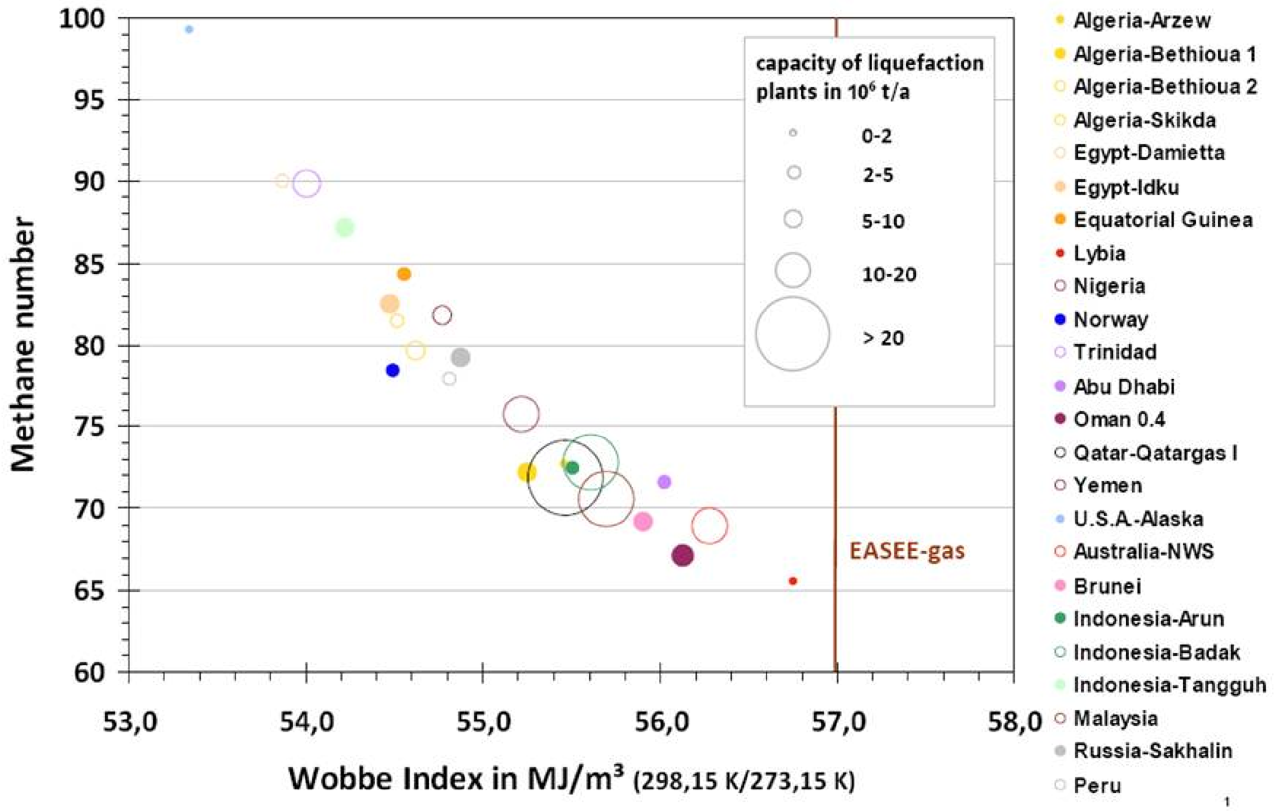
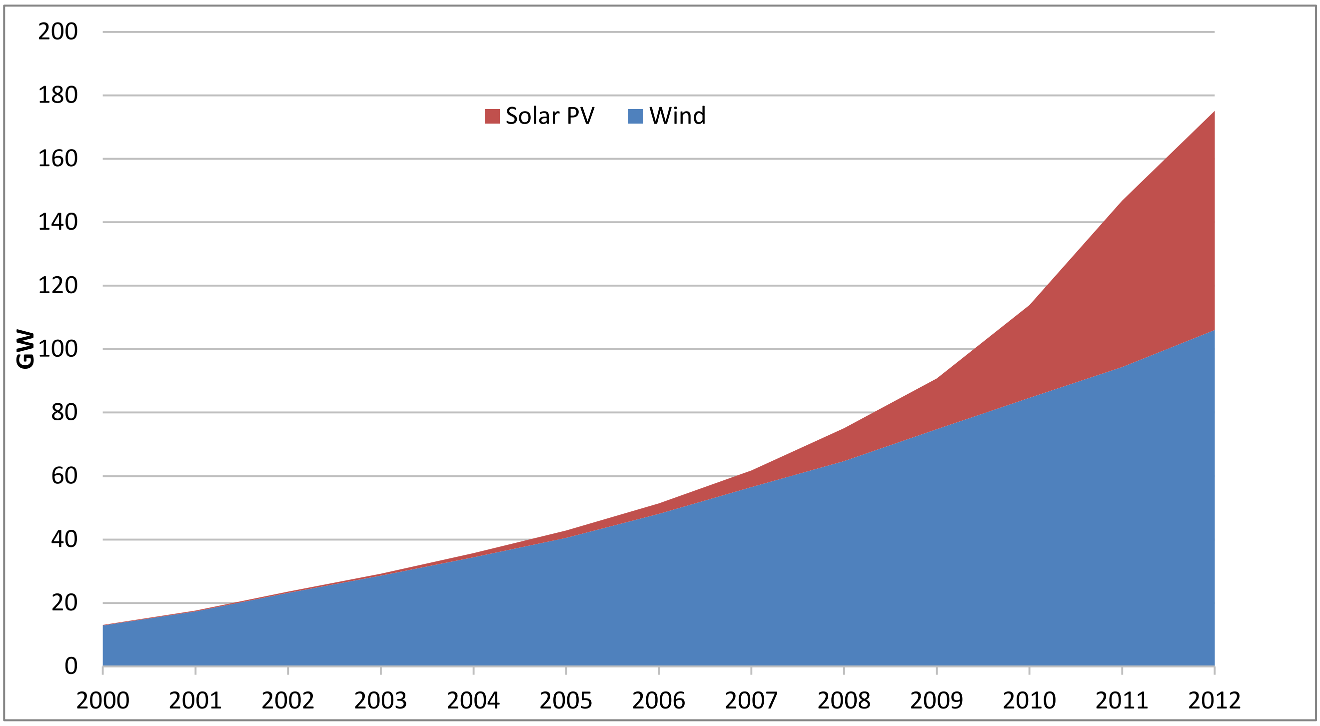


Fig. 1: Methane Number vs Wobbe Index for LNG Qualities according to GIIGNL Report 2010

Source: EON Ruhrgas

ATTACHEMENT-2

5) Wind and Solar in EU 27



Source: European Wind Energy Association (EWEA), European

EUROMOT is the European Association of Internal Combustion Engine Manufacturers. It is committed to promoting the central role of the IC engine in modern society, reflects the importance of advanced technologies to sustain economic growth without endangering the global environment and communicates the assets of IC engine power to regulators worldwide. For more than 20 years we have been supporting our members - the leading manufacturers of internal combustion engines in Europe, USA and Japan - by providing expertise and up-to-date information and by campaigning on their behalf for internationally aligned legislation. The EUROMOT member companies employ all over the world about 200,000 highly skilled and motivated men and women. The European market turnover for the business represented exceeds 25 bn euros. Our **EU Transparency Register** identification number is **6284937371-73.**

http://www.euromot.eu – your bookmark for IC engine power worldwide

Our members are:

DIESEL AND GAS ENGINE MANUFACTURERS

AGCO POWER
CATERPILLAR GROUP
CNH INDUSTRIAL GROUP
CUMMINS
DAIMLER
DEUTZ
DOOSAN
GE POWER & TRANSPORTATION GROUP
HATZ
JCB POWER SYSTEMS
JOHN DEERE
KOMATSU ENGINES
LIEBHERR
LOMBARDINI
MAN GROUP
MITSUBISHI TURBOCHARGER & ENGINE EUROPE
MOTEURS BAUDOUIN
ROLLS-ROYCE POWER SYSTEMS
SAME DEUTZ-FAHR
SCANIA
STEYR MOTORS
VOLKSWAGEN INDUSTRIAL ENGINES
VOLVO CONSTRUCTION EQUIPMENT
VOLVO PENTA
WÄRTSILÄ
YANMAR GROUP
ZETOR

SMALL SI ENGINE MANUFACTURERS

BRIGGS & STRATTON
DOLMAR
EMAK
HONDA EUROPE
HUSQVARNA GROUP
KAWASAKI EUROPE
KOHLER GLOBAL POWER GROUP
SOLO
STIHL
TORO EUROPE
WACKER NEUSON
YAMABIKO GROUP