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ITALIAN CONSIDERATIONS ON THE LPG EURO CONNECTOR

INTRODUCTION

The different filling systems used in the LPG refuelling networks of the various contracting Parties produce a series of negative effects affecting the use of LPG vehicles in terms of safe, easy and environmental friendly refuelling.

Consequently the mobility of the European LPG vehicles is generally restricted in their national territories.

The above situation is unacceptable and nowadays, after the entry into force of 67/01 ECE Regulation times are ripe for the adoption of an **ECE connector/nozzle system.**

Italy fully supports this decision.

Unfortunately the evolution process from the present situation to the future one cannot be achieved in zero time.

In order to make clear the meaning of the difficulties of this kind of operation it is important to bear in mind that as far as the first ECE/connector will be installed in a car, its owner must have the possibility to supply the LPG he needs wherever and whenever he likes.

A transitional period is needed in order to provide the fleet and the refuelling network with new connectors and nozzles with the minimum inconvenience and cost for both consumers and LPG suppliers.

In the above described scenario, the management of the transitional period is the most important problem the solution of which concerns many aspects such as: safety, environment protection, inconveniences and costs for consumers and LPG suppliers, etc.....

This means that the management of the transitional period, more than a technical is an economical problem, and on the basis of this consideration the Italian delegation asked for a reconsideration of the problem before the adoption of a definitive solution.

GENERALS

The aim of this document is:

a) to provide an overwiew of the present situation;
b) to develop various hypotesis of the transitional period;
c) to draw out a series of conclusions.

All the data on which the present paper is based come from AEGPL sources, but since the Italian LPG fleet of 1.300.000 vehicles and the Italian refuelling network of 2.200 stations constitutes the most important LPG phenomenon of the European Union, when considering trends and evolution of the market, reference was made to the Italian situation.

The document consists of two parts:

PART I 1/

1/ Part I, related to vehicle problems was drafted by the Italian MOT.

PART II 2/

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PART I

1.THE PRESENT SITUATION IN EUROPE

1.1 Hints on the national situations

- The volumes of the European LPG vehicle fleets are shown in the following table (source AEGPL):

Country	***No. of LPG Vehicles***	***% of Total***
Italy (*)	**1.300.000**	***48,35%***
Austria	900	***0,03%***
Belgium	80.000	***2,98%***
Bulgaria	17.000	***0,63%***
Croatia	12.000	***0,45%***
Czech Republic	145.000	***5,39%***
Germany	6.500	***0,24%***
Danmark	0	***0,00%***
Spain	7.500	***0,28%***
Finland	0	***0,00%***
France	180.000	***6,69%***
United Kingdom	13.000	***0,48%***
Greece	2.500	***0,09%***
Hungary	100.000	***3,72%***
Ireland	1.200	***0,04%***
Luxembourg	0	***0,00%***
Netherlands	325.000	***12,09%***
Norway	0	***0,00%***
Poland	470.000	***17,48%***
Portugal	28.000	***1,04%***
Sweden	200	***0,01%***
Total	**2.688.800**	***100,00%***

(*) Italian MOT source

2/ *Part II, related to the filling network problems was drafted by the expert of the concerned sector. The different implementation scenarios analysed in this part and their impact was taken into account in the conclusion of part I.*

- The refuelling network (source AEGPL):

Country	*No. of LPG filling stations*	*% of Total*
Italy (*)	**1.980**	***19,95%***
Austria	14	***0,14%***
Belgium	630	***6,35%***
Bulgaria	35	***0,35%***
Croatia	30	***0,30%***
Czech Republic	493	***4,97%***
Germany	160	***1,61%***
Danmark	70	***0,71%***
Spain	43	***0,43%***
Finland	2	***0,02%***
France	1.600	***16,12%***
United Kingdom	285	***2,87%***
Greece	32	***0,32%***
Hungary	70	***0,71%***
Ireland	200	***2,01%***
Luxembourg	0	***0,00%***
Netherlands	2.200	***22,16%***
Norway	31	***0,31%***
Poland	1.900	***19,14%***
Portugal	140	***1,41%***
Sweden	11	***0,11%***
Total	**9.926**	***100,00%***

(*) Italian Ministry of Industry source

- The mainly used filling units.

Three filling units systems are currently co-existing in Europe (see slide 1):

- The “ACME – thread”: used in Austria, Belgium, Germany, Poland and Ireland;
- The “BAYONET – quick coupling” used in the Netherlands, UK, Poland;
- The “DISH coupling” used in Italy, France, Poland, Portugal, Greece, Spain.

1.2 The Italian situation

In Italy, almost the totality of LPG vehicle fleet result from retrofitting.

As said before, the DISH coupling converter fits 100% of LPG vehicles. It is fitted on the car in three different configurations according to the bodywork lay out:

- Configuration A: DISH coupling installation in the petrol receptacle -if possible- (see slide 2);
- Configuration B: when the previous solution is not possible, installation in the petrol receptacle of a two parts DISH coupling (see slide 3), one part in the vehicle and the other has to be screwed on the first only for filling operation.
- Configuration C: DISH coupling installation on the bumper (see slide 4).

The three configurations are related to the Italian consumers acceptance.

Today in Italy about the 90% of the LPG fleet is fitted in B configuration.

As a matter of facts, Italian consumers, for aesthetic considerations, do not like holes cut in the bodywork.

On this bases, and in order to prevent fancy solution, the Italian MOT encouraged B configuration.
The technical justification for this choice were:

- to minimize the corrosion risk of car bodies;
- to limit the risk of fires caused by the spilling of gas through the no return valve by using the existing receptacle designed by the car manufacturer to ensure efficient ventilation against the fuel vapours.

2. THE "EURO CONNECTOR"

2.1 Main features.

In order to ensure the filling of all the LPG vehicles in all the European fleet without any difficulties and prejudice for safety and environment, the GRPE recently adopted a new filling unit: the so called "**Euro connector**".

The **euro connector** is defined as a profile (see slide 5) and its technical characteristics are exhaustively defined in the document TRANS/WP29/2001/61.

Anyway, referring to the aim of the present document, it is useful to remind the following points:

- the **euro connector** "……shall not be dismountable by design".
- Its overall dimensions must be roughly contained in a cylinder ∅33mm and height 40mm (corresponding to its maximum protrusion).
- It is conceived with a male section.
- The dead volume between front sealing surface and the front of the no-return valve shall not exceed 0.1cc.

2.2 Comments.

From the technical point of view only two comments are made:

- the filling nozzle is the filling system part more sensitive to the dirt. So, the choice of the male profile for the connector and the female one for the nozzle does not seem the most appropriate solution in order to minimize the risk of LPG contamination during the filling operation;

- The overall dimensions together with the dismountability prescriptions make the **euro connector** incompatible with the quasi totality of petrol receptacles, of the existing vehicles.

2.3 The Italian problem.

The fitting of the **euro connector** on the vehicles, according to our national situation, is a major problem.
In order to understand the reasons of the Italian concerns it is important to remind the following considerations:

- as said in the introduction and according to what will be demonstrated in the Part II of this document, a short duration of the transitional period will reduce the negative effects of the co-existence of two filling systems in the same network..
- this implies that the LPG existing fleet must be equipped with new connectors as soon as possible.
- the present Italian fleet, shown in point 1.1, consists of 1,300,000 vehicles all equipped with DISH coupling, 90% of which in B configuration (two parts connector).
- the **euro connector** is incompatible with the quasi totality of petrol receptacles fitted in the existing vehicles.

Bearing in mind above assumptions, the conclusion is that in Italy the 90% of LPG fleet, namely 1,170,000 vehicles, need bodywork intervention.

The above conclusion brings to the economical aspects associated with the connector replacement campaign.

The cost per vehicle are calculated for two different cases:

- the case "unscrew the old – screw the new";
- the case "unscrew the old – adapt the bodywork – screw the new".

Case 1)	
- cost of the **euro connector** (estimated)	10 +
- cost of labour	12 =
Total per vehicle	22

Case 2)	
– cost of the **euro connector** (estimated)	10 +
– cost of labour (including cutting the holes, antirust treatment, removing hupholstery, adapting the hosery to the new connector location etc	65 =
Total per vehicle	75

Projecting the two cases into the Italian LPG vehicle fleet, the total cost of the **euro connector** replacement campaign is:

total cost = (0.10 x 1,300,000 x 22) + (0.90 x 1,300,000 x 75) = 90,610,000

Assuming that the costs of the various connector types are about the same, the costs related to a new smaller connector that implies only the "unscrew the old – screw the new" would be:

total cost = 1,300,000 x 22 = 28,600,000

This means that, because of the choice of the **euro connector,** the Italian public would pay an extra cost of :

90,610,000 – 28,600,000 = 62,010,000

This extra cost appears senseless and unacceptable by the Italian public.

3. CONCLUSION

The Italian MOT is convinced that times are ripe for the adoption of an ECE LPG connector and fully agrees that it shall be safe and environmentally friend: namely no dismountable by design and with a small dead volume.

But, at meantime, Italian MOT considers that the future **ECE connector** differently from the **euroconnector**:

- must be female section in order to reduce the risk of contamination of LPG during the refuelling operation;
- and that its overall dimensions compatible with the dimensions of currents petrol receptacle used today by the car manufacturer.

This, in order to avoid:

- senseless extra costs associated with the re-fitting of the fleet;
- the risks of corrosion of the car bodies in case of re-fitting the present fleet and retrofitting new vehicles;
- the car manufacturers to redesign the existing receptacle when type-approving bifuel cars.

Moreover, based on the result of the analyses developed in Part II, the envisaged **ECE connector** would meet the desiderata of the LPG filling Association that need:

- certain and short implementation times,
- safe and environmental friend filling operation.

PART II

4. IMPLEMENTATION ON THE MARKET

4.1 Introduction

The implementation of European connection on the market means how to manage the transitional period from the present situation, with the presents filling system (connector and nozzle), to the final one, with the new filling system.

During such transitional period there will be a decreasing number of cars fitted with old connectors and an increasing number of cars fitted with new ones.

Considered that in each European country LPG filling station network is just sufficient to ensure a good service to LPG customers, we have to permit all of them to refuel their cars at every filling station.
So we have to provide for some measures to ensure in any case the connection.

The two possible options considered in this assessment are: adaptors and double nozzles.

The involved scenario is shown in the following figure:

	Present situation	***Transitional Period***	***Steady situation***
Cars	Current connectors	1. Old connectors 2. New connectors	New connectors
Filling stations	Current nozzles	1. Old nozzles and adaptors for new connectors 2. New nozzles and adaptors for old connectors 3. Double nozzles	New nozzles

The main aspects for a right implementation of an European connection on the market are the following:

- **Times**
- **Safety**
- **Pollution**

Since the replacement of the existing nozzles will be a commercial operation based on what will be decided for LPG vehicles in terms of rules, filling stations owners need a **reliable timing of implementation** of connectors on existing and new cars in order to plan replacement of the present nozzles in the best way.

Since during the transitional period some less safe and more polluting tools will be used to allow every LPG consumer to refuel his own car, the implementation will have to be as short as possible.

As a result safety of the implementation will be deemed according to how safe refuelling of all running cars will be in the whole transitional period.

Concerning pollution an analysis will be carried out with the same approach as for safety.

In conclusion the implementation of new European connectors depends on which type of connection will be chosen, so in the following paragraphs we are going to assess which proposed connection is better according to what has been highlighted above.

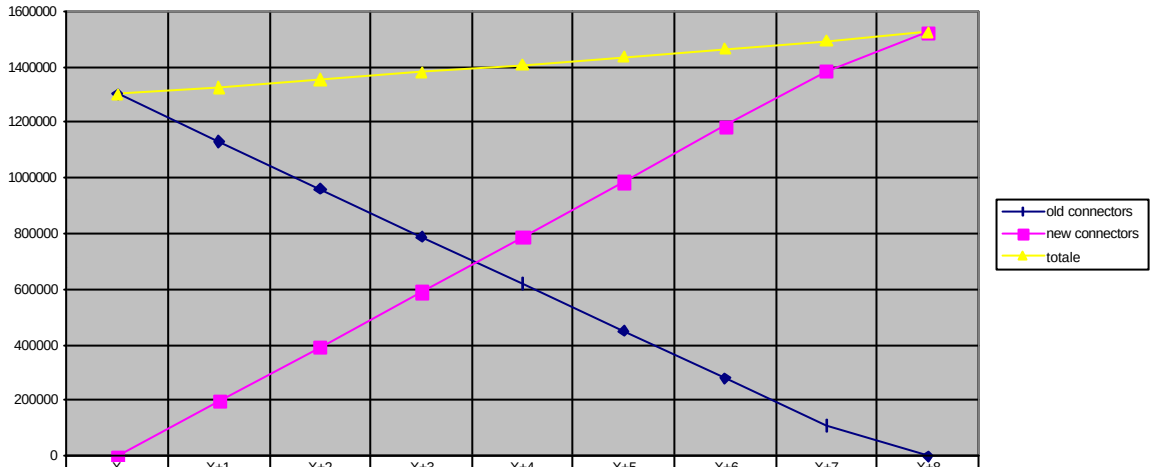
4.2. TIMING

4.2.1 Euroconnector proposal

With such profile only few existing connectors will be replaced because that could imply a high cost for consumers (see par 2.3). So neither Ministry of Transport will be disposed to impose it nor customers will be attracted to spend so much money for an old car.

This way the steady situation will be reached trough a natural substitution of running LPG cars, fitted with past connectors, with new LPG cars (new OEM's and retrofits), fitted with new connectors.

According to what has been mentioned above and taking into account average annual turn over (170.000 per year) and average annual increase (2% per year) of LPG cars, a possible future figure is shown in the following graph.

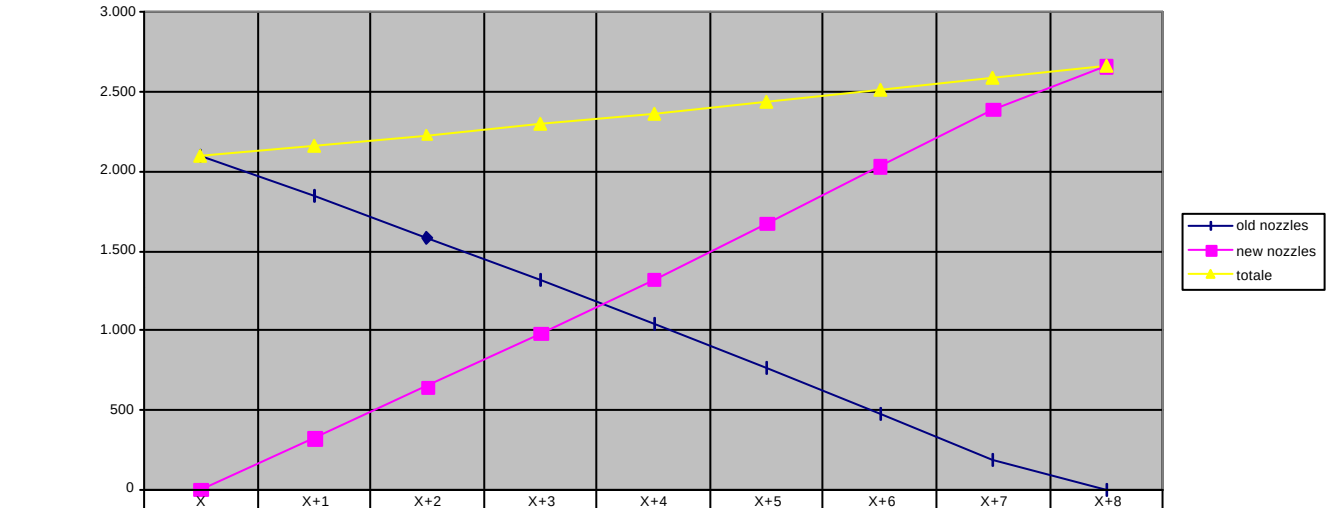


	X	X+1	X+2	X+3	X+4	X+5	X+6	X+7	X+8
old connectors	1300000	1130000	960000	790000	620000	450000	280000	110000	0
new connectors	0	196000	392520	589570	787162	985305	1184011	1383291	1523157
totale	1300000	1326000	1352520	1379570	1407162	1435305	1464011	1493291	1523157

As can be seen, the transitional period would be long (at least eight years) and the last date would be uncertain because it is based on hardly foreseeable data.

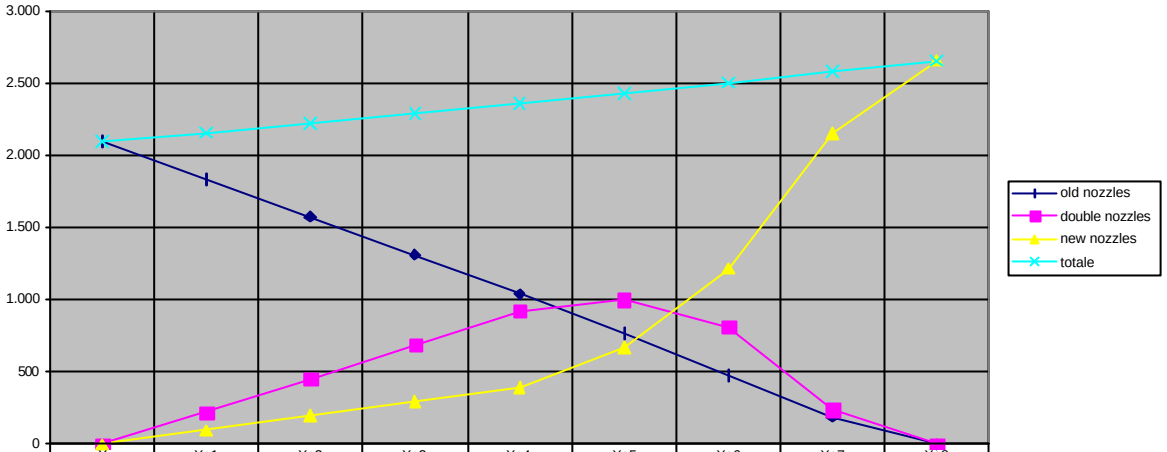
As regards filling stations we expect that the total amount of filling stations will increase by 3% per year, mean value of increasing in the last years.

Since the annual replacement of existing nozzles will follow the annual replacement of connectors in a proportional way, in this case the implementation of new nozzles will be as follows:



	X	X+1	X+2	X+3	X+4	X+5	X+6	X+7	X+8
old nozzles	2.100	1.843	1.581	1.314	1.041	763	480	190	0
new nozzles	0	320	647	981	1.322	1.671	2.028	2.392	2.660
totale	2.100	2.163	2.228	2.295	2.364	2.434	2.508	2.583	2.660

If double nozzles will be checked as proposable, the foreseeable situation will be:



	X	X+1	X+2	X+3	X+4	X+5	X+6	X+7	X+8
old nozzles	2.100	1.843	1.581	1.314	1.041	763	480	190	0
double nozzles	0	224	453	686	926	1.003	811	239	0
new nozzles	0	96	194	294	397	668	1.217	2.153	2.660
totale	2.100	2.163	2.228	2.295	2.364	2.434	2.508	2.583	2.660

Of course in the beginning those owners who will decide to implement new nozzles will prefer to install double nozzles (new and old ones), while others will replace old ones with new ones without spending additional money (double hoses, by-pass valve, trestle).

4.2.2 ECE connector proposal

If a new profile in line with the above paragraph 3. suggestions, namely:

- *With female section in order to reduce the risk of contamination of LPG during the refuelling operation;*
- *And with an overall dimensions compatible with the dimensions of currents petrol receptacle used today by the car manufacturer.*

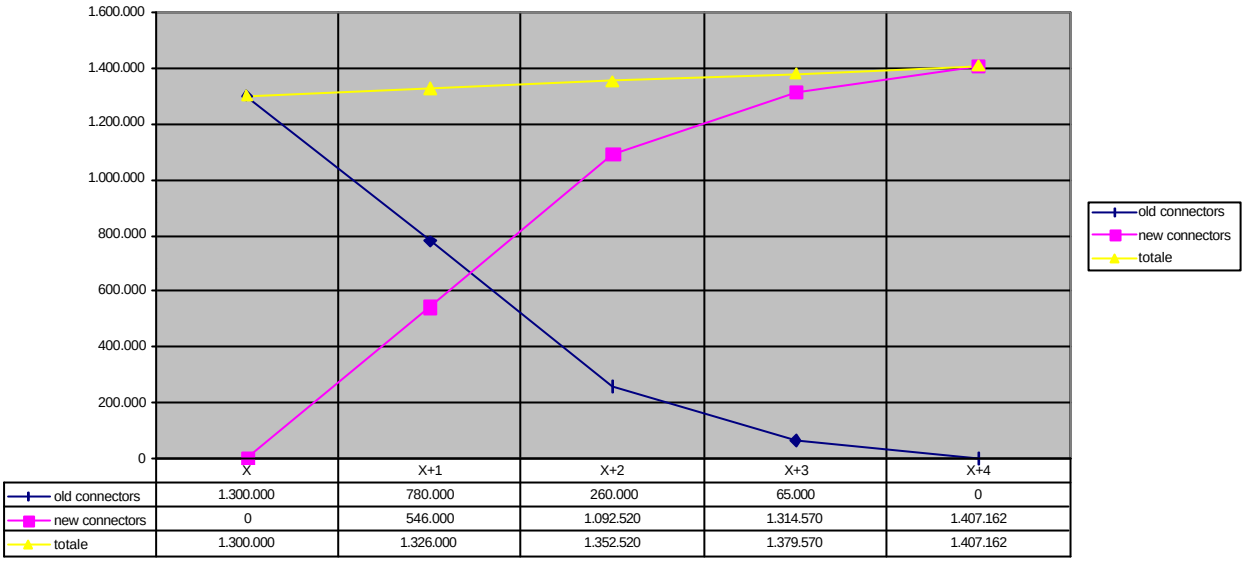
Was adopted, such a profile would make it possible to **force** the implementation of the new connectors, and in this case it would be the real ECE connector.

Indeed, as the quasi totality Italian cars are equipped with connectors placed inside petrol receptacles, the replacement of old connector would be **easy and cheap**. And in this case Italian MOT could evaluate the possibility to impose the substitution of the connector at the first technical inspection of the car in line with the times laid down by the EC directive.

As known, cars have to pass the first technical inspection when four-years old and the next ones every two years.

Therefore, if the implementation of new connectors began at the end of year X, after two years most old connectors would be replaced, whereas only few old connectors would be replaced in the following two years. Anyway it would be possible to adapt all old cars in four years.

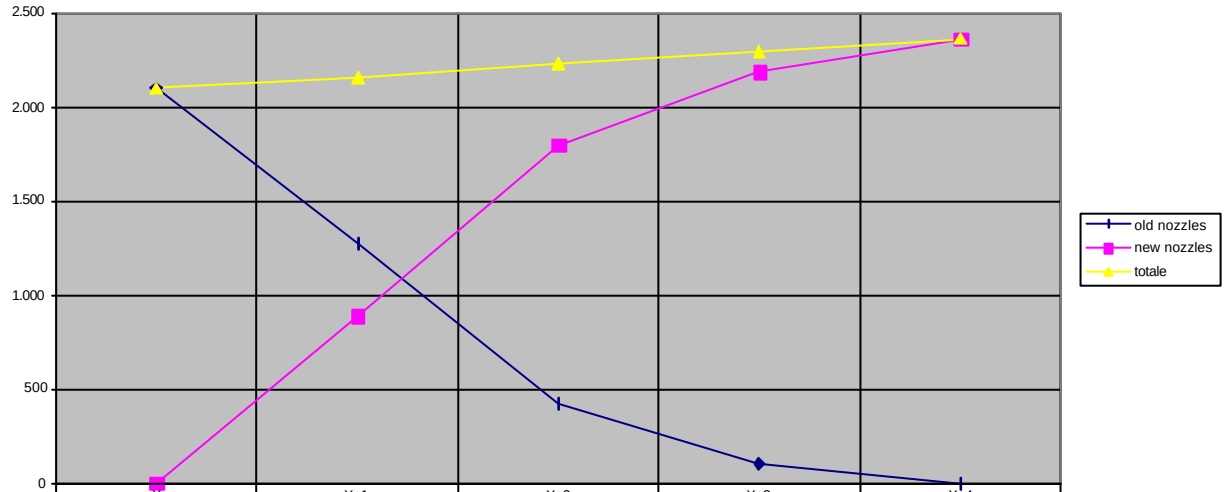
As can been seen below, at the end of the first two years 80% of running cars (at time zero) will be fitted with new connectors, whereas the residual 20% will be adapted in the following two years.



	X	X+1	X+2	X+3	X+4
old connectors	1.300.000	780.000	260.000	65.000	0
new connectors	0	546.000	1.092.520	1.314.570	1.407.162
totale	1.300.000	1.326.000	1.352.520	1.379.570	1.407.162

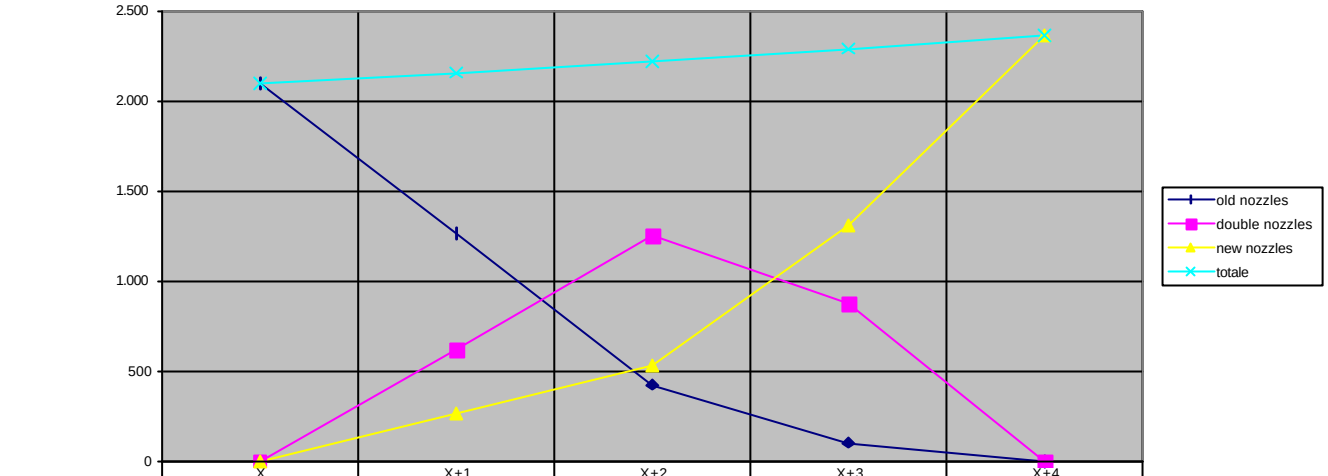
<u>In this case the duration of transitional period is not an output data, but an input data: four years instead of at least eight.</u>

As regards the implementation of new nozzles, confirming the same hypotheses of the previous case, the implementation of new nozzles will be as follows:



	X	X+1	X+2	X+3	X+4
old nozzles	2.100	1.272	428	108	0
new nozzles	0	891	1.800	2.187	2.364
totale	2.100	2.163	2.228	2.295	2.364

If double nozzles were checked as proposable, the foreseeable situation would be:



	X	X+1	X+2	X+3	X+4
old nozzles	2.100	1.272	428	108	0
double nozzles	0	623	1.260	875	0
new nozzles	0	267	540	1.312	2.364
totale	2.100	2.163	2.228	2.295	2.364

4.3. SAFETY

4.3.1 Euroconnector proposal

As specified in the introduction, safety of implementation will be weighted taking into account how safe every refuelling, carried out in the whole transitional period, will be.

Only refuelling made with adaptors are to be considered “less safe” refuelling, then we will calculate annual mean number of refuelling made with a non-coherent connection. This means calculating annual refuelling both between old nozzles and new connectors and between new nozzles and old connectors.

In line with mentioned above, annual refuelling that need the connection of old nozzles and new connectors are calculated as follows:

s annual average LPG sells / filling station

CT average capacity of tank

NC% annual average number of new connector/ total running connectors

ON annual average number of filling station with old nozzles

#r annual average of refuelling / filling station = s/ CT

$r_{ON\text{-}NC}$ annual average number of refuelling ON-NC / filling station = #r * NC%

$R_{ON\text{-}NC}$ total annual number of refuelling ON-NC = $r_{ON\text{-}NC}$ * ON

Where
CT = 40 litres
s = 1.300.000 litres
=> #r = 32.500 [refuelling/filling station]

Proceeding the same way for refuelling between new nozzles and old connectors, we will have the results shown in the following tables:

Without double nozzles

	X	X+1	X+2	X+3	X+4	X+5	X+6	X+7	X+8	
Filing with adaptors ON e NC	0	4.735.803	12.188.062	16.880.864	18.884.566	18.268.068	15.098.830	9.442.901	2.977.719	98.476.813
Filling with adaptors NN e OC	0	4.811.464	12.263.141	16.955.340	18.958.421	18.341.281	15.171.384	9.514.775	3.024.093	99.039.898
Total fillings with adaptors	0	9.547.267	24.451.203	33.836.204	37.842.987	36.609.349	30.270.214	18.957.676	6.001.811	197.516.711

With double nozzles

	X	X+1	X+2	X+3	X+4	X+5	X+6	X+7	X+8	
Filling with adaptors ON e NC	0	4.735.803	12.188.062	16.880.864	18.884.566	18.268.068	15.098.830	9.442.901	2.977.719	98.476.813
Filling with adaptors NN e OC	0	1.443.439	3.678.942	5.086.602	5.687.526	6.526.382	7.731.995	7.253.782	2.880.900	40.289.569
Total filling with adaptors	0	6.179.242	15.867.005	21.967.466	24.572.092	24.794.449	22.830.825	16.696.684	5.858.619	138.766.382

4.3.2 New ECE connector proposal

In this case the two involved scenarios according to the two options on filling stations side are shown in the following tables:

Without double nozzles

	X	X+1	X+2	X+3	X+4	
Filling with adaptors ON e NC	0	11.282.504	16.851.000	7.673.272	1.715.538	**37.522.313**
Filling with adaptors NN e OC	0	11.493.276	17.059.784	7.752.077	1.741.892	**38.047.030**
Total filling with adaptors	0	22.775.781	33.910.784	15.425.349	3.457.429	**75.569.343**

With double nozzles

	X	X+1	X+2	X+3	X+4	
Filling with adaptors ON e NC	0	11.282.504	16.851.000	7.673.272	1.715.538	**37.522.313**
Filling with adaptors NN e OC	0	3.447.983	5.117.935	3.601.324	1.407.062	**13.574.304**
Total filling with adaptors	0	14.730.487	21.968.935	11.274.595	3.122.600	**51.096.617**

4.4 Pollution

4.4.1 Euroconnector proposal

To analyse the pollution linked to the we disregard the negligible and unavoidable leakage due to two coherent connections.

Starting from results above and according to leakage of every adaptors (see attachment) the pollution due to use of adaptors is indicated in the following tables.

Without double nozzles

	X	X+1	X+2	X+3	X+4	X+5	X+6	X+7	X+8	
Pollution fillings with adaptors ON e NC [m^3]	0	14,21	36,56	50,64	56,65	54,80	45,30	28,33	8,93	295,43
Pollution fillings with adaptors NN e OC [m^3]	0	24,06	61,32	84,78	94,79	91,71	75,86	47,57	15,12	495,20
Total pollution filling with adaptorsrifornimenti con adattatori [m^3]	0	38,26	97,88	135,42	151,45	146,51	121,15	75,90	24,05	790,63

With double nozzles

	X	X+1	X+2	X+3	X+4	X+5	X+6	X+7	X+8	
Pollution filling with adaptors ON e NC [m^3]	0	14,21	36,56	50,64	56,65	54,80	45,30	28,33	8,93	295,43
Pollution filling with adaptors NN e OC [m^3]	0	7,22	18,39	25,43	28,44	32,63	38,66	36,27	14,40	201,45
Totale pollution filling with adaptors [m^3]	0	21,42	54,96	76,08	85,09	87,44	83,96	64,60	23,34	496,88

4.4.2 New ECE connector proposal

Proceeding as above we have in this case the following scenarios.

Without double nozzles

	X	X+1	X+2	X+3	X+4	
Pollution filling with adaptors ON e NC [m^3]	0	29,33	43,81	19,95	4,46	97,56
Pollution filling with adaptors NN e OC [m^3]	0	11,49	17,06	7,75	1,74	38,05
Totale pollution filling with adaptors [m^3]	0	40,83	60,87	27,70	6,20	135,61

With double nozzles

	X	X+1	X+2	X+3	X+4	
Pollution filling with adaptors ON e NC [m^3]	0	29,33	43,81	19,95	4,46	97,56
Pollution filling with adaptors NN e OC [m^3]	0	3,45	5,12	3,60	1,41	13,57
Totale pollution filling with adaptors [m^3]	0	32,78	48,93	23,55	5,87	111,13

4.5 Summary and Conclusion

In order to compare the different implementations of two assessed profiles, we summarize the results above in the following table

		Times [years]	Safety [#refuelling with adaptors]	Pollution [m^3]
Euro connector proposal	**Without double nozzles**	**at least 8**	**197.516.711**	**790,63**
	With double nozzles	**at least 8**	**138.766.382**	**496,88**
ECE connector proposal	**Without double nozzles**	**4**	**75.569.343**	**135,61**
	With double nozzles	**4**	**51.096.617**	**111,13**

As can be seen, the ECE connector proposal shows better results from any point of view concerning implementation.

Furthermore, the solution with use of double nozzles has, in both cases, a better impact on the implementation, so if it was viable it would be the best solution on filling stations side.

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