RELEVANT INFORMATION USED IN THE DETERMINATION OF THE NATIONAL TRASNSMISSION CHARGES FOR THE TARIFF PROPOSAL REFERRED TO YEAR 2019

Document prepared by Snam Rete Gas S.p.A. in compliance with art. 23.9 of Resolution no. 575/2017 / R / GAS of the Regulatory Authority for Electricity Gas and Water.

INTRODUCTION

In compliance with Article 23.9 Annex A of the Resolution 575/2017/R/GAS by the Regulatory Authority for Electricity Gas and Water, Snam Rete Gas makes available the relevant information used in the determination of the unit charges for the national gas network.

The unit charges for the national network are derived according to the provisions of the Regulatory Authority for Electricity Gas and Water defined in Annex A of Resolution 575/2017/R/GAS (RTTG) and on the basis of the following procedural steps:

1. **NATIONAL GAS TRANSMISSION NETWORK AND DEFINITION OF THE ENTRY AND EXIT POINTS;**
2. **SIMULATION OF THE GAS FLOWS IN THE NETWORK AT PEAK CONSUMPTION CONDITIONS;**
3. **DETERMINATION OF THE UNIT TRANSPORTATION COST ON THE BASIS OF THE TRANSPORT CAPACITIES AS FUNCTION OF THE PIPES DIAMETER;**
4. **DETERMINATION OF THE "EXTENDED" ENTRY/EXIT MATRIX;**
5. **DETERMINATION OF THE "SYMPLIFIED" ENTRY/EXIT MATRIX;**
6. **CALCULATION OF THE ENTRY/EXIT CHARGES (CP_e e CP_u);**
7. **ALLOCATION OF OWN CONSUMPTIONS AT ENTRY POINTS.**

1. NATIONAL GAS TRANSMISSION NETWORK AND DEFINITION OF THE ENTRY AND EXIT POINTS

The perimeter for the application of the entry/exit charges calculation procedure is represented by the National Network, which is yearly defined by the Ministry of the Economic Development pursuant to Article 9 of the Legislative Decree 23 May 2000, no. 164. The National Network is updated to take into account also the network structure expected to be operational in 2018.

Definition of the Entry Points

For year 2019, the following 84 entry points into the National Network have been defined:

- n. 5 entry points at the interconnections with import foreign pipelines located in the proximity of Mazara del Vallo, Passo Gries, Tarvisio, Gorizia and Gela;
- n. 3 entry points at the interconnections with the LNG regasification plant of Panigaglia, with the LNG regasification plant of Porto Viro located at Cavarzere and with the LNG regasification plant of OLT di Livorno;
- n. 59 entry points in the location of the delivery points from national gas production fields. For tariff purposes the entry points from national production have been grouped into 10 homogeneous territorial areas; consequently, 10 different values of CPe unit charges have been identified, in line with the the previous regulatory period;
- n. 14 entry points in the location of the delivery points of gas from biomethane production plants, not included in the reference map, combined to the 10 values of CPe unit charges analogously to the national productions;
- n. 3 entry virtual hubs, one for each storage operator (Stogit S.p.A., Edison Stoccaggio S.p.A. and Ital Gas Storage S.p.A.). For tariff purposes, it was considered a single unit entry charge for storages as provided for in paragraph 12.1.c of the RTTG.

Definition of the Exit Points

For year 2019, the following 14 exit points from the National Network have been defined:

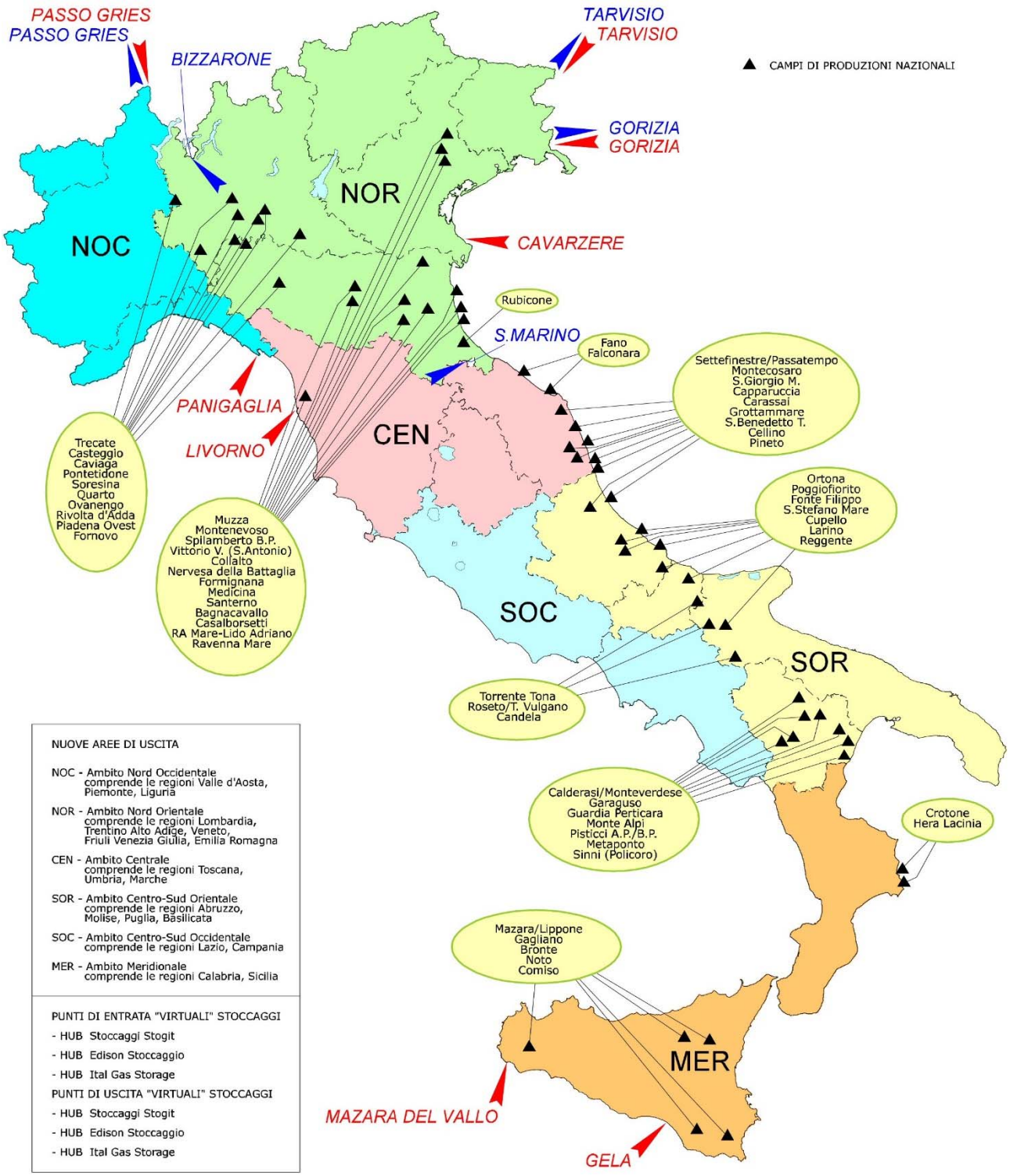
- n. 6 Consumption Areas distributed throughout the country;
- n. 5 exit points for gas export in the location of Gorizia, Bizzarone, San Marino, Passo Gries and Tarvisio;

- n. 3 exit virtual hubs, one for each storage operator (Stogit S.p.A., Edison Storage S.p.A. and Ital Gas Storage S.p.A.). or tariff purposes, it was considered a single unit exit charge for storages as provided for in paragraph 12.1.c of the RTTG.

The 6 Consumption Areas have been defined on the basis of the tariff geographical areas for the gas distribution service identified by the Delibera ARG/gas n. 159/08 and confirmed with Delibera 573/2013/R/GAS:

NOC – North-West Area, comprising Valle d'Aosta, Piemonte and Liguria Regions;
NOR – North-East Area, comprising Lombardia, Trentino – Alto Adige, Veneto, Friuli - Venezia Giulia, Emilia – Romagna Regions;
CEN – Central Area, comprising Toscana, Umbria and Marche Regions;
SOR – Central-South Area, comprising Abruzzo, Molise, Puglia, Basilicata Regions;
SOC – Central-South Area, comprising Lazio and Campania Regions;
MER – Southern Area, comprising Calabria and Sicilia Regions.

Punti di Entrata e Uscita dalla Rete Nazionale
Anno Solare 2019



2. SIMULATION OF THE GAS FLOWS IN THE NETWORK AT PEAK CONSUMPTION CONDITIONS

Every year it is defined the scenario for the evaluation of the gas flow in the peak demand with reference to the intakes and offtakes forecasted for the winter period, usually a working day of the second week of January. In particular the referred scenario is the day of maximum demand, that is represented by a working day of the second week of January in normal winter conditions.

Gas transportation in the network is analyzed by means of hydraulic simulations performed using simulation system, developed “ad hoc” for meshed network like Snam Rete Gas network and it allows to:

a) create a model of the network consisting of sections of gas pipeline and calculation points corresponding to physical elements such as main nodes connecting pipelines, detachment points of off-takes or distribution networks, changes in diameter, significant variations of elevation profile of the pipelines. Calculation points are also set at the inlet and outlet of compressor stations and at the entry points interconnected with import pipelines or main production fields;
b) create a model for the compressor stations based on the application of the control criterion characteristics of the station for distribution of the rate flow between the units; realistic simulation of the operating point of compressors and turbines, using a mathematical model that describes the characteristic curves of each individual machine obtained from the field measurements (where available) or the expected curves provided by the manufacturers; this simulation provides quite an accurate determination of the operating range of the plants based on the actual limit curves (antisurge, minimum and maximum number of revolutions, maximum power);
c) simulate the network to calculate the following parameters, by solving a system of transportation equations on the basis of formulae and models recognized by scientific literature and the technical gas associations:
    - pressure, temperature and composition of the gas at the calculation points;
    - flow rate and composition of the gas in every section of the gas pipeline;
    - operating points of the compressor stations;
    - operational parameters in particular elements (compressor stations, valves, imports, national productions, storages, offtakes).

The calculation models used adopt the following main basic equations:

Pessure drop calculation	Fergusson equation
Equation of state for calculation Z and derived factors	Redlich-Kwong equation
Calculation of friction factor	Colebrook equation
Calculation of viscosity	Dean-Stiel method

The target of the hydraulic simulation consists of defining the predominant flows, that is the characterization, in each section of the national network, of the predominant gas flows in the scenario of maximum demand above described; such flow distribution in each section of the network allows to:

- define, for each possible path of gas from an entry point to an exit point of the national network:
    - sections in accordance to the flow (where the path of gas has the same direction of the predominant flow) to which is given a transportation cost equal to 100% of the transportation cost per unit;
    - sections in counter-flow (where the path of gas has the opposite direction of the predominant flow) to which is given, instead of the entire cost, a reduced transportation cost (14%) of the transportation cost per unit;
- calculate the weighted average if an entry point and an exit point are composed of respectively more than one delivery and redelivery points; this activity allows to pass from the large matrix to the reduced matrix.

SCHEMATIZZAZIONE
RETE NAZIONALE GASDOTTI
FLUSSI DOMINANTI
2019

3. DETERMINATION OF THE UNIT TRANSPORTATION COST ON THE BASIS OF THE TRANSPORT CAPACITIES AS FUNCTION OF THE PIPES DIAMETER

The national pipeline network is schematized in:

- important nodes or points of interception and derivation (hereinafter: PIDIs), which are the physical points of the network that correspond to interconnection points or important points of withdrawal;
- network elementary sections, ie the network sections comprised between two PIDIs, characterized by a length and a diameter.

To each elementary network section is associated a unit transport cost according to the considered length and diameter.

The unit transport cost of each section is calculated by applying the following formula:

$$CT=IS * (\alpha + \beta +\gamma) / QT$$

where:

• CT is unit transport cost, expressed in €/cm/day/km;

• IS is the specific cost, expressed in €/km and depending in function of the pipe diameter;

• α, β and γ are parameters used to attribute to one single year the specific investment costs and they represent respectively the return on invested capital, the depreciation and the operating costs.;

• QT is the theoretical capacity of the pipe, expressed in cm/day, and determined according to the following simplified formula:

$$QT = \sqrt{\frac{P_1^2 - P_2^2}{L * K}}$$

- P1 is the initial pressure of the pipeline section;
- P2 is the final pressure of the pipeline section;
- L is the length of the pipeline;
- K is a constant function of the diameter, the gas specific weight, the temperature,

è una costante in funzione del diametro, del peso specifico del gas, della temperatura, the friction coefficient and the compression coefficient.

For the determination of the theoretical capacity QT, it is made reference to Colebrook-White diagrams for medium-big size diameters and to Weymouth diagram for medium-small size diameters. For the calculation of the theoretical capacity QT as function of the diameter, it is assumed a square pressure drop $\Delta P2/km$ equal to 15 bar^2/km, generally adopted in the sector technical literature.

The transport cost for each section is directly proportional to the pipeline lenght; to calculate the transport cost of a section of L length, the unit transport cost is multiplied by the length L of the pipeline.

4. DETERMINATION OF THE "EXTENDED" ENTRY/EXIT MATRIX

For the determination of the extended entry/exit matrix, a unit transport cost Ci,j (€/cm/day)is associated to each combination of entry point and PIDI. Such unit transport cost is calculated as the sum of the unit transport costs referred to the series of network sections which constitute each entry-PIDI combination, calculated as previously explained.

For the purpose of identifying the paths from each entry point to each exit point it is used the minimum cost criteria. This means that for each of the possible alternative paths between each entry and exit points the unit transport cost is calculated as sum of

the costs of each elementary section which is part of the path and for the purpose of the matrix calculation the path with the minimum cost is considered.

5. DETERMINATION OF THE "SIMPLIFIED" ENTRY/EXIT MATRIX

The determination of the simplified entry/exit matrix is made by aggregating the PIDI of each consumption or exit area, by calculating the weighted average of the transport costs in function of the flows exiting from each PIDI of the area.

For the current regulatory period six areas have been considered in line with the territorial areas defined by the Regulator for the distribution service.

In the table below the values representing the relative weights of the costs associate to each path have been normalized.

	NOC Nord Occidentale	NOR Nord Orientale	CEN Centrale	SOR Centro-sud Orientale	SOC Centro-sud Occidentale	MER Meridionale	S. SALVO	SABBIONCELLO	MINERBIO	SERGNANO	SETTALA	BRUGHERIO	RIPALTA	CORTE	COLLALTO	CELLINO	CASTEL BOLOGNESE	BORDOLANO	SVIZZERA - BIZZARONE	SLOVENIA - GORIZIA	R.S.MARINO	PASSO GRIES	TARVISIO
Mazara del Vallo	1,000000	0,888257	0,877145	0,729039	0,742245	0,227144	0,610908	0,725058	0,705273	0,760008	0,778031	0,803940	0,762242	0,767035	0,767688	0,643374	0,716362	0,764400	1,071982	0,948616	0,923583	0,971553	0,875648
Gela	0,932614	0,820871	0,809758	0,661652	0,674858	0,173387	0,552956	0,667106	0,647320	0,702056	0,720078	0,745987	0,704290	0,709083	0,709735	0,585422	0,658410	0,706448	1,004596	0,881230	0,856197	0,904166	0,808261
Passo Gries	0,178850	0,181444	0,383433	0,398678	0,331560	0,404761	0,292151	0,149711	0,147051	0,127971	0,128041	0,153950	0,128139	0,132932	0,192341	0,324617	0,176806	0,132363	0,200725	0,279608	0,486719	-	0,206640
Tarvisio	0,366402	0,254160	0,480420	0,498721	0,431603	0,504803	0,378188	0,235254	0,233087	0,215114	0,233136	0,259045	0,217348	0,222141	0,139957	0,410654	0,262843	0,219506	0,438384	0,163459	0,535110	0,337955	-
Gorizia	0,298796	0,185751	0,412814	0,431115	0,363996	0,437197	0,320047	0,177112	0,174946	0,156973	0,174995	0,200904	0,159207	0,163999	0,081816	0,352512	0,204701	0,161364	0,370778	-	0,467504	0,270348	0,022884
GNL Panigaglia	0,193997	0,102150	0,243439	0,259964	0,192846	0,266047	0,172857	0,047542	0,027757	0,082492	0,100851	0,126760	0,085062	0,050828	0,090172	0,205323	0,057512	0,086884	0,284564	0,160807	0,348005	0,184134	0,087838
GNL Cavarzere	0,266334	0,161949	0,300852	0,314108	0,246990	0,320190	0,219421	0,094105	0,074320	0,129056	0,147078	0,172987	0,131290	0,136083	0,136735	0,251887	0,104076	0,133448	0,338317	0,214951	0,402148	0,237887	0,141982
GNL OLT Livorno	0,266322	0,160485	0,104438	0,176154	0,109036	0,182237	0,100781	0,094094	0,074309	0,129045	0,147067	0,172976	0,131279	0,136072	0,136724	0,133247	0,070143	0,133436	0,338304	0,214938	0,330412	0,237874	0,141969
Hub 1 - Ripalta	0,113672	0,050639	0,234434	0,249679	0,182561	0,255762	0,164012	0,023228	0,018912	0,015956	0,015788	0,041697	-	0,004793	0,065858	0,196478	0,048667	0,020348	0,185654	0,132535	0,337720	0,085224	0,059566
Hub 2 - Ravenna	0,195847	0,085380	0,187221	0,205921	0,138803	0,212003	0,126380	0,033486	0,013701	0,068437	0,086459	0,112368	0,070671	0,075464	0,076116	0,158846	0,043457	0,072828	0,267829	0,144464	0,201933	0,167400	0,071495
Hub 3 - Rubicone	0,205380	0,094241	0,141052	0,158467	0,091349	0,164549	0,085570	0,041684	0,021899	0,076635	0,094657	0,120566	0,078869	0,083662	0,084314	0,118035	0,051655	0,081026	0,277362	0,153996	0,154478	0,176932	0,081027
Hub 4 - Falconara	0,243378	0,131635	0,135977	0,170949	0,103831	0,177032	0,096304	0,074363	0,054577	0,109313	0,127335	0,153244	0,111547	0,116340	0,116992	0,128770	0,065667	0,113705	0,315360	0,191994	0,166961	0,214930	0,119025
Hub 5 - Pineto	0,255572	0,143830	0,132717	0,160376	0,112126	0,189226	0,106792	0,084850	0,065065	0,119801	0,137823	0,163732	0,122035	0,126827	0,127480	0,003166	0,076154	0,124192	0,327554	0,204189	0,179156	0,227125	0,131220
Hub 6 - S.Salvo	0,290175	0,178433	0,167320	0,107629	0,110681	0,126861	0,000459	0,114609	0,094823	0,149559	0,167581	0,193490	0,151793	0,156586	0,157238	0,032924	0,105913	0,153951	0,362157	0,238792	0,213758	0,261728	0,165823
Hub 7 - Candela	0,363419	0,251676	0,240564	0,092135	0,182886	0,085144	0,063448	0,177598	0,157813	0,212549	0,230571	0,256480	0,214783	0,219575	0,220228	0,095914	0,168903	0,216940	0,435401	0,312035	0,287002	0,334972	0,239067
Hub 8 - Monte Alpi	0,501843	0,390100	0,378987	0,231034	0,244092	0,083858	0,182493	0,296643	0,276857	0,331593	0,349615	0,375524	0,333827	0,338620	0,339272	0,214959	0,287947	0,335985	0,573825	0,450459	0,425426	0,473395	0,377490
Hub 9 - Crotone	0,580655	0,468912	0,457800	0,309694	0,322900	0,066369	0,250271	0,364421	0,344636	0,399372	0,417394	0,443303	0,401606	0,406398	0,407051	0,282737	0,355726	0,403763	0,652637	0,529271	0,504238	0,552208	0,456303
Hub 10 - Gagliano	0,881689	0,769947	0,758834	0,610728	0,623934	0,134353	0,509161	0,623311	0,603525	0,658261	0,676283	0,702192	0,660495	0,665288	0,665940	0,541627	0,614615	0,662653	0,953672	0,830306	0,805273	0,853242	0,757337
San Salvo	0,290175	0,178433	0,167320	0,107629	0,110681	0,126861	0,000459	0,114609	0,094823	0,149559	0,167581	0,193490	0,151793	0,156586	0,157238	0,032924	0,105913	0,153951	0,362157	0,238792	0,213758	0,261728	0,165823
Sabbioncello	0,197909	0,094673	0,252452	0,266170	0,199052	0,272252	0,178194	-	0,033094	0,070211	0,088233	0,114142	0,072444	0,077237	0,077890	0,210660	0,062849	0,074602	0,269892	0,146526	0,354210	0,169462	0,073557
Minerbio	0,179916	0,075530	0,214433	0,227689	0,160571	0,233771	0,145101	0,019785	-	0,054736	0,072758	0,098667	0,056970	0,061763	0,062415	0,177567	0,029755	0,059127	0,251898	0,128532	0,315730	0,151468	0,055563
Sergnano	0,116269	0,048414	0,237032	0,252277	0,185159	0,258359	0,166246	0,021740	0,021145	-	0,018022	0,043931	0,002234	0,007027	0,064369	0,198712	0,050901	0,004391	0,188251	0,130804	0,340317	0,087822	0,057836
Settala	0,114692	0,059637	0,252092	0,267337	0,200219	0,273420	0,179198	0,036758	0,034097	0,015018	-	0,025909	0,015186	0,019979	0,079387	0,211664	0,063853	0,019410	0,184839	0,148267	0,355378	0,084410	0,075299
Brugherio	0,120129	0,064494	0,257529	0,272775	0,205656	0,278857	0,183874	0,041434	0,038774	0,019694	0,004676	0,001049	0,019862	0,024655	0,084063	0,216340	0,068529	0,024086	0,190277	0,153705	0,360815	0,089847	0,080736
Ripalta	0,113672	0,050639	0,234434	0,249679	0,182561	0,255762	0,164012	0,023228	0,018912	0,015956	0,015788	0,041697	-	0,004793	0,065858	0,196478	0,048667	0,020348	0,185654	0,132535	0,337720	0,085224	0,059566
Corte	0,144671	0,067535	0,234444	0,249690	0,182572	0,255772	0,164021	0,023237	0,018921	0,054992	0,054824	0,080733	0,039036	0,004802	0,065867	0,196487	0,048676	0,059384	0,231044	0,132546	0,337730	0,130615	0,059577
Collalto	0,332307	0,223797	0,446325	0,464626	0,397507	0,470708	0,348866	0,205932	0,203765	0,185792	0,203815	0,229723	0,188026	0,192819	0,076411	0,381332	0,233521	0,190184	0,404289	0,184602	0,501015	0,303860	0,111634
Cellino	0,281868	0,170494	0,158203	0,186396	0,138421	0,215522	0,129406	0,107464	0,087679	0,142415	0,160437	0,186346	0,144649	0,149441	0,150094	-	0,117434	0,146806	0,353850	0,230484	0,205451	0,253421	0,157515
Castel Bolognese	0,185314	0,080258	0,182265	0,193644	0,126526	0,199726	0,115822	0,024428	0,004642	0,059378	0,077400	0,103309	0,061612	0,066405	0,067057	0,148288	0,000477	0,063770	0,257296	0,133930	0,321128	0,156866	0,060961
Bordolano	0,154559	0,065630	0,232892	0,247158	0,180040	0,253240	0,161844	0,018910	0,016743	0,032930	0,050952	0,076861	0,035163	0,039956	0,061540	0,194310	0,046499	0,001562	0,226542	0,127514	0,335199	0,126112	0,054545

6. CALCULATION OF THE ENTRY/EXIT CHARGES (CPe e CPu)

The last step is related to the calculation of the unit charge values in each entry and exit point such as to minimize, respecting the constraints defined by Delibera 575/2017/R/gas, the sum of the squared differences between the CPi and CPj charges and the unit transport costs Ci,j identified for each path from each entry point I to each exit point j.

In mathematical terms it means the application of the following minimization criteria:

$$min \sum_{i,j} (CPi + CPj - Cij)^2$$

The constraints to be considered in solving the calculation algorithm are the following:

- The exclusion of those solutions where the charges have a negative value;
- The allocation of 40% of the allowed revenues to entry points and 60% of the allowed revenues to exit points;
- The difference among the unit charge values of adjacent exit points cannot exceed 30% of the national average value of CPu charges;
- The unit charges multiplied for the capacities which are expected to be booked shall be equal to the reference revenues allocated to the national network.

The following table shows the adjusted and final tariffs respecting the constraint on the allowed revenues and with an attribution of 40% of the revenues at the entry points and 60% of the revenues to the exit points as well as in the application of the constraints described above.

TARIFFE 2019 -Scalate			
ENTRY		**EXIT**	
Mazara del Vallo	**3,797131**	NOC Nord Occidentale	**2,281723**
Gela	**3,454935**	NOR Nord Orientale	**1,787898**
Passo Gries	**0,690045**	CEN Centrale	**2,281723**
Tarvisio	**1,146643**	SOR Centro-sud Orientale	**2,148134**
Gorizia	**0,798560**	SOC Centro-sud Occidentale	**1,787898**
GNL Panigaglia	**0,285901**	MER Meridionale	**1,654308**
GNL Cavarzere	**0,578877**	S. SALVO	**1,050796**
GNL OLT Livorno	**0,349267**	SABBIONCELLO	**0,325066**
Prod Naz. - Hub 1	**0,092522**	MINERBIO	**0,162135**
Prod Naz. - Hub 2	**0,131684**	SERGNANO	**0,609807**
Prod Naz. - Hub 3	**0,092522**	SETTALA	**0,800137**
Prod Naz. - Hub 4	**0,233335**	BRUGHERIO	**1,153076**
Prod Naz. - Hub 5	**0,252999**	RIPALTA	**0,608597**
Prod Naz. - Hub 6	**0,344684**	CORTE	**0,639150**
Prod Naz. - Hub 7	**0,670955**	BORDOLANO	**0,646963**
Prod Naz. - Hub 8	**1,328570**	COLLALTO	**0,736631**
Prod Naz. - Hub 9	**1,709427**	CELLINO	**1,368150**
Prod Naz. - Hub 10	**3,196717**	CASTEL BOLOGNESE	**0,459614**
S. SALVO	**0,344684**	SVIZZERA	**3,598777**
SABBIONCELLO	**0,261344**	SLOVENIA (Gorizia Esp.)	**1,891253**
MINERBIO	**0,135829**	R.S.MARINO	**3,645859**
SERGNANO	**0,092522**	PASSO GRIES	**2,107685**
SETTALA	**0,107527**	TARVISIO	**0,845674**
BRUGHERIO	**0,128160**		
RIPALTA	**0,092522**		
CORTE	**0,136654**		
BORDOLANO	**0,113455**		
COLLALTO	**1,012839**		
CELLINO	**0,385927**		
CASTEL BOLOGNESE	**0,101383**		

7. ALLOCATION OF OWN CONSUMPTIONS AT ENTRY POINTS

The specific percentages to cover own gas consumptions (fuel gas and line consumptions) are determined attributing the compressor stations to each entry point, proportionally to the injected volumes as resulting from the company budget.

The estimated gas amount for year 2019 to cover own gas consumptions in comparison to the total gas amounts forecasted in injection at entry points of the national network is equal to 0,511173%. This value will be applied to all entry points of the national network according to the provisions of article 14.1 RTTG of the Delibera 575/2017/R/gas.

	M Smc	γFuel*
Autoconsumi	**359,11**	0,511173%
Immessi 2019	**70.253,08**	