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Biogas injection into the natural gas pipeline grid:
framework; conditions, methods, barriers and demand for regulation

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Creation of a Bio-Gas-Entry-Exit-Model and quantification of the possible economic effects resulting from using it in the participants countries

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REDUBAR
WP05 D16

Investigations targeted to the creation of legislative instruments and the reduction of administrative barriers for the use of gaseous fuels produced from renewable energy sources for heating and cooling

Agreement No.: EIE/06/221/SI2.442663

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Glossary

Allocation

Assignment of natural gas quantities to individual contracts, with common recording of measured values in a metering station. The adopted procedures are pro rata assignment and declaration.

Balancing group

The aggregation of any number of entry and exit-points with the ability to balance variations between the feed-in and feed-out.

Balancing group manager

Any person or entity that is responsible to the Balancing Group Network Operator for handling the transport in his balancing group. This may be a transmission customer or third party, who must fulfil the same qualifications. For network balancing groups the exit network operator, who closed the network balancing group contract, is the balancing group manager.

Balancing group network operator

A market area spanning network operator or a third party with whom a balancing group may be set up and with whom a balancing group contract is concluded.

Basic balancing service

Service to be provided for compensation of unavoidable fluctuations of gas flow (variation between inflow and outflow) within specified limits.

Entry-point

A point within the market area where gas may be provided to the network operator of the network, including provision at import interconnection points, domestic production, storage facilities or facilities for blending and conversion.

Entry-exit-model

The entry-exit-model is also called a two-contract model. It is the realisation of a gas transport cross-network within a market area on the basis of one entry contract and one exit contract.

Exit-point

A point within the market area where gas may be offtaken from the network of the network operator by a transmission customer for supply to final consumers or market area interconnection points or for the purpose of injection into a storage. If the exit network operator is a local distribution network operator, the exit-point corresponds to the metering point.

Market area

A combination of networks and sub-networks from several gas grid operators with the same gas quality (h-gas, l-gas, ll-gas). The affiliation of each network and subnetwork in Germany is stated under www.gasnetzkarte.de.

Virtual point

Virtual entry-point

Entry-point that is not to be booked but is used for transfer of gas from one balancing group to another.

Virtual exit-point

Exit-point that is not to be booked but is used for transfer of gas from one balancing group to another.

Virtual trading point

A virtual point where gas may be traded after entry and before exit within the market area. The virtual trading point is not allocated to a physical entry-point or exit-point and enables the transmission customer without capacity to be booked to purchase and sell gas.

1 Introduction and targets

In the European Union, the actual potential for biogas production is about 4,896 PJ per year (approx. 270 billion Nm^3 per year). As the biogas production takes place mainly in rural areas, with a high potential of biogas production but low energy needs, the biogas feed-in could help to transport the biogas to urban areas, where often both electrical energy and heat are needed. This would increase the efficiency of the biogas use to about 90 % for combined heat and power generation (CHP) instead of 40 % efficiency for sole power generation.

The transportation of biogas also works trans-European, so that member states with high potential of biogas production possibilities and low energy demand could supply member states with a high demand of energy. This would also decrease the dependency from natural gas imports and cause the creation of value in the European Union.

Preconditions for a long term assured biogas feed-in are technical, economical and judicial guidelines. The technical guidelines are i.e. the German DVGW[1] guidelines, where things like gas grids and gas quality are ruled. The economical and judicial issues for biogas are concerned mostly in the German law EEG[2], especially the fees and the obligation to use the fed-in biogas.

To simplify the feed-in, feed-out and trade of biogas, an entry-exit-model shall be developed in this deliverable. This could base on the entry-exit-model for natural gas, which was adopted with the national implementation of the European guidelines, regarding the liberalisation of the gas market, in 2003/2004.

Additionally, the possible economic effects resulting from using the pipeline systems for biogas in the participant’s countries will be quantified.

Examples for laws, guidelines, etc. are primarily relating to Germany, as the state of implementation of the entry-exit-model is far proceeded and there were the most of information available.

[1] German Technical and Scientific Association for Gas and Water

[2] Act on Granting Priority to Renewable Energy Sources

2 The entry-exit-model

The main issues of an entry-exit-model are to simplify the booking of gas transport capacities. The entry-exit-model is part of the national implementation of the European guidelines:

- 2003-54-EC “common rules for the internal market in electricity“
- 2003-55-EC “common rules for the internal market in natural gas”
- 2004-67-EC “measures to safeguard security of natural gas supply”

The entry-exit-model has displaced the further applied “point to point”-model, which is explained in the following chapter 2.1.

2.1 The “point to point”-model

The “point to point”-model is a booking system for natural gas transportation capacities. The “point to point”-model in Germany has been replaced by an entry-exit-model in 2005, when the Energiewirtschaftsgesetz[3] EnWG came into effect.

In a “point to point“-model, the gas transportation capacities have to be booked bound to a concrete transportation path through the gas grid.

There is only one contract which rules the capacity for the gas transportation along the transportation path between the entry and exit-points.

The costs for the gas transportation depend on the length of the transportation path and thus on the theoretically way of the gas flow.

As shown in Fig. 2.1, the bookable (free) transportation path can be disadvantageous and therefore expensive, if parts of the transportation path are already booked.

[3] German Energy Economy Act

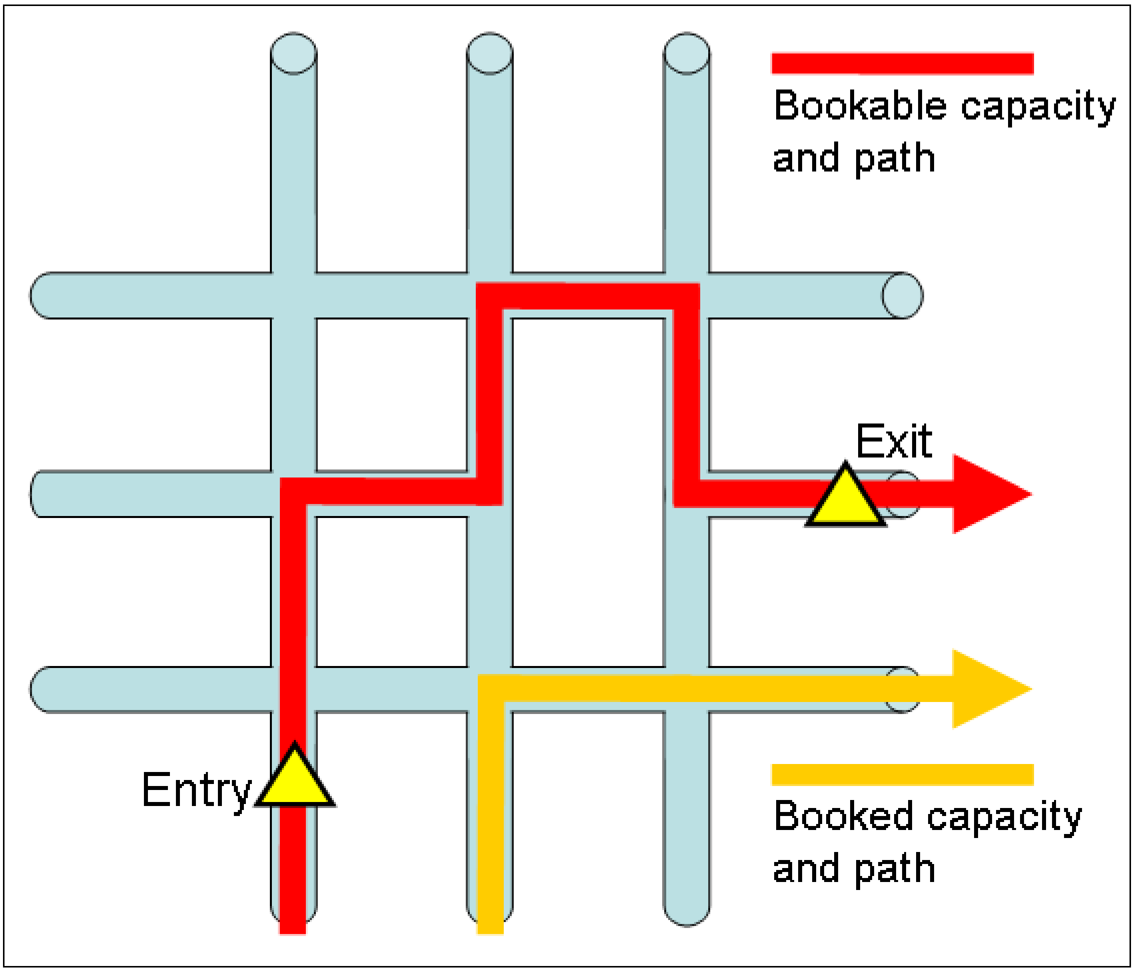

Fig. 2.1 - Point to point model

2.2 Main issues and intentions of an entry-exit-model

During the deregulation of the European energy market the access to the natural gas grid has been simplified by replacing the former “point to point”-model with an entry-exit-model.

The operators of natural gas grids have to offer feed-in and feed-out capacities, which enable the access to the gas grid without defining a transportation path depending on the transaction. Feed-in and feed-out capacities have to be usable and tradable independent from each other. The booking of entry and exit capacities may occur in different amounts, to different times and for different periods.

To conduct the access to a gas grid, a contract, regarding the feed-in capacities with the operator of the gas grid in which the feed-in should occur, must be concluded. This contract is called feed-in contract.

Additionally, a feed-out contract with the operator of the gas grid, from which the feed-out should occur, must be concluded.

Because of the separate feed-in and feed-out contracts, the entry-exit-model is also called a two-contract-model.

The feed-in and feed-out points/stations in the gas grid are called entry and exit-points. In the following Fig. 2.2, there are entry and exit-points shown exemplarily in the gas grid of WINGAS, the operator of a huge German transmission gas grid.

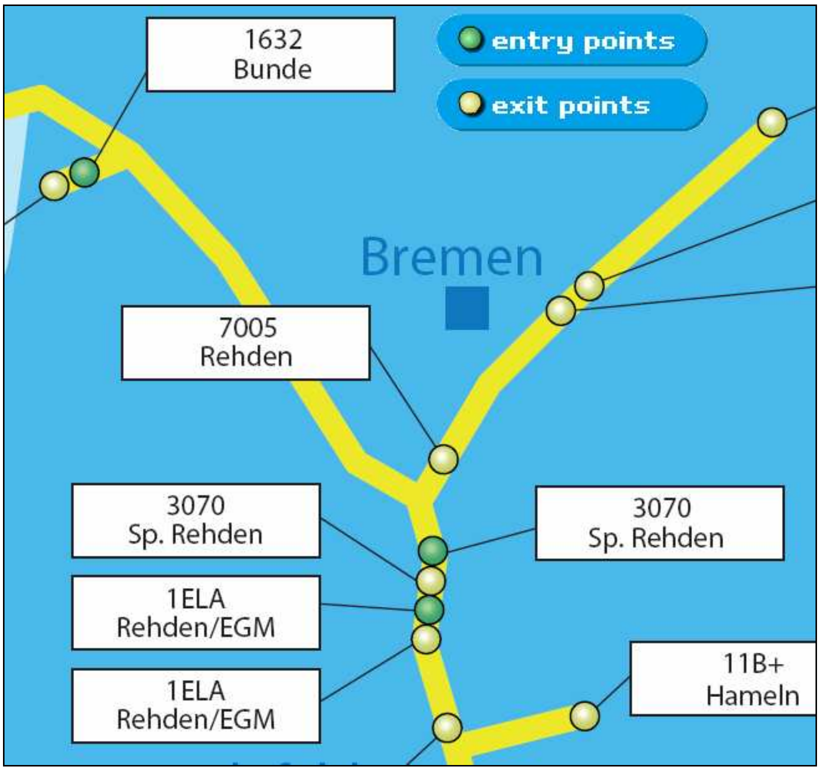

Fig. 2.2 - Entry and exit-points in a gas pipeline grid (detail)

Entry-points can be fed e.g. directly from natural gas production, from proceeding gas grids or from transmission pipelines.

Exit-points can feed-out to e.g. subsequent gas grids or major customers.

To book transportation capacity, the customer has to conclude two contracts, one for the feed-in capacity (entry) and one for the feed-out capacity (exit).

In an entry-exit-model, the costs for the gas transportation depend only on the booked capacity, they are independent from the way of the gas flow.

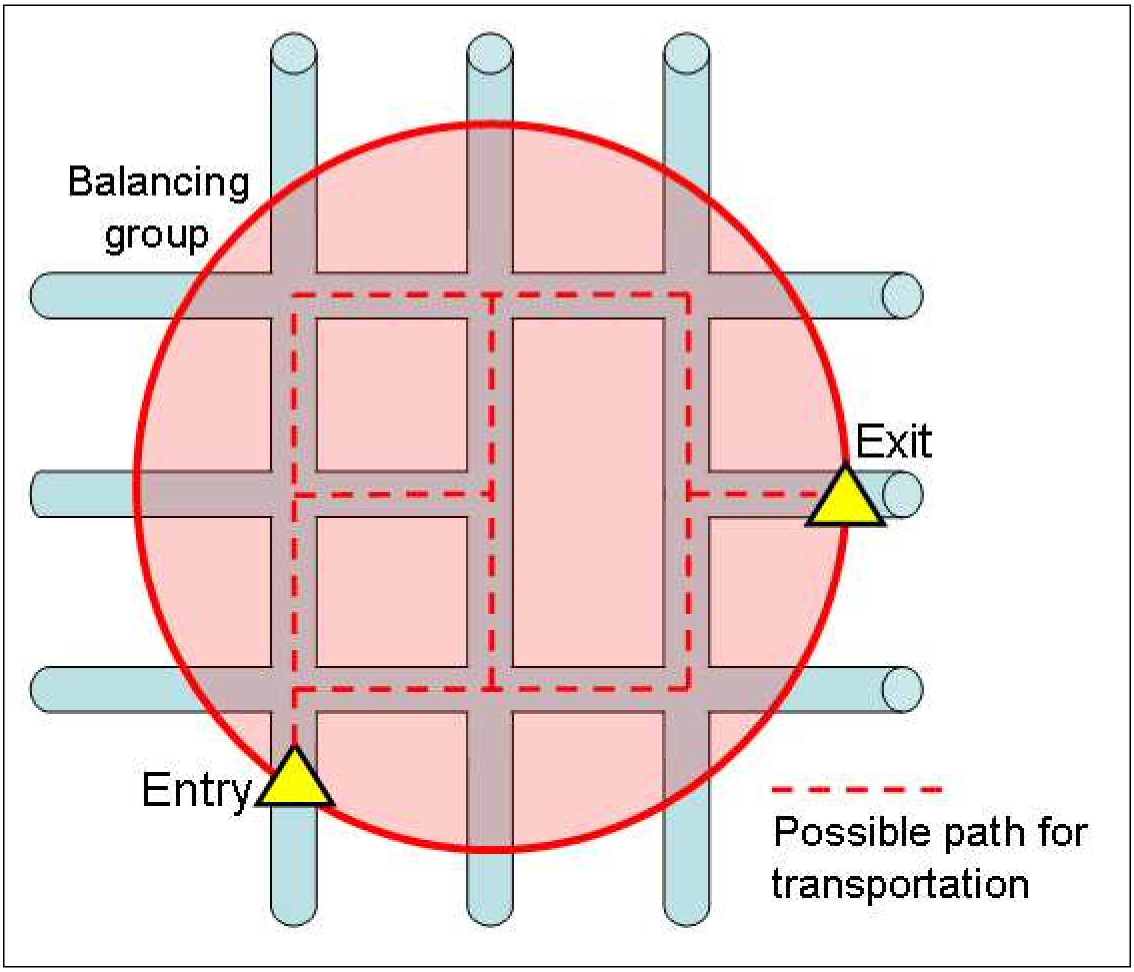

Fig. 2.3 - Entry-Exit-model

Operators of gas grids are committed to cooperate in a way, that customers need only one feed-in and one feed-out contract, even if the transportation of the gas goes about multiple, via interconnection points connected, gas grids. Precondition is, that the cooperation is technical possible and economical reasonable.

The main issues of the cooperation are:

- to calculate and offer capacities for gas transportation,
- to perform services regarding the access to the gas grid,
- to collaborate regarding the cost- and fee-allocation and
- to develop common standard contracts for the gas grid access.

2.3 Virtual gas trade

To enable the gas trade between balancing groups within a market area and also between several market areas (not yet fully implemented), a tool called virtual trading point was created.

A virtual trading point is not allocated to a physical entry- or exit-point. It allows transmission customers to purchase and sell gas without booking transportation capacity in the gas grid.

The balancing groups can be formed from physical entry- and exit-points as well as from virtual and physical entry /exit-points or solely virtual points.

The possibilities of a virtual gas trading system are shown in the following Fig. 2.4.

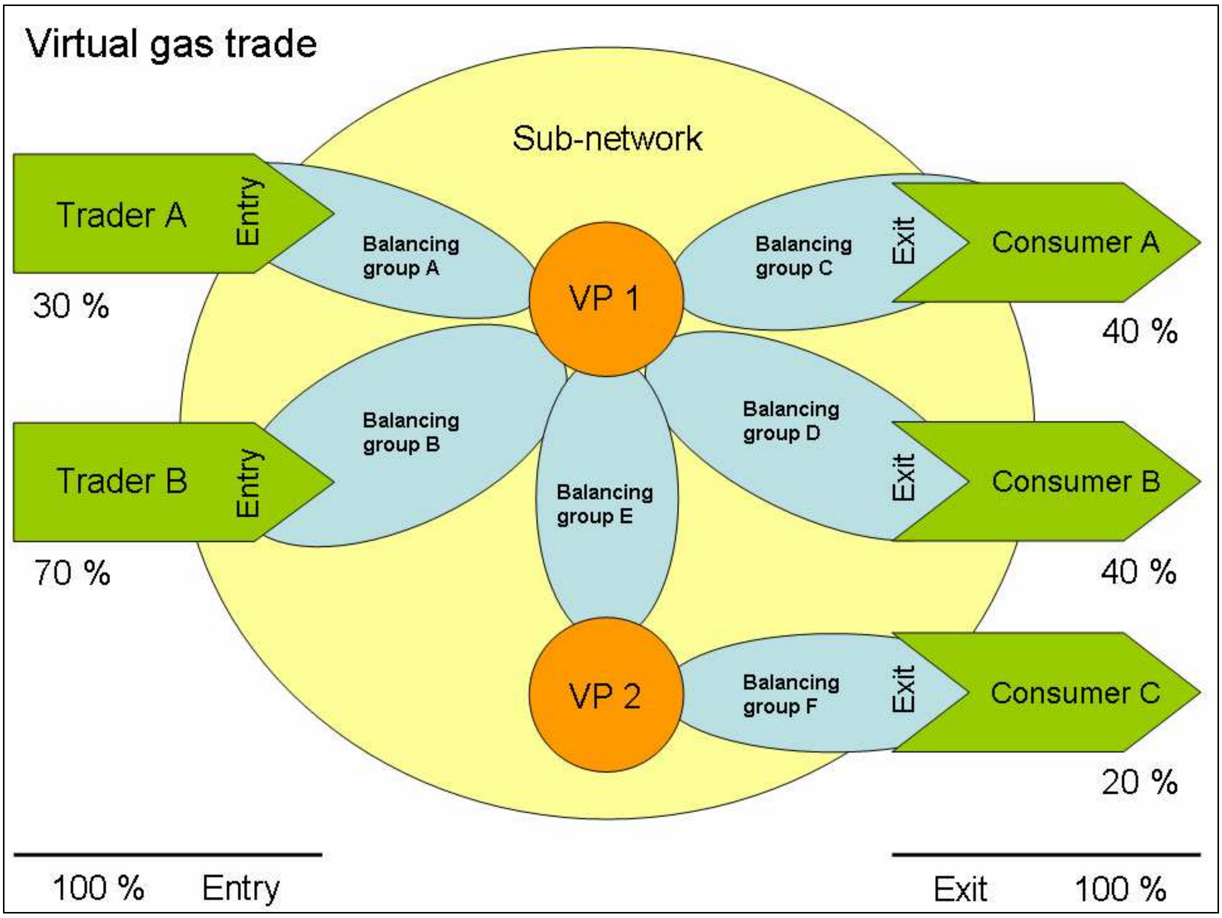

Fig. 2.4 - Virtual gas trade

On the left side of the figure the entry-points can be found, on the right side the exit-points. The yellow circle stands for a sub-network, this can be a also a market area. The orange circles stand for the virtual trading points (VP), the blue fields are the balancing groups.

In the shown case, trader B supplies VP1 with 80 % of the gas and purchases gas from trader A so that he offers 100 % of the gas at the VP1. The VP1 becomes an exit-point, as there is only one direction for the gas trade.

Gas customers A and B buy their gas from trader B at the VP1. They form the according balancing groups C and D.

AT VP2, a middleman purchases gas from VP1 and sells gas over the VP2 to customer C.

In the end, all balancing groups have to be balanced regarding the fed-in and fed-out gas quantities.

3 National implementation of the European entry-exit-model

In 2003 and 2004, the European guidelines, according common rules for the natural gas market and the security of natural gas supply, have been passed. As European guidelines require a national implementation, all members of the European union will have to pass adequate national laws.

The information and opinions about the national implementation of an entry-exit-model in the states of the project partners stem from the partners themselves.

3.1 Germany

3.1.1 State of the national implementation

In Germany, the an entry-exit-model has been implemented with the passage of the Gasnetzzugangsverordnung[4] (GasNZV) in 2005. Since then, natural gas grid operators have to replace their "point to point"-model with a two-contract-model, the entry-exit-model.

The German gas grid operators have aligned to enable the transportation of natural gas through several gas grids of a market area (Fig. 3.1).

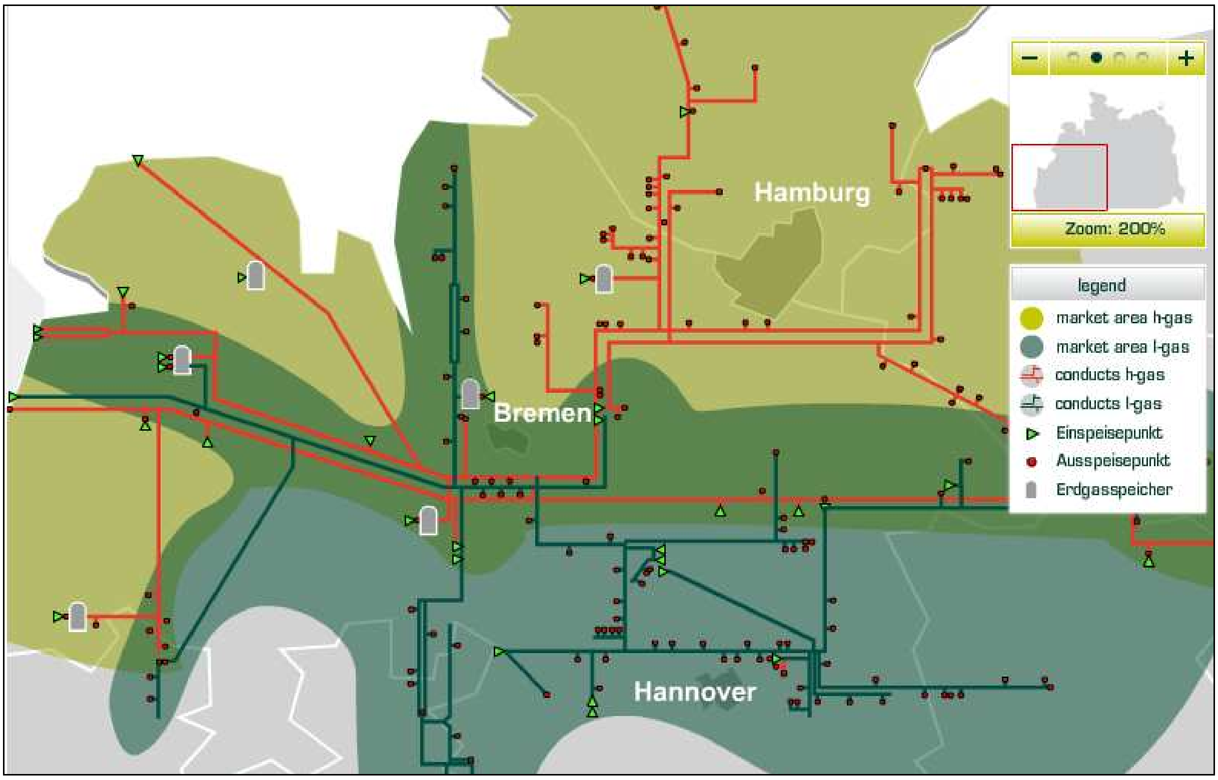

Fig. 3.1 - Market areas in northern Germany

[4] Ordinance about access to the natural gas grid

For the transportation of gas through a market area only one feed-in and one feed-out-contract are needed, independent from the number of gas grids of different operators. The operators have to arrange themselves in a way, that the booking of transportation capacity cross-network will be enabled.

Several gas net operators have collaborated to form a market area, so the number of market areas has to be as small as possible, regarding the efforts of the gas grid operators. There is not only a differentiation between the gas grid collaborations, but also between the different kinds of gas (H and L), so that at the moment 14 market areas exist in Germany as shown in the following Fig. 3.2. Each colour stands for one market area.

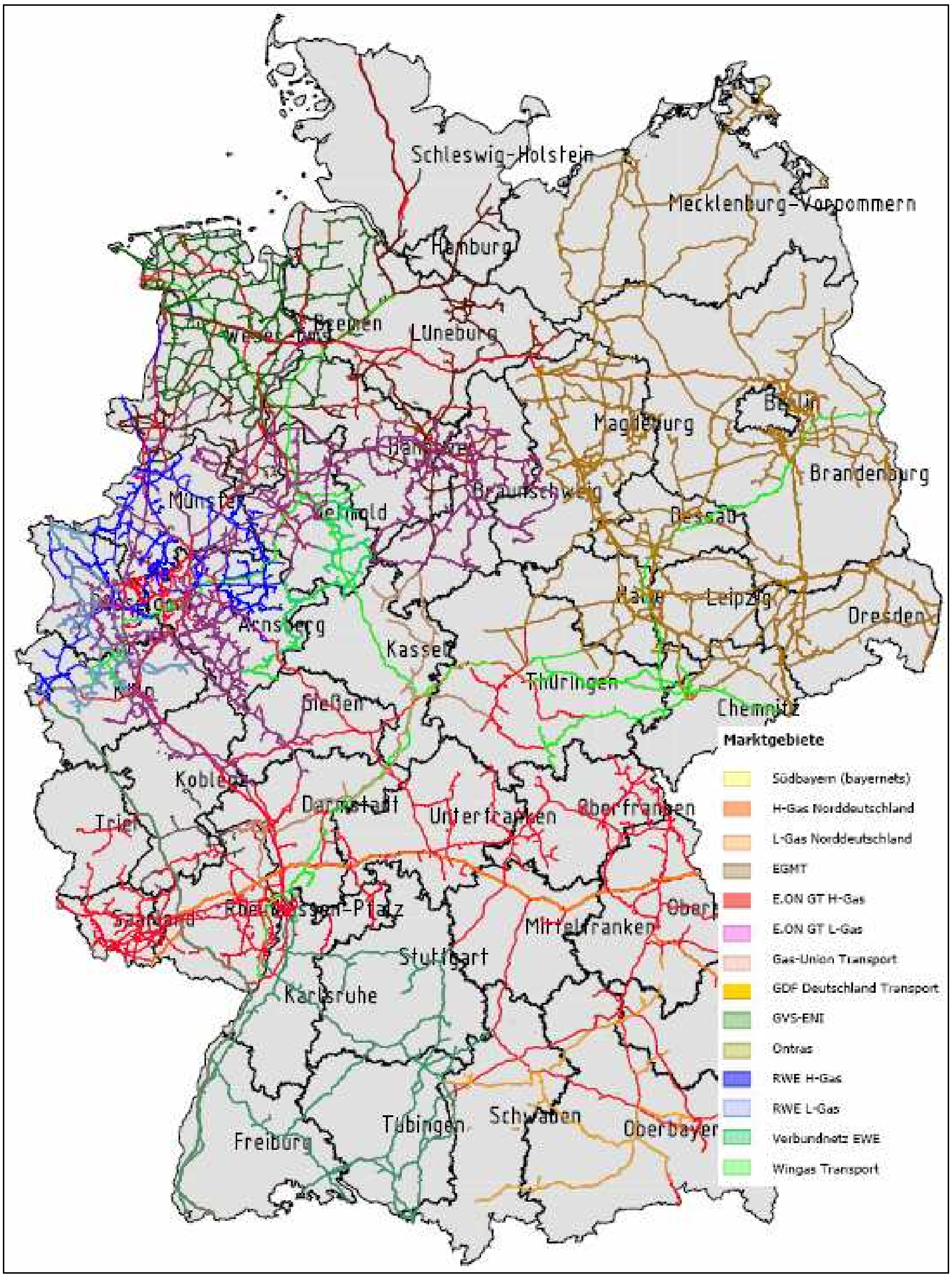

Fig. 3.2 - Market areas in Germany

3.1.2 Relevant laws and guidelines

The national implementation of the European guidelines, regarding the liberation of the energy market, results in Germany in the following laws, ordinances and guidelines:

- EnWG – Energiewirtschaftsgesetz[5], July 7th, 2005

  The intention of the ENWG is to enable a safe, reasonably priced, consumer friendly, efficient and ecological grid-bound energy supply. Therefore, e.g. the unbundling of gas trade and gas grid operation and the regulation of the energy market are ruled.
- GasNZV – Gasnetzzugangsverordnung[6], July 25th, 2005

  Based on the ENWG the GasNZV was passed. This ordinance rules the conditions to which gas grid operators must afford access to the gas grid to customers.
- All DVGW[7] (Deutsche Vereinigung des Gas- und Wasserfaches e.V.) regulations, especially
  - DVGW G 260 - Gasbeschaffenheit[8]
  - DVGW G 262 - Nutzung von Gasen aus regenerativen Quellen in der öffentlichen Gasversorgung[9]
  - DVGW G 685 - Gasabrechnung[10]

3.2 Hungary

3.2.1 State of the national implementation

In Hungary the gas transportation system equates an entry-exit-model. There are two entry-points for import gas and eleven entry-points for natural gas from domestic gas production. For the underground storages there are additional five entry-points.

The present law prescribes the charge for the entrance, ca. 1.30 EUR/(m³/day)/year, independent from the location of the entry-point.

For the exit-points (about 400) there are also prescribed exit tariffs: 0.38 EUR/(m³/day)/year for every exit-point.

The transport tariff is 3 EUR per 1000 m³, independent from the transportation distance.

[5] German Energy Economy Act

[6] Ordinance about access to the natural gas grid

[7] German Technical and Scientific Association for Gas and Water

[8] Gas conditions

[9] The use of gas from renewable sources in the public gas supply

[10] Gas billing procedure

The above mentioned data are valid at the towns and villages. The competitive sphere has the same values, but the time unit of the system's use is 1 hour. The annual entry's charge is accordingly 31.20 EUR per m^3/hour, respectively the exit's fee is 9.12 EUR/m^3.

The currently used charge system isn't far from the "post stamp" model, but the entry and exit tariffs appear separately in the law, creating the possibility for the future change of the values of different points without change of decree, i.e. simply through changing of items of the tariffs.

The distributing system has the „post stamp" character. The only influencing parameter is the capacity of the consumption. The tariffs are summarized at the following table:

Tab. 3.1 - Exit tariffs for gas distribution in Hungary

Capacity of the consumption	Distribution's basic tariff	Distribution's capacity tariff
Consumer without gas meter	0.0345 EUR/m^3	0
Consumption < 20m^3/h	17.54 EUR/year	0.0245 EUR/m^3
20m^3/h ≤ Consumption <100m^3/h	21.1 EUR/year	0.0381 EUR/m^3
100m^3/h ≤ Consumption <500m^3/h	45.74 EUR/year	0.0174 EUR/m^3
Consumption ≥ 500m^3/h	55.08 EUR/year	0.0026 EUR/m^3

Without gas meter operate only the very small consumers, e.g. flats of blocks using natural gas for cooking only.

In case of use of the storage system the tariff is created by the following four components:

Tariff of storage in: 4.49 EUR/1000 m^3

Tariff of storage out: 1.52 EUR/1000 m^3

Mobil tariff of storage (TM) EUR/m^3

There is a formula considering the ratio (r) of the contracted mobile (m^3) and maximum (peak) capacities (m^3/day).

$$TM = 0{,}0194\ r^{0{,}48}\ EUR/m^3$$

The peak tariff for storage (TCS) [EUR/(m³/day)/year] is calculated with the following formula considering the ratio of the contracted mobile (m^3) and maximum (peak) capacities (m^3/day).

$$TCS = 0{,}899\ r^{0{,}48}\ EUR/(m^3/day)/year$$

3.2.2 Relevant laws and guidelines

The most important law regarding the gas transportation market in Hungary is:

“A gazdasági és közlekedési minister 56/2007.(V1.1.) GKM rendelete egyes földgáz árakkal kapesolatos miniszteri rendeletek módosításáról”[11]

3.3 Czech Republic

3.3.1 State of the national implementation

Czech gas market is fully liberalised from 1st January 2007 and the European directive is implemented.

Taxes for gas transition and distribution are regularly published by Energy Regulatory Office (ERO; ERU in Czech). The main task of ERO is especially the fixing of gas transmission and distribution prices and related services, the fixing of gas supply prices for protected consumers throughout duration of this category incl. the price for natural gas storage, determination and evaluation of the rules for Natural Gas Market Organization and, in cooperation with the Ministry of Industry and Trade, the definition of the conditions for gas transmission and distribution system operation.

3.3.2 Relevant laws and guidelines

Following, the relevant laws and guidelines regarding the Czech gas market are listed:

- Zákon o podmínkách podnikání a o výkonu státní správy v energetických odvětvích a o změně některých zákonů (energetický zákon)[12], 2007
- Vyhláška o pravidlech pro organizování trhu s plynem a tvorbě, přiřazení a užití typových diagramů dodávek plynu[13], 2006
- Vyhláška o kvalitě dodávek plynu a souvisejících služeb v plynárentsví[14], 2006

3.4 Lithuana

In Lithuania there is not yet an entry-exit-model implemented. The reasons therefore are above all political, as the Russian company "Gazprom" has controlling interests of the Lithuanian company "Lietuvos dujos", which is owner of the natural gas grids in Lithuania.

According to the Lithuanian partners, there are no administrative barriers or something similar at the moment, but Lithuania is dependent to Russian capital and political forces.

[11] Departmental Order of the Ministry of Economic and Transport Nr. 56/2007.(VI.1.) about the Modification of Certain Departmental Orders of Prices and Taxes of Natural Gas

[12] Czech energy law

[13] Regulation about the administration of the gas market

[14] Regulation about the quality of supplied gas and replayed utilities in the gas industry

In Lithuania there are two categories of consumers: regulative and not regulative consumers.

- Regulative consumers: Consumers with a low gas demand like flats or small companies
- Non-regulative consumers are the district heating companies, which have a huge gas demand.

There are even two natural gas supply companies in Lithuania: “Lietuvos dujos” and “Dujoteka”.

- “Lietuvos dujos” is the Lithuanian gas supplier for regulative consumers and the owner / operator of the natural gas grid.
- “Dujoteka” is the gas supplier for non-regulative customers. “Dujoteka” is a Russian capital company, this is considered to be a political danger from Russia for Lithuania.

The Lithuanian partners say, that because of Russians economic and political influence, there will be whether a liberalisation of the energy market in Lithuania nor an entry-exit-model expected in the near future.

4 The integration of biogas into an entry-exit-model

4.1 Gas quality scenarios, which should be considered

For the feed-in of biogas three scenarios shall be differentiated, as different gas qualities result in different technological and economical requirements regarding the feed-in.

The scenarios are:

- Feed-in of raw biogas
- Feed-in of conditioned biogas (desulphurized, dried)
- Feed-in of "biomethane" (biogas conditioned to natural gas quality)

There is also a difference between the feed-in of biogas as exchange gas or additional gas, which results in a different scale of gas conditioning. If the biogas can be fed-in as exchange or additional gas depends on the parameters of the gas grid like gas quality and flow rate.

- Exchange gas means, that the gas meets all the requirements of the German regulations like DVGW G 260 – "Gasbeschaffenheit"[15] and DVGW G 262 – "Nutzung von Gasen aus regenerativen Quellen in der öffentlichen Gasversorgung"[16]. Therefore a conditioning, consisting of CO_2-removal, desulphurisation and drying, is necessary.
- Additional Gas means, that the gas for the feed-in did not have to meet all the requirements of the DVGW G 260, DVGW G 262 and DVGW G 685 – "Gasabrechnung"[17]. Precondition for the feed-in of additional gas is that the entire gas in the grid has to meet the requirements of the related regulations. Due to that, the amount of gas which can be fed-in depends on the flow rate and the pressure stage of the gas grid.

4.1.1 The feed-in of raw biogas

The feed-in of raw biogas is critical, as unwanted gas escort substances like hydrogen sulphide, carbon dioxide and siloxanes will reach to the natural gas grid and thus to end users. As the gas compositions don't comply with regulations like DVGW G 260 and DVGW G 262 and to avoid changing gas qualities and corrosive escort substances, the feed-in and transportation of raw biogas is not possible in general from a technical point of view and will not be considered in the following chapters.

Each single case of feed-in of raw biogas will demand a special investigation and evaluation of the conditions and limits. Therefore a general rule for the feed-in of raw biogas can not be given in this report.

[15] Gas conditions

[16] The use of gas from renewable sources in the public gas supply

[17] Gas billing procedure

4.1.2 The feed-in of conditioned biogas

Treated biogas can be fed in into the natural gas grid, if the gas composition remains within the limits of the regulations DVGW G 260 and DVGW G 262.

The scale of conditioning depends on the required gas quality for the feed-in. Gas grids with a high flow rate like transmission gas grids tolerate lower degrees of purity than distribution grids in rural areas. It also depends on, if the gas shall be fed in as exchange gas or as additional gas.

4.1.3 The feed-in of biomethane

If the biogas is conditioned to biomethane it can be handled and fed-in feed-in like natural gas, as the properties of biomethane are similar to the properties of natural gas.

The transportation of biomethane into or through gas grids with different gas qualities can be handled like the conveyance of e.g. low grade gas through a high grade gas grid.

4.2 Integration of biogas into an entry-exit-model

To support the feed-in of biogas in the European Union regulations and conditions for access to the gas grid must be adapted to the needs of biogas. This occurred in Germany with the modification of the GasNZV[18] in April 2008, which will be shown in the following chapters as an example for a national implementation of a to biogas adapted ordinance. This may help the member states of the European Union with the national implementation of an entry-exit-model in the European member states.

4.2.1 Intentions of the GasNZV

The intentions of the modification are to increase the biogas feed-in in Germany from 6 million m³ per year in 2007 up to 6 billion m³ per year until 2020 and 10 billion m³ per year until 2030 [GasNZV, 2008]. This will result in a raise of efficiency, as biogas from rural areas can be transported in areas with a high demand of energy to use it in combined heat and power cycles (CHP).

4.2.2 Connection to the gas grid

In GasNZV § 41c Netzanschlusspflicht[19] is ruled, that grid operators have to connect biogas plants to their gas grid preferential. The costs for the connection have to be shared one each half between the gas grid operator and the operator of the biogas plant (connection taker). If the connection pipeline is longer than 10 km, the network client has to bear the additional charge.

[18] Ordinance about access to the natural gas grid

[19] Obligation to connect to the gas grid

The grid connection consists of the following components:

- the connection pipeline between the gas conditioning plant and the gas grid
- the access to the connection point of the gas grid
- the pressure regulation station
- the facilities for pressure increase and
- the measurement which has to be appropriate for verification

The grid connection is owned by the grid operator. He also is responsible for operation and maintenance and has to bear the whole costs.

All required information for the grid connection have to be provided on their web site:

- the required information for the examination of the proposal for connection to the gas grid
- standardised conditions for the grid connection
- a well arranged representation of the load of the whole gas grid including effective and expected bottlenecks

4.2.3 Preferential access to the gas grid

Natural gas grid operators are obliged to close feed-in and feed-out contracts preferential with biogas transportation customers and to prior transport biogas, if these gases are compatible to the gas grid. The compatibility is given, if the conditioned biogas meets the requirements of the DVGW G 260 and DVGW G 262. This is because biogas plants produce their gas constant all over the year and they are only hard controllable. To make sure, that the operators of biogas plants are independent from the load profile of the gas demand.

The feed-in of biogas can be denied for technological or economical reasons. All economic reasonable actions to increase the capacity of the gas grid for the all-year transportation of biogas must be performed by the grid operator. He also has to ensure, that the gas grid may meet the demand for biogas transportation capacities, if the necessary measurements are economical reasonable.

4.2.4 Advanced balancing service

Balancing group network operators within a market area have to offer an advanced balancing service for the feed-in and feed-out of biogas, additionally to the basic balancing service.

The advanced balancing service has to be offered for all balancing groups in which exclusively biogas is fed in (special biogas balancing group contract) additionally to the basic balancing service. The exchange of gas quantities between balancing groups and the allocation of difference quantities has to be carried out between biogas balancing groups.

A transfer of biogas quantities into natural gas balancing groups is possible, but not a transfer of quantities from natural gas balancing groups into biogas balancing groups.

The special biogas balancing group contract contains a balancing for 12 months (the standard period for balancing) with a flexibility frame of 25 %. This value is relating to the accumulated variation between the fed-in and fed-out quantities during the balancing period. A balancing period of less than 12 months can be agreed between the balancing group network operator and the balancing group manager.

The balancing group manager has to inform the balancing group network operator about the excepted feed-in and feed-out quantities and their distribution about the year before the beginning of a balancing period.

The balancing group manager has to make sure that the feed-in and feed-out quantities remain within the accepted flexibility frame. They also have to be balanced at the end of the period. The excepted distribution about the period is not binding for the balancing group manager.

If the balancing group is perpetuated after the balancing period, a positive closing balance can be assigned to the following balancing period under compliance of the flexibility frame.

After the ending of a balancing period the difference between the actual feed-in and feed-out quantities, which is not within the flexibility range, have to be compensated. The compensation has to happen transparent, non-discriminating and orientated to the actual costs.

The balancing group manager of a special biogas balancing group has to pay to the balancing group network operator a fee of 0.001 EUR per kWh for the advanced balancing service for the effectively engaged part of the flexibility frame.

4.2.5 Quality requirements for biogas

The supplier of biogas has to ensure, that the gas at the entry-point and during the feed-in meets the requirements of the German DVGW guidelines G 260 and G 262. The costs have to be beard by the biogas supplier.

During the gas conditioning, the methane emissions must not exceed 1.0 % in the first three years after passing the GasNZV. After the three years, the methane emissions must not exceed 0.5 %.

Aberrant from the requirements of the DVGW regulations, the biogas can be delivered with a higher primary pressure to the grid operator.

The grid operator is responsible, that the gas at the exit-point meets the requirements of the DVGW guideline G 685, he also has to bear the costs.

The grid operator has to odorize the gas and is responsible for the metering of the gas condition, he also has to bear the costs.

4.2.6 Monitoring

The effects of the special biogas regulations in the GasNZV have to be surveyed by the German Federal Network Agency until may 2011 and then annually. The main issues of the analysis are the achieving of the objectives in chapter 4.2, the cost structure for the biogas feed-in, the achievable revenues and the charging of costs of gas grids and gas storages.

5 Economic effects of biogas transport in an entry-exit-model

5.1 General

The economic effects for the transportation of biogas can be classified insofar, that on one hand the transportation of biogas through the natural gas grid causes additional costs for the operator of biogas plant, respectively for the end user of the biogas. On the other hand, for the operators of the gas grid, there will be additional efforts to manage the advanced biogas balancing groups. As there are special fees for that, the efforts of the gas grid operators will be cleared.

The biggest economic influence to the costs for the biogas feed-in is caused by the gas conditioning, as the biogas has to be conditioned so far, that the gas for the feed in meets the requirements of guidelines like the German DVGW G 260 – "Gasbeschaffenheit"[20] and G 262 – "Nutzung von Gasen aus regenerativen Quellen in der öffentlichen Gasversorgung"[21]. After conditioning, the gas must be very similar to natural gas for the feed-in as additional gas or nearly identical to natural gas for the feed in as exchange gas.

The costs for gas conditioning won't be considered in the following, as they depend on many parameters which can't be significant shown in this work. Parameters for the conditioning costs can be:

- The size of the biogas plant (a single plant or a combination of several plants)
- The required gas quality for the feed in
- The gas composition which comes out of the biogas plant
- The operating costs for the conditioning, which depend mainly on the cost for energy and operating resources
- The development of prices for the material of the conditioning plant

Even if biogas can not compete against natural gas at the moment, increasing gas prices will cause a change in the economic efficiency. There is a chance especially for states with huge agricultural areas, to cover their energy demand long term with domestic biogas production and maybe become a biogas exporting country.

[20] Gas conditioning

[21] The use of gas from renewable sources in the public gas supply

5.2 Economic effects of the German entry-exit-model

The possible economic effects will be shown exemplary for Germany, as there already a entry-exit-model for natural gas has been adopted and therefore costs for the gas transportation are available. Additionally, with passing the modifications of the German regulation GasNVZ[22] in 2008, fees for the advanced balancing service were defined.

5.2.1 Cost structure of the German entry-exit-model

As the tariffs for feed-in and feed-out capacity differ between the market areas and even between the grid points (feed-in and feed-out stations), the tariffs of two big German transportation gas grid operators will be shown exemplary.

The following tariffs are currently in effect:

ONTRAS – VNG Gastransport GmbH:

Feed-in capacity: 0.18 – 7.17 EUR/(kWh/h)/a (it depends on the grid points)

The tariffs for feed-out capacity are classified into four tariff-zones:

Zone 1:	3.20 EUR/(kWh/h)/a
Zone 2:	2.50 EUR/(kWh/h)/a
Zone 3:	1.80 EUR/(kWh/h)/a
Zone 4:	2.50 EUR/(kWh/h)/a
Zone 5:	5.90 EUR/(kWh/h)/a

Additionally, some grid points are not assigned to one of the zones, thus they have differing tariffs. The zones, which cover big parts of Eastern Germany, are shown in the following Fig. 5.1.

[22] Ordinance about access to the natural gas grid

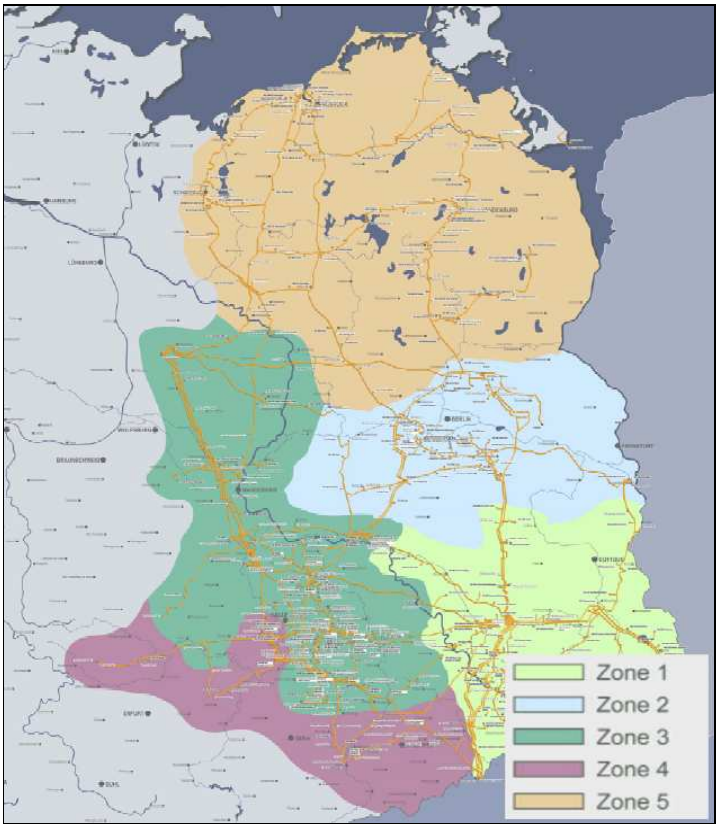

Fig. 5.1 - Tariff-zones ONTRAS

WINGAS Transport GmbH & Co. KG:

Feed-in capacity:	3.00 EUR/(kWh/h)/a
Feed-out capacity:	2.18 EUR/(kWh/h)/a

At some grid points differing tariffs are valid. For feed-in the tariffs vary between 3.40 EUR and 6.90 EUR, for feed-out between 3.40 EUR and 5.20 EUR.

The tariffs for biogas transportation capacity are the same as for natural gas. The only difference lies in the advanced balancing service for biogas balancing groups. This causes additional costs of 0.001 EUR/kWh for the actually used flexibility frame (see also chapter 4.2.4).

Another economic effect is caused by the costs for the connection of the biogas plant to the gas grid (chapter 4.2.2), which has to be parted between the gas grid operator and the operator of the biogas plant. The gas grid operator has to bear additionally the costs for operation and maintenance of the grid connection and all its components.

It is hard to define the capital and operation costs resulting from the grid connection, as they depend on the size of the biogas plant, the distance between the gas conditioning and the natural gas grid and the pressure difference between the biogas after conditioning and the pressure required for the feed-in.

5.2.2 Resulting economic effects of the German entry-exit-model

The economic effects using the German natural gas grid for transportation of biogas can be classified, next to the national economic effects, to three groups:

- The operators of biogas plants
- The operators of the natural gas grids
- The final consumers

The national economic effect results in the replacement of natural gas by biogas.

As the natural gas price at the spot market is actually about 25 EUR/MWh and the costs for biogas production (incl. gas conditioning and transportation) is about 49 EUR/MWh (biogas plant with 500 m³/h raw biogas), the biogas production is not economic efficient in the moment.

It is hard to quantify the economic effects as the development of the natural gas prices can not be foreseen. If in the year 2020 6 billion m³ biogas will be fed-in and therefore replace 6 billion m³ natural gas, the actual prices would cause additional costs of about 1.44 billion EUR. A doubling of the natural gas price until 2020 would cause an economic equilibrium between natural gas and biogas.

In the future the significantly increasing oil- and gas prices will cause a change in the economic efficiency, even if the biogas price raises, because of increasing substrate costs, like it does in the moment. The substrate costs will become nearly constant, as the agricultural areas in Germany are big enough for food and energy production.

An additional point is the creation of value by biogas production in structurally lagging regions, mainly in Eastern Germany.

For the operators of biogas plants there are positive economic effects to expect, as for electrical energy from biogas, which is conditioned to natural gas quality and fed-in into the natural gas grid, a higher remuneration, the technology-bonus (additional 0.02 EUR/kWh), will be achieved.

For electrical energy generated in a CHP-process with full waste heat utilisation a CHP-bonus (0.02 EUR/kWh) will be obtained.

Altogether 0.04 EUR/kWh more can be achieved, than for electrical energy generated near to the biogas plant without reasonable waste heat utilisation.

An overview of the possible remunerations is given in the following Tab. 5.1:

Tab. 5.1 - Remuneration for electrical energy from biogas

[EUR/kWh]	Basic-remuneration (2005)	NawaRo[23]-Bonus	CHP-Bonus	Technology-Bonus
≤ 150 kW	0.115	0.06	0.02	0.02
≤ 500 kW	0.099	0.06	0.02	0.02
≤ 5 MW	0.089	0.04	0.02	0.02
> 5 MW	0.084	0	0.02	0

The costs for gas conditioning and feed-in for a biogas plant with 500 m³/h raw biogas or 250 m³/h biomethane can be assumed as about 0.02 EUR/kWh. In this case, the gas conditioning and feed-in is economic efficient. Raising biogas plant sizes will decrease the costs for conditioning, so that they become more efficient.

One risk remains for the operators of biogas plants. If their plants break down, they have to buy biogas or natural gas at the spot market to comply with their supply contracts. This would increase their costs, as they have to pay for the gas compensation additionally to the losses caused by the biogas plant breakdown.

A biogas plant with a feed-in of 250 m³/h (2,500 kWh) and a breakdown would have to pay 62.5 EUR/h for natural gas at the spot market, respectively 1500 EUR/day additionally to his loss of income.

For the operators of the gas grids there will be increasing costs for connecting the biogas plants to their grid, as they have to bear half of the costs for the grid connection (see also chapter 4.2.2).

As the transportation of conditioned biogas is the same as the transportation of natural gas and the quantity of gas, which can be transported in the gas grid stays the same, there won't be any further economic effects for the gas grid operators.

For the final users the increasing assignment of biogas will cause additional costs as the remunerations for electrical energy from biogas and even the costs for the connection of biogas plants to the gas grid will be referred in the end to the final users. The effect will decrease if the increasing gas prices reach a level similar to the costs for biogas production.

[23] Bonus for biogas plants, where only renewable primary products, liquid manure and/or draff is treated

5.3 A dynamic forecast calculation model for the economic effects

This dynamic forecast calculation should enable to calculate the national economic effects of domestic biogas production and injection in comparison with the use of natural gas.

This will help to decide if the feed-in of biogas into the natural gas grid is economical reasonable, if state subsidies or cross subsidies are necessary and if there is demand for research and development regarding biogas production and conditioning.

The result of the calculation will be a comparison between the total costs of natural gas and biogas, as shown in the following Fig. 5.2. Both result from input values made by the user, therefore the result will reflect the national status quo regarding the economical effects of using biogas and natural gas.

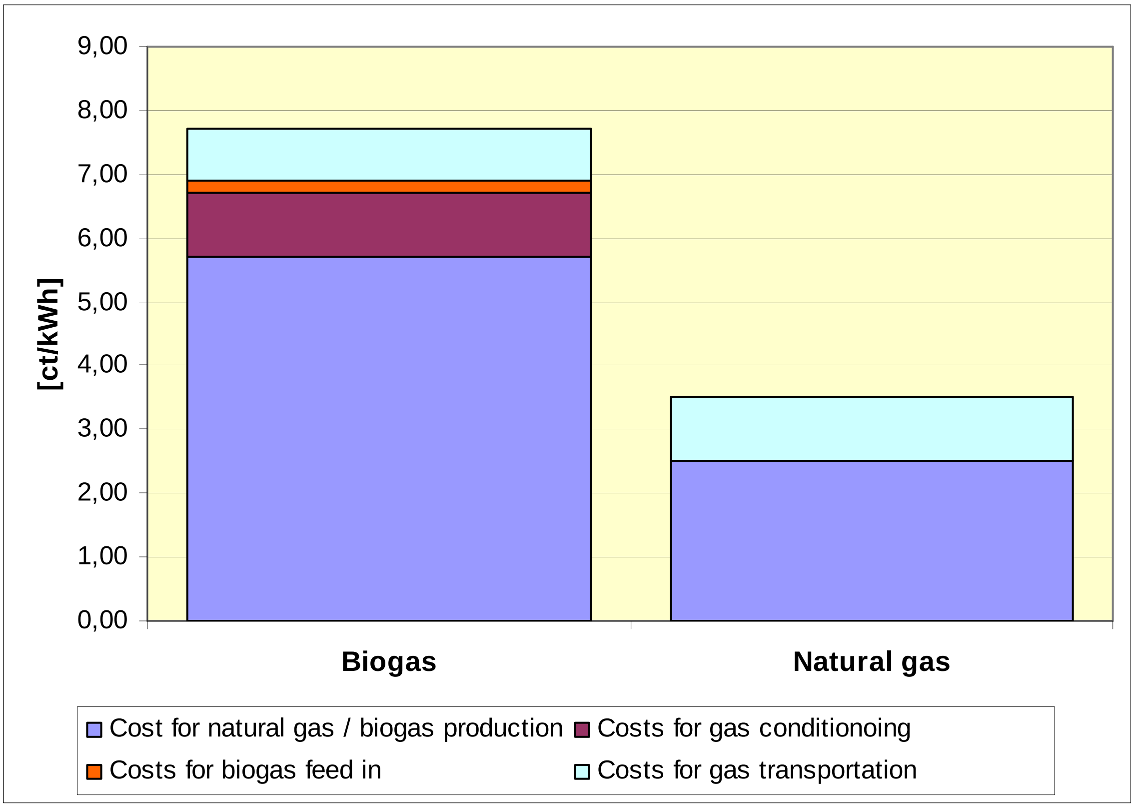

Fig. 5.2 - Comparison of the costs of natural gas and biogas

Required information for the calculation are:

- The price for natural gas [ct/kWh]
- The costs for biogas production, conditioning and feed-in [ct/kWh]
- The costs for transportation of natural gas and biogas [ct/kWh]

The price for natural gas depends on the target group for the calculation. For end-users there might be another price than for industrial gas users or gas fired power stations.

The price for biogas must include all relevant costs from the production to the conditioning and compression to a pressure level appropriate for the injection.

The costs for transportation can't be neglected as the transport distances of biogas and natural gas may vary because of their different points of production and therefore also the entry- and exit-points.

The forms for entering the input values for biogas and natural gas are shown in the following figures Fig. 5.3 and Fig. 5.4.

Biogas		
Costs for raw biogas production	5,70	[ct/kWh]
Costs for gas conditioning	1,00	[ct/kWh]
Costs for the biogas feed-in	0,20	[ct/kWh]
Costs for transportation of biogas	0,80	[ct/kWh]
Total	7,70	[ct/kWh]

Fig. 5.3 - Input values for biogas

Natural gas		
Costs for natural gas	2,50	[ct/kWh]
Costs for natural gas transportation	1,00	[ct/kWh]
Total	3,50	[ct/kWh]

Fig. 5.4 - Input values for natural gas

Another result of the calculation work sheet is a sensitivity analysis to recognize the influence of mid- or long-term prices changes to the costs of biogas feed-in. The following Fig. 5.5 shows exemplary the comparison between biogas and natural gas as well as the influence of changing prices of price components to the total costs.

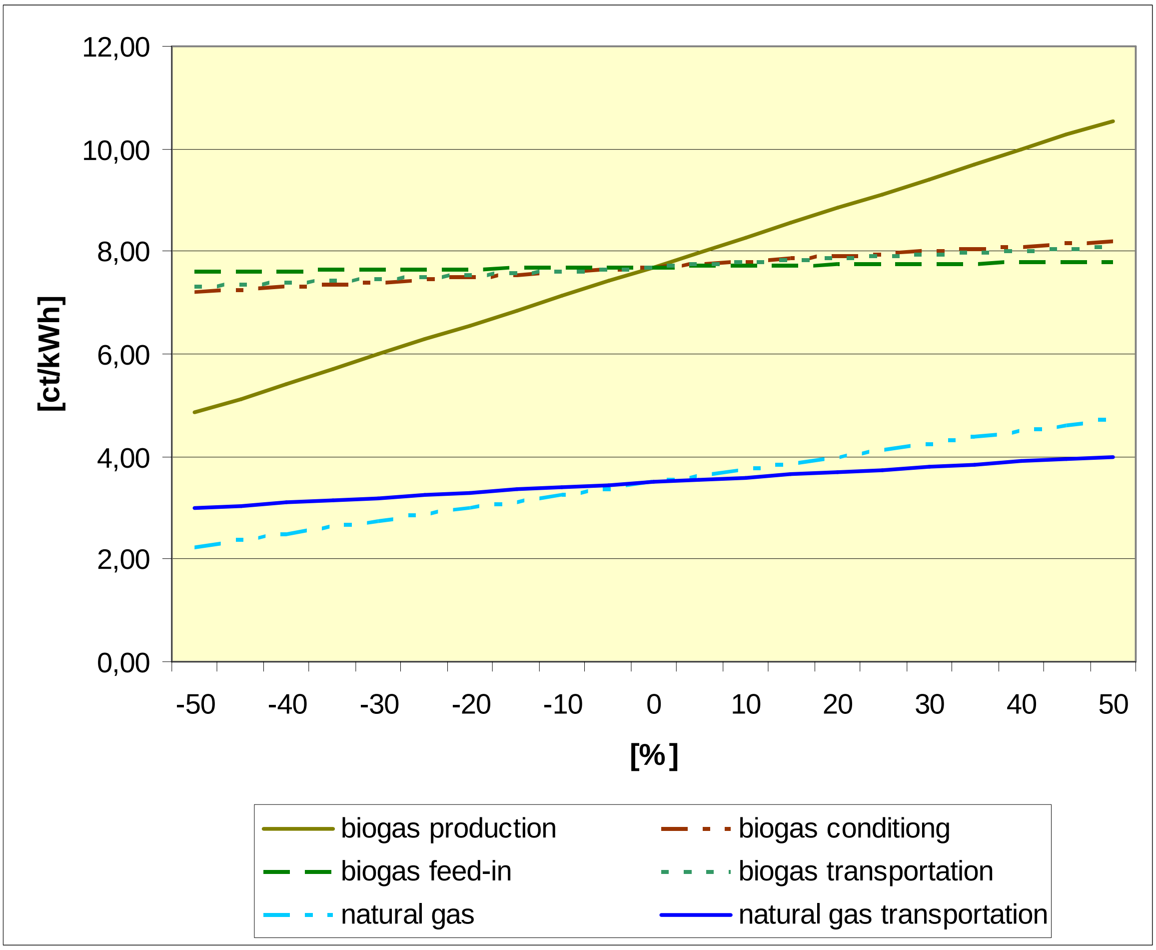

Fig. 5.5 - Sensitivity analysis of costs for biogas feed-in

This calculation model gives an idea about the economic effects resulting from substituting natural gas with biogas.

There is an additional question regarding the quantities of gas, which can be substituted. Therefore the following input values must be determined:

- The expected biogas injection potential [kWh]
- The total demand of natural gas [kWh]

The expected biogas injection potential must be determined in a potential analysis, where the biogas potential is aligned with the maximum gas quantity which can be fed-in into the gas grid. Therefore, the load profiles of the pipelines, which come into question for a feed-in have to be analysed regarding the minimum flow rate.

The total demand of natural gas can be determined to see which part of the natural gas demand can be covered with biogas. This might be also important for the control of climate protection targets.

Generally is to aspire, that not the “clean” energy source natural gas but other energy sources like coal and oil should be replaced by biogas. Therefore a change in the pattern of energy consumption might be necessary as coal and oil fired units have to be replaced by gas fired units.

Both gas quantities must be charged with the costs for the calculation model against each other to find out the real possible national effects of substituting natural gas with biogas.

6 Outlook

The next steps, to adopt an European biogas entry-exit-model, must be the implementation of an entry-exit-model for natural gas in the member states of the European Union, according to the European guidelines named in chapter 2.

Therefore, the first steps lay in the hands of the national legislature, which is also responsible for the timing of the implementation, as the time schedule depends on the time for passing new or modified laws and the transit time which will be given to gas grid operators.

Another factor, important for the initiation of an entry-exit-model, is the structure of gas supply and gas grid operation in the member states and also the satellisation from other states like it is shown in chapter 3.4 exemplary with Lithuania.

The European member states could learn from the experience of Germany and other states which have already implemented an entry-exit-model. As the biogas entry-exit-model in Germany, described in chapter 4, has passed in April 2008, there will be some interesting experience, soon.

A simplification of the access to the natural gas grid and an increase of the long term safety for operators of biogas plants will be able to boost the feed-in of biogas to the natural gas grid in the European Union.

7 Abstract

In the European Union, the actual potential for biogas production is about 4,896 PJ per year (approx. 270 billion Nm³ pear year). As the biogas production takes place mainly in rural areas, with a high potential of biogas production but low energy needs, the biogas feed-in could help to transport the biogas to urban areas, where often both electrical energy and heat are needed. This would increase the efficiency of the biogas use from 40 % for sole power generation to about 90 % for combined heat and power generation (CHP).

The transportation of biogas also works trans-European, so that member states with high potential of biogas production and low energy demand could supply member states with a high demand of energy. This would also decrease the dependency from natural gas imports and cause the creation of value in the European Union.

Preconditions for a long term assured biogas feed-in are technical, economical and judicial guidelines in the European member states .

To simplify the feed-in, feed-out and trade of biogas, an entry-exit-model has been developed in this deliverable. It is based on the entry-exit-model for natural gas, which was adopted with the national implementation of the European guidelines, regarding the liberalisation of the gas market, in 2003/2004.

The entry-exit-model has displaced the further applied “point to point”-model, where the gas transportation capacities have to be booked bound to a concrete transportation path through the gas grid. The costs for the gas transportation depend on the length of the transportation path and thus on the theoretically way of the gas flow.

In an entry-exit-model, the operators of natural gas grids have to offer feed-in and feed-out capacities, which enable the access to the gas grid without defining a transportation path depending on the transaction. Feed-in and feed-out capacities can be usable and tradable independent from each other. The booking of entry and exit capacities may occur in different amounts, to different times and for different periods.

Entry-points can be fed e.g. directly from natural gas production, from proceeding gas grids or from transmission pipelines, exit-points can feed-out to e.g. subsequent gas grids or major customers.

Operators of gas grids are committed to cooperate in a way, that customers need only one feed-in and one feed-out contract, even if the transportation of the gas goes about multiple, via interconnection points connected, gas grids. Precondition is, that the cooperation is technical possible and economical reasonable.

To enable the gas trade between balancing groups within a market area and also between several market areas, a tool called virtual trading point was created.

A virtual trading point is not allocated to a physical entry- or exit-point. It allows transmission customers to purchase and sell gas without booking transportation capacity in the gas grid.

The balancing groups can be formed from physical entry- and exit-points as well as from virtual and physical entry /exit-points or solely virtual points.

In 2003 and 2004, the European guidelines, according common rules for the natural gas market and the security of natural gas supply, have been passed. As European guidelines require a national implementation, all members of the European union will have to pass adequate national laws.

In Germany, an entry-exit-model has been implemented with the passage of the Gasnetzzugangsverordnung[24] (GasNZV) in 2005. Since then, natural gas grid operators have to replace their "point to point"-model with a two-contract-model, the "entry-exit-model".

In the co-partners states Hungary and Czech, the European guidelines were implemented in 2007.

To transport biogas into the natural gas grid, the question of the required gas quality has to be considered.

The feed-in of raw biogas is critical, as unwanted gas escort substances like hydrogen sulphide, carbon dioxide and siloxanes will reach to the natural gas grid and thus to end users. Even lightly conditioned biogas (desulphurized, dried) won't meet the requirements of the regulations regarding the gas quality in the natural gas grid (i.e. the German regulation DVGW G 260 – "Gasbeschaffenheit"[25]), as the main parameters like heating value and wobbe index differ highly from the parameters of natural gas. Lightly conditioned biogas can be fed-in as additional gas, if the flow rate in the gas grid is high enough, so that the parameters of the gas mixture meet the requirements of the regulations.

To feed-in as exchange gas, a conditioning consisting of CO_2-removal, desulphurisation and drying, is necessary. Therefore, the gas can be handled like natural gas.

To support the feed-in of biogas in the European Union regulations and conditions for access to the gas grid must be adapted to the needs of biogas. This occurred in Germany with the modification of the GasNZV in April 2008 with the intention, to increase the biogas feed-in in Germany from 6 million m³ per year in 2007 up to 6 billion m³ per year until 2020 and 10 billion m³ per year until 2030.

As the adoption of an entry-exit-model is far proceeded and there are the most information available, the German biogas entry-exit-model will be shown as an example and prototype for the implementation of an entry-exit-model in the European member states.

The natural gas grid operators have to connect biogas plants to their gas grid preferential. The costs for the connection have to be shared one each half between the gas grid operator and the operator of the biogas plant (connection taker). If the connection pipeline is longer than 10 km, the connection taker has to bear the additional charge.

The grid connection consists of the following components: the connection pipeline between the gas conditioning plant and the gas grid, the access to the connection point of the gas grid, the pressure regulation station, the facilities for pressure increase and the measurement which has to be appropriate for verification.

[24] Ordinance about access to the natural gas grid

[25] Gas conditions

The grid connection is owned by the grid operator. He also is responsible for operation and maintenance and has to bear the whole costs.

The natural gas grid operators are obliged to close feed-in and feed-out contracts preferential with biogas transportation customers and to prior transport biogas, if these gases are compatible to the gas grid.

Balancing group network operators within a market area have to offer an advanced balancing service for the feed-in and feed-out of biogas, additionally to the basic balancing service. The advanced balancing service has to be offered for all balancing groups in which exclusively biogas is fed in (special biogas balancing group contract). The exchange of gas quantities between balancing groups and the allocation of difference quantities has to be carried out only between biogas balancing groups.

A transfer of biogas quantities into natural gas balancing groups is possible, but not a transfer of quantities from natural gas balancing groups into biogas balancing groups.

The balancing group manager of a special biogas balancing group has to pay to the balancing group network operator a fee of 0.001 EUR per kWh for the advanced balancing service for the effectively engaged part of the flexibility frame.

The supplier of biogas has to ensure, that the gas at the entry-point and during the feed-in meets the requirements of the accordant German DVGW guidelines. The costs have to be beard by the biogas supplier.

In Germany, the economic effects be substituting 6 billion m³ of natural gas with the same quantity of biogas like it is planed in 2020, with the current costs for natural gas and biogas additional costs of 1.44 billion EUR would be created. A doubling of the natural gas price until 2020 would cause an equilibrium between the natural gas price and the price for biogas.

A dynamic forecast calculation model was created which enables the user to compare the costs for natural gas and biogas having regard to different transportation costs, as the entry-points for biogas (nearby the biogas production) will be others than for natural gas, even if the exit-points are the same.

The next steps, to adopt an European biogas entry-exit-model, must be the implementation of an entry-exit-model for natural gas in the member states of the European Union with immediately or subsequent integration of biogas.

A simplification of the access to the natural gas grid and an increase of the long term safety for operators of biogas plants will be able to boost the feed-in of biogas to the natural gas grid in the European Union.

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