ASSESSMENT OF
MARKET INTEGRATION OPTIONS AND SIMPLIFIED COST-BENEFIT ANALYSIS

Non-binding English version of a study conducted by Wagner, Elbling & Company (WECOM) for E-Control Austria

Vienna, 31 January 2017

BACKGROUND AND SCOPE OF STUDY

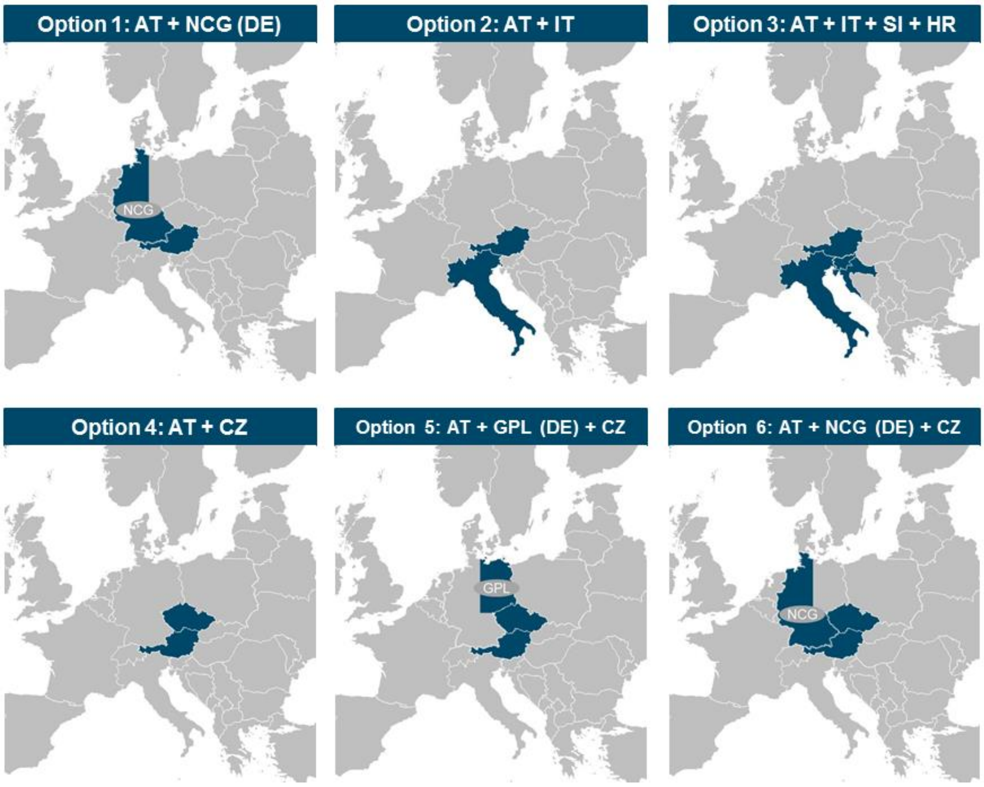
The publication of the EU's 1998 Gas Directive (98/30/EG) marked the official starting point for the Union's pursuit of the Internal Energy Market in natural gas. The ACER Gas Target Model (AGTM) of January 2015 further develops the concept of a competitive European gas market that consists of closely interconnected and well-functioning market areas or entry-exit systems. It defines a series of metrics that can be used to evaluate a wholesale market's functioning and liquidity (Market Participants' Needs Metrics) and upstream diversification (Market Health Metrics). Where the thresholds set for each AGTM metric are met, it is considered that consumers and suppliers in the EU have access to functioning gas wholesale markets. Entry-exit systems should not automatically correspond to national borders but should instead follow the boundaries that emerge from existing and planned infrastructure. This should lead to a positive cost-benefit ratio, to be confirmed via calculations defined in the AGTM.

In the study, WECOM assess a number of (cross-border) market integration options for Austria's eastern market area. First, they use quantitative indicators to evaluate the options' structural characteristics, such as the upstream market, security of supply, direct access to new sources and effects on the availability of existing entry-exit capacity. Second, they apply a simplified cost-benefit analysis to calculate the expected net economic welfare gain for consumers from each of the options. This also includes an estimate of how strongly this welfare gain would be reduced in the case of partial market integration (e.g. if a trading region with national zones were established). In the end, they assess the needs for harmonisation that each of the options would entail and compare them with each other.

EXECUTIVE SUMMARY

The study analyses six market integration options that represent the potential further evolution of Austria's eastern market area (AT). The options are depicted below. WECOM apply quantitative indicators to assess the options' structural characteristics and conduct simplified cost-benefit analyses to evaluate their potential for generating welfare gains.

Figure 1: Geo-graphical scope of market integration options



Quantitative indicators for structural evaluation

The study applies a series of quantitative indicators to analyse the structural characteristics of each market integration option. The results are presented below and summarised in Table 1.

Market Health Metrics

All market integration options have a sufficient number of supply sources (this is also the case if looking at the eastern market area only). The Residual Supply Index (RSI), which measures a market's capability to compensate for an outage of its largest supplier, is sufficient in all combinations except AT + NCG (DE). The Herfindahl-Hirschman Index (HHI) is in line with the findings on the number of supply sources. While none of the options reaches the AGTM threshold, the combinations with NCG (DE), GPL (DE) or IT have lower concentrations than are currently observed in Austria. This is not the case for the pairing with CZ, where dependence on the largest supplier potentially increases and the metric deteriorates compared with the current situation.

Additional security of supply indicators

All options fulfil the infrastructure standard (N-1) from Regulation (EU) 994/2010, with an ability to supply at least 100% of each market's maximum demand even if faced with an outage of the largest infrastructure. None of the options fulfils the standard set for import route diversification (IRD), but the results achieved for Austria as a standalone market improve in all market integration options. With the exception of the AT + CZ combination, they only miss the threshold by a narrow margin.

The Austrian market can cover 78% of its annual demand from working gas volume of storage facilities (storage demand coefficient, SDC). This percentage dramatically drops (to 31-62%) in all of the market integration options; only a combination with CZ or CZ + GPL (DE) achieves levels that are comparable to the Austrian standalone market.

Looking at the market's ability to cover peak demand with storage deliverability (storage rate coefficient, SRC) yields similar results. Austria's own storage rate coefficient is at 131% and the results for market integration options with CZ or German market areas are lower but still in the same order of magnitude. This is particularly striking in the AT + GPL (DE) + CZ option, which has a storage rate coefficient of 115%. As is the case for the storage demand coefficient, the two options that include Italy reach levels that are significantly lower at around 70% but still high in international comparison.

HHI for storage

Austria alone does not have a sufficient number of storage system operators. Almost all market integration options increase the number of operators so that the required threshold is reached. Exceptions are only the combinations with Italy, where the storage market is highly concentrated; the metric deteriorates further in these options.

Direct market access (DMA)

The direct market access metric assesses the degree to which Austria gains access to new gas sources in each market integration option, and the degree to which Austria's net import needs can be covered from these new sources (taking into consideration how much capacity is currently available, i.e. unused).

Options that include Italy result in five new gas sources and very high DMA of 99%. Combinations with NCG (DE) tap four new gas sources, but there is only little unused capacity, which is why direct market access for these options is only 18-31%. The remaining two options, i.e. the combinations with CZ, have comparatively little potential to improve the Austrian result for this metric.

Theoretical interconnection deficit and capacity restriction rate

Based on the capacity situation and domestic consumption in each market of a market integration option, the theoretical interconnection deficit (TID) estimates the average annual impact of market integration on existing freely allocable capacity in worst case nomination scenarios. This is then put in relation to the total freely allocable capacity to calculate the theoretical capacity restriction rate (TCRR).

All market integration options show considerable interconnection deficits, with AT + CZ and AT + GPL (DE) + CZ presenting the highest restriction rates at 55 and 80% respectively. The combinations with NCG (DE) show restriction rates only slightly below 50%. Options with IT have the lowest TCRRs, at 25 and 29%, due to the very large interconnection capacity.

The below table summarises the results of WECOM's calculations for all market integration options. If the metrics are usually paired with thresholds, these are indicated in the table as well, along with the degree of fulfilment for each option. The storage metrics (SDC and SRC) make reference to a market's demand or peak load, which is why scores beyond 100% are possible.

Table 1: Summary of results for quantitative indicators, in degree of fulfilment

	Quantitative indicators							
	Threshold	AT	AT+NCG(DE)	AT+IT	AT+IT+SI+HR	AT+CZ	AT+GPL(DE)+CZ	AT+NCG(DE)+CZ
AGTM Market Health Metrics								
Number of supply sources	≥ 3	100%	100%	100%	100%	100%	100%	100%
HHI	≤2000	36%	70%	77%	78%	32%	50%	66%
RSI	≥ 110% of demand	100%	89%	100%	100%	100%	100%	100%
Security of supply								
N-1	≥ 100%	100%	100%	100%	100%	100%	100%	100%
IRD	≤ 2000	33%	97%	93%	95%	38%	93%	76%
SDC	% of demand	78%	31%	31%	31%	62%	47%	33%
SRC	% of peak demand	131%	99%	72%	70%	98%	115%	95%
Storage								
HHI for storage	≤ 2000	90%	100%	48%	51%	100%	100%	100%
Capacity metrics								
Max. DMA (% of net dom. demand)			18%	99%	99%	13%	13%	31%
New direct sources			4	5	5	1	3	4
Individual markets TID TWh/a of freely allocable entry cap.			AT: 440 NCG: 240	AT: 188 IT: 231	AT: 188 IT: 293 SI: - HR: 19	AT: 460 CZ: 102	AT: 605 GPL: 324 CZ: 34	AT: 440 NCG: 21 CZ: 102
Individual markets TCRR % of freely allocable entry cap.			AT: 77% NCG: 29%	AT: 27% IT: 23%	AT: 27% IT: 29% SI: - HR: 70%	AT: 67% CZ: 31%	AT: 88% GPL: 44% CZ: 18%	AT: 77% NCG: 18% CZ: 31%
Aggreg. TID TWh/a of FAEC			679	419	501	562	963	563
Aggreg. TCRR % of FAEC			48%	25%	29%	55%	60%	37%

Cost-benefit analysis

WECOM's simplified cost-benefit analysis for each market integration option is based on the premise of a full market merger. As far as the specifics of each individual market are concerned, they use the infrastructure base case in section 1 and the underlying data in annex A.1. The analysis assumes that in a well-functioning and competitive market, the potentials realised at each stage of the value chain trickle down to consumers in the end.

Any interconnection deficits etc. that result would be addressed by restricting existing capacity. This is why the study does not use costs to represent capacity restrictions but rather, reduces the calculated welfare gain by the impact on free connection capacity between the markets in a worst case nomination scenario. They do not quantify any other cost elements (e.g. one-off implementation costs), because it is assumed that they are offset by efficiencies that are not quantified either (particularly synergies between market player roles).

In the end, three types of benefits are quantified as part of the study. These are briefly explained below and a synopsis of the results is presented.

Wholesale market efficiency
Market integration enables players to use open bids from the lower-priced wholesale market to bring down prices in the integrated market. Theoretically, this sees wholesale market prices converge towards the lowest price level observed on the individual markets.

To take account of existing interconnection deficits that limit the possibilities to freely ship gas in the integrated market, however, the study does not assume full price convergence. Instead, the calculated benefit is reduced by applying the aggregated theoretical capacity restriction rate for each market integration option.

Bid-ask spread
The bid-ask spread on an integrated market with a central VTP as pivotal venue for all wholesale transactions corresponds to the lowest bid-ask spread previously observed on the individual markets. The study uses (historical) trade data to calculate the benefit of this effect in each market integration option. Like for wholesale market efficiency, the calculated benefit is reduced by the aggregated TCRR.

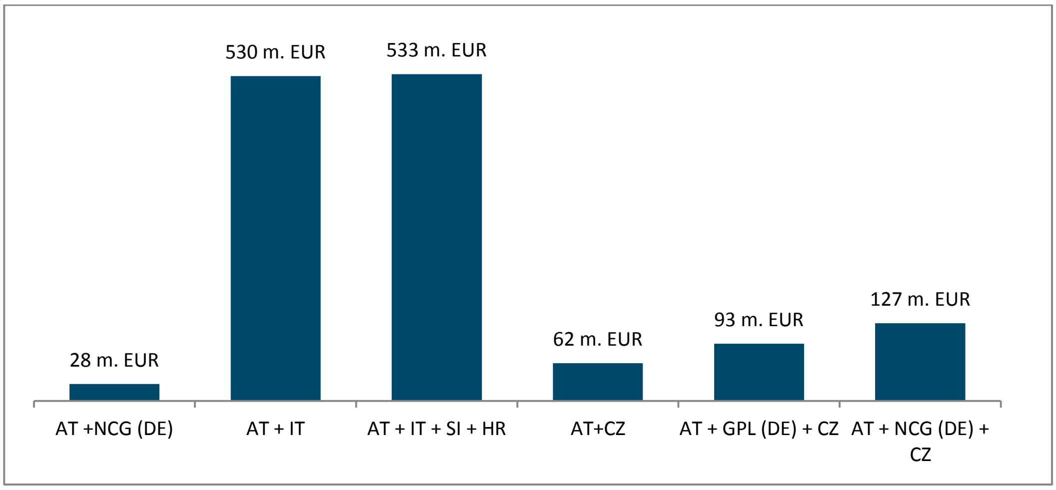
Retail market efficiency
Integrated markets enable more retail market efficiency by eliminating national market barriers and increasing competition. Differences in wholesale and household/business prices between the national markets disappear, the most efficient competitors launch attractive offers that are available across the integrated market, and prices converge towards the lowest level currently observed. This results in benefits for active household and business consumers (i.e. consumers who have already switched contract or supplier). In the industry segment, the spread between wholesale and consumer prices is already

quite narrow, so it is unlikely that it will close even further. Adjusting the calculated benefit for interconnection deficits is not necessary for this type of benefit given that the connection between consumers and the VTP is always assumed to be congestion free.

The figure below displays the calculated overall welfare gain for each of the market integration options investigated. Costs for building the additional infrastructure (BACI) foreseen in the infrastructure base case (s. Figure 4) are included.

Summary results of the cost-benefit analysis

Figure 2: Calculated welfare gain of each market integration option, in million EUR/year



The calculated welfare gain is particularly high for the two options that include Italy. This is thanks to the considerable size of the Italian market and the relatively small capacity restrictions. The other four market integration options offer much smaller gains, while among these, the combinations with three markets (i.e. those that result in larger integrated markets) score better. The market integration option with the German market area NCG has the lowest calculated welfare gain, followed by the AT + CZ option.

All options that include CZ assume that the BACI interconnection project is realised (16,561 MWh/h (DN1200)), which is why the calculated welfare gain for these options is reduced by the projected costs (CAPEX and OPEX, as communicated) of that project.

Options including NCG (DE) assume that capacities at the Oberkappel and Überackern points remain stable, as is displayed in the infrastructure base case (s. Figure 4). If additional capacity were created at these points, the welfare gain from these market integration options could increase somewhat, though this would depend on the costs of the related infrastructure investments (which are currently unknown).

Applicability, implications and harmonisation requirements of market integration tools

The AGTM presents a number of market integration tools and describes their main characteristics. The descriptions focus on typical features and examples and include pointers towards alternative implementation options. Also, the AGTM emphasises that the list is not exhaustive.

Applicability

From the basic features of the different market integration tools, the AGTM derives conditions for market characteristics such as interconnection capacity and upstream/downstream market structure that should be fulfilled in order for a tool to be feasible. It then proceeds to check which markets fulfil the conditions.

The GTM finds that only full market mergers or trading regions are feasible for Austria. Forming part of a satellite market is an option only if Austria (possibly together with another market) serves as supplier for downstream markets (e.g. SI and/or HR). The study therefore focuses on the full market merger and the trading region as the two tools that are relevant for Austria.

Implications for calculated welfare gain and cost-benefit analysis

The welfare gain calculations and cost-benefit analyses conducted previously assume that a full market merger would take place. If trading regions (with the typical features described in the AGTM) were to be installed instead, this would impact the retail market efficiency benefits that could be realised. How strongly retail market efficiency would be reduced depends on the concrete characteristics of the trading region, i.e. can only be calculated once a detailed market integration concept has been elaborated.

Harmonisation requirements

Any assessment of the degree of harmonisation that will be necessary for concrete market integration options to work must be able to rely at least on a basic concept for the tool that will be applied. In the study, WECOM use the typical features as presented in the AGTM. They focus on aspects that must be addressed so that the market integration tool can function from a legal and operative point of view, i.e. issues without which the tools could not be applied. Further approximation that aims to install a level playing field and push the overall efficiency of the new market area, though recommended, is outside the scope of the study.

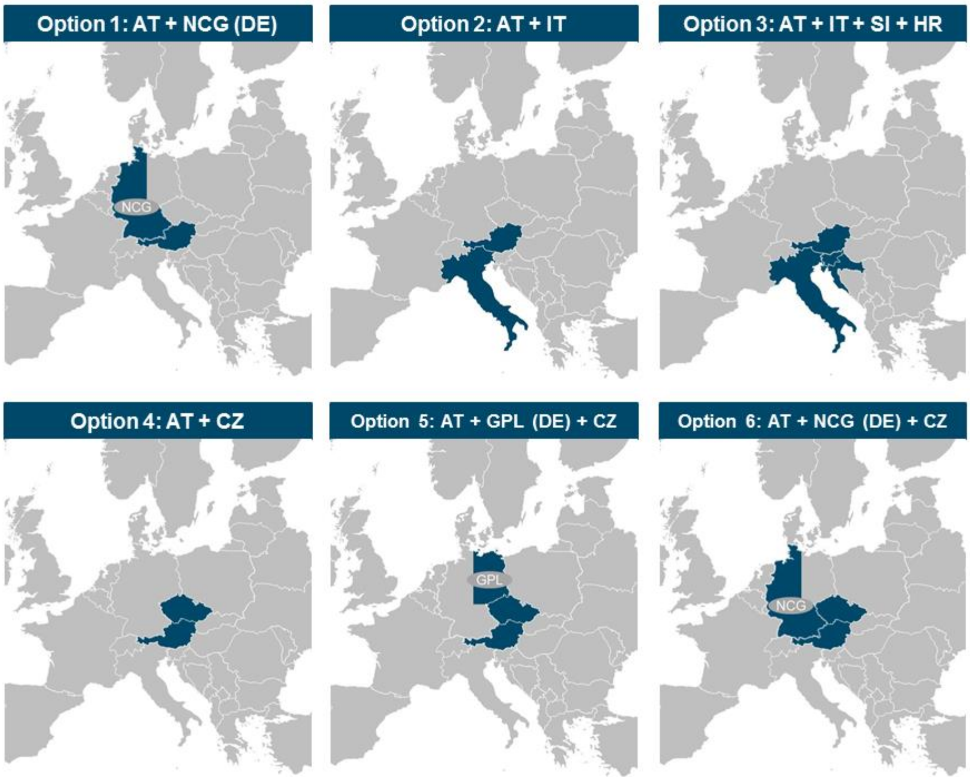
Absolute prerequisites for market integration include harmonisation in the area of grid access and, to a lesser extent, in the fields of security of supply and charges. When comparing the need for uniform rules between the full market merger and trading region tools, WECOM find that the latter presents an absolute necessity for harmonisation in only a few areas and that these are areas at the level of the integrated trading region, i.e. they do not interfere with the national specificities of supply, balancing etc. of consumers.

CONTENTS

1 Market integration options and their characteristics

The study analyses six market integration options defined by E-Control that represent the potential further evolution of Austria's gas market (AT)[1]. The options are depicted below. WECOM apply quantitative indicators to assess the options' structural characteristics and conduct simplified cost-benefit analyses to evaluate their potential for generating welfare gains.

Figure 3: Geographical scope of market integration options



An *infrastructure base case* to be defined in the following will serve as the primary basis for various analyses and provide a first overview of the structural characteristics of the market areas considered in the market integration options.

The existing technical interconnection capacity and market-area-specific properties such as consumption, production and the resulting *net import demand* (NID), which is calculated as consumption less production, are presented. Furthermore, direct sources of

[1] Throughout the study, the abbreviation AT stands for Austria's eastern market area (the Tyrol and Vorarlberg market areas have not been considered in this study).

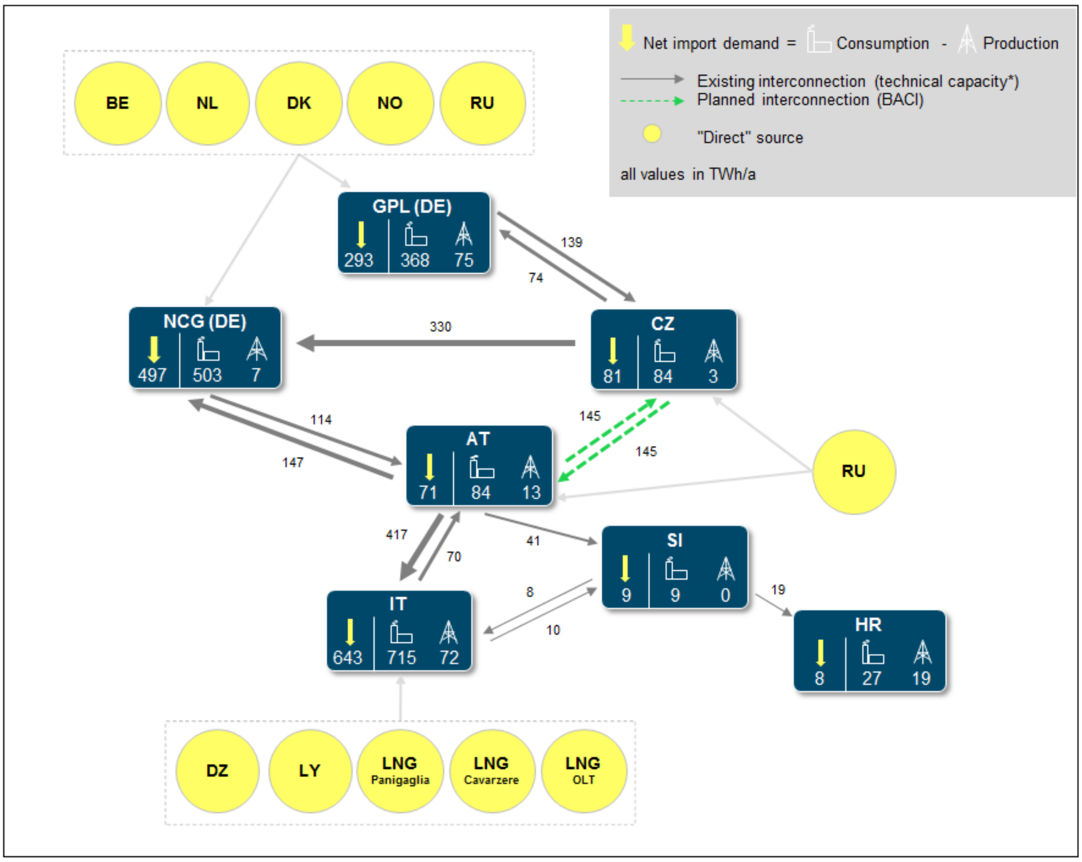
the relevant market areas are marked in yellow[2]. Functioning natural gas markets, LNG facilities and net exporters are considered new gas sources (for details s. section 2.1.3.1).

The BACI DN1200 project[3] with a capacity of 16,561 MWh/h, which is currently in the planning stage and would connect the two market areas AT and CZ, is additionally marked in green and considered as interconnection capacity in the market integration options that comprise CZ and AT. The infrastructure base case is based on the data explained in annex A.

[2] Where producers (= net exporters) directly and explicitly deliver natural gas to a target market area based on existing transit contracts and routes or make it available directly at the entry points of this market area, the supply source is considered as existing direct access (relevant for AT, NCG (DE) and CZ with regard to Russian supply).

[3] Also s. Coordinated Network Development Plan 2016 (https://www.e-control.at/documents/20903/388512/Konsultationsversion+Koordinierter+Netzentwicklungsplan+2016_2025_EN.PDF/abc8125f-377c-43ce-bc2c-4c2f531e6491).

Figure 4: Infra-structure base case



Note(*): Technical capacity does not include explicitly excluded capacity of transit routes that are not or only partially regulated (also s. annex A).

2 Quantitative indicators for a comparative assessment of structural characteristics of the market integration options

This chapter deals with quantitative metrics that serve to evaluate structural characteristics of the examined market integration options. Topics covered include import diversification, security of supply, the storage market, effects on the existing capacity offer as well as access to new, direct sources. The calculation methodology will be explained in detail in section 2.1 below. The results obtained (relating to 2015, the year under review, and the underlying data described in annex A) are presented in section 2.2.

2.1 Detailed description of quantitative indicator calculation methodology

2.1.1 Market Health Metrics

Market Health Metrics are used to evaluate a given market's level of competitiveness and stability as well as its security of supply. They are based on three indicators:

- Number of supply sources
- Herfindahl-Hirschman Index (HHI)
- Residual Supply Index (RSI)

The following calculation methodology is in principle based on the procedure outlined in Annex 3 of the AGTM. On the following pages, this fundamental methodology used by WECOM for the analyses in this study is discussed in detail.

2.1.1.1 Market indicator: number of supply sources

Theoretical concept

The number of supply sources indicator states the diversity of the supply sources of a given gas market. In addition to the number of import sources (regardless of whether access is provided via pipelines or LNG), domestic production, if any, is considered as an additional source. As this indicator does not directly express the level of competition or market concentration, it should always be viewed and interpreted in connection with other metrics, such as the Herfindahl-Hirschman Index or the Residual Supply Index.

The AGTM defines the target for the number of supply sources at which supply is sufficiently diversified at a minimum of three.

Calculation methodology

Based on import and production data for the respective markets, existing supply sources are identified; only countries in which production exceeds consumption are considered supply sources (“supply countries”). For countries that are divided into several market areas (e.g. Germany), direct import points or known transit routes are used to examine whether supply sources are relevant for all market areas.

2.1.1.2 Market indicator: Herfindahl-Hirschman Index

Theoretical concept

The Herfindahl-Hirschman Index (HHI) defined in the framework of the AGTM measures the concentration of gas suppliers on a given market. Competition authorities often use the index to assess market concentration. The higher the HHI, the higher the market concentration. The AGTM defines a value of 2,000 as the HHI maximum at which a market is still considered to be functioning.

Calculation methodology

The HHI is calculated as the sum of squared market shares for the individual gas producers (companies) supplying the respective market. The calculation requires data related to imports from supply countries and, where applicable, the distribution of the respective supply amounts among the gas suppliers from these countries as well as data on gas production in the domestic market (domestic production).

As the distribution among gas suppliers is not always sufficiently transparent, the HHI calculation is based on the following assumptions:

- For the supply countries of Russia, the Netherlands, Qatar and Algeria[4], it is assumed that a single gas producer supplies the examined markets.
- Supply amounts not exceeding 5% of the total amount imported on a given market are assigned to a single company, as further subdivision would have a negligible effect on the calculated HHI (< 1.5% of the threshold).
- For the Italian production, it is assumed that 84% stem from the company ENI[5]. The remaining amount is assumed to be supplied by an indefinite number of producers with no significant bearing on the HHI.
- Domestic production in Austria is assumed to stem from the companies OMV (75.5%) and RAG (24.5%)[6].
- The Libyan supply to Italy is assumed to be provided by the two companies ENI and NOC (a Libyan state-owned company) in equal parts[7].

[4] This assumption is based on publicly available information.

[5] Source: https://www.oxfordenergy.org/wpcms/wp-content/uploads/2013/06/NG-76.pdf

[6] Source: data provided by E-Control

- Where Norway is a supply country for an examined market and its supply reaches or exceeds 5% of the total import amount of that market, a calculation for two scenarios is carried out and their mean value is used for calculating the HHI, as no transparent information regarding the respective shares of Norwegian gas suppliers is available.
  - “Minimum HHI”: For Norway, it is assumed that 70% stem from the company Statoil and the remaining amount from an indefinite number of producers with no significant bearing on the HHI.
  - “Maximum HHI”: The supply that cannot be attributed to Statoil is assumed to stem from a single further gas supplier.

The data for Austria’s eastern market area have to be filtered out from the aggregated import data for Austria provided by EUROSTAT. This is done based on the eastern market area’s share of total consumption in Austria.

As the underlying data are structured according to countries, EUROSTAT’s import data must also be separated for the German NCG (DE) and GPL (DE) market areas, which are separately addressed in the analyses. This separation is realised as follows:

- Assignment of German cross-border and market area interconnection points that are of relevance to imports to Germany’s supply countries as identified by EUROSTAT
- Aggregation of the respective entry allocations according to supply country and market area at the cross-border and market area interconnection points identified
- Calculation of the sum of entry allocations for Germany (sum of both market areas) and the respective (percentage) distribution for NCG (DE) and GPL (DE)
- Breakdown of the EUROSTAT import data for Germany between NCG (DE) and GPL (DE) based on the share per market area and supply country calculated in the previous step

In this process, only those cross-border interconnection points that have a clear direction of import flows amounting to 15% of the technically available capacity are considered as relevant to imports[8].

The cross-border interconnection points are then assigned according to the direct technical links between a given market and supply countries and/or publicly available

[7] Source: http://www.eni.com/en_IT/innovation-technology/eni-projects/western-lybian-gas-project/western-lybian-gas-project.shtml

[8] LNG terminals are always considered relevant points because, as a rule, they are only used for imports in Europe.

information on transit routes[9]. Entry allocations at market area interconnection points of an investigated market are assigned to supply countries based on the supply countries' aforementioned percentage shares in the neighbouring market's cross-border interconnection points.

As the considered entry allocations include, where applicable, transit amounts, WECOM delimit them as follows:

- Transit through investigated market = entry allocations at analysed cross-border and market area interconnection points + domestic production – consumption
- Identification of transit share per supply country based on the supply countries' previously calculated share in entry allocations[10]

2.1.1.3 Market indicator: Residual Supply Index

Theoretical concept

The Residual Supply Index (RSI) assesses a market's ability to compensate for an outage of its largest supplier, i.e. the supplier producing the largest of amount of gas, by obtaining supplies from alternative sources.

To this end, the respective market's consumption is compared to the import potential that is not assigned to the largest supplier (based on entry capacities of pipelines and LNG terminals). The higher the RSI, the less the market is reliant on supply from the largest supplier. The AGTM defines the RSI threshold at which the supply situation is sufficiently stable at a minimum of 110% of annual consumption.

Calculation methodology

The RSI is calculated as the sum of import volumes – less those from the largest supplier – and domestic production relative to consumption in the market in question. The calculation steps are as follows:

- The largest supplier in a given market is determined according to the market shares of this market's individual gas suppliers identified in the course of calculating the HHI.
- The largest supplier's pipeline and LNG entry points are identified based on the methodology used for calculating the HHI (considering import points with an

[9] WECOM check the plausibility of this assignment by comparing:

- the ratio of net entry allocations assigned to individual supply countries
- the ratio of total supply quantities from supply countries in a particular market

[10] Dutch transit through Germany is an exception and is fully attributed to NCG (DE). This is the case because entry allocations from the Netherlands to TENP (an important transit pipeline) less exit allocations in Wallbach (DE→CH) correspond to the amount supplied to the German market in 2014 as stated by the Netherlands and respective allocations for 2015 with comparable dimensions have been reported.

unambiguous flow direction that have been assigned to the respective supply countries/gas producers) and are not taken into account when calculating the RSI.

- For the remaining entry capacities, the following utilisation is assumed in line with the AGTM's calculation methodology:
  - 75% of technical capacity for LNG facilities
  - 85% of technical capacity for pipelines
  - 100% of domestic production
- The interim results thus obtained are the infrastructure capacity available for alternative import sources and the importable volume on the basis of capacity utilisation assumptions. To compare these values with the respective market's consumption, it is first necessary to deduct the transit remaining after the outage of the largest supply country.
- In the event that no detailed information regarding transit is available, the remaining transit volume is determined based on the assumption that the supply countries' shares in transit amounts are identical to the relative distribution of total import quantities (and hence of consumption quantities). Based on this assumption, the remaining transit volume is calculated as the difference between total transit and transit of the largest supplier as follows:
  - Total transit equals the entry allocations at the investigated entry points + production – consumption
  - Transit is broken down based on the market shares of individual supply countries, through which the largest supply country's transit share is determined
- Based on a detailed analysis of the import structure of the markets and their respective downstream markets investigated by WECOM in this study, the remaining transit volume is calculated based on the following, more specific assumptions:
  - AT[11]: it is assumed that there is no Norwegian transit (assumption: Italian imports from NO are supplied via the TENP/Transitgas pipeline), which leaves all transit flows to RU
  - CZ and SI: all transit flows are assigned to RU (further neighbouring markets not considered in detail in the analysis, such as SK and HU, essentially import from RU)
- After subtracting the remaining transit quantities, the importable gas volumes for domestic use are compared to the market's current consumption. The resulting figure states the RSI value in percent.

[11] There seem to be no supply relationships between NO and SI/HR (downstream markets of Austria in this scenario); imports from HU, RS and BA are exclusively assigned to RU (s. EUROSTAT import data and https://www.energy-community.org/portal/page/portal/2D86B61364B31B23E053C92FA8C0092A).

2.1.2 Additional security of supply indicators

In addition to the RSI, which is an important indicator for security of supply among the AGTM indicators (Market Health Metrics), WECOM analyse further indicators for security of supply providing additional information. The calculation methodology these indicators are based on is explained in detail in the following.

2.1.2.1 Infrastructure standard (N-1)

Theoretical concept

Regulation (EU) No 994/2010 concerning measures to safeguard security of gas supply[12] views the failure of the single largest gas infrastructure for natural gas in a member state (N-1 principle) as a realistic scenario and, against this backdrop, obliges member states to take measures that ensure that they would be able to maintain national supply in such a case.

Specifically, the Regulation holds that in the event of a disruption of the single largest gas infrastructure, the capacity of the remaining infrastructure must be able to satisfy total gas demand of the calculated area during a day of exceptionally high gas demand occurring with a statistical probability of once in 20 years[13].

Calculation methodology

The infrastructure standard is calculated based on the following formula defined in Regulation (EU) No 994/2010:

$$N-1=\frac{EP_m+P_m+S_m+LNG_m-I_m}{D_{max}}\times 100$$

The parameters (all in mcm/d) are defined as follows:

- D_{max} ... total daily gas demand of the examined market area during a day of exceptionally high gas demand occurring with a statistical probability of once in 20 years
- EP_m ... technical capacity of entry points from other market areas that is available to meet gas demand
- P_m ... maximum technical production capacity of the market area that is available to meet gas demand

[12] Amendments to this Regulation are currently under consideration and consultation versions have been published.

[13] This obligation is also considered to be fulfilled where it can be demonstrated that a supply disruption may be sufficiently compensated for, in a timely manner, by appropriate market-based demand-side measures.

- S_m ... maximum technical storage capacity of the market area, i.e. the maximum technical withdrawal capacity of all storage facilities that are available to meet gas demand
- LNG_m ... maximum technical capacity at LNG terminals in the market area, i.e. the maximum technical withdrawal capacity of all LNG facilities that are available to meet gas demand
- I_m ... technical capacity of the largest infrastructure in the investigated market area

The actual calculation including the necessary preparation and editing of data for the investigated geographical constellations is carried out using the methodology described below:

- Consideration of capacities at cross-border and market area interconnection points based on the technical capacities as specified in the underlying data
- Consideration of storage capacities according to information provided in the national preventive action plans of the investigated markets (where applicable, e.g. for the German market areas, information provided by country is broken down between the various market areas based on their assignment to system operators)
- Consideration of demand ("1 in 20") and production capacities[14] according to information provided in the national preventive action plans of the investigated markets (information provided by country is again broken down between various market areas based on existing connections)
- Consolidation of the individual values to a total value applicable to the investigated integrated market (produces a conservative overall result due to the consideration of maximum demand ("1 in 20") with no time classification in the individual markets)
- Identification of the single largest gas infrastructure in the integrated market based on technical capacities of the types of entry points outlined above

2.1.2.2 Import route diversification (IRD)

Theoretical concept
The import route diversification (IRD) index assesses the diversification of existing import routes of a given market, depending on the characteristics of structures located further upstream of the import points (directly the country of the original supplier, functioning wholesale market with trading point, LNG).

[14] For Germany, total gas demand ("1 in 20") and production capacities are assigned based on the distribution of annual total demand and production across the market areas (s. underlying data in annex A).

Sometimes termed the “HHI of import routes”, the IRD indicates the concentration of these import possibilities of the investigated market. The lower the value, the more diversified the import routes of the market are.

The AGTM has defined a value of 2,000 as the HHI threshold for a sufficiently diversified supply situation; the same threshold is applied to the IRD of the respective markets (and their combinations).

Calculation methodology

The IRD index is calculated based on the technically available capacity at interconnection points with other entry-exit systems, direct import sources and LNG terminals using the following formula[15]:

$$IRD = \sum_{l \in MA} \left(\sum_{k \in IPMA_l} IP_k \right)^2 + \sum_{l \in S} \left(\sum_{k \in IPS_l} IP_k \right)^2 + \sum_{l} {LNG_l}^2$$

The following definitions apply:

- MA ... number of adjacent market areas that are not directly adjacent import sources
- S ... number of directly adjacent import sources
- $IPMA_l$ ... number of interconnection points with an adjacent market area l
- IPS_l ... number of interconnection points with a direct import source l
- IP_k ... share of the technically available capacity of the interconnection point k in the total technically available entry capacity of the investigated market area in percent
- LNG_l ... share of the technically available send-out capacity of the LNG terminal l in the total technically available entry capacity of the investigated market area in percent

This means that, both for interconnection points with direct sources and with other market areas, the technically available capacity is first aggregated per source/market area and that share (as a percentage) is squared. This calculation rests on the assumption that interconnection points of one market/one source often depend on the same infrastructure. This does not apply to LNG terminals, which are viewed as independent from other shared infrastructure.

[15] Source for calculating IRD: http://www.entsog.eu/public/uploads/files/publications/CBA/2015/INV0175-150213_Adapted_ESW-CBA_Methodology.pdf

The actual calculation is derived from the capacities at cross-border and market area interconnection points, which are, in turn, based on the technically available capacities discussed in the underlying data presented in the annex.

2.1.2.3 Storage demand coefficient (SDC)

Theoretical concept

Natural gas storage facilities play an important role for security of supply. This is not least the case because in addition to their traditional use in a market's seasonal structuring of supply and demand, they can also serve to temporarily compensate for absent or reduced import flows, provided they are filled to an adequate level.

When evaluating market integration plans in terms of their effect on security of supply, it is thus interesting to explore the impact of integrating markets (i.e. amalgamating the storage volume available on the market and to the market as well as the entire market's demand) on the storage facilities' capability to cover total market demand.

Calculation methodology

The indicator compares the available working gas volume of an examined (integrated) market to this market area's total annual consumption. The steps are as follows:

- Identification of annual gas consumption
- Consideration of the working gas volume available to the market in the analysed market area
- Based on these data, the storage demand coefficient indicator identifies the share of total annual consumption (in percent) that can be covered by the working gas volume assessed in step 2.

2.1.2.4 Storage rate coefficient (SRC)

Theoretical concept

In addition to compensating flows in the event of an outage or disruption, storage facilities can also (especially with a view to their above-mentioned role in seasonal structuring) significantly contribute to delivering the required output and play a major role for the security of supply in peak phases.

In much the same way as the volume-related view in the context of the *storage demand coefficient* metric, the present indicator assesses the peak load in domestic consumption and the technical potential of the storage facilities of the investigated market to cover this demand.

Calculation methodology

The indicator is based on the ratio of the maximum daily withdrawal capacity of all storage facilities in a market area that are available for this market and the potential maximum daily withdrawal occurring with a statistical probability of once in 20 years. The following steps are taken:

- Identification of the maximum daily withdrawal in a market area in times of exceptional demand for gas (“1 in 20”) based on the national preventive action plans of the investigated markets[16]
- Consideration of the maximum daily withdrawal capacity of all storage facilities in the investigated market area and the share available for this investigated market
- As a final step, the share of the initially identified maximum withdrawal that can be guaranteed by the maximum daily withdrawal capacity assessed in step 2 is calculated; the result is the indicator’s value.

2.1.3 Capacity-related indicators

Capacity-related indicators provide a further significant analysis and assessment dimension for the integration options investigated by WECOM in this study. For one thing, these metrics highlight the potential for (direct) access to new sources, for another, they provide information regarding the potential impact of a given market integration option on existing capacity and thus the indicative scope of potentially necessary measures that have to be taken to address congestions in an extended market area. The indicators WECOM use in the comparative analysis of the integration options are discussed in the following.

2.1.3.1 Direct market access (DMA)

This metric assesses the potential improvement with regard to direct market access (DMA) to potential new gas sources of a market that can result from market integration. In this study, the following are considered new gas sources:

- Functioning markets: physical/virtual trading points that are sufficiently diversified, enabling an adequate level of competition[17];
- LNG facilities: due to their potential to increase and diversify import;
- Supply countries: immediate connection with an active net exporter[18]

[16] For Germany, total gas demand (“1 in 20”) is assigned based on the distribution of annual total demand across the market areas (s. underlying data in annex A).

[17] Based on this criterion, for instance the Czech, Polish and Slovak markets are not considered relevant markets (cf. a respective study by the Oxford Institute for Energy Studies: “The evolution of European traded gas hubs” – http://www.oxfordenergy.org/wpcms/wp-content/uploads/2015/12/NG-104.pdf).

[18] Where producers (= net exporters) directly and explicitly deliver natural gas to a target market area based on existing transit contracts and routes or make it available directly at the entry points of this market area, the supply source is considered as existing direct access (relevant for AT, NCG (DE) and CZ with regard to Russian supply).

Without market integration, access to sources of a neighbouring market is restricted by various factors that limit direct competition for these sources at the VTP of the investigated market. These factors include the following:

- Capacity bookings at interconnection points (problems regarding deliverability, dependencies, etc.)
- Additional charges ("pancaking", differing charges calculation bases, etc.)
- Different balancing regimes in the market areas to be integrated
- Different registration and licensing procedures in the market areas to be integrated

The integration of market areas reduces these barriers for the markets to be integrated and would thus create direct access to new sources previously inaccessible or only indirectly accessible to individual markets. Against this backdrop, it is one of the objectives of market integration to maximise direct access to new sources for all participating market areas (s.

Figure 5: Theoretical concept of direct market access

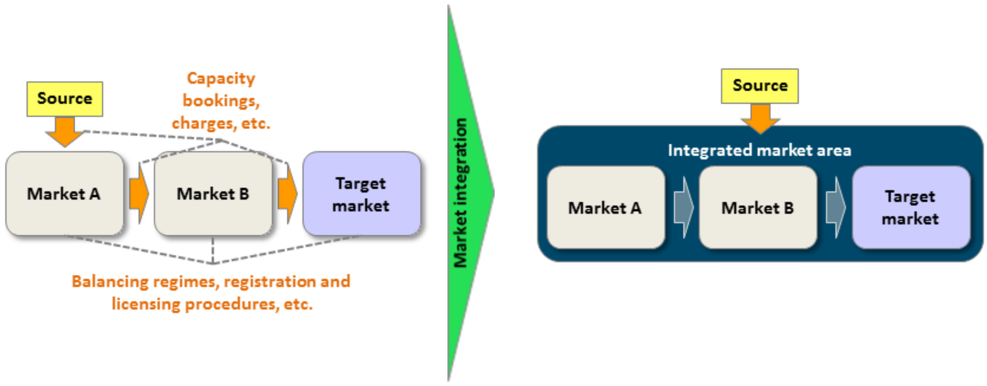


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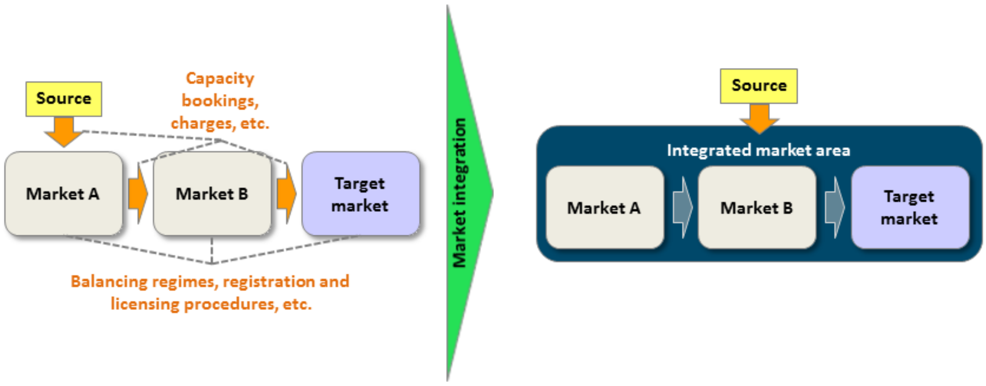
Figure 5: Theoretical concept of direct market access



The DMA metric states the (percentage) share of net import demand (NID) in the investigated market ("target market") that can be covered through direct market access to a new source based on currently available capacities.

The calculation is based on the following data assessed on a yearly basis:

- Consumption and production data of the target market
- Freely allocable capacity[19] of the connecting routes between sources and target markets
- Entry allocations[20] at connecting routes between sources and target markets in order to provide information regarding their use

Since DMA also takes account of the existing utilisation of these routes, expressed by entry allocations, and in light of the distinction made between capacity qualities, the entry allocations at relevant points are reduced to the proportion of the freely allocable capacity to the total technically available capacity.

Schematic presentation of the calculation methodology based on an example

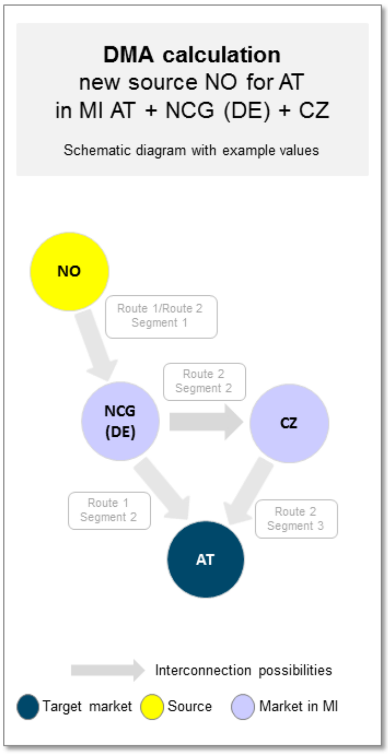
In the following, the calculation methodology for the DMA value for AT is explained based on an example. First, all potential routes for linking new sources to the target market are identified and available capacities are calculated, also considering potentially blocked capacities. Blocked capacity means capacity that is not available to provide direct access to new sources due to its current utilisation.

[19] Here it has to be taken into account that by deducting all technically available capacities, potential dynamically allocable capacities/capacities with restricted allocability with (non-transparent) allocation restrictions with respect to freely allocable capacity entries, which could, in principle, be used to satisfy transport requirements, are also deducted, potentially increasing the interconnection deficit (conservative approach).

[20] Using flows to identify available capacity is appropriate and necessary, as, inter alia, these points are no longer bookable or all bookings cease to apply when market integration is implemented.

The sum of available capacities of the individual routes, delimited by the available capacities of all transport routes from source to market integration MI ($AC_{Source>MI}$), then determines the total available capacity for potential use of the source by the target market ($AC_{Source>Target\ market}$). The total available capacity is finally contrasted with the NID of the target market, producing the DMA value $DMA_{Source>Target\ market}$.

Figure 6: Schema-tic calculation of direct market access with example values



1. Determination of all possible routes source > target market

Route i
Segment j

Route	Segment 1	Segment 2	Segment 3
R1	NO>NCG	NCG>AT	-
R2	NO>NCG	NCG>CZ	CZ>AT

2. Determination of free capacities of these routes per segment

$$AC_{ij} = FAC_{ij} - BC_{ij}$$

Segment	FAC	Booked capacity (BC)	Available capacity (AC)
NO>NCG	150 TWh/a	80 TWh/a	70 TWh/a
NCG>AT	50 TWh/a	40 TWh/a	10 TWh/a
NCG>CZ	0 TWh/a	-	0 TWh/a
CZ>AT	60 TWh/a	0 TWh/a	60 TWh/a

3. Calculation of total available capacities for use of source by target market

$$AC_{Source>Target\ market} = min\left\{ \sum_{Route\ i} \min_{Segment\ j} \{AC_{ij}\}; AC_{Source>MI} \right\}$$

Route	Available capacity (AC)
R1	10 TWh/a
R2	0 TWh/a
Total	10 TWh/a

4. Calculation of DMA value

$$DMA_{Source>Target\ market} = \frac{AC_{Source>Target\ market}}{NID_{Target\ market}}$$

Available capacity (AC)	Net import demand (NID)	DMA
10 TWh/a	70 TWh/a	14%

Aggregated presentation of the maximum DMA per target market

In the calculation methodology for the DMA outlined above, effects are assessed separately (ceteris paribus) and evaluated with respect to their potential. As different sources compete for available capacity, this approach does not allow a direct aggregation of these results. To present an overview of the outcome, an additional optimisation calculation is necessary. In this calculation, the scenario with sequential access to new sources which has the highest overall potential for the target market to meet NID is identified.

2.1.3.2 Theoretical interconnection deficit (TID)

Theoretical concept

Based on the capacity situation and domestic consumption in each market of a market integration option, the theoretical interconnection deficit (TID) estimates the impact of market integration on capacity in worst case nomination scenarios for each market[21]:

- If there is no interconnection deficit in a market to be integrated, the total sum of freely allocable entry capacity for the individual market can be maintained also after the market integration is implemented.
- If there is an interconnection deficit, it has to be addressed by measures such as the introduction of usage and allocation restrictions[22], marketable dynamic capacity or commercial measures aiming to maintain the existing yearly capacity or even network expansion.

WECOM stress that this indicator is only a rough estimate of the average impact of worst case nomination scenarios on the marketable capacity of the individual markets. The consideration of the average annual domestic consumption in the investigated markets (also as a result of local structuring through storage facilities) – based on the current yearly freely allocable entry capacity – indicates the average expected interconnection deficit over the year as the result. In fact, monthly or quarterly deviances from the annual averages may at times give rise to higher or even lower restrictions.

This indicator can neither replace nor predict the results of a detailed analysis based on a fully specified capacity model for an integrated market area, as the actual design of such capacity models gives rise to questions of a complexity that cannot be addressed by this indicator. They include:

[21] An indicator is identified for each market constituting a given market integration option. These constituting markets are referred to as “upstream markets”.

[22] It is important to point out that restrictions on the use of capacities resulting from an interconnection deficit only apply to the expanded entry-exit system and the joint VTP and that the technical interconnection options available prior to market integration remain unchanged.

- Consideration of depicting network restrictions between the entry and/or exit side and/or between different bookable points (e.g. taking account of the type of point)
- Basic approach to identifying capacity and the resulting necessity to ex ante limit capacity products (capacity that is statistically firm or guaranteed over the long term)
- Frequency and scope of consumption scenarios in the investigated markets that can lead to higher or lower interconnection deficits
- Consideration of the actual booking situation

An analysis of this kind must be realised as part of a cost-benefit analysis of a pre-defined market integration option.

The following information constitutes the respective data basis:

- Annual freely allocable entry and exit capacity with respect to markets adjacent to the market combination
- Interconnection capacity[23] that can be freely connected between the markets of an investigated market integration option[24]
- Annual average of domestic consumption for every market of the investigated market integration option

Calculation methodology
General calculation methodology in the case of two markets (for a schematic presentation of the calculation methodology s. **Fehler! Verweisquelle konnte nicht gefunden werden.**):

- Calculation of the maximum transport requirements (TR) as the smaller value of the:
  - maximum input from the upstream market (total freely allocable entry capacity upstream less average domestic consumption upstream) and

[23] Here it has to be taken into account that capacities restricted by allocation requirements (dynamically allocable capacity/capacity with restricted allocability) are deducted from the technically available capacity as a whole despite their potential availability, which might increase the resulting interconnection deficit (conservative interpretation of the capacity situation).

[24] With regard to the option AT + NCG (DE) + CZ, it is assumed that the transport NCG (DE) → CZ is possible as reverse flow to an extent equivalent to the average annual amount that was allocated to the main flow direction (CZ → NCG (DE)) in Waidhaus in 2015 (“reverse flow potential”).

    - maximum withdrawal in the downstream market (total freely allocable exit capacity downstream plus average domestic consumption downstream)
- Comparison of these maximum transport requirements to the available interconnection capacity in a downstream direction:
    - if the maximum transport requirements exceed the interconnection capacity in this direction, there is a theoretical interconnection deficit equal to the freely allocable entry capacity upstream that cannot be transported;
    - if this is not the case, there is no interconnection deficit for the upstream market.

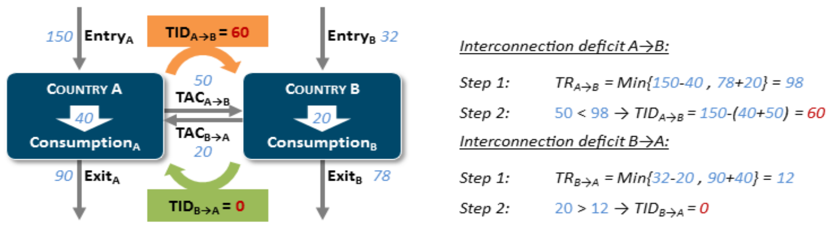
Extension of the calculation methodology for options with more than two markets:

- Calculation of the theoretical interconnection deficit per market as described above for all permutations of combinations consisting of two markets[25]
- The preliminary total interconnection deficit as seen from a respective upstream market is the maximum of individual interconnection deficits per permutation.[26]
- The total interconnection deficit is derived from considering additional interconnection options (via other markets that are part of this overall market integration option but are not part of the investigated two-market combination) to the extent to which these capacities have not already been blocked as freely allocable capacities of these other markets.
    - In market integration options with three markets, there is a maximum of one additional interconnection option.
    - In market integration options with four markets, there is a maximum of four additional interconnection options.

[25] In the case of a combination of N markets, the number of two-market combinations to be examined is N x (N-1).

[26] This preliminary total interconnection deficit relates to the need to restrict freely allocable entry capacity in the market examined and is determined by the largest individual interconnection deficit.

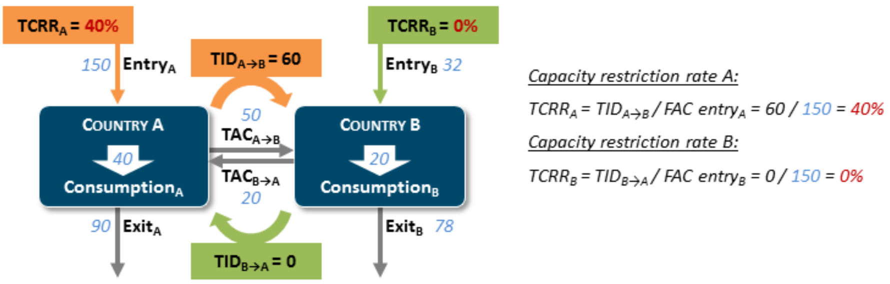
Figure 7: Schematic calculation of the theoretical inter-connection deficit with example values



2.1.3.3 Theoretical capacity restriction rate (TCRR)

Building on the value of the indicator described above (TID), the theoretical capacity restriction rate (TCRR) expresses that value's relative consequence, i.e. the proportion of the average reduced freely allocable entry capacity – relative to the current yearly freely allocable entry capacity of the markets to be integrated – for which usage/allocation restrictions are required to compensate the theoretical interconnection deficit. The following figure shows an example illustration of the relevant calculation methodology:

Figure 8: Schematic calculation of the theoretical capacity restriction rate with example values



2.1.4 HHI for storage

Theoretical concept

Comparable to the HHI, which assesses the concentration of gas supply to a given market by looking at the individual gas suppliers, this index can be used in a similar way to evaluate the concentration of storage system operators in an investigated market. The resulting value allows for conclusions about competition among storage system operators to be drawn particularly for markets without extensive storage regulation.

The AGTM has defined a value of 2,000 as the HHI threshold for a sufficiently diversified supply situation; the same threshold is applied to the concentration of storage system operators in the investigated markets (and their combinations).

Calculation methodology
The HHI for storage is calculated as the sum of the squared market shares of the individual storage system operators (companies) in the total supply of stored working gas volume on an investigated market.

It is important to note that stored working gas volume classified as "strategic" is, as is also the case for the actual demand and booking situation of the storage facilities, not considered in this calculation.

2.2 Results of the quantitative indicators

2.2.1 Summary

This section summarises the results obtained by applying the calculation methodologies outlined so far (section 2.1). It thus serves as a basis for assessing the effects of the investigated market integration options on the structural characteristics of the markets concerned.

Wherever possible, the summary to follow will state results in terms of the degree of fulfilment of each threshold as a percentage.[27]. The storage metrics *SDC* (storage demand coefficient) and *SRC* (storage rate coefficient) make reference to a market's demand or peak load, which is why scores beyond 100% are possible. The results on the capacity-related indicators, in turn, are presented in absolute values, as the use of thresholds would not be expedient. For the DMA metrics, a differentiated illustration is shown based on the *number of new sources* and the *maximum DMA* (the maximum share of NID that could be covered through the ideal use of all sources) (also s. section 2.1.3.1). For the *theoretical interconnection deficit (TID)* and the *theoretical capacity restriction rate (TCRR)*, an aggregated result applicable to the integration option as a whole is shown in addition to the results for the individual markets.

[27] The reciprocal function $\frac{Threshold\ value}{Actual\ value}$ was used to determine the degree of fulfilment for metrics whose fulfilment occurs below a certain threshold.

Table 1: Comprehensive overview of quantitative indicators for the investigated market integration options

	Quantitative indicators							
	Threshold	AT	AT+NCG(DE)	AT+IT	AT+IT+SI+HR	AT+CZ	AT+GPL(DE)+CZ	AT+NCG(DE)+CZ
AGTM Market Health Metrics								
Number of supply sources	≥ 3	100%	100%	100%	100%	100%	100%	100%
HHI	≤2000	36%	70%	77%	78%	32%	50%	66%
RSI	≥ 110% of demand	100%	89%	100%	100%	100%	100%	100%
Security of supply								
N-1	≥ 100%	100%	100%	100%	100%	100%	100%	100%
IRD	≤ 2000	33%	97%	93%	95%	38%	93%	76%
SDC	% of demand	78%	31%	31%	31%	62%	47%	33%
SRC	% of peak demand	131%	99%	72%	70%	98%	115%	95%
Storage								
HHI for storage	≤ 2000	90%	100%	48%	51%	100%	100%	100%
Capacity metrics								
Max. DMA (% of net dom. demand)			18%	99%	99%	13%	13%	31%
New direct sources			4	5	5	1	3	4
Individual markets TID TWh/a of freely allocable entry cap.			AT: 440 NCG: 240	AT: 188 IT: 231	AT: 188 IT: 293 SI: - HR: 19	AT: 460 CZ: 102	AT: 605 GPL: 324 CZ: 34	AT: 440 NCG: 21 CZ: 102
Individual markets TCRR % of freely allocable entry cap.			AT: 77% NCG: 29%	AT: 27% IT: 23%	AT: 27% IT: 29% SI: - HR: 70%	AT: 67% CZ: 31%	AT: 88% GPL: 44% CZ: 18%	AT: 77% NCG: 18% CZ: 31%
Aggreg. TID TWh/a of FAEC			679	419	501	562	963	563
Aggreg. TCRR % of FAEC			48%	25%	29%	55%	60%	37%

2.2.2 Detailed results

2.2.2.1 Market Health Metrics

In this section, the results of the AGTM's Market Health Metrics for the investigated market integration options are discussed. The table below provides an overview of the results obtained and of the threshold values for these metrics set by the AGTM. Results that meet the requirements of the AGTM are highlighted in green.

Table 2: Market Health Metrics for the investigated market integration options

	Market Health Metrics		
	SS	HHI	RSI
Threshold	≥ 3	≤ 2,000	≥ 110% of demand
AT	3	5,495	202%
AT + NCG (DE)	4	2,873	97%
AT + IT	9	2,605	121%
AT + IT + SI + HR	9	2,568	120%
AT + CZ	3	6,308	210%
AT + GPL (DE) + CZ	4	4,004	126%
AT + NCG (DE) + CZ	4	3,012	112%

With regard to the number of supply sources, the results clearly show that all options (including an Austrian standalone market) meet the requirements. In an integration option including AT and one of the German market areas, AT only gains one further source (the Netherlands), whereas a combination with IT results in a significant improvement of diversification, particularly owing to existing LNG terminals and connections of IT with the south (DZ, LY). A coupling involving CZ entails no changes for AT, as the supply sources are the same.

The HHI is in line with the findings on the number of supply sources. While none of the options reaches the AGTM threshold, the combinations with NCG (DE), GPL (DE) or IT have lower concentrations. This is not the case for the pairing with CZ, where dependence on RU as the largest supplier further increases and the HHI deteriorates.

The RSI, which measures a market's potential ability to compensate for the outage of its largest supplier, is met in all combinations except for AT + NCG (DE). The analysis reveals that a majority of market integration options have an RSI between 110% and 130%. The combination with CZ is the only option that improves the already very high RSI of the Austrian standalone market. The poor results of the option including NCG (DE) are on the one hand due to sinking production and increasing demand in NCG (DE), and on the other hand, Dutch and Norwegian transit (e.g. TENP) that has to remain in place in case RU fails to supply capacities in NCG (DE) and that has to be deducted when calculating the available import capacity also plays a role.

2.2.2.2 Additional security of supply indicators

In addition to the Market Health Metrics discussed above, WECOM have introduced four additional indicators for the security of supply (for the calculation methodology s. section 2.1.2). The results are summarised in the following table. In this analysis, thresholds were introduced only for N-1 and IRD, while the storage metrics *SDC* (storage demand coefficient) and *SRC* (storage rate coefficient) make reference to an investigated market's (or an investigated combination of markets') demand or peak load. For N-1 and IRD, fulfilment of the thresholds is marked in green.

Table 3: Additional indicators for the security of supply for the investigated market integration options

	Security of supply			
	N-1	IRD	SDC	SRC
Threshold	≥ 100%	≤ 2,000	% of demand	% of max. output
AT	181%	5,989	78%	131%
AT + NCG (DE)	163%	2,062	31%	99%
AT + IT	116%	2,145	31%	72%
AT + IT + SI + HR	114%	2,096	31%	70%
AT + CZ	188%	5,212	62%	98%
AT + GPL (DE) + CZ	218%	2,147	47%	115%
AT + NCG (DE) + CZ	149%	2,635	33%	95%

WECOM find, based on the calculation methodologies presented, that all options fulfil the infrastructure standard[28] from Regulation (EU) No 994/2010, with an ability to supply at least 100% of each market's maximum demand even if faced with an outage of the largest infrastructure.

The results of the analysis further show that the import route diversification (IRD) index, as a measure of the diversification of existing import routes of the market in question depending on the properties of the structures upstream of the import points, is above the set threshold for all of the market integration options investigated. For all options, however, the value improves and, except for the combination with CZ (IRD = 5,212), reaches a level slightly above the set threshold.

For AT as a standalone market, a potential to cover 78% of its annual demand from working gas volume of storage facilities is shown. This percentage dramatically drops in all of the market integration options; only a combination with CZ or CZ + GPL (DE) achieves levels that are comparable to the Austrian standalone market.

Looking at the market's ability to cover peak demand with storage deliverability yields similar results. Compared to the result for AT (131%), particularly integration options involving CZ or the German market areas reveal a similar potential to cover peak demand with storage deliverability. This is particularly striking in the AT + GPL (DE) + CZ option, which has a storage rate coefficient of 115%. As is the case for the *SDC*, the two options that include Italy reach levels that are significantly lower, but still high in international comparison. With regard to these results, it must be borne in mind that

[28] These results do not take into account the fact that pursuant to Regulation (EU) No 994/2010, a regional (beyond the borders of individual member states) calculation can formally only replace the national calculation where the single largest gas infrastructure of an investigated option is of major importance for the gas supply of all member states concerned according to the joint risk assessment.

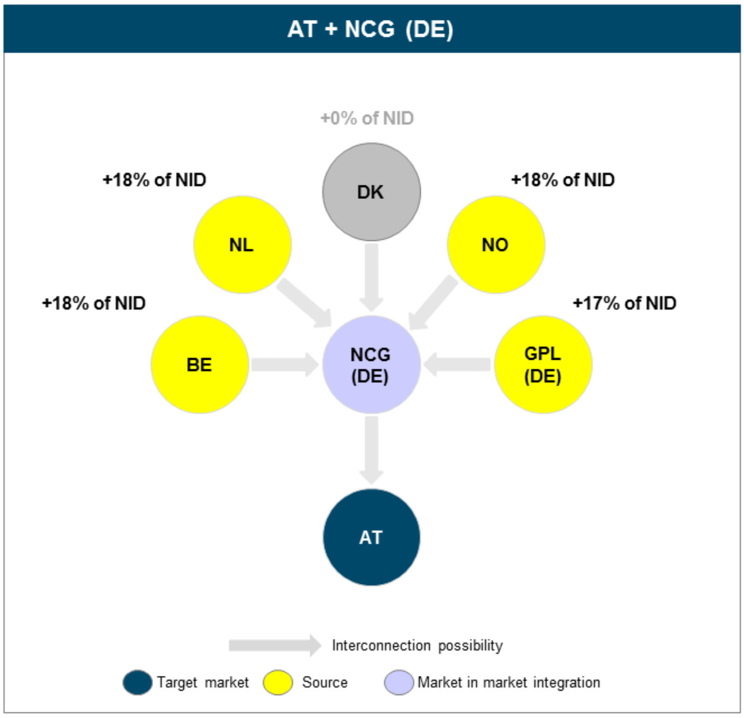
- the reference point is the technical capability of the storage facilities and not the withdrawal capacities, which are dependent on the level in the facilities, and
- any existing or relevant network congestions in the market areas are not taken into account.

2.2.2.3 Capacity-related indicators

Direct market access (DMA)

This section discusses the results of the *direct market access* metric obtained with the calculation methodology outlined in section 2.1.3.1. In this context, the DMA value is a percentage of NID (domestic consumption less domestic production) that can be met by the new sources in each case. It must be pointed out that these effects are assessed separately (ceteris paribus) and evaluated with respect to their potential. As different sources compete for available capacity, a direct aggregation of these results is not possible with this approach. The procedure used to present aggregated values is described in section 2.1.3.1. The respective results can be found in the overall evaluation in section 2.2.1.

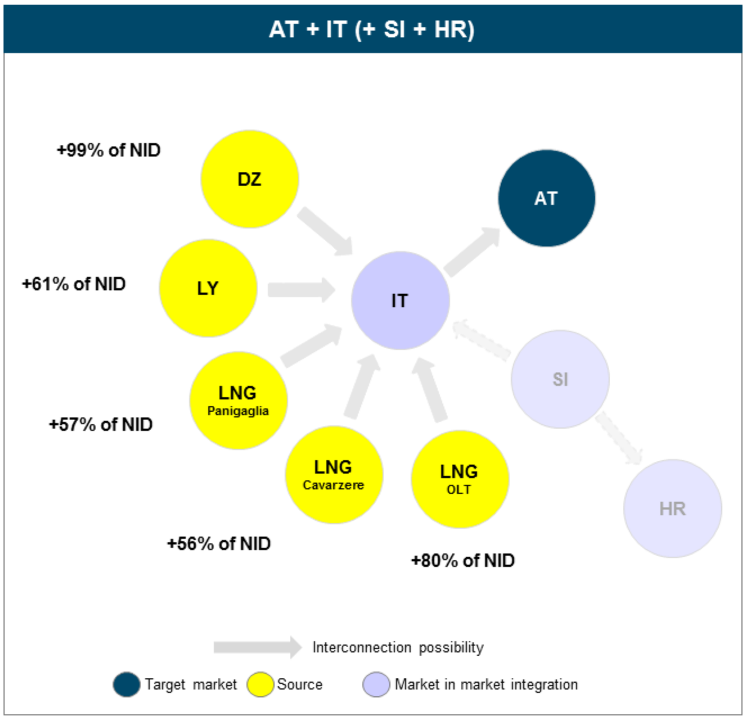
Figure 9: Results of the direct market access criterion for AT + NCG (DE)



In this market integration option, AT gains four new sources, which can be directly used to cover NID. In this scenario, the freely allocable capacity available between NCG (DE) and

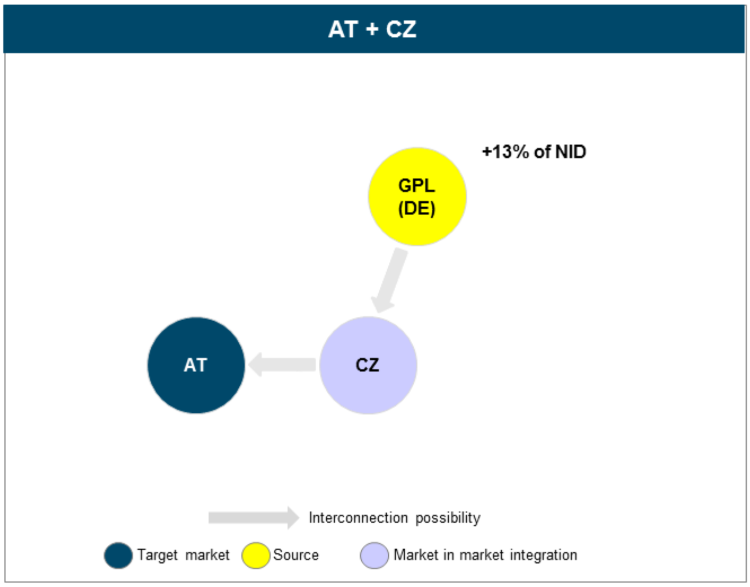
AT restricts the use for all sources except for GPL (DE). The latter is, however, limited due to the existing congestion between the two German market areas GPL (DE) and NCG (DE).

Figure 10: Results of the direct market access criterion for AT + IT (+ SI + HR)



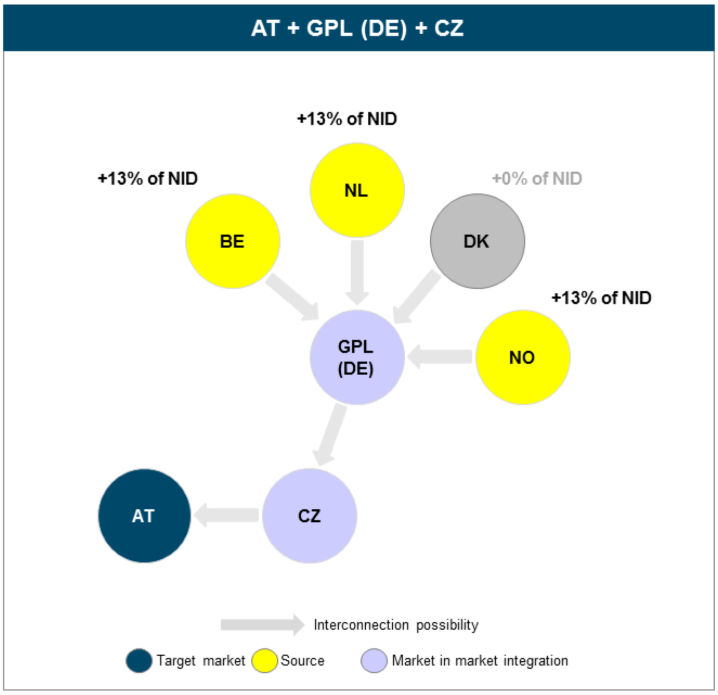
This combination adds five new, direct sources to AT, three of which are Italian LNG terminals and could thus make a significant contribution to diversifying import sources. In all cases, at least 50% of NID can be covered. At 99%, the source DZ meets NID of the Austrian market almost by itself.

Figure 11: Results of the direct market access criterion for AT + CZ



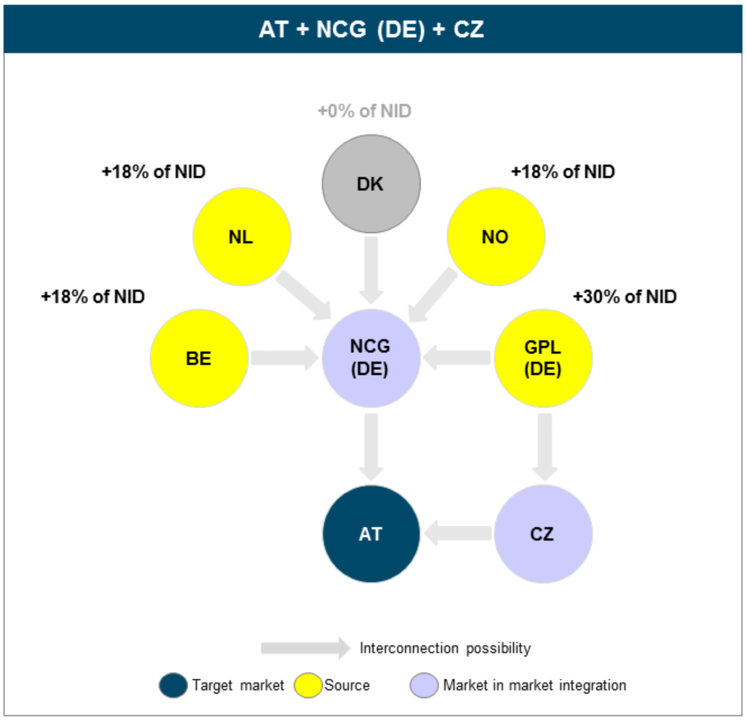
In the option AT + CZ, AT gains the new source GPL (DE), which can be used to cover 13% of NID. The low level of the available capacity between GPL (DE) and CZ is responsible for this result, as the planned BACI project would consistently provide a sufficient amount of freely connectable interconnection capacity.

Figure 12: Results of the direct market access criterion for AT + GPL (DE) + CZ



If GPL (DE) is additionally added to the combination, AT gains access to three new sources, as one of the additional sources (DK) cannot be used due to a lack of available capacity. Similar to the combination discussed above, there is a congestion in the connection between GPL (DE) and CZ, which restricts the scope of use of the remaining three sources to 13% of NID.

Figure 13: Results of the direct market access criterion for AT + NCG (DE) + CZ



The results gained in the analysis of this market integration option are similar to the ones of the combination AT + NCG (DE), which was the first one to be discussed in this section. Here as well, AT gains four new sources, which can be used to cover NID. The existing congestion between NCG (DE) and AT imposes a restriction of 18% of NID. With regard to the new source GPL (DE), the connection between GPL (DE) and AT via CZ (BACI) can additionally be used. This increases the potential for meeting market demand to 30%.

Theoretical interconnection deficit (TID) and capacity restriction rate (TCRR)

The following figures illustrate the detailed results of the *theoretical interconnection deficit* (TID) metric and consequently those of the *theoretical capacity restriction rate* (TCRR) on the basis of the calculation methodologies described in sections 2.1.3.2 and 2.1.3.3. They also include the individual quantities[29] (in TWh/a) used in the calculations.

In this context, arrows signify freely allocable entry capacity[30], freely allocable exit capacity and freely allocable interconnection capacity for the respective market area. The results of TID (and therefore of TCRR) refer in each case to the freely allocable entry capacity in the specific market areas, as shown in the figures.

[29] The rounding up or down of figures to simplify the presentation of diagrams may lead to discrepancies between the reader's own calculations/deliberations and the results actually presented in this study.

[30] The freely allocable entry capacity figure given also includes production in the market area.

In interpreting the results, it should be pointed out that by taking the average annual domestic consumption in the investigated markets as the result – based on the current yearly freely allocable entry capacity – the average expected interconnection deficit over the year is indicated. In fact, monthly or quarterly deviances from the annual averages may at times give rise to higher or even lower restrictions. Based on the recognised average consumption for the markets examined, the remaining freely allocable entry capacity can no longer be stated as yearly freely allocable capacity, or only if non-quantified costs for measures to maintain the capacity are taken into account. Essentially, the remaining marketable freely allocable entry capacity represents the average value of a dynamic technical capacity. Without further use of market-related measures, the marketable freely allocable entry capacity would be lower in some months, while in others it would be higher due to higher consumption in the markets examined. Given the lack of knowledge as to how often these different load flow and consumption scenarios occur over time, these results cannot be directly applied to a cost analysis for e.g. measures to maintain capacity etc.

Figure 14: Theoretical interconnection deficit and capacity restriction rate for AT + NCG (DE)

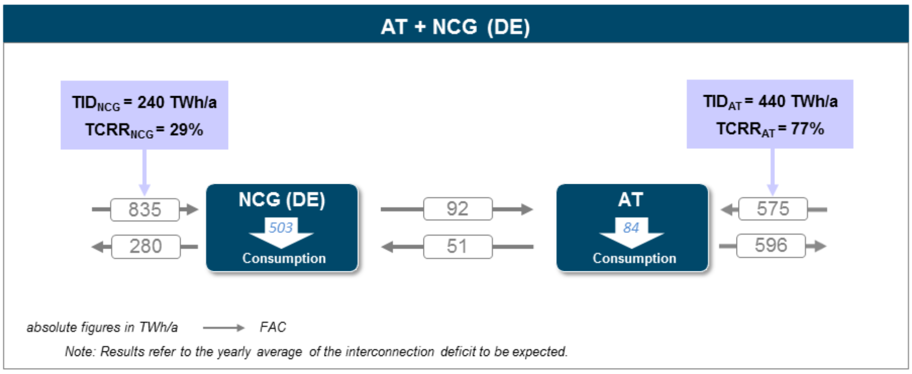


Figure 15: Theoretical inter-connection deficit and capacity restriction rate for AT + IT

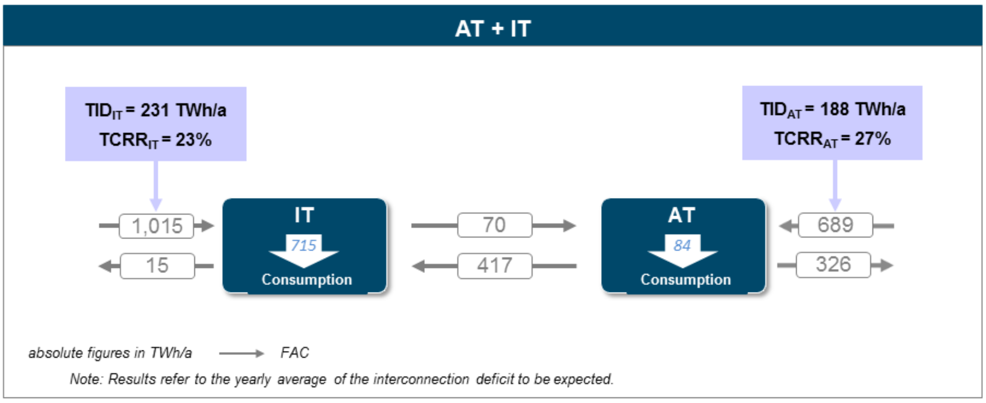
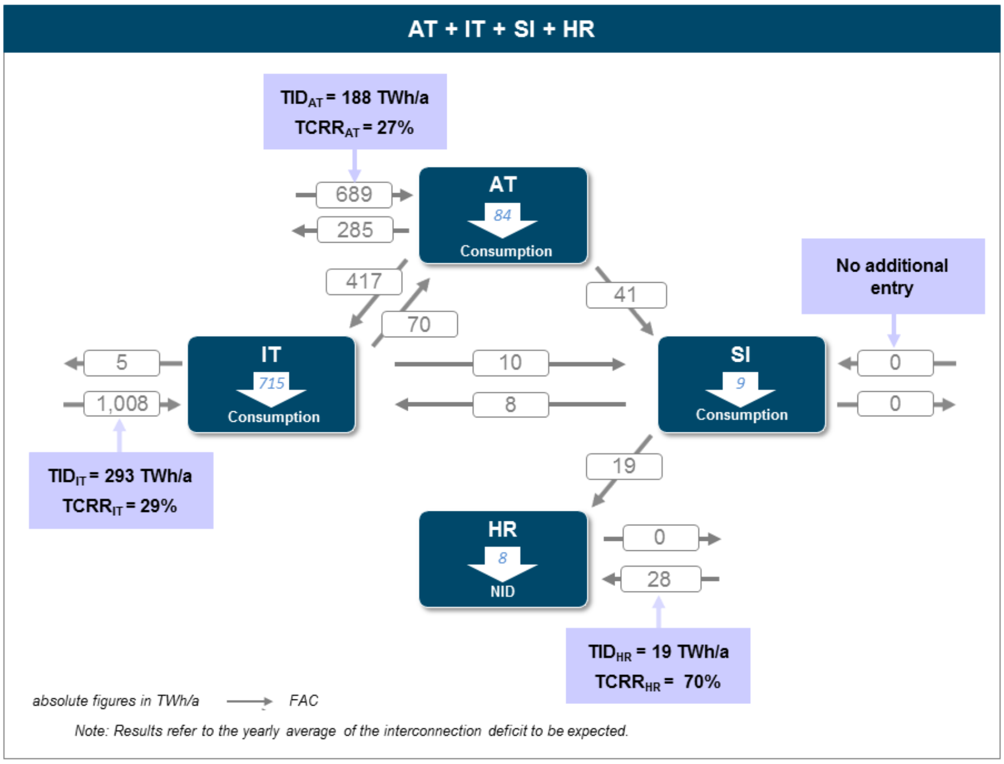


Figure 16: Theoretical inter-connection deficit and capacity restriction rate for AT + IT + SI + HR



Notes on option AT + IT - SI + HR: In view of the Slovenian market's consumption and required flow towards HR, a corresponding capacity share in the connection AT to SI explicitly intended for supplying the Croatian market is considered as part of the amount of the presented connection SI to HR. It is further assumed that Croatian production is exclusively used to cover Croatian consumption (resulting in lower import demand and freely allocable entry capacity of the production which does not have to be delivered abroad in the underlying worst case nomination scenario).

Figure 17: Theoretical interconnection deficit and capacity restriction rate for AT + CZ

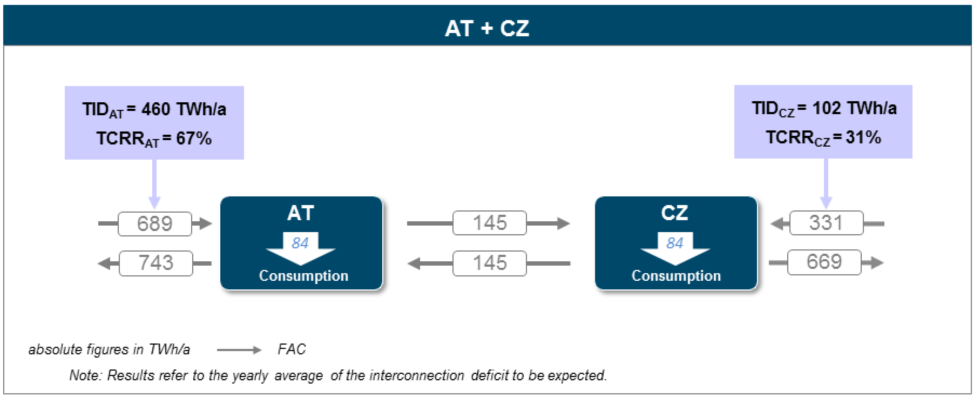


Figure 18: Theoretical interconnection deficit and capacity restriction rate for AT + GPL (DE) + CZ

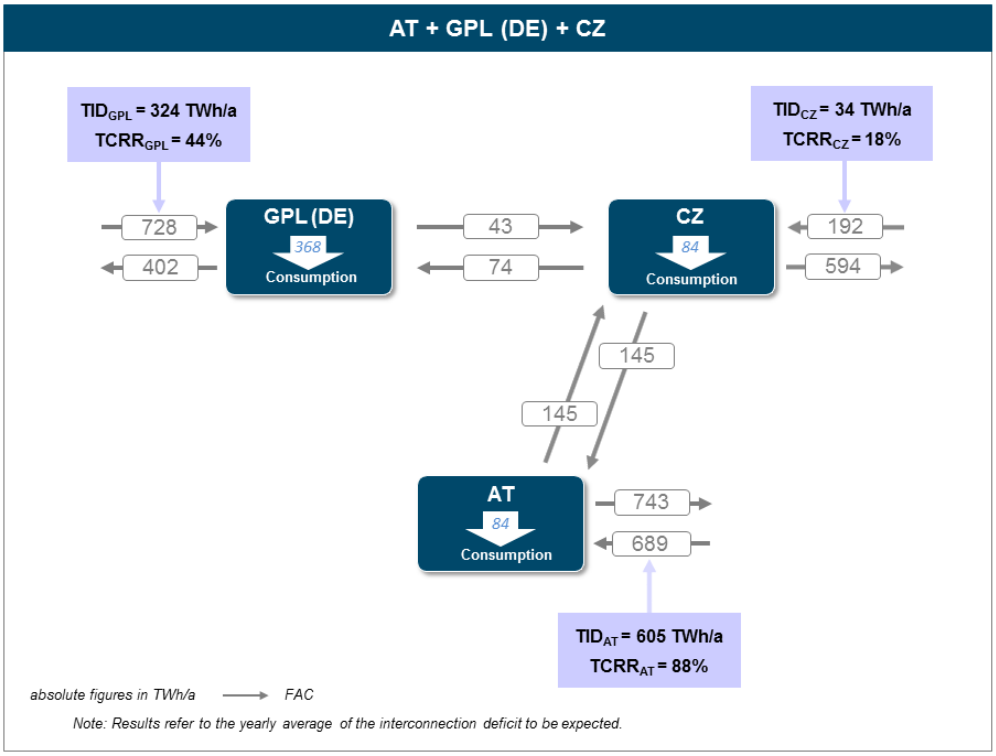
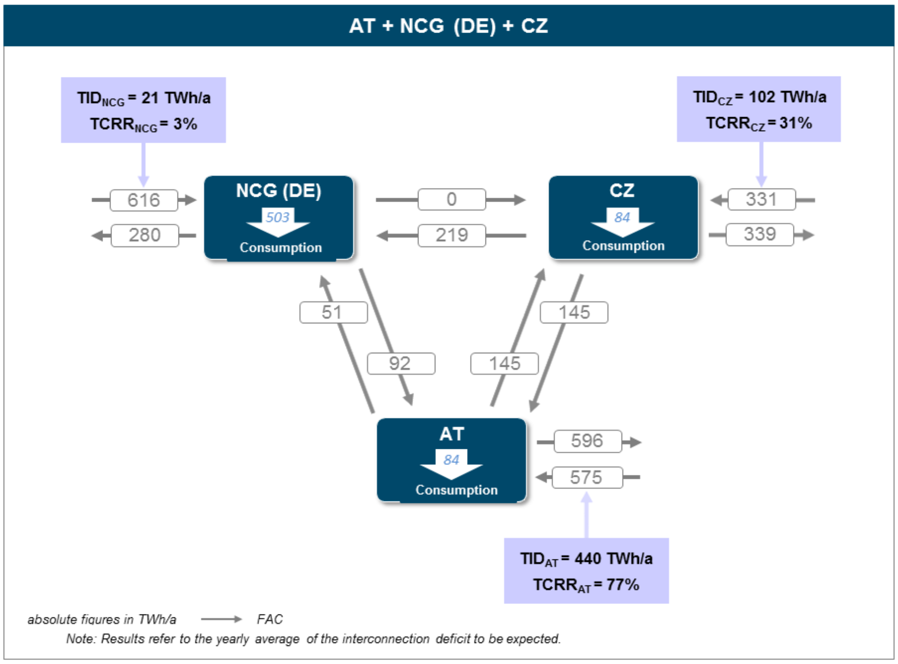


Figure 19: Theoretical interconnection deficit and capacity restriction rate for AT + NCG (DE) + CZ



2.2.2.4 HHI for storage

As part of the quantitative metrics, the market concentration of storage system operators has also been examined in the relevant markets. The Herfindahl-Hirschman Index was used in the evaluation and a threshold of 2,000 was fixed by analogy with the corresponding AGTM market health metric. The results are summarised in the table below, with results that fulfil the threshold highlighted in green.

Table 4: Results of the storage HHI for the investigated market integration options

	Threshold	AT	AT + NCG (DE)	AT + IT	AT + IT + SI + HR	AT + CZ	AT + GPL (DE) + CZ	AT + NCG (DE) + CZ
Storage HHI	≤ 2,000	2,231	1,864	4,181	3,904	1,738	1,119	1,440

Austria alone does not have a sufficient number of storage system operators. Almost all market integration options increase the number of operators so that the required threshold is reached. Exceptions are only the combinations with Italy, where the storage market is highly concentrated; the metric deteriorates further in these options.

Notes: For the results presented, it should be borne in mind that stored working gas volume classified as "strategic" is not considered in this calculation and that these values solely refer to the technical storage capacity of system operators. The actual supply or booking situation of the storage facilities is not considered due to a lack of transparent underlying data.

3 Cost-benefit analysis

In this chapter, the methodology of the simplified cost-benefit analysis of selected market integration options and the respective results obtained are presented. First, principles and assumptions on which the calculations are based are explained, after which quantitative and qualitative benefit and cost elements and the calculated results are discussed. As was the case for the quantitative indicators, calculations refer to 2015 as the year under review and the underlying data described in annex A (for a presentation of specifics of individual markets, such as domestic production or consumption, also s. the infrastructure base case in section 0).

3.1 Principles of the cost-benefit analysis

WECOM's cost-benefit analysis for each market integration option is based on the premise of a full market merger. As far as the specifics of each individual market are concerned, they use the infrastructure base case in section 0 and the underlying data in annex A. The analysis assumes that in a well-functioning and competitive market, the potentials realised at each stage of the value chain trickle down to consumers in the end.

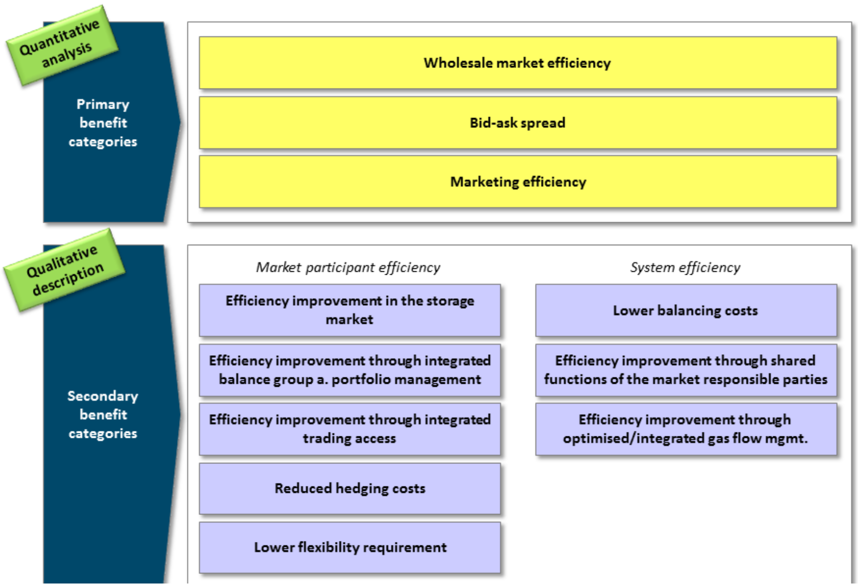
Experience from past cost-benefit analyses has shown that market integration generates potentials to produce welfare gains but also creates, most notably, costs to maintain the capacity at commercial borders of the integrated market. In this simplified cost-benefit analysis, however, WECOM assume that any resulting interconnection deficits would be addressed by restricting existing capacity. This is why the study does not use costs to represent capacity restrictions but rather, to an appropriate degree, reduces the calculated welfare gain by the impact on free connection capacity (on this topic, s. sections 2.1.3.2 and 2.2.1) between the markets in a worst case nomination scenario.

The analysts do not quantify any other cost elements (e.g. one-off implementation costs), because it is assumed that they are at least offset by efficiencies that are not quantified either (particularly synergies between market player roles).

3.2 Benefit categories

The following figure shows the categories relevant to the analysis of welfare gains. According to the methodology used (quantitative analysis or qualitative description), they are divided into *primary* and *secondary* categories in this cost-benefit analysis. The secondary benefit categories are further subdivided into two main groups: *market participant efficiency* and *system efficiency*.

Figure 20: Relevant benefit categories and analysis approach used (quantitative/ qualitative)



3.2.1 Primary benefit categories

The following part discusses the theoretical concept and the underlying calculation methodology for the primary benefit categories. In this context, it has to be noted that the reduction of the calculated benefit by the impact on free connection capacity (s. principles above) is not yet considered in this generic description of the calculation methodology.

3.2.1.1 Wholesale market efficiency

Theoretical concept

Coupling market areas turns bookable interconnection points between the previously existing standalone markets into internal points on the integrated market, which renders them irrelevant to system users. This means that charges, capacity bookings and contractual congestions no longer apply to these points, resulting in a more efficient use of the existing infrastructure. The introduction of a joint balancing regime for the new market area thus created furthermore leads to:

- a simplification in operative handling (no nominations, etc.) and a reduction of balancing risks, as all injections and withdrawals in an integrated market area are recorded in a central balancing portfolio and
- a concentration of liquidity and trade at an integrated VTP as the pivotal venue.

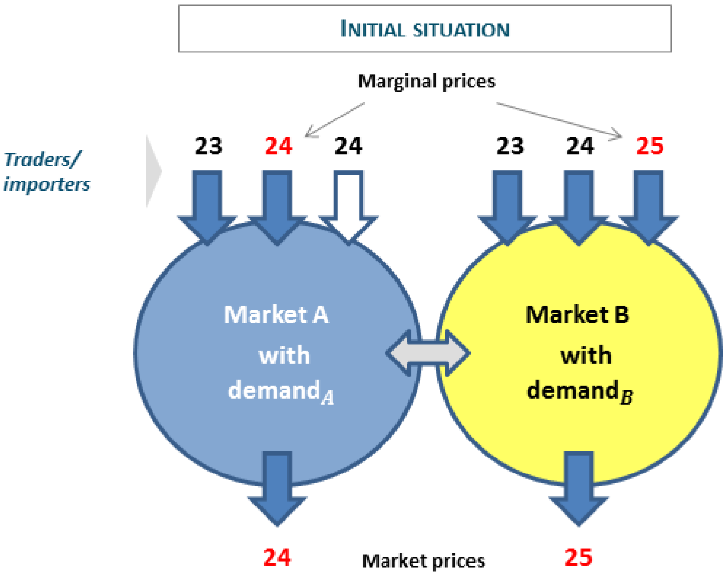
A liquidity increase and cost and risk reduction, in turn, attract additional suppliers to enter and, among other things, trade on the newly constituted market area. This again improves liquidity and also furthers competition.

The aggregated market consumption resulting from market integration is paralleled by a greater diversity of offers. When covering demand, it is thus possible to choose the overall (when currently separated markets are imagined as an integrated whole) most attractive offer and exclude commercially less favourable propositions. Symbolically speaking, market-specific merit orders are thus bundled into an integrated merit order for the integrated market area.

As market prices are usually formed based on marginal prices (i.e. the price of the "worst" offer that is necessary to cover consumption), an exclusion of less attractive offers reduces the overall price on the market. For this reason, the coupling of two previously independent market areas does not establish a new, median market price, which might be a reduced price for one market and a potentially increased price for the other market, by which one market would benefit at the expense of the other. Instead, the result is wholesale market efficiency, generating welfare gains for all markets involved.

The following figures illustrate this theoretical concept based on a schematic example involving the two markets A and B.

Figure 21: Initial situation – improvement of wholesale market efficiency

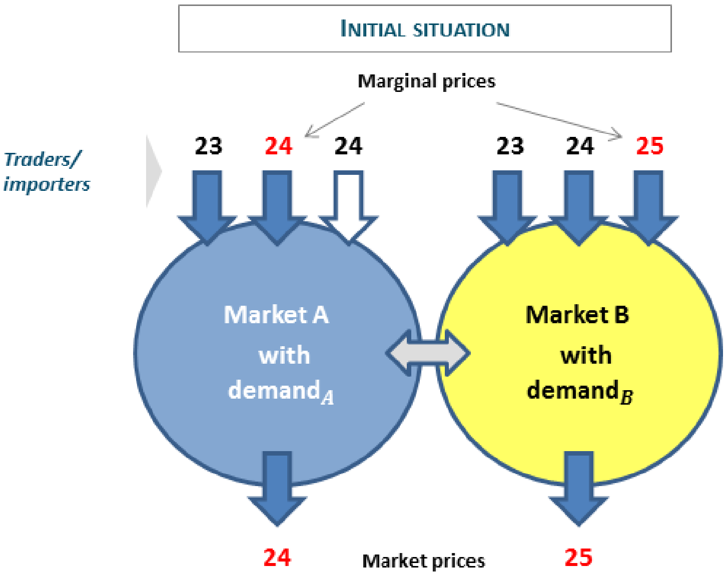


shows the initial situation of the two independent markets:

- Both markets have internal demand and a number of offers with different marginal prices on the wholesale market.
- Based on the concept of marginal prices, the two markets A and B also have different market prices.

Note: Blue arrows point to offers that are currently used to cover demand, white arrows point out currently unused offers.

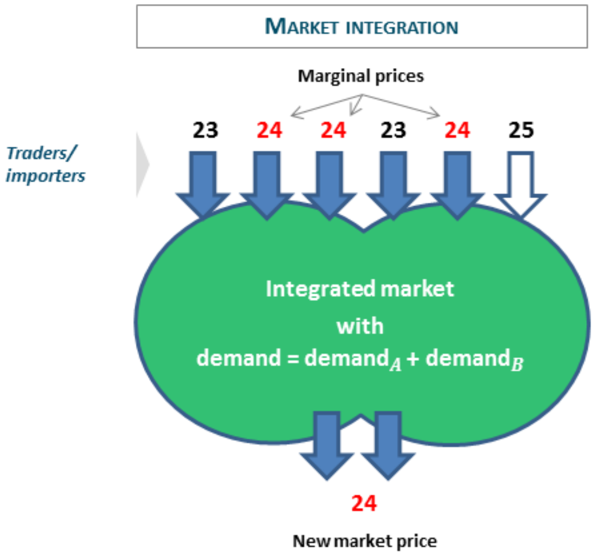
Figure 21: Initial situation – improvement of wholesale market efficiency



Market integration aggregates the consumption of the two previously independent markets and bundles all offers at one central VTP. The most efficient use of these offers results in the exclusion of the more expensive offers that are no longer necessary to cover the aggregated consumption.

Note: An additional market entry of potential new suppliers on the integrated market is not considered in this scenario.

Figure 22: Market integration – improvement of wholesale market efficiency



The resulting new market price of the integrated market is lower than the market price of market B in the initial situation, whereas there is no change for market A. This price change is an efficiency improvement for market B, which means that in an overall perspective, a welfare gain can be reported.

Calculation methodology

To directly analyse the benefit of wholesale market efficiency, information on the supply and demand curves, i.e. the bid and offer quotes, of the wholesale markets of both markets investigated would be necessary. As such data is not available, WECOM's calculation uses an approximation based on the spread of wholesale market prices.

It is a core assumption in this methodology that market integration results in a convergence of wholesale market prices towards the lowest price level observed on the individual markets ("price effect")[31]. This price effect is then multiplied by the respective market volumes ("volume effect"), i.e. the volumes of the previously more "expensive" market, to calculate the maximum benefit derived from the examined market integration option.

Based on the general assumption that in a functioning market, wholesale market prices determine the fundamental price level based on which consumer prices are calculated, the corresponding consumption of consumers is used as the market volume mentioned above.

[31] WECOM check the plausibility of this assumption by analysing available order book and trade data. This plausibility check is explained in more detail in annex B.

The potential benefit for the examined markets depends on the actual (yet unknown) supply and demand curves and differs on a daily basis: from situations in which there is no benefit to the maximum theoretical benefit. As it cannot be predicted how likely these situations actually are to occur, a uniform distribution is assumed and the calculated total theoretical maximum benefit is multiplied by a factor of 0.5 according to Laplace's rule:

$$B = \left(\sum_{d \in D} \left(\sum_{m \in M} (P_{m,d} - \min_{m^* \in M} [P_{m^*,d}]) * C_{m,d} \right) \right) * 0.5$$

The following definitions apply:

- B ... maximum theoretical benefit,
- M ... number of market areas that are considered in this integration option,
- D ... number of examined gas days,
- $P_{m,d}$ … wholesale price (spot) of market m on day d and
- $C_{m,d}$ … consumption on market m on day d.

3.2.1.2 Bid-ask spread

Theoretical concept

Market integration and the resulting introduction of a central VTP including an integrated balancing regime for the newly created market area bundles all wholesale transactions and traders of the previously independent markets at one VTP as the pivotal venue and increases liquidity and competition. This lowers the respective liquidity risks, i.e. the risk of being unable to close deals on open positions within a reasonable amount of time and at an acceptable price, for the market participants active at this VTP.

In this context, the bid-ask spread is an important metric. Expressing the price dimension of a trading point's liquidity as the spread between the highest bid and the lowest ask price, it is an important component in the assessment of the liquidity risks market participants have to expect. The higher the liquidity level, or in other words: the better demand and supply are harmonised, on a given market, the lower the bid-ask spread usually is. The same applies to the transaction costs to be expected by market participants. At an integrated VTP at which all wholesale transactions are bundled, furthering liquidity and competition, a decreased bid-ask spread can be expected as a consequence of increased market efficiency.

In a conservative approach, it can be assumed that the market with a higher bid-ask spread before market integration would see a decrease of this spread to the level of the market with the lower bid-ask spread. This reduction of the bid-ask spread, which determines the implicit transaction costs, i.e. the costs resulting from the difference between the theoretical equilibrium price and the actual market price, creates a welfare gain for the market participants on the market that previously offered worse conditions.

Calculation methodology

A quantification of the benefit category described above would require, with a temporal granularity of days, both bid-ask spreads and the respective trade volumes of all relevant markets for the spot, prompt and forward segments. For lack of such detailed underlying data, benefits are determined by way of approximation.

WECOM transform the available bid-ask spread values established as yearly averages in the course of calculating the AGTM's Market Participants' Needs Metrics into absolute figures using market prices of the individual markets averaged over the course of the respective year.

Based on the central assumption that the lowest bid-ask spread prevails following market integration, the market with the lowest bid-ask spread is determined and the difference in relation to the spreads of all other markets is calculated ("price effect"). As spot markets tend to have the lowest spread (and also the smallest difference between the individual markets) and are thus usually well available to most other markets due to their high liquidity, they are used for further analysis in the conservative approach.

The calculated differences on the spot markets are then multiplied by the respective annual cumulated trade volumes of the markets ("volume effect") and the results for the individual markets are added up to obtain the overall welfare gain.

$$B = \sum_{m \in M} (S_m - \min_{m^* \in M}[S_{m^*}]) * V_m$$

The variables used stand for:

- B ... theoretically plausible benefit,
- M ... number of market areas that are considered in this integration option,
- S_m … bid-ask spread (spot) of market area m and
- V_m … annual trade volume of market area m.

3.2.1.3 Retail market efficiency

Theoretical concept

The standalone market areas currently in place all differ in terms of their balancing regimes, registration and licensing requirements and regulatory rules. These factors hinder cross-border and cross-market sales, as suppliers pursuing sales activities in several independent markets are required to build market-specific portfolios that include the respective local gas quality, storage and flexibility instruments, forecast models for demand development over time, etc.

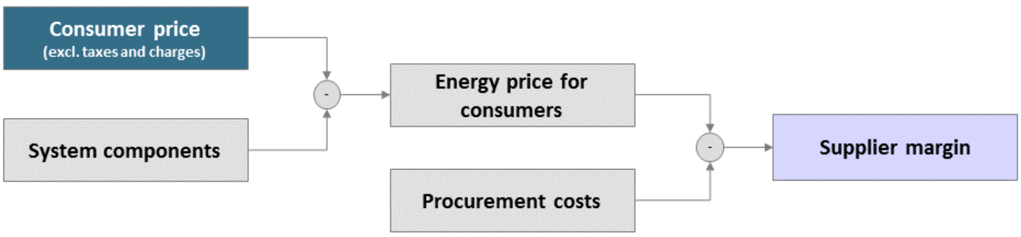
An integrated balancing zone and harmonised regulatory rules resulting from market integration would reduce such obstacles. Existing sources and portfolios of suppliers could then directly be used to supply customers in previously adjacent markets. Suppliers benefit from cross-border and cross-market portfolio and hedging effects in the integrated market area and can potentially reduce balancing risks and costs.

Against such a backdrop, WECOM expect that suppliers will start to extend their sales activities to supply consumers in the entire integrated market. This in turn stimulates competition and increases retail market efficiency, which would, as a consequence of harmonised spans between wholesale and consumer prices ("supplier margins"), finally converge at the lowest level of the previously independent markets.

Calculation methodology

To calculate the welfare gains resulting from retail market efficiency, consumer prices (representative prices of the best offers in the main cities of the examined markets/countries, also s. underlying data in annex A) of suppliers as well as price components on the markets to be integrated are analysed (s. figure below).

Figure 23: Elements constituting retail prices



In a first step, a subtraction of taxes/duties and system components (system charges, licence fees, etc.) produces the net energy prices ("energy-only prices") for consumers. These are made up by the wholesale market price, which reflects the supplier's procurement costs, and the "supplier margin". This margin is a crucial element in the calculation of the concrete welfare gain obtained through retail market efficiency.

The supplier margin is calculated in a simplified method as the difference between the energy prices for consumers and the average spot market price and constitutes an indicator for procurement costs[32].

[32] This method disregards the possibility that the actual procurement costs may result from structured procurement procedures on the futures and spot markets.

It is assumed that differences between the supplier margins obtained in this way disappear, i.e. that the most efficient competitors place attractive offers on the overall market (“price effect”). The extent to which this benefit pays off for consumers (“volume effect”) depends on their willingness to switch supplier or contract. In this context, the volume effect is defined as the volume of consumers who have already switched to another contract or supplier, thus signalling price affinity[33].

The welfare gain of retail market efficiency is calculated by multiplying the two terms.

The calculation, which starts with an analysis of representative best-price offers and respective supplier margins and ends with a calculation of the concrete welfare gains, is carried out separately for household (average consumption of 15,000 kWh/a) and business (average consumption of 100,000 kWh/a) customers in order to account for differences in the prices applicable to the two customer groups[34]. The overall welfare gain resulting from retail market efficiency is the sum of the previously separately calculated benefit components for household and business customers and can thus be calculated using the following formula:

$$B = \sum_{m \in M} (M_{m,H} - \min_{m^* \in M} [M_{m^*,H}]) * C_{m,H} * S_H + \sum_{m \in M} (M_{m,B} - \min_{m^* \in M} [M_{m^*,B}]) * C_{m,B} * S_B$$

The variables used stand for:

- B ... theoretical benefit,
- M ... number of market areas that are considered in this integration option,
- $M_{m,H}$ … supplier margin in market area m for household customers,
- $M_{m,B}$ … supplier margin in market area m for business customers
- $C_{m,H}$ … annual consumption of consumers of market m for household customers,
- $C_{m,B}$ … annual consumption of consumers of market m for business customers,
- S_H ... number of consumers among household customers that have already switched to another contract or supplier and
- S_B ... number of consumers among business customers that have already switched to another contract or supplier.

[33] For lack of available data for the relevant markets, the simplified cost-benefit analysis assumes a cumulative switching rate (change of supplier or contract) of 30% for both the household and the business segment (in comparison, the German Federal Network Agency’s 2015 Monitoring Report states a value of 76% for the German market).

[34] For a further group, industrial customers, it is assumed that they, for the most part, already actively procure gas on the wholesale market or have supply contracts with spot market indexations. This means that the welfare gain for this customer segment is already included in wholesale market efficiency.

3.2.2 Secondary benefit categories

In addition to the primary benefit categories described above, there are further effects contributing to the creation of overall welfare gains obtained through market integration. As no respective data is available and such additional categories cannot be quantified, WECOM subject these effects to a qualitative analysis only. They stress, however, that these effects should not be underestimated, as their contributions to the overall welfare gain underline the quantitative results of the primary categories and can be expected to at least compensate for cost elements such as one-off implementation costs (s. section 3.3.2).

3.2.2.1 Qualitative description of secondary benefit categories: market participant efficiency

Efficiency improvement in the storage market
Market integration bundles all storage facilities that were previously located in independent markets in the newly created market area and, in principle, makes them directly available to all market participants. This direct access to a wider selection of storage products furthers competition between storage facilities (and their operators), creating a level playing field for the respective products. Additionally, the higher level of competition in the market can be expected to encourage storage facility operators to pursue a stronger customer orientation, resulting in, inter alia, an extended and demand-oriented offer of storage products (e.g. various unbundled products, varying contract terms, prices based on hub indexations, etc.). In the long term, market integration thus leads to a more efficient storage market on which prices tend to fall due to the new competition situation.

Efficiency improvement through integrated balance group and portfolio management
Coupling markets to form one market area with a uniform balancing regime creates a significant efficiency potential. Market participants with balancing accounts in more than one of the markets to be integrated require only one uniform balance group and portfolio management system after the integration and can thus lower their operative costs and reduce associated risks. Activities they will no longer have to carry out multiple times are for instance:

- Continuous monitoring of allocation data, resulting balancing positions and their balancing
- Operation and maintenance of balance group management and portfolio management systems
- Examination of bills relating to balancing and use of the VTP

- Monitoring of national regulatory developments, analysis of the resulting consequences on balancing and portfolio management and coordination of internal system changes, e.g. to abide by new market rules
- Administration of contract relationships with balancing organisations, VTP operators, etc.

Efficiency improvement through integrated trading access
Like the benefit category relating to the implementation of a joint balance group and portfolio management system discussed above, the integration of standalone markets also brings potential efficiency improvements with regard to trading access to market participants active on several markets.

As wholesale trade on an integrated market is concentrated at a central VTP, traders are not required to have access to a multitude of trading points. This reduces direct costs related to market access (membership fees at exchanges or for brokers, costs associated with the technical connections to exchanges and brokers, costs resulting from different trading systems, etc.). It also facilitates operative handling, which reduces the indirect costs for activities and tasks market participants are no longer required to do.

Reduced hedging costs
With regard to long-term supply contracts, sellers of gas quantities tend to choose functioning trading points with a sufficient level of diversification and competition for indexing the contract prices in order to minimise buyers' possibilities to influence price formation.

Buyers, on the other hand, prefer indexing at a "local" trading point, as this can mitigate the mark-to-market risk arising from potential spreads between the price at the local trading point and at the indexed trading point.

If market integration thus results in the development of a sufficiently diversified market that sellers accept as the reference point for price formation for the purpose of long-term contracts, importers can reduce their costs, as hedging to account for mark-to-market risks is no longer necessary. The cost reduction can be substantial, as potentially all import quantities are concerned.

Lower flexibility requirement
When standalone markets are integrated, different consumer portfolios relevant on separate markets can be combined or the flexibility needed to structure these portfolios can be exchanged at the newly created joint VTP in the most efficient way.

As a result, overall flexibility requirements, i.e. requirements to ensure balancing of the difference between structured consumption of consumers and typically constant procurement, are reduced. There are fewer such requirements, which are usually met through flexibility instruments such as storage facilities or flexible contract conditions, on an integrated market compared to their sum on the currently independent market areas, as opposing load deviations offset each other and the portfolio effect reduces the flexibility requirement as a whole.

The reduced flexibility requirement resulting from market integration reduces the costs of system users and/or costs for the balancing regime to be borne by the system users and thus generates a welfare gain.

3.2.2.2 Qualitative description of secondary benefit categories: System efficiency

Lower balancing costs
Integrating previously separate market areas enables a more efficient use of physical balancing measures (balancing energy).

This is based on the assumption that potentially opposite linepack situations in the standalone markets can be balanced through coordinated system operation by all involved transmission system operators (TSOs), resulting in a reduced need for balancing energy. The costs prevented in this way thus do not have to be borne by the system users and constitute a further potential benefit of market integration.

Efficiency improvement through shared functions of the market responsible parties
By creating a common VTP and a joint balancing zone, market integration provides the opportunity to bundle the tasks associated with commercial and physical balancing and operating the VTP formerly carried out by separate entities into one central body to carry out all of these tasks for the entire integrated market area. WECOM assess the resulting synergy effects (cost savings) as constituting a potential welfare gain.

Efficiency improvement through optimised/integrated gas flow management
The establishment of an integrated market means that system points previously relevant to system users at interconnection points between the markets to be integrated become irrelevant. They are then located within the system and become points at which gas flow is regulated by coordinated actions of the responsible TSOs. This results in new or additional flexibility in connection with gas flows within the market area, enabling an optimisation or efficiency improvement. For this reason, cost savings can be expected for fuel gas, particularly if the currently most efficient gas flow is presently prevented by contractual supply duties at points that would constitute market-internal points after market integration. The resulting welfare gain increases with the developing flexibility of TSOs, i.e. the number of bookable points eliminated and thus the size or number of markets to be integrated.

3.3 Cost categories

In this simplified cost-benefit analysis of selected integration options, WECOM address central potential cost elements of market integration. In the following, their theoretical background and utilisation in this analysis are discussed.

3.3.1 Costs associated with the capacity offer

Costs associated with the capacity offer form a core cost element in the context of market integration. They include, inter alia, costs for investments in transport infrastructure, costs for commercial instruments such as flow commitments or the inverse use of local balancing energy (potentially including capacity rates for long-term hedging of call-off volumes), etc. that are necessary to maintain the level of existing (quantitative and particularly qualitative) capacities at the commercial borders of an integrated market area.

In this analysis, WECOM carry out the quantitative assessment of such cost effects based on the assumption that there are limits to the possibilities to freely ship gas at the remaining commercial system points. Through this approach, they present the theoretical interconnection deficit calculated for the integration options based on the infrastructure base case (s. section 0), the resulting theoretical capacity restriction rate (s. sections 2.1.3.2 and 2.1.3.3) and an internally consistent capacity model.

Where deemed appropriate, WECOM reduce the quantified welfare gain to the extent of the restrictions on free connection capacity within the examined integration options (for which they assume a worst case nomination scenario) to determine the above-mentioned cost effect.

This methodology's concrete implications on the calculated welfare gains are discussed in the following:

Wholesale market efficiency
As has been described in the theoretical concept of this benefit category (s. section 3.2.1.1), market integration generally results in an integrated merit order of offers to cover the market's aggregated demand. However, due to existing interconnection deficits and resulting limitations on the possibility to freely ship gas in the integrated market to all exit points, this integrated merit order does not have the capacity to cover the entire demand. For this reason, the welfare gain calculated without taking this fact into account has to be reduced. This is done by multiplying this theoretical welfare gain with the aggregated theoretical capacity restriction rate of an examined integration option based on the following formula:

$$B = \left(\sum_{d \in D} \left(\sum_{m \in M} (P_{m,d} - \min_{m^* \in M} [P_{m^*,d}]) * C_{m,d} \right) \right) * \ 0.5 * (1 - TCRR)$$

The following definitions apply:

- B ... maximum theoretical benefit,
- M ... number of market areas that are considered in this integration option,
- D ... number of examined gas days,
- $P_{m,d}$ … wholesale price (spot) of market m on day d,
- $C_{m,d}$ … consumption of consumers on market m on day d and
- $TCRR$... aggregated theoretical capacity restriction rate (TCRR) of the examined integration option.

Bid-ask spread

In much the same way as the reduction of wholesale market efficiency, the theoretical welfare gain is reduced, also in this case, based on the theoretical capacity restriction rate. The overall calculation is based on the following formula:

$$B = \left(\sum_{m \in M} (S_m - \min_{m^* \in M} [S_{m^*}]) * V_m \right) * (1 - TCRR)$$

The variables used stand for:

- B ... theoretically plausible welfare gain,
- M ... number of market areas that are considered in this integration option,
- S_m … bid-ask spread (spot) of market area m,
- V_m … trade volume of market area m and
- $TCRR$... aggregated theoretical capacity restriction rate (TCRR) of the examined integration option.

Retail market efficiency

WECOM stress that “supplier margins”, which are an important factor for this benefit category and must be taken into account in its calculation, are independent of capacity restrictions, because all consumers have access to the joint VTP and because the original role of the supplier in an entry-exit system prescribes that quantities needed to supply consumers must stem from the VTP. For this reason, the welfare gain calculated for this category does not have to be reduced.

3.3.2 One-off implementation costs

Additional cost elements arising in the course of the implementation of a market integration project tend to be relatively small or merely have a negligible effect. What is more, sometimes they are compensated by benefit elements that cannot be quantified (s. *secondary benefit categories* in section 3.2.2) and synergies resulting from these elements. Such additional implementation costs can, for instance, be due to the realisation of necessary implementation steps, adaptations of regulatory stipulations and their subsequent realisation and the associated organisation and coordination tasks arising during implementation.

3.4 Results of the cost-benefit analysis

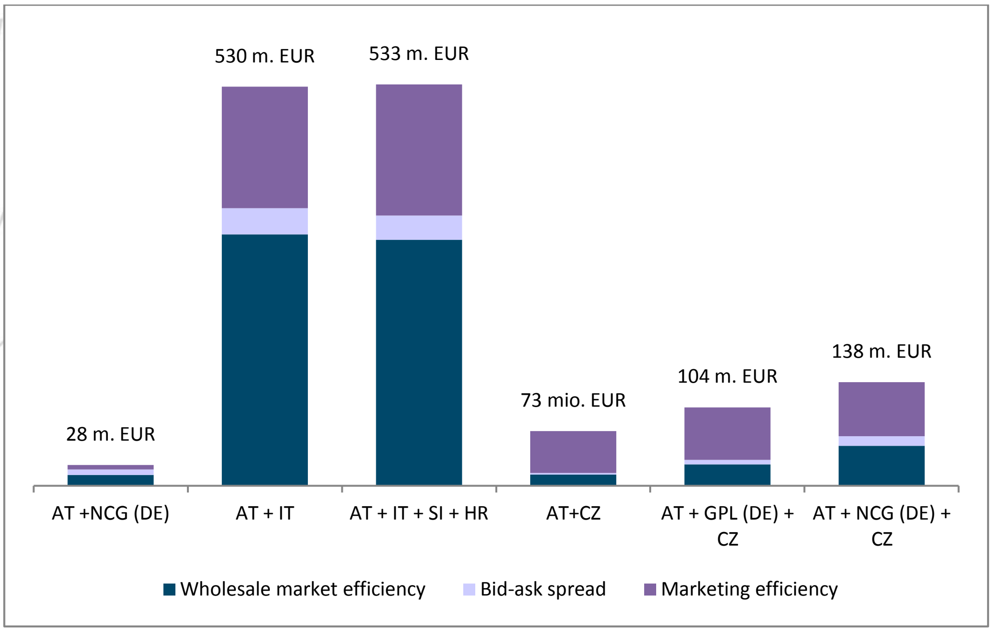
3.4.1 Summary

The following figure shows a summary of the potential welfare gains of the examined integration options.

Since this analysis is based on the assumption that arising interconnection deficits, etc. are addressed by introducing capacity restrictions for existing capacities, no costs associated with the capacity offer are considered and the calculated theoretical welfare gain is, where appropriate, reduced to the extent of the limitations on free connection capacity (s. sections 2.1.3.2 and 2.2.1) between the standalone markets to be integrated (based on the assumption of a worst case nomination scenario) (s. section 3.3).

The following figure shows the welfare gain obtained in this way for all three primary benefit categories on an annual basis. A respective detailed analysis of the individual benefit categories will follow in section **Fehler! Verweisquelle konnte nicht gefunden werden.**.

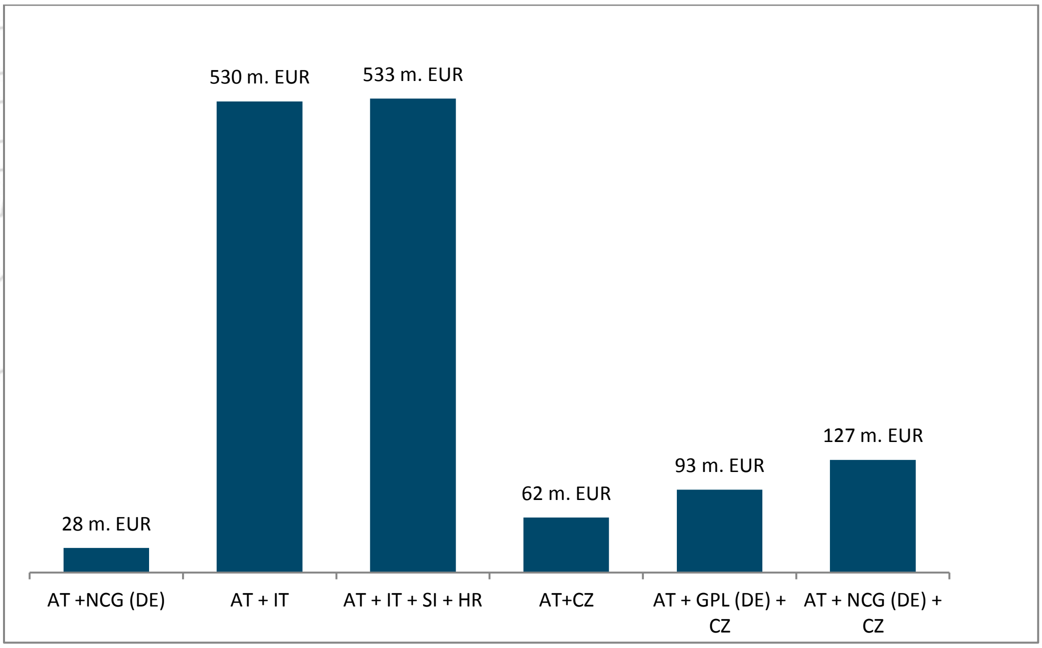
Figure 24: Calculated welfare gain of each market integration option in million EUR/year before subtracting required investment costs



However, particularly with regard to the three options that include CZ, WECOM point out that all of these options assume that the BACI interconnection project is realised (16,561 MWh/h (DN1200)), but that the respective costs (CAPEX and OPEX) are not directly considered in the calculation of potential welfare gains. Projections for both CAPEX and OPEX (total of AT and CZ) point to an annual figure of 11 million EUR[35]. In the assessment of the overall welfare gains to be expected, such projected costs must be separately considered and reduce the calculated welfare gains (s. figure below).

[35] The projection assumes a depreciation period of 25 years as stipulated in the rates calculation methodology according to section 82 *Gaswirtschaftsgesetz* (Natural Gas Act) 2011 and an estimated annual OPEX of 0.8% of the investment sum (according to the guidelines on investment measures of the German Federal Network Agency).

Figure 25: Calculated welfare gain of each market integration option in million EUR/year after subtracting projected BACI costs

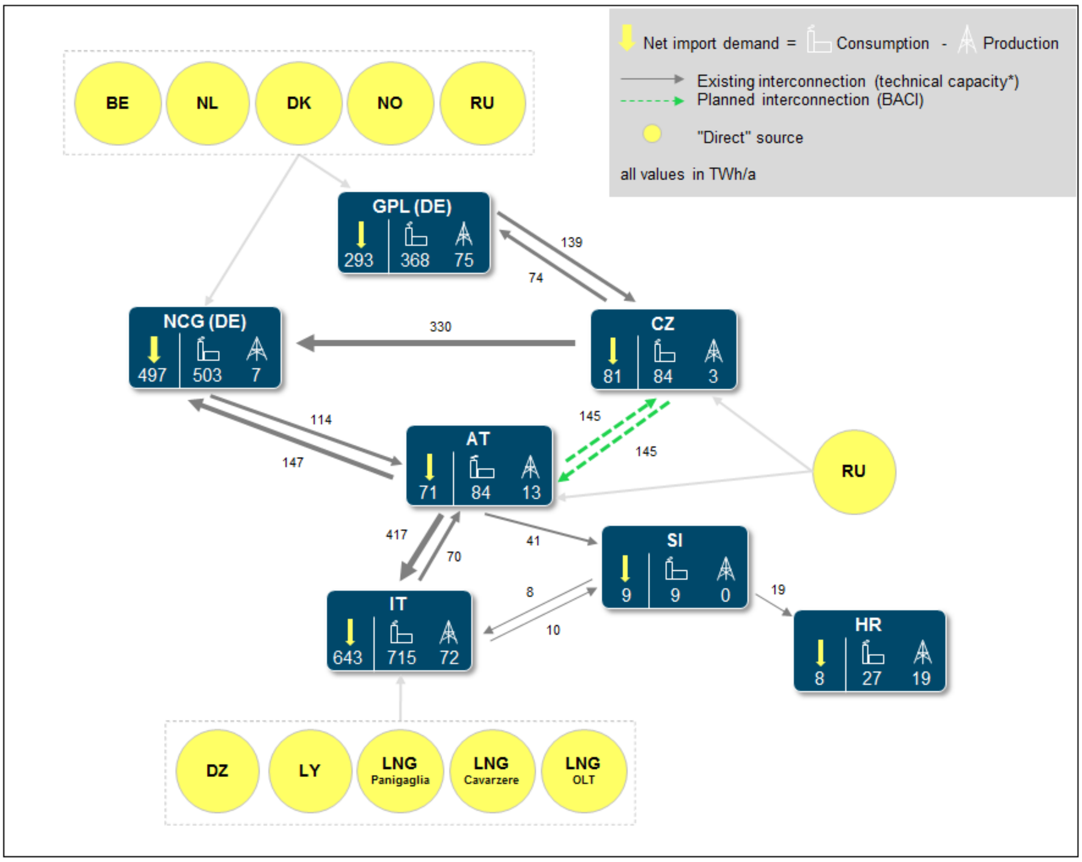


Additionally considering these projected BACI costs does not fundamentally change the overall insights gained in the course of the cost-benefit analysis, however, the options including CZ fare worse than before when compared to options involving, for instance, IT.

Digression: Measures increasing capacity in Überackern

In addition to the above analysis of the welfare gains based on the infrastructure base case (s.

Figure 4: Infra-structure base case



), WECOM also look into the potential implications of increasing capacity in Überackern. To this end, they assume a significant capacity expansion at these points based on projects derived from the coordinated network development plan to increase freely allocable interconnection capacity between the eastern market area and NCG. This increase is additionally considered in the options AT + NCG (DE) and AT + NCG (DE) + CZ. As the potential welfare gain of integrating the eastern market area with, inter alia, NCG is limited by the interconnection deficit (s. section 3.3.1 for an explanation of the methodology), such an expansion would potentially increase the welfare gains of these options, but the gains would be relatively low and would not change the overall result of the cost-benefit analysis. Yet in the same way as in the assumption for BACI, the (unknown) costs of capacity expansion would have to be considered as a factor reducing the calculated welfare gains.

3.4.2 Detailed results

3.4.2.1 Wholesale market efficiency

This section addresses the primary benefit category *wholesale market efficiency*, whose theoretical welfare gain is based on the core assumption that market integration enables players to use open bids from the lower-priced wholesale market to bring down prices in the integrated market. Theoretically, this sees wholesale market prices converge towards the lowest price level observed on the individual markets (for details s. section 3.2.1.1). To take account of existing interconnection deficits that limit the possibilities to freely ship gas in the integrated market, however, the study does not assume full price convergence. The required reduction of the theoretical welfare gain is realised based on the theoretical capacity restriction rate (TCRR) of an examined market integration option (s. section 3.3). The respective results are shown in Figure 26.

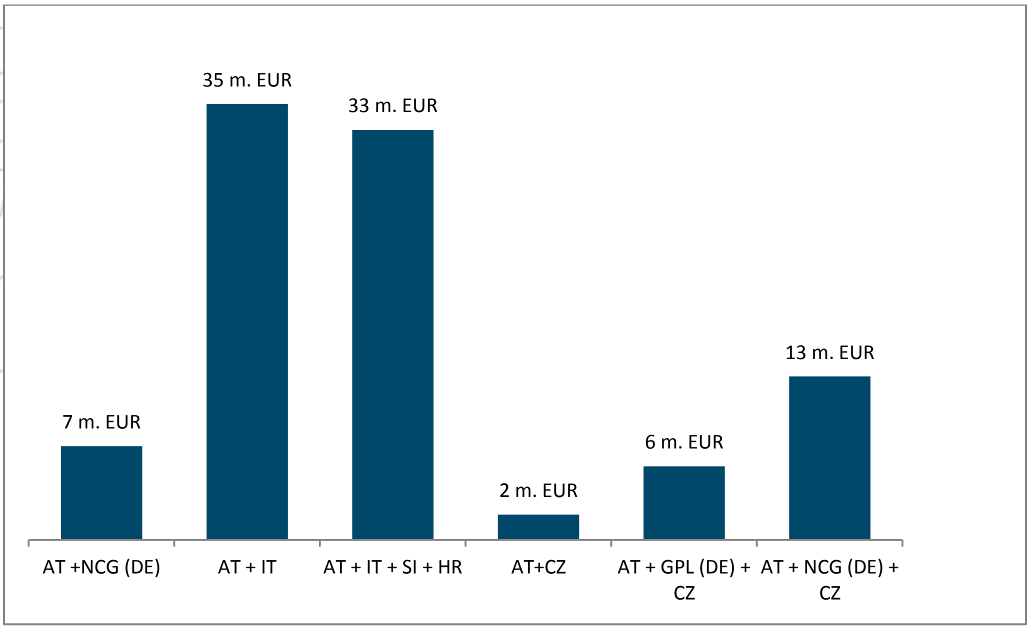
Additional reduction of welfare gains for options incl. IT by separately considering transport costs AT→IT

When calculating welfare gains associated with wholesale market efficiency for integration options including AT and IT, the marginal costs of the gas transport (expressed as a “commodity charge” by Snam Rete Gas for actual injections in Italy) in Arnoldstein are separately considered as a factor reducing the welfare gain, as, in contrast to the other options, the following applies to this scenario:

- The market price on the downstream market IT is significantly higher than in AT (this is not the case in all other examined markets, where the differences are markedly lower) and
- entry allocations in Arnoldstein amount to about 50% of all entry allocations in Italy, thus constituting a significant portion of the offer in the country with a respective impact on price formation in IT.

The reduction to the extent of the use-dependent “commodity charge” deducted by Snam Rete Gas (determined by entry allocations at the Tarvisio point in 2015 and the charge stated in the price lists, also s. annex A) is therefore already considered in the welfare gains stated as a result of wholesale market efficiency for the options AT + IT and AT + IT + SI + HR.

Figure 26: Results of the benefit category wholesale market efficiency for the examined market integration options in million EUR/year



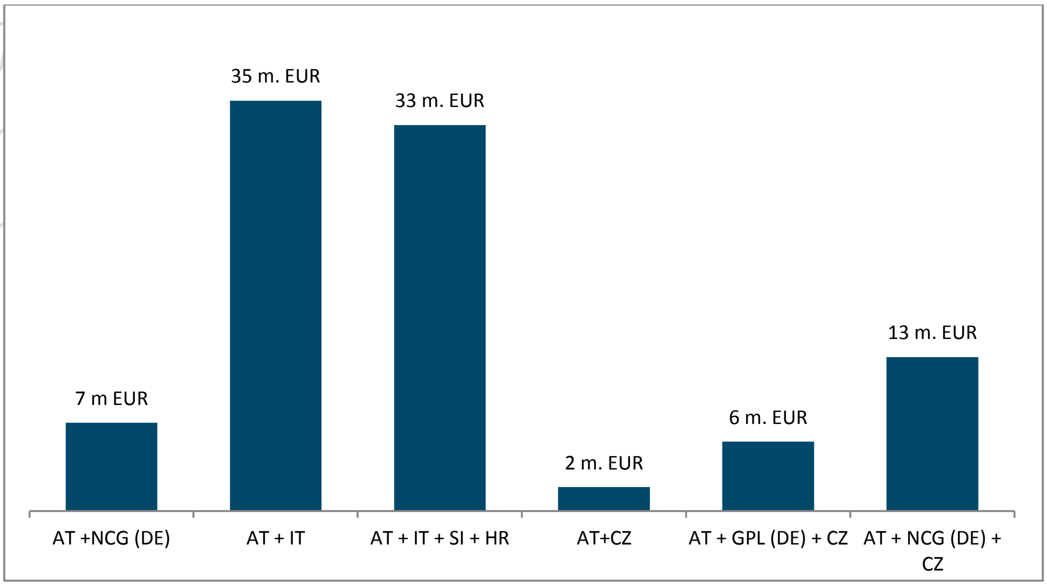
Note: A welfare gain resulting from wholesale market efficiency cannot be directly calculated for SI and HR, which have no such wholesale markets. In this analysis, WECOM thus approximate the welfare gain arising from a coupling of AT and IT in relation to the market volumes of SI and HR (again accounting for the results of the necessary capacity restrictions in this estimate).

Owing to the calculation methodology utilised, the results depend on the spreads between the examined markets, which fluctuate on a daily basis, the respective market volumes and the theoretical capacity restriction rate used to reduce the theoretical welfare gain. The consistently high spreads (IT mostly shows a significantly higher market price compared to AT), high consumption in Italy and the comparatively low restriction rate for options that include AT and IT translate into respectively high welfare gains, which would particularly show in IT. The benefits to be expected for all other market integration options, which have smaller spreads and are subject to higher restriction rates, are lower. In the options AT + NCG (DE) and AT + CZ, the welfare gain produced mostly benefits Austria because of the country's higher prices on most days. For all other market integration options including AT + CZ and one of the German market areas, the welfare gains cannot be clearly attributed to one market that would primarily benefit, as market prices in CZ and in the German markets produce a cheaper market area that changes on a daily basis.

3.4.2.2 Bid-ask spread

Based on the core assumption that the lowest bid-ask spread would be observed following market integration, the resulting welfare gain potential of the examined market integration options is calculated based on the calculation methodology presented in section 3.2.1.2. As in the case of wholesale market efficiency (s. section 3.4.2), the calculated benefit is reduced by the theoretical capacity restriction rate of the various market integration options. The results thus obtained are presented in the following figure:

Figure 27: Results of the benefit category bid-ask spread for the examined market integration options in million EUR/year



Note: As there are no wholesale markets in SI and HR, the welfare gain resulting from a reduction of the bid-ask spread can neither be calculated nor appropriately assessed for these countries. Based on the low market volume of these markets, however, it can be assumed that the welfare gain would be negligible. The result presented for this option thus solely rests on the welfare gain created for the two markets AT + IT (in which, as above, the impacts of the required capacity restriction have already been considered).

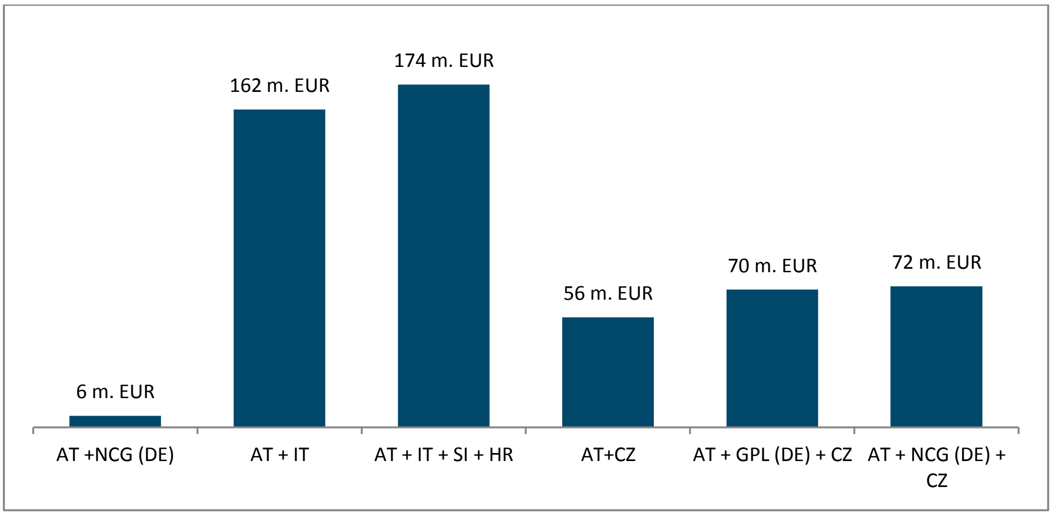
As is the case for the benefit category of wholesale market efficiency, these results also depend on various factors. These factors include the bid-ask spreads for the individual market areas identified according to the AGTM, the respective trade volumes and the resulting theoretical capacity restriction rate for the various market integration options. The resulting overall outcome is fairly similar to the benefits arising from wholesale market efficiency. Options including IT have high results due to the large bid-ask spread and the large trade volumes in Italy combined with a low restriction rate. However, these results would only manifest in IT. The spreads of the Czech market are also significantly higher than those in AT, but due to the extremely low Czech trade volume and the comparatively higher restriction rate, the welfare gain experienced by CZ would be substantially smaller. Integration options with German market areas are characterised by the lowest spreads. The resulting welfare gain, which is significantly lower than in options with IT, benefits Austria or the Czech Republic.

3.4.2.3 Retail market efficiency

Integrated markets enable more retail market efficiency by eliminating national market barriers and increasing competition. Differences in wholesale and household/business prices between the national markets disappear, the most efficient competitors launch attractive offers that are available across the integrated market, and prices converge towards the lowest level currently observed. This results in benefits for active household (average consumption of 15,000 kWh/a) and business (average consumption of 100,000 kWh/a) customers (i.e. consumers who have already switched contract or supplier). Adjusting the calculated benefit for interconnection deficits is not necessary for this type of benefit given that the connection between consumers and the VTP is always assumed to be congestion-free.

The results obtained based on this rationale and the associated calculation methodology (for details s. section **Fehler! Verweisquelle konnte nicht gefunden werden.**) are presented in the following figure. Details regarding price and volume effects with a bearing on the results are summarised in annex B.

Figure 28: Results of the benefit category retail market efficiency for the examined market integration options in million EUR/year



Note: A welfare gain resulting from retail market efficiency cannot be calculated for SI and HR, which have no wholesale markets. For HR, WECOM thus rely on regulated supplier margins and use the market price in AT plus costs for transport via Murfeld as the procurement price for SI.

This benefit category also shows a high potential for welfare gains for market integration options including AT and IT, as the level of the best price is significantly higher in Italy, while the country's sales to consumers are very substantial (i.e. the potential for welfare gains is particularly high for Italian consumers). Czech supplier margins are also markedly higher than Austrian ones, which is why the AT + CZ option also harbours great potential for welfare gains for Czech consumers. In all remaining options, the German market areas show the best offers and welfare gains are experienced in Austria or the Czech Republic.

4 Applicability, implications and harmonisation requirements of market integration tools

This chapter deals with the analysis of the market integration tools presented in the AGTM. Due to the main characteristics of these tools, different conditions must be met for them to be applicable. These will be reviewed on the following pages and form the basis for selecting tools that are relevant to AT. In a next step, WECOM identify the implications of these tools for the previously calculated results of the quantitative indicators (section 2.2) and the cost-benefit analysis (section 3.4), which are based on the premise of a maximum depth of integration, i.e. a full market merger. Finally, this chapter also analyses and outlines the harmonisation requirements of the different market integration tools.

4.1 Overview: typical features of the AGTM market integration tools

As a basis for subsequent analyses, this section provides an overview of the market integration tools presented in the AGTM and their characteristics. These tools are proposals with adjustable implementation options and fluid boundaries between one another. In principle, the tools each envisage a different depth of integration, although it is conceivable that integration will increase over time as a result of the sequential application of different integration tools — in other words, implementing any integration tool other than a full market merger (maximum depth of integration) leaves open the possibility of reaching a full market merger at a later stage.

4.1.1 Full market merger

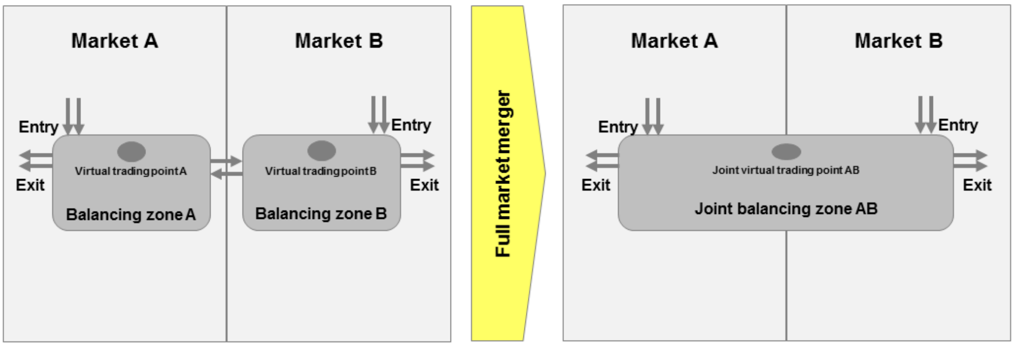
In the case of a full market merger, neighbouring gas markets interconnected by common transport infrastructure merge their balancing zones, thereby creating an integrated gas market with a central virtual trading point. This virtual trading point is underpinned by an entry-exit system that encompasses the entire integrated market area.

The main features of this integration tool are thus as follows:

- an integrated balancing zone that includes all transmission and distribution systems,
- an integrated entry-exit system that, inter alia, reaches down to all consumers, where interconnection capacity between TSOs and DSOs is booked and paid for by DSOs (and not by transport customers or traders),
- a cross-border balancing manager that is also in charge of balancing energy management, and

- largely harmonised obligations to be fulfilled by suppliers (e.g. licences, minimum storage requirements, etc.).

Figure 29: Schematic diagram of a full market merger



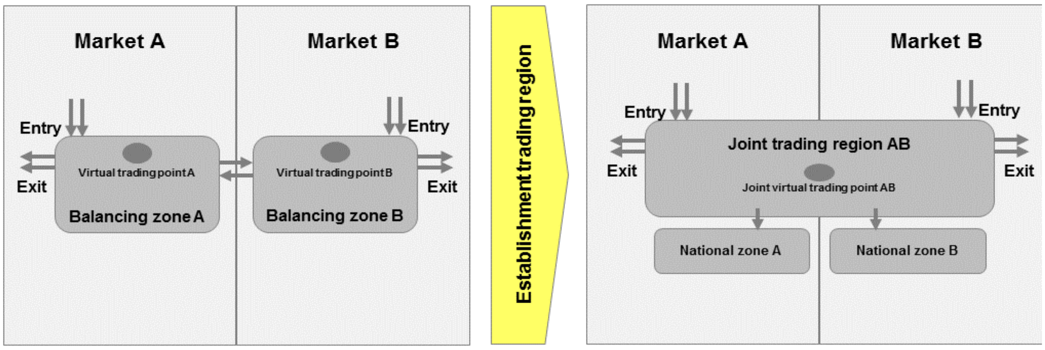
4.1.2 Trading region

A trading region consists of two or more previously independent gas markets that establish a cross-border balancing zone with a single virtual trading point. As described in the AGTM, this zone typically encompasses the system points that are subject to nomination (cross-border interconnection points, market area interconnection points, storage facilities, production, etc.) and therefore essentially the transmission system, but does not affect national consumer balancing regimes.

Accordingly, the principal features of a trading region are:

- an integrated balancing zone and an integrated (on the capacity side) entry-exit system that includes the above system points ("trading zone"),
- additionally, separate national balancing zones for consumers ("downstream zones"),
- consumer managers that are in charge of (commercial and physical) balancing of the consumer zones, and
- harmonised obligations to be fulfilled by suppliers (e.g. licences, minimum storage requirements, etc.).

Figure 30: Schematic diagram of a trading region



Aside from the typical features of this tool described in the AGTM, there is a fundamental degree of freedom in shaping the framework of the trading region. As regards the demarcation between the joint trading region and national zones, it is thus also possible to apply integration tools that have a significantly reduced need for implementation and/or harmonisation.

For instance, by limiting the joint zones to an integrated VTP ("hub trading region") that allows for congestion-free exchange with the national zones based on an integrated capacity model, the national zones could remain largely unchanged, thus reducing harmonisation work.

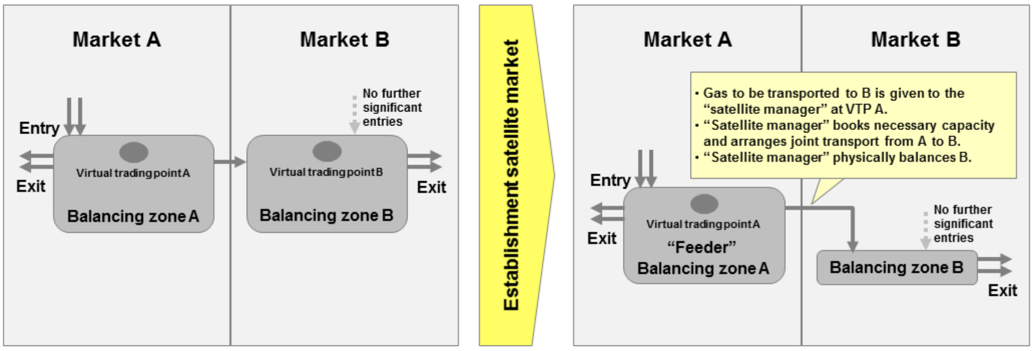
4.1.3 Satellite market

A gas market ("satellite") does not establish its own virtual trading point but co-uses that of a neighbouring country ("feeder"), thus obtaining access to an integrated wholesale market.

This integration tool has the following key characteristics:

- separate balancing zones for the satellite and the feeder,
- an entity known as the satellite manager with the following responsibilities:
  - booking of interconnection capacity,
  - balancing energy management in the satellite market,
  - transport of all gas volumes from the virtual trading point in the feeder market to the satellite market.

Figure 31: Schematic diagram of a satellite market



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4.2 Applicability and specific consideration of the different market integration tools

Based on the basic features of the different AGTM market integration tools outlined in section 4.1, WECOM define certain conditions that must be fulfilled in order for a tool to be feasible. They are summarised below.

Table 5: Conditions for market integration tools with the typical features as described in the AGTM

FULL MARKET MERGER / **TRADING REGION**	■ The markets to be integrated are directly connected with each other or plan to establish such a connection. ■ All gas markets concerned have at least one other relevant entry point from another source[36].
SATELLITE MARKET	■ A gas market is adjacent to a better developed gas market and ■ is almost exclusively supplied by this better functioning market.

Note: If the conditions for the application of a satellite market are met, the conditions for a full market merger or a trading region are also met (although this is not true the other way around). When compared with the latter two tools, significantly lower implementation and harmonisation work is to be expected for a satellite market, albeit with similarly lower expectations of benefits.

These conditions enable an assessment of the feasibility of the individual tools for each of the considered market integration options based on an analysis of the structural

[36] In this context, the term "source" is understood to mean: net producer, LNG, functioning trading market.

characteristics of the market areas involved (also s. infrastructure base case in section 0). For all market integration options without SI and HR, it is shown that:

- in the event of the implementation of a market integration option, direct (and in most cases also bidirectional) connections between the individual market areas involved are either in place or planned (connection between AT and CZ through the planned BACI project) and
- all markets concerned have remaining relevant entry points from other sources.

These market combinations are therefore suitable for both a full market merger and a trading region.

In contrast, the analysis for HR and SI reveals a clear upstream/downstream market structure[37], where HR and SI are supplied by AT and/or IT (HR being supplied via SI). No other relevant entry points would remain for these markets following integration[38]. What is more, neither HR nor SI can rely on a developed wholesale market. Therefore, both SI and HR can be integrated as an extension of a market integration option between AT and IT as part of the tool chosen for that purpose, but they also meet the necessary requirements for implementation as satellite markets attached to the integrated AT/IT market area. The latter would be preferable in that the use of the satellite market concept would yield roughly the same benefits as a trading region while requiring significantly less implementation and/or harmonisation work.

Specific market integration tools considered in the study

The above evaluation finds that only market integration options in which AT is part of a full market merger or a trading region are feasible for Austria. Forming part of a satellite market concept would thus only be an option if Austria (possibly together with another market) served as a potential feeder for downstream markets. Practical experience with this integration tool has shown that the initiative for implementation is usually taken by the satellite market, which is also mainly tasked with carrying out the implementation work, so there would be no need for specific action on the part of AT. Therefore, the following sections provide more details on the full market merger and the trading region as the two tools that are relevant for AT.

[37] Production in HR, while considerable in size, is significantly lower than consumption in Croatia and is also not meant for export due to a lack of firm exit capacities.

[38] In 2015, the year under review, less than 3% of all entry allocations to HR were reported at the HU entry point, which is why that point is not regarded as relevant for the purpose of this study.

4.3 Implications of the examined market integration tools for the results of the quantitative indicators and the cost-benefit analysis

The results of the quantitative indicators (section 2.2) and the cost-benefit analysis (section 3.4) calculated in the study are based on the premise of a maximum depth of integration, i.e. a full market merger. The following table outlines the potentially reduced potential for welfare gains in each of the investigated categories if a trading region were implemented instead. It should be noted that this evaluation is based on the typical features of the integration tools as described in the AGTM and may yield different results if alternative implementation options are used.

Table 6: Implications of a trading region for the results of the quantitative indicators and the cost-benefit analysis

	Full market merger	Trading region	Explanation/description
Market Health Metrics			
Number of supply sources	Maximum benefit	Maximum benefit	As Market Health Metrics mainly focus on the wholesale and/or import level, the implementation of an integrated entry-exit system results in maximum benefit for both a full market merger and a trading region.
HHI	Maximum benefit	Maximum benefit	
RSI	Maximum benefit	Maximum benefit	
Security of supply/storage			
N-1	Maximum benefit	Maximum benefit	The N-1 standard defined by the relevant EU regulation is calculated on the basis of the available capacities of a given entry-exit system; maximum benefit is thus achieved in the case of both a full market merger and a trading region, which both provide for an integrated entry-exit system.
IRD	Maximum benefit	Maximum benefit	Establishing a joint entry-exit system creates maximum benefit for both a full market merger and a trading region, as the IRD index measures the diversification of existing entry capacities (import routes) of the resulting system.

	FULL MARKET MERGER	TRADING REGION	EXPLANATION/DESCRIPTION
SDC	Maximum benefit	Maximum benefit	Both integration tools potentially have the same benefits. Whether or not the two integration tools are actually feasible, however, depends on the existing technical connections of the storage facilities at the VTPs (congestion-free, freely connectable access).
SRC	Maximum benefit	Maximum benefit	
HHI FOR STORAGE	Maximum benefit	Maximum benefit	
Cost-benefit analysis			
WHOLESALE MARKET EFFICIENCY	Maximum benefit	Maximum benefit	Concentration of supply and demand at one joint VTP within an integrated entry-exit system results in maximum benefit in the case of both a full market merger and a trading region.
REDUCED BID-ASK SPREAD	Maximum benefit	Maximum benefit	Concentration of supply and demand at one joint VTP within an integrated entry-exit system results in maximum benefit in the case of both a full market merger and a trading region.
RETAIL MARKET EFFICIENCY	Maximum benefit	Reduced benefit	A trading region permits integrated procurement (for an integrated wholesale portfolio) and thus simplifies operative procedures. Implementing a trading region reduces maximum benefit as a result of, e.g.: ■ remaining barriers such as different regulations/registration procedures, ■ separate balancing in the consumer zones or ■ potentially remaining capacity bookings at the interface between TSOs/DSOs.

Note: As far as the Market Participants' Needs Metrics not considered in the study are concerned, maximum benefit is also obtained in the case of both a full market merger and a trading region owing to a concentration of supply and demand as a result of establishing a joint VTP.

In summary, this means that the benefit reduction to be expected in the case of the implementation of a trading region is confined to a lower degree of retail market efficiency benefits to be expected. However, as outlined in the above table, how strongly retail market efficiency would be reduced depends on the concrete characteristics of the trading region, i.e. can only be calculated once a detailed market integration concept has been elaborated.

4.4 Harmonisation requirements for the different market integration tools

Any assessment of the degree of harmonisation that will be necessary for concrete market integration options to work must be able to rely at least on a basic concept for the tool that will be applied. For this reason, the following analysis conducted in this study is based on the typical features of the full market merger and trading region tools as defined in the AGTM (s. section 4.1), thus providing a first indication of the resulting harmonisation need and a comparison of the basic features of these integration tools.

WECOM focus on aspects that must be addressed so that the market integration tool can function from a legal and operative point of view, i.e. issues without which the tools could not be applied. Further harmonisation of other aspects that aim to install a level playing field and push the overall efficiency of the new market area, though recommended, is outside of the scope of the study. Such aspects include:

- Capacity products and their characteristics (specifications, allocation, reductions)
- Fundamental aspects of storage access (regulated or negotiated, capacity allocation, charges)
- Congestion management measures
- Crisis management (joint establishment of preventive action or emergency plans, specifications concerning emergency-related security instruments, etc.)
- Capacity tarification (non-annual multipliers, rules regarding connection points to storage or production facilities, etc.)

The following analysis, however, predominantly focuses on mandatory aspects and subject areas that must be addressed and/or harmonised and that are crucial for the functioning of the relevant integration tools. After assessing the most important harmonisation requirements in connection with a full market merger, a comparison with the potentially reduced harmonisation requirements that would apply if a trading region were implemented instead is carried out (s. results in the following table).

Table 7: Extract – mandatory harmonisation requirements and tasks for a full market merger and a trading region (comparison)

No.	Subject area	Full market merger: Harmonisation requirements and tasks	Trading region: Differences compared to a full market merger
System access			
1.	Entry-exit system	■ Integration of all entry-exit points in transmission and distribution systems into a joint entry-exit system ■ Joint and/or coordinated network planning for the integrated entry-exit system	Essentially the same as in the case of a full market merger, but limited to the scope of the trading region (e.g. only points where nominations are permitted, no exit points to consumers, etc.)
2.	Capacity allocation	■ Harmonised procedures and obligations for capacity bookings at TSO-DSO interconnection points	Harmonisation of capacity bookings/allocation at TSO-DSO interconnection points (for withdrawals towards the remaining national zones) is not mandatory
3.	VTP	■ Harmonisation with regard to trade notifications and quantity allocations (times, deadlines, content requirements and matching rule) ■ Institutional responsibility for VTP operation (“VTP operator”)	—

No.	Subject area	Full market merger: Harmonisation requirements and tasks	Trading region: Differences compared to a full market merger

4.	Balancing energy	■ Joint and harmonised determination of balancing energy needs
		■ Harmonised rules for short-term standardised balancing energy products
		■ Harmonised rules for determining balancing energy needs and procurement of additional balancing energy flexibility services
		■ Harmonised rules on the criteria and merit order for using the various balancing energy products
		■ Harmonised rules on internal balancing energy, including rules on:
		  ■ Determining the need for and the potential for exchanging internal balancing energy
		  ■ Commercial principles (for, e.g., determining and allocating costs)
			All harmonisation measures required for a full market merger are limited to the scope of the joint trading region.

5.	Nominations	■ Harmonised rules on temporal granularity of nominations
		■ Harmonised nomination rules on:
		  ■ Content requirements
		  ■ Implementation of a pre-nomination cycle
		  ■ Default rule in the event that no nomination is made
		  ■ Times and deadlines
		  ■ Nomination rules for points other than cross-border/market area interconnection points
			■ Harmonisation of temporal granularity of nominations is also mandatory if a trading region is implemented.
			■ Nomination rules, however, need only be harmonised as far as they apply to the joint trading region and can remain unchanged (and, as the case may be, different) for downstream national zones.

No.	Subject area	Full market merger: Harmonisation requirements and tasks	Trading region: Differences compared to a full market merger
6.	Balancing	■ Harmonised rules on determining imbalance quantities and the related charges ■ Fundamental decision as to when to apply/when not to apply within-day obligations and (if applied) which of the types as set out in the BAL NC to apply ■ Harmonisation of (time series) types for the allocation of injections and withdrawals and the related model of information provision as set out in the BAL NC ■ Harmonised rules on the methodology for calculating the contribution (apportionment amongst network users, credit risk management, etc.) ■ Fundamental decision as to when to apply/when not to apply linepack flexibility services and (if applied) which procedures to apply ■ Harmonised rules on procedures for eliminating differences between preliminary and final allocations ■ Establishment of a central balancing manager	■ All harmonisation measures required for a full market merger are limited to the scope of the joint trading region. ■ As downstream national zones remain separate, rules applicable in such zones can remain unchanged, thus reducing harmonisation work. ■ A joint balancing manager is not mandatory in order to implement a trading region.
Security of supply			
7.	Market-based security instruments	■ Harmonised specification of market-based security instruments (e.g. market-related storage obligations, etc.) ■ Definition of regulations concerning the market-based use of such measures and the allocation of costs incurred to the beneficiaries of such measures	(no difference compared to a full market merger, provided that market-based security instruments are allocated to the trading region)

No.	Subject area	Full market merger: Harmonisation requirements and tasks	Trading region: Differences compared to a full market merger
Charges			

8.	VTP charge	■ Fundamental decision on the application of a VTP charge
		■ If applied, harmonised rules on the:
		  ■ Design of the tariff methodology
		  ■ Billing procedure
		  ■ Regulatory responsibility
			—

9.	Inter-TSO compensation	■ Rules for the design/implementation of inter-TSO compensation between TSOs within an entry-exit zone (in accordance with Article 5 of the draft TAR NC), taking into account non-incurred network charges	—

When comparing the need for uniform rules between the full market merger and trading region tools, WECOM find that the latter presents an absolute necessity for harmonisation in only a few areas and that these are areas at the level of the joint (integrated) trading region, i.e. they do not interfere with the national specificities of supply, balancing, etc. of consumers. As mentioned above, adapting the trading region concept (s. section 4.1.2) would potentially allow to further reduce harmonisation work without significantly affecting potential benefits.

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ACER	Agency for the Cooperation of Energy Regulators
AGTM	ACER Gas Target Model II
BACI	Bidirectional Austrian-Czech Interconnector
BAL NC	Regulation (EU) No 312/2014 establishing a network code on gas balancing of transmission networks
CAPEX	capital expenditure
DMA	direct market access
DSO	distribution system operator
ENI	ENI S.p.A.
ENTSOG	European Network of Transmission System Operators for Gas
EU	European Union
EUROSTAT	Statistical Office of the European Union
GPL (DE)	GASPOOL market area
GSE	Gas Storage Europe
HHI	Herfindahl-Hirschman Index
IRD	import route diversification
LNG	liquefied natural gas
MAM	market area manager
MI	market integration
N-1	infrastructure standard
NAM	Nederlandse Aardolie Maatschappij BV
NCG (DE)	NetConnect Germany market area
NID	net import demand
NOC	National Oil Corporation
OGE	Open Grid Europe GmbH

OMV	OMV AG
OPEX	operational expenditure
OTE	OTE, a.s., Czech electricity and gas market operator
RAG	Rohöl-Aufsuchungs AG
RSI	Residual Supply Index
SDC	storage demand coefficient
SRC	storage rate coefficient
TAC	technically available capacity (total firm capacities)
TAR NC	TAR NC for re-submission to ACER (TAR0500-15), 31 July 2015 (draft)
TCRR	theoretical capacity restriction rate
TENP	Trans Europa Naturgas Pipeline
TID	theoretical interconnection deficit
TR	transport requirement
TSO	transmission system operator
VTP	virtual trading point

Note: The country abbreviations correspond to the ISO 3166-1 alpha-2 codes.

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Annex

A Underlying Data

Note: Throughout the study, the abbreviation AT stands for Austria's eastern market area (the Tyrol and Vorarlberg market areas have not been considered in this study).

No.	Input data	Description/Notes
1.	Domestic produc-tion	■ EUROSTAT (period under review: 2015) ■ Assignment of domestic production in Austria to AT ■ Breakdown of domestic production in Germany between the NCG (DE) and GPL (DE) market areas: ■ For calculation purposes the NCG (DE) production is determined solely on the basis of the values provided by OGE (ENTSOG Transparency Platform[39]) and the remaining production quantities are allocated to GPL (DE).

2.	Domestic con-sumption	■ EUROSTAT (period under review: 2015)
		■ Publications by the balance responsible party on the breakdown of consumption for the Tyrol and Vorarlberg market areas
		■ Breakdown of domestic consumption in Germany between the NCG (DE) and GPL (DE) market areas according to the ENTSOG publication[40]
		  ■ NCG (DE): 58% of the country's total consumption
		  ■ GPL (DE): 42% of the country's total consumption

3.	Import data	■ EUROSTAT (period under review: 2014)[41] (import data for destination countries relates to the actual countries of origin) ■ Import data for Austria's eastern market area is determined based on its share in total consumption (95.7%).

[39] https://transparency.entsog.eu/

[40] http://www.entsog.eu/public/uploads/files/publications/GRIPs/2014/entsog_grip_snc_low.pdf

[41] AT imports per source of origin are determined based on the breakdown published for 2013, as no respective data is available for 2014.

<table>
<tr><th>No.</th><th>Input data</th><th>Description/notes</th></tr>
<tr><td>4.</td><td>Techni-cally available capa-cities</td><td>ENTSOG Capacity Map 2015 except for/amended regarding the following points:
Capacity for Emden for NCG (DE) and GPL (DE) taken from the input list of the 2015 network development plan with capacity statements for 2015
Breakdown of capacities provided by ENTSOG between NCG (DE) and GPL (DE) for Dornum and Ellund based on shares as stated in the input list of the 2015 network development plan with capacity statements for 2015
LNG capacities: minimum constituted by capacities stated for GLE LNG Map 2015 and adjacent TSO (Snam Rete TYNDP 2015-2024[42])
OPAL capacities that are not subject to regulation (Greifswald entry point and Brandov exit point) are not considered.
Additionally considered, technically available capacity planned for the future:
For market integration options including both AT and CZ, the BACI DN1200 project with a bidirectional (freely allocable) capacity of 16,561 MWh/h is taken into account.</td></tr>
<tr><td>5.</td><td>Freely allocable capacity</td><td>Germany: input list of the 2015 network development plan with capacity statements for 2015
Austria:
In principle structural data of the MAM
For the Arnoldstein entry (IT→AT), the technically available capacity (ENTSOG) is treated as freely allocable capacity for the market integration options that include AT and IT.
In all other markets, the technically available capacity is treated as freely allocable capacity.</td></tr>
<tr><td>6.</td><td>Entry and exit allo-cations[43]</td><td>ENTSOG Transparency Platform (period under review: 2015)</td></tr>
<tr><td>7.</td><td>Entry and exit bookings (TSOs)</td><td>ENTSOG Transparency Platform (period under review: 2015)</td></tr>
</table>

[42] http://pianodecennale.snamretegas.it/static/upload/201/2015-decennale-eng_web.pdf

[43] In the event that there are no allocations, the reported renominations are used. If there are no renominations either, data of the individual TSOs is used.

<table>
<tr><th>No.</th><th>Input data</th><th>Description/Notes</th></tr>
<tr><td>8.</td><td>Storage data</td><td>In principle GSE Storage Map 2015
Additional information and details provided by E-Control are used to assign stored working gas volume and withdrawal capacity to the investigated markets.
Exception: The withdrawal capacity used to calculate the infrastructure standard is based on information provided in the national preventive action plans.</td></tr>
<tr><td>9.</td><td>Consumer load profiles</td><td>Consumer load profiles with a temporal granularity of days are only available for AT.
For all other markets, data on monthly withdrawal (EUROSTAT) is broken down to days using the daily structure of AT.</td></tr>
<tr><td>10.</td><td>Trade volumes</td><td>Trade volumes in 2014 according to Table 6 in “The evolution of European traded gas hubs” (Oxford Institute for Energy Studies), serving as an aggregated source for both broker and exchange volumes</td></tr>
<tr><td>11.</td><td>Wholesale prices</td><td>Publicly available wholesale prices for NCG (DE), GPL (DE), AT and CZ:
AT: MAM market reference price
NCG (DE) / GPL (DE): daily reference prices of market area coordinators
CZ: intraday market index of OTE
Wholesale prices in CZ are only available until November 2015 → data for December is extrapolated based on the average changes on all other examined markets
Wholesale price in IT provided by E-Control
No wholesale markets in SI and HR (no spot reference prices or spreads)</td></tr>
</table>

No.	Input data	Description/notes

12.	Retail prices	■ Historical data meeting the requirements not available for 2015 → collection and use of current best-price offers for annual consumptions of 15,000 kWh/a (household) and 100,000 kWh/a (business) customers based on national price comparison portals (average of top five offers) using the main cities of the investigated markets
		■ Data collection at two times (beginning and end of May); the average of the two collected results is used to improve reliability
		■ Price comparison portals used:
		  ■ AT: E-Control tariff calculator (http://www.e-control.at/konsumenten/service-und-beratung/toolbox/tarifkalkulator)
		  ■ DE: Verivox (http://www.verivox.de/gas/)
		  ■ IT: AEEG tariff calculator (http://trovaofferte.autorita.energia.it/trovaofferte/TKStart.do)
		  ■ CZ: CZ tariff calculators (http://kalkulator.tzb-info.cz/cz/dodavka-zemniho-plynu-vyber-kraje)
		  ■ SI: AGEN tariff calculator (http://www.agen-rs.si/primerjalnik)
		■ HR: Publication of regulated prices (https://www.hera.hr/hrvatski/html/cijene_plin.html) and regulated supplier margins for HR (http://www.gpz-opskrba.hr/default.aspx?id=27)
		■ Best-price offers are considered without subtracting potential discounts

13.	System compo-nents	■ System components are subtracted in the course of collecting information on best-price offers (based on price comparison platforms, DSO price lists, etc.)
14.	Con-sumption quan-tities of house-hold and business cus-tomers	■ Total consumption was broken down to the share of these two segments based on annually presented EUROSTAT data that is available for 2014 (“final energy consumption: households” and “final energy consumption: commercial and public services”) → use of these shares for consumption in 2015 as the period under review

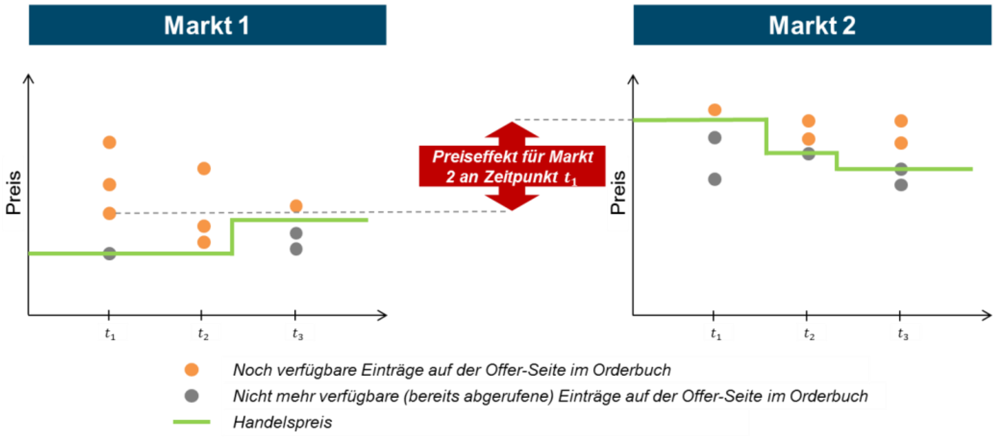
No.	Input data	Description/notes
15.	Trans-mission tariffs	■ AT: *Gas-Systemnutzungsentgelte-Verordnung* (Gas System Charges Ordinance) 2015 – https://www.e-control.at/documents/20903/415340/GSNE-VO-2013-konsolidierte-Fassung-1.2.2015/a8ef39b3-dc0c-42a4-b37c-5aa5420715ef ■ IT: Snam Rete price list (2015): http://www.snamretegas.it/export/sites/snamretegas/repository/file/ENG/Thermal_Year_20142015/Gas_transmission_tariffs/Tariffe_di_Trasporto_Anno_2015_Inglese.pdf ■ SI: Plinovodi price list (current as of April 2017): http://www.plinovodi.si/en/access/transmission-charges/
16.	Calorific value	■ Assumption: 11 kWh/m³

B Plausibility check of the price effect of the benefit category wholesale market efficiency

In order to carry out a plausibility check of the price effect used for calculating wholesale market efficiency, WECOM analyse available order and trade data of day-ahead products as follows (also s. figure below):

- For order book snapshots containing entries for the two markets to be compared (up to approx. 5,800 time entries), a valid trade price (buy side) is separately calculated for each of the two markets as the final volume-weighted closing price, based on which the "cheaper" market at that point in time can be identified.
- Offer entries (= offers) of the cheaper market that are above the market price valid on this market, i.e. that were not used for price formation or to cover local demand, are generally deemed to be available to the more expensive market.
- The resulting price effect is thus the difference between:
  - the calculated market price of the more expensive market and
  - the most attractive and still available offer on the cheaper market.
- The median value (as a measure of scale that is robust to outliers) of all price effects on the examined markets calculated for the period under review (2014) is the average price effect to be expected.
- Based on the AGTM, only results that are calculable for at least 80% of trading days (and that are thus sufficiently statistically significant) are presented.

Figure 32: Theoretical concept of the plausibility check of the price effect of the benefit category wholesale market efficiency



The calculations produced the following results, which justify the use of the chosen calculation methodology to determine welfare gains due to wholesale market efficiency.

Table 8: Results of the plausibility check of the benefit category price effect of the wholesale market efficiency on a yearly basis (2014)

EUR/MWh	"Cheaper" market	Maximum theoretical price effect (absolute spreads)	Maximum price effect acc. to plausibility check		Price effect (50%) for welfare gain calculation
AT/IT	AT	1,01	0,97		0,51
AT/NCG	NCG	1,00	0,96		0,50
AT/GPL	GPL	1,13	1,04		0,56

It is shown that the price effect used for the calculation is a plausible measure. Against the backdrop of non-transparent information regarding volumes, however, it is used in a conservative way.

C Price and volume effects of the benefit category retail market efficiency

Table 9: Price and volume effects of the benefit category retail market efficiency for the examined market integration options

		Household		Business	
		Price effect €/MWh	Volume effect MWh/a	Price effect €/MWh	Volume effect MWh/a
Option 1	AT	1.31	3,915,263	0.31	2,059,736
	NCG (DE)	-	43,153,589	-	23,502,620
Option 2	AT	-	3,915,263	-	2,059,736
	IT	2.14	64,059,971	0.97	25,426,749
Option 3	AT	-	3,915,263	-	2,059,736
	IT	2.14	64,059,971	0.97	25,426,749
	SI	4.59	364,094	9.23	150,784
	HR	3.65	1,770,953	5.76	541,102
Option 4	AT	-	3,915,263	-	2,059,736
	CZ	4.85	6,686,561	5.84	4,015,454
Option 5	AT	1.21	3,915,263	0.21	2,059,736
	GPL (DE)	-	31,546,447	-	17,181,054
	CZ	6.06	6,686,561	6.05	4,015,454
Option 6	AT	1.31	3,915,263	0.31	2,059,736
	NCG (DE)	-	43,153,589	-	23,502,620
	CZ	6.16	6,686,561	6.15	4,015,454