Calculation of Available Capacities: Understanding and Issues -

An ERGEG Public Consultation Paper

Ref: C06-CAP-06-03
14-June-2007

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RPM 0861.035.445

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1. Introduction

1.1. Background

(1) A question that is often raised is how much firm capacity the existing transmission system can offer. Especially at interconnections where congestion is experienced, the capacity assessment process is crucial. This ERGEG public consultation paper addresses the issue of calculating the available capacity (AC) of gas transportation networks in general and the calculation of available long term (e.g. for more than one month) firm physical border entry and exit capacity per EU network interconnection point in particular.

(2) The theory of capacity calculation is broad. However, from the objectives of this consultation it is sufficient to treat the more practical matters relating to the calculation of capacities. This means for instance that the performance of physical network models operated by TSOs is not questioned. However, updating of the network model according to new concepts and new transportation services together with the need of regular recalculation of the network capability necessitate capable software as well as trained personnel.

(3) The aim is not to calculate the available capacity on individual pipelines (the calculation would be merely based on hydraulics) but the available capacity of interconnected and meshed systems as the European networks taking into account of the full interaction of flow patterns and operations (the calculation is based on "network scenarios"). The focus is on assumptions on flow patterns and operational constraints (e.g. pressure requirements) composing network scenarios (input) chosen by TSOs to calculate available capacity (output). It turns out that TSOs have flexibility in the way they set the assumptions and operational constraints to calculate available capacities. Network scenarios imply a certain level of policy making: which incidents are selected to resist, which level of gas flows netting is taken for granted, against which temperature are the peak consumptions for heating purposes calculated, etc.. Calculated available capacities and the underlying network scenario go hand in hand and this relationship has to be transparent and communicated to the market. More openness is needed on how the level of capacity that is made available can be maximised.

(4) The current capacity calculation practice can be summarized as follows: "Available capacities are calculated according to several network scenarios per operational control area (access-area) identified by the TSO. Each network scenario generates another level of available capacity. The TSO selects a scenario and presents the simulated figure as available capacity. This selection is based on the TSO's judgements and policy. Who selects the scenario, bears the liabilities." (GTE workshop on Transmission Capacity 26.06.2006). This flexibility in the hands of individual TSOs raises some concerns of proper AC calculation:

- no guarantee for coordination: no industry-wide guidelines for network scenario selection are available;
- no guarantee that the TSO's judgements in the selection of the network scenario are in line with the objective of creating a more fluid and more competitive market;
- no guarantee for consistency over time and across European networks;
- no guarantee that the generated level of available capacity corresponds to the maximum capability of the system;
- no transparency concerning any possible residual risks of interruption associated to the network scenario (reliability).

Furthermore, adequate AC calculation is necessary for effective capacity allocation and congestion management. The predictability of the network system is a cornerstone for AC calculation. There are many assumptions or choices made during the capability calculation which can greatly influence the level of capacity offered on the market. The more interconnected and meshed gas networks - as the European - the more interactive the individual actions, the more sophisticated the capacity calculation.

(5) The major weakness of AC calculation at a certain interconnection point lies within the arbitrariness of the network scenario since TSOs have large discretion in choosing the network scenario and this without jeopardising the committed capacity. Consequently, AC levels are extremely sensitive to the underlying assumptions made. Variations in the way AC is calculated generate risks for undue discrimination and create obstacles for trading.

(6) The development of competition and the convergence to an internal European gas market require that capacities in gas transmission networks are calculated and provided in a consistent manner both over time and across networks. The network users must be informed about the ability of a network to transport and corresponding network services must be offered to meet the market needs.

(7) Booked, nominated and available firm and interruptible capacities should be published for every period of time together with the procedure used to determine available capacities. This information should be provided and refreshed online on a bulletin board.

What is your understanding of transparency and how should greater transparency be achieved?

(8) TSOs still have large discretion in calculating available capacities and there is no guarantee that networks are always efficiently operated and that capacity is offered on a fair and non-discriminatory basis to all network users: incumbents and new entrants, large and small (see e.g. the impediments identified in the findings of the European Commission's report on the energy sector inquiry[1]). The move to a multi-shipper network use and the increasing volatility of dispatch and operating conditions (see e.g. entry/exit models) raise significant new challenges for capacity calculations that represent correctly the capabilities of a given network.

(9) Capacity calculation is a complex technical area of work that makes use of sophisticated computer tools which ought to be of the latest technologies. The AC determination involves constraints and uncertainties that are difficult to define. It's difficult to predict the real network configuration and the corresponding most efficient operation mode of the network. Therefore, it would be a mistake to assume that AC at any entry point is a fixed number throughout time, e.g. a year.

What is your understanding of capacity calculation and how should greater consistency be achieved?

[1] View the finding report of the sector inquiry of 10th January 2007 on the website of DG Competition. http://ec.europa.eu/comm/competition/sectors/energy/inquiry/index.html

(10) Adequate calculation of available capacities under all circumstances is a key aspect for proper provision of capacity to the market. Available capacity must be calculated under all network circumstances in a consistent manner. However, the more the system moves to congestion, the higher the efficiency impacts of proper capacity calculation for network access as well as for deciding on infrastructure reinforcement projects. There is a need for openness of the tools available for TSOs to maximise system performance and TSOs must have the objective to apply these tools in an efficient way. The capability of a network is not only a matter of pipeline capacities. The 11th Madrid Forum addressed the "role of capacity calculation principles in order to ensure that maximum capacity is offered to the market".

What is your understanding of transportation capacity maximisation and how should greater network efficiency be achieved?

1.2. Purpose and structure of the paper

(11) ERGEG seeks ways for greater transparency, greater consistency and optimisation of Available Capacity (AC) calculation throughout the EU gas transmission networks. The public consultation is an opportunity to provide guidance on how to achieve these objectives.

(12) The purpose of this consultation document is to explain concepts for available capacity calculation and to discuss issues for further regulatory investigation. This public consultation paves the way for any further action to be taken by European regulators. Depending on this outcome, a second consultation on specific guidelines will be organised.

(13) ERGEG seeks views on whether there is a need for the regulation of capacity calculation and on the nature of recommendations for proper capacity calculation. ERGEG wants to contribute to the debate by investigating the possibility of capacity calculation guidelines. This discussion may in turn result in some requests for change or for additional regulatory framework, either from ERGEG or National Regulatory Authorities (NRAs).

(14) The following key high level capacity issues are considered and views are sought to address these areas :

- transparency and communication of AC calculation across European networks;
- consistency and coordination of AC calculation over both time and networks;
- calculation process of AC;
- ways to maximise the level of AC and the use made of it;
- market matching of AC: transportation services provision to meet services demanded by the market.

(15) Given the situation described above, the way forward depends on answers to questions such as the following:

- do current capacity calculations comply with the objectives of a competitive market?
- can capacity calculation schemes work together, even if they use different methods?
- what degree of harmonisation is necessary for effective co-ordination?

(16) The issue of calculating available capacities appears in several other areas of on-going work like for instance under ERGEG's Gas Regional Initiative[2]. This ERGEG public consultation may provide insights on calculation issues that may support these activities too.

(17) The consultation paper continues as follows. Chapter 2 addresses the understanding of capacity calculation and aims to achieve a common comprehension of related issues. Chapter 3 discusses possible ways to maximise available capacity. Some tools are described like for instance the use of "operational options" (or "commitments to flow") in order to reduce the uncertainty on gas flows and to enhance the level of AC. Transparency and consistency issues are discussed in chapter 4. Chapter 5 summarises the main areas for consultation. The relationship with other areas of work is addressed in chapter 6. Finally, details on the invitation to comment are given in Chapter 7. Three annexes give some more background on definitions, network assumptions and network scenario simulation respectively.

2. What is the understanding of capacity calculation?

2.1. Capacity definitions

(18) Available capacity means the maximum physical operating capacity (technical capacity) minus the physical operating capacity which is necessary to fulfil (see also annex 1):

- booked capacity: the commitments under any valid and legally binding agreements and including capacity necessary for non-discriminatory transportation of natural gas owned by the owner and/or operator of the system;
- operational margin: capacity necessary for the efficient operation of the transportation facilities including any operating margin necessary to ensure the security and reliability of the system.

(19) Firm capacity is made available by the TSO unconditionally. The ways TSOs use for guaranteeing that firm is firm may vary from the capacity model applied. In a point to point model firm capacity is secured between entry and exit in any case. In an entry/exit model with much more flexibility for system users, the firm capacity must as well be secured regardless the behaviour of the system users. TSOs have several means to keep the capacities secured independent of individual behaviour of system users (see e.g. use of "operational options"[3]) and must apply them in order to keep firm capacity firm.
It is true that firm capacity can be interrupted in cases of *force majeure*. But that is no contradiction to the notion of a firm commitment since *force majeure* incidents are defined to be beyond the control of the TSO and not foreseeable. On a contractual basis there is no remedy to enforce such impossible obligation.

[2] http://www.ergeg.org/portal/page/portal/ERGEG_HOME/ERGEG_RI/Gas_Regional_Initiative

[3] "Operational options" (or "commitments to nominate") is a general notion covering instruments of committing a network user in return for compensation to guarantee a gas flow at a specified point on the transmission network, at a specified moment (e.g. on request of the TSO), in a specified direction, at a specific flow rate for a specific period. Operational options avoid critical network scenarios and enhance the availability of capacity (see § (50) and section 3.2).

(20) Basically capacity can be firm or interruptible. TSOs manage their networks in order to guarantee the firmness of firm capacity. Interruptible capacity can be voluntarily (and not arbitrarily) interrupted by the TSO and the firm not. The probability of an interruption may depend on different factors as e.g. temperature or actual flows in the system. There may be different commercial arrangements for interruptible capacity leading to different probabilities that the service may be interrupted.

(21) The capacity rights for the part of capacity that is booked but not actually used are with the capacity holder. They should be made available as firm or interruptible capacity to the market by the capacity holder directly (secondary market) or - if respective arrangements exist - by the TSO as firm or interruptible capacity.

2.2. Dependence on network scenarios

(22) The network scenario (see also annex 2) shall primarily cover the flows already committed by the TSO. This means that all the capacity necessary to comply with the sold transportation rights is put aside, and the same holds for the operational margin, before calculating the available capacity.

(23) The calculation of transmission capacity requires a network model and flow simulations in which due account is taken of the fact that interruptible transmission contracts, if any, allow the alleviation of peak flows. Interruptible contracts are interrupted in order to safeguard the firm capacity commitments. The methods for the calculation of available capacities should take into account the capacity commitments for the years ahead. The method should guarantee a maximum netting of predicted flows and schedules.

The network simulation model used by the TSO to simulate network scenarios for capacity calculation should be adequate and accurate.
Is there a need to validate these network models by an independent organisation?
What should be the role of the NRA? What about any responsibilities and liabilities?

(24) The more interconnected and meshed network systems are, the more dynamic the network physics and consequently the more complex the calculation of available capacities. Hence, the calculation of available capacities of isolated transit pipelines is more straightforward than the calculation of entry capacities for meshed networks with many interconnections. The stability of a meshed network is less dependent on the behaviour of individual system users or on an incident, reasons why interconnected networks in general better guarantee security of supply. This observation is important for the judgement of the likelihood of critical (worst case) network flow scenarios.

(25) Different transportation services have different contract terms and each therefore rely on a specific network scenario taking account of the contractual constraints. However, network scenarios have to share the same assumptions except for those which make the service different from another, e.g. the duration of the commitment. Generally, TSO should offer services, and compose network scenarios, according to the needs of the market.

(26) Shippers can contract for several types of transportation services, including firm and interruptible services and for different durations. The availability of each type of transportation service depends on the capability of the network according to a selected network scenario that matches that specific service.

(27) Due to the existing differences in the systems the type of network scenario used for capacity calculation can be different from system to system. Even the information about and the predictability of these factors may be different from system to system. Furthermore, contractual pressure requirements may be different and so may national legislation concerning security of supply for instance. Therefore, network scenarios for providing the same type of AC may differ from system to system.

(28) Critical (worst case) or most conservative network scenario selection determines the lowest level of available capacity but with the highest availability when effectively requested for. A more market-based approach with higher efficiencies would be the calculation according to the maximum likely constraint (e.g. based on historic flows) and to apply buy-back mechanisms should the constraints exceed the maximum expected values. This would imply an active management of network usage in the capacity calculation process (these issues will be specifically discussed in section 3.2 concerning ways for maximisation).

Would capacity buy-back be an option that TSO may apply in order to guarantee the effective availability of capacity when requested (see also §(51))?
This option will influence the capacity calculation process. Buy back of capacities is only one of the options of TSOs to actively guarantee network stability.
The options of TSOs within the calculation process are, among others, the following:
- co-operation of TSOs (see §(29)) assistance contracts with adjacent operators (see §(77)), interactions with regional grids or distribution grids (see §(72));
- commitments to nominate on TSO's request (see section 3.2 and §(46)), guarantee of gas flows at specific points (see §(76)), minimum levels of "forward flow" nominations (see §(84));
- reduction of operational constraints (e.g. pressure promises) (see §(30)c);
- interruptible contracts (see §(77));
- oversell of capacities (see §(51)
- building of entry-zones and exit-zones;
- investment in pipelines, compression, connections.

(29) Consistency in network scenario selection improves the comparability of network performances across the EU. This is not only relevant for adequate benchmarkings for different kind of purposes but makes the portfolio management of shippers crossing several European networks easier and therefore more accessible. The market requires a more accurate prediction of the available capacity and this implies a closer co-operation between TSOs and more data exchange between TSOs.

2.3. Network scenario building

(30) TSOs are confronted in the network scenario building to competing operational objectives determining the AC (see also annex 3). Besides hypotheses regarding network patterns and configuration, one may identify key operational issues which deserve particular attention because of their significant impact on AC:

a. operational margin (OM): how much capacity is booked by the TSO for guaranteeing system integrity. The necessary OM depends on the network situations and therefore may change from day to day. Operational security means keeping the transmission system within agreed security limits. The higher (lower) the OM, the less (more) available capacity, the more (less) robust the network against incidents;

b. provision of flexibility: how much capacity is booked by the TSO for offering flexibility services to meet the balancing needs of the network users (e.g. commercialisation of linepack). This part may fluctuate over the seasons. The more (less) flexibility services, the less (more) AC (at least in general), the more flexible the network against fluctuating offtake patterns;

c. reliability of AC: the more (less) stringent dynamic assumptions and operational constraints, the less (more) available capacity, the more (less) reliability of AC. For instance firm capacity must meet a certain critical network scenario. Worst-worst case network scenarios can dramatically reduce the AC.

(31) TSOs must guarantee the secure operation of their network. This task is performed by the TSO on the basis of the national grid codes and/or additional guidelines issues by NRA. Hence, the capacity availability for Third Party Access (TPA) is capped as soon as the security rules in the network are violated. The baseline is generally defined as system integrity (to meet minimum pressure, quality, linepack requirements) which must be maintained in order to allow physical transportation and contractual commitments.

Are the following requirements adequate?
Each TSO should make its OM values and calculation methodology available to the NRA. The OM should be reviewed by the NRA and appropriate updates must be made.
What about any responsibilities of the NRA? What type of reviewing process is feasible and reasonable? Is it right to stipulate that the NRAs investigate when there is a refusal of capacity request or a complaint but does not approve network scenarios nor calculation methods? Is it right to stipulate that adequate calculation of available capacities must remain one of the core responsibilities of TSOs?

(32) Capacity booked by TSO as OM should be sold on an interruptible basis providing that reliability of the network is not jeopardised. Booked capacity for OM may not be sold as firm capacity.

(33) Security of supply requires also that technical security of supply availability of capacity is guaranteed. The network scenarios for calculating firm capacity have to take account of these security criteria which may differ from country to country and depend also on infrastructural issues as well as the overall supply situation of the country.

Are following requirements adequate?
Network scenarios for calculating available firm capacity must meet at least EU security of supply criteria (see e.g. Directive 2004/67/EC concerning measures to safeguard security of gas supply). This implies that legislative standards as the “1 in 20 winters” rule for households have to be translated in practical criteria. Any more critical constraints for network scenarios for calculating firm capacity than for which EU legislation exists, have to be reviewed by the NRA and communicated to the market?
What about any responsibilities of the NRA? What type of reviewing process is feasible and reasonable? Is it right to put that NRAs investigate when there is a refusal of capacity request or a complaint but do not approve network scenarios nor calculation methods? Is it right to put that adequate calculation of available capacities must remain one of the core responsibilities of TSOs?

(34) There is a strong relationship between the capacity model and the calculation method of AC. The capacity model applied can be characterised as notional path models at one end of the scale and entry/exit-models with pool characteristics at the other end of the scale. The chosen model is a primary determinant of the capacity calculation and the level of AC. While there is a tendency in favour of entry/exit-models, capacity models still differ from TSO to TSO. Generally, AC calculation in an entry/exit-model asks for more assumptions because the flow patterns are less predictable since more freedom of action is given to the shippers. Each capacity model entails a fundamental trade-off between allowing shippers greater flexibility in system use (e.g. entry/exit) and maximising the amount of firm capacity that can be sold (e.g. point-to-point). Greater flexibility and freedom to shippers increases the importance of e.g. "operational options" (see section 3.2) and the concept of "total network service" (see §(37)) for efficient calculation of AC.

The co-existence of different capacity models may not jeopardise the proper and consistent calculation of AC across networks. Are there any likely bottlenecks to guarantee consistency? How could any bottleneck be remedied?

(35) It is the responsibility of the TSO to provide capacity as well as flexibility services to the market. The network capability offered as flexibility services should meet the network balancing needs of the shippers.

Are following requirements adequate?
Should each TSO make its linepack values and calculation methodology available to the NRA? Should the flexibility requirements be reviewed by the NRA and must appropriate updates be made?
What about any responsibilities of the NRA? What type of reviewing process is feasible and reasonable? Is it right to stipulate that the NRAs investigate when there is a refusal of flexibility services request or a complaint but do not approve the calculation method of linepack and flexibility needs? Is it right to stipulate that adequate calculation of linepack and flexibility needs must remain one of the core responsibilities of TSOs?

(36) The reliability of offered transportation services depends basically on the selection of all the values and the choice of operational options which finally determine the robustness of the system. The transportation reliability depends on the risk management of the TSO reflected by uncertainty thresholds: the possible operational margin including reserves for incident management, the treatment of uncertainty in scenario building, the linepack provisions, etc.. These security provisions may absorb some transportation capacity for TPA. However, safeguarding the robustness of the system does not necessarily reduce the available capacity since there exist more options than just reserving capacity (see list in §(28)).

Are following requirements adequate? Should each TSO make its reliability values and calculation methodology available to the NRA? Should the reliability requirements be reviewed by the NRA and must appropriate updates be made?
What about any responsibilities of the NRA? What type of reviewing process is feasible and reasonable? Is it right to put that NRAs investigate when there is a refusal of capacity request or a complaint but do not approve the reliability requirements nor calculation methods? Is it right to stipulate that adequate calculation of available capacities must remain one of the core responsibilities of TSOs?

(37) The network capability concept must be the guidance for capacity calculation. Not just pipeline assets create capacity, also the operational facilities of the TSO (management of e.g. valves and dams, operating mode of ancillary equipments, etc.). Efficient network operation means the management of the network capability as a whole. All the tools at TSO's disposal must be used. The objective is to deliver transportation services as much as possible to meet market demand.

(38) The available capacities should be set at the maximum levels consistent with the safety standards of secure network operation. On the other hand, it is important to avoid distortion of competition from different safety, operational and calculation standards used by TSOs. Moreover, there should be transparency for market participants concerning available capacities and the security, calculation and operational standards that affect the available capacities.

(39) Different time periods may generate different levels of available capacity, keeping all the other parameters of the network scenario constant. These fluctuations depend on the expiration dates of the existing transportation contracts. TSOs should consider variations in capacity availability over the short term in order to maximise the offer of transportation services (see EU Regulation 1775/2005, 3.3.3).

(40) Of course, available capacities are dynamic in time. Once new capacity is committed, the network scenario must be updated and this should lead to new values of the available capacity at every point of the grid (see section 2.5). Assumptions differ between winter and summer and between short term and longer term. Calculating available capacities necessitates a regular update in order to inform the market correctly (at least monthly, see EU Regulation 1775/2005, 3.3.2).

2.4. Operational margin and risk management

(41) The scenario building is essentially an exercise of risk management. Some TSOs are more risk-avert than others and this may have significant impacts on network scenario selection and hence on the level of the AC.

ERGEG seeks views whether there are elements which can be agreed within the EU for enhancing the consistency of risk management and liabilities.

(42) The available capacity is calculated from a network scenario constructed from system information available at a given moment. There is some uncertainty or inaccuracy in this computation. These uncertainties generally increase when longer time frames are considered. Some uncertainties are hard to characterise *a priori*, it is important to note that it would be practical to collect empirical data on the changes in scenario assumptions as time progresses.

(43) TSOs have to take account of emergency situations during the calculation of the capacity to ensure transportation. Some TSOs apply the 'n+1' investment principle while other do not and this has impact on the level of AC. Some TSOs interrupt exits at the border (transit) in the case of an incident and other not in order to prioritise gas flows to the domestic market (e.g. UK).

Is there a need for more evidence and consistency of incident management?

(44) Clauses that releases TSOs of any responsibility is a key item in the network scenario development and selection and hence the level of AC. These clauses generally cap the transportation guarantee.

Is there a need for more evidence and consistency of 'Force Majeure' clauses?

What about any contractual clauses going beyond the standard legal definition of force majeure?
How to deal with e.g. planned maintenance? Should TSOs provide back-up capacity for firm contracts and guarantee that the network users can reorganise themselves without bearing extra costs or are contracts still considered firm if contracts may be interrupted for maintenance as specified in the contract? What about the reasonable durations for maintenance?
What about incidences due to negligence of the TSO, including lack of investment?

(45) No matter what the transportation contract is, there always exists a residual risk of interruption.

May financial commitments improve network efficiency? Firm should be firm but what might happen if firm capacity sold cannot be honoured for some reason?

(46) Risk management raises some specific questions related to the behaviour of TSOs as well as to the behaviour of network users.

Generally, there is a risk that TSOs opt for the very worst network scenario to hedge themselves against problems of liabilities. On the other hand, very worst network scenarios may dramatically drop the AC.
How should guidance on this hedging behaviour of TSOs look like? How can an appropriate equilibrium between liabilities and levels of AC be found?
How should failures of commitments to nominate on TSO's request be dealt with ? How should the circumstances where a shipper cannot provide anticipated gas flow that have been relied upon in capacity calculations by the TSO (cf. operational options see section 3.2) be dealt with? Is there a possibility to release TSOs responsibility?

2.5. Recalculation process of available capacity

There exist various ways of how TSOs may simulate network scenarios by using their computer network models to calculate the available capacity at an interconnection point (entry and exit) and how AC are updated.
This section seeks ideas on how these procedures may be designed. Would it be possible to specify a common procedure, or at least steps within the procedure, applicable throughout the EU?
Are there any other options to guarantee adequate calculation procedures?

(47) The baseline for any AC calculation is the capacity needed to fulfil all the own needs of the TSO (OM) and the existing transportation contracts. When a transport contract expires the corresponding capacity must be made available to the market, and published as such (see §(39)) and EU Regulation 1775/2005, 3.3.3). Booked capacities are updated and published on a regular basis.

(48) Recalculation of AC, meaning new computer simulations based on refreshed inputs, may be quite complex and an intensive task. In contrast to 'automatic' recalculations after each booking, periodical recalculations simulate the AC that will be considered for a certain period and within that time period the AC is updated by simply subtraction (AC – booked capacity) until the start of the next period (the moment of AC recalculation).

Could periodical recalculations be an option?

It is recognised that there are pros and cons to both approaches. Periodical recalculation gives more stability of information and transparency regarding the AC update (simply subtraction within the period). On the other hand automatic recalculation, or the shorter the time periods of periodical recalculations, may lead to higher levels of AC since the network capability is each time recalculated (e.g. there are no shifts of entry capacity within the period). Losses of efficiency may, however, be recovered by an adequate investigation after refusal of capacity request because of lack of capacity (see §(50)).

In the case of periodical recalculations, there may be room to harmonise the period and therefore the dates of AC recalculation (network simulation) throughout the EU. What time period would be reasonable and practical feasible? Annual, quarterly, monthly recalculations?

(49) Different sets of network scenarios may enhance maximum provision of AC, at least on a seasonal basis. The AC might be different in summer and winter. Short term and long term availability may vary and should be published separately.

No matter whether there are automatic or periodical AC recalculations, should network scenarios be set according to the moment of the year, for instance different sets of network scenarios in summer than in winter; in spring than in autumn for instance?

(50) No matter whether there are automatic or periodical AC recalculations, published AC should be considered as binding to the TSO, it must be available when effectively requested for. Any refusal of capacity request because of lack of capacity will be investigated by the NRA.

In a capacity calculation regime where AC are not indicative, how can a situation be avoided where the TSOs chooses the very worst network scenario that may lead to a dramatic drop in the level of AC?
Could guidance on parameter values in the critical scenario be an adequate option? For instance, parameters in the network scenario for which (national) legislation, directives, rules, guidelines, etc. exist are set equal to these values and may not have more critical values (for the calculation of available firm capacity). Secondly, parameter values for network scenarios should be consistent with values in other areas such as network planning, congestion management, security of supply, etc.. This parameter setting may avoid that more critical values are used than for which rules exist.

2.6. Handling of capacity requests

(51) It is the responsibility of the TSO to secure that available capacities are effectively available when requested. Where e.g. a firm right cannot be honoured, the TSO must apply all the reasonable tools to buy back capacity from the market. On the other hand, the calculation method should avoid situations of “over-allocation” of capacity. Though, controlled overselling of capacities is one of the means to maximise AC. This oversell may not lead to a situation that makes firm capacities non-firm.

(52) The TSO is not allowed to deny a capacity which was marked as available, or to grant more capacity to a system user than what appeared to be available, because this is likely to be discriminatory.

(53) TSOs may not limit entry or exit capacity in order to solve (local) congestion inside their own control area (network), except for reasons of operational security. Such a situation can only be tolerated until the long-run solution is found. The methodology and projects to achieve the long-term solution shall be described and transparently presented to all the users by the TSOs.

(54) If a TSO denies firm capacity because it exceeds the published available firm capacity, this can be considered as a duly substantiation of refusal. The TSO should inform the NRA about any refusal of request. The system user retains the possibility of appeal to the NRA on any decision of the TSO. The NRA investigates any refusal to grant access to the network because of lack of capacity.

(55) Although a capacity request has to be denied when the published AC is not sufficient, there are some issues for discussion. The published AC for each point is binding to the TSO and the TSO guarantees that the capacity is effectively available when requested. However, the refusal at this level does not mean that the TSO must not search for a solution together with the involved network user by managing e.g. a shift to another point. This process must be transparent and the NRA should be involved herein. Finally, the principle should be that a particular request for transportation capacity shall only be denied definitively when the incremental physical flow resulting from the acceptance of this request implies that secure operation of the gas transmission network may not longer be guaranteed.

Is it feasible to consider the published AC for each point as binding to the TSO? Or should the published AC for individual point be considered as binding but not necessarily the sum of all AC at all points?
How should we deal with the risk that under a binding regime of published AC, TSO's may choose the most critical network scenarios which lead to a dramatic drop of AC?

(56) Firm transportation curtailment shall only be used in well defined emergency situations where the TSO must act in an expeditious manner and any other tool is not possible. Except in cases of *force majeure* and for planned maintenance, market participants who have been allocated capacity shall be compensated for any curtailment. Only legal *force majeure* is meant and not any contractual *force majeure* clauses which go beyond the legal definition of *force majeure*. In any case, these emergency situations, *force majeure* clauses and interruptions due to planned maintenance must be transparent and communicated to the market.

2.7. Summary of key capacity calculation principles

(57) AC is a snapshot of the capability of a network. Something like a fixed or constant amount of capacity that a network infrastructure is able to offer does not exist.

(58) Physical network models are necessary calculation tools and the amount of available capacity varies according to the selected network assumptions.

(59) Each network scenario consists of a set of assumptions with varying degrees of uncertainty. The market must be informed of any residual risks. Emergency situations and *force majeure* clauses must be transparent and communicated to the market.

(60) After selection of the assumptions, the corresponding amount of capacity has to be made available to the market.

(61) There are several competing operational objectives in the capacity calculation process. Generally, an adequate balance has to be found between guaranteeing the robustness of a system and the provision of capacity. TSO's operational options, risk and incident management (e.g. any back up means at the TSO disposal which alleviate for instance critical scenarios) are fundamental determinants of AC for TPA.

(62) Capacity calculation must consider the capability of a network. The capability depends on all the tools at the disposal of the TSO and on the way the network is used (shippers). The concept that capacity reservation means the booking of physical capacity along a route is far from reality where the network capability is managed as a whole (a fortiori in entry/exit systems).

(63) Capacity calculation must take the advantage of decreasing uncertainty as time passes. The provision of short term services can increase the efficiency of the use of the system.

(64) Capacity calculation must be updated on a rolling basis after each new capacity booking.

(65) The maximum provision of transportation services to meet market needs must be the objective of each TSO and any guidance should incentivise this objective. Maximum long term firm capacity is the most important kind of capacity.

(66) The nature of AC figures, and therefore the market value, may vary strongly according to the underlying choices. Therefore, TSOs must provide objective evidence to the market that the calculation process and the resulting AC figures are reasonable and appropriate.

3. Possible ways towards maximisation of available capacity

3.1. Cooperation between networks

(67) Due to interconnections between areas (distribution grids included), the TSO's capacity assessment process must be coordinated. The accuracy of the capacity assessment depends on the availability of reliable information about each TSO's network.

(68) TSOs shall, as far as technically possible, net the capacity requirements of any gas flows in opposite direction in order to put the capability of the network to its maximum capacity on the market. Having full regard to network capacity, nominations that enhance the system performance shall never be denied.

(69) The point is made that the TSO's calculation method does not take into account the limitations of the neighbouring grids and that therefore a European gas flow model would be required. It is necessary to use a bilateral and coordinated approach for the calculation of capacity of the interconnections, instead of the present unilateral methodologies.

(70) The EU gas network is not a system of individual TSOs but a strongly interconnected system split up in control areas (generally still the country borders, except Germany for instance) and operated by different TSOs. The creation of an effective internal market requires that TSOs coordinate operations in order to streamline upstream and downstream operations.

- How to achieve consistency of AC calculation across networks?
- How can coordinated network planning and operation solve network inefficiencies like under-utilisation of facilities?
- How can coordinated network operation lead to a "network service concept" that crosses borders with maximum assistance between TSOs?

(71) Shippers crossing several networks will need consistent capacity information moving from system to system. The accessibility of compatible data concerning AC is an important factor in international trade and security of supply and for the development of competition in the European gas market.

(72) Where needed, interactions with regional grids or distribution grids, must also included in the capacity calculation process on the transmission network.

(73) Coordination and information exchange mechanisms shall put in place to ensure adequate capacity calculation.

3.2. Predictability of flows and operational options

(74) It has been stressed that the prevailing flow pattern in the network has a great influence on the AC. The predictability of flows is fundamental for capacity calculations. Systems characterised by high predictability have generally higher levels of AC.

(75) The predictability of flow scenarios is limited as they depend on the number and location of different sources, transit ratio and market participant's behaviour.

(76) There exist market instruments to improve the predictability of the flow patterns and the creation of AC (to control the uncertainty). Operational options commit the shipper in return of compensation to guarantee a gas flow at a specified point on the transmission network, at a specified moment (e.g. on request of the TSO), in a specified direction, at a specific flow rate for a specific period. Therefore they may also be called "commitments to flow". Operational options avoid critical network scenarios.
Operational options require a degree of certainty that notified flows will materialise in practice.

How to deal with the potential of shippers themselves to provide capacity by means of signing contracts of the "operational options" type?

(77) Proper capacity calculation means the optimisation of the predictability through operational options, interruptible contracts, assistance contracts with adjacent operators, etc. by the TSO.

(78) The use of operational options in one network may have impact on the neighbouring networks, the TSO shall take into account the effect of these measures. This in turn is also an issue for co-operation.

(79) TSOs shall optimise the use of the overall network through operational options in compliance with the rules of secure network operation.

3.3. Backhaul capacity

(80) Nominated exit capacity at a cross-border point creates entry capacity in the opposite direction. Theoretically, capacity may be created until full netting is achieved. However, this level of backhaul capacity may be capped for technical and operational reasons.

(81) Backhaul capacity is conditional on nomination of physical flows, and therefore non-firm. Backhaul may become firm capacity as soon as and to the extent of the guarantee of nomination is given beforehand. This can be achieved through the introduction of operational options.

(82) Since nominations create capacity in counterflow, TSOs are requested to offer the resultant capacities at least on the day-ahead market. TSOs shall endeavour to sell this backhaul capacity as much as requested by the market and according to the requested reliability level.

(83) Selling backhaul capacity and keeping systems efficient is only possible if this happens in a coordinated manner between the TSOs involved.

(84) Backhaul capacity has to be offered as firm as possible. TSOs have to negotiate in their "bulk" contracts minimum levels of "forward flow" nominations if there is a reasonable demand for the corresponding firm backhaul service. Firm backhaul capacity can be offered according to these minimum flow levels.

4. Possible ways towards transparency and consistency

4.1. Transparency of the calculation process[4]

(85) Not only the knowledge of AC is important for the market participants but also transparency about the method and the main rules governing the levels of AC contributes to a better understanding and level playing field.

(86) TSOs shall publish all relevant data related to network availability (e.g. booked and nominated capacities) and a general description of the calculation method and a general scheme for the calculation of the entry and exit capacity for the different transportation services (especially firm and interruptible capacity) and for the different timeframes based upon corresponding types of network scenarios. This scheme shall be transparent regarding any residual risk and periods of reduced availability (for the purpose of maintenance, for instance).

Shall such a scheme be subject to review by the NRA? What about any responsibilities of the NRA? What type of reviewing process is feasible and reasonable?

(87) The system users, who can be interrupted, must be advised of the type of circumstances that could affect the availability of capacity. The TSO shall inform shippers on a regular basis before the beginning of a calendar year about those works planned on its facilities, for the maintenance or development of the installations that may affect the amount of capacity available in the forthcoming year and about additional available capacity to be built by the TSO in the forthcoming year. This schedule shall be updated regularly and as soon as reasonably practical (see EU Regulation 1775/2005, 1.9).

(88) TSOs shall publish the obligations and rights of both the TSO and the party requesting the capacity, including the liabilities that accrue upon failure to honour obligations, shall be described in detail and made transparently available to all potential networks users by TSO. The operational options shall be published and tendered if applicable.

(89) The operational security standards shall form an integral part of the information that TSOs publish in an open and public document.

(90) Besides the development of standards for calculating capacities, there may be a need for a more flexible instrument for network users. The development of a flexible web based simulator accessible for network users to provide the capability to respond easily to any request for a transportation calculation may be considered as an option.

[4] Only particular issues related to capacity calculation are addressed in this consultation document. The overall transparency guidelines regarding network availability can be found in the transparency GGP.

Is there a need for such kind of web based simulator? Should it be designed for the whole EU grid? Is such a tool feasible and practical? Should GTE be requested in particular to put forward such a tool to calculate available capacities on a case-by-case basis? Who is liable for this capacity? Which information does the published AC provide if shippers can calculate different values? Is the system blocked while one shipper calculates?

4.2. Harmonisation of the calculation process

(91) Different treatment of capacity availability between TSOs shall be kept to a minimum. Any differences in how capacity availability is treated must be shown not to hinder the development of competition.

(92) NRAs and TSOs shall endeavour to harmonise, where possible, rules for calculating available capacities in order to enhance consistency between networks. Where appropriate, common rules on minimum security and operational standards for the calculation of available capacity shall be set. This means that the basic scenarios have to be commonly agreed and that the calculation procedures of all the TSOs are comparable. This approach helps to make it easier for TSOs to agree about concrete values, to check their global transparency and to ensure in a best way transparency towards the market and NRA. There is a need for minimum requirements for capacity calculation.

(93) Calculation of AC depends on the network scenario that is specific to each TSO. For the sake of transparency, key elements of short-term and long-term scenarios should be communicated to the market. NRA should have access to the modelling tools and network scenarios used by TSOs.

5. Consultation on areas for developing guidelines

(94) Does the general understanding and the addressed issues in this consultation document provide an adequate basis for further development in order to recommend on capacity calculation guidelines? How can consensus be reached on a consistent and transparent method of calculation?

(95) There is a need for reliable and complete mechanisms for computing and evaluating transportation capacity suitable for giving capacity information to market actors in a consistent manner over time and across European networks.

(96) Shippers should be able to know whether there is capacity available. TSOs shall take all possible measures to be in the possibility of publishing quantitatively the available capacities. ERGEG considers as a priority the issue of European TSOs providing adequate information to all market parties. A guideline could help shippers, TSOs and NRAs, to have a common language, understanding and procedures.

(97) This part of ERGEG's work addresses primarily the assumptions of network simulation. These assumptions have a dominant impact on the simulation outcomes and it is therefore important that they are transparent and calculated as consistently as possible both over time and across networks in Europe. This is to be done in a context where the contractual commitments of TSOs and the legal obligations are respected. Network modelling, on the other hand, is much more a matter of the physics and architecture of the system. However, network models have to match the applicable allocation regime and allow the relevant types of capacity according to that regime to be calculated.

(98) Transparency requires that available capacities as well as the contractual commitments (booked capacities), the underlying assumptions and the operational constraints have to be transparent and communicated to the market according to the extent and for the purpose of increasing the visibility of the capacity market. What should be the level of detail of this published information? Is it needed to publish contractual pressure promises at every point (as is the case in Germany)?

(99) The network scenario composition and selection has to result from a transparent maximisation procedure according to reasonable criteria. A practical approach has to be developed to make adequate trade-offs between competing objectives: amount of capacity/firmness, capacity/flexibility and operational margin/available capacity. Firm capacity is unquestionable firm, how could transparency on “firm is firm” be achieved? Which criteria are reasonable to determine the adequate network scenario for calculating firm capacity while guaranteeing that firm is firm?
Network scenarios should be based on the “network capability” concept: efficient system operation entails using all the tools at TSO’s disposal.

(100) Which approach is adequate to attribute probabilities to network scenarios? Are historical data sufficient for statistical probability analysis?
The sensitivity of a single value of available capacity is difficult to control but at least the market players should be aware of this sensitivity in there prospects. This sensitivity may become tangible by offering capacity according to some varying assumptions or even by specifying a function of AC depending on the network utilisation and operation conditions. May this approach be adequate?
The TSO must take advantage of the increasing certainty as time passes and update available capacity on annual, monthly and daily basis.

(101) What are the issues in the development of a guideline on generic rules for calculating available capacity: minimum calculation requirements which are commonly applicable in the EU?
For instance, is the principle of calculating available firm capacity according to the security of supply standard adequate? Is there a more appropriate alternative which meets the market needs? How can firmness requirements be adopted as a starting point of capacity calculation while guaranteeing that firm is firm? How should it be monitored?
In the progress towards an internal European gas market, it is desirable that TSOs publish available capacities according to a comparable network scenario. Is there a need to specify a standard network scenario?
Which approach is adequate to match the network scenario according to which the available firm capacity has to be calculated? Once the network scenario is specified, it is straightforward to simulate the available capacity by using the appropriate network flow model.

(102) What are the issues in the development of a guideline on the use of “operational options” for enhancing flow predictability: “back-to-back” nominations on request? This implies automatically that the role of shippers in creating capacity becomes explicit. May there be a market for security products able to evolve? The calculation of available capacity according to these new products needs to be analysed together with the way to provide these products. The provision of these products may not reduce the firmness or available capacity of other participants.

(103) Which problems are related to insurance issues and liabilities in the calculation of available capacity? May maintenance be invoked to cancel temporarily a firm capacity right and this without the provision of an alternative entry and/or exit by the TSO? What happens if the available capacity seems not available once requested for? Are there any specific issues in the treatment of capacity refusals?
Generally, contractual "force majeure" specifications (and these may sometimes go beyond the pure legal notion of force majeure) cap the firmness. Is there a need to identify the contractual clauses that TSO's may put under the force majeure terms in a contract? Is there a need to provide statistical failure rates? The threshold from which events may be considered as "force majeure" has to be transparent and consistently applied.

(104) What capacity calculation issues have to be addressed for inter-TSO coordination: considering issues of inter-TSO coordination and establish a process to obtain the necessary degree of coordination – calculation and cross-border maximisation.

(105) The methods for the calculation of capacities should ensure consistent principles are used between TSOs at European level. The role of NRA is not always straightforward. The principle remains, of course, that the TSO is responsible and liable for adequate capacity calculation. Views are sought on the role of the TSO on the one hand, and the role of the NRA on the other hand in guaranteeing proper calculated available capacity levels.
For instance, what's the role of NRAs in approving criteria to select the assumptions and in monitoring the matching between the input and the output of network models?

(106) What has to be the role of the NRA in the capacity calculation procedure in order to guarantee that the market is correctly informed and to keep the calculation procedure practical. Which are the minimum tasks to control?

6. Interdependency with other areas of work

(107) Each TSO should operate in a consistent manner across the different areas of work: capacity calculation, congestion management, network planning and security of supply which are strongly interdependent. TSOs should endeavour to use the same basic hypotheses.

How can consistency be achieved between network design criteria, the capacity calculation method and the definition of congestion? Convergence of planning and capacity calculation criteria must be an objective, e.g. it would be inconsistent with the applicable planning criteria to evaluate a transmission service request using more extreme events than planned for. Consistency would mean for instance that if the network is designed according the "1 in 20" winters rule, the networks scenario for firm capacity calculation must also use this rule and not for instance a more stringent temperature according to a "1 in 40" winter.

(108) Congestion management depends on the way AC is calculated: e.g. the more stringent the network scenario for calculation AC the faster the system moves to congestion.

(109) Transparency on AC in the present and the future is needed. TSOs should inform the market about their investment project and the corresponding raise of available capacities.

7. Invitation to interested parties to comment

(110) ERGEG invites all interested parties to comment on the understanding and issues raises in this paper. Any comments should be received by **10th August 2007** and should be sent by email to **calculationcapacities@ergeg.org**. Following the end of the public consultation period, ERGEG will publish all comments received from stakeholders. Any respondent wishing ERGEG to treat its contribution as confidential should clearly state this in their reply and endeavour to give any confidential material in annexes that can be separated from publishable non-confidential material.

Any questions relating to this document should in first instance be directed to:
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Annex 1: Capacity Definitions

For the sake of clarity and transparency it is important to use agreed capacity definitions. The consistent use of agreed definitions contributes to a better understanding of the functioning of the capacity market. This document applies the definitions of the European Directive 2003/55/EC (EC 2003) and the Regulation on Conditions for Access to the Gas Transmission Networks 1775/2005 (EC 2005a). Figure A1/1 shows capacity definitions which are used in this paper. Capacity is defined as normal cubic meters per unit of time. The total useful capacity is equal to the total theoretical capacity (technical capacity) minus the capacity reserved for the TSO for system integrity and operational requirements (so-called operational margin).

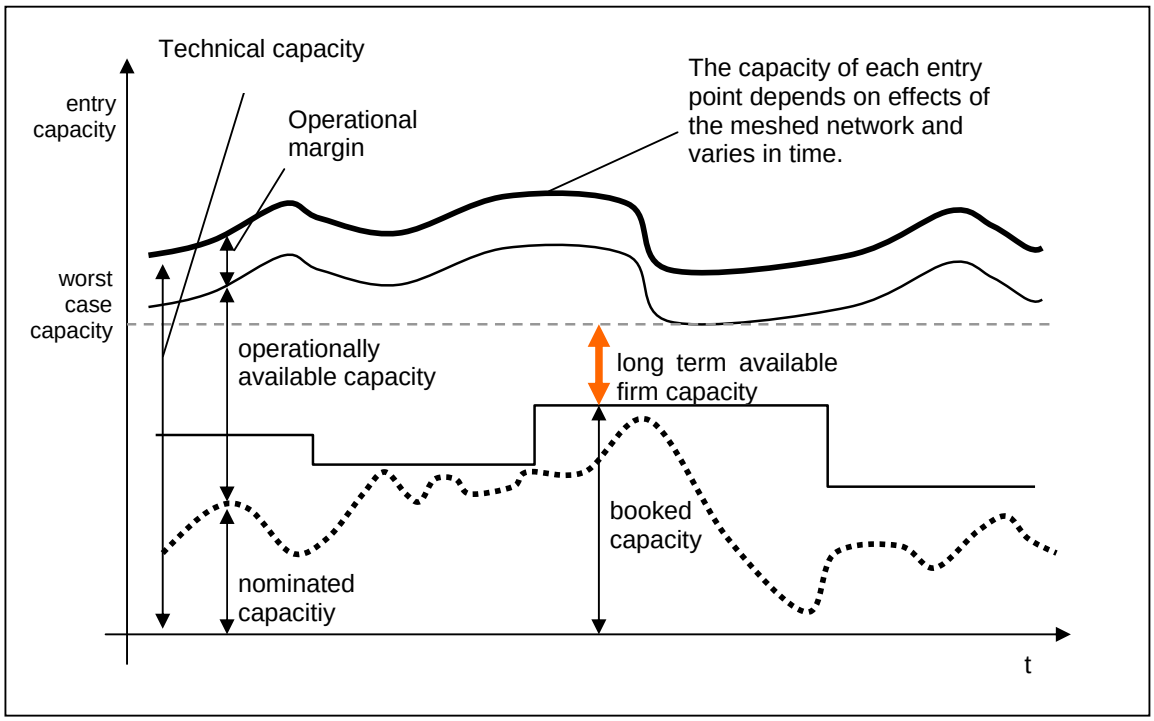

Figure A1/1 - Capacity definitions

Figure A1/1 illustrates the variation in time of the capacity (and load) of one particular entry point in a network and the breakdown.

- the technical capacity (useful capacity) varies in time because of network effects;
- the operational margin is thought to be constant in this diagram;
- the booked capacity changes in steps because different shippers may book differently (different levels and periods);
- the nominated capacity changes very strongly;
- the available capacity is the difference between the technical capacity minus the operational margin and the booked capacity according to the applied network flow scenario;

- the operationally available capacity is greater than the “available capacity” and varies continuously. It changes due to the changing of technical capacity and nominated capacity in a probabilistic way. Ideally, this operationally available capacity should be brought to the market, at least partially. This is an important way of maximisation of available capacities.

Another point that needs to be kept in mind (although not pointed out here) is the precise knowledge of available capacities by the TSO: generally, the shorter in time, the more precise the calculation of available capacity can be carried out. More precision may result in higher values, as reliability margins / operational margins can be lower.

Annex 2: Network Assumptions

The transport capacity of a transportation network depends on static and dynamic elements, as well as on operational constraints and contractual obligations:

- The static elements are the technical characteristics of the network itself. These elements include the network architecture (positioning of the entry points, of the exit points and of the inner nodes; design of the arcs between the nodes; presence of other equipments which modify the properties of the flow) and the specific properties of the arcs and other equipments. In a gas transport network, these properties include:

  - the diameter and pressure specifications of the pipelines (and their length) on each arc or portion of arc;
  - the roughness of the pipeline material on each arc, which has an influence on the pressure losses;
  - for other equipments, such as valves or compression and heating facilities, the technical characteristics of these equipments. The network configuration can be changed and sometimes should be changed by closing/opening of some of the valves. For example in summer, gas injection into storage generally needs another network configuration than the winter peak day.

- The dynamic elements refer to the way the network is being utilized (by the users) and operated (by the system operator). These elements vary continuously over time. For a gas transport network, these variables include:

  - the properties of the gas injected at the entry points (pressure, temperature, chemical composition) by the shippers;
  - the distribution of the nominations between the various entry points of the network;
  - the usage of the flexibility services offered by the system operator;
  - the consumers' gas demand at each exit point;
  - the operating mode of the ancillary equipments by the network operator.

- The operational constraints are the boundaries set on each variable by the different parties. In particular:
  - the operator requires a number of gas properties to remain within tight boundaries at each entry point;
  - the operator requires the gas supply (at the entry points) and off-take (at the exit points) to be the same, within certain margins;
  - the consumers require a minimum gas pressure at their exit point; this pressure threshold varies from consumer to consumer;
  - the operating limits of the ancillary equipments, typically on the volume flow and thermodynamic properties.

- The contractual obligations.

Because of the dynamic elements, the transport capacity available in the network varies continuously. Making adequate assumptions about the variables is therefore necessary to estimate properly the capacity available in the network. System users have to be aware that available capacities vary as function of these determinants.

Annex 3: Network Scenario Simulation

The available capacity of a gas transport network depends on static and dynamic characteristics as well as on operational constraints and contractual obligations. The static features depend on the technical characteristics of the network itself (network architecture and physics). The dynamic elements refer to the way the network is being utilized (by the users) and operated (by the system operator). These elements vary continuously over time. The operational constraints are the boundaries set on each variable by different parties (e.g. minimum pressures).
Making appropriate assumptions about the variables is necessary to robustly and accurately estimate the capacity available in the network, i.e. the scenario used will lead to the output. This has to be done in a framework where capacity definitions are adequately specified. This calculation scheme is illustrated in Figure A3/1.

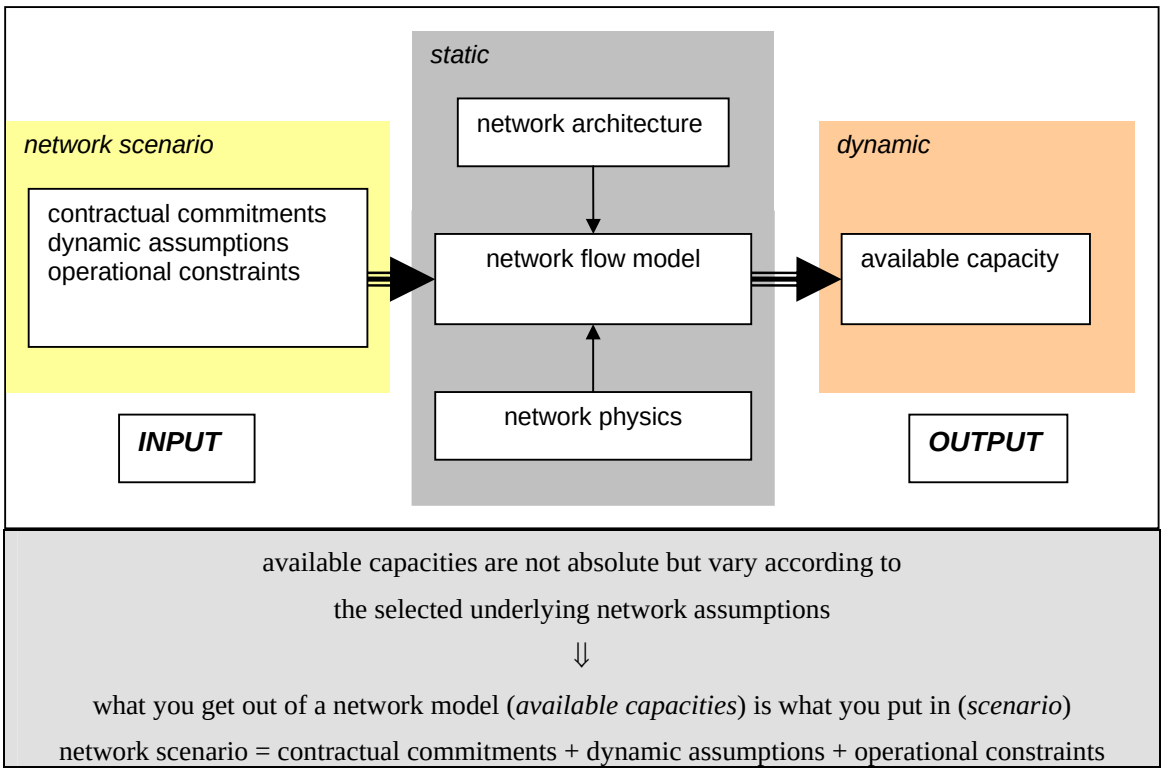

Figure A3/1 - Scheme of network scenario simulation

System operators generally have the best knowledge of the network physics and the network architecture. The physical modelling of the system is, however, not sufficient to calculate system performance. Before capacities can be calculated network models have to be fed with a large set of data and conditions related to initial and boundary conditions of the network. Many of these parameters are exogenous and they are subject to a varying degree of certainty:

- to calculate available capacity it is necessary to first estimate a network scenario and the initial step in undertaking this is to identify the contractual commitments of the TSO (e.g. booked capacities and contractual pressure specifications);

- the dynamic assumptions refer e.g. to the way the network is operated by the TSO and to the behaviour of the network users. Model forecasts and statistical analysis of historical data provide valuable information to elaborate these assumptions;
- the necessary capacity for operational needs of a TSO has to be calculated according to the requirements for the efficient operation of the transportation facilities (safeguarding system integrity) including any operating margin necessary to ensure the security and reliability of the system.

Different flow patterns and configurations lead to strongly different capacity distributions in the network. The dynamic and probabilistic nature of system simulation outcomes regarding available capacity calculation necessitates transparent calculation procedures in order to inform the market correctly about the transmission services offered. It is crucial that the calculation methods share the same minimal requirements and that any differences are understood and made clear to all parties.

The distinction between the calculation method used by the network flow model and the selected scenario is important. The calculation method has to correspond to the physics and particularities of the network and is as such not optional. On the other hand, there is much more flexibility in choice of the network assumptions to design scenarios for simulating network performance.

Depending on these choices, a whole spectrum of scenarios may be defined going from “worst-worst-case” network scenarios to less stringent scenarios and each scenario leads to a particular level of AC (see Figure A3/2).

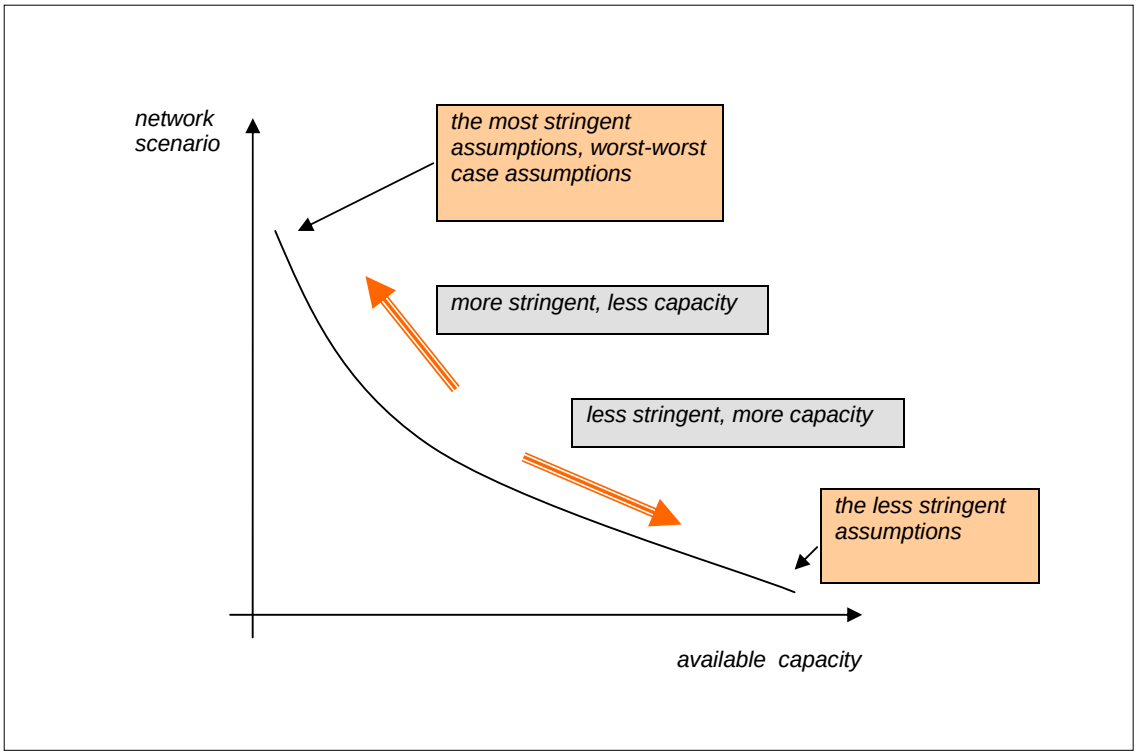

Figure A3/ 2 - The amount of AC is scenario based

There exists a trade-off between different forms of capacity, which entails a choice between allowing greater flexibility and/or reliability (and system security) and increasing the total amount of capacity that can be made available. In some circumstances TSOs may be able to increase flexibility without reducing available capacity, and vice versa, and in situations of physical congestion this may be of great importance. For example, most systems can afford to provide much greater flexibility on “normal” days than on peak flow days. It may therefore make sense to accompany capacity availability with balancing tolerances that vary over the course of the year, or that depend directly on ambient temperature (e.g allow TSOs to make more flexibility available in the summer)[5].

A TSO should provide objective evidence that its offered capacity represents a reasonable trade-off between capacity availability, flexibility and reliability. Capacity should be analysed using gas flow models that estimate the interaction between capacity availability and different degrees of flexibility, reliability and time schedules. TSOs should share these models with regulatory authorities. Further analysis concerning the trade-offs between alternative capacity forms is needed taking into account the economic rationale for balancing the benefits and costs.

[5] For instance in the Czech Republic there is a defined formula for the amount of linepack for shippers which depends on the usage of booked capacity by shippers (the lower usage, the higher the linepack))