Flowgates

An essential tool for transmission access or an irrelevant distraction?

Introduction

Within the USA and Continental Europe the use of flowgates to allocate and manage transmission congestion has been much talked about in recent months and it has been suggested that their use may be incorporated into the new transmission access arrangements being worked up for England and Wales. It is therefore worth taking a look at what they are, why some people appear to be enthusiastic about their introduction and whether they do indeed have merits for use in general and in England and Wales in particular.

What are flowgates?

Flowgates are boundaries between two parts of a transmission system across which there may be congestion i.e. a limitation in the amount of power allowed to flow across the boundary. They may cut across a number of circuits and because they "cut" across circuits they are sometimes known as cut sets. Thus in terms of the England and Wales transmission system the main system boundaries e.g. "Midlands to South, Upper North etc. etc." would be classified as flowgates. The key characteristic of a flowgate is that it has a well-defined limit of the power that can flow across it.

How are they intended to be used?

If somebody wants to transmit power from A to B the traditional "contract path" methodology employed extensively in the USA would trace a path along transmission lines between A and B and arrange with whoever owned/operated those lines for transmission, including what rights each party had if the lines became congested. There are even people/organisations/computer software that will trace several alternative paths between A and B and price each of them to find the cheapest.

Obviously the contract path approach to transmission access described above is fundamentally flawed as for a given network configuration and injection at A and withdrawal at B power flows will be independent of any contracts. Differing contractual arrangements with different transmission providers will therefore not affect any of their costs and if shopping around between them can result in different prices the charging framework can not be in any sense cost reflective. What is equally important, life is made very difficult for anybody trying to manage congestion as the transmission owner suffering it may not even have any contract with any of the parties who could take action to relieve the congestion.

Flowgates, being boundaries across which there is a defined physical transport capability, are intended to get around these shortcomings. For any two points of power injection and withdrawal, A and B, there would be a table of which flowgates that power passed through and in what proportion. Thus for example if there were

three flowgates "in series" between A and B one would have to arrange rights for 100% of the flow across each of these flowgates. If some of the power flows through parallel paths that contain a flowgate then the proportion of the power that flows through each flowgate can be calculated. This proportion is a function of the network only…it is not affected by other flows on it. Thus for a flow between A and B there would be a table of all the flowgates effected and the proportion of the flow that uses each flowgate.

Traders would purchase capacity on the flowgates according to what they required in accordance with the volume of their desired transaction and the table telling them what proportions of this volume was required for each flowgate for transactions between A and B. The primary sale of rights to transit a flowgate would be by the appropriate transmission system operators but secondary trading between market participants could take place without the involvement of the System Operator.

The same flowgates would of course be used for many different combinations of power injection and withdrawal points A and B. By however decomposing the congestion management problem into rights to cross flowgates, the volume available of which should be independent of other network flows, a framework exists in which market participants can trade rights amongst themselves in order to be able to execute whatever trades they wish. By tabulating the flowgates and proportions of the transaction volume needed of each for every combination of injection points A and B, parties can organise their transmission access themselves with a result that should be extremely close to the actual capability of the system. By trading capacity on flowgates that many parties will use there should be liquidity in the market for capacity on that flowgate and therefore efficient secondary trading should be possible.

Some observations:

1. Compatibility with non-transaction based charging

The first point to make is that the use of flowgates grew up with and is built around transaction based or point to point transmission access arrangements. Under these parties transmission access arrangements are to inject power at point A **and** withdraw it at point B i.e. to transmit it, in a notional sense at least, from A to B. No rights whatsoever are conferred by this to transmit from A to anywhere other than B or to get power to B from anywhere other than A.

Such transaction based or point to point transmission access rights are surprisingly common, particularly in markets where third party access to transmission systems is not very common and energy markets are not yet well developed. The basic problem with point to point or transaction related definitions of transmission rights is that every time the parties at A and B decide that they want to sell to or buy electricity from somebody else they have to rearrange their transmission access arrangements. This does not make it easy for liquid energy markets to emerge, particularly if the arrangements for acquiring new rights takes longer than the time in which it is desired to execute a new energy buy/sell (which may of course be a couple of seconds with electronically based markets).

A way around this is to have non-transaction based transmission contracts, i.e. ones where access arrangements are independent of who you are buying from or selling to. Such arrangements in England and Wales have taken the form of separate rights for generation and demand. Each generating station effectively pays for the right to put a certain amount of power on to the system and each demand (in England and Wales through a combination of contracts with the Distribution Company for embedded demand and the Supplier of that demand), pays for a right to extract power. These arrangements are completely independent of who is selling energy to whom. Of course currently almost all electricity in England and Wales is traded physically through the Pooling and Settlement Agreement but there is no reason why the basic framework should not continue under the more bilateral trading world of NETA.

So could flowgates be used with a "transaction independent point of access" system like the UK's or would their use demand a change to transaction related charging? The answer is that one can use flowgates with non-transaction based access arrangements by defining the access for generators as the right to transport power from wherever they are to a fixed location where energy was traded, a "national balancing point" in gas market parlance. Demand would purchase rights defined in terms of transporting power from this "National Balancing Point" to wherever it was located. The journey to or from the NBP would make use of a number of flowgates, depending on the location of the generation or demand. It is thus quite possible, by fixing a location or hub for energy trading, to utilise the flowgate concept and still maintain transaction independent access arrangements.

2. Is there a snag?

Generally parties buying and selling electricity want to be able want to be able to trade with as wide a choice of counter-party as easily as possible. Hence transaction based arrangements for transmission access should be avoided. What however a generator wants is to be able to sell is a defined amount from his facility to a selection of possible customers. A customer wants to be able to purchase his demand from a selection of generators. To avoid complicating the issue traders without physical generation or demand will be ignored.

Parties are not primarily concerned with how their power gets from A to B (or to or from the NBP in a notional sense). They are merely concerned with whether they can generate or take the demand they want to and if not whether they are due any compensation. Buying rights to capacity on flowgates is therefore an additional complication that they have no primary wish to indulge in.

If they could buy one set of flowgate rights to get to the NBP and these would always be able to achieve precisely that then there would be no great disadvantage over having bought a right explicitly to do that in the first place. Unfortunately the precise set of flowgate rights needed to get from a location to the NBP (or any other point if you want to work in a point to point paradigm) will not remain constant for two reasons.

Firstly, with the exception of flowgates that are strictly in series, the proportion of power going through any flowgate will vary with the network topology and in most networks this topology does vary more frequently, if for no other reasons than line

outages, than is sometimes realised. The use of phase shifting devices to maximise the use of valuable transmission capacity gives rise to a further variation in the way power flows are shared between circuits. It could be argued that one could overcome this by having a larger number of flowgates, in the extreme having each line as a separate one. Ignoring the complexity, this would not work anyway.

One can not define a secure capacity of a single circuit. One can define the capacity of the circuit, but that is of no use as a figure, as all power systems are operated to some sort of security standard (commonly known as n-1 or n-2) such that (amongst other things) following a contingency outage none of the remaining circuits is overloaded. By definition for a flowgate to have a secure transmission capability i.e. something worth buying and selling parts of, it must comprise a group of more than one circuits.

Secondly whilst analysis of thermal overload limits can often be decomposed into a set of limits across certain circuits independently of actual plant running, more complex limits relating to voltage and in particular stability related constraints are always critically sensitive to whether particular plant is running or not. The use of flowgates does nothing to divorce capabilities from what plant happens to be running in these cases.

Thus it is impossible to define many stability and voltage related limits in terms of flowgates and having rights to transit a flowgate is of limited value anyway if the system operator can at short notice change the quantity of rights you need over various flowgates in order to achieve what you really want to do, for example to transport power to or from the NBP.

In other words although rights over flowgates can be created and traded what use are they if the rights you really need can be changed by a third party without notice? If the system operator is not allowed to make these changes whenever necessary then flowgates can not be used for managing accurately even thermal constraints.

Reflection

People who believed that the moon was made of green cheese had to do some rethinking in 1969 when man first landed there. They either had to change this belief or come up with a radically new type of cheese. Parties who continue to think in terms of contract path transmission likewise need concepts such as flowgates to keep in some sort of contact with the real world. Flowgates can be used within a non-transaction related transmission access paradigm, but they do not, on their own, deal with more complex i.e. non-thermal limits very well. In addition, although flows across them can be traded independently of the system operator, this is of limited use if the combination of rights that one needs can be altered by the system operator.

The aim of allowing parties to undertake secondary trading of transmission rights as far as possible independently of the system operator is a worthy one. It is however no advance trading flowgate rights in this manner to be foiled by the combination of rights one needs being altered. Modern communication and particularly internet based technology allows many parties to have access to information about the actual conditions on the system and methods can be devised of using this information to

allow them to trade transmission rights, independently of the system operator if desired, that are of real value to them. It is down this path that people should be working, rather than devoting much effort a paradigm that, in the final analysis, is based on the continued belief that the moon is made of green cheese.