



Available Flowgate Capability and the AFC Methodology

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What is a flowgate?

- **Flowgate** – A single transmission element or group of transmission elements, which may include an associated contingency(ies), that is intended to model MW flow impact relating to transmission limitations and transmission service usage.
- For example, a flowgate can be the Bull Run-Volunteer 500 kV line for the loss of the Watts Bar-Volunteer 500 kV line or it can be the Blue Lick 345/161 kV transformer
 - **Clifty Creek-Northside 138 kV**
 - **Newtonville – Cloverport 138 kV (flo) Coleman-Nat. Aluminum 161 kV**
 - **Volunteer – N. Knox 161kV (flo) Bull Run – Volunteer 500kV and Watts Bar – Volunteer 500kV**

Why use flowgates?

- You could monitor every one of the 960 transmission elements in E.ON's system but...
 - Time consuming, studies take too long
 - No easy way to exchange all that data
- Flowgates overcome these problems by only monitoring elements that would overload first in a certain area or for certain transfers.
 - **Coordination:** This allows you to exchange the loading of the flowgate elements with your neighbors.
 - **Calculation Speed:** Complete an AC study much faster allowing you to complete more studies.
 - **Accuracy:** Using flowgates, in a flow-based analysis, you can account for the actual flows of a transfer instead of path approximations

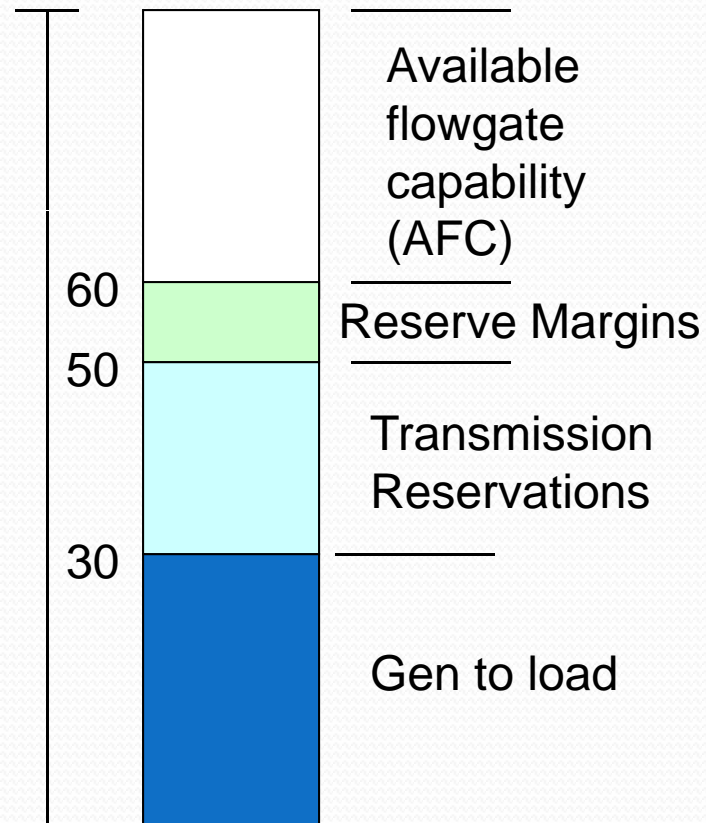
Potential issues with flowgates

- Only reliable if the flowgate definitions are up to date.
- Not everyone uses flowgates in their transmission service process yet, making it difficult to exchange the data.
- Can be hard to understand to people who don't use flowgates.
 - AFCs not as intuitive as ATCs



How do flowgates work?

Flowgate Rating – 100 MW

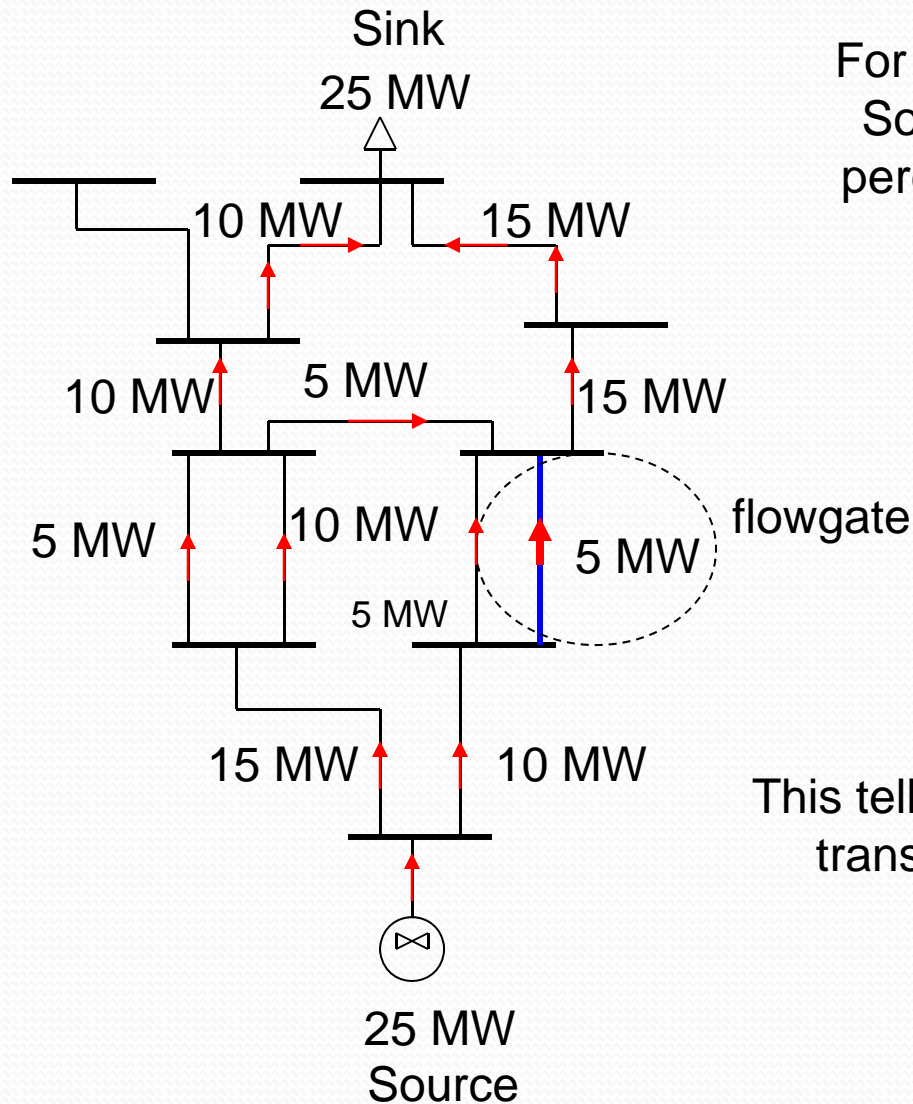


Reserve Margins

- There are two types of Reserve Margins used in transfer capability analysis
 - These reserve margins are used in order to maintain reliability on the transmission system
- **TRM – Transmission Reliability Margin**
 - Used to account for uncertainty on the transmission system
 - Also used to set aside capability for reserve sharing groups
- **CBM – Capacity Benefit Margin**
 - Used to reserve capacity in order to import for emergency generation deficiencies



Small Scale Example



For a 25 MW transfer from Source to Sink a certain percentage flows over the flowgate

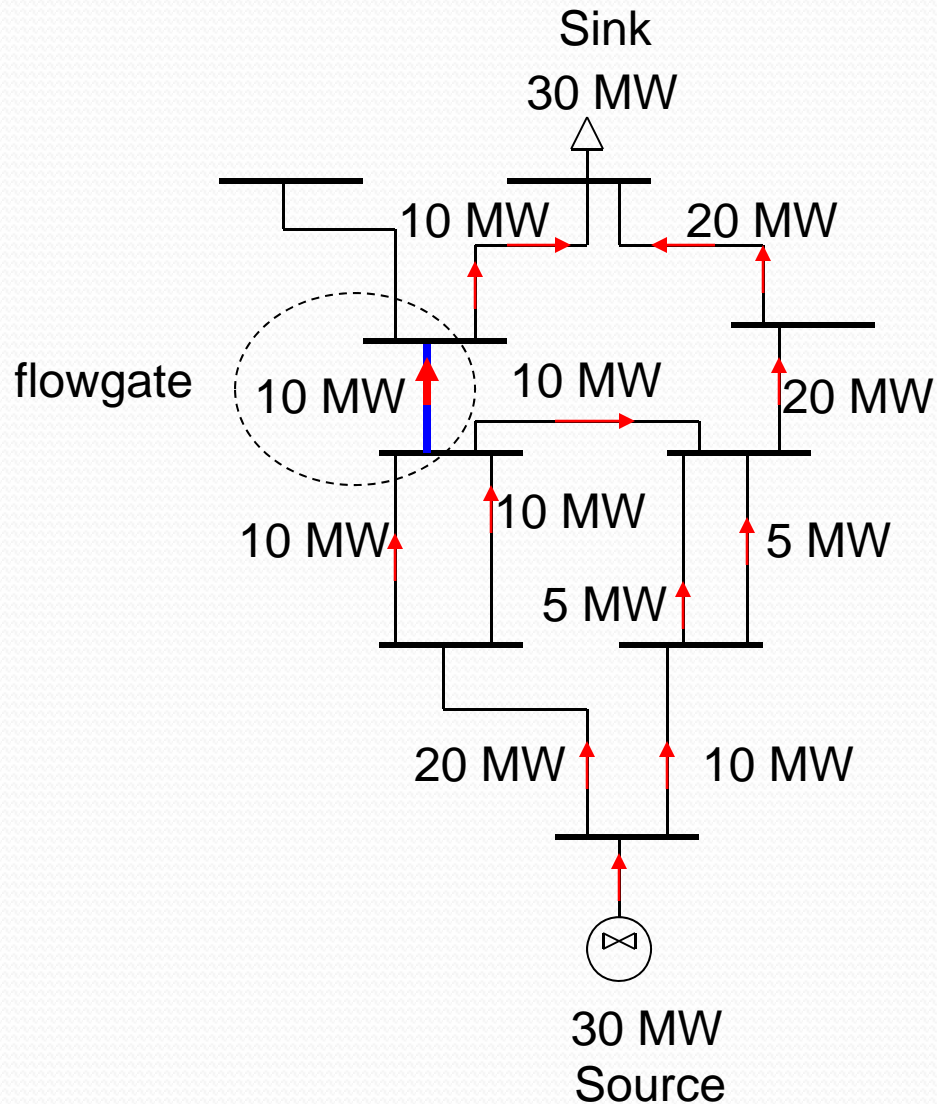
Transfer Distribution Factor (TDF)

$$5/25 = .20 = 20\%$$

This tells us how much impact a transfer has on a flowgate



Small Scale Example



Transfer = 30 MW

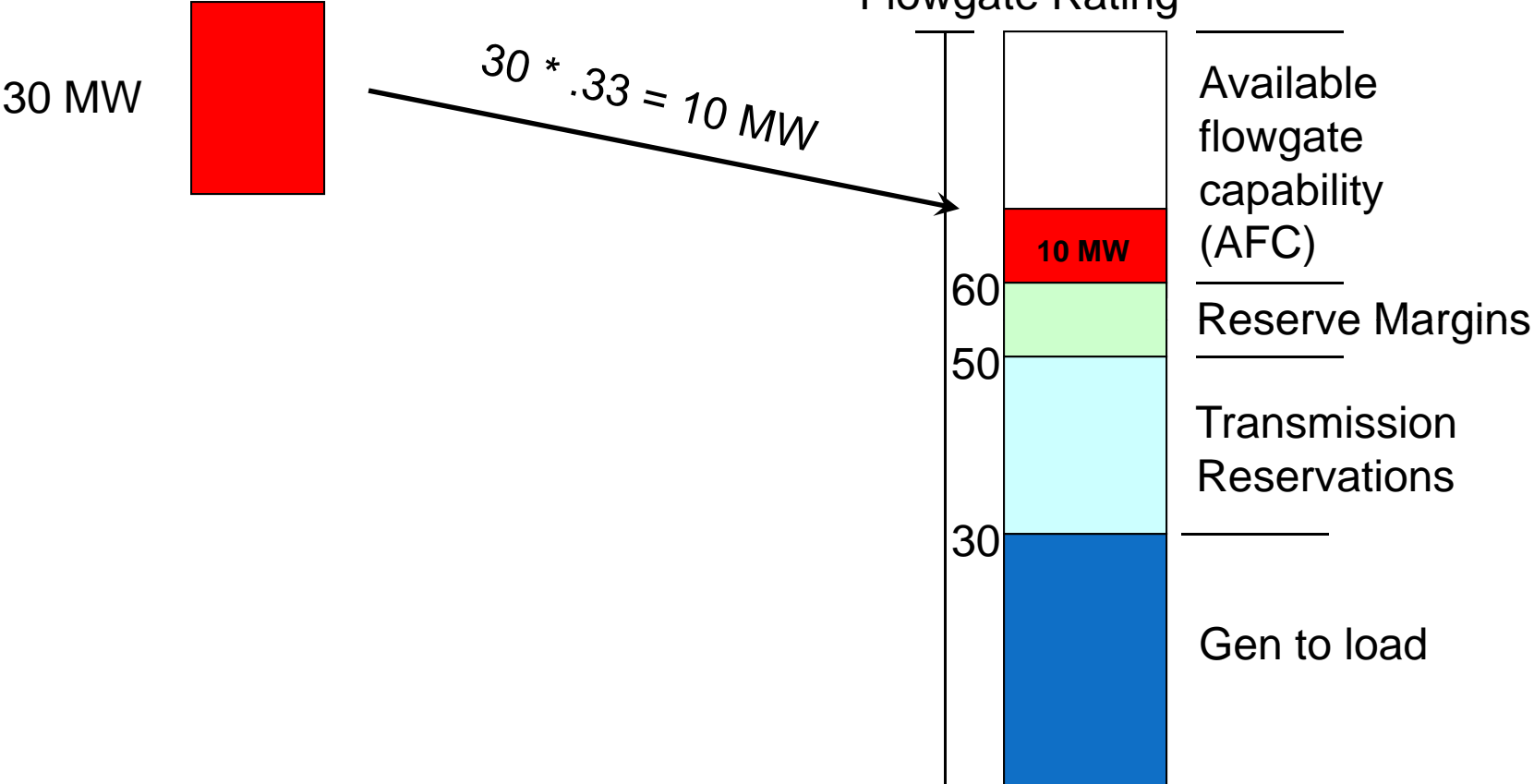
Flowgate Impact = 10 MW

Transfer Distribution Factor:

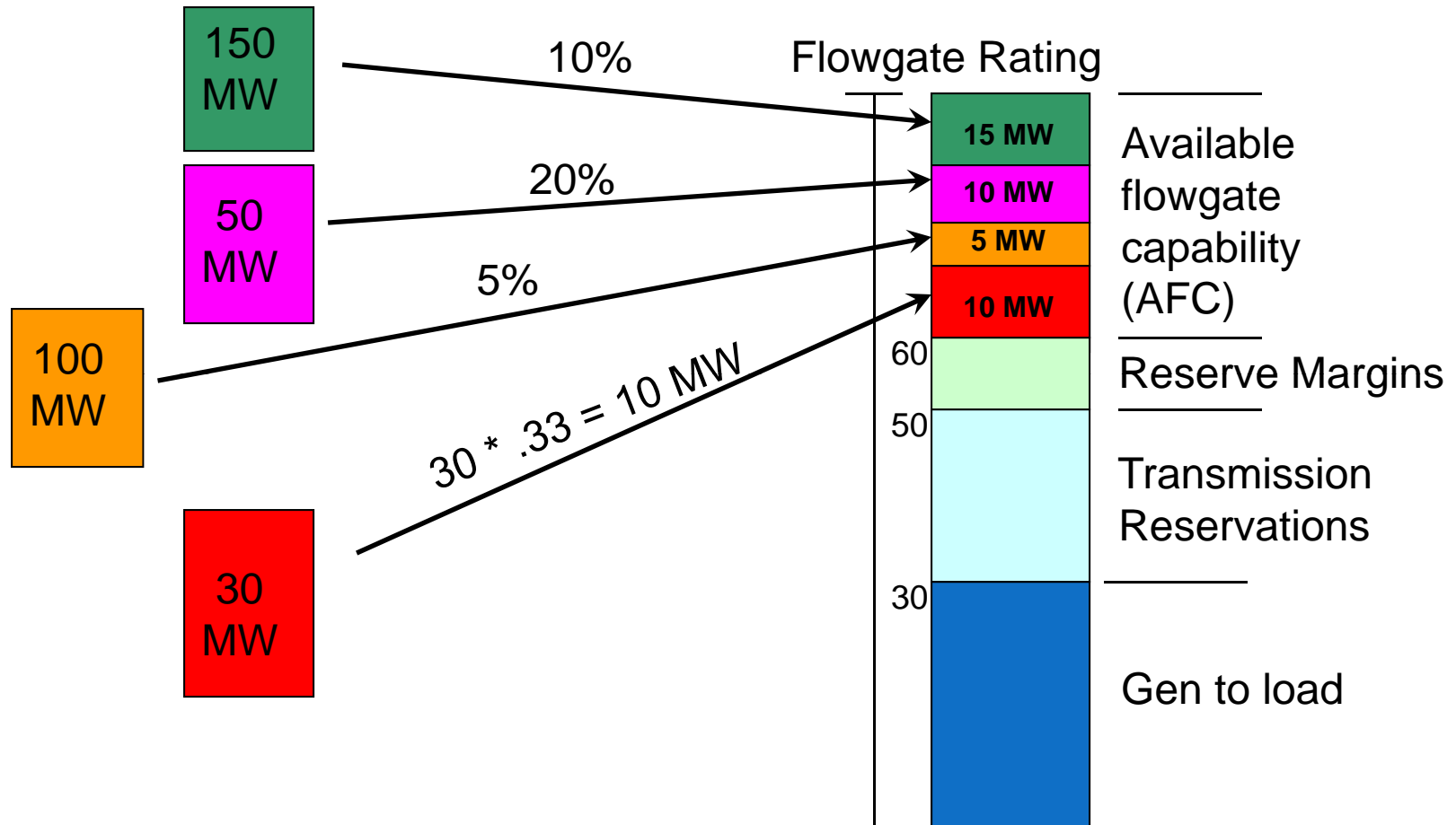
$TDF = \text{Impact MW} / \text{Transfer MW}$

$$10/30 = .33 = 33\%$$

Transfer amount X TDF = Effect on flowgate



Transfer amount X TDF = Effect on flowgate



$$\text{AFC} = \text{Rating} - \text{GTL} - \text{Transmission Reservations} - \text{Reserve Margins}$$

$$\text{New AFC} = \text{Previous AFC} - \text{Transfer Amount} * \text{TDF}$$

$$= 100 - 30 - 20 - 10 - 10 - 5 - 10 - 15 = 0 \text{ MW}$$

AFC → ATC

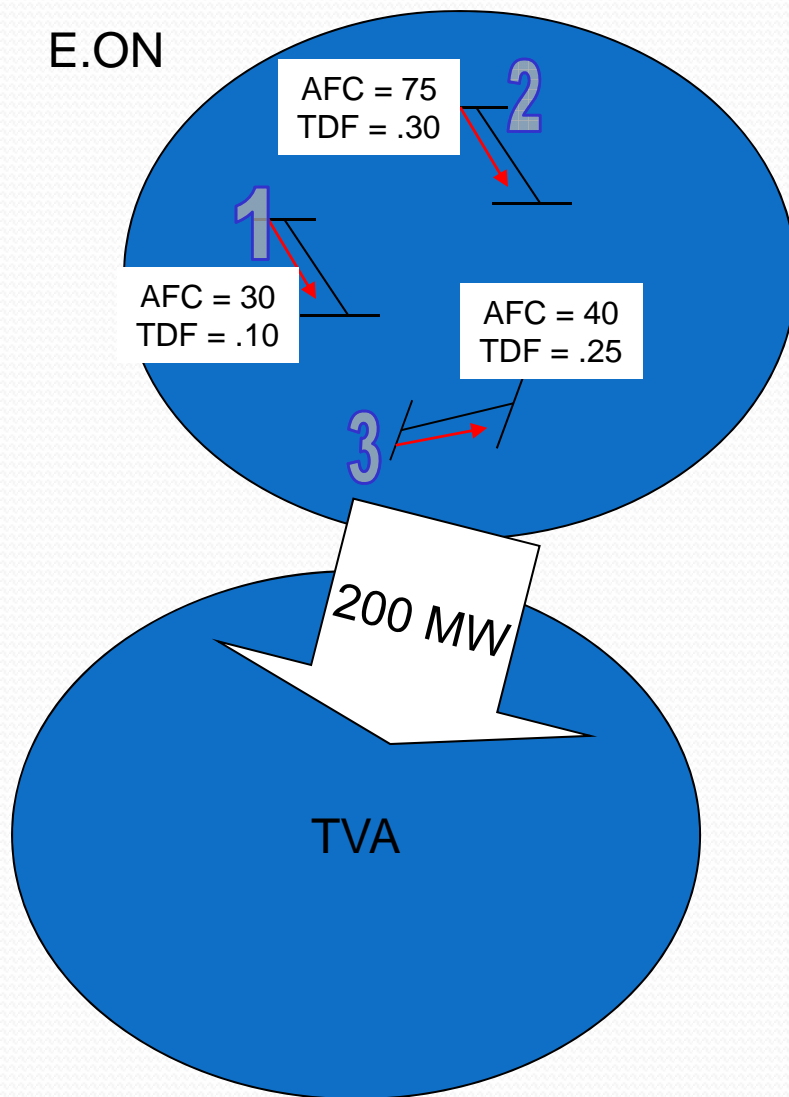
- ATC – Available Transfer Capability from a specified source to a specified sink
- **Min** $[AFC_{\text{flowgate}}/TDF_{\text{flowgate}}] = ATC$
 - for all flowgates with a TDF greater than the cutoff

Flowgate Impact Threshold

Cut-off

- A cut-off of 5% is normally used for PTDF flowgates
- A cut-off of 3% is normally used for OTDF flowgates
- Energy doesn't just flow over "path of least resistance" it flows over all paths from source to sink.
 - Models are only so accurate
 - Source and sink identification is best guess
 - Without a threshold one limit could limit all transfers across an area
- TRM is used to keep those that fall below the radar from being oversold

Limiting Flowgate



For a 200 MW transfer from TVA to SOCO, which flowgate would be the limiting element?

1. Impact = $200 * .10 = 20$ MW
2. Impact = $200 * .30 = 60$ MW
3. Impact = $200 * .25 = 50$ MW

For this transfer path, flowgate #3 would limit the available transfer capability.

Contract Path – Sched Limit

- Contract path is the capability of the ties between two entities
- It is **not** the amount of power you can reliably transfer from one area to the other
- Most of the time you could reliably transfer more than the contract path amount
 - This is because energy flows over all paths and not just the source/sink path
- Contract path came about through the contracts signed during tie line projects. It grew into an agreement among entities not to transfer to an area more than your tie lines capabilities.

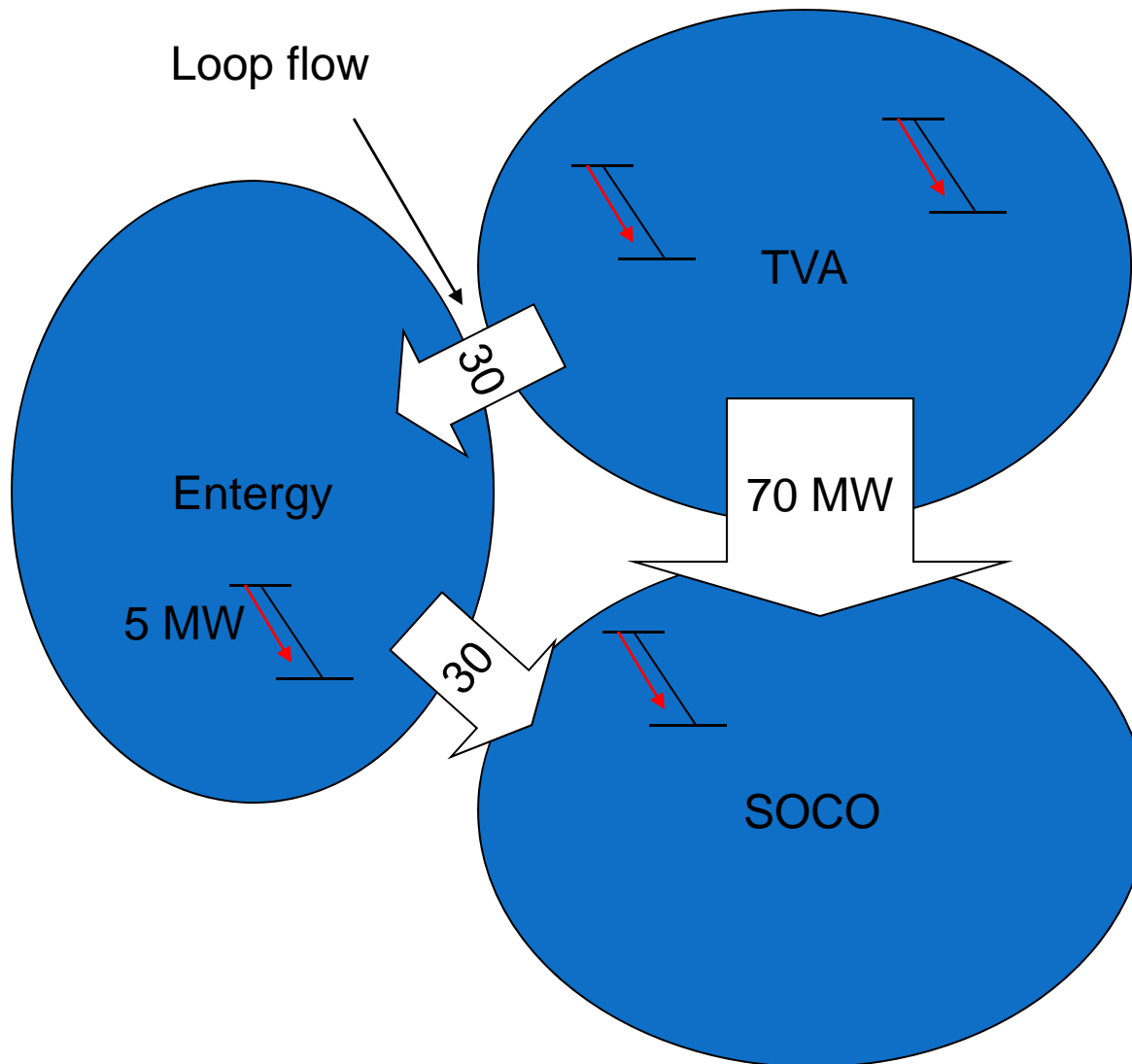
One more layer of complexity

- In order to monitor and manage area flow interaction the Congestion Management Process was formed
- Each entity in the CMP gets allocation on each applicable flowgate
 - Allocation keeps the markets from causing too much loop flow on the non-market entities
 - Doesn't limit many transactions because entities are allowed to borrow allocation

Coordination and AFC Overrides

- Coordination of transfer capability keeps an entity from selling transfer capability that would cause an overload on another system.
 - These flows are called loopflows.
- One of the advantages of using AFCs is the ability to easily coordinate with other entities that use AFC.
- It allows an entity to coordinate how much transfer capability is left on their transmission system, merely by exchanging AFCs.
- E.ON presently exchanges AFCs with PJM, MISO and SPP, BREC, EKPC, TVA.
- The Congestion Management Process details the process for coordinating data for the calculation of ATC.

Larger Scale 100 MW transfer



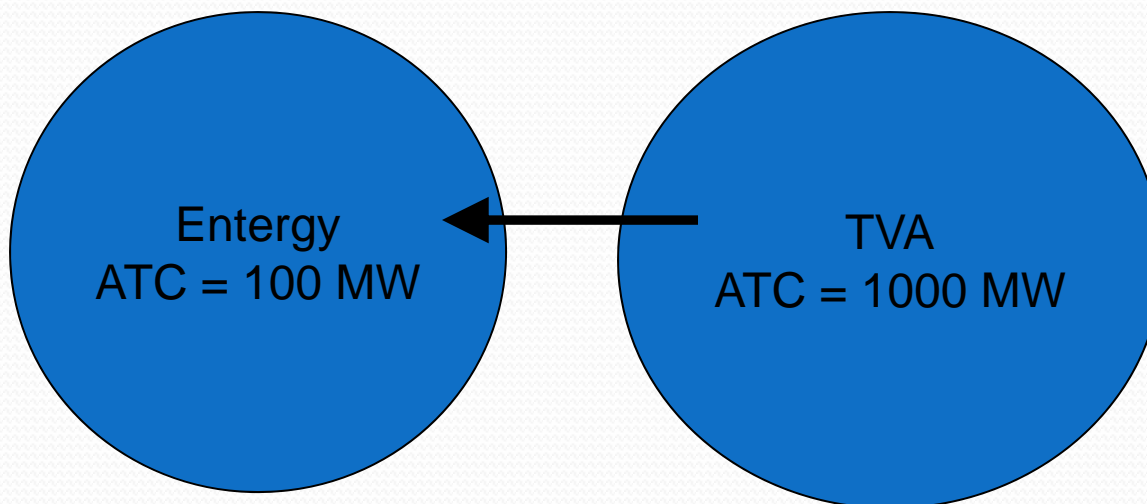
For a 100 MW transfer from TVA to SOCO, 70 MW may flow directly to SOCO while 30 MW flows through Entergy

$$\text{TDF} = 5/100 = .05 = 5\%$$

It is important we know how much AFC is available on Entergy's flowgates

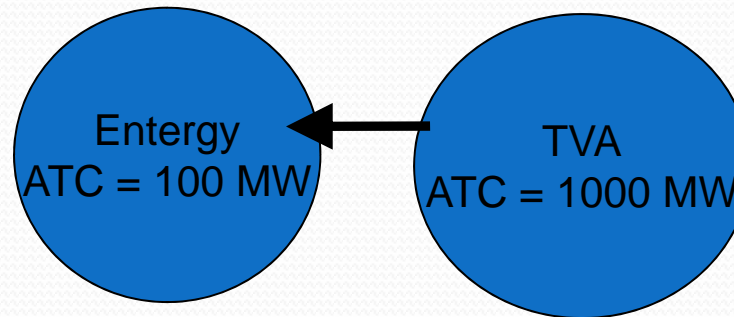
Frequently Asked Question

- Why isn't the ATC the same on a path on for both entities on that path?



For example, TVA to Entergy can be 1000 MWs on TVA's OASIS, yet only 100 MWs on Entergy's OASIS. How is this possible?

FAQ - Answer



1. On the path logic
2. Different source/sink definitions
3. One honoring a flowgate the other is not
4. Partial Path Reservations
5. Reservation Screening Logic
 - Accepted vs. Study

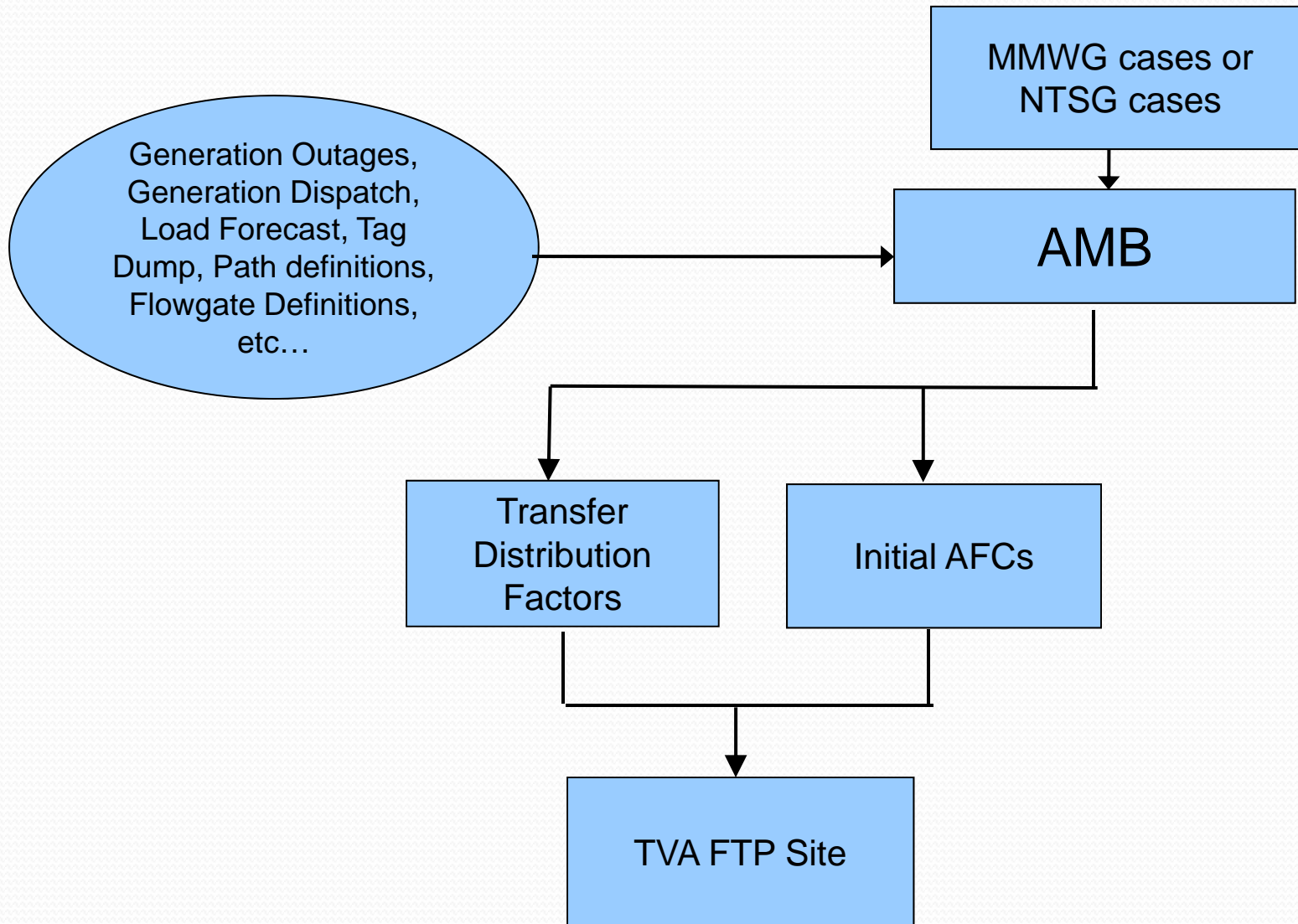


AFCs at TVA

- In order to calculate AFCs you need to start with transmission models and TVA builds a lot of them...
- **48** – Next 48 hourly cases every hour
- **146** – hourly cases four times a day
- **35** – daily cases four times a day
- **18** – monthly cases once a day
- That's almost 1900 cases a day!



AMB – Automated Model Builder



The ATC equation

- AFC are derived from the flowgate rating.
- $AFC = \text{flowgate rating} - \text{base case flow impacts} - \text{TRM} - \text{CBM} - \text{Existing Transmission Commitments (ETC)}$ impacts.
TVA's Part
- $ATC = \text{Most limiting (AFC / Associated TDF)}$

Any Questions?