Conformity assessment process

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24 October 2023

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Evolution in modelling for conformity assessment

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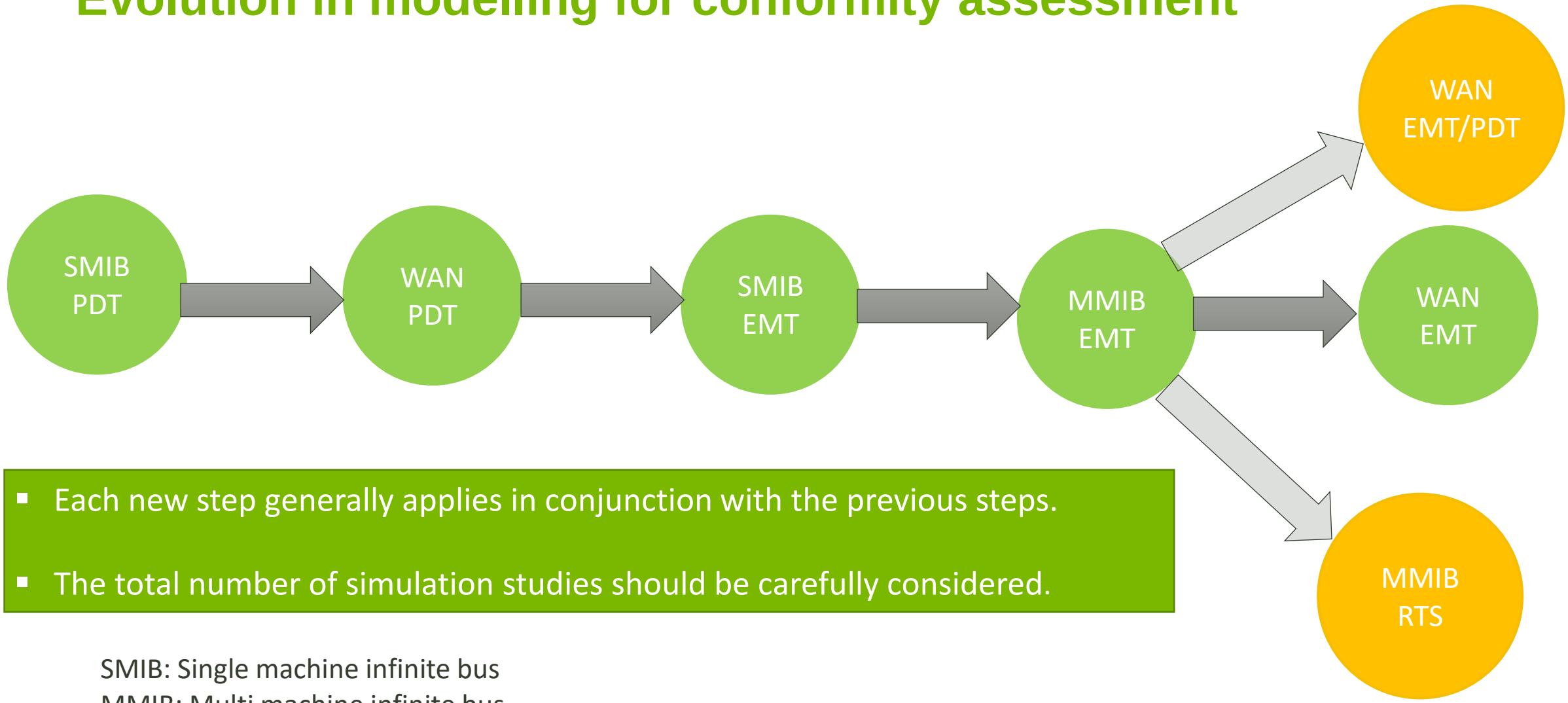
Evolution in modelling for conformity assessment



- Each new step generally applies in conjunction with the previous steps.
- The total number of simulation studies should be carefully considered.

SMIB: Single machine infinite bus
MMIB: Multi machine infinite bus
WAN: Wide-area network
PDT: phasor-domain transients (aka RMS or positive-sequence in North America)
EMT: Electromagnetic transients
RTS: Real-time simulation

Extent of the network modelled

SMIB

- Remain the very first step of conformity assessment in all regions.
- Required for both EMT and PDT models.
- Neither can correctly account for dynamics associated with other plants.
- Determining the equivalent impedance for each IBR is a non-trivial task.

MMIB

- Added value of MMIB is primarily for EMT modelling.
- Use cases include both offline EMT and hardware-in-the-loop simulation with RTS tools.
- The latter pursued by InterOPERA for multi-vendor HVDC and offshore wind farms.
- More accurate inclusion of dynamics of nearby IBRs but not those of the power system.

WAN

- WAN model accounts for both the dynamics of nearby IBRs and the wider power system.
- Provision of WAN PDT models is already possible in some countries such as Australia.
- Provision of WAN EMT models useful for all parties remains a key challenge.

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Conformity assessment in Australia

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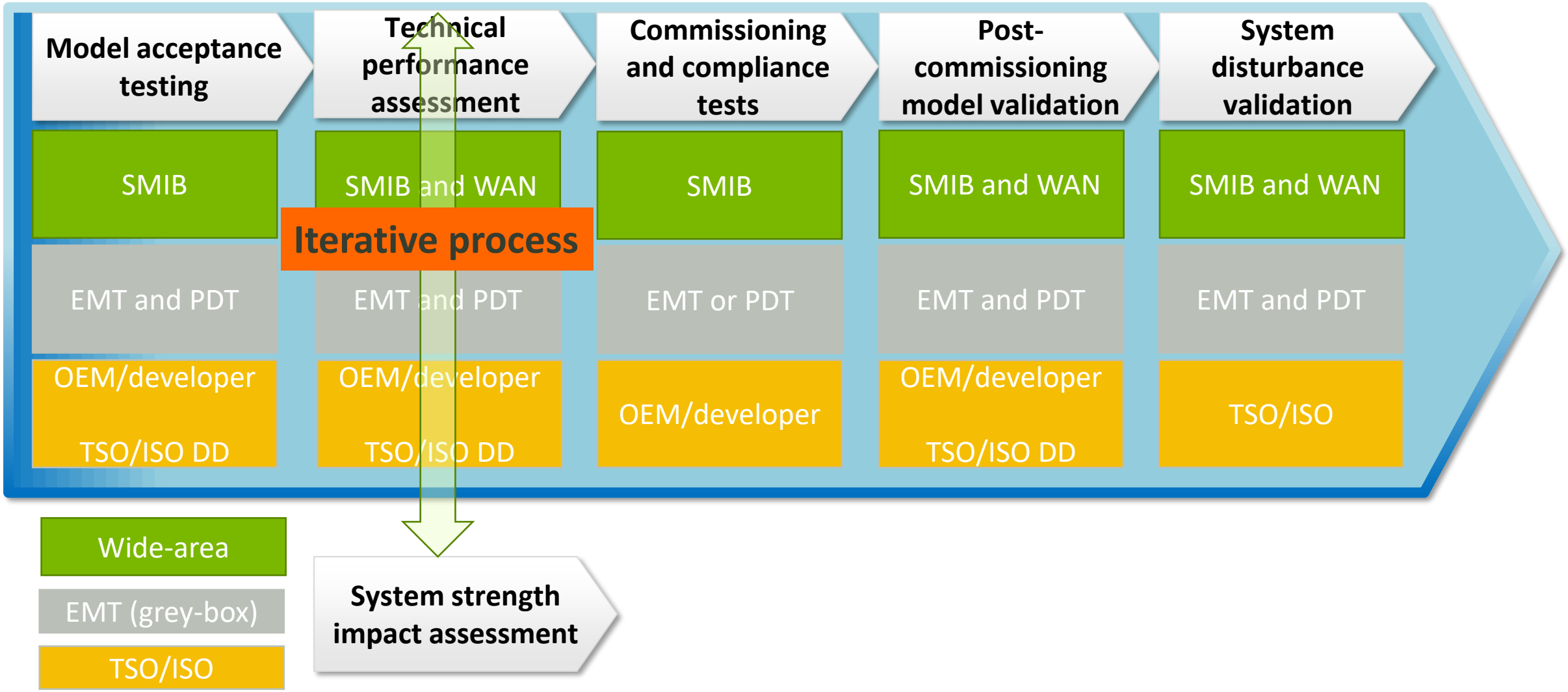
Current process in Australia's National Electricty Market (NEM)



Modelling challenges for conformity assessment (1)

Legend
- Most challenging
- Least challenging

	As Is	Likely future practice	Challenges
Extent of the system modelled	**IBR under consideration** + **Wider power system** including cross-region plants with a likely impact (developer with PDT, network owner with PDT and EMT)		3 Determining the boundaries of WAN EMT model 2 WAN EMT model development skills gaps, in particular forward-looking models 2 Lack of adequate screening methods to reduce the number of studies or size of the system
Modelling tools for connection studies	**PDT and EMT** + **Other tools such as small-signal stability, etc.** ?		2 Access of all parties to the same source of truth 2 EMT or even PDT tools cannot efficiently determine the stability margin

Modelling challenges for conformity assessment (2)

	As Is	Likely future practice	Challenges
Interaction with other nearby IBRs	**Considered** by <u>including dynamic models</u> of all such IBRs (generally both PDT and EMT models)		1 The criteria for collective and concurrent performance assessment of IBRs has not been determined

Legal and regulatory challenges for conformity assessment (1)

	As Is	Likely future practice	Challenges
Responsibility for grid connection studies	**Developer (SMIB PDT and EMT, WAN PDT)**	**Network owner will often need to undertake systm strength impact assessment or stability assessment using WAN EMT models**	1 Access of responsible party to WAN EMT models 2 Time taken for PDT and EMT SMIB and WAN studies
Access to PDT and EMT models of other plants	**All registered participants have access to encrypted WAN PDT models**	**Access to Connection Simulation Tool (CST) (a block-box WAN EMT model)**	1 CST does not provide access to outside the connection point, nor includes models of non-committed generation.

Legal and regulatory challenges for conformity assessment (2)

Solution to address instabilities

As Is	Likely future practice	Challenges
• Control system Tuning of one IBR • Network owner to install devices and request IBRs to pay system strength charges (SSC) • IBR to install SynCon or GFM BESS	• Coordinated control system Tuning of multiple IBRs • The rest remains the same	1 OEMs need to use WAN EMT models if control system tuning is needed. 2 IBR owners concern that the SSC may be excessive and is not necessarily correlated with fixing a real instability

Challenges on how to consider the future power system for conformity assessment (1)

	As Is	Likely future practice	Challenges
Ongoing performance assessment and validation	When there is evidence of non-compliance or after major system events, also occasionally staged system testing is conducted + Routine testing are required every 3-5 years but not exercised rigorously Studies, model validation and testing in regular intervals, e.g., every three year		2 Network owners' and AEMO's ability to request connected IBRs to adjust their settings if they are compliant. 2 AEMO and network owner to ensure that the models provided will remain valid during plant's lifetime
Reference year for connection studies	Current power system with all connected and committed generation + For several future years		2 The need for WAN EMT model development for all those reference years

Challenges on how to consider the future power system for conformity assessment (2)

	As Is	Likely future practice	Challenges
Access of each new IBR to system strength available in the future	Set out in AEMO's System Strength Impact Assessment Guidelines		2 WAN EMT models are used, however, they are not truly forward-looking 2 Treatment of grid-forming (GFM) inverters
Future network and generation changes	All connected and committed network and generation projects, but largely based on current power system models	Considered With forward-looking PDT and EMT models of network, future generation including emerging technologies, e.g. GFM	2 The need for WAN EMT model development for future years 2 Whether to use generic or vendor-specific models for future plants

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Conformity assessment in North America

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Modelling challenges for conformity assessment (1)

	As Is	Likely future practice	Challenges
Extent of the system modelled	**Wider power system** including cross-region plants with a likely impact **(PDT)**	**IBR under consideration** + **Wider power system** including cross-region plants with a likely impact **(EMT)** ?	2 Determining the boundaries of WAN EMT model 1 WAN EMT model development skills gaps
Modelling tools for connection studies	**PDT** (with exception of some regions such as ERCOT who use EMT modelling as well) + **EMT**		2 Many grid connections have required transmission system upgrade using PDT modelling. It is unknown if PDT can predict emerging instabilities. 1 Skills gap in EMT studies

Modelling challenges for conformity assessment (2)

	As Is	Likely future practice	Challenges
Interaction with other nearby IBRs	**Not Considered** PDT dynamic models of IBRs maybe included, however, they may not be sufficient for this purpose.	? **Considered** by including dynamic models of all such IBRs in EMT	1 The criteria for readiness of a project to proceed to the studies stage, and collective dynamic modelling of IBRs shall be determined

Legal and regulatory challenges for conformity assessment (1)

	As Is	Likely future practice	Challenges
Responsiblity for grid connection studies	RTO/ISO	+ Increased Involvement from the developer	1 Access of all parties involved to WAN EMT and PDT models
Access to PDT and EMT models of other plants	RTO/ISO only	+ Developer (directly or via authorised 3rd party)	1 Currently no requirements for the OEMs to provide EMT models to other parties
Performance specifications	Very few detailed capability and performance specifications	Comprehensive and detailed capability and performance specifications	2 Timely adoption of IEEE minimum standards to avoid buildup of legacy IBR requiring retrofits

Legal and regulatory challenges for conformity assessment (2)

Solution to address instabilities

As Is	Likely future practice	Challenges
• **RTO/ISO to install the devices** (only SynCons so far) • **Restrict** IBR operation	• **Control system Tuning of one or more IBRs** • **RTO/ISO to install SynCons or other network reinformenet** • **IBR to install GFM BESS or SynCon** • **Retrofit of existing assets**	1 Need for OEMs to use wide-area EMT models if control system tuning is needed. 2 Responsibility for installing the solution and cost sharing, in particular when existing assets are involved 1 Models provided can change significantly during the connection process, hence the remediation needed

Challenges on how to consider the future power system for conformity assessment (1)

	As Is	Likely future practice	Challenges
Ongoing performance assessment and validation	**When there is evidence of non-compliance or after major system events**	**likely regular intervals checks** (e.g., every three years) ?	1 RTO/ISO ability to request connected generators to adjust their settings 1 RTO/ISO to ensure that the models provided will remain valid during the lifetime of the installation
Reference year for connection studies	**Anticipated IBR commissioning year**	**For several future years** ?	2 The need for wide-area EMT model development for all those reference years

Challenges on how to consider the future power system for conformity assessment (2)

	As Is	Likely future practice	Challenges
Access of each new IBR to system strength available in the future	**No defined methodology**	**Likely based on SCR calculation methods ?**	2 Any detailed methodology will rely on WAN EMT models which do not currently exist
Future network and generation changes	**Not adeqautely considered** from a dynamic response perspective (PDT generic models of prospective plant are sometimes included)	**?** **Considered With forward-looking PDT and EMT models of network and emerging technologies, e.g. GFM**	2 The need for WAN EMT model development for future years 2 Whether to use generic or vendor-specific models for future plants

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Additional slide

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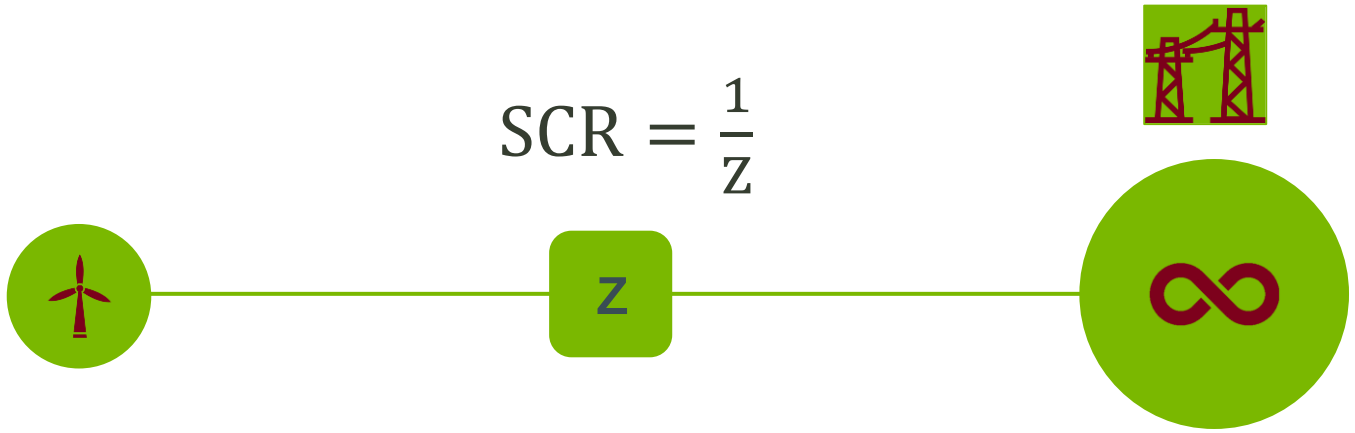
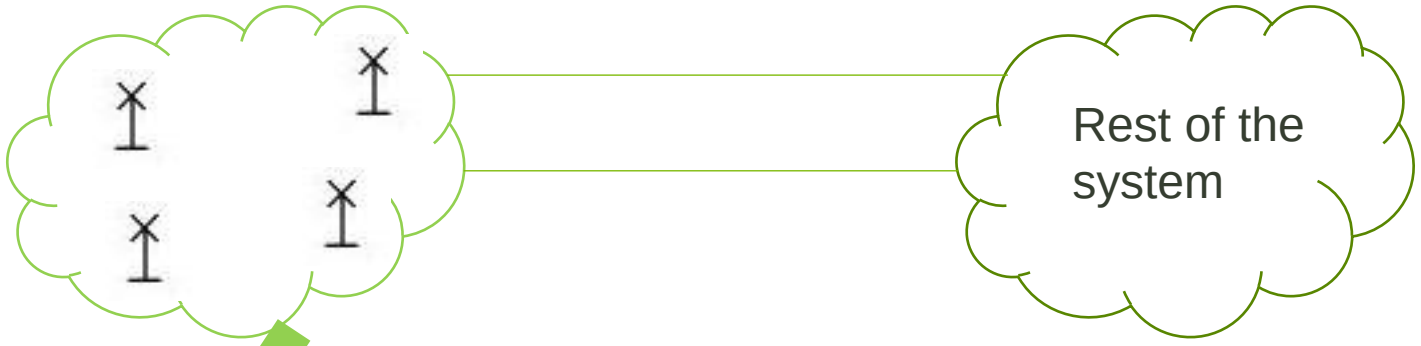
SMIB representation

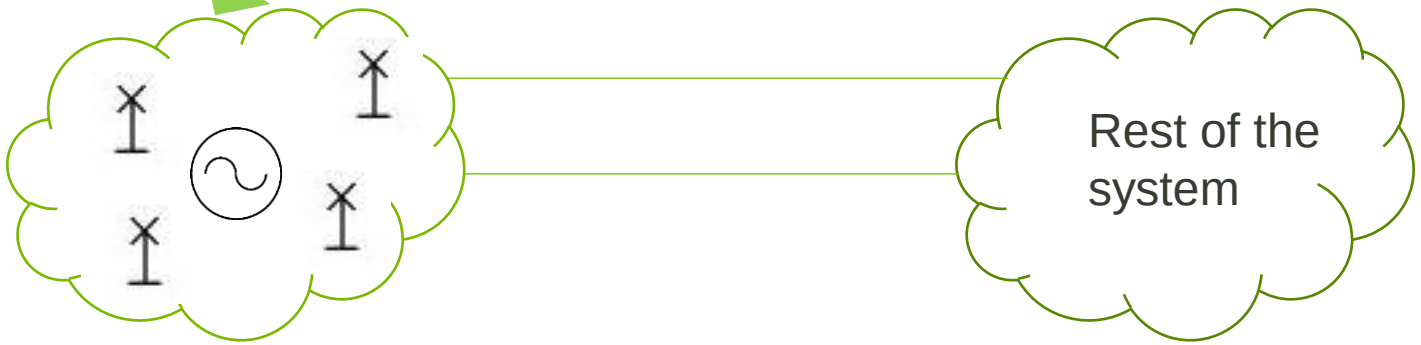
$$SCR = \frac{1}{Z}$$



Currently only fundamental frequency impedance is considered.



- Aggregate SCR calculation methods such as CSCR, ESCR, MIESCR and WSCR are developed with this situation in mind.



- Sometimes connections can be far more complex than a radial connection.
- ESCR and MIESCR may be more adaptable, also on deciding where to stop, i.e. boundary buses.