

Constraint Modelling in RCUC

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Presentation overview

- **Some background issues - system security**

- **Contingency criterion**

- **RCUC TCG's**

- **TCG limits**

- **Sample of constraints**

- **Review**

Some background – system security

- **Price Waterhouse Coopers poll:**
- **148 utilities in 47 countries**
- **Security of supply is the biggest worry**
- **91 % of European utilities believe blackouts will become a regular occurrence**
- **Our aim is not to be one of this 91%**
- **6 blackouts in 6 weeks affecting 112 million people in 5 countries**
- **Worst in Europe was whole of Italy except Sardinia 57 M people. Restoration time 4 hours**

Blackout issues

- **All blackouts were transmission based**
- **No problems with generation adequacy**
- **Systems were not stressed prior to blackouts**
- **Cross-border trades**
- **Reports published but systemic reasons not explained**

Overview of issues

- **It is not possible to prevent an occasional localised blackout but the trick is to prevent them from spreading**

- **To do this we carryout studies to consider**
 - Thermal stability
 - Voltage stability
 - Dynamic stability

- **In these studies we consider different contingency criterion**

Contingency criterion

- **As prudent system operators we consider many different contingency criteria**

- **In state N when all elements of the system are in normal operation, operating conditions are in accordance with rules (generally tested for different states)**

- **We then consider different incident's such as**
 - N-1 the disconnection of one item of item of plant or equipment
 - N-D the loss of a double circuit (perhaps a lightning strike)
 - N-M-1 the loss of item of plant whilst another is out for maintenance

- **The nominal operating point and the system should stay within the rules for any of the above incident's**

RCUC

- **RCUC run commits generating units in order to meet the varying demand for electricity**

- **RCUC is constrained in two areas as part of the sequence**
 - System balance: output of units =demand (considering reserve)
 - Unit constraints: e.g. Min up/down times, MSG, ramp rates etc

- **RCUC then has additional constraints put on it by the TSO's called a Transmission Constraint group (TCG)**

- **It is via these TCG's that we model the results of our system studies**

- **RCUC has three TCG types**

TCG Details

- **MW: TCG applies a limit to the total MW output from a unit or group of units**

$$GMN_a(t) \leq \sum_{i \in a} G_i(t) \leq GMX_a(t)$$

- **MWR: Inter-area constraints between SONI and EirGrid (North South flow) including reserve**

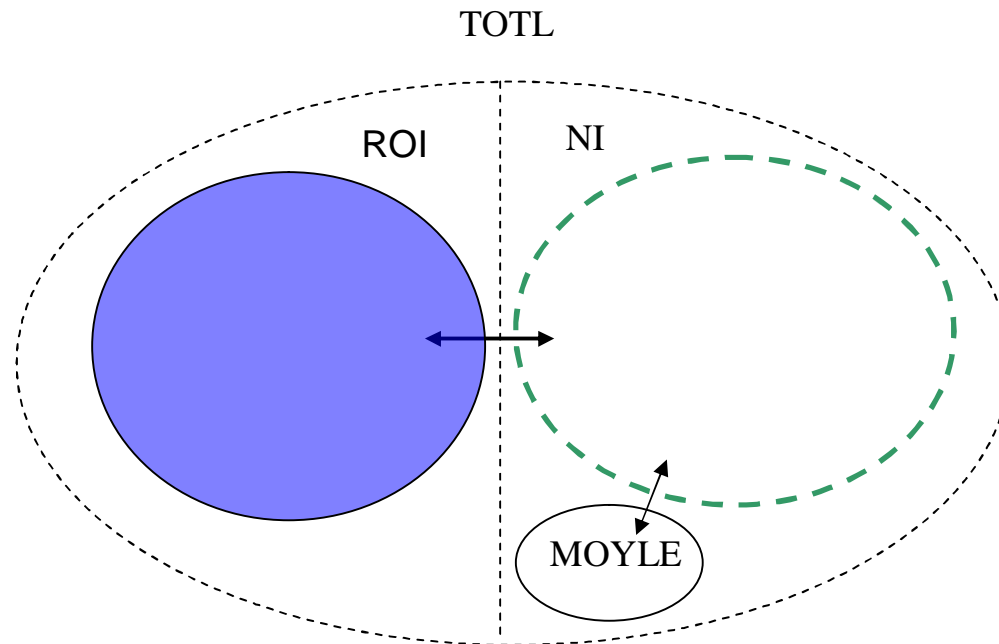
$$\sum_{i \in a} G_i(t) + \sum_{i \in a} R_{i1}(t) - L_a(t) \leq EXP_a(t) - \Delta$$

- **NB :Limits on the number of units online in an area**

$$UMN_a(t) \leq \sum_{i \in a} U_i(t) \leq UMX_a(t)$$

TCG's

- RCUC has certain set TCG's
- ROI contains all EirGrid units and is used for the MWR TCG, which is used to control the flow S-N
- NI contains all the SONI units (including Moyle) and is used for the MWR TCG, which is used to control the flow N-S
- Moyle which contains the Moyle Interconnector units
- Others



TCG limits

■ All TCG's have one of three limits

- X: for export, but means that the sum or output is \leq to the specified value
- N: for import, but means that the sum or output is \geq to the specified value
- B: for between, and means that the sum or output is between value A and value B

■ A TCG can be disabled by setting the limit flag above to G (ignore)

■ TCG limits can vary in each trading period as required

Sample Constraints Currently Active in RCUC

Name	TCG Type	Limit Type	Limits	Resources	Description
ROI	MWR (reserve + MW)	X: < =	440 all day	All Units in ROI	MW plus reserve from South to North cannot exceed 440MW <i>required for system stability</i>
MINNIU	NB (# of Units)	N: > =	3 All day	All Units in NI	There must be at least 3 units synchronised at all times in NI <i>required for SONI system stability</i>
GENNTH	MW	B >= and <=	>=0 <=135 By day	All Units in Turlough Hill	Upper limit of 135MW ensures the scheduled output of Turlough Hill remains below 135MW. Lower limit prevents Turlough Hill from pumping. <i>required to ensure that Turlough Hill is being used to provide highly reliable and effective operating reserve</i>
TARBRT	NB (# of Units)	N: >=	1	TB3 and TB4	Ensures that at least one large unit in Tarbert is scheduled on load – <i>required for voltage stability</i>

Optimisation time frame issues

- **RCUC does not look beyond 11:30 am D+1**
- **In winter the EirGrid peak evening system demand will often be in excess of 700 MW higher than at 11:30 am**
- **For units like PBC with start-up costs in excess of €128,000 it is not economic to schedule it off at night when it is required for the next evening peak thus possibly incurring this cost daily**
- **This tends to be more a winter issue than a summer one, as the daily peak moves to the morning, and this constraint will be relaxed as summer approaches**
- **We are continuously monitoring this issue and investigating the costs associated with it - we are not perfect yet**

RCUC overview

- **RCUC is an optimisation tool not a system security constrained tool**
- **To make RCUC reflect physics and our prudent system operation we have to apply constraints to it**
- **Two system operators using the one tool to produce a realistic operating schedule considering the relevant contingency criteria**
- **Production costs can be managed with RCUC but the need to balance these costs against security of supply is a licence issue**
- **Our aim as TSO's is not to be one of the 91% of European utilities who believe blackouts will become a regular occurrence**

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