RRE Reliability and Risk Engineering

EHzürich



Impact of Power-to-Gas on Cascading Failures in Interdependent Electric and Gas Networks

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| 11/27/2015 | 1









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Motivation









Gas Network

Operational constraints and corrective actions

Constraint	Value	Correction	
Maximum pressure	100 bar	Gas curtailment	
Minimum pressure	10 ÷ 42 bar	Gas curtailment	
Compressor envelope	4000 ÷ 9500 rpm 3500÷20000 m³/h	Compressor shutdown	
Power required by the compressor	Depending on the working set point	Compressor shutdown	
Ramp rate of power plants	0.5 p.u./h	Ramp up/down limitations	

Gas curtailment can affect the electrical system limiting the power output of gasfired power plants



| 11/27/2015 | 9

Electrical Network

Operational constraints and corrective actions

Constraint	Value	Correction	
PP capacity	680 ÷1100 MWe	Generation limitation	
Minimum PP output	340 ÷550 MWe	Power plant shutdown	
Line rating	700 MW	Line disconnection	
GFPP ramp rate	0.5 p.u./h	Ramp up/down limitations	
Maximum line temperature	100 °C	Line disconnection when temperature reaches threshold	



AA5 Ho eliminato la presentazione dell'algoritmo ed invece ho spiegato come viene fatto il collegamento tra i modelli. Le violazioni dei vincoli dei sistemi e le possibili reazioni implementate vengono comunque spiegate nelle tabelle nelle slide 5 e 7 Antenucci Andrea; 03.09.2015

Case Study



Cascading process triggered by PP removal Electrical network perspective



Total generation after removing PP2

- Remove PP2
 Power Balance
 Min. pressure violation and gas curtailment
 Power Balance
 - Line overload
- 3. Power line disconnection
 Power Balance
- 4. Load shedding
- 5. Island formation and new power balance
- ²⁵ 6. Additional power lines disconnections and load shedding
 - 7. New steady state

Cascading process triggered by PP removal Gas network perspective



Results: Effect of PtG following a random component failure

Settings

- Shut down PP
- Time of simulation: 25 h
- PtG injection: [0,5]% of TGD (440 kg/s)
- Electrical demand: 6254 MWe
- Non-electrical gas demand: 257 kg/s
- ✤ Total Generation: 7377 MWe



Results: Effect of PtG following a random component failure



Results: Effect of a Sudden Decrease of Renewable Power

3 different generation portfolios

Instant RES	Scenario	RES	GFPP	Other	const
Time c	1	10%	85%	5%	WWe
Electri	2	20%	75%	5%	
	3	30%	65%	5%	



Results: Effect of a Sudden Lack of Renewable Power





Thank you! Questions?

