

Network Issues for Renewable Energy Generation

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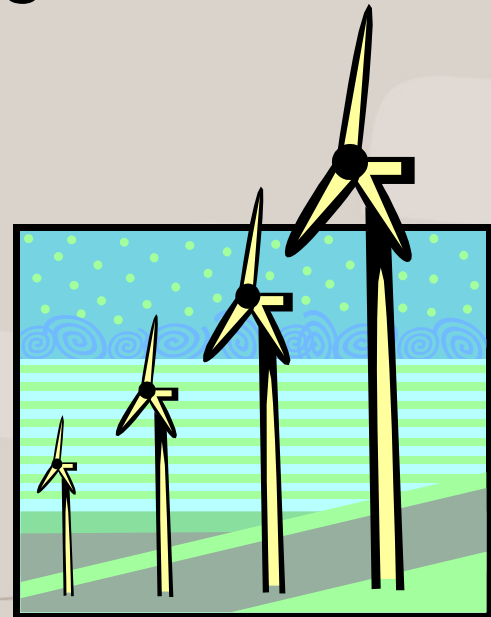
MAC - REGWG
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PRESENTATION OBJECTIVES

To provide an overview of:

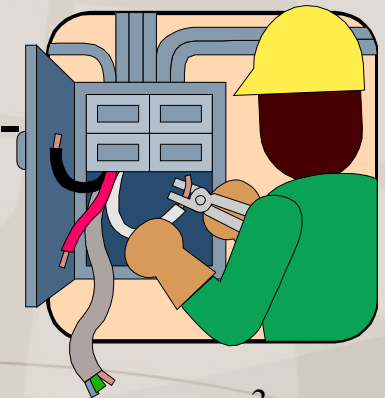
1. Network issues as they apply to renewable energy generators in the SWIS



TECHNICAL RULES

Technical Rules performance requirements:

- generally apply to the windfarm as a whole, not to individual wind generators
- apply at the connection point
- are plant performance NOT operational requirements
- Concessions to windfarms and other non-conventional generation



POWER SYSTEM SECURITY (1)

- Relies on generating plant performing in accordance with the Rules
- Conventional generators that currently make up the bulk of the generation portfolio provide services to operate the network, for example reactive power and frequency response

POWER SYSTEM SECURITY (2)

- To facilitate the growth in wind generation and ensure that barriers for local or overall developments are not introduced, it is necessary that this technology can broadly provide similar level of functional performance to existing generating plant

POTENTIAL CONSEQUENCES

- Losing multiple power stations for a single fault
- Increased risk of widespread customer disconnection
- Restrictions on the development of renewable energy
- Substantial increase in operating costs for holding additional spinning reserve

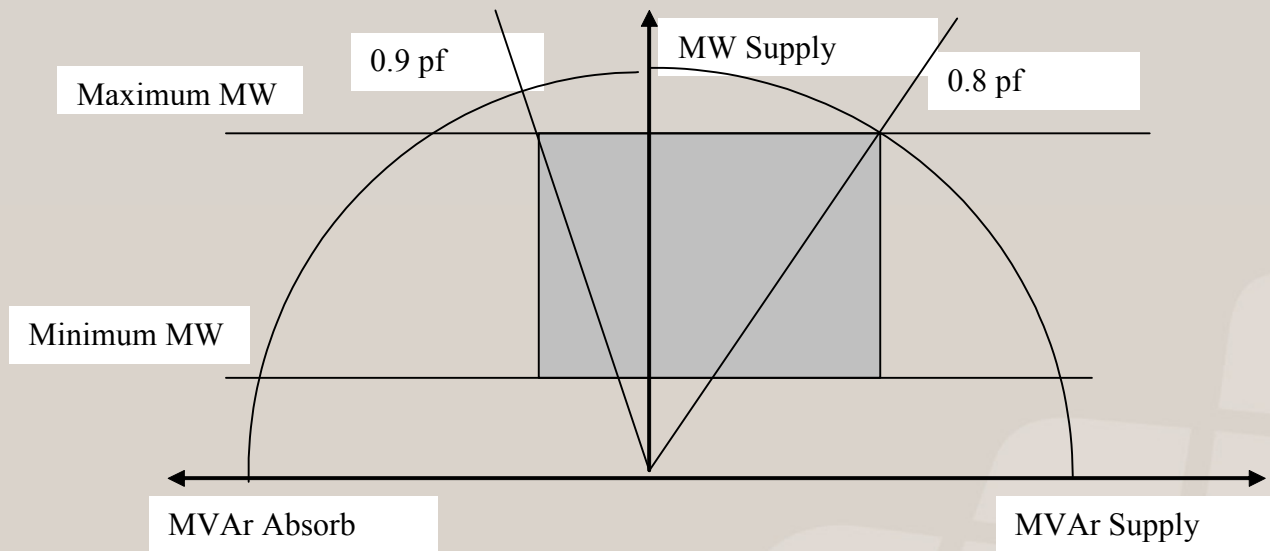
LESSONS LEARNT

- European UCTE 2006 blackout
- Italian 2005 blackout
- UK, Ireland major disturbances, ...

KEY TECHNICAL ISSUES

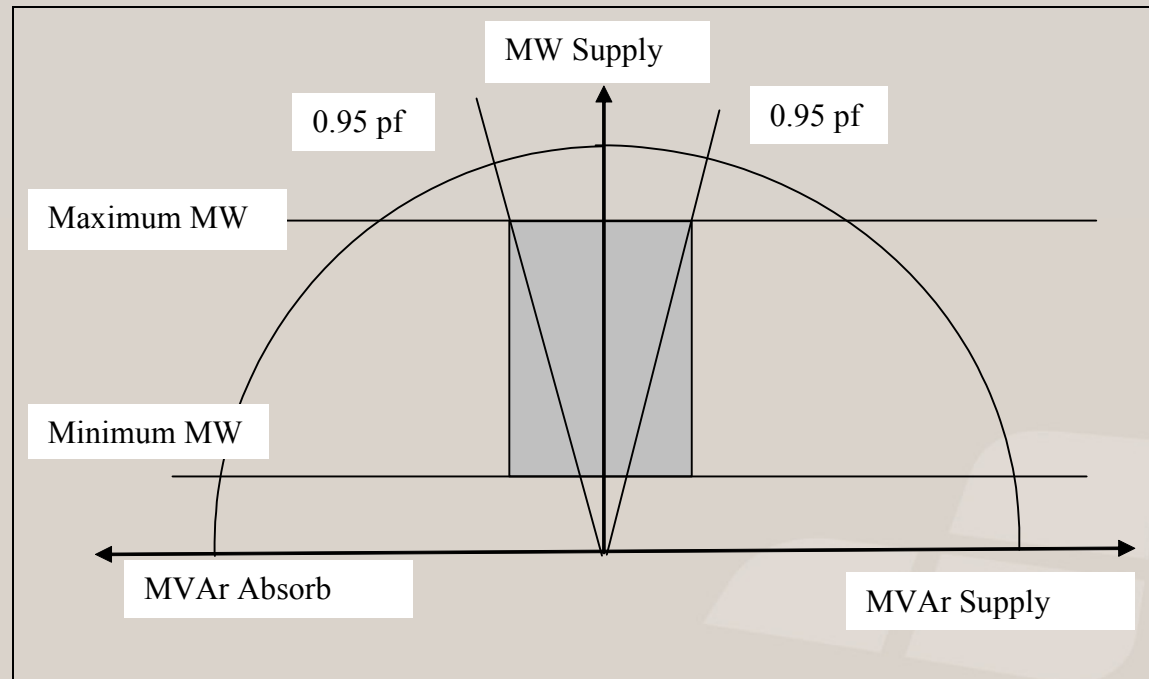
- Immunity to disturbances
 - Frequency
 - Voltage
 - Continuity of infeed
- Reactive power capability
- Frequency / Active power control

REACTIVE POWER CAPABILITY (1) SYNCHRONOUS GENERATORS

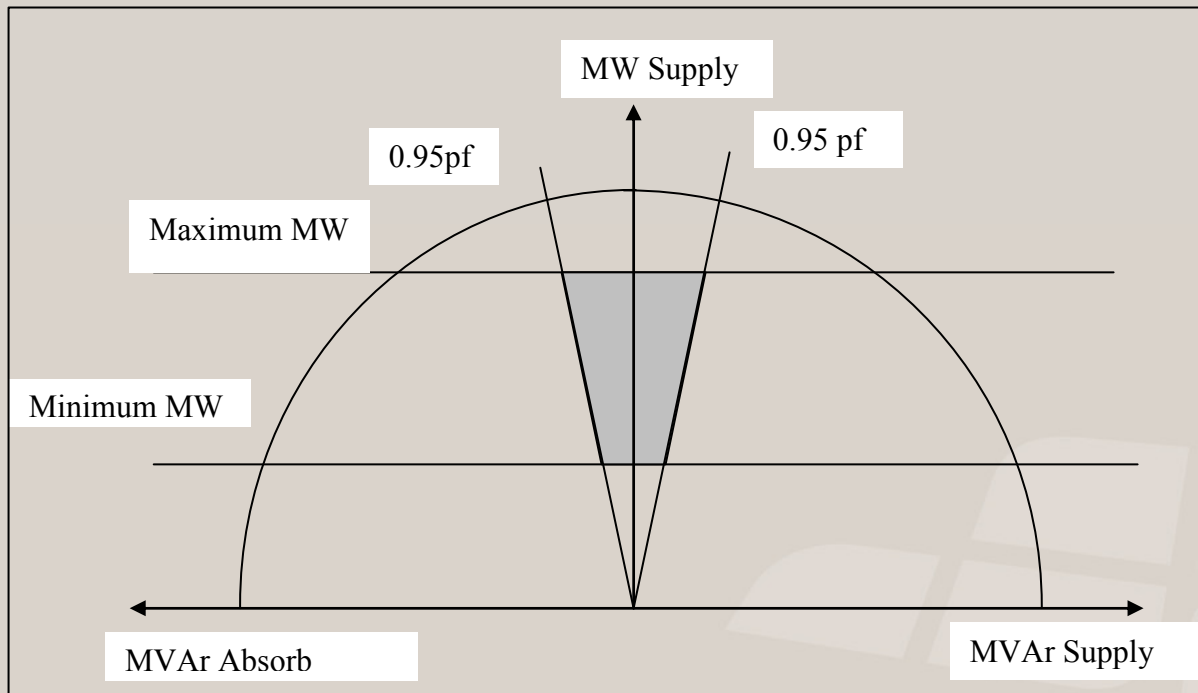


REACTIVE POWER CAPABILITY (2)

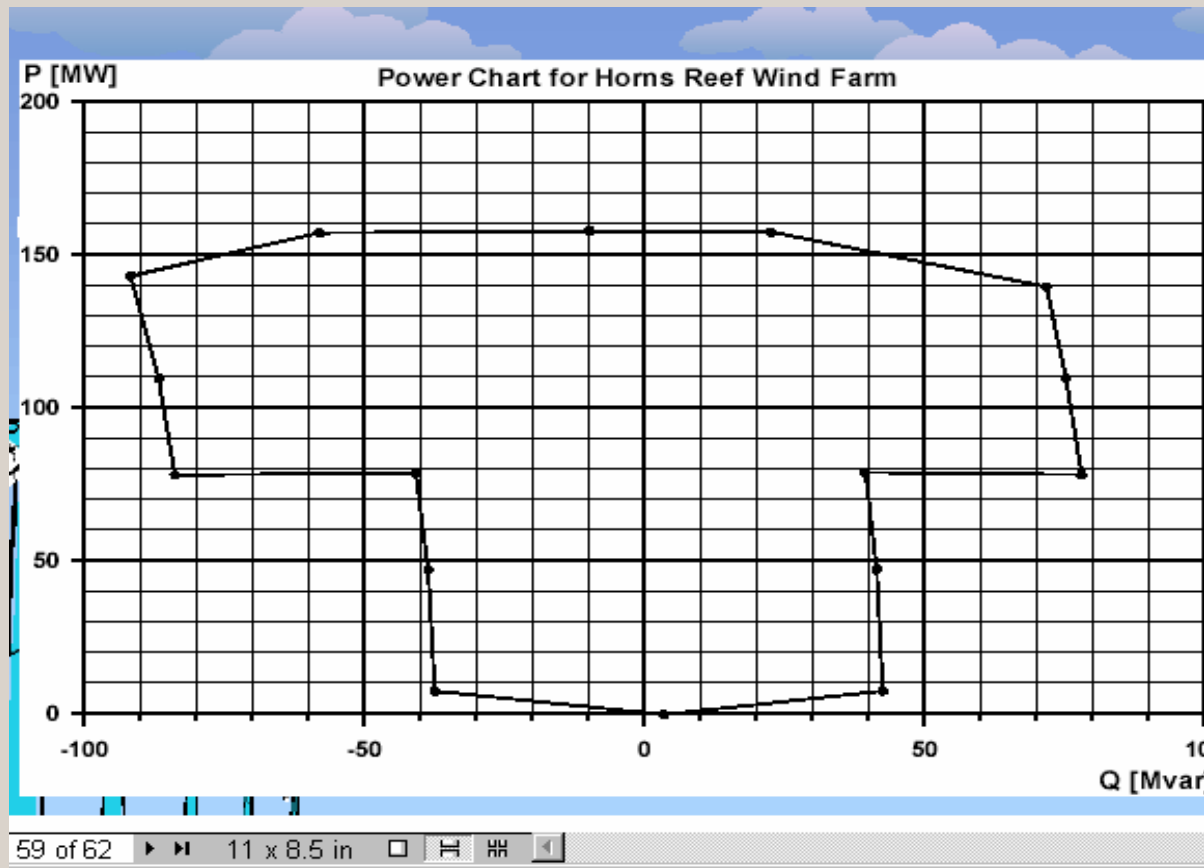
INDUCTION GENERATORS



REACTIVE POWER CAPABILITY (3) INVERTER CONNECTED GENERATORS



REACTIVE POWER CAPABILITY (4) WINDFARM IN DENMARK



Frequency / Active Power Control (1)

- Simple induction generators with no / little control of the power extracted
- Recent developments to improve efficiency allow wind turbines to control the power extracted

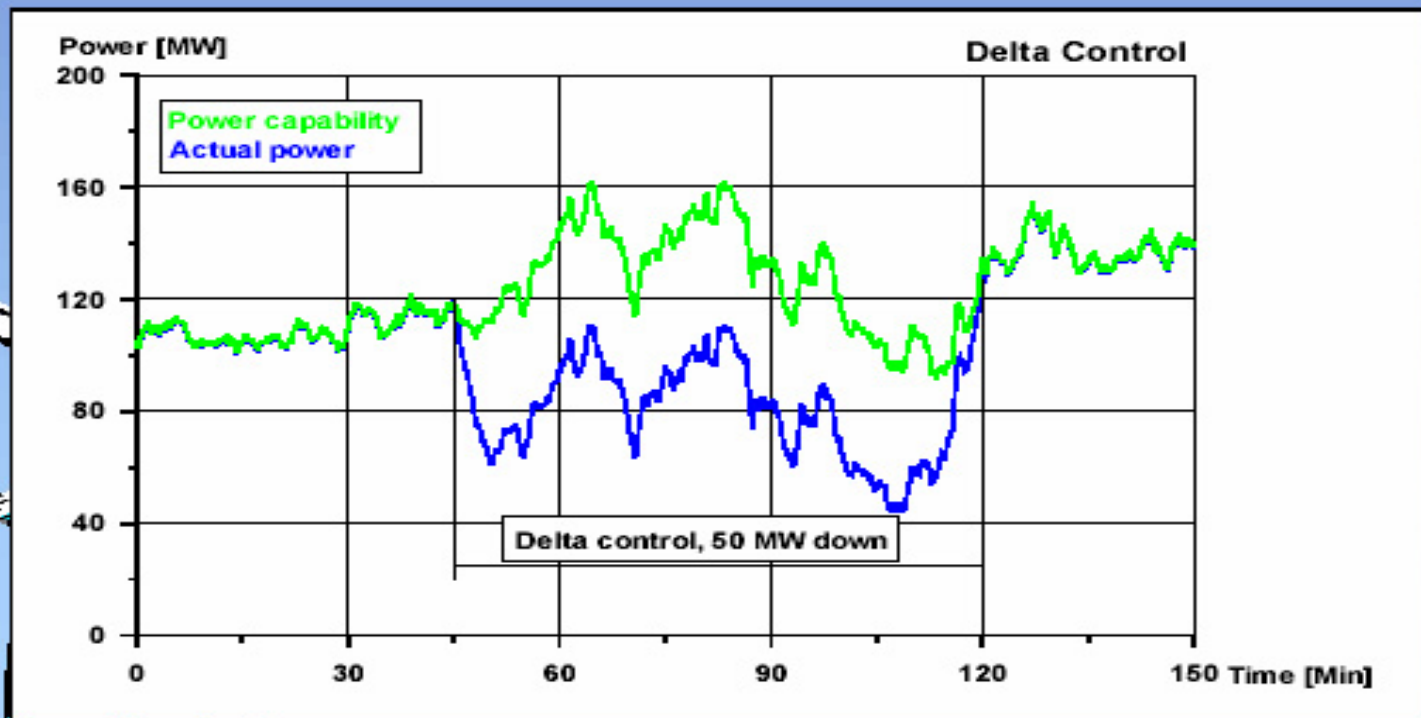
Frequency / Active Power Control (2)

- This generation technology has an intrinsic capability to provide frequency response by controlling the electrical power output relative to the maximum energy that can be extracted from the wind
- May increase stress on the shaft

Frequency / Active Power Control (3)

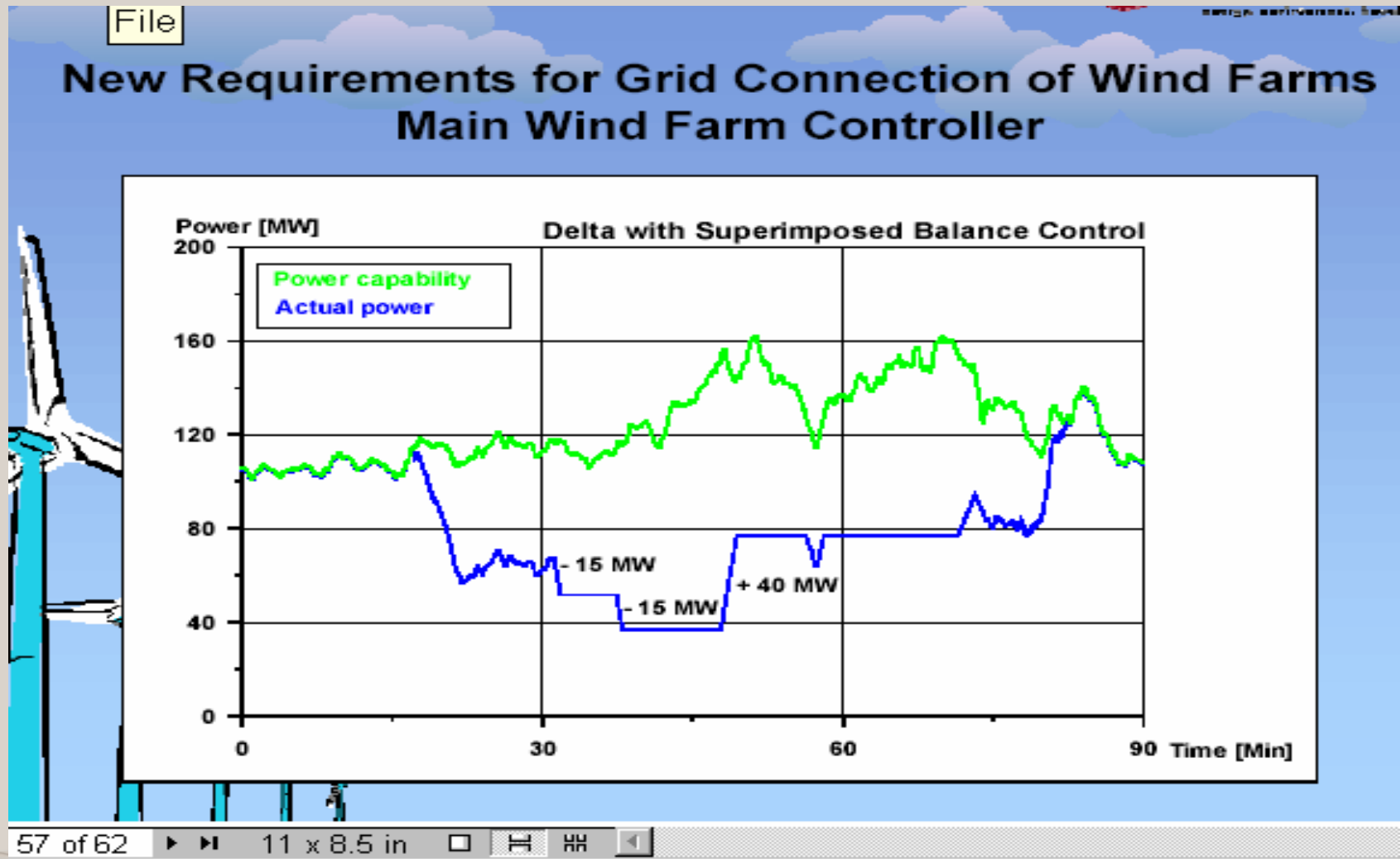
WINDFARM IN DENMARK

New Requirements for Grid Connection of Wind Farms Main Wind Farm Controller



Frequency / Active Power Control (4)

WINDFARM IN DENMARK



Frequency / Active Power Control (5)

- Utilities in Europe have begun mandating the frequency response capability
- Large windfarm projects demonstrate successful operation of such a plant
- Market and financial reward rules need to evolve accordingly

ANY QUESTIONS