IEEE Winter Meeting 2000, Singapore, 23-27 January 2000

Overview of voltage sag mitigation techniques

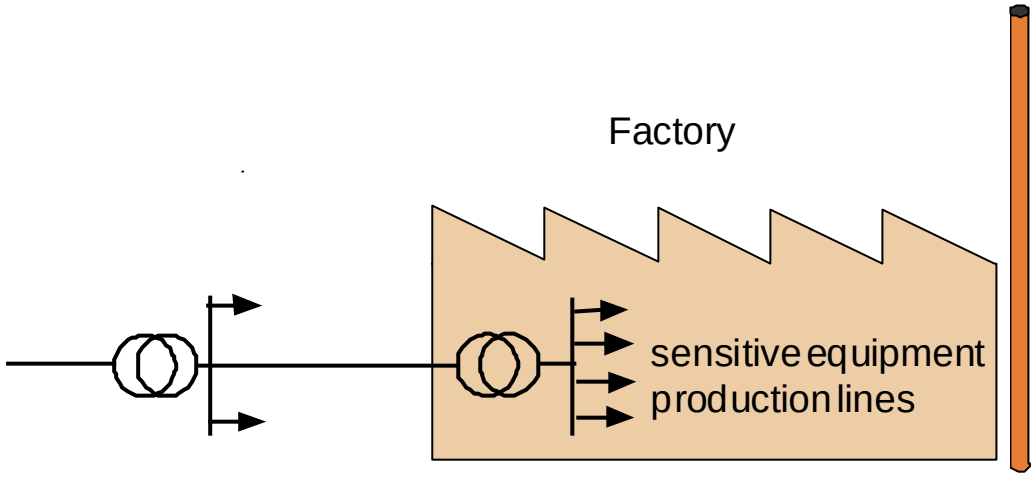
Ambra Sannino
Department of Electrical Engineering
University of Palermo, Italy

Michelle Ghans Miller, Math H.J.Bollen
Department of Electric Power Engineering
Chalmers University of Technology
Gothenburg, Sweden

outline

- need for voltage sag mitigation
- mitigation through system improvement
- increasing equipment immunity
- installation of additional equipment
- conclusions

today's scenario
the need for power quality improvement

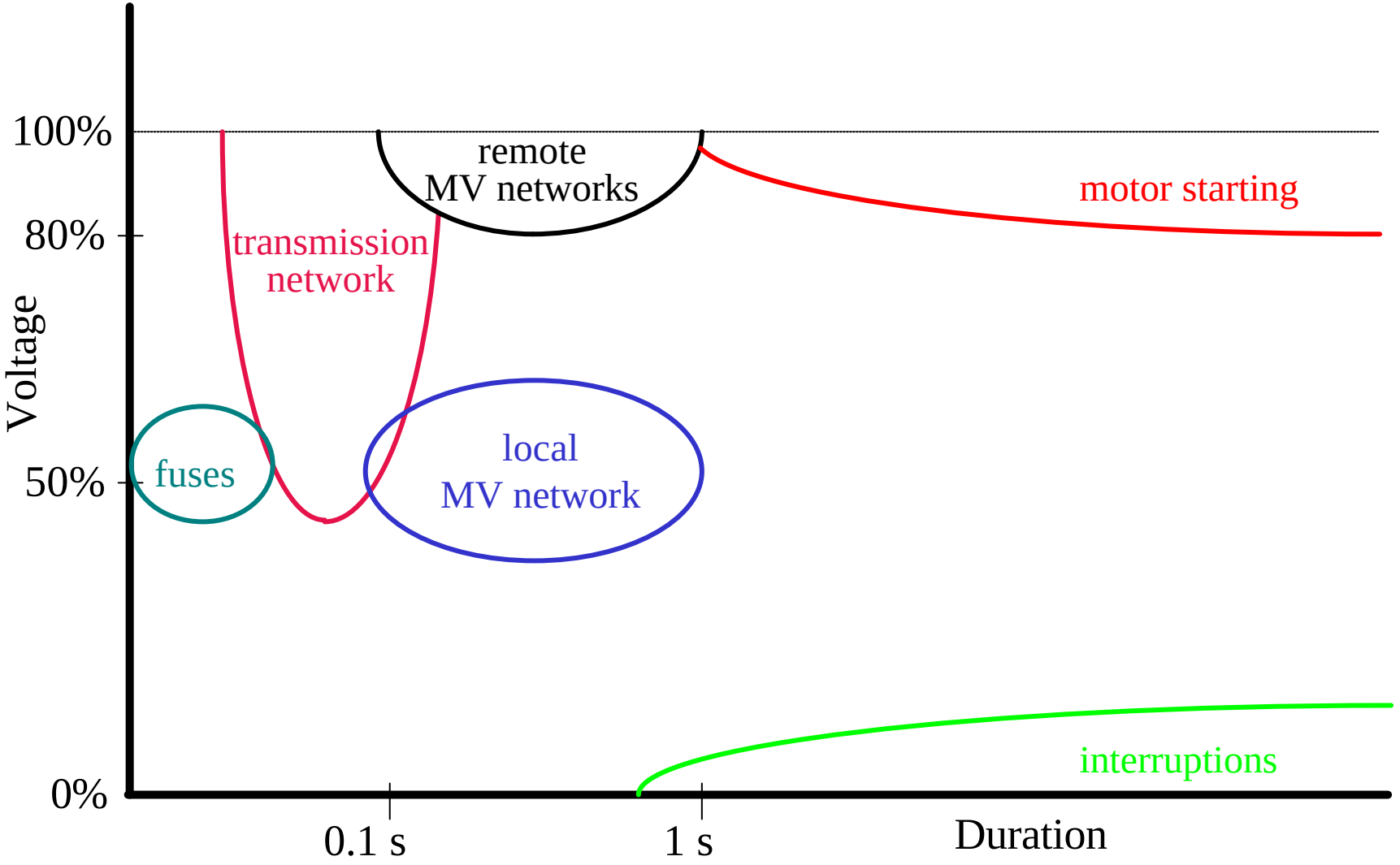


Automated factories use sensitive equipment

- power electronics (AC and DC drives)
- process-control electronics (computers, PLCs)

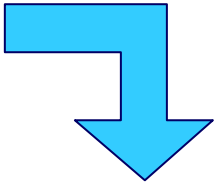
Faults in the power system can cause process interruptions with associated costs due to loss of production, damaged product and equipment, and other factors

different faults cause different sags

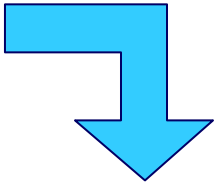


from system faults to process interruptions

Faults in the utility power system:
- three-phase
- single-phase-to-ground
- phase-to-phase

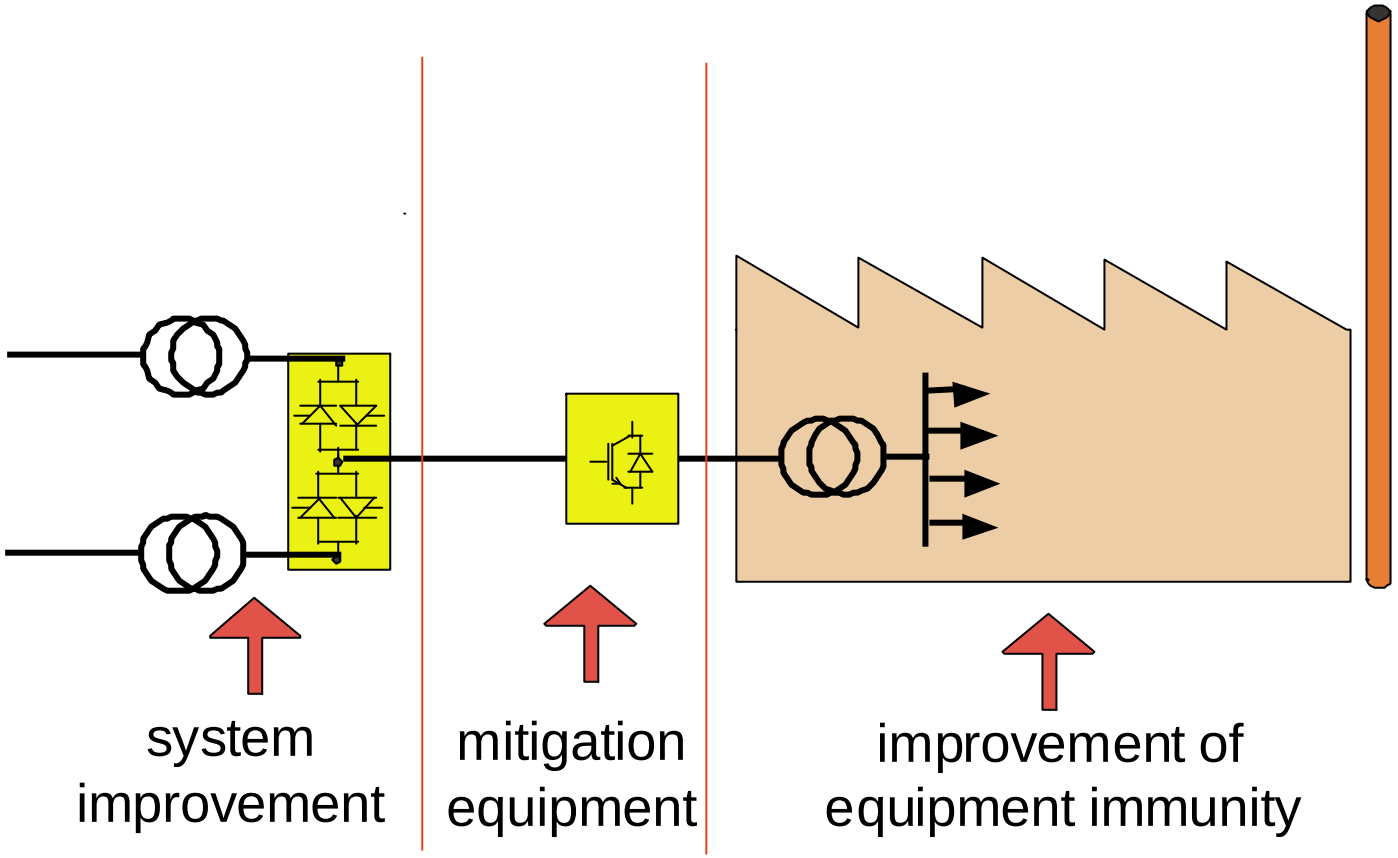


Consequences at the PCC:
- voltage sags
- interruptions



Consequences on the process:
- equipment trip
- process interruption

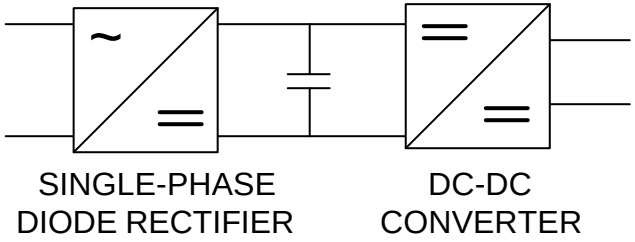
improving power quality for sensitive customers



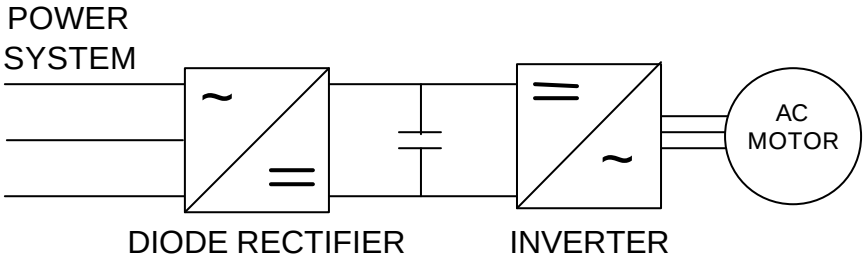
mitigation through system improvement

critical factors:	improvements:
• frequency of events	• reducing the number of faults
• sag duration	• reducing the duration of faults
• sag magnitude	• changing power system layout

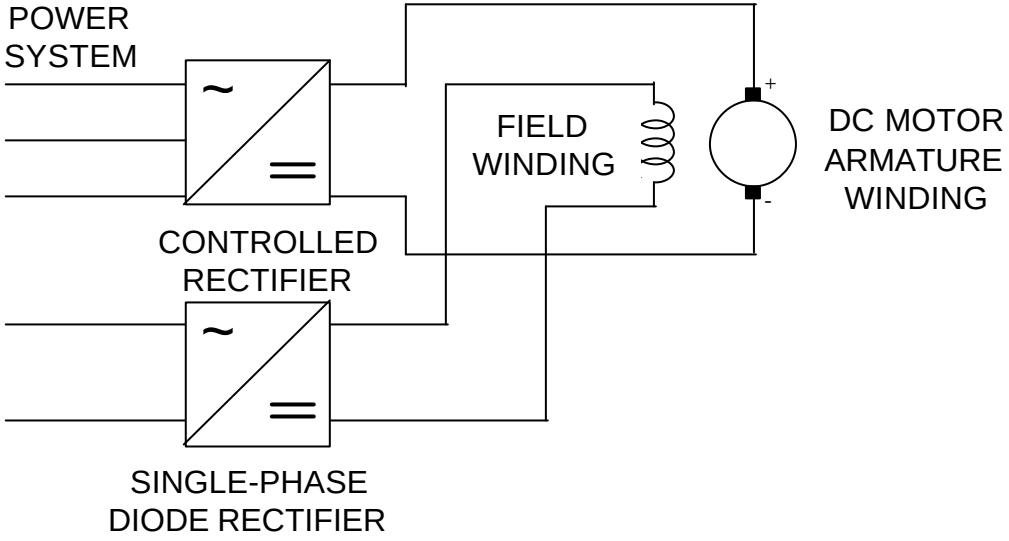
equipment sensitivity (1)



low-power electronics

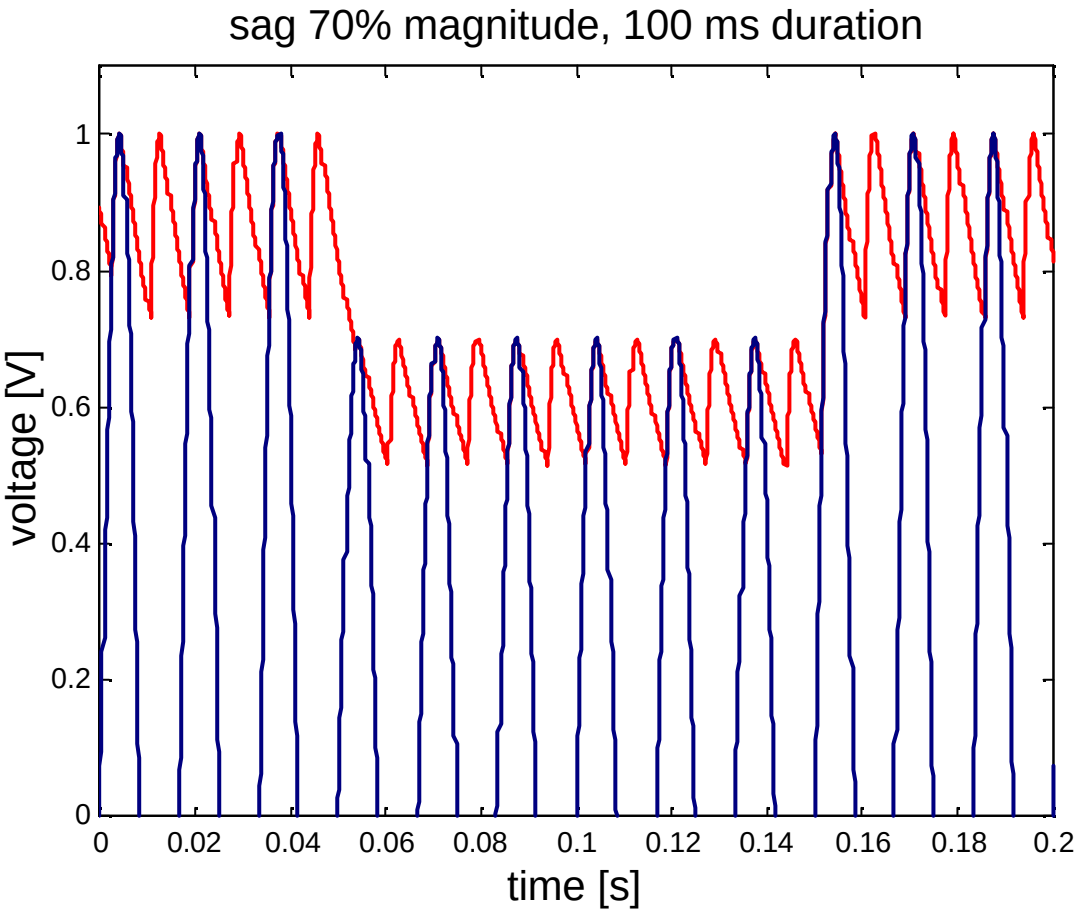


AC drive



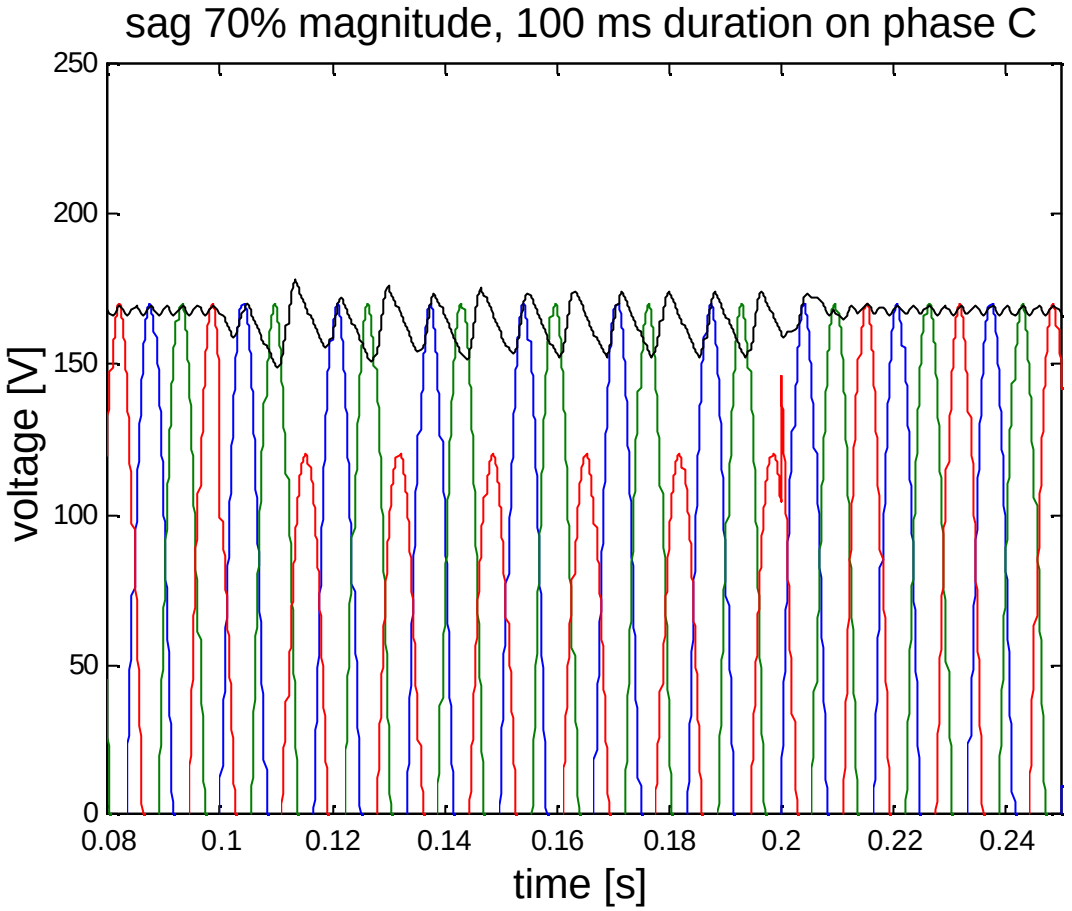
DC drive

equipment sensitivity (2)



effect of a sag on a single-phase rectifier

equipment sensitivity (3)



effect of an unbalanced sag on a three-phase rectifier

improving equipment immunity

- **low-power electronics:** adding capacitance, improving the dc/dc converter

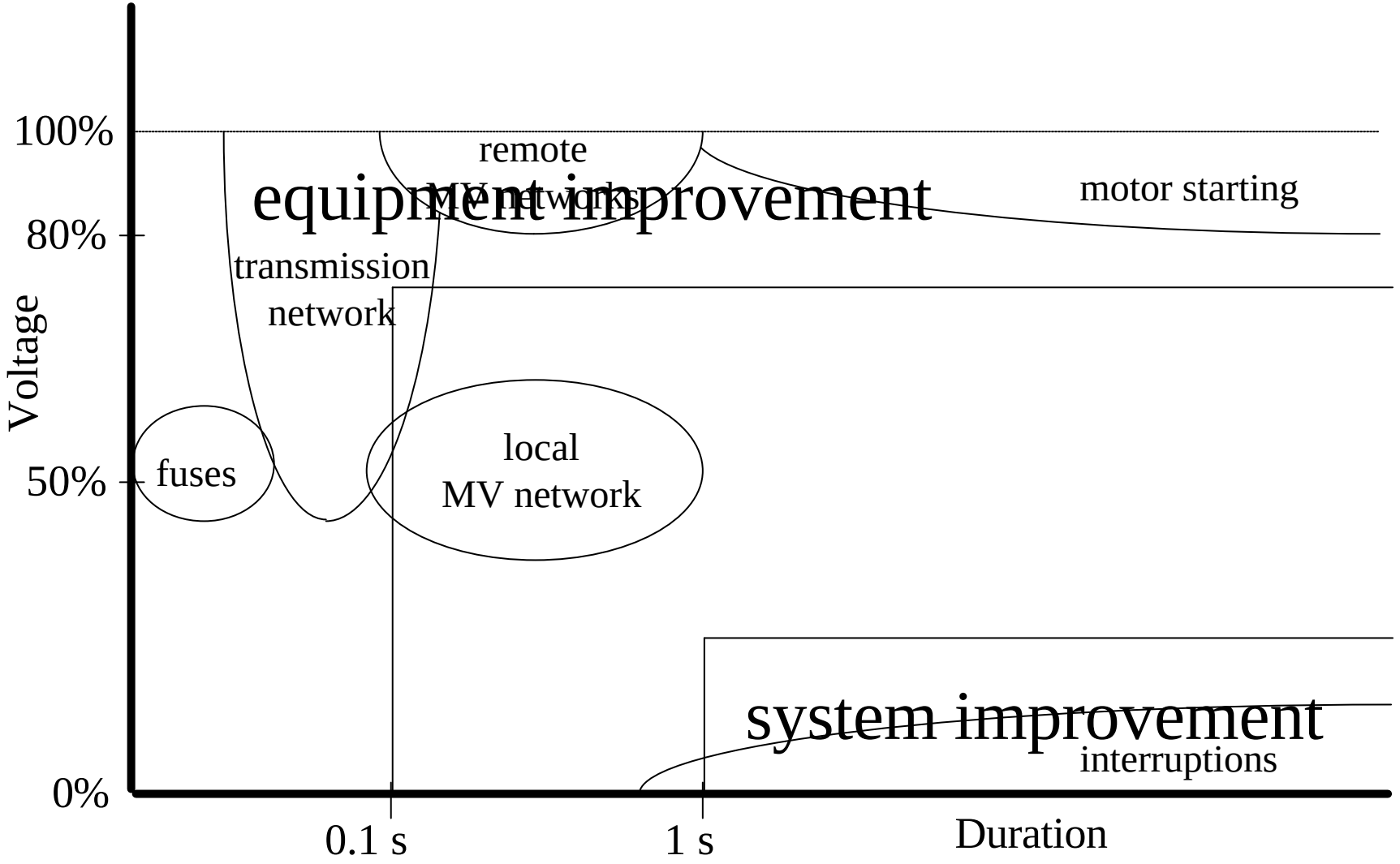
- **AC drives :** adding capacitance, reducing the setting for the dc bus protection

- **DC drives:** implementing proper control algorithms for adjusting the firing angle of the devices according to changes in the input voltage. **Adding capacitance is not a viable option**

mitigation devices

- motor-generator set
- ferroresonance transformer
- electronic tap changer
- uninterruptible power supply
- static transfer switch
- series-connected voltage source converter
- shunt-connected back-up source

different sags require different solutions



conclusions

- mitigation of voltage sags requires careful inspection of the characteristics of the process and of the nature and origin of sag events

- the installation of mitigation devices (normally the only choice for the customer) can be seen as a short-term solution. The mitigation capability of these devices is mainly limited by the energy storage capacity

- only improvement of system performance (for long, deep sags) and of equipment tolerance (for short, shallow sags) can solve the problem in the long term