Demonstrating Network Code Compliance for Small Wind Turbines

The New & Renewable Energy Centre (NaREC)

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Outline of presentation

- Introduction to NaREC
- What is small wind
- Connecting to the UK network, which standards apply
- Focusing on micro-wind: G83/1
- NaREC G83/1 testing
- Future developments

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Introduction to NaREC

- NaREC – set up by One North East (RDA) in 2003
  - Four key operational areas:
    - Mechanical – Wind turbine blade testing & marine testing
    - Electrical – HV testing & electrical systems testing
    - PV – Silicon cell development & manufacture
    - Innovations – R&D and consultancy




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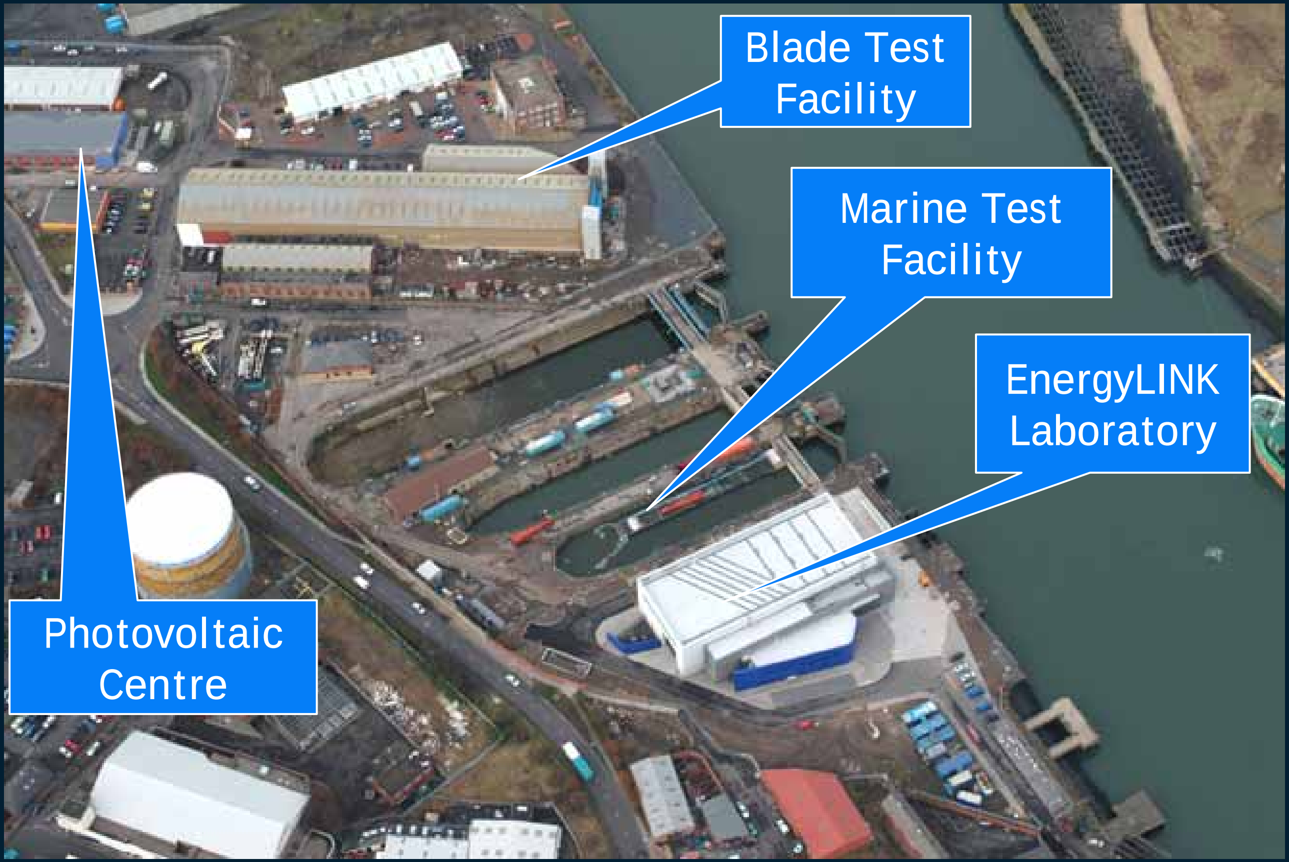
NaREC testing services: Facilities



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What is small wind?

- BWEA definition is currently that small wind is anything ≤ 50kW
  - Technology includes: Vertical axis, Horizontal axis turbines from a few watts upwards.
  - Applications include: Battery charging, grid connected, building mounted and free standing .
- Given the current interest in grid connected, building mounted systems, a better definition and sub categories are likely to be taken up:
  - Small Wind: ≤ 50kW, <16m diameter, < 200m^2 swept area
  - Micro Wind: ≤ 3.8kW, <3.5m diameter, < 15m^2 swept area
    - (G83/1 maximum permitted electrical rating is 3.84kVA per phase)
    - (ref BWEA small wind technical sub-group)

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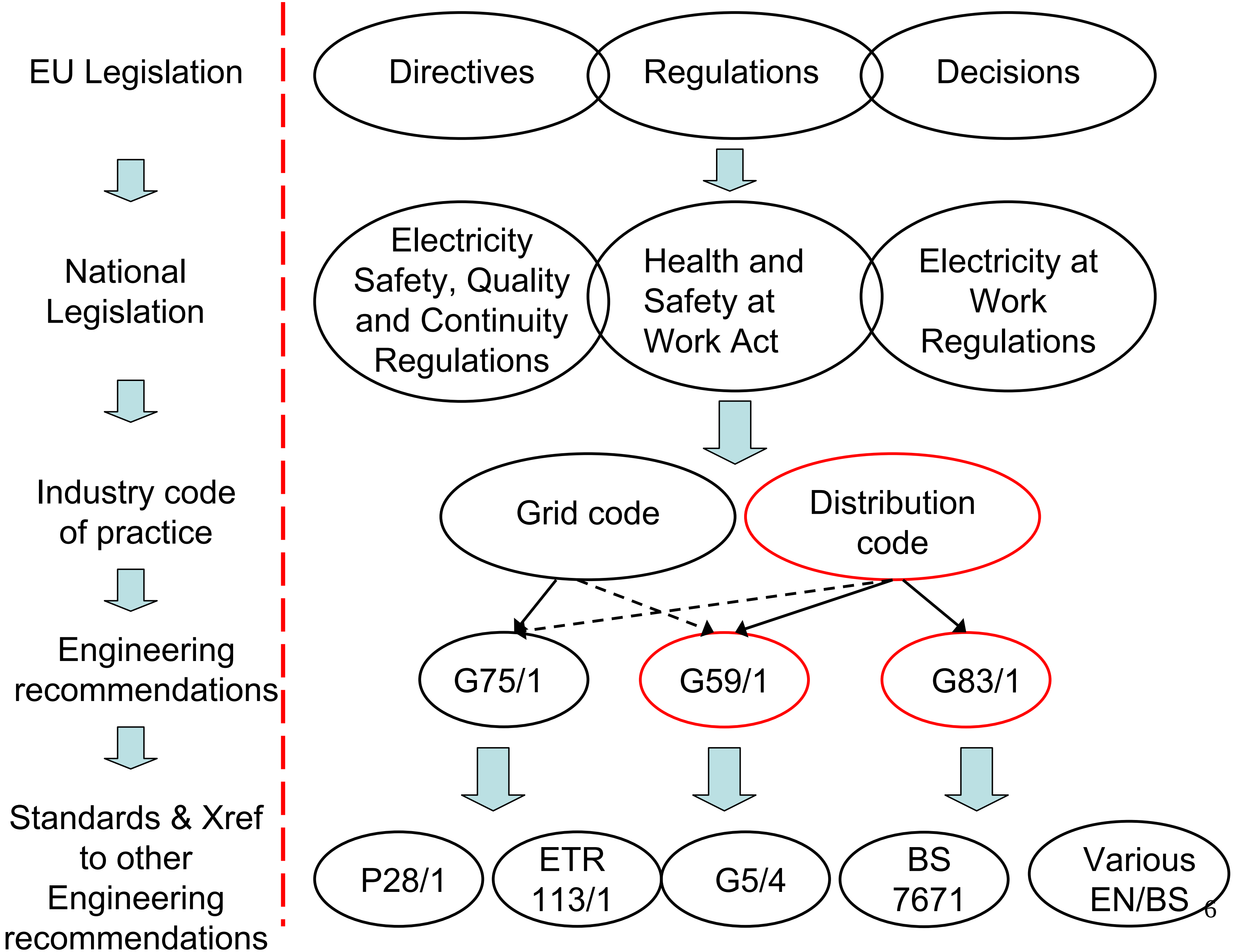
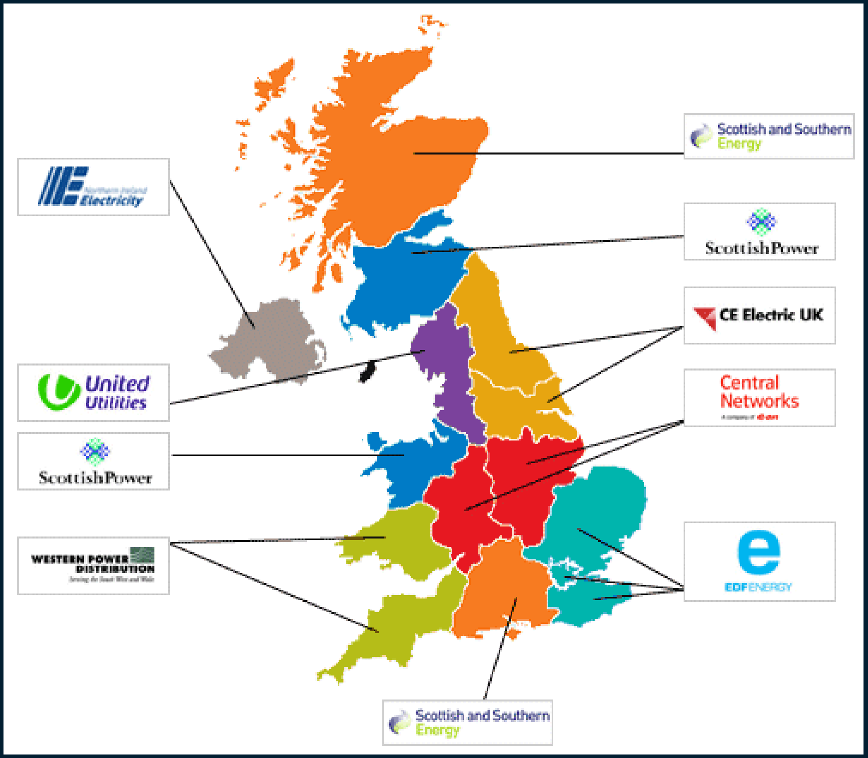

EU Legislation
National Legislation
Industry code of practice
Engineering recommendations
Standards & Xref to other Engineering recommendations
Directives
Regulations
Decisions
Electricity Safety, Quality and Continuity Regulations
Health and Safety at Work Act
Electricity at Work Regulations
Grid code
Distribution code
G75/1
G59/1
G83/1
P28/1
ETR 113/1
G5/4
BS 7671
Various EN/BS

Connecting small wind to the electrical distribution network in the UK

- Engineering Recommendation G59/1
  - Recommendation for the connection of private generating plant to the Public Electricity Suppliers' distribution systems.
- Engineering Recommendation G83/1
  - Recommendations For The Connection Of Small-Scale Embedded Generators (Up To 16 A Per Phase) In Parallel With Public Low-Voltage Distribution Networks.



Map kindly provided by the Energy Networks Association - http://www.energynetworks.org/

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Key differences between G83 and G59

G59/1

- Onus on applicant to demonstrate compliance of each installation.
- Written agreement from DNO required before connection.
- Can take a long time and applicant may struggle to provide necessary technical details.
- Each system has to be individually designed and evaluated prior to installation. An on-site witness test may be required
- Type testing may be acceptable

G83/1

- Manufacturer provides a type test certificate for representative system.
- No DNO approval required for Type 1 installation.
- Applicant simply has to send details of scheme within 30 days of commissioning.
- Applicant simply follows manufacturer's installation guidelines and ensures the installation complies with BS7671

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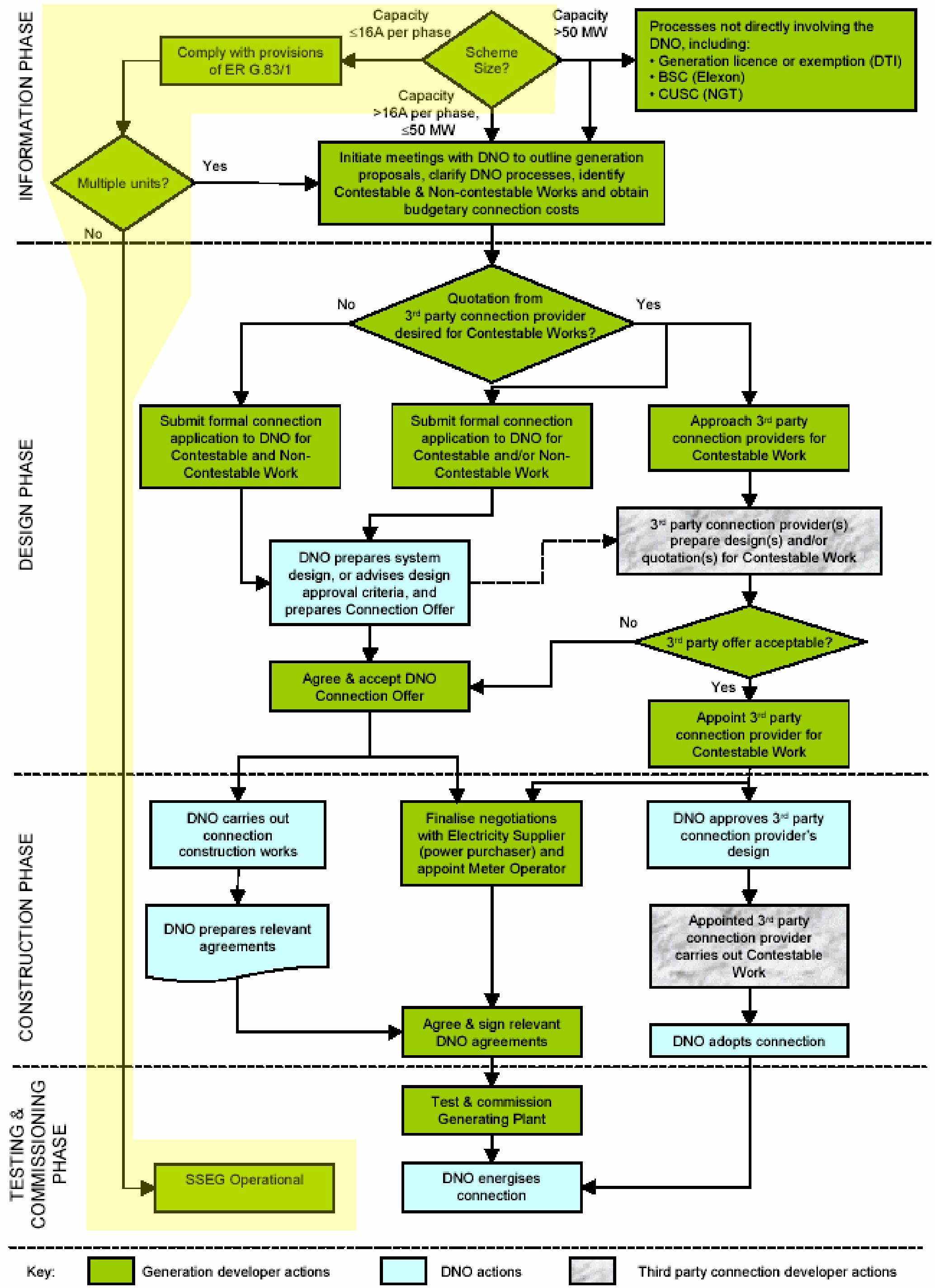

Key differences in the connection process between G83 and G59

Source: Technical Guide to the Connexion of Generation to the distribution network, Power planning associates for the DTI. K/EL/00318/REP

Which connection standard applies to your project?

	G59/1 (1991)	G83/1 (2003)
Generator power	11.1kW < P_{rated} < 5MW	P_{rated} ≤ 11.1kW 3ø P_{rated} ≤ 3.7kW 1ø
Voltage at Point of Common Coupling (PCC)	400V ≤ V_{rated} ≤ 20kV	V_{rated} = 400V 3ø V_{rated} = 230V 1ø

- Multiple sources of micro-generation on one site can push the whole installation into a G59/1 category
- Multiple planned G83/1 installations on a local network, e.g a housing estate, require “stage 2” application – which will involve the DNO assessing the impact of the proposal.

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G83/1 Key features

- Provides guidance on both the installation and commissioning requirements as well as the type testing requirements.
- Annex for wind is incomplete, for inverter connected systems we need to refer to the PV annex.
- NaREC has developed a facility for type testing and development of small generators.

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Type testing to G83/1

- Equipment needs to be type tested:
  - Over Voltage trip in 1.5 seconds @ 264V } No
  - Under Voltage trip in 1.5 seconds @ 207V } reconnection
  - Over Frequency trip in 0.5 seconds @ 50.5Hz } within
  - Under Frequency trip in 0.5 seconds @ 47Hz } 3
  - Loss of mains in 0.5 seconds } minutes

  - Harmonics to EN61000-3-2 Class A
  - Voltage fluctuations & flicker to EN61000-3-3, d_c=4% max
  - DC injection under 20mA
  - Power Factor within 0.95 leading to 0.95 lagging
  - Short Circuit current (Short circuit at terminals) i_p, A, i_k, i_{DC} $^X/_R$

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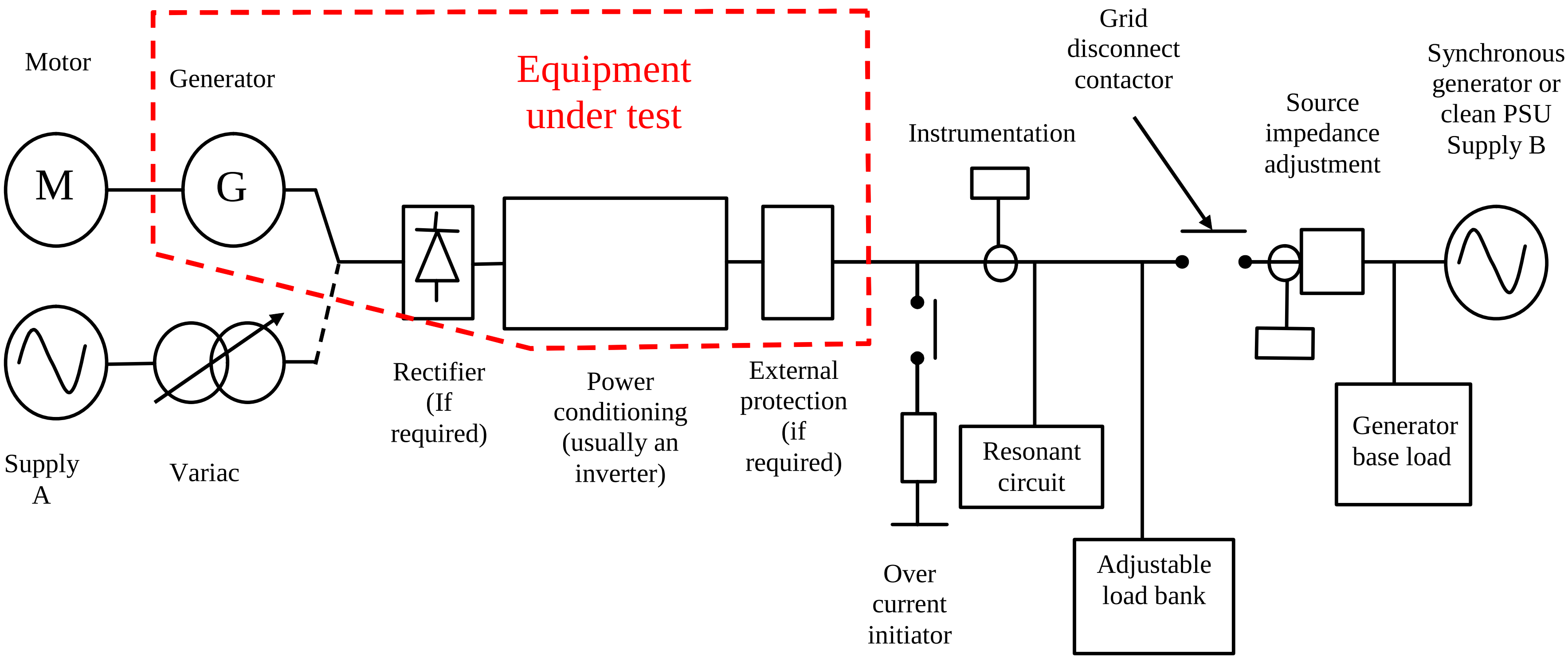
NaREC type test arrangement



Challenges for test houses and manufacturers

- DC injection < 20mA
- Methods for measuring trip times accurately
- Conflicts in standard, e.g upper frequency trip limit and operating limit
- Lack of clarity/detail for testing other wind generator types
- Who validates the test procedures
- Lack of clarity for measuring flicker conditions
- Verifying extreme operation and lifetime performance

Future developments

- NaREC
  - Automate the Small Scale Electrical Generator (SSEG) test facility using a Virtual power supply
- G83/1
  - Generator ride through (what happens when many SSEG's are in situ)
  - Ancillary services (can SSEG's provide Var support, local voltage control)
  - Network stability enhancement (Can communications be used to enable SSEG's to provide grid support rather than just disconnecting as at present)
  - Metering and charging issues (Can SSEG's become part of a local intelligent solution delivering power when needed)

Low power Virtual power supply, developed in collaboration with Newcastle University