



# Grid Connection

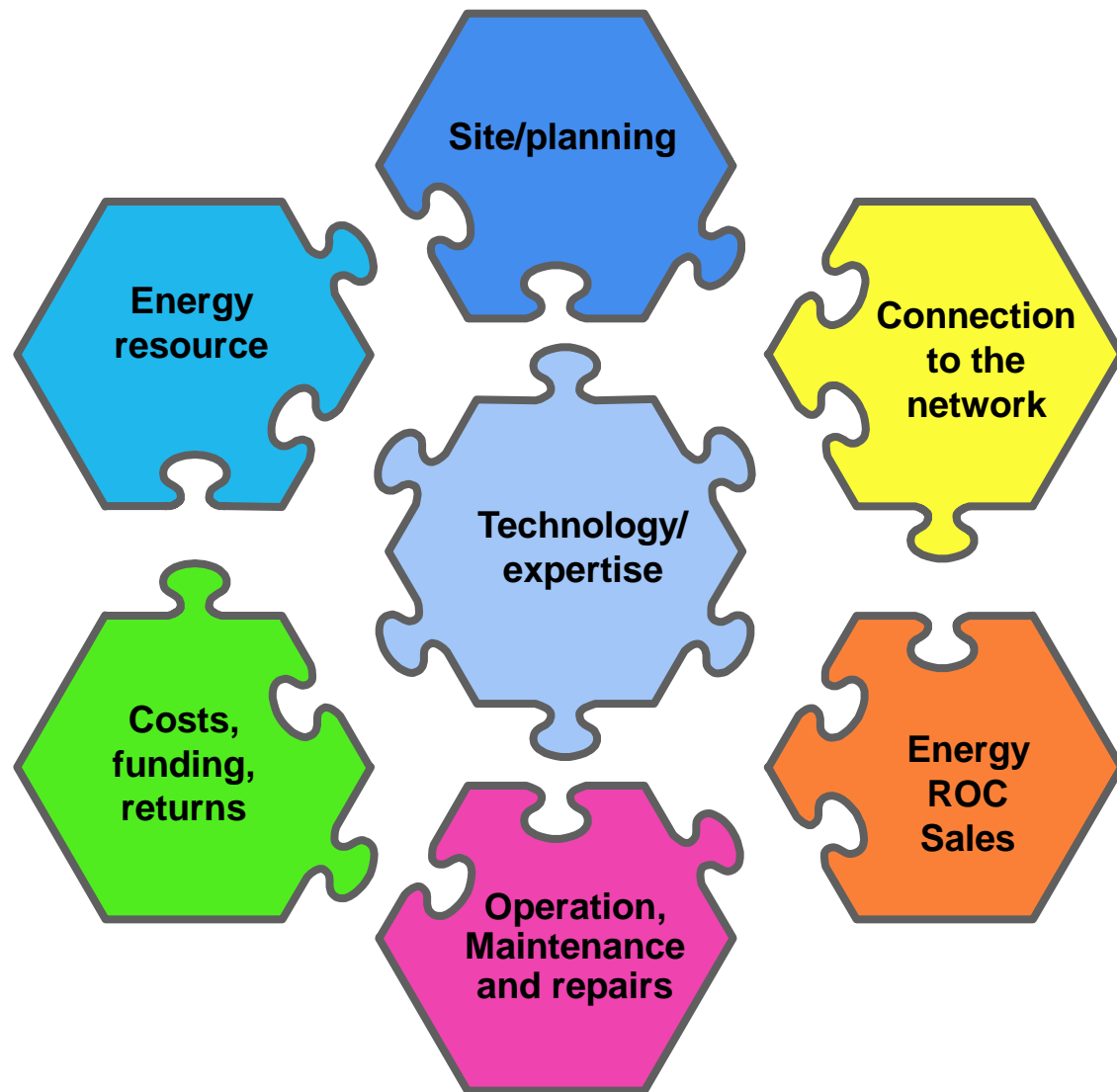
20th October 2011

# Agenda

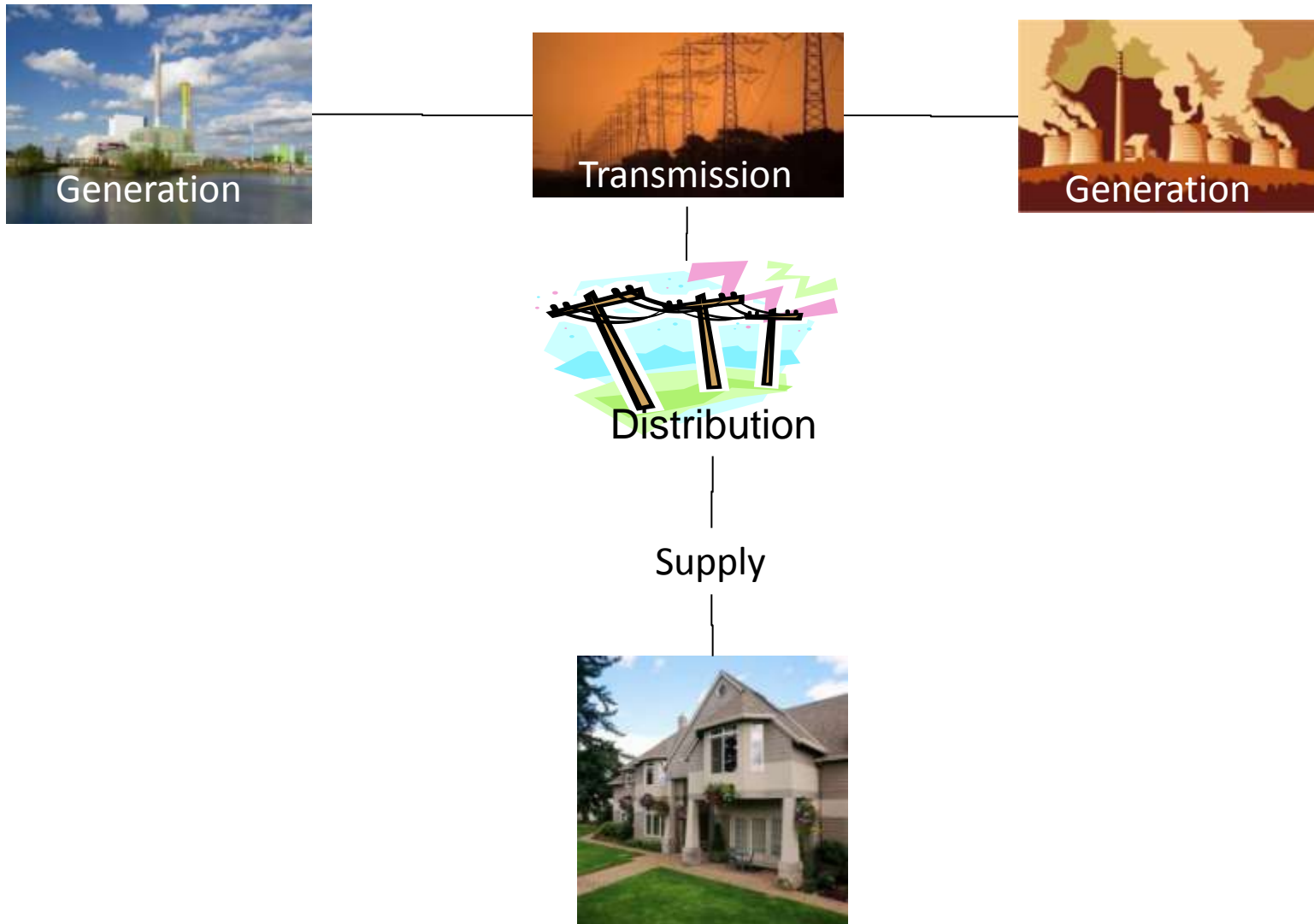
- Introduction
- Technical Aspects of Grid Connection
- Practical Aspects of Grid Connection
- Process and Timescales
- Safety Clearance

# Introduction

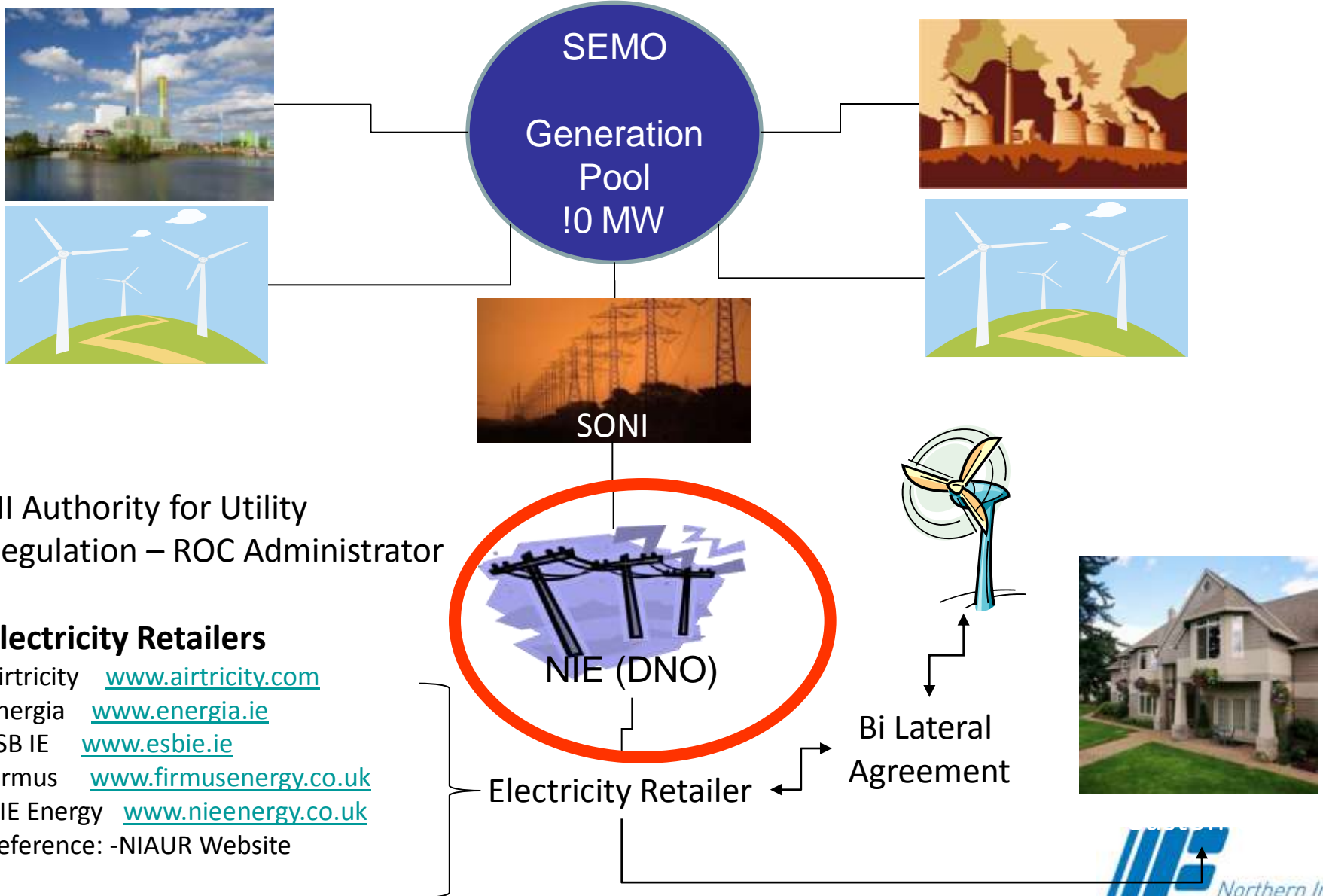
# Network connection - part of the overall jigsaw



# NIE -Historical Arrangements



# Current Market Arrangements



NI Authority for Utility  
Regulation – ROC Administrator

## Electricity Retailers

Airtricity [www.airtricity.com](http://www.airtricity.com)

Energia [www.energia.ie](http://www.energia.ie)

ESB IE [www.esbie.ie](http://www.esbie.ie)

Firmus [www.firmusenergy.co.uk](http://www.firmusenergy.co.uk)

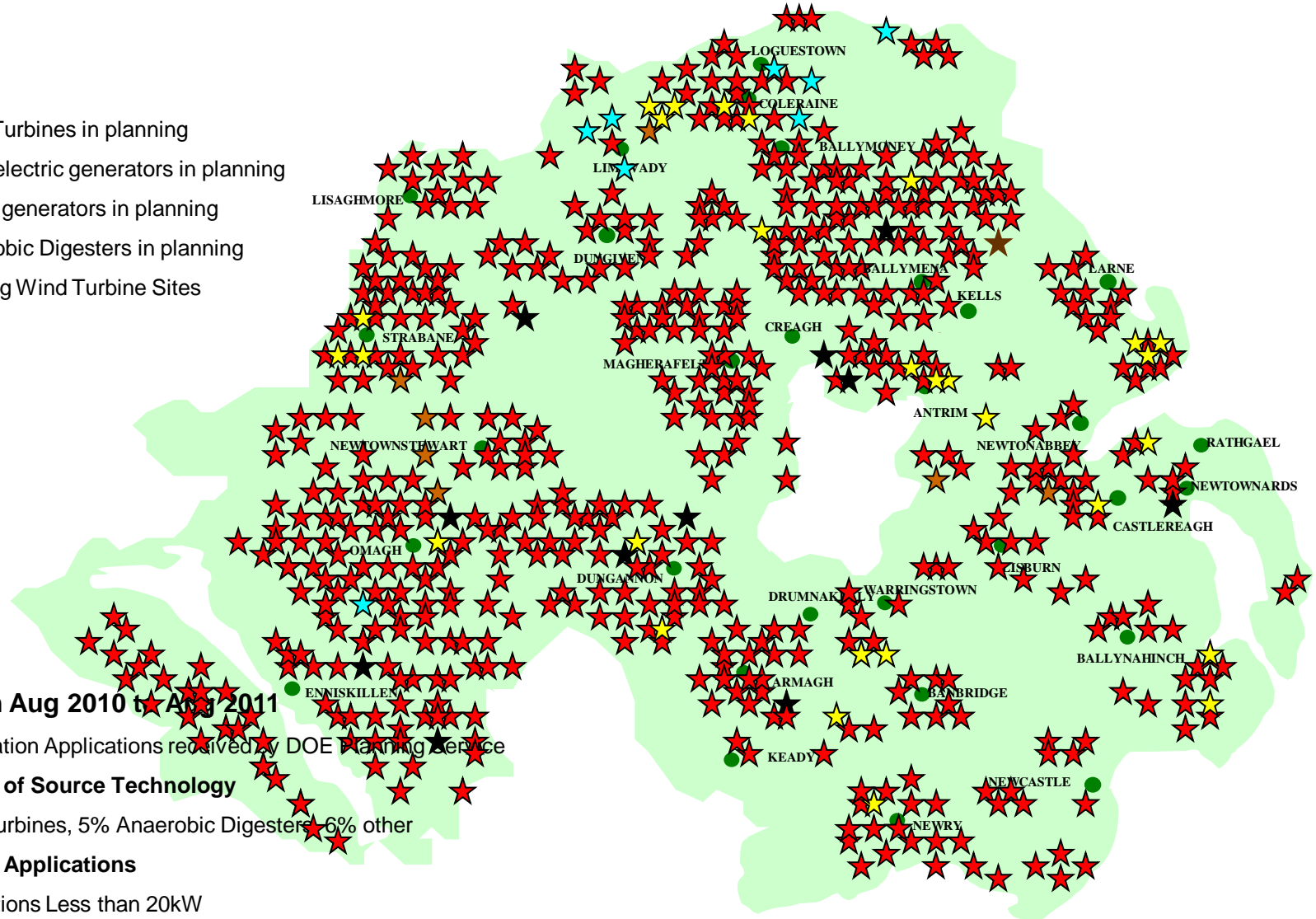
NIE Energy [www.nieenergy.co.uk](http://www.nieenergy.co.uk)

Reference: -NIAUR Website

# Planning Applications (DOE) for Individual Generation Units

## Key

- ★ Wind Turbines in planning
- ★ Hydroelectric generators in planning
- ★ Diesel generators in planning
- ★ Anaerobic Digesters in planning
- ★ Existing Wind Turbine Sites



## Data from Aug 2010 to Aug 2011

• 765 Generation Applications received by DOE Planning Service

## Breakdown of Source Technology

• 89% wind turbines, 5% Anaerobic Digesters, 6% other

## Capacity of Applications

- 65 applications Less than 20kW
- 120 between 20kW and 150kW
- 274 between 150kW to 250kW
- 306 250kW or above

# Volume of Applications

- Due to the ROC incentive mechanism interest and inquiries have increased tenfold in this area over the last 2 years.
- We have put more resources in place and we have recruited further resources.
- We will deploy whatever resources are required to meet the volume of work going forward.
- The timescale to get connected is usually dictated by planning and consents for the overhead line work.

# Technical Aspects of Grid Connection

# Network Issues

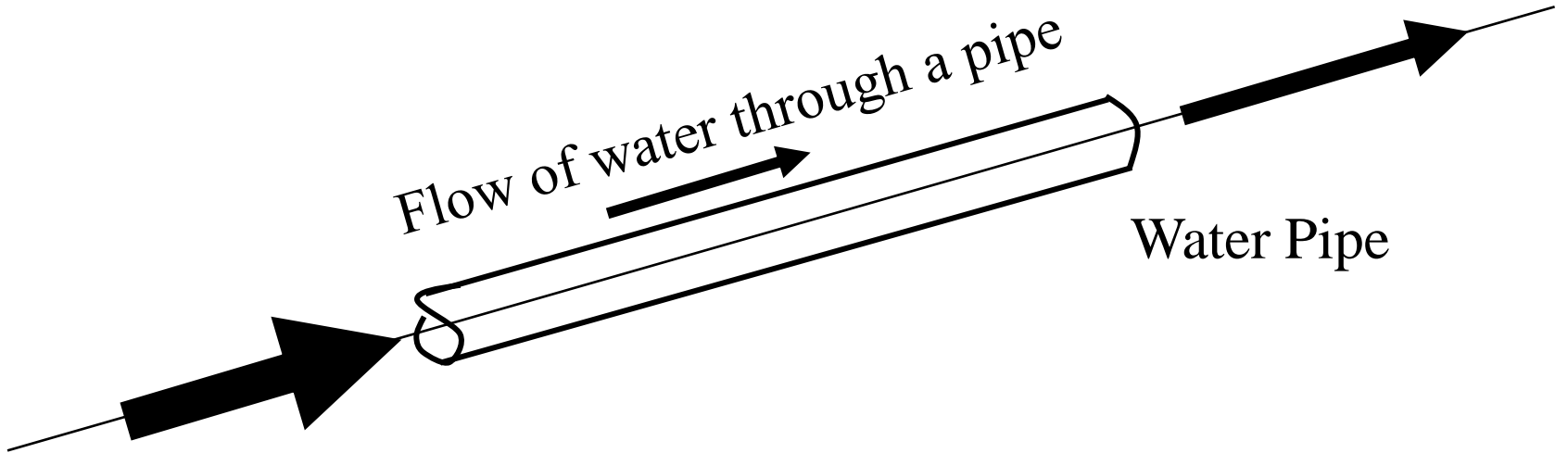
- Network Voltage
- Thermal Issues
- Fault Levels
- Quality of Supply
  - Voltage Dip
  - Flicker
  - Voltage Imbalance
  - Harmonics

# Water Pipe Analogy

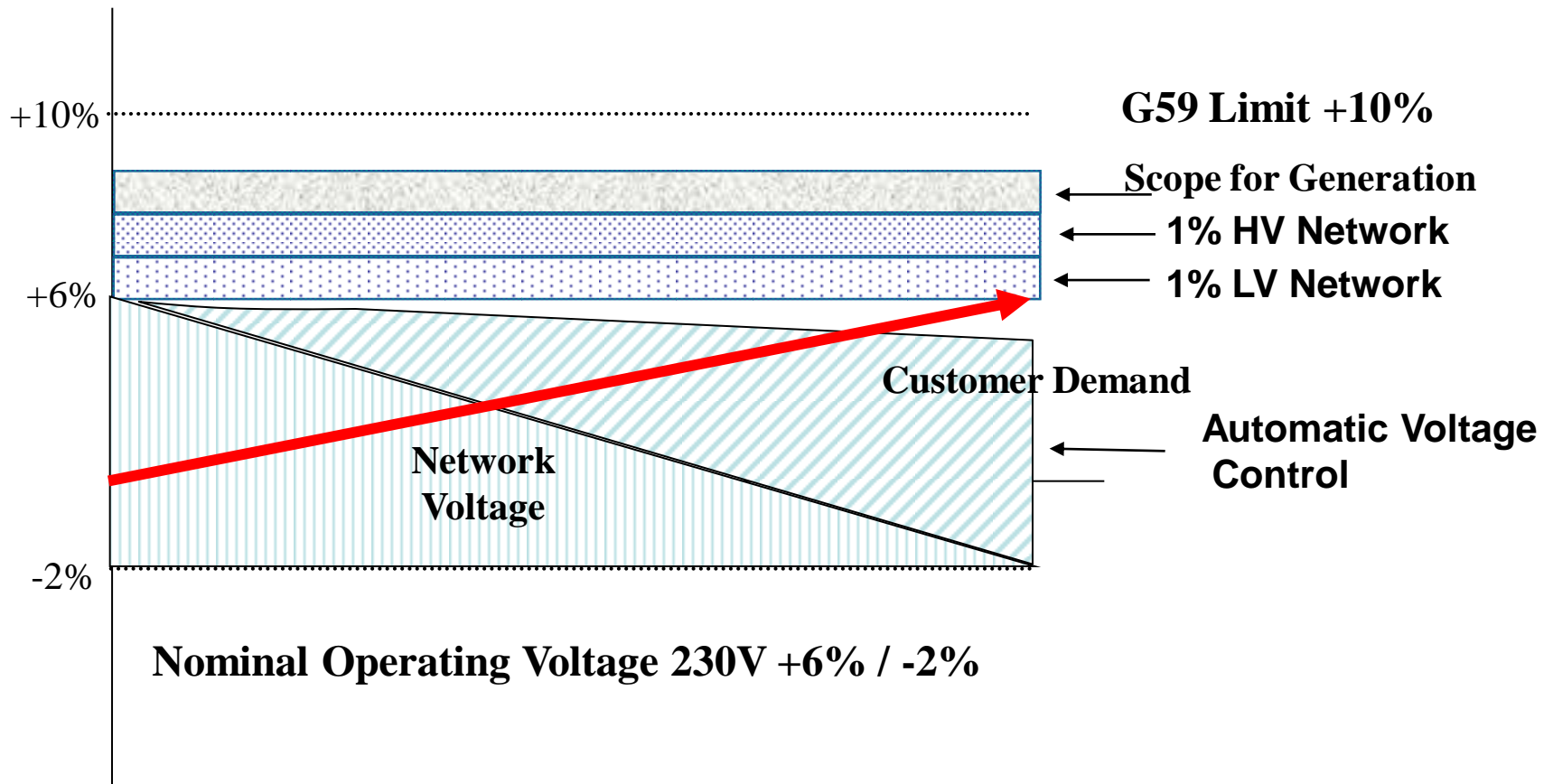
Pressure  
Greatest at the  
Sending End

Electricity

Pressure (Voltage)  
Greatest At the  
Sending End



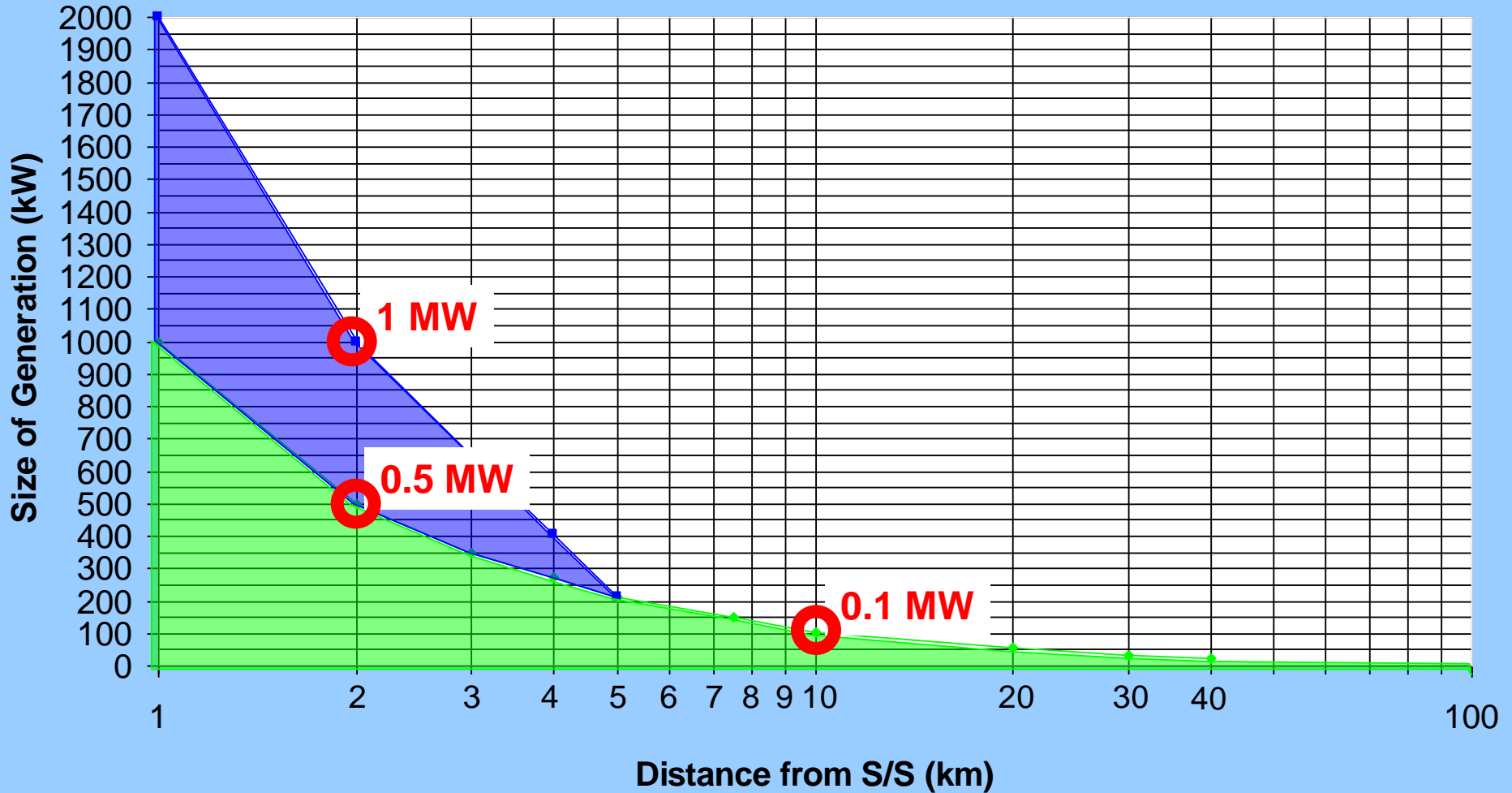
# Network Voltage



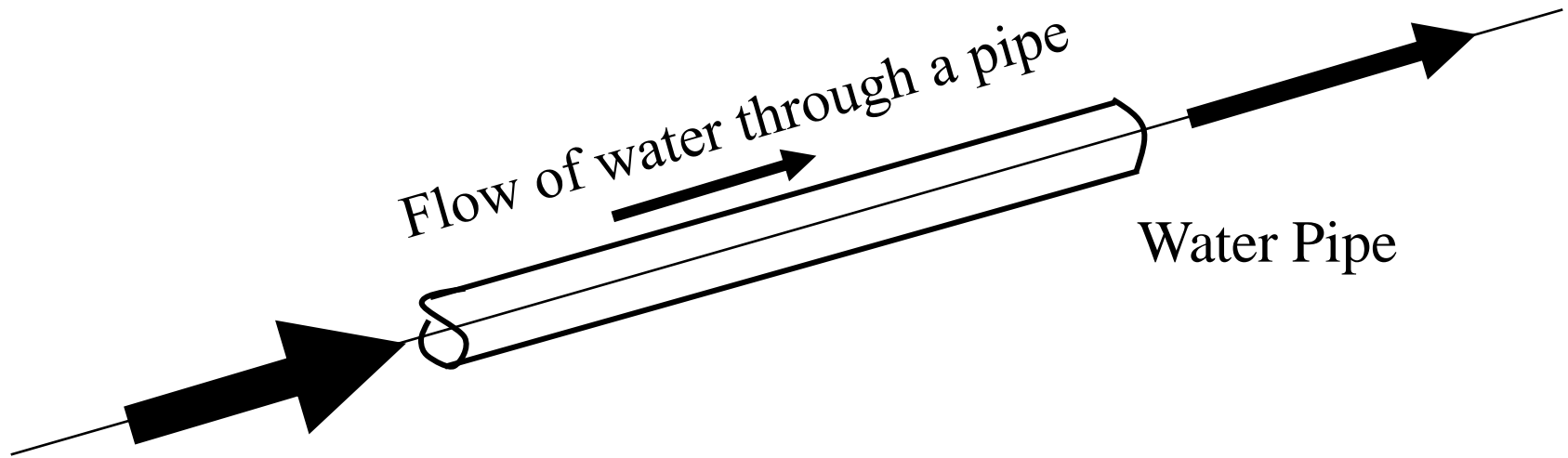
Scope for Generator Connection

# Maximum Size of Generator 11kV Network - 1% Voltage Rise

- 3x25 ACSR Line
- 3x50 ACSR Line



# Water Pipe Analogy

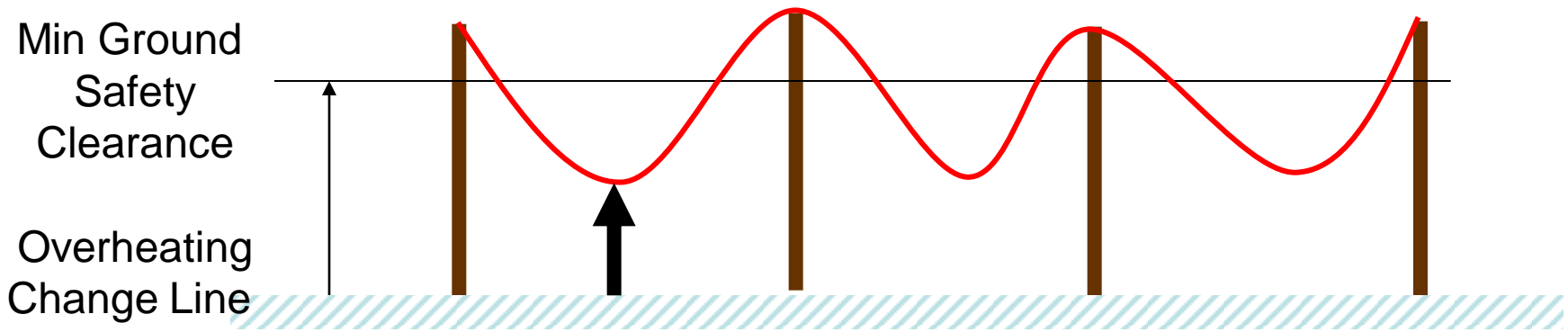
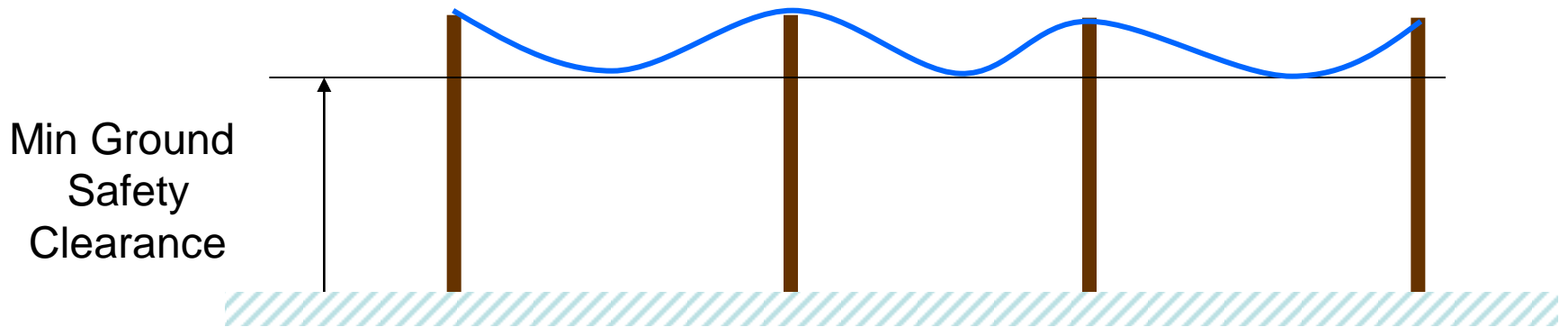


Flow Rate  
Limited by the  
Pipe's Diameter

Electricity

Flow Rate (Current )  
Limited by the  
Conductor's Diameter

# Thermal Rating

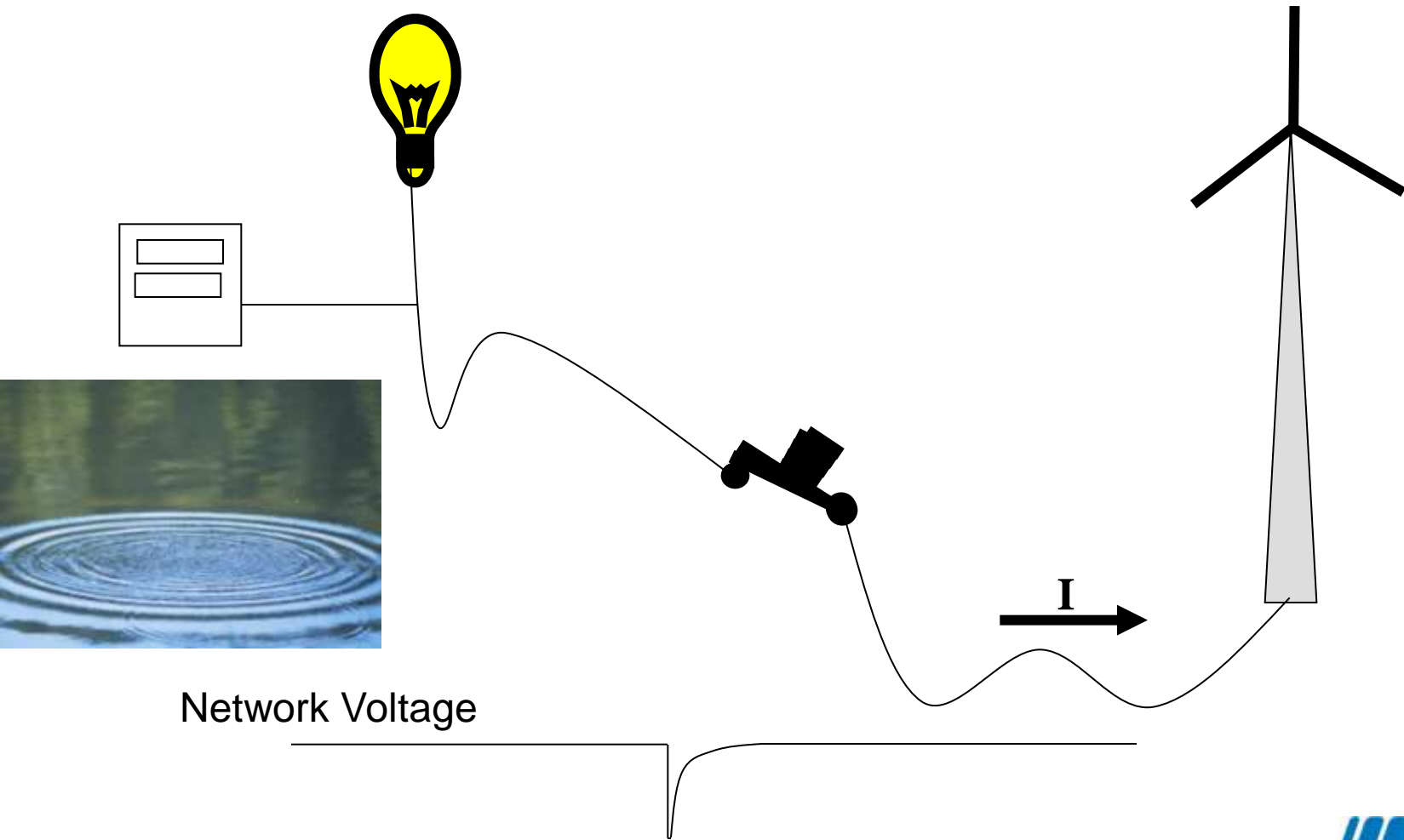


**Insufficient Ground Clearance**

# Power Quality Issues

# Voltage Dip

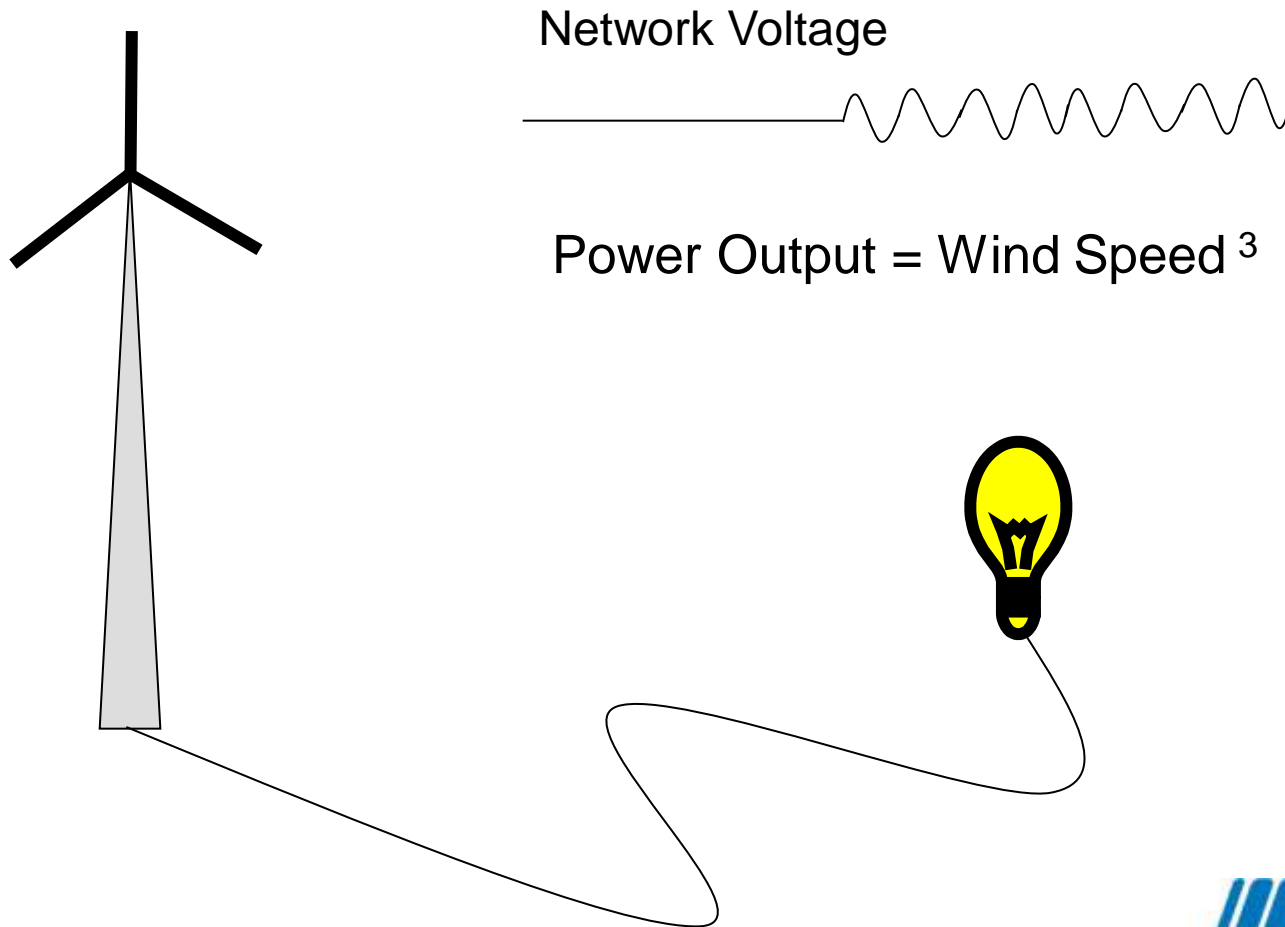
Caused by a Surge of Current when connecting Generator





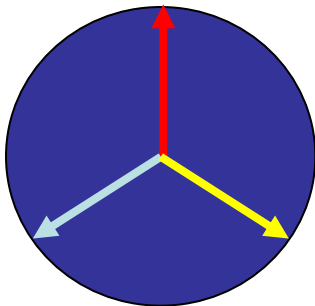
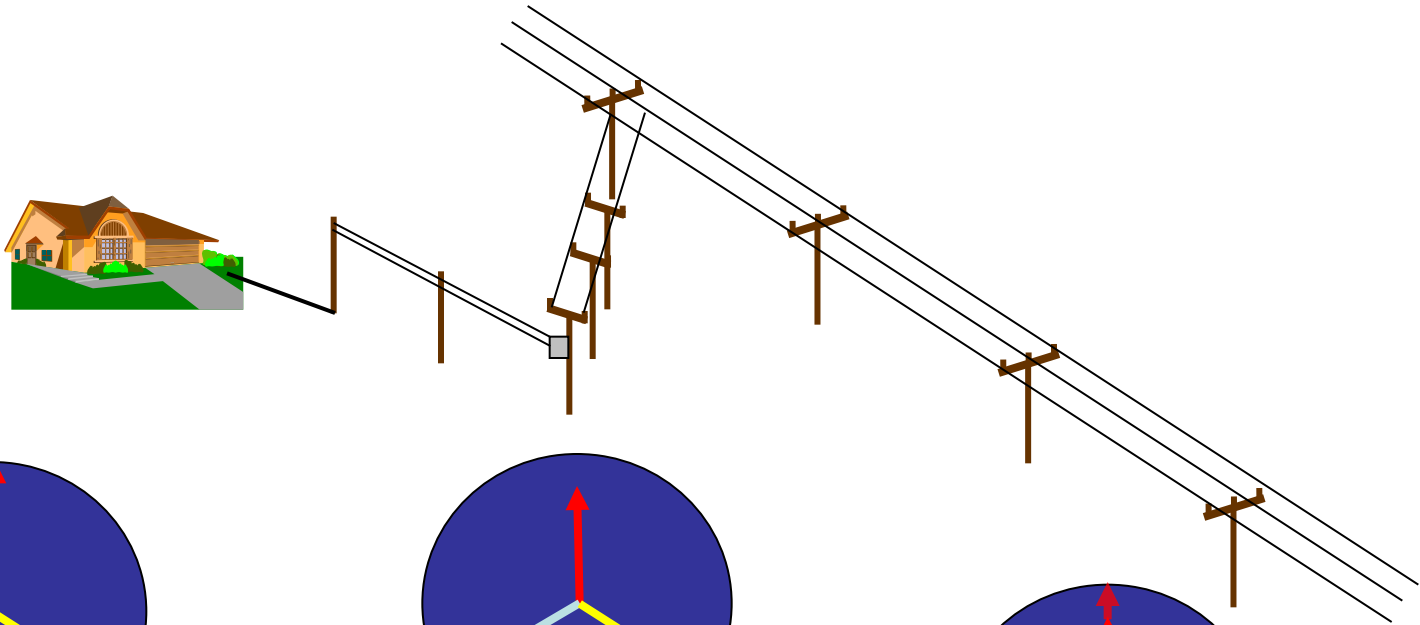
# Flicker

Caused by the varying of the Generator output

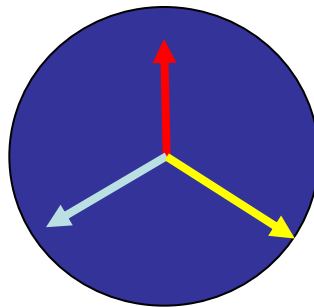


# Voltage Imbalance

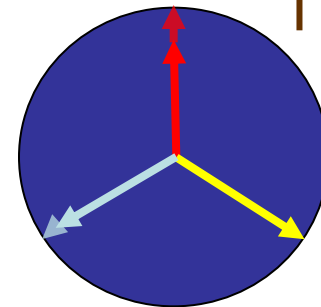
Caused by Large No. Single Phase Load connections



Balanced Network  
All Voltages Equal



Imbalance Network  
Different Phase Voltage

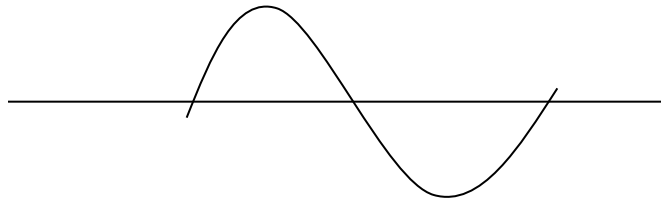


Circulating Current  
In induction Generator

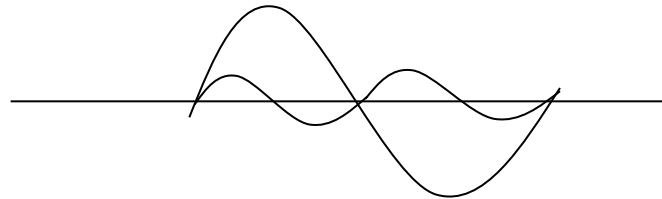
# Harmonic's

Caused by Inverters & Variable Speed Drives  
(Range 2<sup>nd</sup> – 50<sup>th</sup> Harmonic)

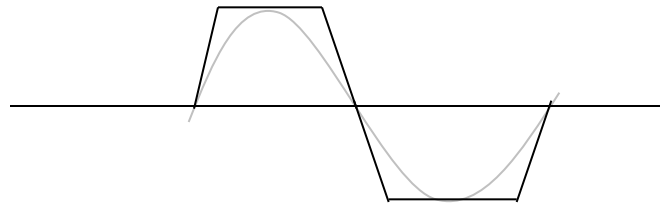
Mains Frequency 50Hz



Mains Frequency 50Hz  
Plus Harmonic



Resulting Waveform  
(Frequency 50Hz  
Plus Harmonic)



# Licence requirements

- Engineering Recommendations
- P5/4 – Harmonic
- P28 – Flicker
- P29 – Voltage Imbalance

# Engineering Recommendations

## **G83/1/Ni Connection Process (Smaller Generation)**

Engineering Recommendation G83/1 is for the Connection of small-scale Embedded Generations (up to 16 Amps per phase) in parallel with public low-voltage distribution networks.

### **G83/1 NIE Limits**

Single Phase = up to 6.5kW

Three Phase = up to 20kW

## **G59/1/Ni Connection Process (Larger Generation)**

Engineering Recommendation G59/1/Ni is for the connection of Embedded Generating Plant to NIE's Distribution System <5MW and < 20kW

### **G59/1 NIE Limits**

Single Phase = > 6.5kW < 20kW

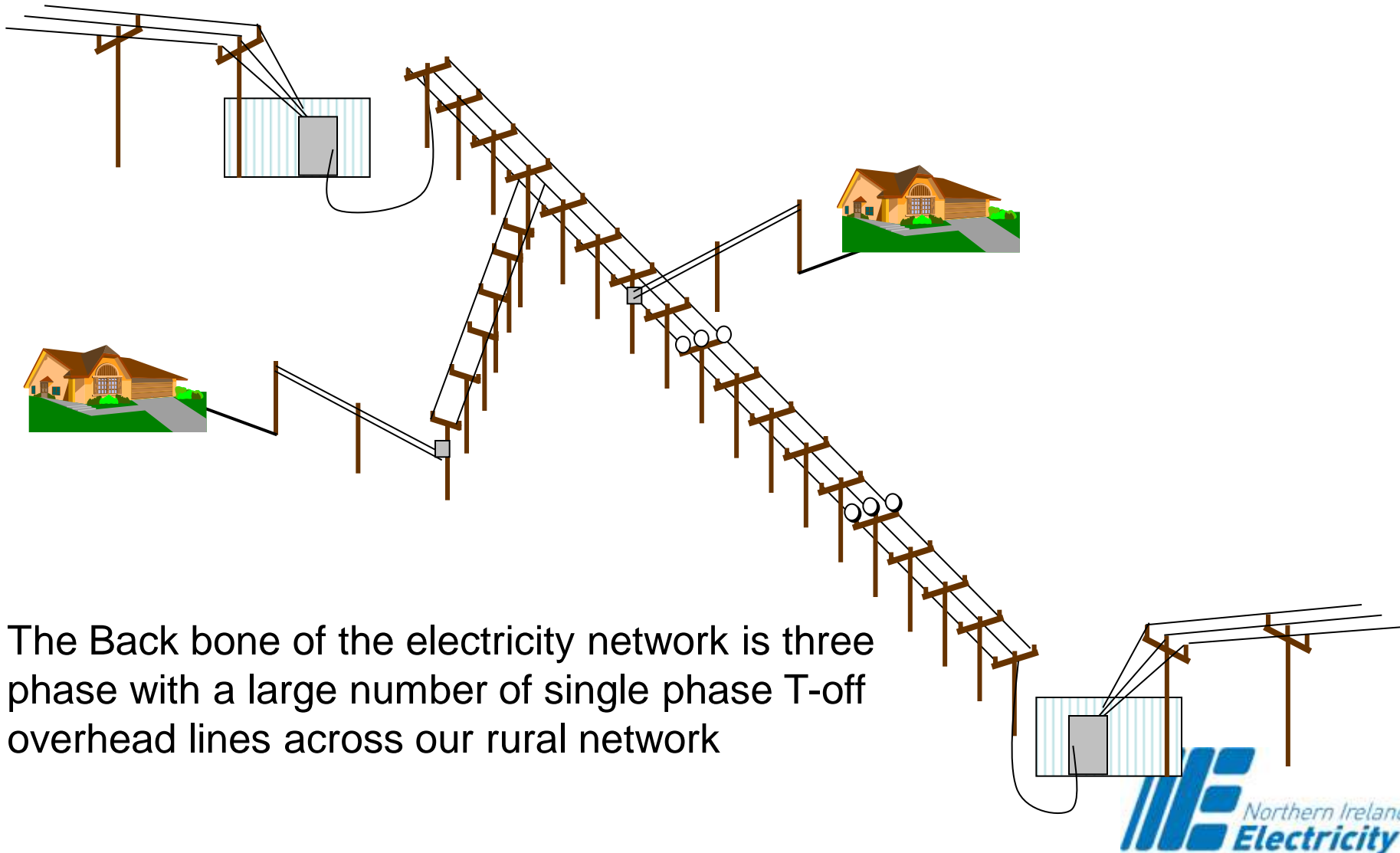
Three Phase = > 20kW < 5MW

Engineering Technical Report 113 is a Note of Guidance For the Protection of Embedded Generating Plant up to 5MW for Operation in Parallel with Public Electricity Suppliers Distribution Systems.

**These Recommendations are important as it ensure the safety of the General Public, NIE Staff and the Network.**

# Practical Aspects of Grid Connection

# Northern Ireland Electricity Grid



The Back bone of the electricity network is three phase with a large number of single phase T-off overhead lines across our rural network

# Grid Connection

- The extent of construction work required to connect your scheme depends entirely on:
  - Site location
  - Connection distance from your generator to the electricity network
  - Distance from your generator to the nearest NIE primary substation which will determine the Network capacity at your location
  - Generator characteristics

# Grid Connection

- Small scale renewables – individual wind turbines or anaerobic digesters
- The 11,000 volt network was mostly built in the 1950's and 1960's to bring electricity to rural homes, farms and communities.
- It was not designed to connect the wind turbines (up to 250KW) that are appearing today (typical farm maximum demand is around a tenth of this figure).
- The cost of the connection will depend on the location of the applicant.
  - If the location is at the extremity of the 11,000 volt network the cost will be greater than a location closer to the central main line.
  - This makes it difficult to provide indicative costs that can be used as a guide by prospective applicants.

# Grid Connection

- The current connection rules (agreed by the Utility Regulator) stipulate that the applicant must bear the full cost of the connection.
- If the applicant doesn't bear the cost then all customers in N Ireland bear that cost, spread over 40 years.
- Connection charges must represent the cost of carrying out the work.
- Currently the Utility Regulator is conducting a consultation in the whole area of connections and one of the areas tabled is possible subsidy (borne by all customers) for this type of connection cost.

# Connection Cost Estimates

Capacity	Cost Estimates	Notes
<p><b><u>Case 1: Single Phase Connection:</u></b></p> <p>Pole mounted transformer to meter box.</p> <p>Generation Capacity up to 20kW single phase</p>	<p>£5000-6000</p>	<p>-Service cable length up to 20m from existing pole.</p> <p>-Assuming existing 11kV single phase overhead line, adjacent to proposed generator connection point.</p>

# Connection Cost Estimates

Capacity	Cost Estimates	Notes
<p><b><u>Case 2: Three Phase Supply:</u></b></p> <p>Pole mounted transformer to meter box. Generation capacities 50kW – 99kW</p> <p>Generation capacity 100kW-150kW, typical connection cost (incl SCADA)</p>	<p>£20,000</p> <p>£40,000</p>	<p>Existing three phase overhead lines are required adjacent to the proposed connection point.</p>

# Connection Cost Estimates

Capacity	Cost Estimates	Notes
<p><b><u>Case 3: Three Phase Supply:</u></b></p> <p>Power supplied from ground mounted substation</p>	<p>£70,000 (incl SCADA)</p>	<p>-Supply directly from the substation . Units &gt; 150kW. -SCADA is required on anything above 100kW. -Existing 11kV three phase overhead line required adjacent to proposed generator connection.</p>

# Connection Cost Estimates

Capacity	Cost Estimates	Notes
<u>Case 4: Conversion of 11kV single phase to three phase supply.</u>	£25,000 – 30,000 / km (three phase line)	Supply may need to be upgraded depending on the point of connection to the network.  - This estimate applies for converting a single phase line to three phase or building a new three phase line.

# Grid Connection Process & Timescales

# Feasibility Studies

- Study is optional
- No planning permission required
- The feasibility study will indicate
  - Connection Voltage Level
  - Connection Point to NIE Network
  - Details of the connection arrangement
  - Indicative costs of the proposed connection
- To carry out a feasibility study NIE require:
  1. Completed Feasibility Study Enquiry Form
  2. Copy of the generator's electrical data sheet if available.
  3. Cheque for the appropriate amount made payable to NIE Ltd

**Generation Maximum installed**

**Capacity Cost incl VAT @ 20%**

**150kW or less**

**£600**

**More than 150kW**

**£1,200**

- A feasibility study does not reserve network capacity for a particular project

# Network Connection & Capacity Study

- Offered to customers who have obtained all permissions, including planning permission
- There is no requirement to have a feasibility study carried out before you request a Network Connection & Capacity Study.
- This study is a full technical appraisal and requires you to submit a formal application (NIE Generator Questionnaire) and the full electrical technical specification of the generator being connected together with the appropriate non-refundable fee as detailed below to

## **Generation Maximum Installed Capacity**

20kW or less

21 kW - 150kW

151 kW - 2000kW

## **Application Cost**

£600

£1,800

£6,000.

# G83 Connection Process

- G83 applies to schemes up to 6.5kw single phase and up to 20KW three phase
- **Stage 1- Single Applications**
  - Fit and Inform Arrangement
  - Appendix 3 Commissioning / Agreement Form

# G83 Connection Process

Customer Registers their interest on NIE website and downloads generator application pack

<http://www.nie.co.uk/genconnect/register.asp>



The Installer fits the generator, completes the commissioning form, ensures the customer signs the agreement section and posts the completed form to  
**NIE Distribution Generation, Fortwilliam House, Edgewater Office Park BT3 9JQ**



Customer contacts their supplier to agree purchase contract and Import/Export meter installation



NIE Countersign the agreement and return signed copy to Customer.

# G59 Connection Process- 9 Steps

- **Step 1 Customer Registers their interest on NIE website and downloads Generator**

**Questionnaire and letter**

<http://www.nie.co.uk/genconnect/register.asp>

- **Step 2 Applicant to complete and return Generator Questionnaire to**

Distribution Generation

NIE Power Networks

Fortwilliam House

Edgewater Office Park

Edgewater Road

BELFAST

BT3 9JQ

## **Checklist for your application to NIE:**

- 1. Completed generation questionnaire**
- 2. Cheque for your Connection Application Fee made out to NIE Ltd**
- 3. Copy of approved planning permission**
- 4. Copy of turbine specification**

# G59 Connection Process- 9 Stages

- **Step 3**                    **NIE consider Applicant's proposal and connection implications.**
- **Step 4**                    **NIE issue Applicant with formal Terms and Conditions for connecting the Generator, where applicable this will include a quotation for Costs.**
- **Step 5**                    **Applicant formally accepts Terms and Conditions for Connection and pays NIE connection charge if applicable.**

**On receipt of acceptance and payment NIE initiates any legalities required:**

- Wayleave Approval**
- Cable Easements**
- Substation Lease**
- Planning Permission**

**Only when legalities are obtained and full payment has been received can the construction work be scheduled.**

**NIE do not carry out any further work if the Terms and Conditions for Connection are not received.**

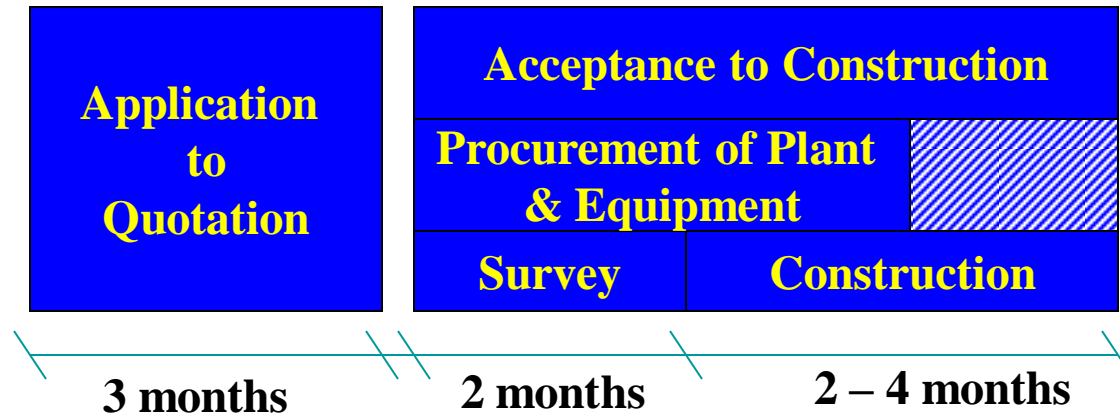
# G59 Connection Process- 9 Stages

- **Step 6**                    **NIE provides Applicant with Generator Connection Agreement and blank copy of the embedded generation test record (Schedule 1A).**
  
- **Step 7**                    **Applicant to advise NIE of the Generator's Trading arrangements.**
  - » **NIE to finalise/agree trading arrangements with the applicant.**
  - » **Installation of metering etc**
  
- **Step 8**                    **Applicant to return signed and witnessed connection agreement.**
- **Applicant carries out tests and provide NIE with signed certification.**
  - » **(10 working days notice required if test require the generator to be paralleled with the NIE Network.)**
  
- **Step 9**                    **NIE countersigns Generator Agreement and returns it to Applicant**

**Once Generator Agreement is in place the Generator can be Paralleled with NIE's Network**

# Timescales - Planning Permission Not Required

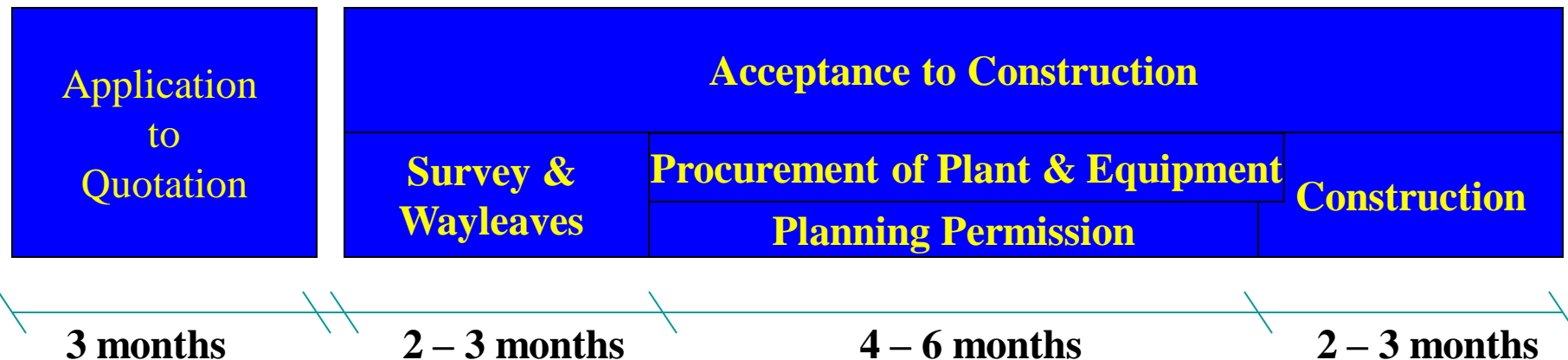
## G59 Connection



- Average time for connection is between 6- 9 months, if plant and equipment is to be ordered. (Lead in time for major items of plant and equipment is up to 20 weeks.)
- Where NIE needs to install equipment on third party property, legal consent in the form of a wayleave agreement and/or easement is required from the relevant landowner. Timescales to obtain landowner approval depends on the landowner's willingness to sign the legal documents.
- Where a substation is required a substation lease must be obtained.

# Timescales - Planning Permission Required

## G59 Connection



- Planning Permission required for construction of any overhead line greater than 100m in length.
- Turnaround time for planning permission approx 4 - 6 months.
- Average time for connection is approx 9 to 12 months following acceptance of terms.

**This timescale is subject to NIE being able to secure legalities ie. wayleaves, easements, substation leases and planning permission**



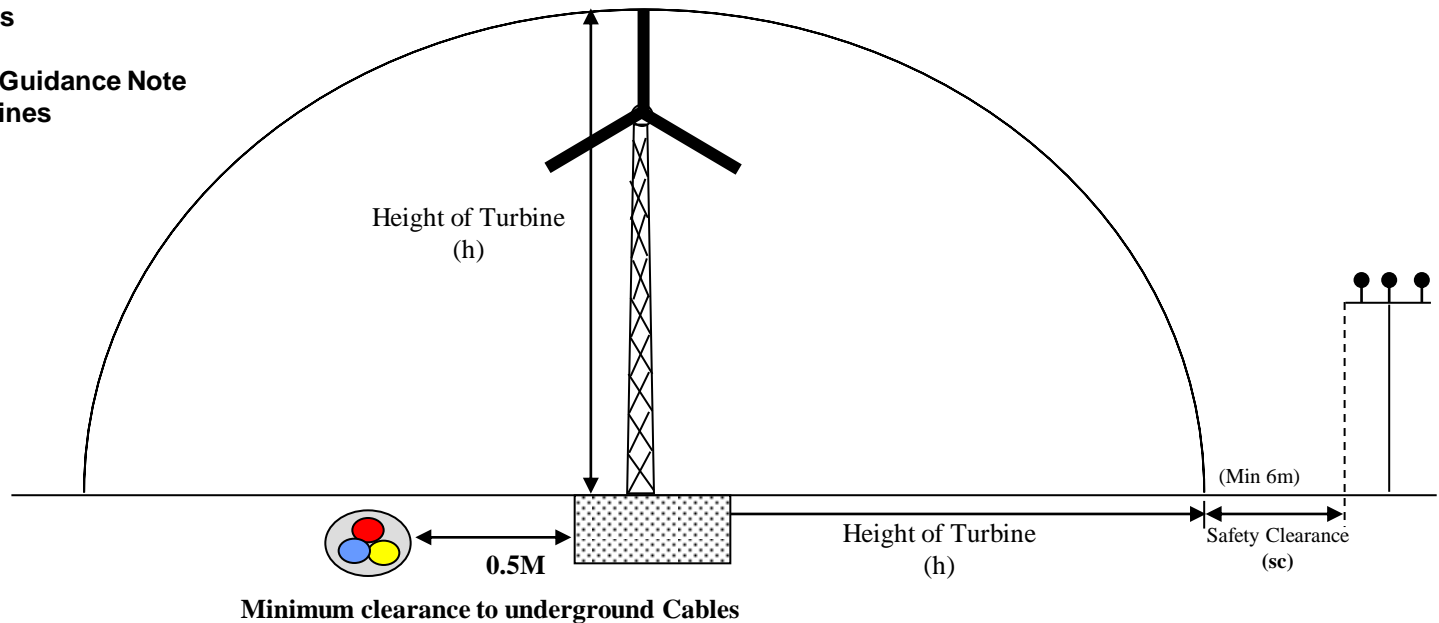
# Safety Clearance to NIE Equipment

# Clearance of Wind Turbines to NIE's Distribution Equipment

## Safety Clearance of Wind Turbines to NIE's Distribution Equipment

The clearance to NIE's distribution network is the total height of the structure including turbine blades plus a minimum safety clearance (**sc**) of 6 metres

**HSE GS4 Guidance Note for O/H Lines**



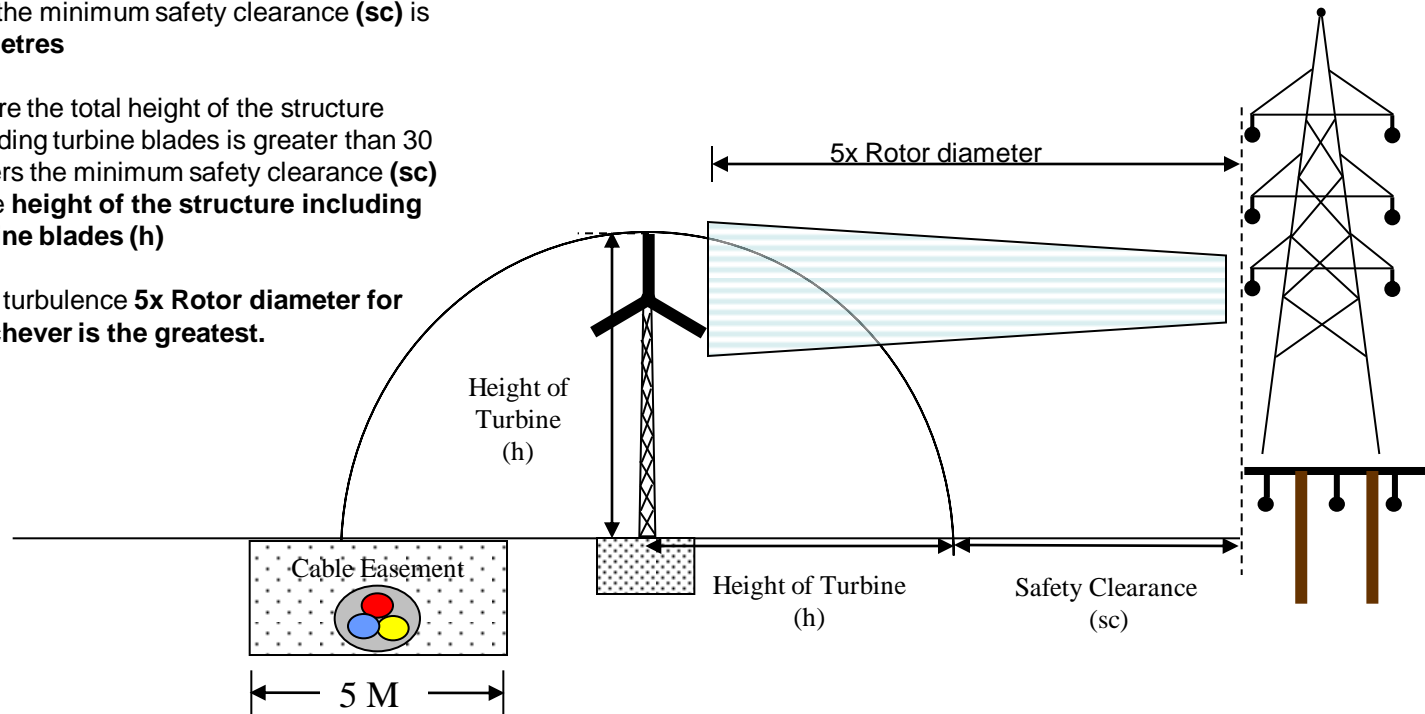
# Clearance of Wind Turbines to NIE's Transmission Equipment


## HSE GS4 Guidance Note for O/H Lines

### Safety Clearance

Where the total height of the structure including turbine blades is 30 metres or less the minimum safety clearance (**sc**) is **30 metres**

Where the total height of the structure including turbine blades is greater than 30 meters the minimum safety clearance (**sc**) is the **height of the structure including turbine blades (h)**  
or  
wind turbulence **5x Rotor diameter** for whichever is the greatest.





Thank you  
Any Questions?