RP5 STAKEHOLDER EVENT

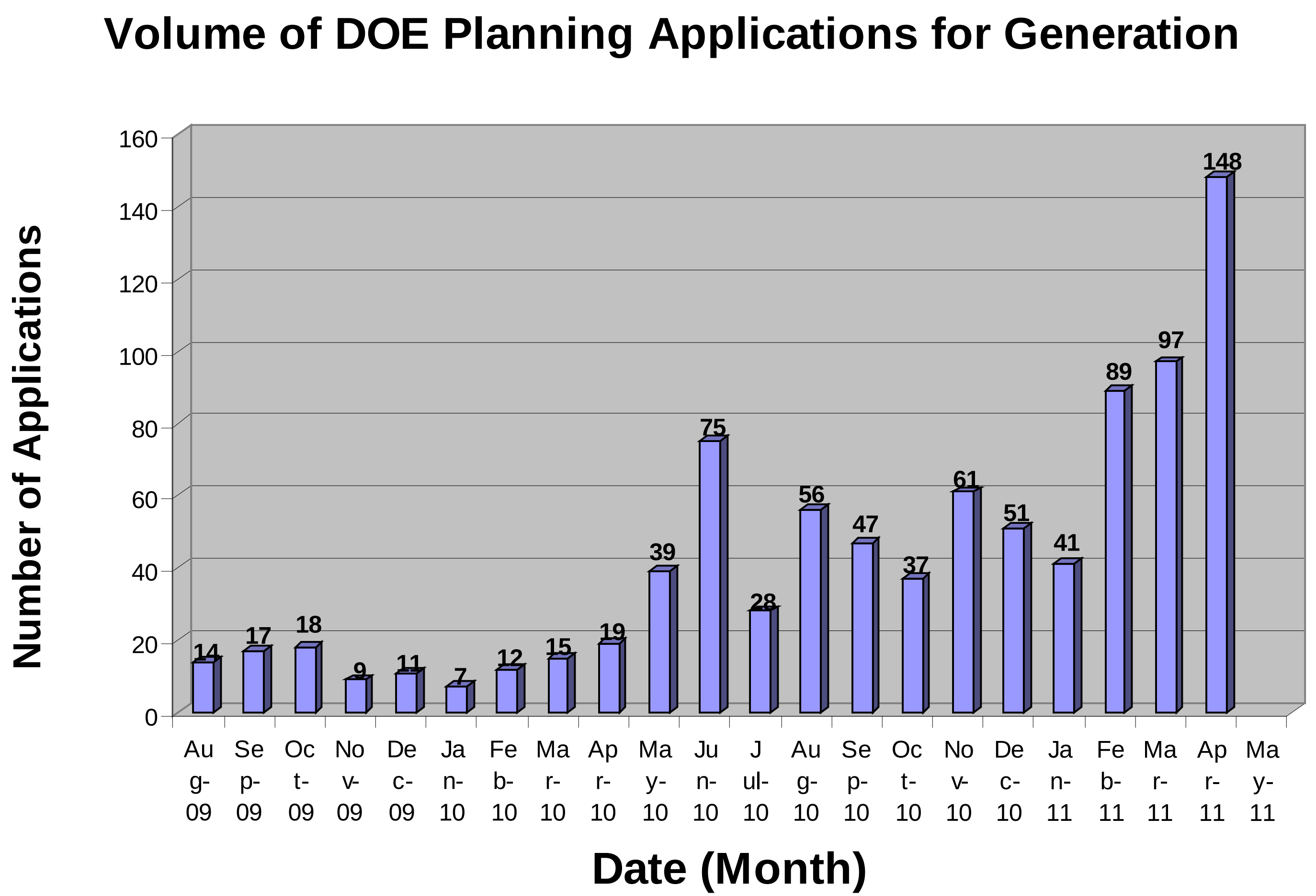
Small Scale Generation Connections

6 June 2011

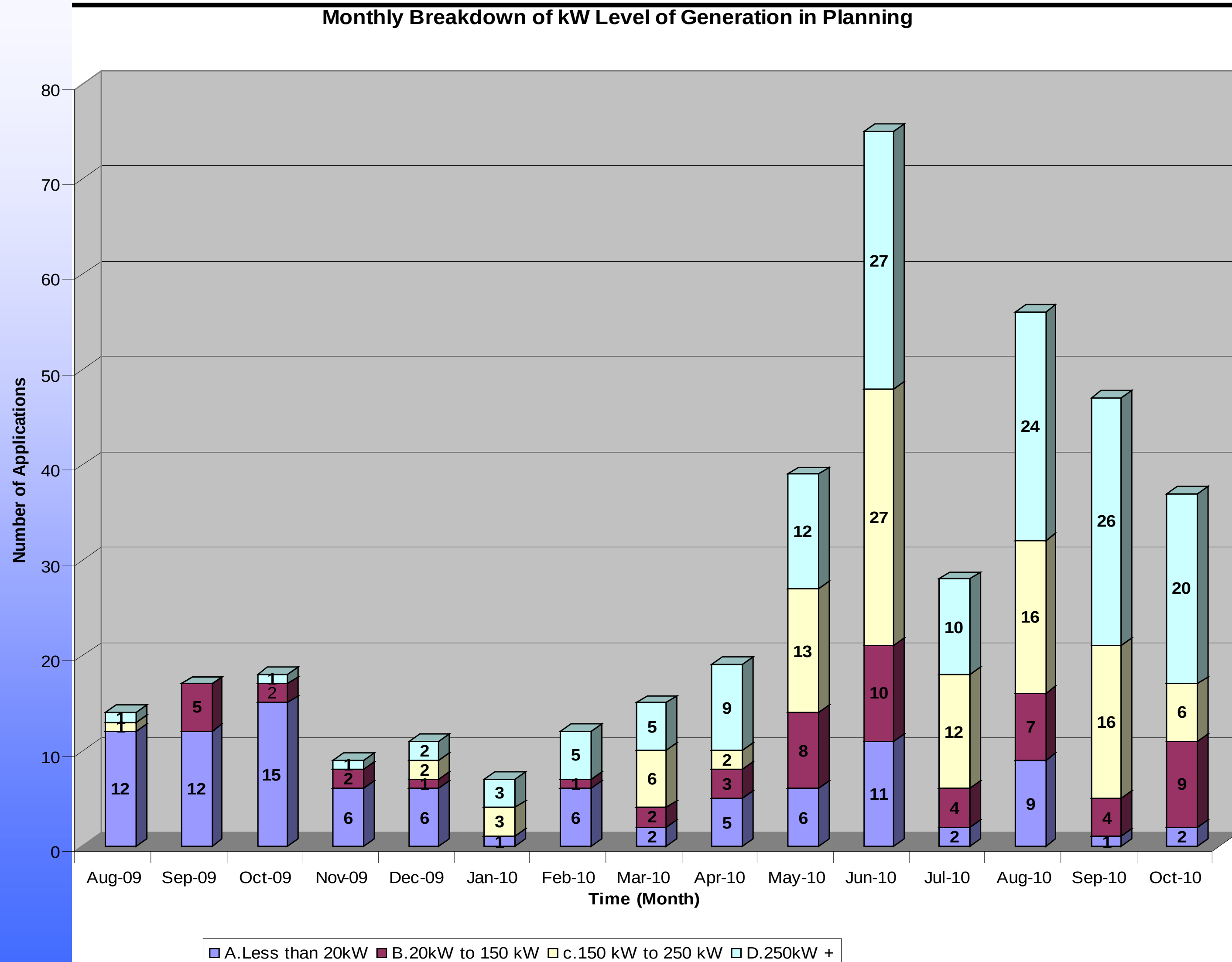
Presentation Approach

- General background with respect to small scale generation connections
  - Anticipated level of connection applications
  - Network issues
  - Technical issues associated with connection to the network
- Approach to assessing a connection application
- Typical connection arrangements and costs
- Resources and processes
- Control, communications and Distribution code
- Issues relating to small scale generation contained in the Utility Regulator's "Next Steps Paper on Electricity Connection Policy for the Northern Ireland Distribution System" dated 10 May 2011

Small Scale Generation seeking planning permission / connection to the 11kV system



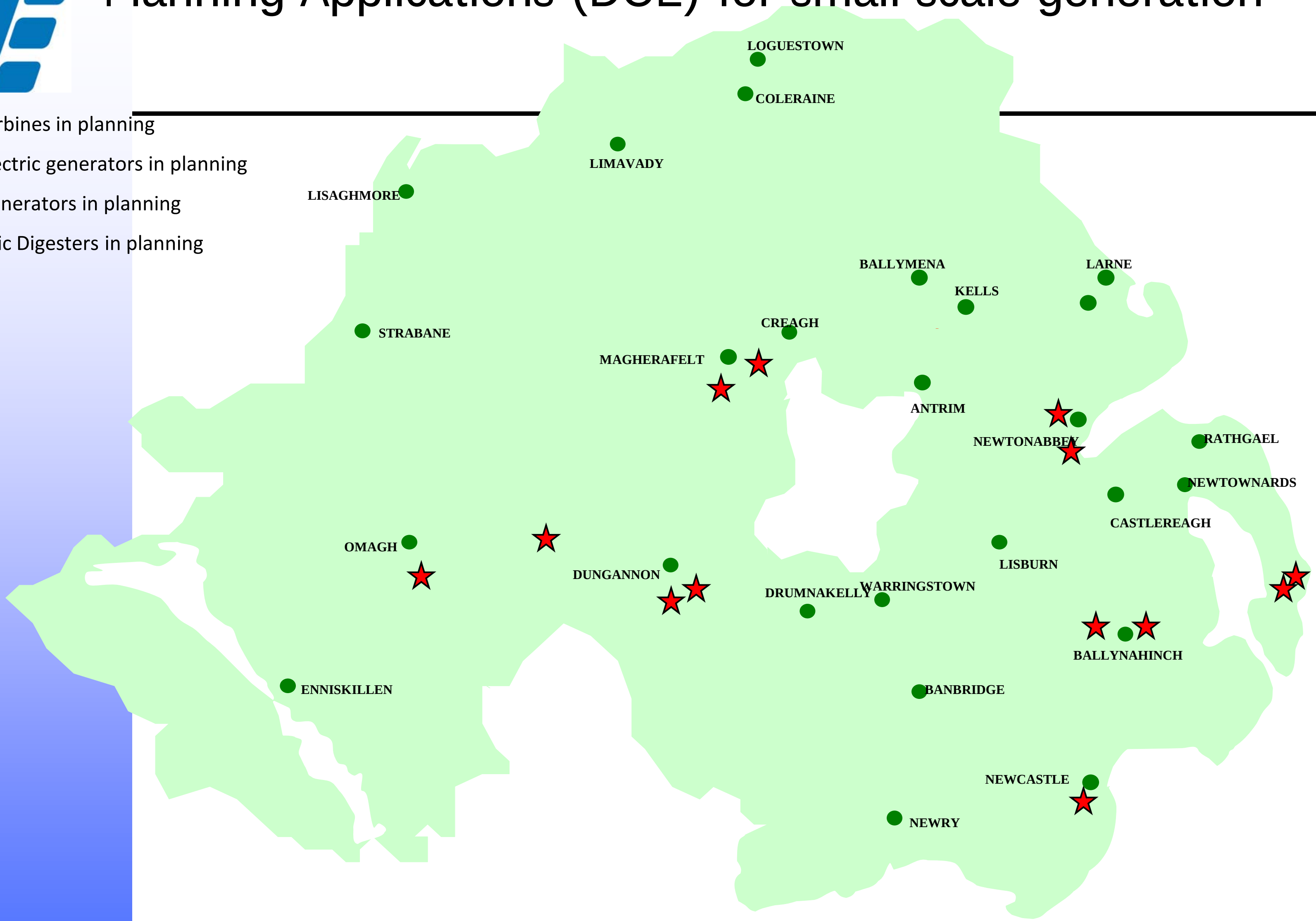
Generation analysed by size



Planning Applications (DOE) for small scale generation

Key

- ★ Wind Turbines in planning
- ★ Hydroelectric generators in planning
- ★ Diesel generators in planning
- ★ Anaerobic Digesters in planning



August 2009

Planning Applications (DOE) for small scale generation

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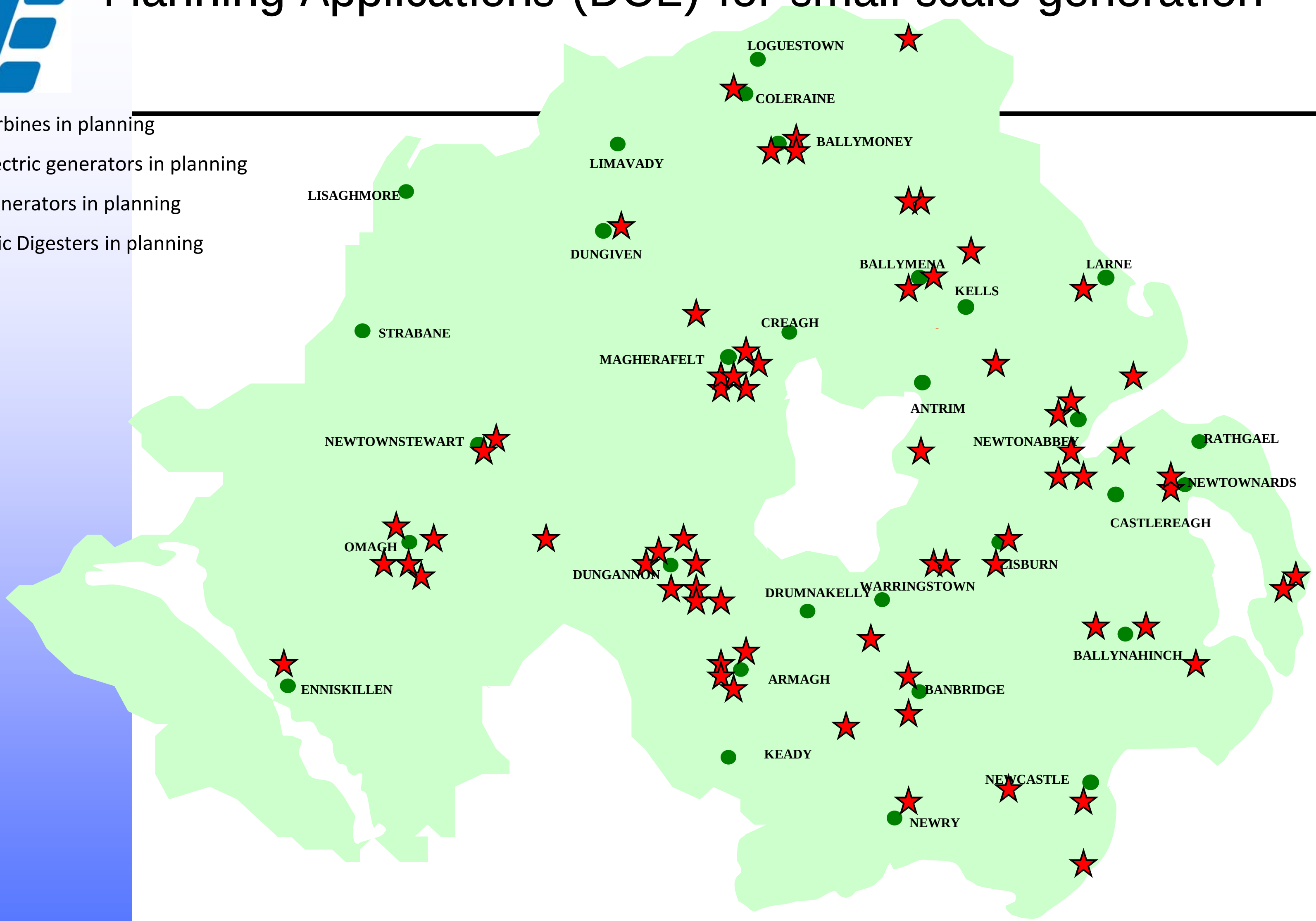

December 2009

Planning Applications (DOE) for small scale generation

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- Hydroelectric generators in planning
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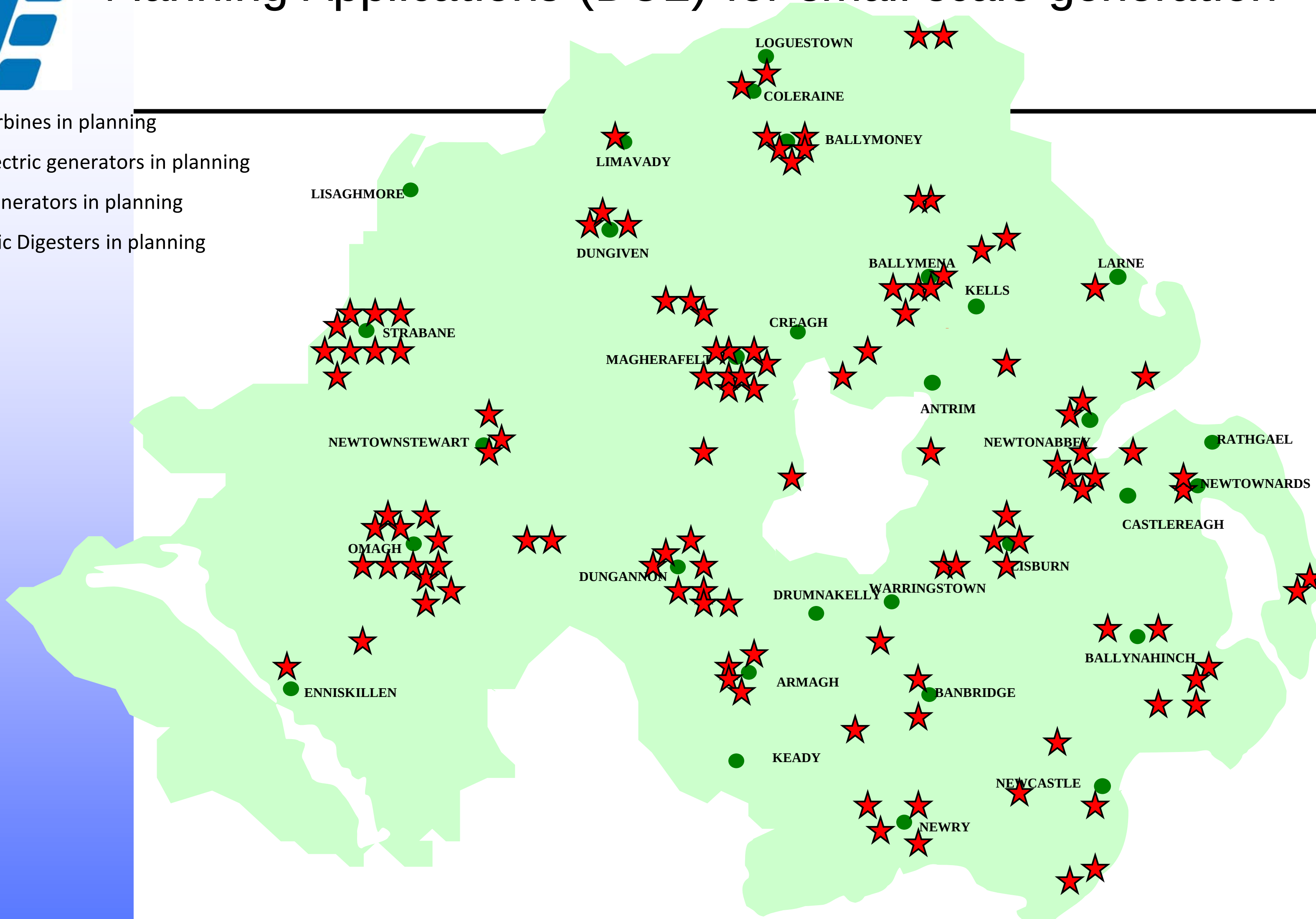

April 2010

Planning Applications (DOE) for small scale generation

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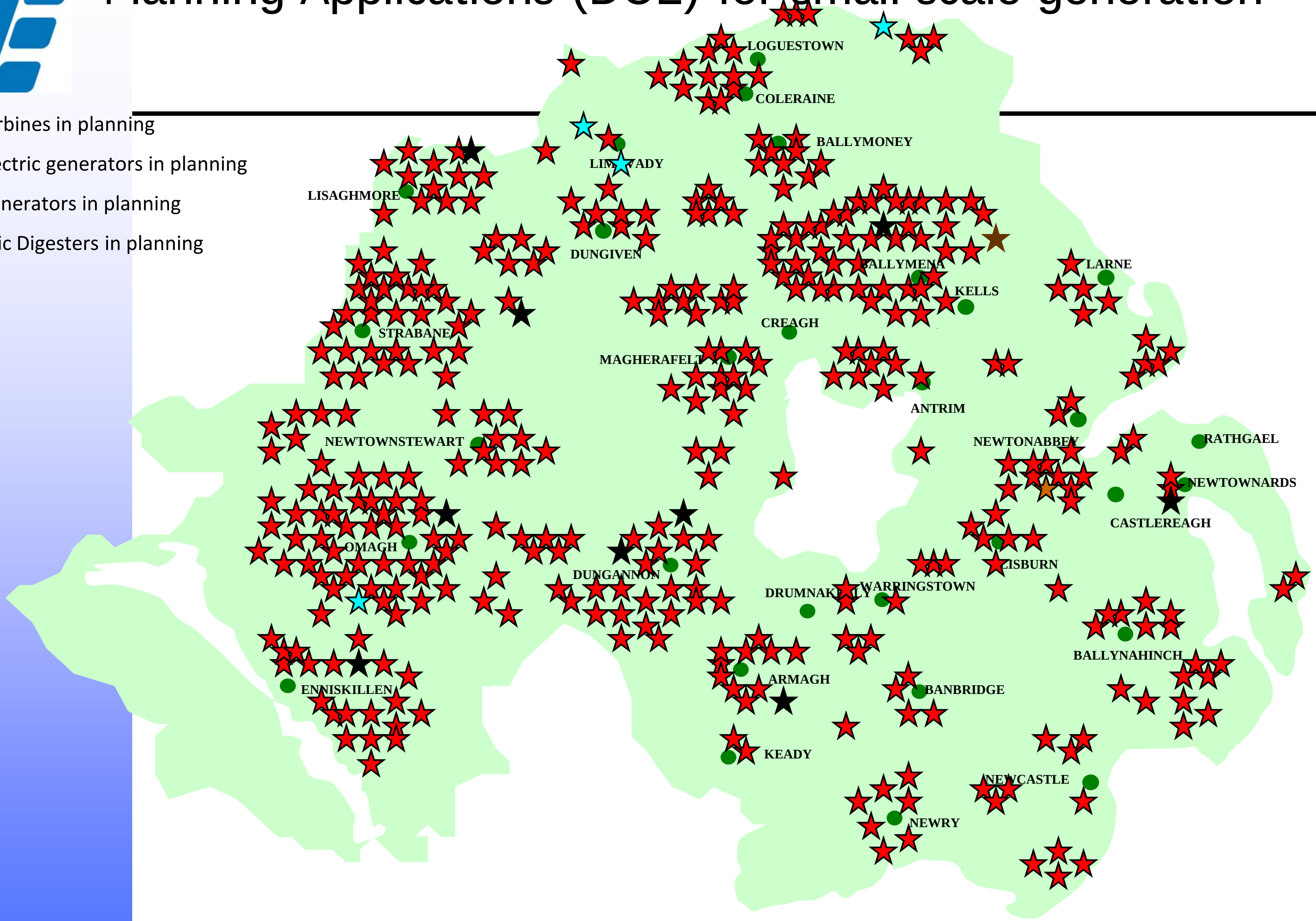
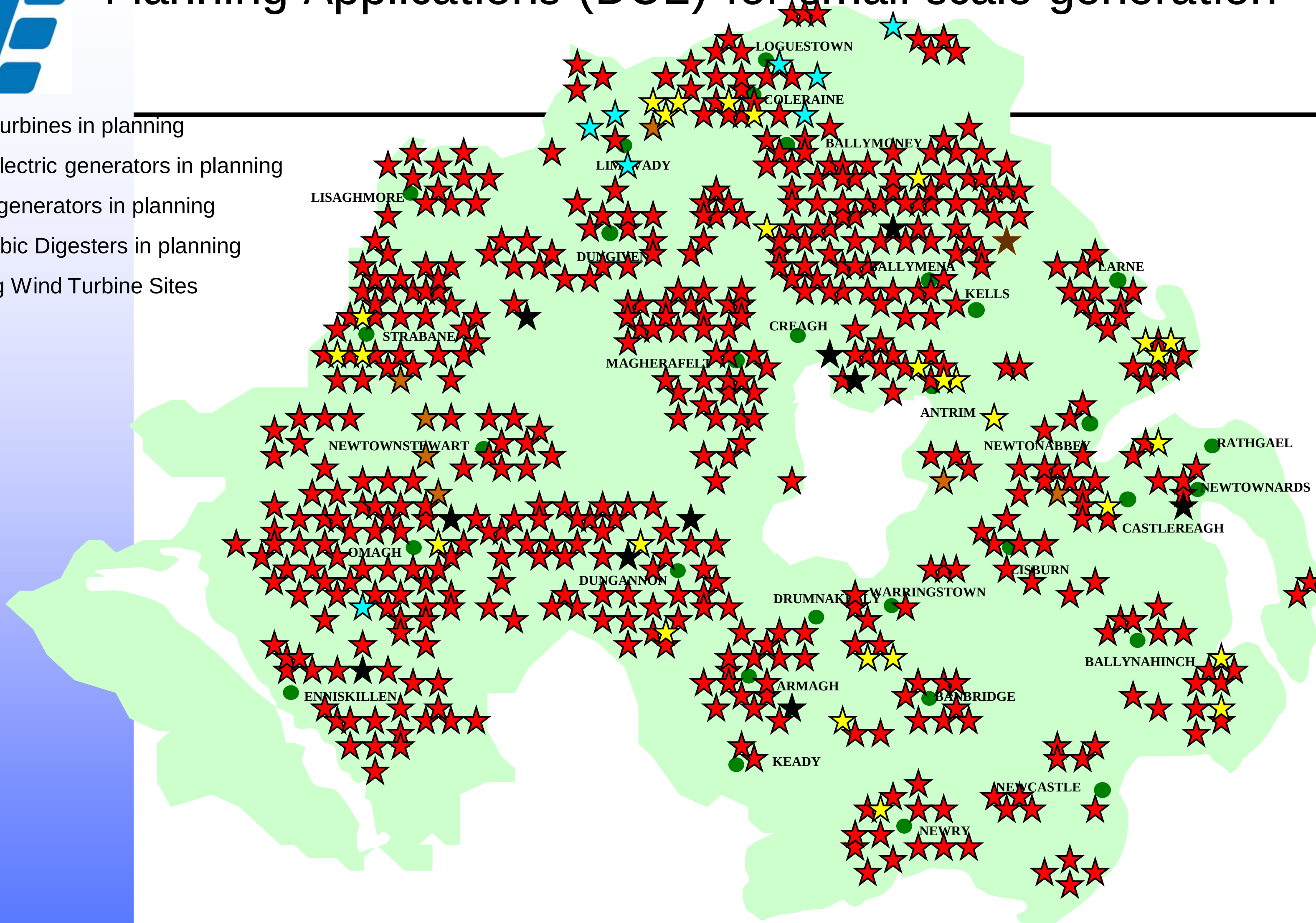


November 2010

Planning Applications (DOE) for small scale generation

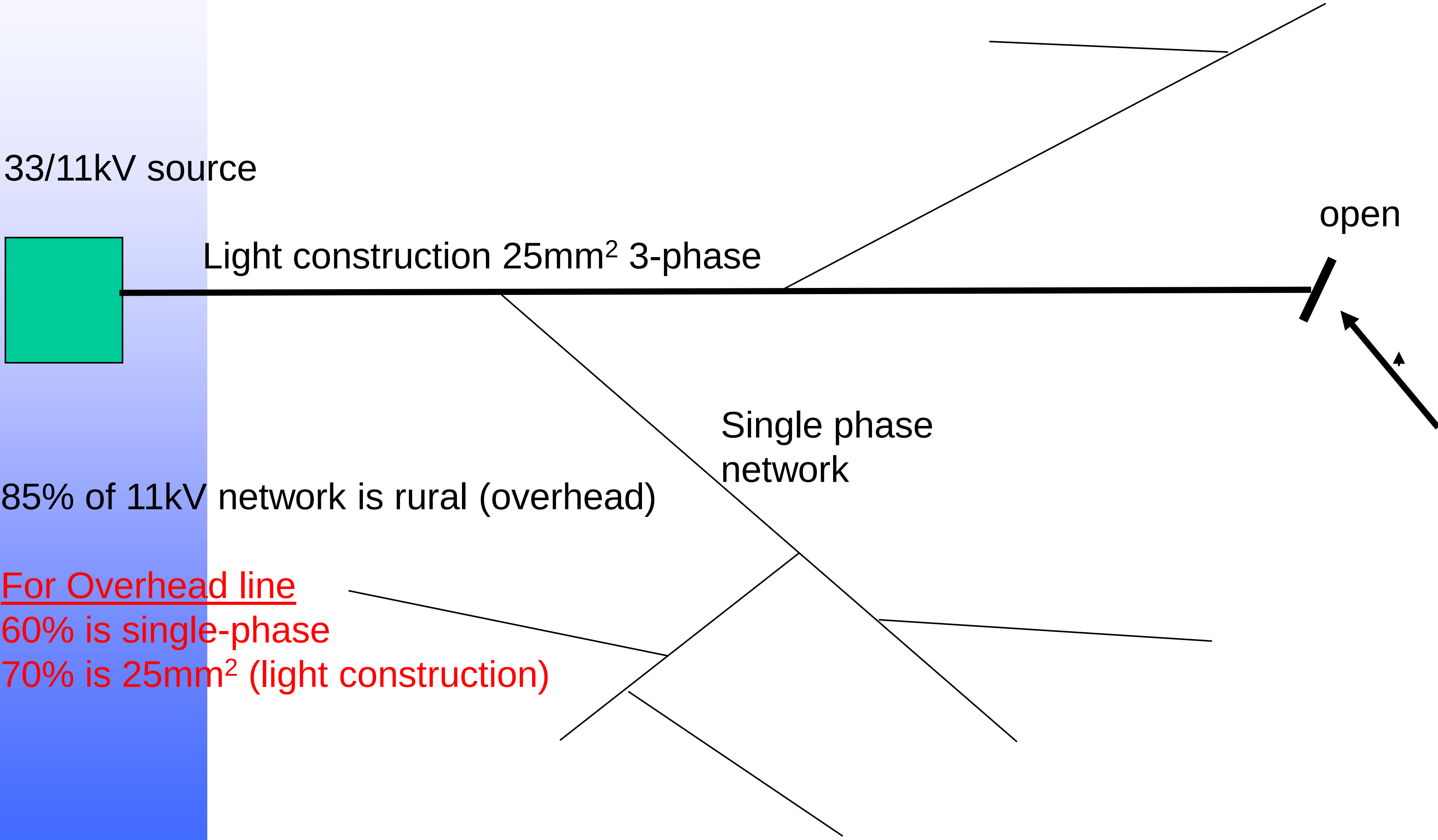
Key

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



January 2011

Typical 11 kV rural network



85% of 11kV network is rural (overhead)

For Overhead line
60% is single-phase
70% is 25mm^2 (light construction)

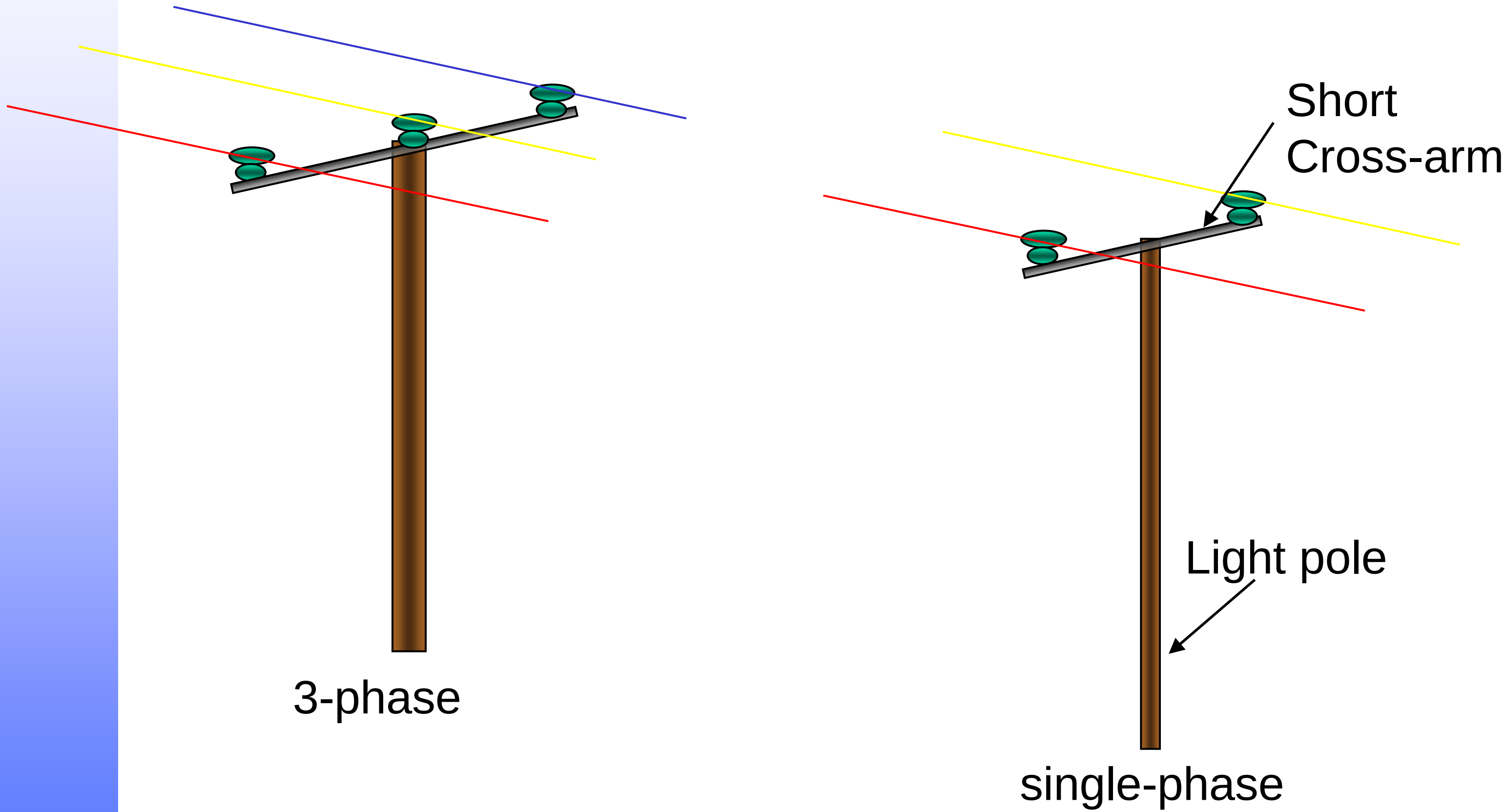
Grid Connection

- Small scale renewables – individual wind turbines or anaerobic digesters
- The 11kV 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 size of wind turbines that are appearing today (typical farm maximum demand is around a tenth of a 250kW generator).
  - Significantly power from generation flows in an opposite direction to traditional demand-related powerflows
- The cost of the connection will depend on the location of the applicant.
  - This makes it difficult to provide indicative costs that can be used as a guide by prospective applicants.
  - However if the location is at the extremity of the 11kV network the cost will be greater than a location closer to the central main line.

Network Issues

- Significant proportion is single phase
- Network Voltage
- Thermal Issues
- Fault Levels
- Quality of Supply
  - Voltage Dip
  - Flicker
  - Voltage Imbalance
  - Harmonics

Single-phase and three-phase line construction

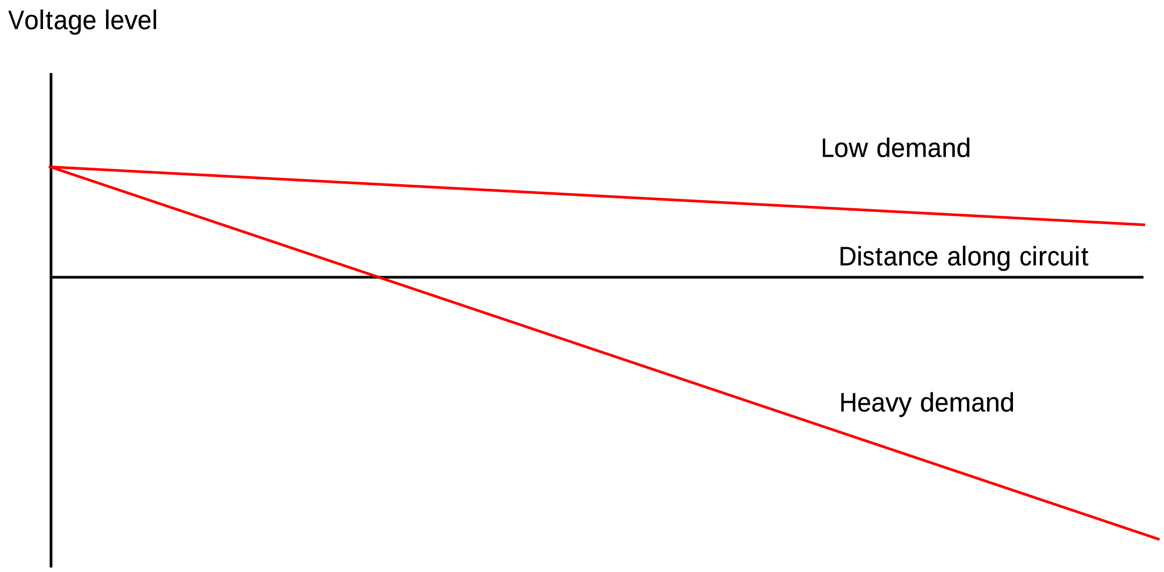


Single-phase to three-phase 11kV line conversion
Complete rebuild often required   £32,000 (indicative)

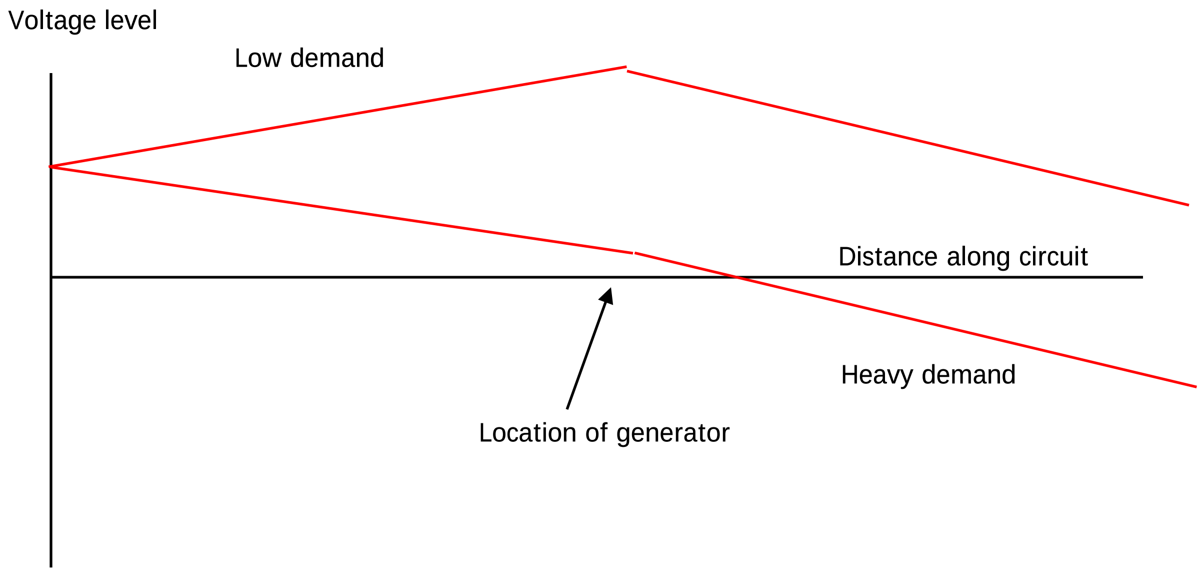
Network Voltage

- Controlled at source substation
- Needs to be set above nominal and controlled at this level to ensure adequate voltage at the end of the line
- Transformers along the line are not controlled to vary the voltage
- Generators will cause voltage rise at their point of connection particularly at times of minimum network demand
- This has the potential to cause voltage to exceed limits for customers on the circuit
- Effect worsens if generator is located remote from our source substation

Network Voltage without generation

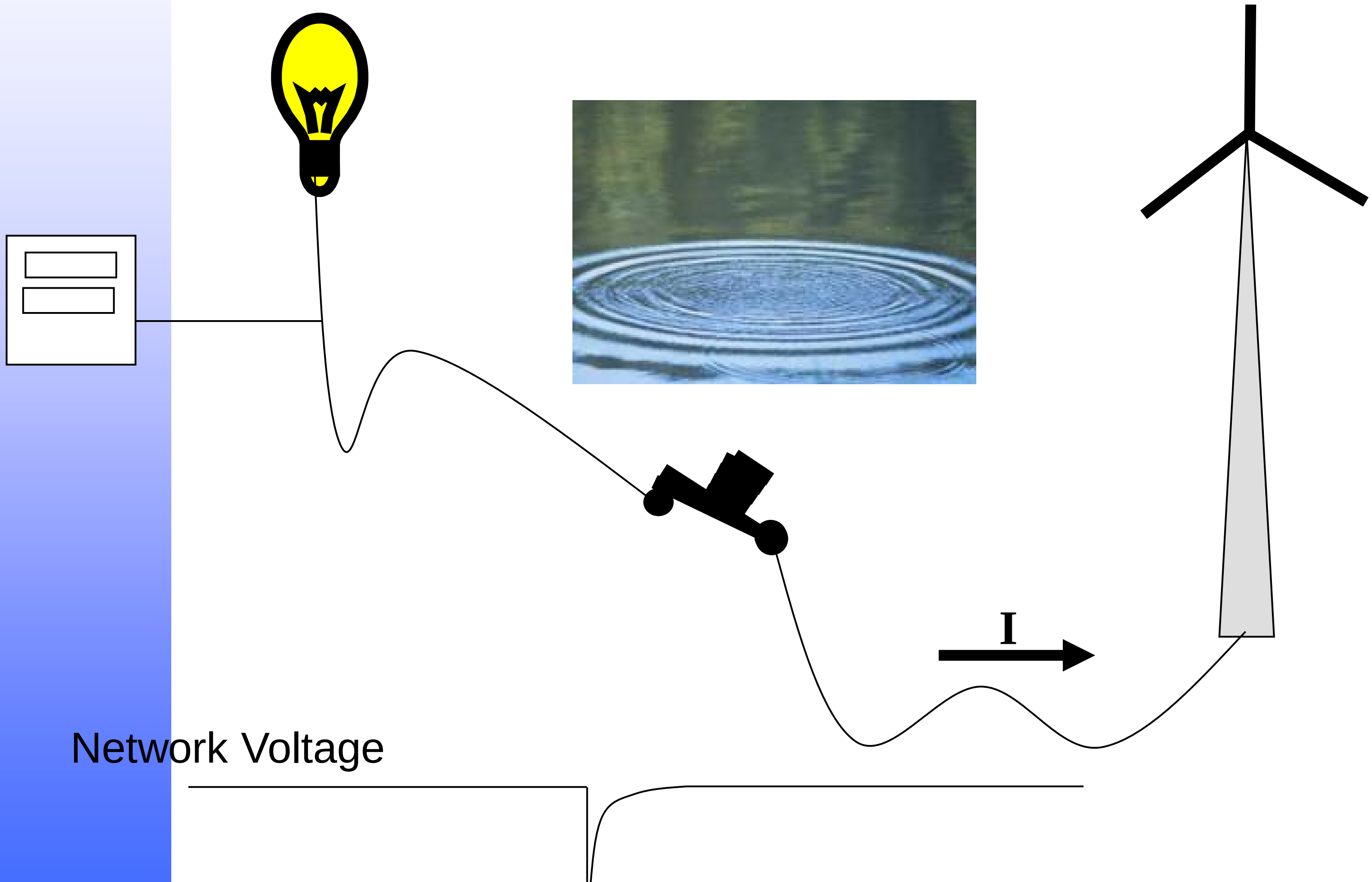


Network Voltage rise as result of generator



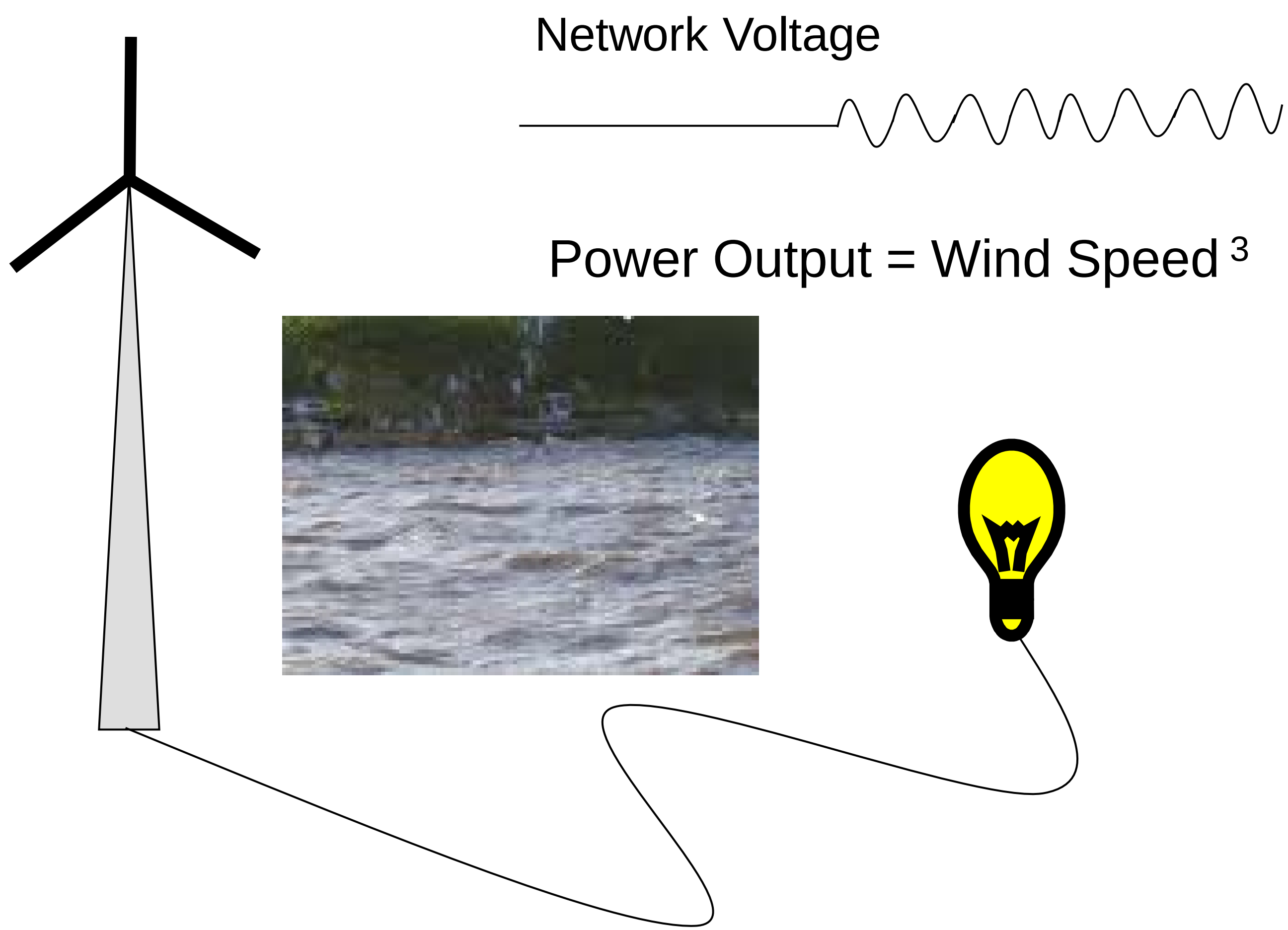
Voltage Dip

Caused by a Surge of Current when connecting Generator



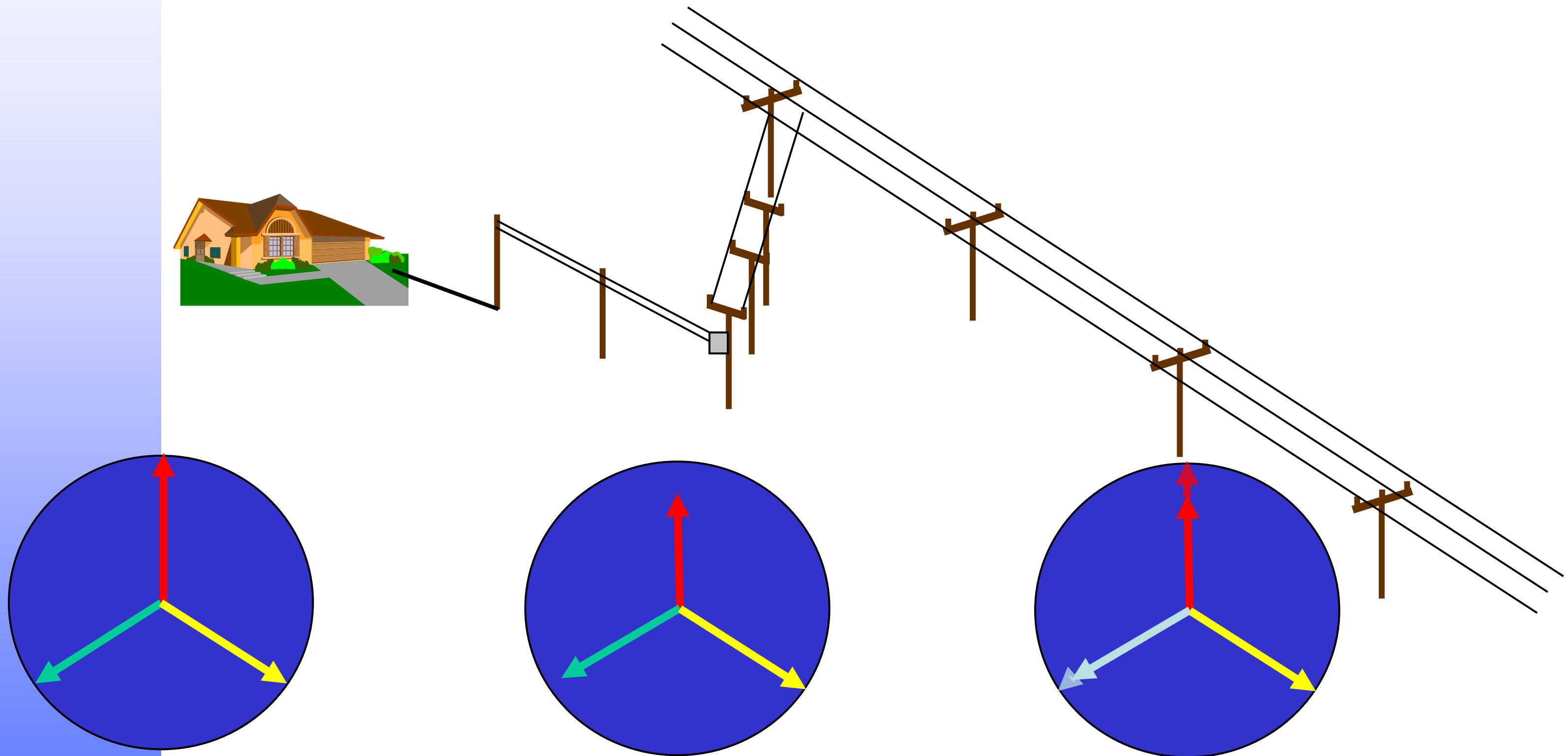
Flicker

Caused by the variations in the Generator output



Voltage Imbalance

Caused by Large No. Single Phase Load connections



Balanced Network
All Voltages Equal

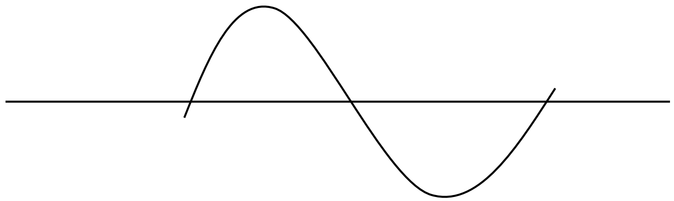
Imbalance Network
Different Phase Voltage

Circulating Current
In induction Generator
can cause overheating
and disconnection

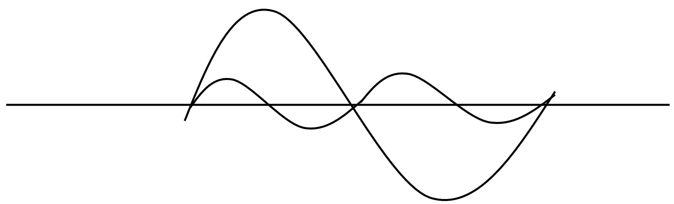
Harmonics

Caused by Inverters & Variable Speed Drives
Can cause overheating of electrical equipment

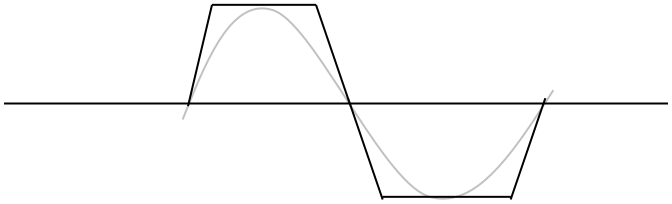
Mains Frequency 50Hz



Mains Frequency 50Hz
Plus Harmonic



Resulting Waveform
(Frequency 50Hz
Plus Harmonic)



Assessment of network connection of a generator

- Require detailed information from applicant
  - Technology
  - Generator size and detailed technical information
  - Location
  - Starting arrangements
- NIE carry out network studies to assess Least cost technically acceptable (LCTA) connection
  - Voltage, Thermal and power quality
  - Worst case assessment (generally minimum demand)
  - Need to consider other generators
  - Protection requirements
- We then consider the physical aspects of the connection
  - Substation location
  - Network extension
  - Landowner and planning
- We then carry out a costing exercise
- Provide connection offer

Typical Connection Projects – Example 1

Example Project 1
The developer has a project which requires no extension to the three-phase 11kV system - 150kW generator

Work

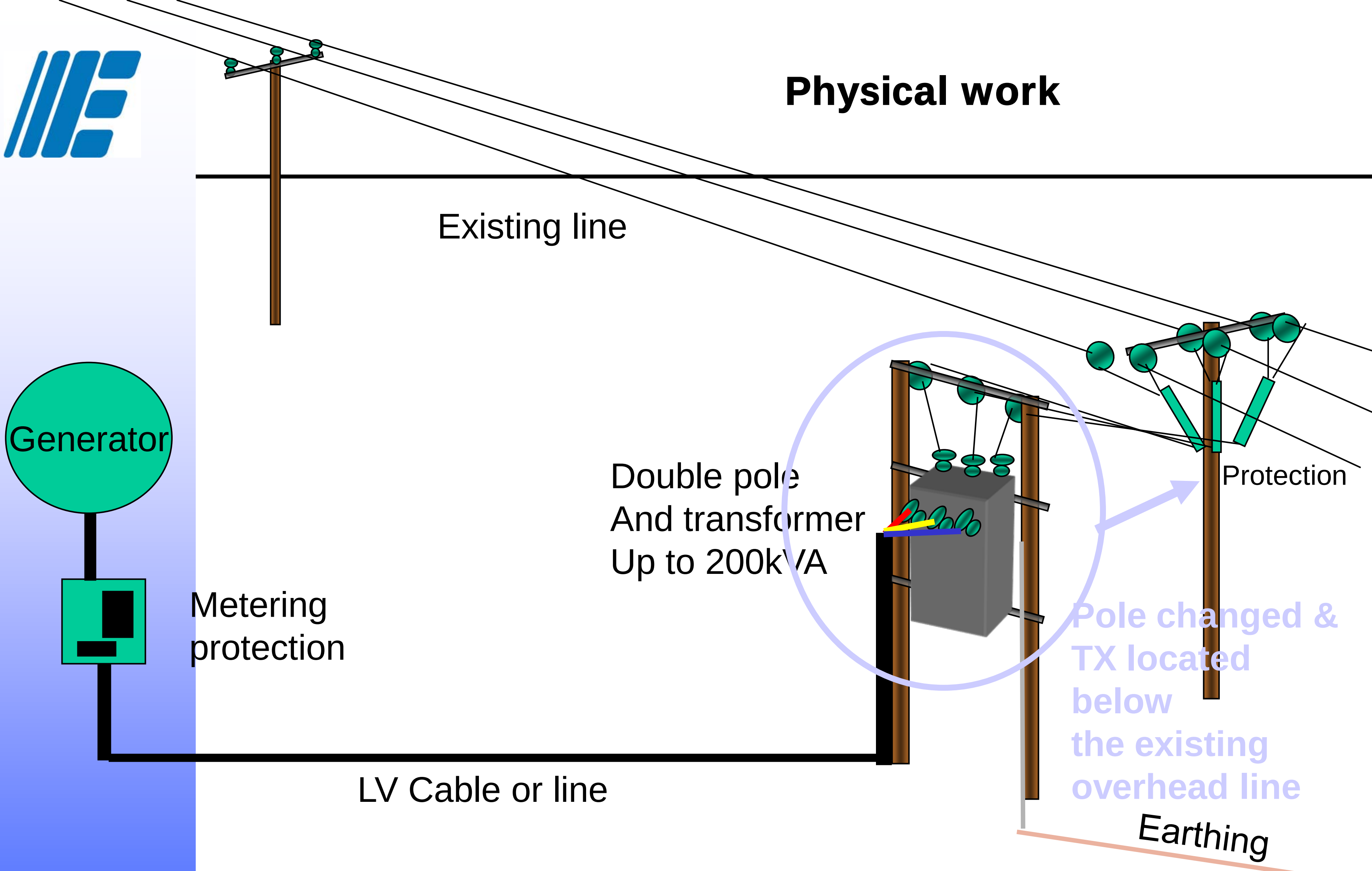
- NIE installs a double pole 11kV structure below the overhead line to support the transformer
- NIE connects the transformer as a fused connection to the existing overhead line
- NIE arranges a short LV circuit from the transformer to the customer

Cost

- Estimated Average Cost for construction £20k
- Communication and control equipment £20k

Total Cost £40k

Physical work



About £20k incl. £3.5k O&M

Typical Connection Projects – Example 2

Project 2

The developer has a project which requires no extension to the three- phase 11kV system - 250kW generator

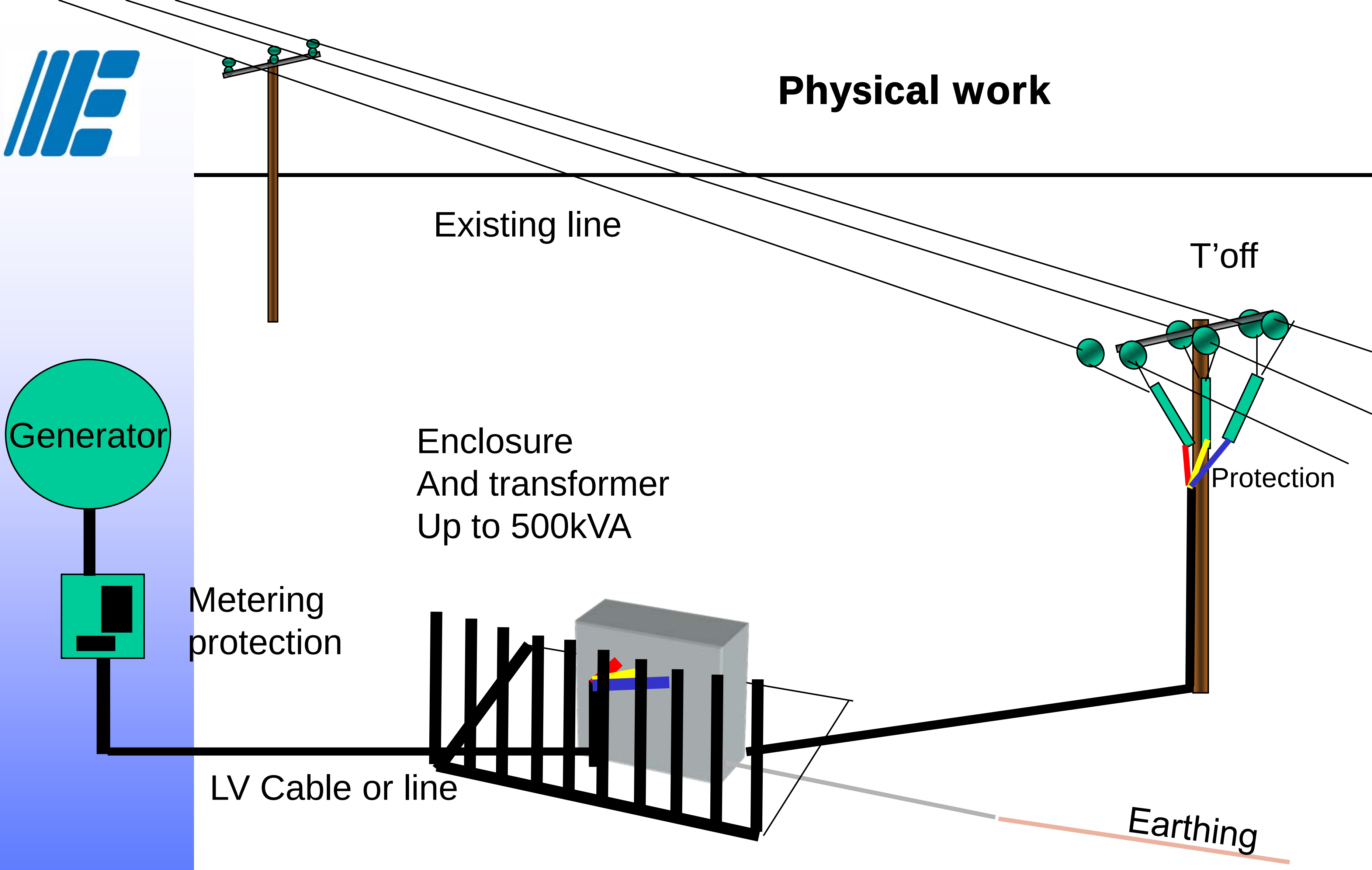
<u>Work</u>

- NIE installs an 11kV structure or cable arrangement
- NIE carries out civil engineering works establishes a safe enclosed compound and installs a ground mounted transformer (transformer is too heavy for pole mounting)
- NIE connects the transformer as a fused Tee'd connection to the existing overhead line
- NIE arranges a short LV circuit from the transformer to the customer

<u>Cost</u>

- Estimated Average Cost for construction £50k
- Communication and control equipment £20k
- **Total Cost £70K**

Physical work



Construction work about £50k incl. £10k O&M

Typical Connection Projects – Example 3

Project 3A

The developer has a project which requires extension of the three-phase 11kV system - 150kW generator

Basic cost	£ 40k
System uprating to 3-phase (4km @£32k/km)	£128k
TOTAL	**£168k**

Project 3B

The developer has a project which requires extension of the three-phase 11kV system - 250kW generator

Basic cost	£ 70k
System uprating to 3-phase (4km @£32k/km)	£128k
TOTAL	**£198k**

Typical Connection Projects – Example 4

Project 4A
4km from a three-phase line requiring upgrade of 5km of the existing 3-phase line – 150kW generator

Basic cost	£ 40k
System uprating to 3-phase	£128k
Backbone reinforcement 5km	£125k
TOTAL	**£293k**

Project 4B
4km from a three-phase line requiring upgrade of 5km of the existing 3-phase line – 250kW generator

Basic cost	£ 70k
System uprating to 3-phase	£128k
Backbone reinforcement	£125k
TOTAL	**£323k**

Resources

- We have increased the resources applied to this area
- Present complement of staff dealing with small scale connection applications
  - Team of 4 engineers (two recently recruited)
  - Process and performance improvement engineer (recently recruited)
  - One admin staff member (recently recruited)
- Whether this is the correct complement will need to be kept under review
  - Depends very much on throughput from planning service

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
  3. Payment

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 payment:-

Generation Maximum Installed Capacity	Application Cost
20kW or less	£600
21 kW - 150kW	£1,800
151 kW - 2000kW	£6,000.

- Connection offers to be processed within 3 months
- Offers remain valid for three months
- Work commences on acceptance of terms/20% deposit

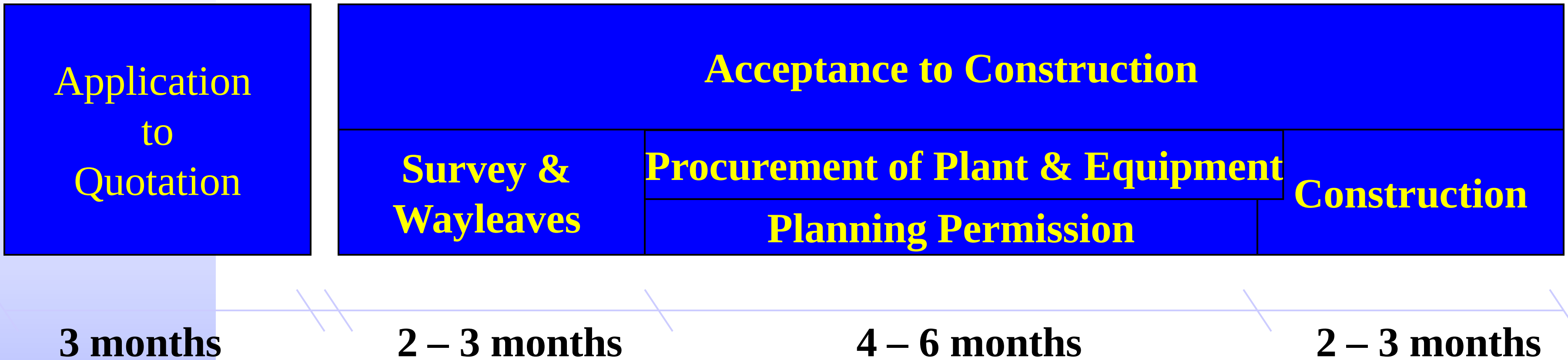
Timescales - Planning Permission Not Required

•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



- 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 i.e.. wayleaves, easements, substation leases and planning permission

Distribution Code, Communications and Control

- The D code is approved by the Utility Regulator
  - NIE and connectees must comply
- D Code sets out technical requirements for generation connecting to the network
- Compliance with D Code is essential for efficient network operation
- Non-compliant generators will not get connected
- D Code Panel made up of industry and utility representatives
- Communications and Control requirement now in D Code for generation
- NIE is developing appropriate communication system for large volume of generators
- Cost presently detailed in connection offers - £20k per site
- Crucial to optimising the volume of generation connected to network
- Future use with Smart grid technology

Utility Regulators Next Steps Paper on Connection Policy

- Following generation issues dealt with in 1st Stakeholders workshop
  - Security Standards & constraints information
  - Rebates
  - Definition of connection assets and associated costs
  - Timing of offers and connection agreements
  - Clusters of generators
  - Cost of connection and published information
  - Operations and maintenance costs
  - SPS and communications

Utility Regulators Next Steps Paper on Connection Policy - Subsidies for Micro generation

- Utility Regulators next steps
  - Not making any decision at this time
  - May consider any future proposals on a cross directorate level
- NIE consider that 100% charging is appropriate
- However there is a question over whether a strategic programme of 11kV reinforcement and conversion to three phase is necessary and if so how should be funded?
- How should such reinforcement be balanced by control of generation to maximise the total capacity of generation connections?
- NIE propose to conduct a study of the costs of reinforcement and the extent to which limited control of generation output and improved network control can avoid reinforcement.

Utility Regulators Next Steps Paper on Connection Policy - Scada and Control

- Utility Regulators next steps
  - As part of NIE's next regulatory price control the Regulator will scrutinise SCADA and communications costs
- NIE consider that scada and control is fundamental to maximising the penetration of small scale generation on the 11kV network
- Seeking to develop the most cost effective approach
- Costs currently being charged will be reviewed in light of outturn
- Refunds provided if costs are lower than charged