

# Design Manual for Roads and Bridges



Control & Communications Technology  
Appraisal

## TA 401

# Renewable energy systems appraisal

(formerly N/A)

Version 1.0.0

### Summary

This document contains the requirements for the appraisal of new and retrofitted renewable energy system installations on motorways and all-purpose trunk roads.

### Feedback and Enquiries

Users of this document are encouraged to raise any enquiries and/or provide feedback on the content and usage of this document to the dedicated National Highways team. The online feedback form for all enquiries and feedback can be accessed at: [www.standardsforhighways.co.uk/feedback](https://www.standardsforhighways.co.uk/feedback).

**This is a controlled document.**

<b>Release notes</b>	<b>2</b>
<b>Foreword</b>	<b>3</b>
Publishing information . . . . .	3
Contractual and legal considerations . . . . .	3
<b>Introduction</b>	<b>4</b>
Background . . . . .	4
Assumptions made in the preparation of this document . . . . .	4
Mutual recognition . . . . .	4
<b>Abbreviations</b>	<b>5</b>
<b>Terms and definitions</b>	<b>6</b>
<b>1. Scope</b>	<b>7</b>
Implementation . . . . .	7
Use of GG 101 . . . . .	7
Competency . . . . .	7
<b>2. Renewable energy system appraisal process</b>	<b>8</b>
<b>3. Concept overview</b>	<b>9</b>
Location of equipment and safety . . . . .	9
Availability of supply . . . . .	9
Reliability of supply . . . . .	9
Standardised equipment . . . . .	10
Non-quantifiable requirements . . . . .	10
<b>4. Economic appraisal</b>	<b>11</b>
Benefit-cost analysis . . . . .	11
Capital expenditure (CapEx) appraisal . . . . .	11
Operational & maintenance expenditure (OpEx) appraisal . . . . .	11
Carbon saving calculator . . . . .	12
<b>5. Findings report</b>	<b>13</b>
<b>6. Normative references</b>	<b>14</b>
<b>7. Informative references</b>	<b>15</b>

## Latest release notes

Document code	Version number	Date of publication of relevant change	Changes made to	Type of change
TA 401	1.0.0	October 2023	Core document	Change to policy, major revision, new document development

Version 1.0.0; Publication: October 2023: New document. See Summary.

## Previous versions

Document code	Version number	Date of publication of relevant change	Changes made to	Type of change
---------------	----------------	--	-----------------	----------------

## **Foreword**

### **Publishing information**

This document is published by National Highways.

### **Contractual and legal considerations**

This document forms part of the works specification. It does not purport to include all the necessary provisions of a contract. Users are responsible for applying all appropriate documents applicable to their contract.

## Introduction

### Background

This document sets out the process for the appraisal of the deployment of renewable energy systems (RES) on motorways and all-purpose trunk roads. It specifically addresses the high-level approach for RES requirements as well as the competencies of those involved in this area of the service.

The primary purpose of introducing RES on the motorway and all-purpose trunk road network is to reduce carbon emissions through a greater proportion of energy to be provided from renewable sources. Consequently a key consideration is the potential carbon saving, which can be used in order to provide economic justification for the introduction of renewable energy systems.

Other considerations where RES provides benefits, such as economic value in remote locations not in the proximity of existing DSO electrical networks, can also be quantifiable and therefore can be recorded and taken into account.

### Assumptions made in the preparation of this document

The assumptions made in GG 101 [Ref 3.N] apply to this document.

This document is written for the competent electrical roadside technology professional/practitioner, electrical engineer and road safety engineer with experience in the appraisal of renewable energy schemes for all electrical roadside assets in order that a renewable energy appraisal is undertaken that is suitable for motorway and all-purpose trunk roads.

### Mutual recognition

Where there is a requirement in this document for compliance with any part of a 'British Standard' or other technical specification, that requirement may be met by compliance with the Mutual Recognition clause in GG 101 [Ref 3.N].

## Abbreviations

<b>Abbreviation</b>	<b>Definition</b>
BCR	Benefit cost ratio
BEIS	Department for Business, Energy & Industrial Strategy
CapEx	Capital expenditure.
COTS	Commercial off the shelf
DSO	Distribution system operator (historically referred to as a DNO).
ITS	Intelligent transport systems
OpEx	Operational expenditure.
OPI	Construction output price indices
PV	Photovoltaic.
RES	Renewable energy system
VSS	Variable signs and signals

## Terms and definitions

Term	Definition
Carbon footprint	The amount of carbon dioxide released into the atmosphere as a result of the activities of a particular individual, organisation, or community
Electrical connection point	A DNO/DSO service point of an adjacent cable network with capacity to provide the load required
Electricity supplier	The company from whom electricity is purchased Note: The electricity supplier is independent of the DSO.
Energy storage	The capture of energy produced at one time for use at a later time to reduce imbalances between energy demand and energy production
Hybrid supply	The combining of two or more sources of electrical energy; typically a combination of DSO-derived energy, energy derived from a renewable energy system and/or an energy storage system
Intelligent transport systems	The technologies employed by transport network operators to enable the delivery of their services
Operational technology	The subset of 'intelligent transport systems' (ITS) used to operate and maintain the strategic road network.
Net zero	In reference to the Overseeing Organisations' aim of achieving a carbon neutral business and assisting government to reduce the carbon impact of transport
Renewable energy	Energy derived from a source that is naturally replenished when used e.g. wind, solar, hydro, geothermal, tidal, etc.
Supply configuration	The potential origin of a source of electrical energy. The supply configurations will include, but not necessarily be limited to; a DSO-derived source, a renewable energy source, an energy storage system or a hybrid arrangement of these. (See 'Hybrid supply').
System autonomy	A period of time (in minutes or hours) that an energy storage system will provide power at a specified load level in the event of atmospheric conditions not being favourable for on-site energy generation. In essence, the system autonomy represents a synergy between the energy generation profile, the load profile and the energy storage capacity (for example battery capacity) of any given RES installation.

## 1. Scope

1.1 This document shall be applied to appraise the deployment of a RES to generate electricity from renewable sources.

*NOTE 1 The reasons for a RES appraisal can include achieving 'Net zero' targets, reducing electricity costs, or off-grid generation at a remote location.*

*NOTE 2 For background information refer to the 'BEIS Net Zero Strategy: Build Back Greener' ( BBG [Ref 5.I]).*

1.2 This document shall not be used to determine whether the roadside asset requiring a power supply is necessary. The requirement for the roadside asset has been determined by a separate and appropriate appraisal process. This document assumes that process has been fully completed and the roadside asset has been justified.

1.2.1 This document should be used to obtain the necessary facts and data to inform the appraisal for deployment of a RES on motorway and all-purpose trunk road networks for the following scenarios:

- 1) new installations of operational technology and lighting (if included) requiring a new electrical connection point; and,
- 2) existing installations of operational technology and lighting (if included) with an existing electrical connection point.

### Implementation

1.3 This document shall be implemented forthwith on all schemes involving the appraisal of new and existing operational technology and lighting (if included) installations on the Overseeing Organisations' motorway and all-purpose trunk roads according to the implementation requirements of GG 101 [Ref 3.N].

1.4 The appraisal shall be carried out remotely, it is assumed, via desktop-based studies and no physical site visits are required to complete the process.

1.5 Where a proposed scheme does not warrant the completion of a full RES appraisal then agreement shall be sought from the Overseeing Organisation.

### Use of GG 101

1.6 The requirements contained in GG 101 [Ref 3.N] shall be followed in respect of activities covered by this document.

### Competency

1.7 All organisations and personnel delivering the RES appraisal shall be registered with an appropriate professional institution, the Engineering Council (ECUK) and hold the competencies and experience in the design and implementation of renewable energy systems and associated infrastructure, with a record made available to the Overseeing Organisation.

## **2. Renewable energy system appraisal process**

2.1 The RES appraisal process shall include the following steps:

- 1) concept overview;
- 2) economic appraisal; and,
- 3) findings report.

*NOTE* These steps in the appraisal process are addressed individually in subsequent sections of this document.

### 3. Concept overview

#### Location of equipment and safety

3.1 The potential location of any RES shall be determined by the operational requirements of the equipment requiring an electrical supply.

*NOTE* Once this location is determined then the feasibility of deploying a RES can be appraised.

3.2 When locating a RES the choice of system and locations shall be assessed to minimise the risk of vandalism and theft.

3.3 Any RES shall be located at a setback from the carriageway as to minimise any risk to all affected populations.

3.4 An assessment in accordance with CD 377 [Ref 4.N] shall be included within the findings report.

3.5 The location of a RES shall assess the likelihood of coming in close proximity with all affected populations.

3.5.1 Where a fence or barrier is required, the cost of this should be included within the economic appraisal.

3.6 Any proposed RES locations shall provide a safe working environment for persons interfacing with the installation.

#### Availability of supply

3.7 The availability of a DSO electrical connection (exit point) shall only be determined through liaison with the DSO and with reference to TG 411 [Ref 2.N].

3.8 Where a DSO-derived supply (exit point) does not currently exist or is not viable, after liaison with the DSO, then a RES shall be appraised as an alternative source of energy.

3.9 Where a DSO-derived supply (exit point) already exists/is viable, the RES shall be appraised either as an alternative source or as a hybrid supply source. This applies to existing electrical connections both to be retained and those requiring an upgrade by the DSO.

3.10 Where a hybrid supply is proposed this shall be documented within the findings report and presented to the Overseeing Organisation with supporting information and evidence of the liaison that has taken place.

*NOTE* Hybrid supplies require liaison with the Overseeing Organisation and the DSO in order to be permitted.

3.10.1 The existing metering arrangement and electrical supply terms and conditions should be ascertained to inform the appraisal report.

#### Reliability of supply

3.11 The supply configuration shall be reliable for the nature of the equipment supplied.

3.11.1 The energy demands of the equipment should be met through either:

- 1) the use of a RES capable of providing reliable energy,
- 2) the use of a RES and a suitable energy storage system,
- 3) the use of a RES and a DSO-derived supply, or
- 4) the combination of RES, a suitable energy storage system and a DSO-derived supply.

3.12 Where the nature of the equipment supplied warrants a reliability of supply, unless it can be demonstrated that a RES can supply this load profile requirement independently, either through generation and/or the provision of an energy storage system, then a DSO-derived supply shall also be required.

3.13 The energy storage system shall be suitable for the environment in which it is proposed.

**NOTE** *For example, street lighting typically operates at night therefore the load requirement can be inversely proportional to the generation profile of a PV-based RES due to the availability of daytime solar insolation, where as VSS can be operational at all times.*

3.14 Where the load profile exceeds the calculated potential energy generation profile (including any contribution from an energy storage system) and reliability of supply is required, then a DSO supply shall also be required.

3.15 The system autonomy of installation supplied from a RES shall be calculated and presented to the Overseeing Organisation.

### **Standardised equipment**

3.16 Industry standard and non-proprietary commercially available off-the-shelf renewable energy components and systems shall be assessed.

**NOTE 1** *The standardisation of equipment ensures less diversity of devices, reduced maintenance stock and improved operative familiarity with the equipment on site. This requires far less effort to get to know the devices and reduces the complexity of keeping the plant operating.*

**NOTE 2** *New innovative systems can be considered for trials off the motorway and all-purpose trunk road networks to determine their viability.*

3.17 Evidence showing proposed equipment complies with the DSO connection requirements shall be included with the appraisal findings report.

### **Non-quantifiable requirements**

3.18 The RES installation and appearance shall be sympathetic to the environment in which it is located.

**NOTE 1** *For example, potential glint and glare from the solar PV panels, shadow flicker and acoustic noise from wind turbines can impact the surrounding environment.*

**NOTE 2** *Installation appearance can be influenced by the choice of equipment and mounting heights.*

3.19 In instances where specific protected or designated fauna or flora are present, national guidance shall be followed to mitigate any adverse effects.

3.20 In locations of historical and cultural significance, specific mitigation shall be required and subject to the agreement of the Overseeing Organisation.

## 4. Economic appraisal

### Benefit-cost analysis

- 4.1 A benefit-cost analysis shall be undertaken reviewing all gains (benefits) and losses (costs) to show the potential rewards expected from a RES compared with a solely DSO-derived supply. This includes capital costs, operating costs, decommissioning costs and carbon savings over the expected operating life of the system.
- 4.2 A RES shall offer an overall proposition that is comparable in terms of overall benefit-cost to that of the DSO-powered alternative.
- 4.2.1 Where a RES is not able to have a favourable benefit-cost ratio then a threshold BCR should not be assumed.

**NOTE** *Reporting energy use and carbon emissions is vital to ensure a full account of climate change and energy impacts when appraising and evaluating projects.*

### Capital expenditure (CapEx) appraisal

- 4.3 The CapEx for both the RES and the DSO-powered alternative shall be assessed in order to provide a basis of comparison.
- 4.4 CapEx for both the RES and DSO-powered systems shall include the full cost of design, procurement, installation and commissioning.
- 4.4.1 Costs should be based on sources and historical pricing data such as; equipment supplier quotes, DSO connection quotes or recent costs for similar works on other projects.

### Operational & maintenance expenditure (OpEx) appraisal

- 4.5 An assessment of the operation and maintenance requirements of the RES shall be carried out with respect to working on the motorways and all-purpose trunk road network environment and the Operations directorate, or equivalent, will be consulted.
- 4.6 This assessment of the operation and maintenance of the RES shall include:
- 1) maintenance tasks that are required for the reliable operation of the RES;
  - 2) expected frequency and duration of these tasks considering the harsh environment on the motorways and all-purpose trunk road network;
  - 3) maintenance staff skills & competencies required and expected duration of maintenance tasks;
  - 4) understanding the safety and cost implications of working on live road networks;
  - 5) impact of maintenance tasks on system operation (e.g. whether they result in interruption to supply); and,
  - 6) other impacts (e.g. whether maintenance requires restriction on access to other areas, temporary traffic management etc.).
- 4.6.1 Maintenance task frequency should take into account the environment and conditions of the motorways and all-purpose trunk road network and the requirement for periodic tasks required to keep the RES operational.

**NOTE** *For example, removal of dirt and salt residue from PV arrays where its build-up could adversely affect the RES performance.*

- 4.7 Whole life costing shall follow BS ISO 15686-5 [Ref 1.N].
- 4.8 OpEx for both the RES and the DSO-derived supply alternative shall be assessed in order to provide a basis of comparison.
- 4.9 An allowance linked to Construction Output Price Indices (OPI) shall be included for increasing the operation and maintenance costs.

4.10 The expected lifetime of components within the RES shall be estimated and allowance made for any components that are expected to require replacement during operating life of the RES.

*NOTE Guidance can be sought from equipment manufacturers on maintenance requirements.*

4.11 Decommissioning costs shall be included as part of the OpEx appraisal process.

### **Carbon saving calculator**

4.12 An appraisal shall be undertaken on the carbon savings, of DSO supplies versus RES alternatives, over the whole life of the equipment supplied.

4.12.1 Guidance on carbon savings should be taken from the Overseeing Organisation's carbon appraisal or calculator scheme or, where unavailable, a suitable alternative.

*NOTE 1 An example of an OO carbon appraisal or calculator scheme is the National Highways carbon emissions calculation tool HECT [Ref 3.] and the associated guidance HECT(G) [Ref 4.].*

*NOTE 2 There are standardised approaches and guidance documents such as the DMRB LA 114 [Ref 2.] and the publicly available standard PAS 2080 [Ref 1.]. These resources give guidance how to measure carbon and what is to be included in your calculations.*

## 5. Findings report

- 5.1 A report shall be produced to document the background information, methodology and the overall findings and recommendations of the RES appraisal.
- 5.2 The report shall include:
- 1) a description of the scheme extents or proposed installation;
  - 2) RES concept overview including:
    - a) operational requirements;
    - b) location of RES equipment;
    - c) CD 377 assessment;
    - d) risks to affected populations and protective measures;
    - e) access requirements;
    - f) availability of existing DSO electrical connections (where applicable);
    - g) calculation of the reliability of supply including load profile and potential energy generation profile;
    - h) details of proposed RES equipment demonstrating standardisation and evidence of DSO connection agreement compliance; and,
    - i) assessment of any further quantifiable and non-quantifiable impacts.
  - 3) economic appraisal including:
    - a) CapEx appraisal;
    - b) OpEx appraisal; and,
    - c) carbon saving calculator reports (include assumptions where applicable); and,
  - 4) conclusion and recommendations.
- 5.3 Where information related to the RES appraisal is not available or incomplete, clear reasons shall be provided within the findings report.
- 5.4 All supporting documentation produced as part of the RES appraisal shall be included within the appendices of the report, such as; evidence of DSO/electricity supplier liaison, system autonomy calculations, capital and operating cost calculation worksheets, and any further relevant appraisal outcomes.
- 5.5 Any recommendations made within the RES appraisal report shall be submitted to the Overseeing Organisation.

## 6. Normative references

The following documents, in whole or in part, are normative references for this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Ref.	Document
Ref 1.N	BSI. BS ISO 15686-5, 'Buildings and constructed assets. Service life planning. Life-cycle costing'
Ref 2.N	National Highways. TG 411, 'Electricity supply connections'
Ref 3.N	National Highways. GG 101, 'Introduction to the Design Manual for Roads and Bridges'
Ref 4.N	National Highways. CD 377, 'Requirements for road restraint systems'

## 7. Informative references

The following documents are informative references for this document and provide supporting information.

<b>Ref.</b>	<b>Document</b>
Ref 1.I	BSI. Construction Leadership Council. PAS 2080, 'Carbon Management in Infrastructure'
Ref 2.I	National Highways. LA 114, 'Climate'
Ref 3.I	National Highways. HECT, 'Highways England Carbon Tool'
Ref 4.I	National Highways. HECT(G), 'Highways England Carbon Tool Guidance'
Ref 5.I	Department for Business, Energy & Industrial Strategy. ISBN 978-1-5286-2938-6. BBG, 'Net Zero Strategy: Build Back Greener'

© Crown copyright 2023.

You may re-use this information (not including logos) free of charge in any format or medium, under the terms of the Open Government Licence. To view this licence:

visit [www.nationalarchives.gov.uk/doc/open-government-licence/](https://www.nationalarchives.gov.uk/doc/open-government-licence/),  
write to the **Information Policy Team, The National Archives, Kew, London TW9 4DU**,  
or email [psi@nationalarchives.gsi.gov.uk](mailto:psi@nationalarchives.gsi.gov.uk).