BUROHAPPOLD ENGINEERING

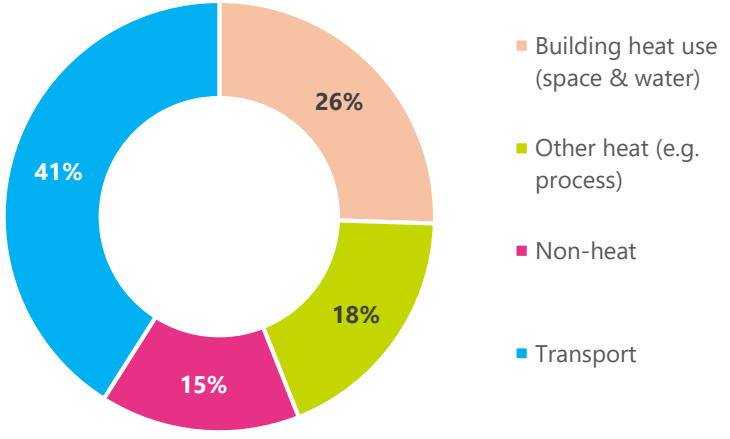
West of England

Key challenges to decarbonisation of heat

26th November 2019

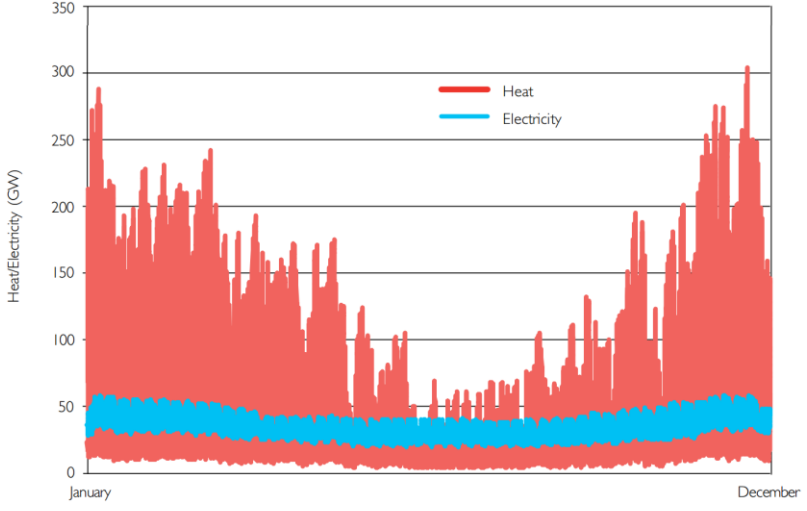
The challenge: UK energy demand

UK Energy Usage 2011



Source: DECC The Future of Heating: Meeting the Challenge & Imperial College

UK heat and electricity demand variability



Source: Sansom (2010)

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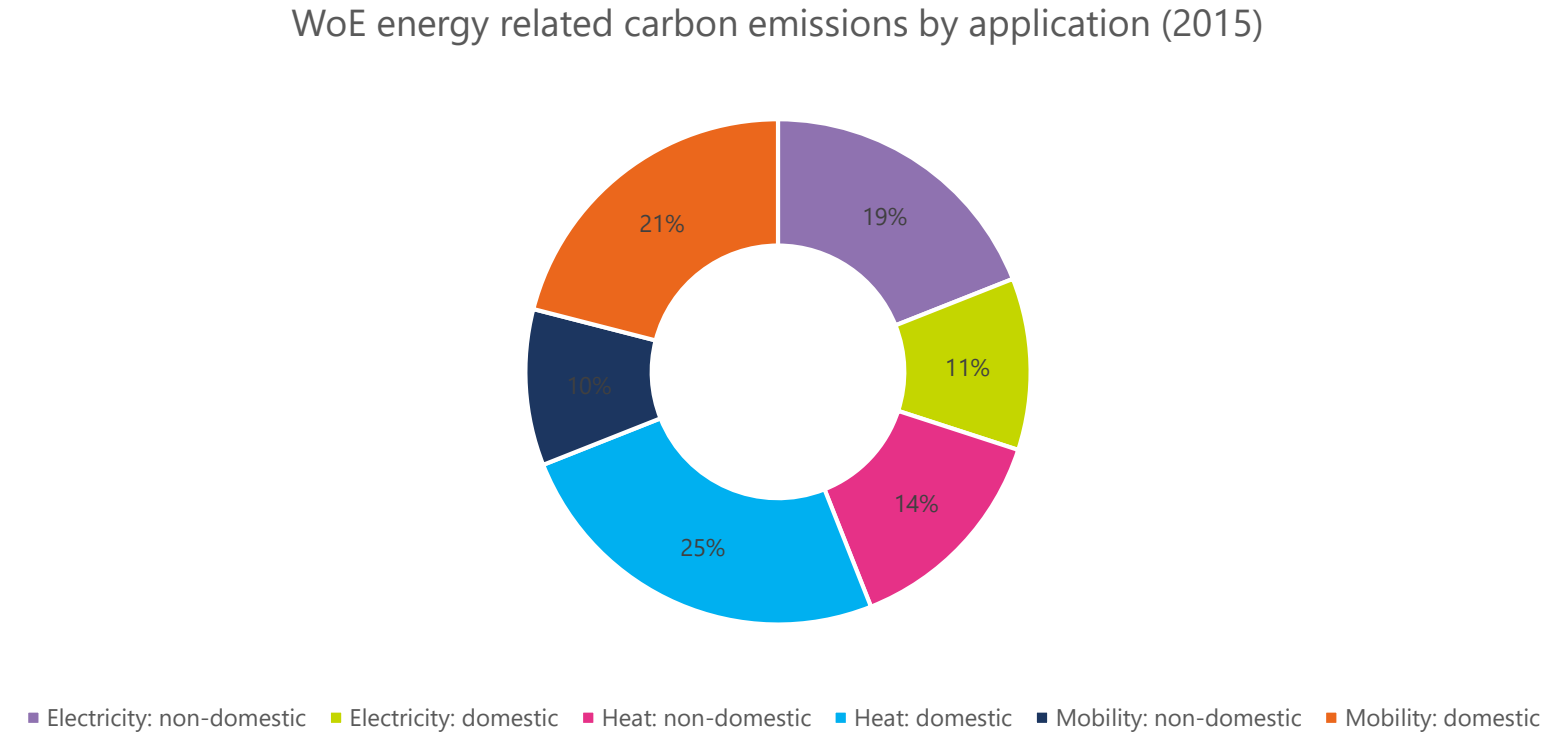
The challenge: heat in the West of England



Source: Towards A Sustainable Energy Future for the West of England (CSE 2018)

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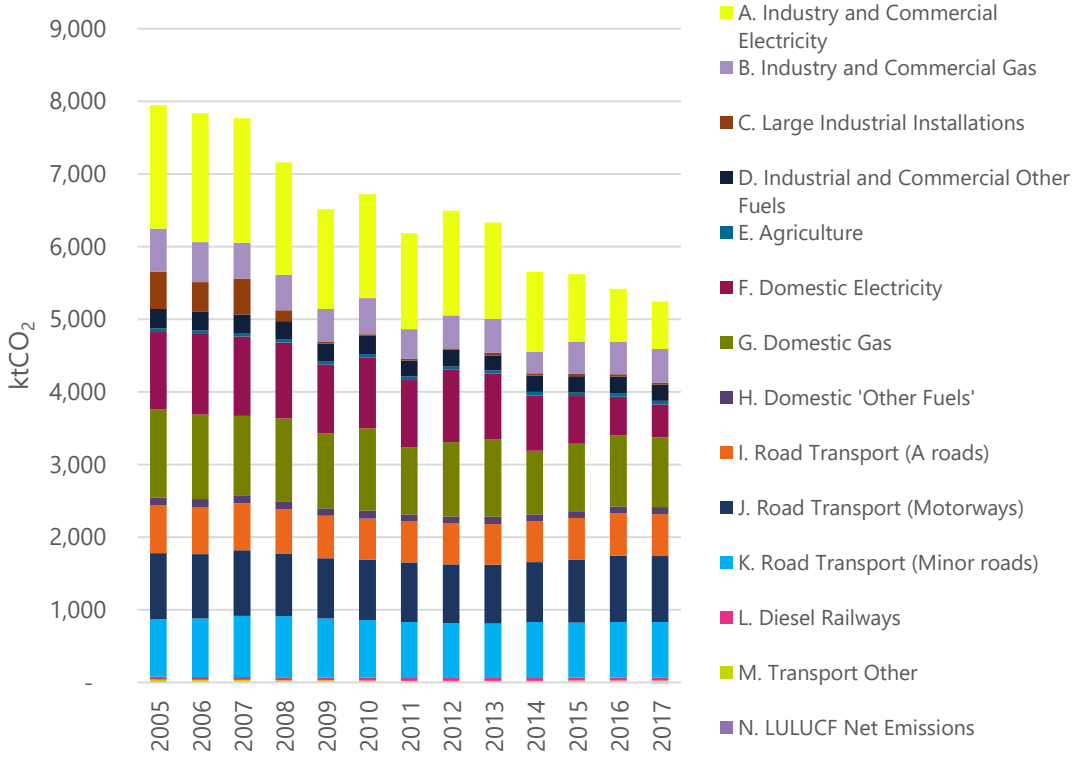
Emissions in the West of England

- Decrease in emissions over period from 2005-2017, driven by reduction in industrial emissions



Source: National Atmospheric Emissions Inventory

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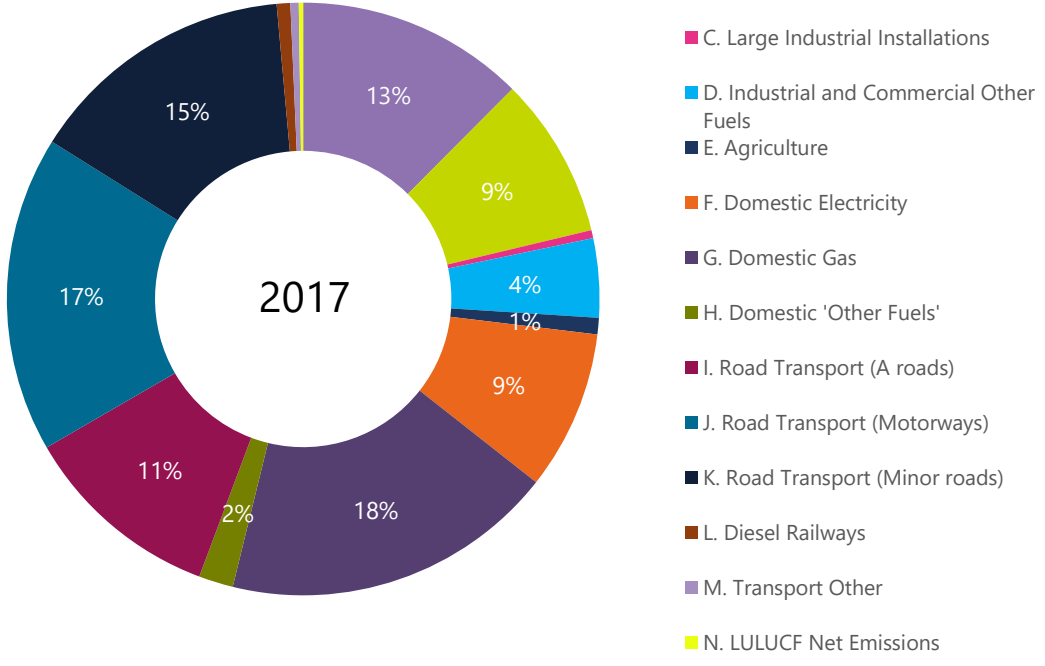
Emissions in the West of England

- Latest reporting period, domestic gas accounts for 18% of emissions



Source: National Atmospheric Emissions Inventory

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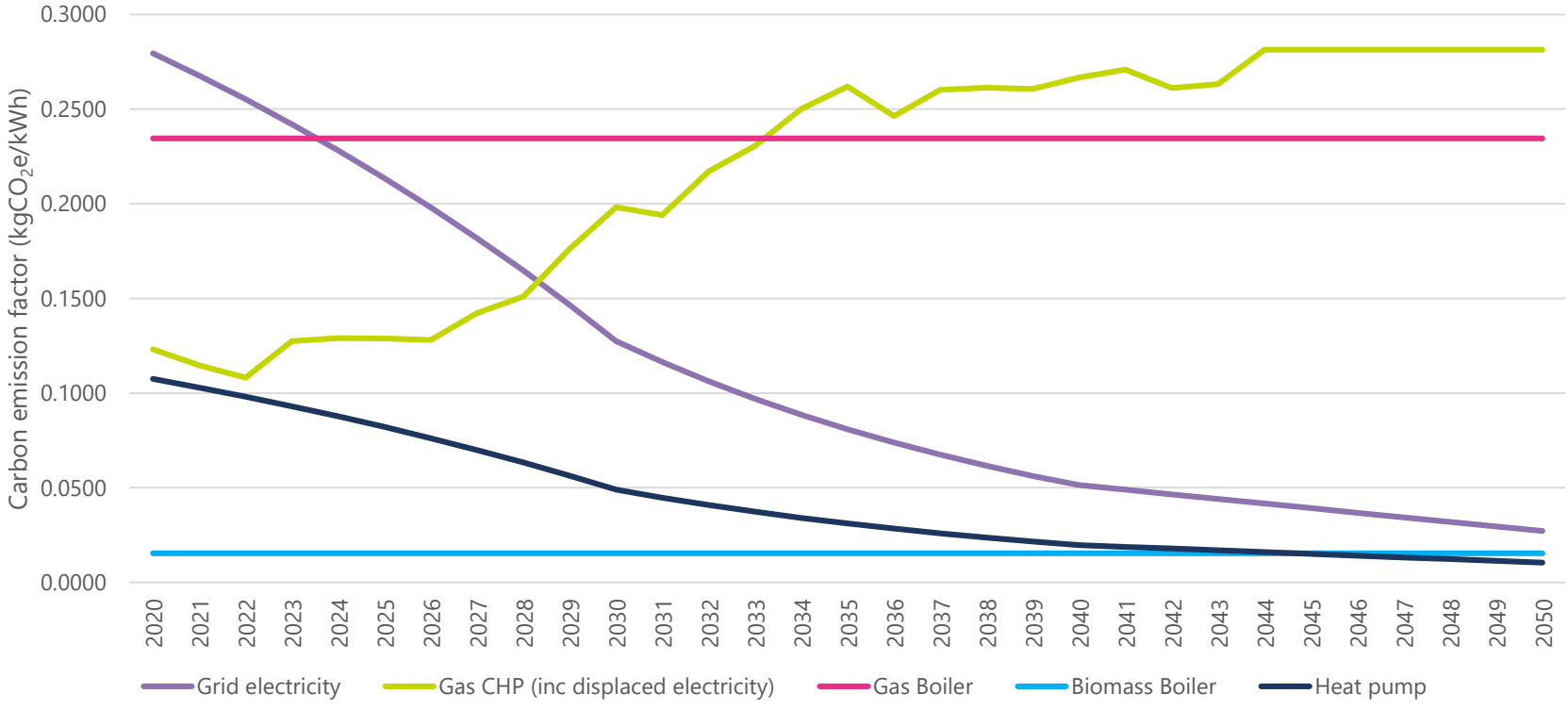
The impact of grid decarbonisation on heating technologies



Use BEIS emissions scenarios

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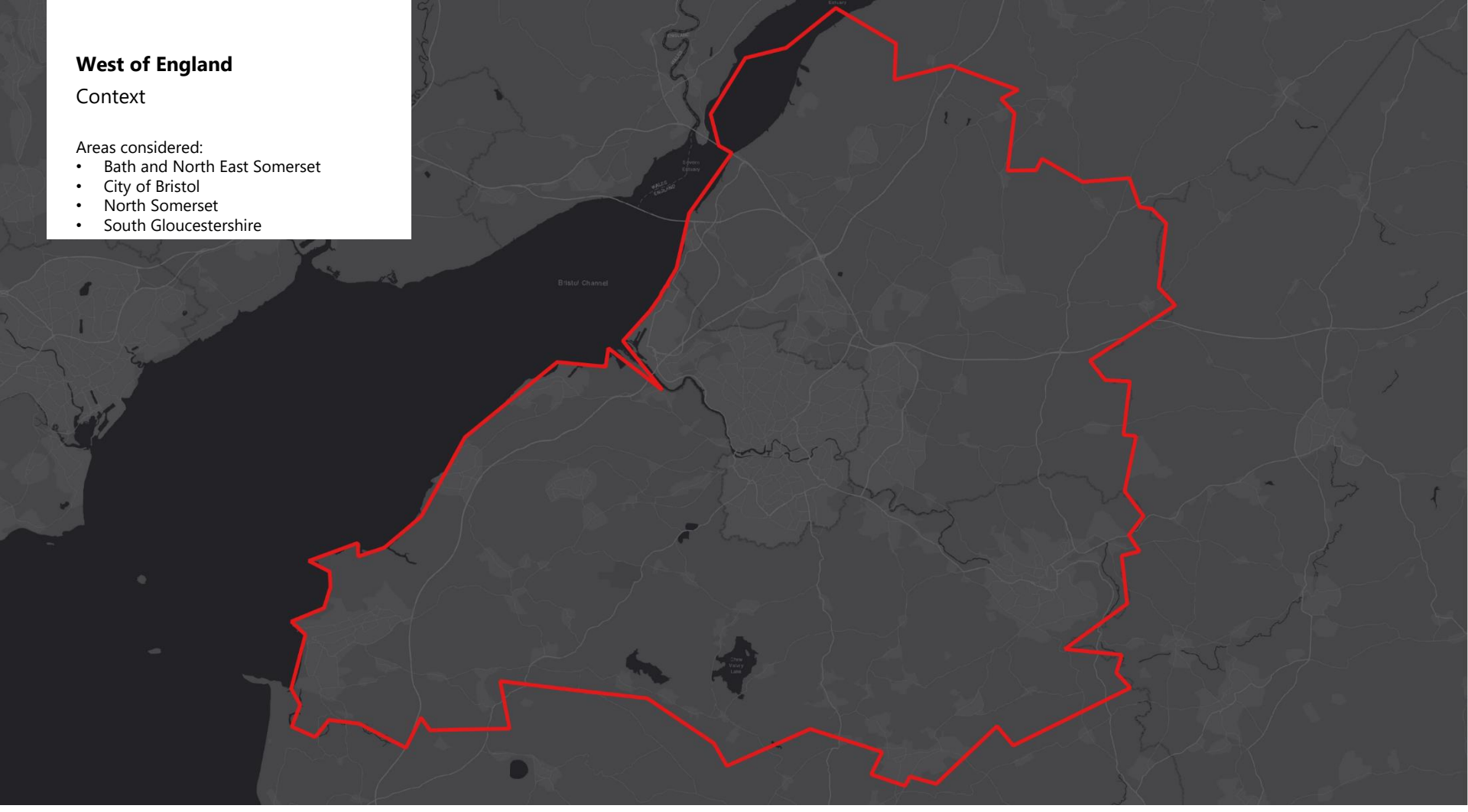
SPATIAL

West of England

Context

Areas considered:

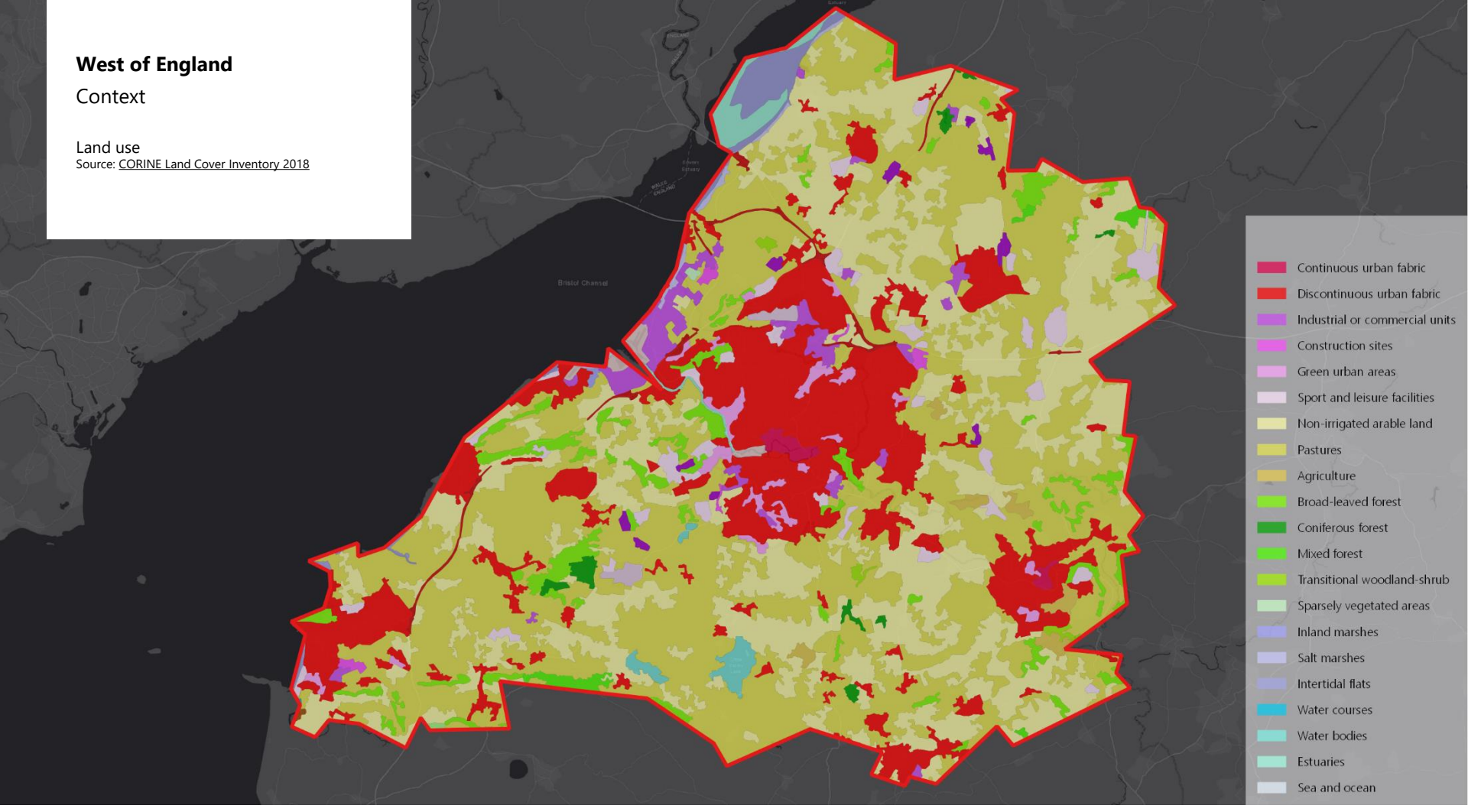
- Bath and North East Somerset
- City of Bristol
- North Somerset
- South Gloucestershire



West of England

Context

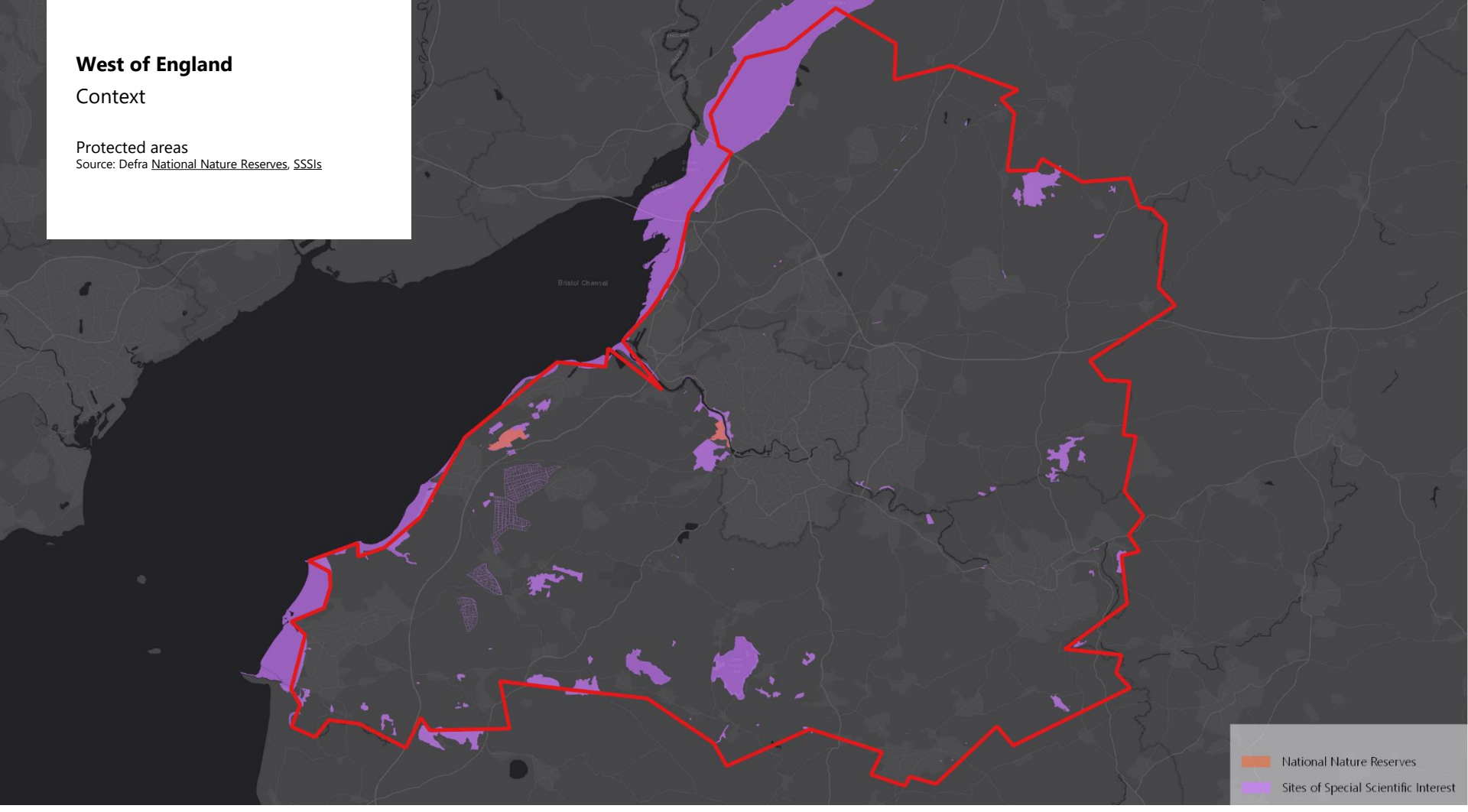
Land use
Source: CORINE Land Cover Inventory 2018



West of England

Context

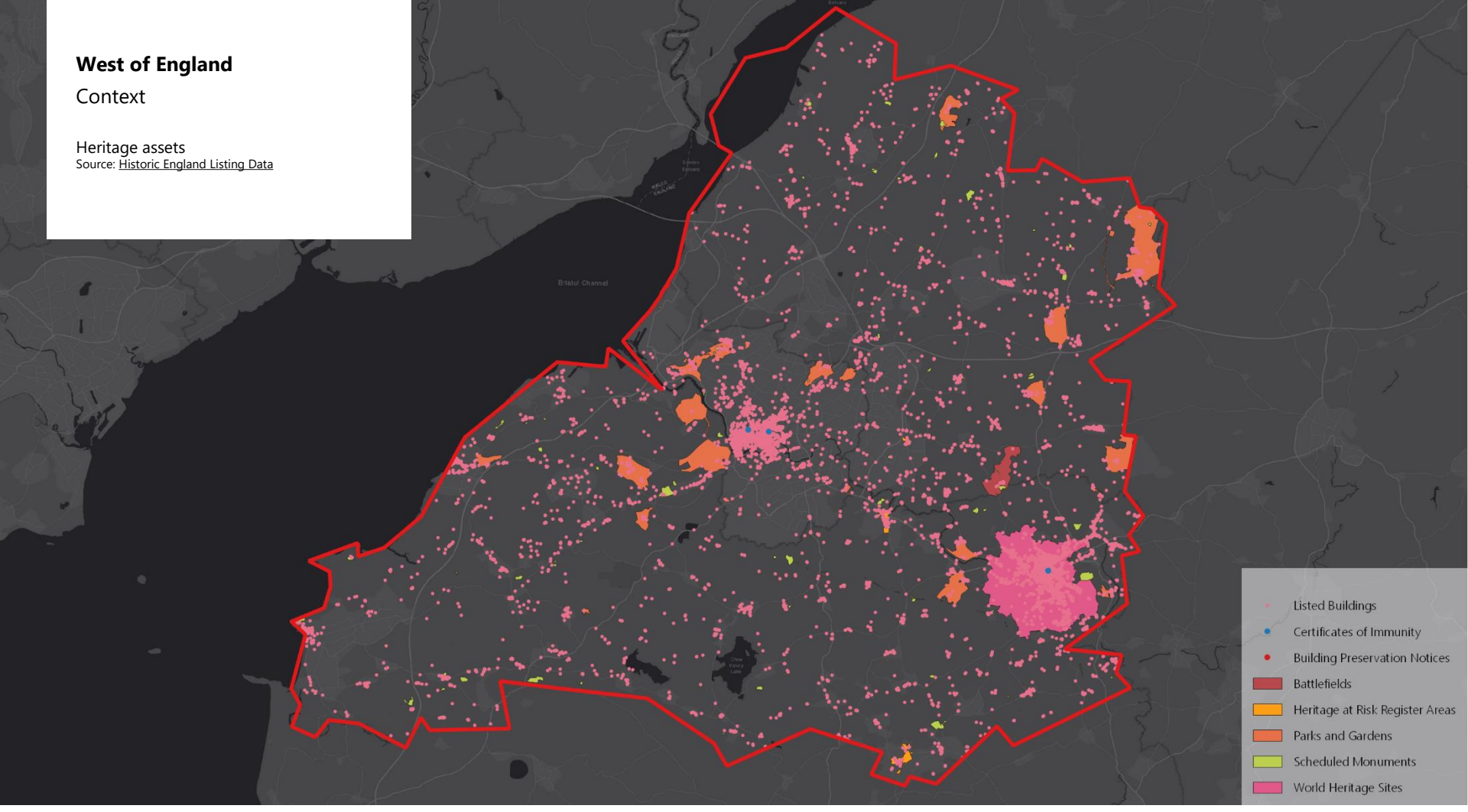
Protected areas
Source: Defra National Nature Reserves, SSSIs



West of England

Context

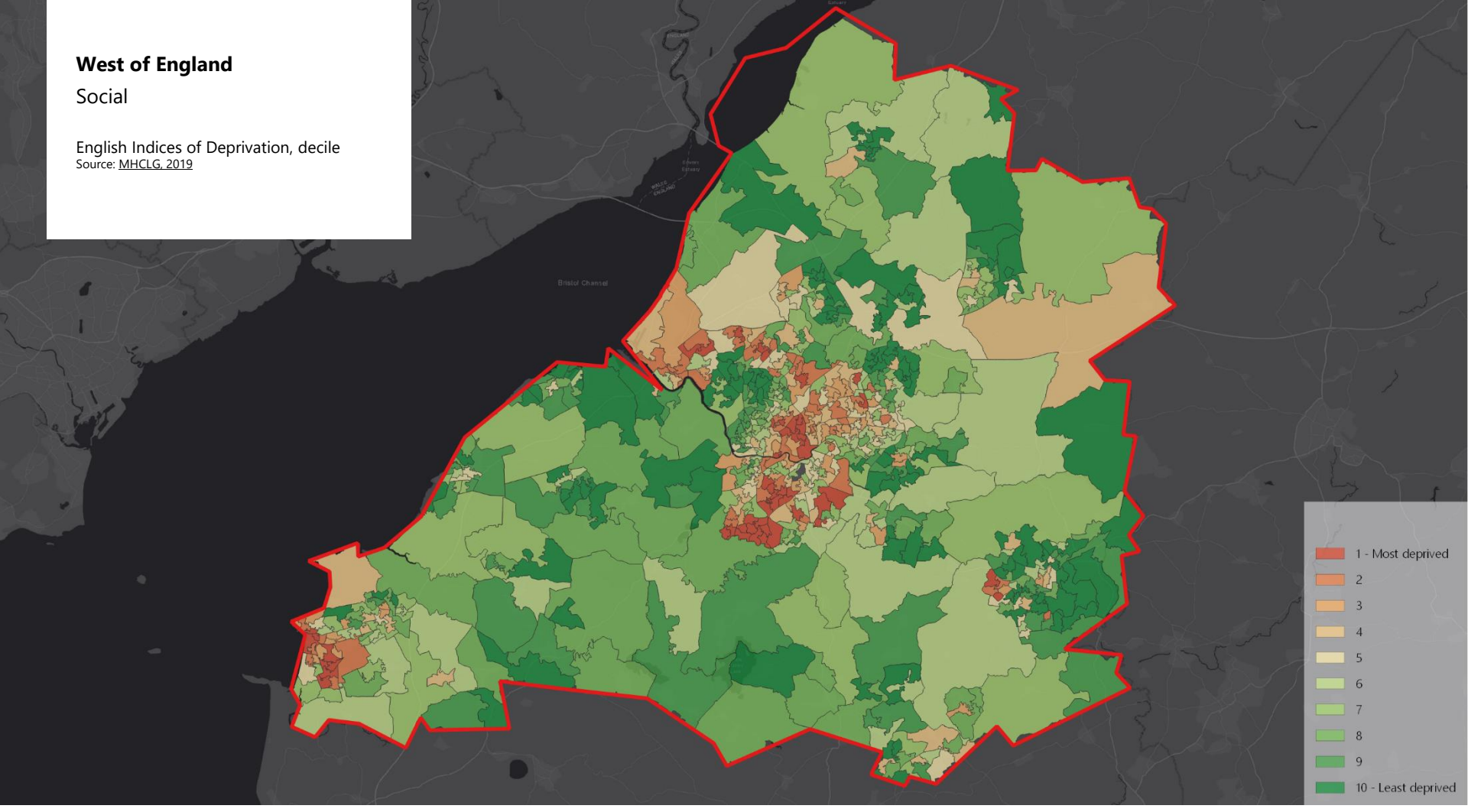
Heritage assets
Source: Historic England Listing Data



West of England

Social

English Indices of Deprivation, decile
Source: MHCLG, 2019

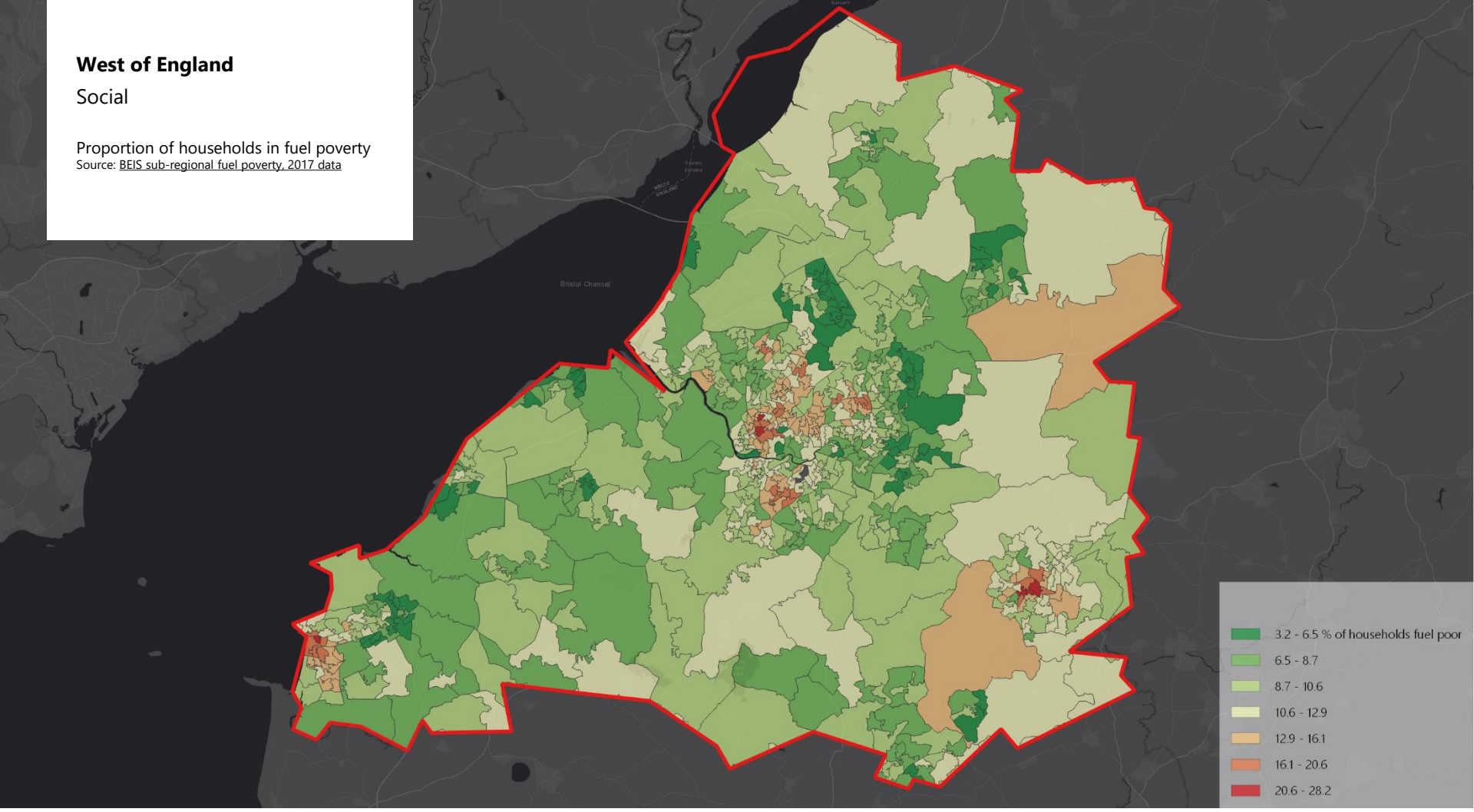


PERFORMANCE OF BUILDINGS

West of England

Social

Proportion of households in fuel poverty
Source: BEIS sub-regional fuel poverty, 2017 data

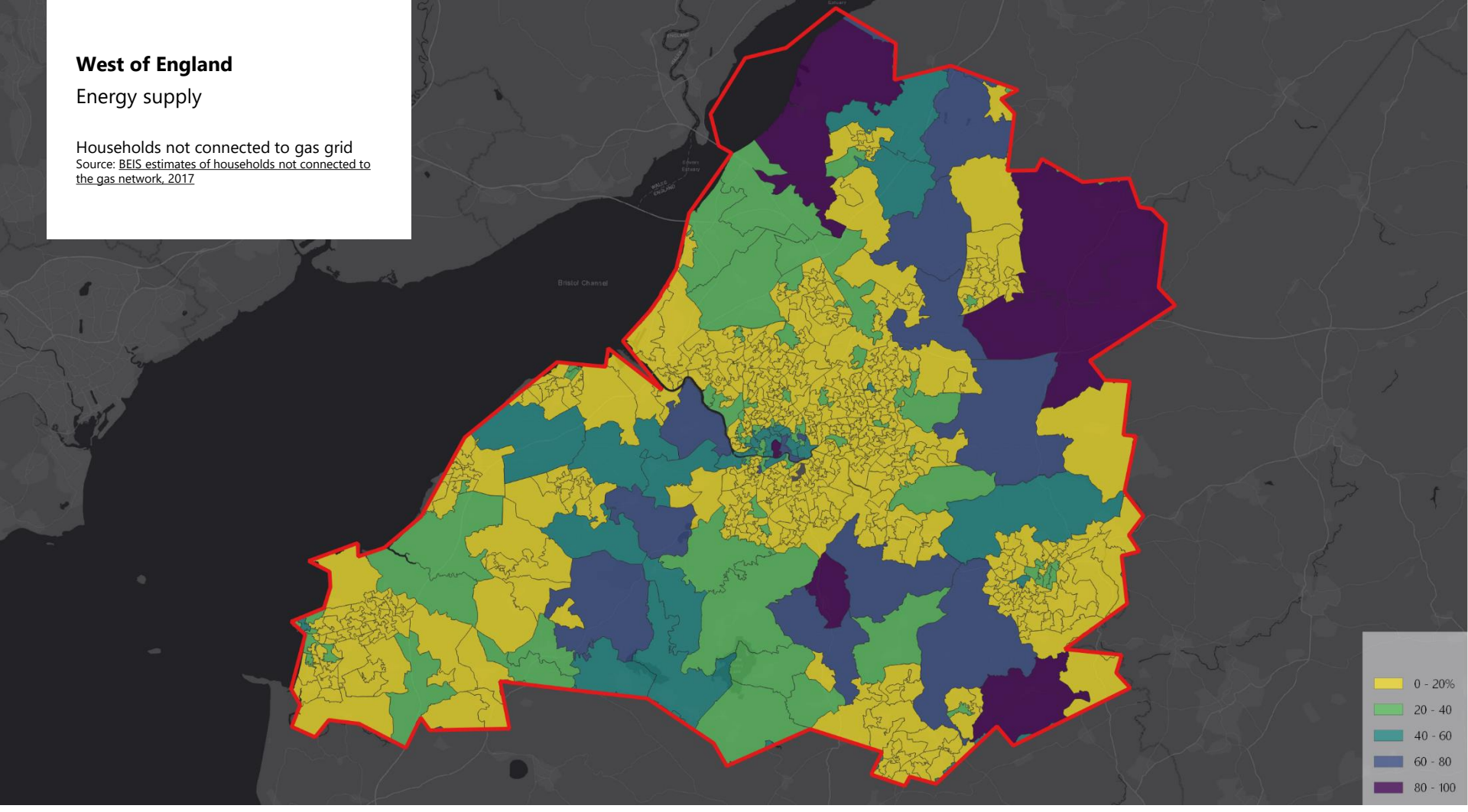


West of England

Energy supply

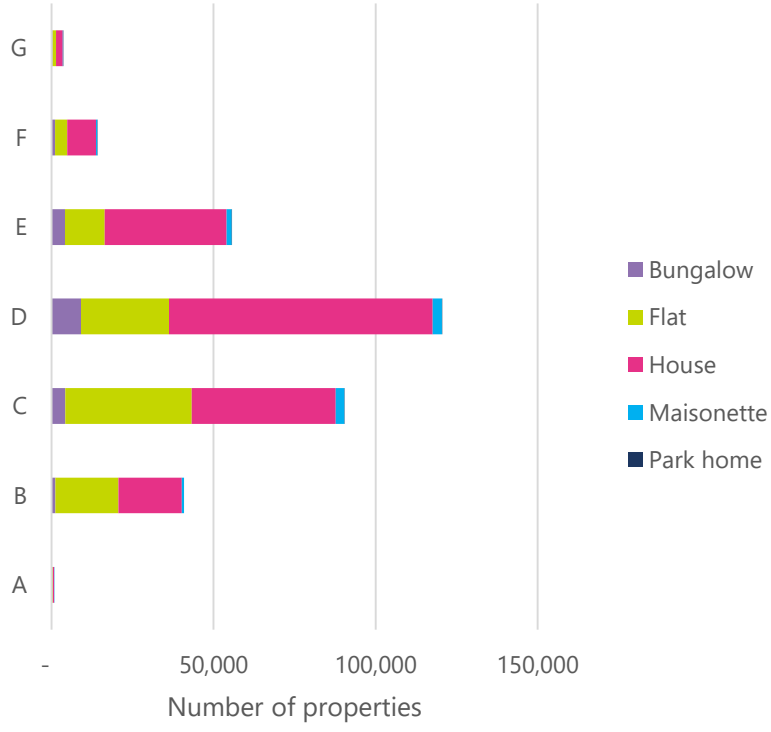
Households not connected to gas grid

Source: BEIS estimates of households not connected to the gas network, 2017



EPCs (domestic)

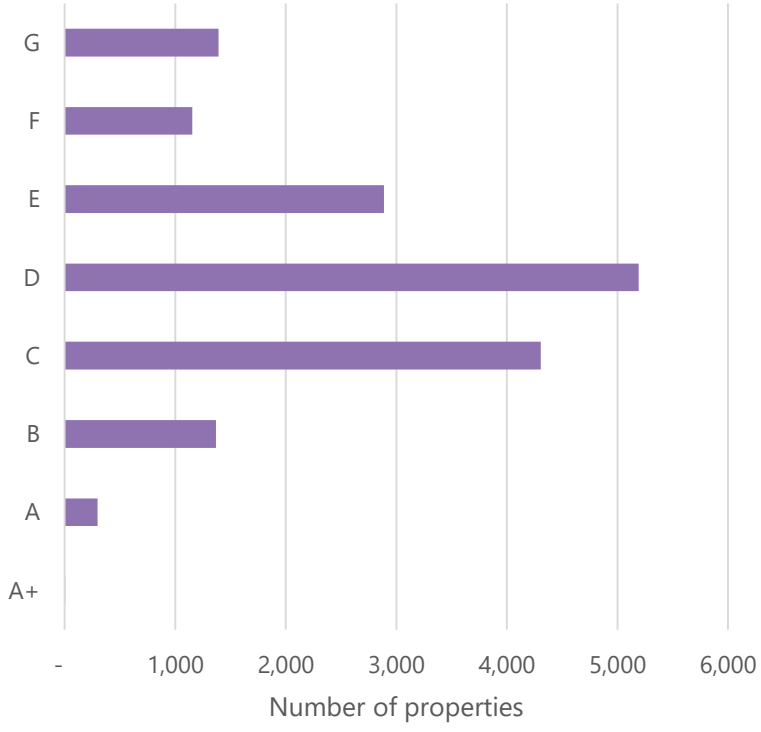
- 326,000 domestic EPCs in West of England available from MHCLG
- EPC band D or below:
  - 67% of houses
  - 47% of flats
  - **59% of all properties**



Source: MHCLG Energy Performance of Buildings Data

EPCs (non-domestic)

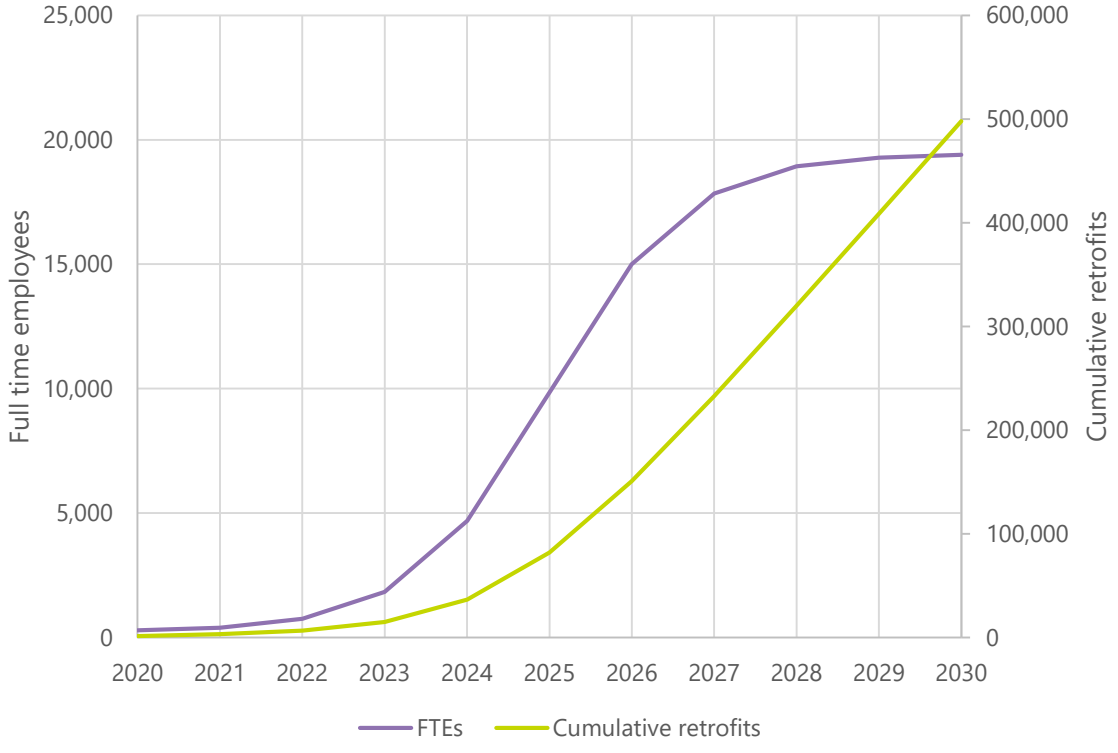
- 15,700 domestic EPCs available from MHCLG
- EPC band D or below:
  - **64% of all properties**



Source: MHCLG Energy Performance of Buildings Data

Skills and jobs

All houses refurbished



- To retrofit all homes in WoE by 2030
- Peak of 20,000 workers required (40% of 2008 employment figures for construction)
- Peak of 250 retrofits completed a day
- Peak growth in workers of 150% per year

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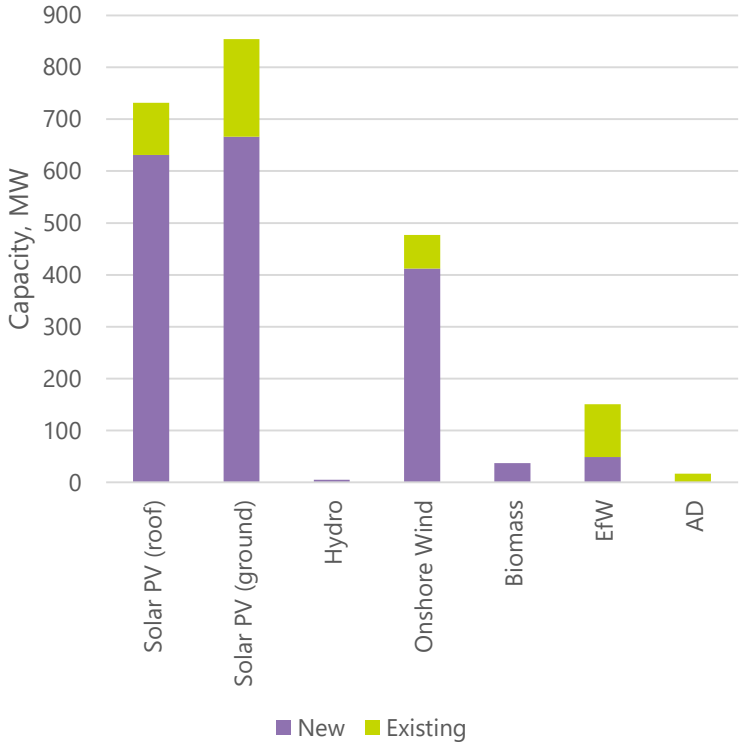
ZERO WEST SCENARIO FINDING

Scenarios

- Range of scenarios tested
  - Achievable
  - **Ambitious**
  - Maximum
- Assumes share of wider UK hydro and offshore wind apportioned by population is accounted for in WoE energy mix



Source: Zero West

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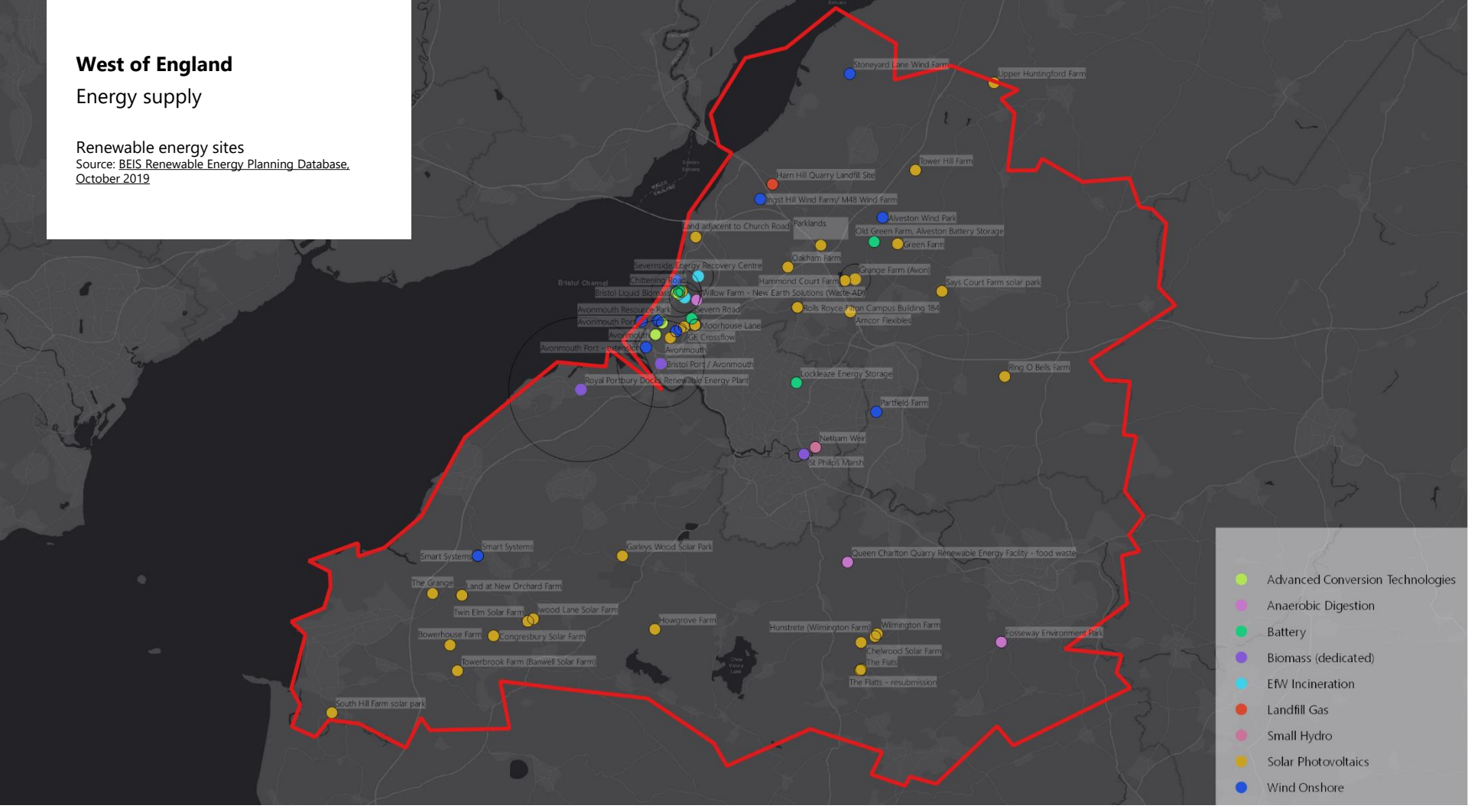
West of England

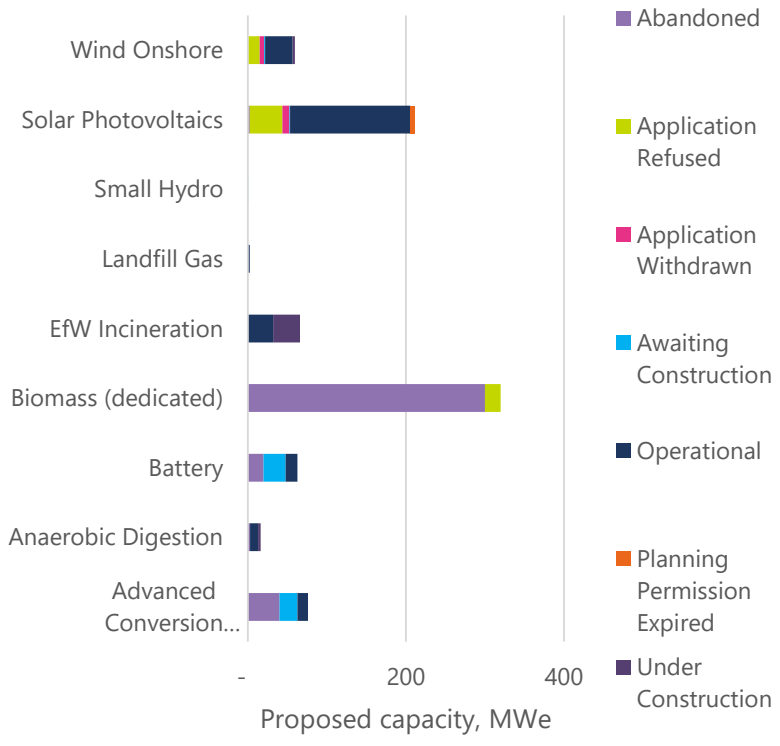
Energy supply

Renewable energy sites
Source: BEIS Renewable Energy Planning Database, October 2019



Renewable Energy Planning Database

- **260 MW operational schemes in West of England**
  - 59% solar photovoltaics
  - 14% offshore wind
  - 12% EfW incineration
- Further 93MW under construction or awaiting construction



Source: BEIS REPD, October 2019

BUROHAPPOLD ENGINEERING

Renewable Energy Planning Database

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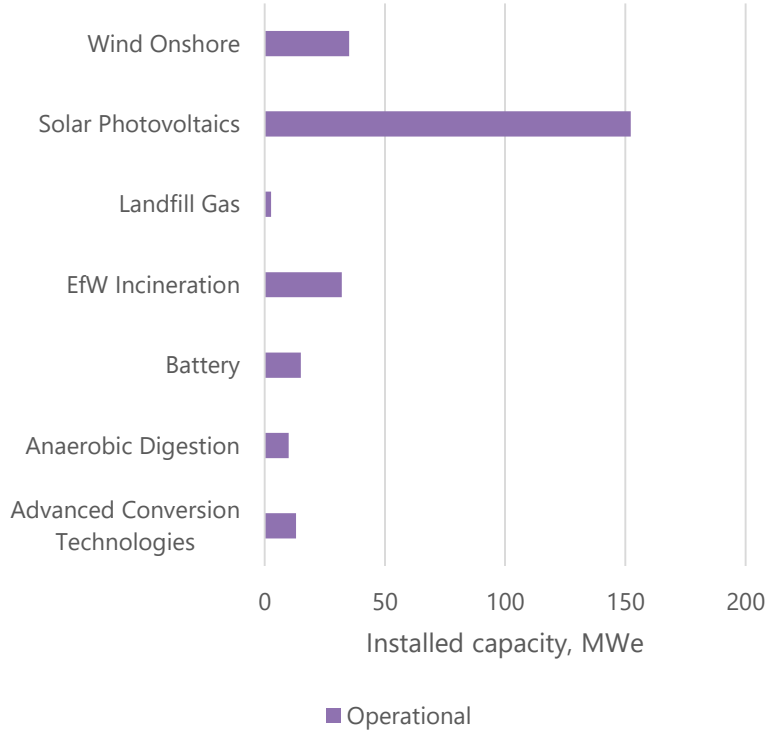
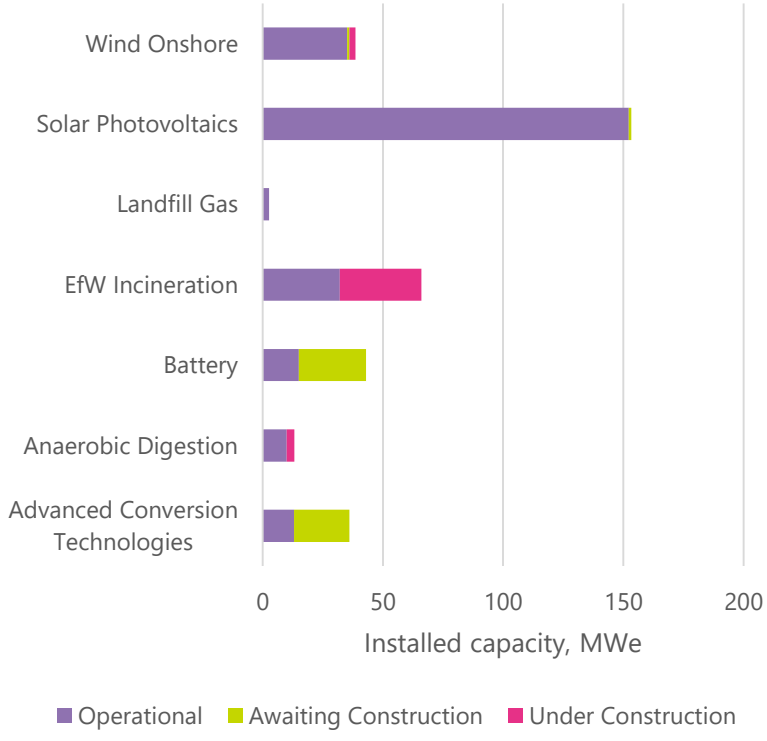


Source: BEIS REPD, October 2019

BUROHAPPOLD ENGINEERING

Renewable Energy Planning Database

- **260 MW operational schemes in West of England**
  - 59% solar photovoltaics
  - 14% offshore wind
  - 12% EfW incineration
- Further 93MW under construction or awaiting construction, including:
  - 28MW battery
  - 23MW advanced conversion technologies



Source: BEIS REPD, October 2019

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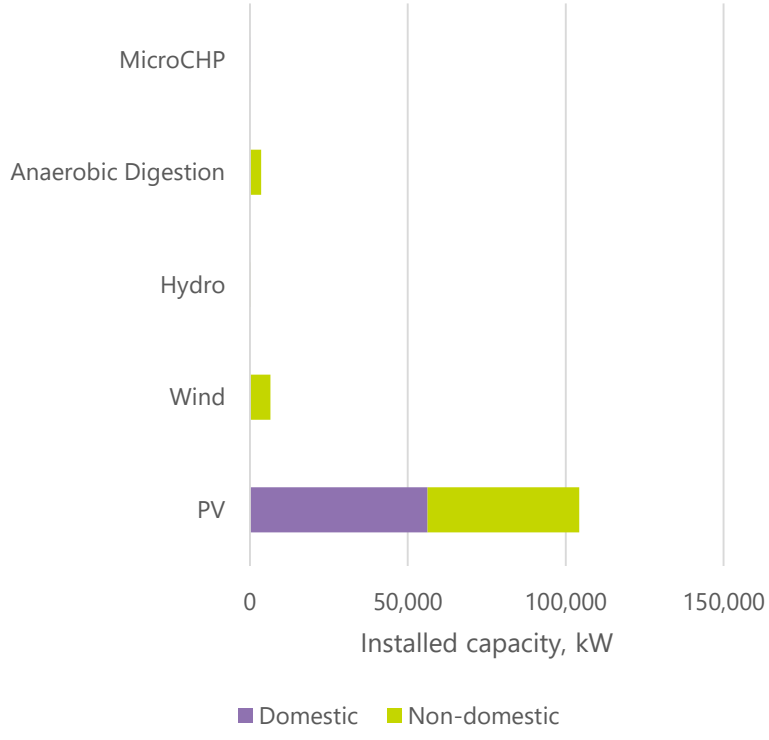
Feed in Tariff Installations

- Cumulative total capacity confirmed on the Central Feed-in Tariff Register as at end March 2019
  - **115 MW total**



Source: BEIS sub-regional Feed-in Tariffs statistics, October 2019

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Scenarios

- Range of scenarios tested
  - Achievable
  - **Ambitious**
  - Maximum
- Assumes share of wider UK hydro and offshore wind apportioned by population is accounted for in WoE energy mix

Capacity (MW)	South Gloucestershire	City of Bristol	B&NES	North Somerset	New	Existing
Solar PV (roof)	137	260	108	125	631	101
Solar PV (ground)	248	55	176	187	666	188
Hydro	0	1	4	0	5	0
Onshore Wind	167	0	114	132	412	65
Biomass	16	0	10	11	37	0
EfW	12	17	9	10	49	102
AD						17

Source: Zero West

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Scenarios

- Solar: greatest potential, limited by interseasonal storage
- Onshore wind: vital contribution (not only day)
- Hydro: tiny contribution (less than national average)
- Biomass: with existing land use, significantly more potential from energy crops than forestry (although energy density lower)
- EfW: WoE imports waste

Capacity (MW)	South Gloucestershire	City of Bristol	B&NES	North Somerset	New	Existing
Solar PV (roof)	137	260	108	125	631	101
Solar PV (ground)	248	55	176	187	666	188
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AD						17

Source: Zero West

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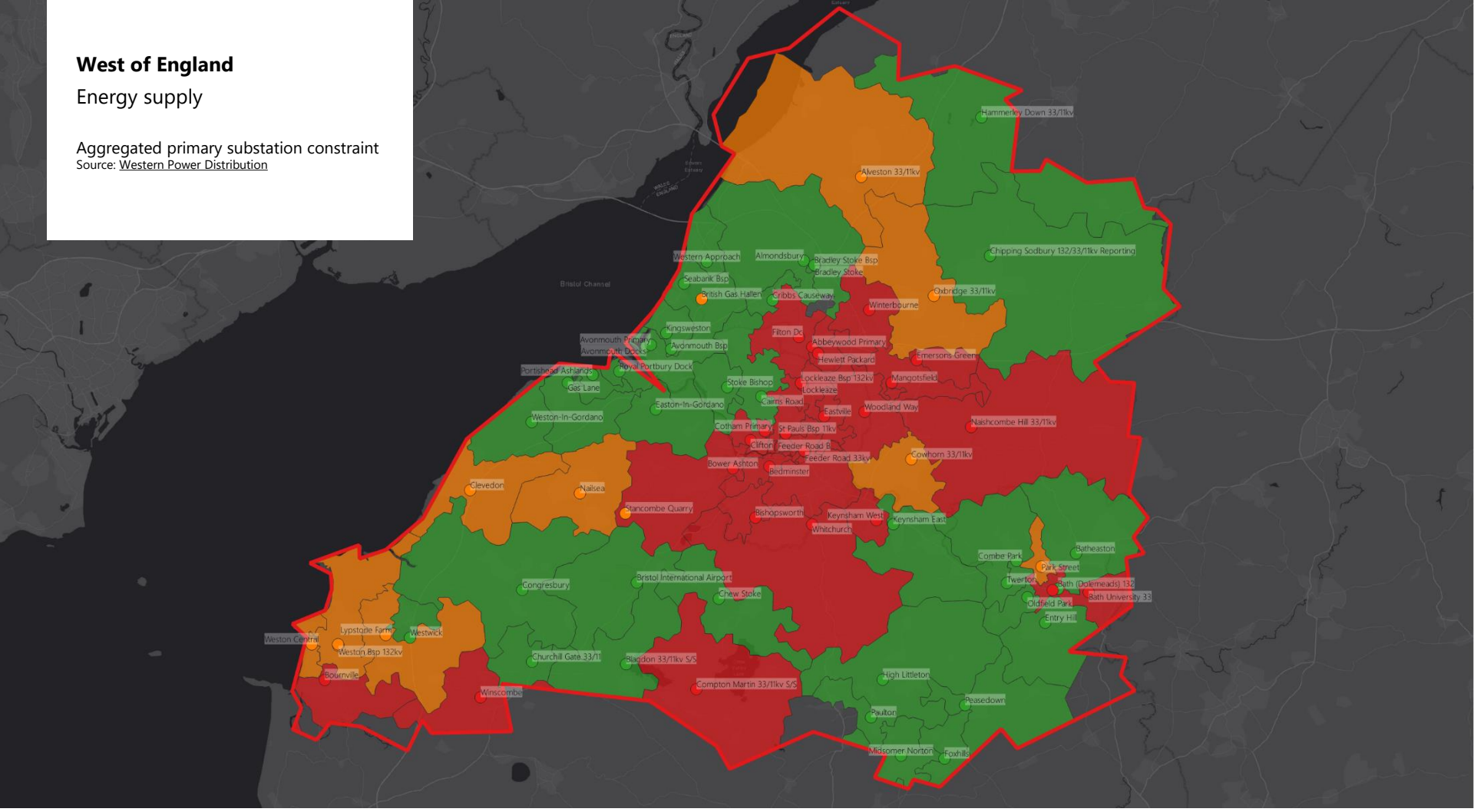
West of England

Energy supply

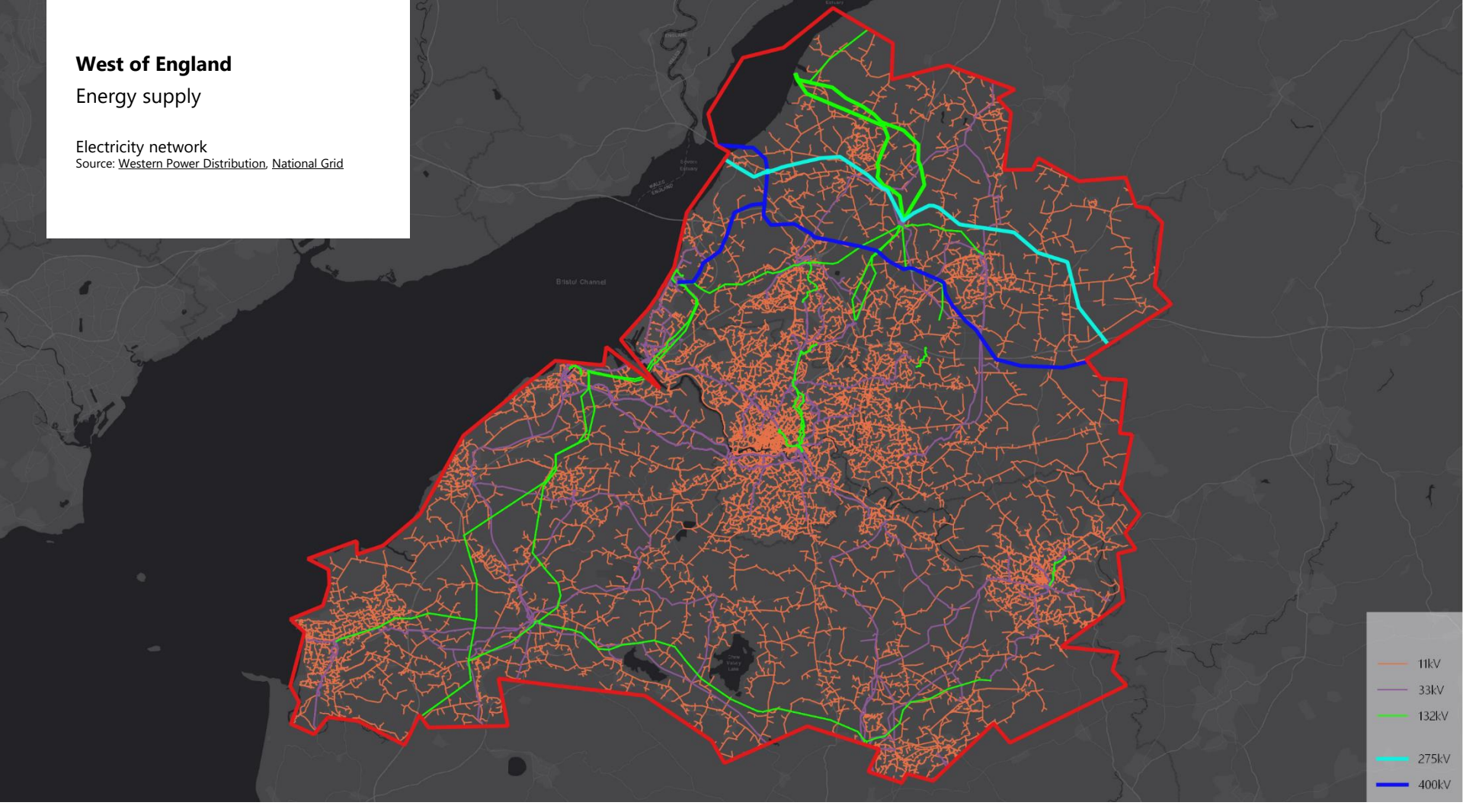
Aggregated primary substation constraint
Source: Western Power Distribution



West of England

Energy supply

Electricity network
Source: Western Power Distribution, National Grid



Scenarios

- Range of scenarios tested
  - Achievable
  - **Ambitious**
  - Maximum

- Solar:
  - 0.5% land area in Ambitious scenario for ground mounted PV (6.7km^2)

Capacity (MW)	South Gloucestershire	City of Bristol	B&NES	North Somerset	New	Existing
Solar PV (roof)	137	260	108	125	631	101
Solar PV (ground)	248	55	176	187	666	188
Hydro	0	1	4	0	5	0
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Biomass	16	0	10	11	37	0
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Source: Zero West

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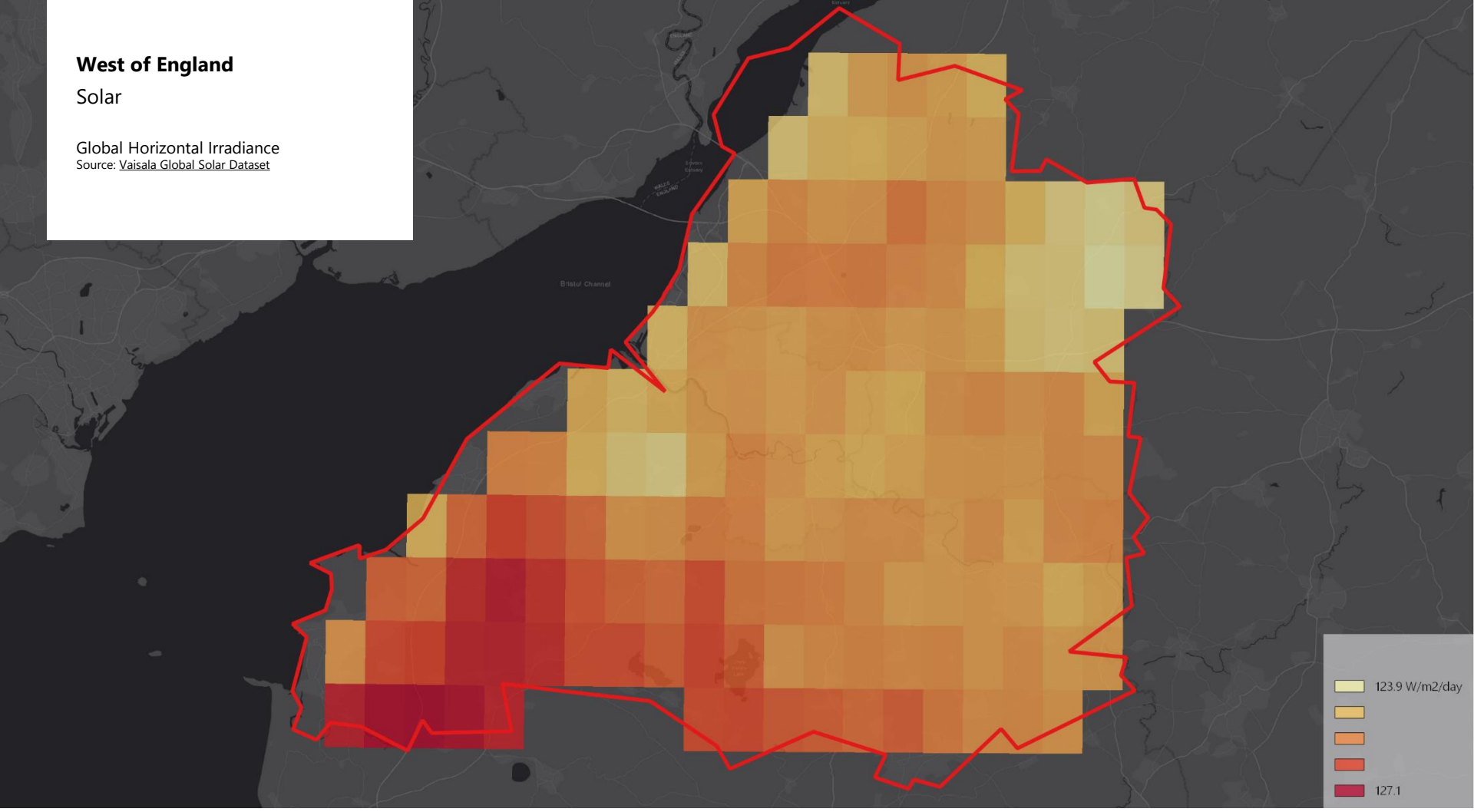
West of England

Solar

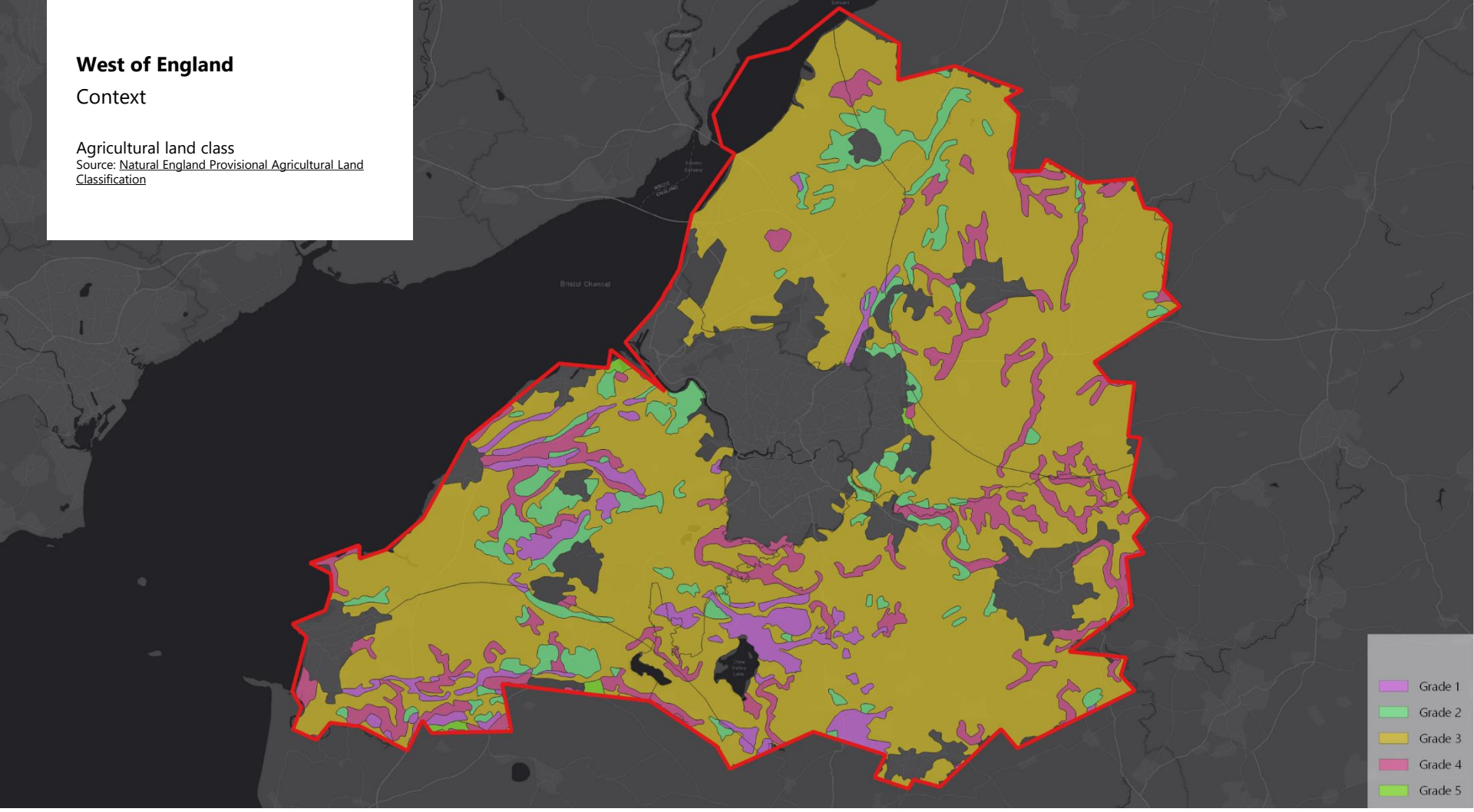
Global Horizontal Irradiance
Source: Vaisala Global Solar Dataset



West of England

Context

Agricultural land class
Source: Natural England Provisional Agricultural Land Classification



Land use

- Agricultural land class in West of England
  - 82% of land classified as agricultural, 1083 km^2
  - 25% of agricultural land is Grade 4 and 5 (119km^2), indicating areas of poorer quality land potentially suitable for large-scale renewables deployment

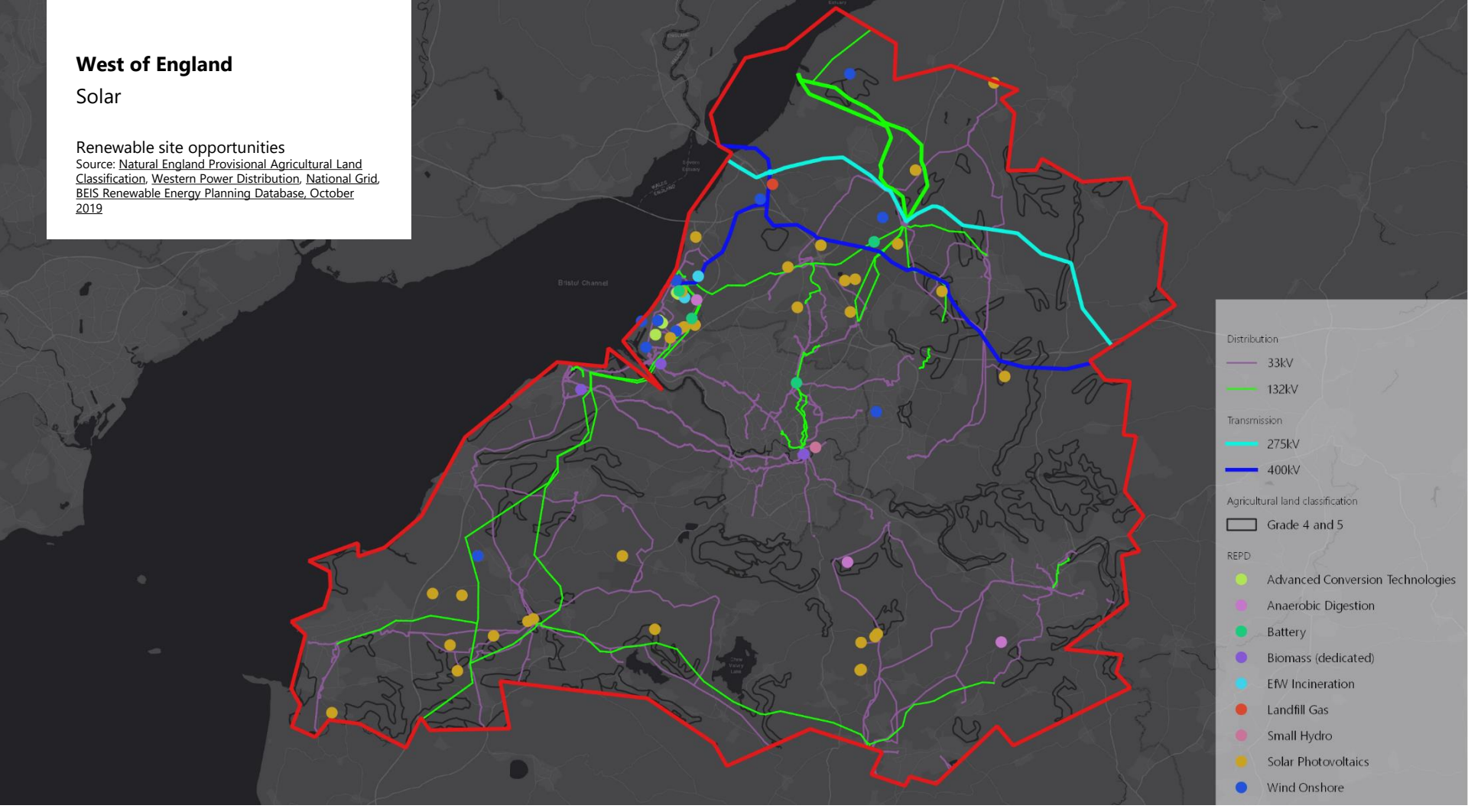
Source: Natural England Provisional Agricultural Land Classification

West of England

Solar

Renewable site opportunities

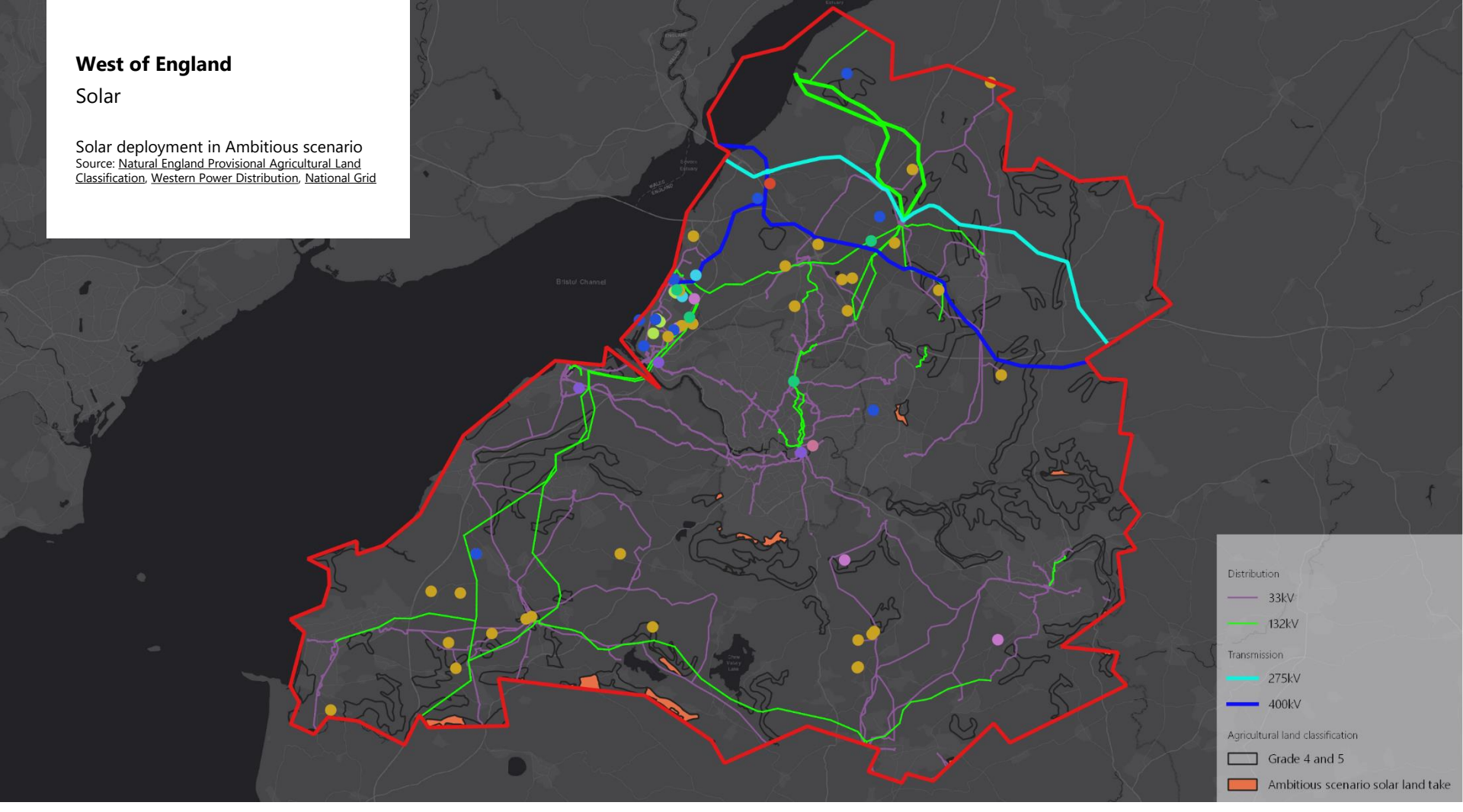
Source: Natural England Provisional Agricultural Land Classification, Western Power Distribution, National Grid, BEIS Renewable Energy Planning Database, October 2019



West of England

Solar

Solar deployment in Ambitious scenario
Source: Natural England Provisional Agricultural Land Classification, Western Power Distribution, National Grid



Scenarios

- Range of scenarios tested
  - Achievable
  - **Ambitious**
  - Maximum
- Wind:
  - 2.8% land area in Ambitious scenario for wind (45.8km^2)

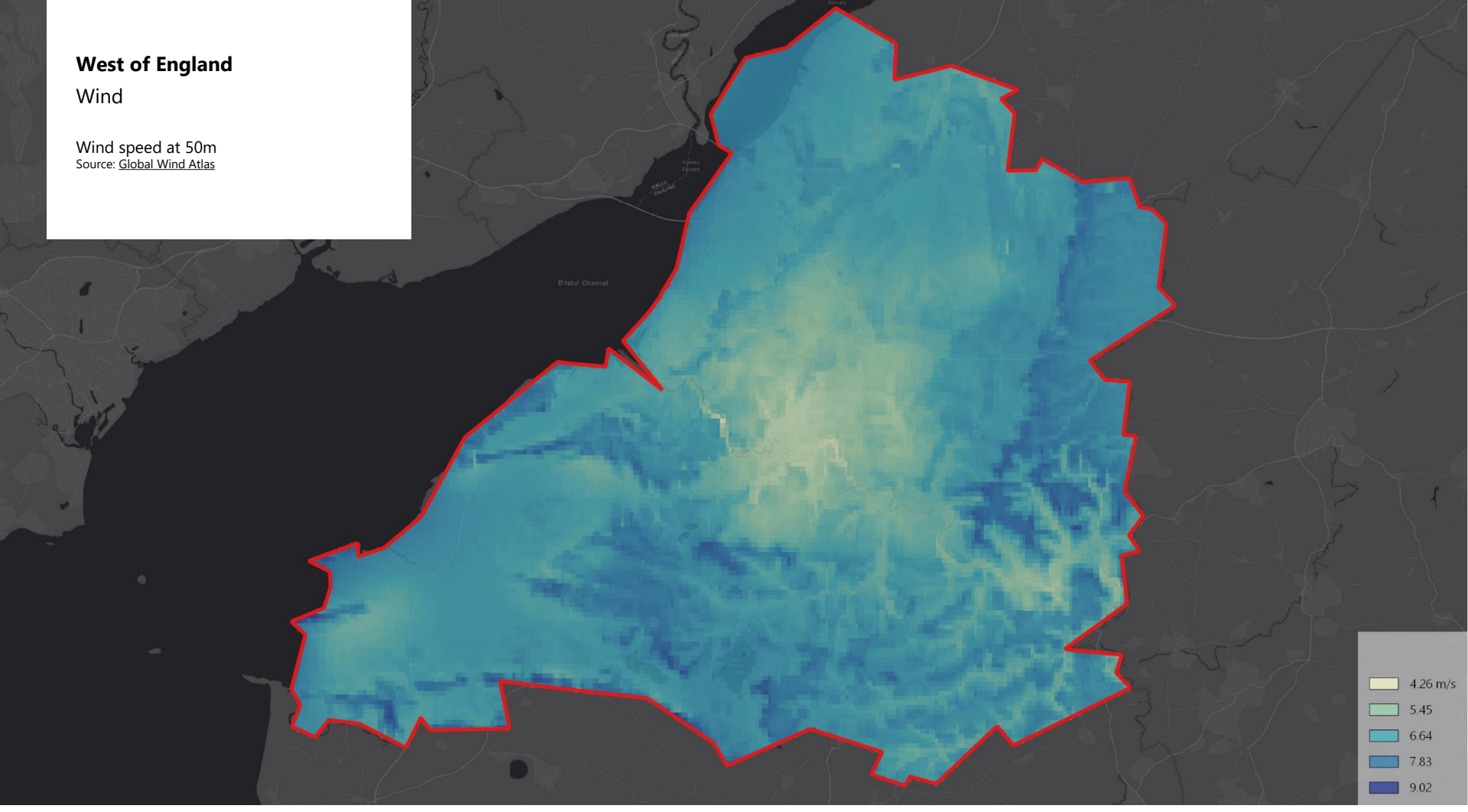
Capacity (MW)	South Gloucestershire	City of Bristol	B&NES	North Somerset	New	Existing
Solar PV (roof)	137	260	108	125	631	101
Solar PV (ground)	248	55	176	187	666	188
Hydro	0	1	4	0	5	0
Onshore Wind	167	0	114	132	412	65
Biomass	16	0	10	11	37	0
EfW	12	17	9	10	49	102
AD						17

Source: Zero West

West of England

Wind

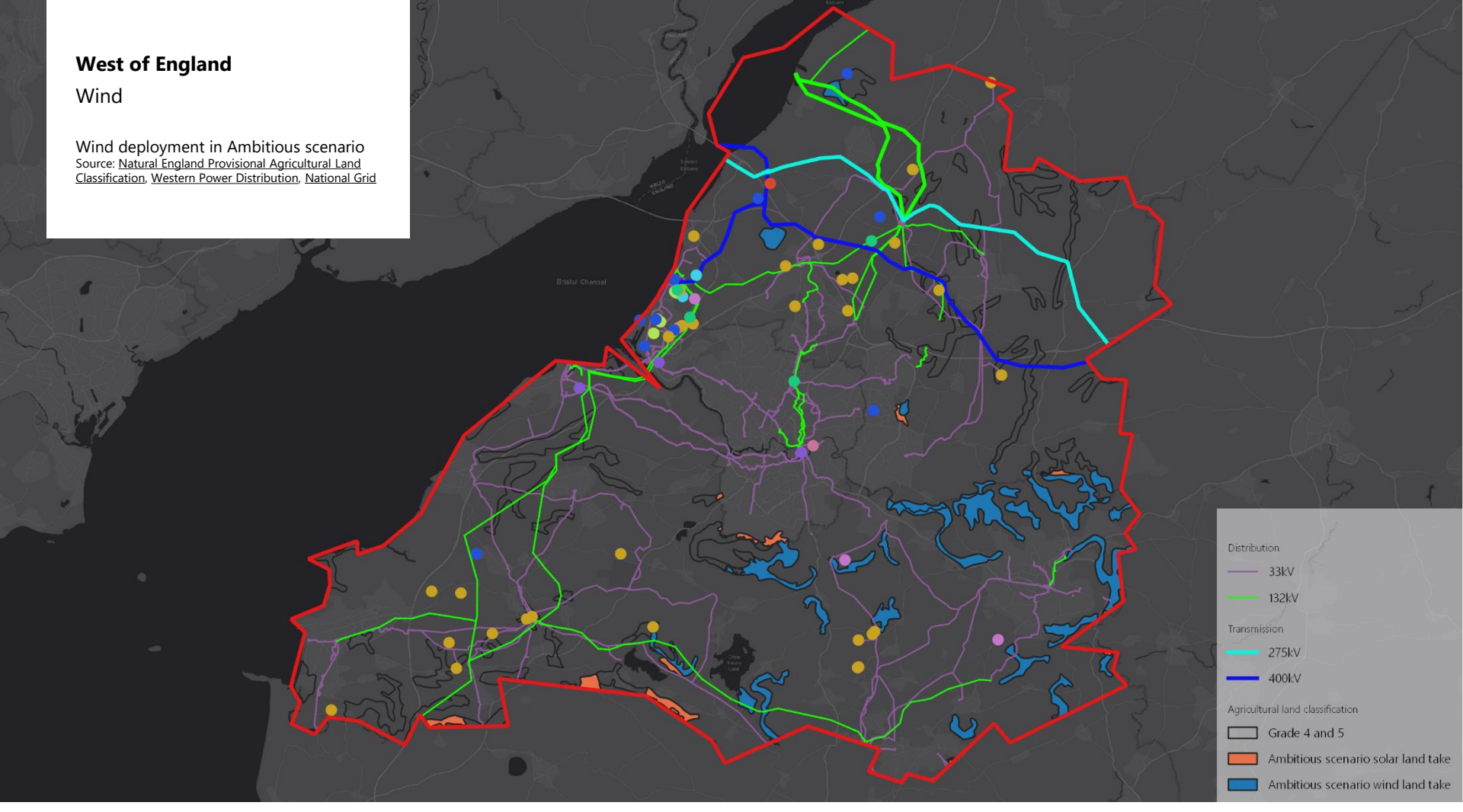
Wind speed at 50m
Source: Global Wind Atlas



West of England

Wind

Wind deployment in Ambitious scenario
Source: Natural England Provisional Agricultural Land Classification, Western Power Distribution, National Grid



Scenarios

- Range of scenarios tested
  - Achievable
  - **Ambitious**
  - Maximum
- Biomass:
  - 190km^2 energy crops

Capacity (MW)	South Gloucestershire	City of Bristol	B&NES	North Somerset	New	Existing
Solar PV (roof)	137	260	108	125	631	101
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AD						17

Source: Zero West

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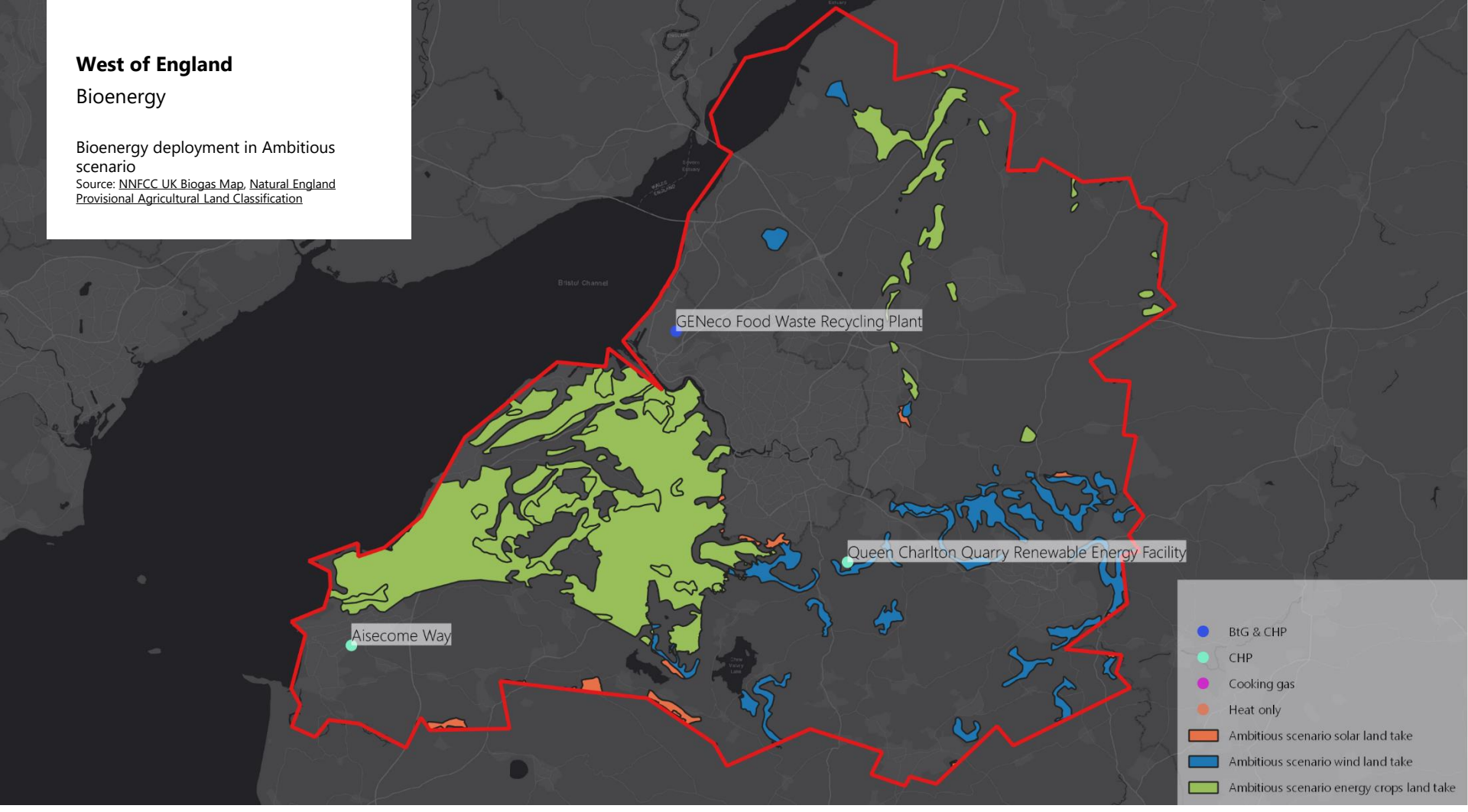
West of England

Bioenergy

Bioenergy deployment in Ambitious scenario

Source: NNFCC UK Biogas Map, Natural England Provisional Agricultural Land Classification

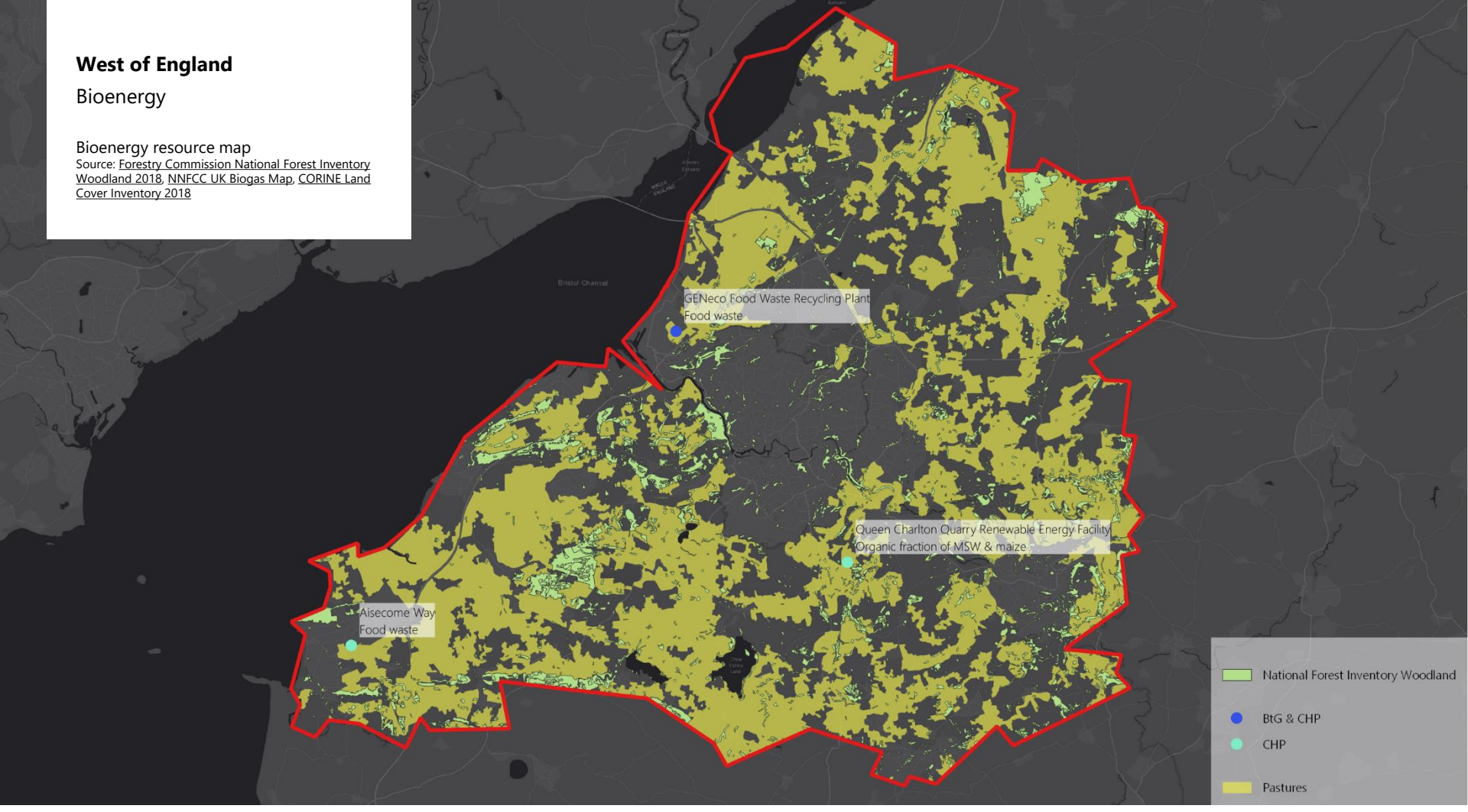


West of England

Bioenergy

Bioenergy resource map

Source: Forestry Commission National Forest Inventory Woodland 2018, NNFCC UK Biogas Map, CORINE Land Cover Inventory 2018

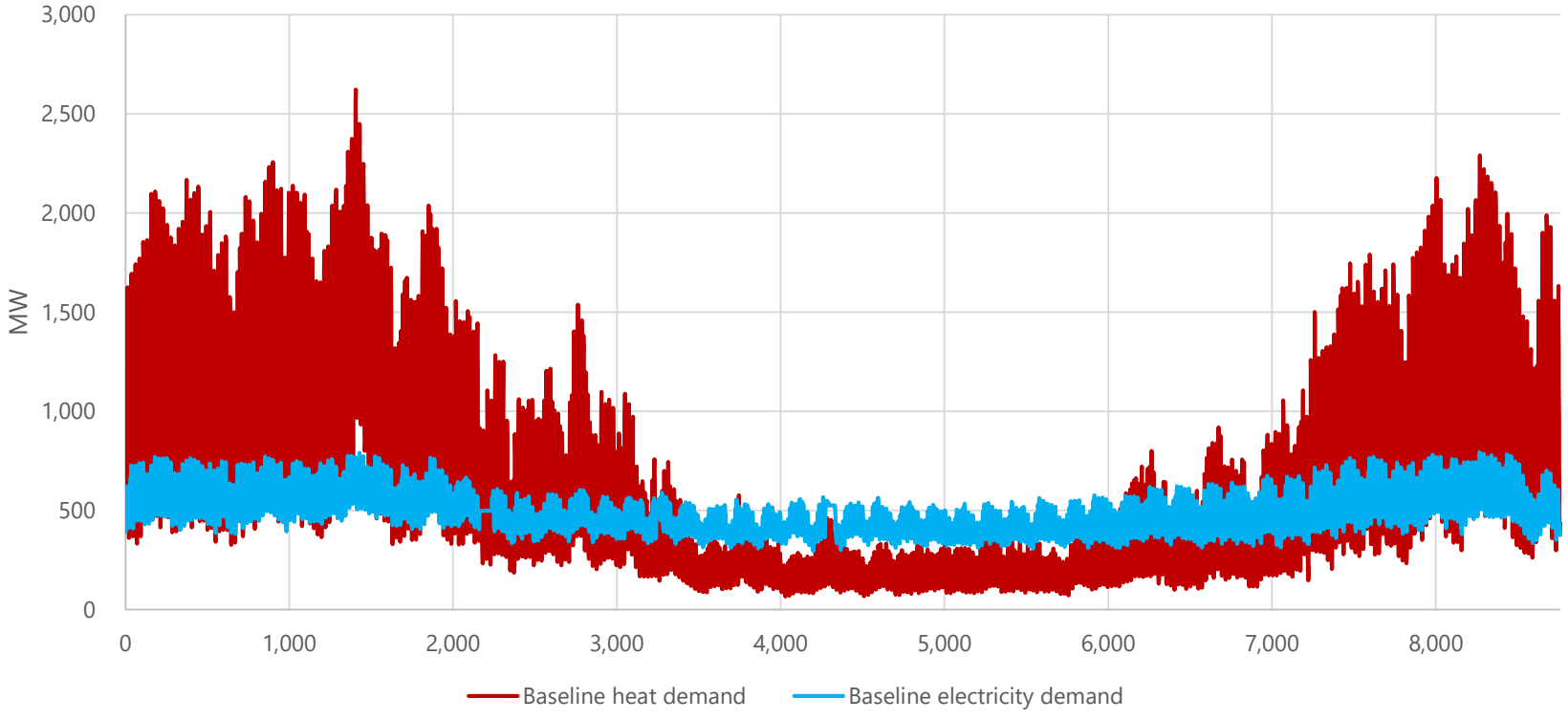


MATCHING HEAT SUPPLY AND DEMAND IN WEST OF ENGLAND

Pathfinder model

- No fossil fuels or nuclear
- Reduce demand by 30%
- Renewables:
  - Ambitious scenario for local solar and wind
  - Added share of offshore wind and national hydro projects
  - Biomass: current EfW, no biomass
- One electric car per household (current figure 1.4 cars/household)
- Interconnector supplies missing energy
- Heat pumps, EVs, hydrogen and batteries use excess generation
- Minimal hours of blackout
- Minimal unused electricity
- Greatest reduction in fossil gas consumption
- Greatest reduction in CO_2 emissions
- Least dependence on interconnector, which could represent:
  - Residual gas
  - Nuclear fission
  - Generation from hydrogen
  - Generation from green/synthetic gas
  - Tidal
  - Imported energy

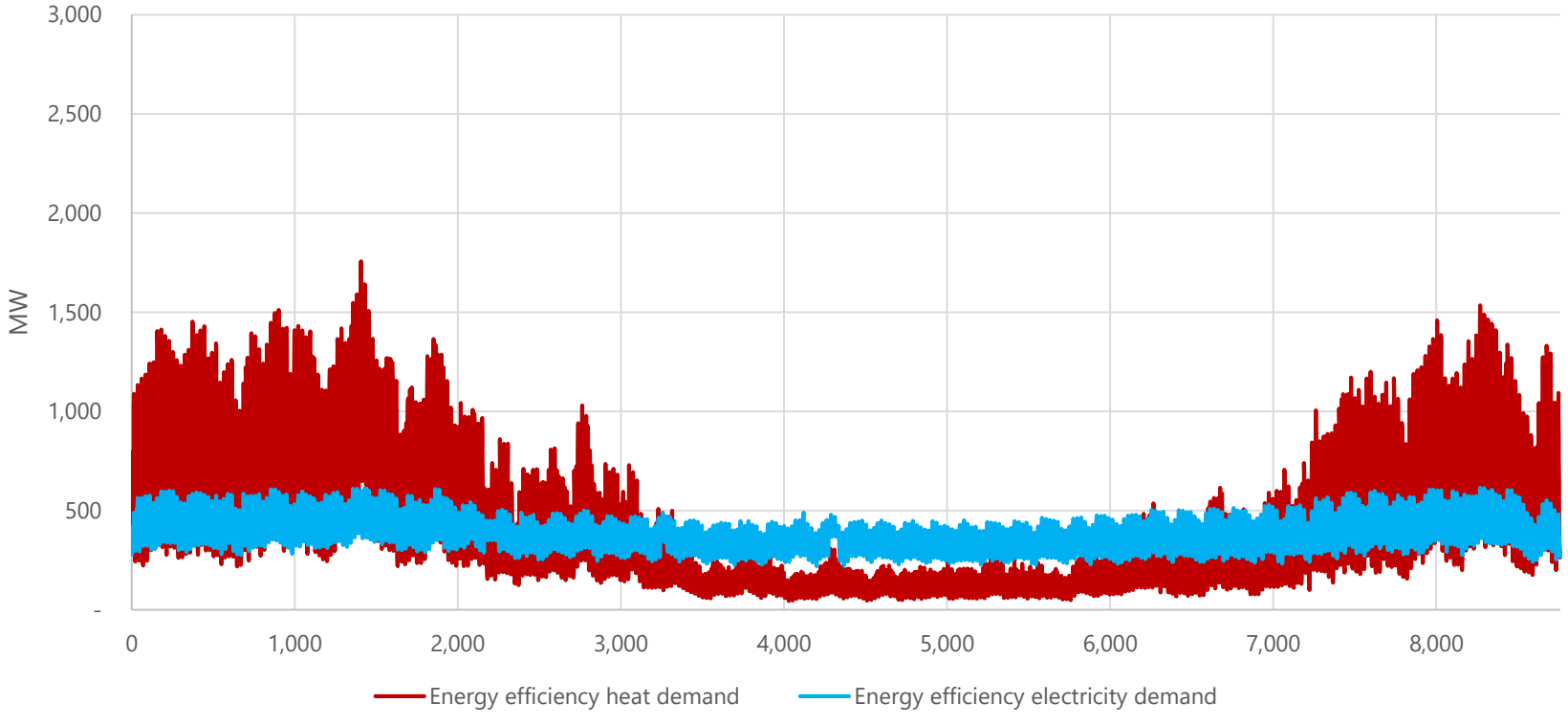
Baseline energy demand



Source: WWU Pathfinder Model/Zero West

BUROHAPPOLD ENGINEERING

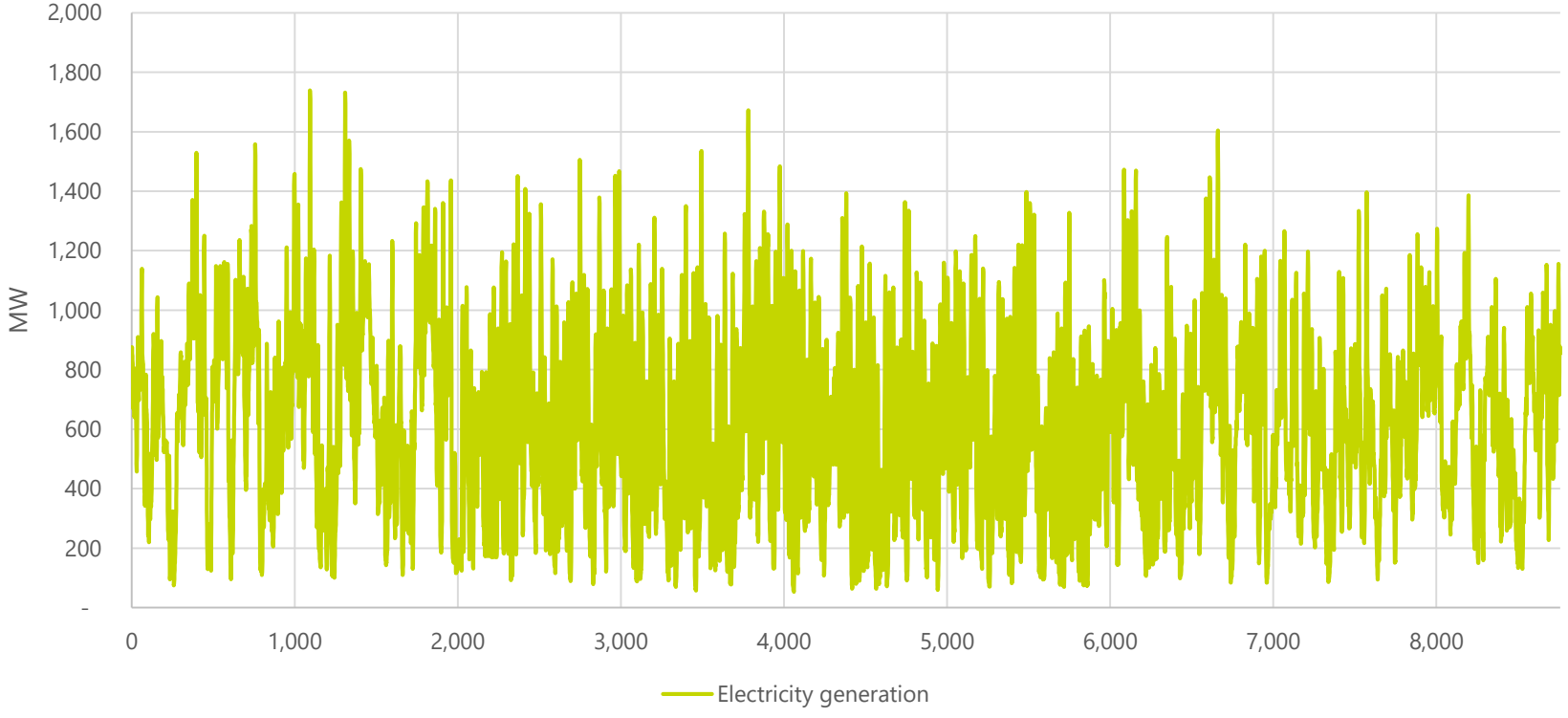
Future energy demand



Source: WWU Pathfinder Model/Zero West Scenario

BUROHAPPOLD ENGINEERING

Profile of generation



Source: WWU Pathfinder Model/Zero West Scenario

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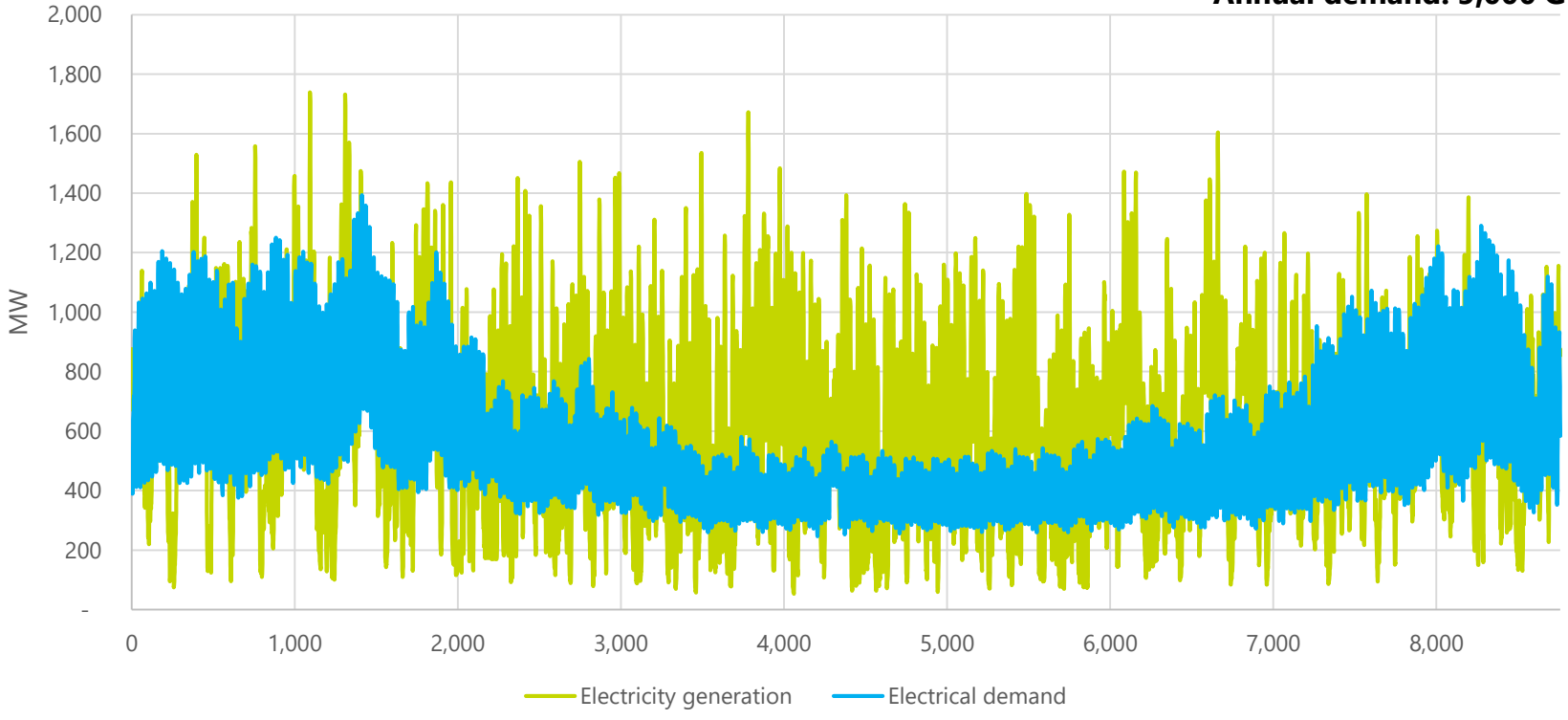
Supply and demand

All heat electrified

Annual generation: 5,200 GWh
Annual demand: 5,000 GWh



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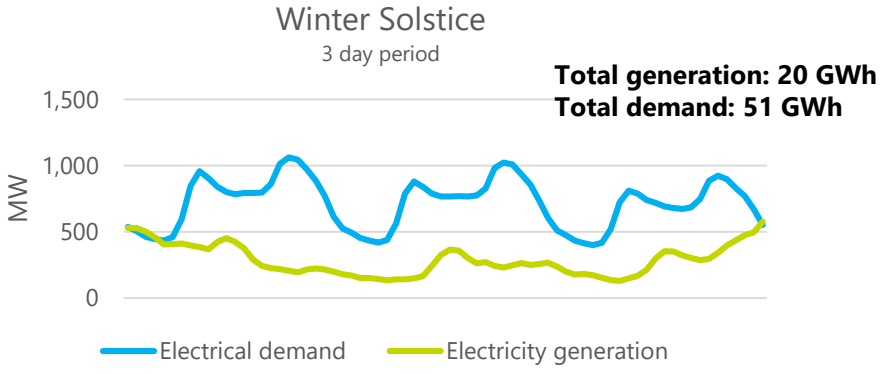
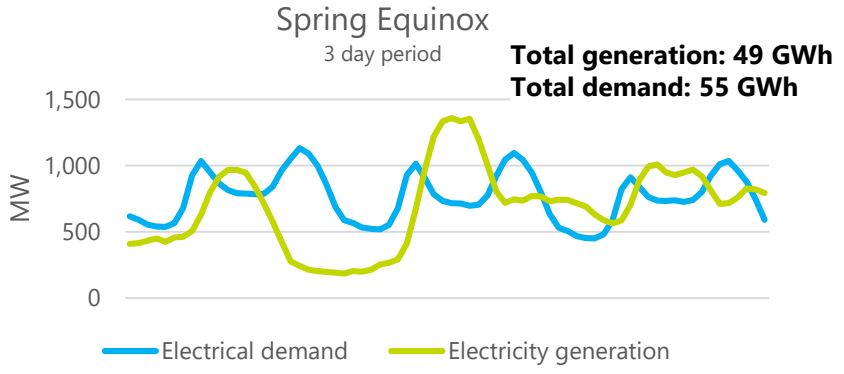
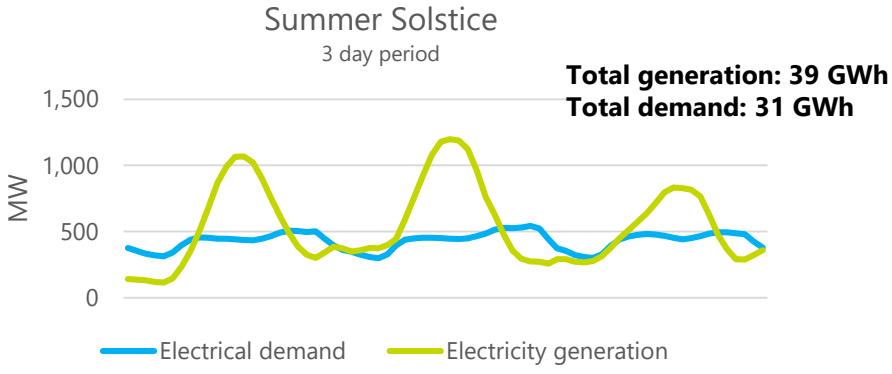
BUROHAPPOLD ENGINEERING

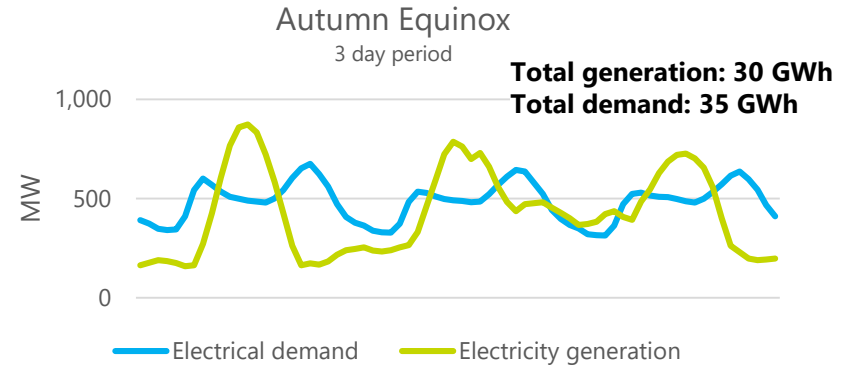
Supply and demand

All heat electrified







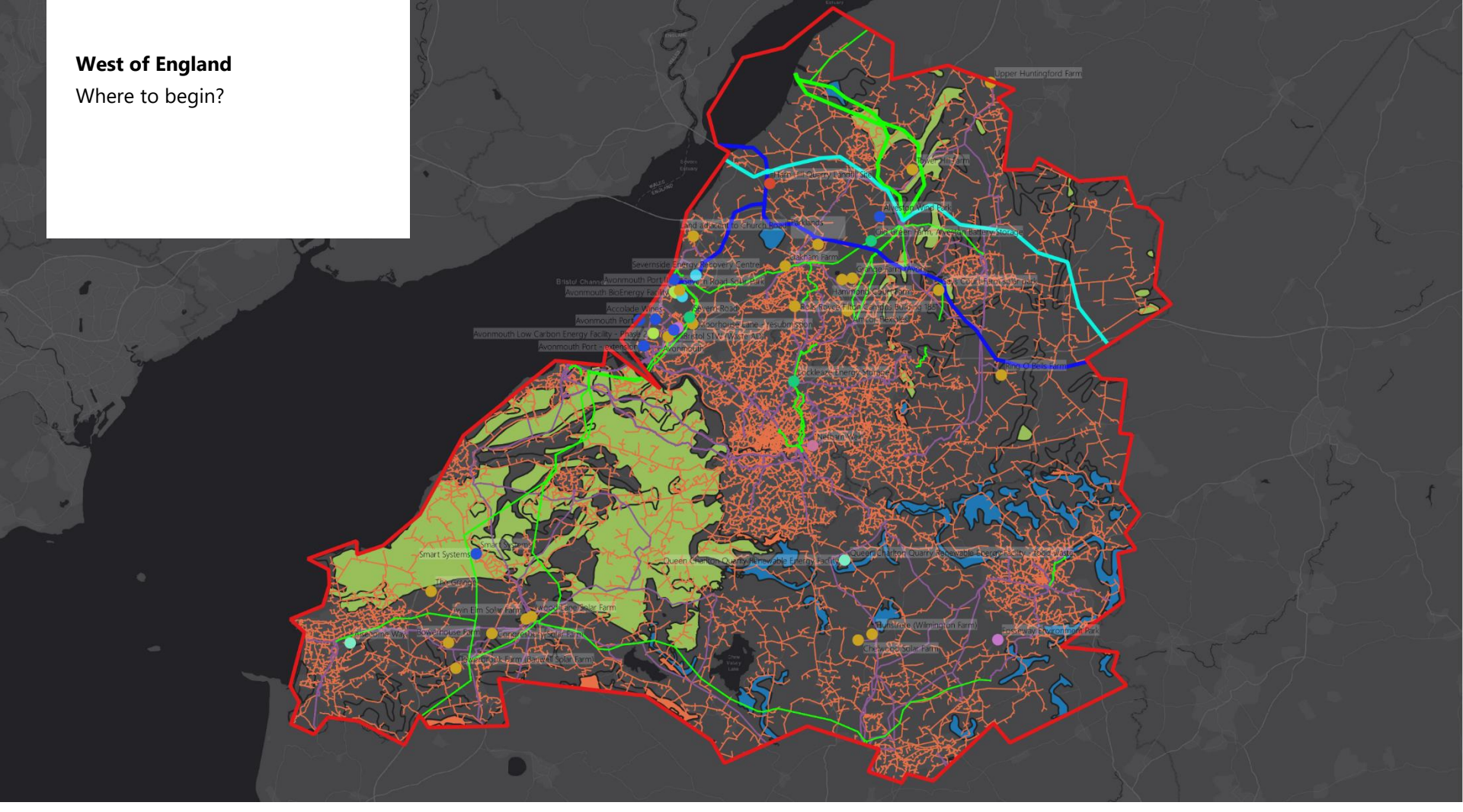


BUROHAPPOLD ENGINEERING

Source: WWU Pathfinder Model/Zero West Scenario

West of England

Where to begin?



BUROHAPPOLD ENGINEERING

Please get in touch…

We'd love to hear from you

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