Value of Lost Load to Customers (VoLL2)

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VoLL background
The financial and social cost of supply interruptions to customers in £ per MWh

VoLL has existed since 1990
2013 - London Economics ~£17k/MWh
average value (excluding I&C)

VoLL varies considerably across domestic and
SME customer segments

A single average figure is used to provide an overall value for
a given asset/decision

Ofgem used a figure of ~£16k/MWh for RIIO ED1

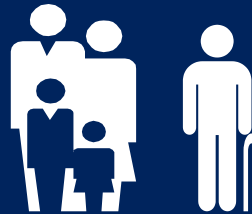# Original Electricity North West research

Quantify VoLL by customer segment now and in the future

What is the impact on customers of lost load?

What is the value of this impact expressed as the financial and social cost to customers in £ per kWh?

How does this vary by customer type?

How does this vary by supply interruption components?

How can DNOs mitigate the cost of lost load?

How will this vary with LCT adoption?

6,500 surveys with a wide range of customers across GB in winter and summer
5050 with domestic customers – 1450 with SMEs
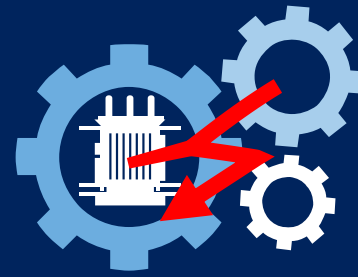
VoLL is increasing over time
Some differences in research approach vs earlier study

Values notably higher than those observed in the last major study by London Economics in 2013

Project developed a statistical model to capture granular impact of an interruption

VoLL estimates expressed relative to an outage at the **worst possible time** rather than the average

Higher VoLL estimate reflects variations in attributes tested by LE & ENWL
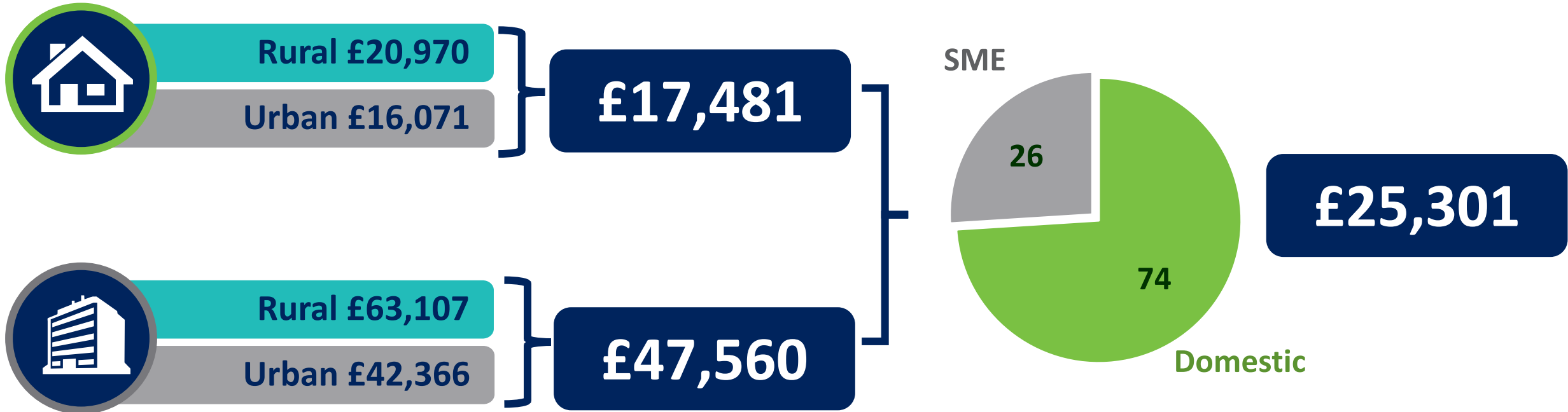
Demonstrates increasing customer needs and expectations

Increase in overall VoLL WTA estimates (£/MWh)
London Economics (2013) = £16,940   Electricity North West (2018) = £25,300

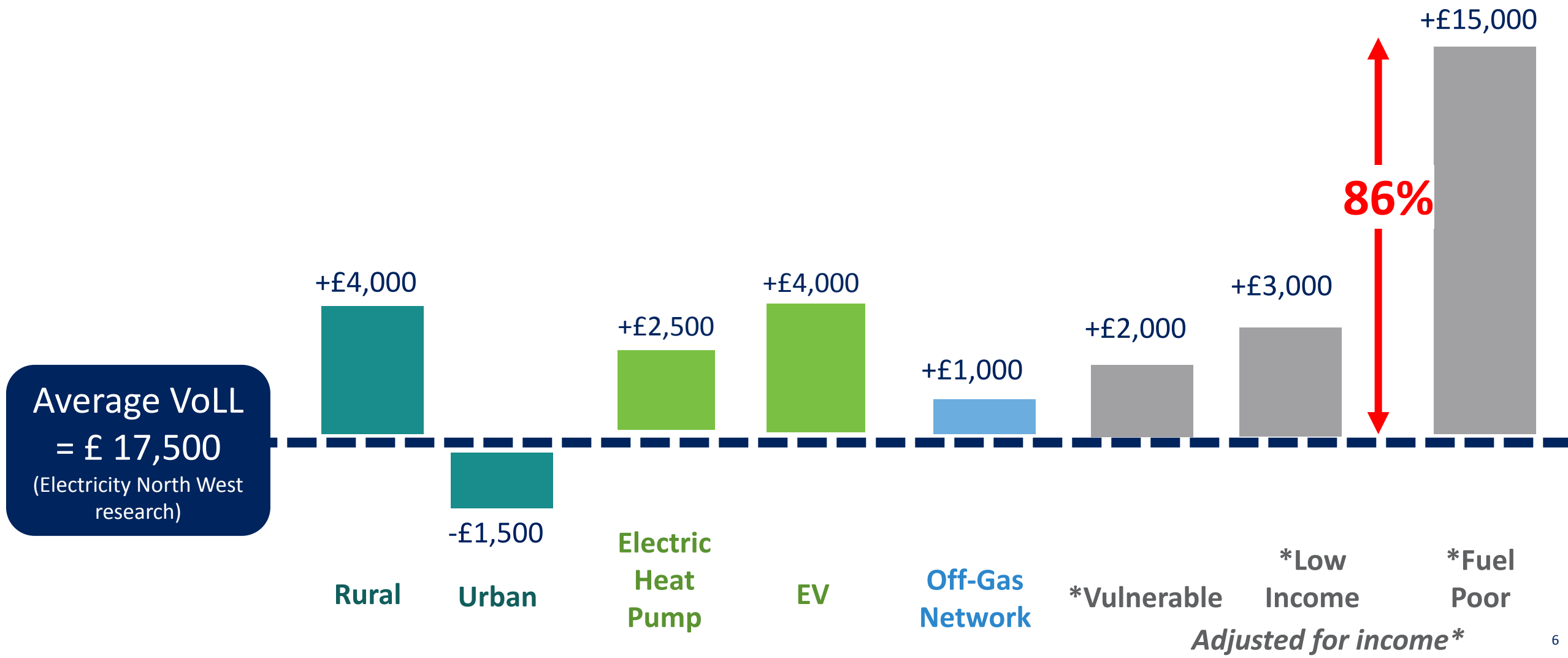# Using our results to replicate LE's value (main study)

Combining our values to reconstruct 'vanilla' VoLL

| Rural £20,970 |
| Urban £16,071 |

£17,481

| Rural £63,107 |
| Urban £42,366 |

£47,560

SME

26

74

Domestic

£25,301

LE value = £16,940

Factors which have more impact on domestic VoLL

Average VoLL = £ 17,500
(Electricity North West research)

- Rural: +£4,000
- Urban: -£1,500
- Electric Heat Pump: +£2,500
- EV: +£4,000
- Off-Gas Network: +£1,000
- *Vulnerable: +£2,000
- *Low Income: +£3,000
- *Fuel Poor: +£15,000

86%

Adjusted for income

New estimation of VoLL

10 hour LV feeder fault occurring once every five years, over a period of 40 years

Two LV feeders, both supplying 50 homes

Old VoLL

New VoLL

Urban
X 30

Low use
X 20

£ 72,000

£ 66,000

Rural
X 15
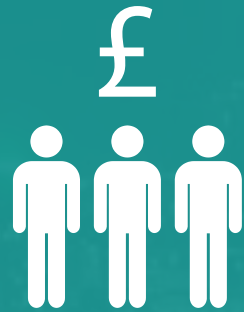
Fuel poor
X 20

X 15

£ 72,000

£ 106,000

VoLL calculated for each household by applying a weighted combination of values for each household characteristic

Summary of original findings

Existing approach undervalues the needs of certain customers

Not reflective of those dependent on LCTs

Fuel poor are hugely under represented

Others are over represented potentially driving inefficient investments

A revised VoLL model will provide an effective tool that all DNOs can use without the need for new data flows

Segmentation model enables DNOs to make decisions more reflective of actual customer needs

VoLL2 overview – matrix currently using VoLL
Early view on potential application in RIIO-ED2

Matrix where current vanilla VoLL is used	Areas where notional VoLL is used	Areas where VoLL concept not currently used
Setting IIS incentive rate Calibrating CBA model to evaluate benefits of investment Tailoring network performance factor in Common Network Asset Indices Methodology (CNAIM)	Worst served customer regime	Guaranteed Standards regime Customer service and/or satisfaction measures

New research questions for VoLL 2

Having established key factors contributing to VoLL and empirical research as to their relative strength, we need to look at the practicalities of implementation

At what scale should a more complex VoLL function be applied?	Over what time period should VoLL be considered?	How to differentiate between embedded and transient factors?	How to incorporate scenario forecasting and associated uncertainty?
Establish the optimum degree of complexity of a new model Range from GB level through to individual MPAN	Today's VoLL Tomorrow's VoLL Lifetime of the asset/network under consideration?	Establish the stability/variability of factors that influence VoLL and the level of detail at which variables might be combined, relative to network parameters	What is the art of the possible with regard to currently available data and systems?

VoLL2 will gather further empirical evidence

How is VoLL best extrapolated to a population? Study will examine relative value HILP events involving many customers vs localised outages	How VoLL is influenced by the greater resilience of certain customer types / communities	The ability of customers to signal VoLL, where social costs are not recognised or borne by the customer	Perceptions of fairness Unintended consequences of a model that recognises divergence

Calculating a Variable Value of Lost Load (VoLL)

Robbie Urwin

31st October 2019

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FRAZER-NASH
CONSULTANCY

Introduction

- ▸ Frazer-Nash tasked by ENWL to explore the implementation of an alternative model for a variable VoLL
- ▸ A higher fidelity model that accounts for the variation in VoLL for different types of customers

- ▸ We have produced a prototype VoLL model that:
  - ▸ Has been derived from customer survey data
  - ▸ Includes key drivers of VoLL such as fuel poverty and electric vehicle ownership
  - ▸ Has been used to estimate VoLL for each LSOA in Great Britain

- ▸ Project Dates: August – November 2019 (still on-going!)

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The Customer Survey (Impact Research)

- Variable VoLL to be derived from choice experiment data
- Collected from a customer survey conducted by Impact Research
- 6,500 customers surveyed
    - 5,000 domestic
    - 1,500 SME
- Customers presented with various trade-off scenarios
- Hierarchical Bayes analysis then used to calculate VoLL

WTA	Option A	Option B	
Frequency of power cuts/s (over a three-year period)	7-14 power cuts	4-6 power cuts	Not sure
Duration of the power cut/s	More than 6 hours per power cut	6 hours per power cut	
The amount you receive for this happening	Payment to you: 15% of your annual electricity bill	Payment to you: 5% of your annual electricity bill	
Please make your selection here	○	◉	○

An example trade-off scenario presented to customers in the survey. Customers were asked to select the option that most accurately reflected their view on what they would expect to receive in such a situation.

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VoLL Indicators
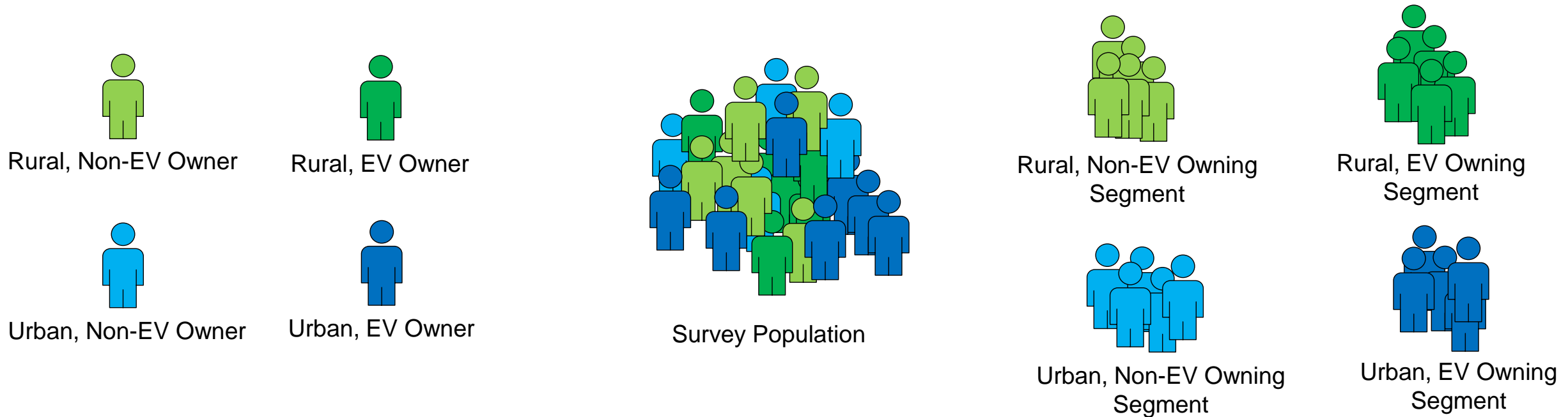
▸ VoLL Indicators: The key characteristics of a customer that most influence how they value loss of electricity supply

▸ For each respondent, the customer survey catalogues:

▸ Customer Type
  ▸ Domestic
  ▸ SME
▸ Age
▸ Gender
▸ Rurality
▸ Income
▸ Vulnerability
▸ Fuel Poverty

▸ Electricity Consumption
▸ Electricity Supply Reliability
▸ Gas Supply
▸ Low Carbon Technology (LCT) Adoption
  ▸ Electric Vehicles (EV)
  ▸ Heat Pumps (HP)
  ▸ Photovoltaics (PV)

▸ Analysis of the survey results can be performed to determine which of these attributes are the most significant VoLL indicators
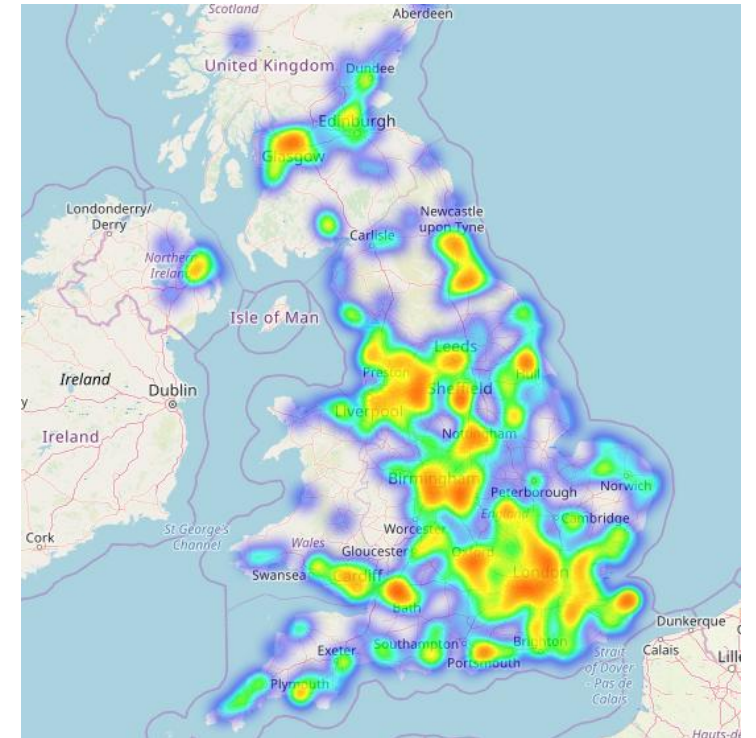
Locations of survey respondents. Orange and red areas have a greater density of respondents.

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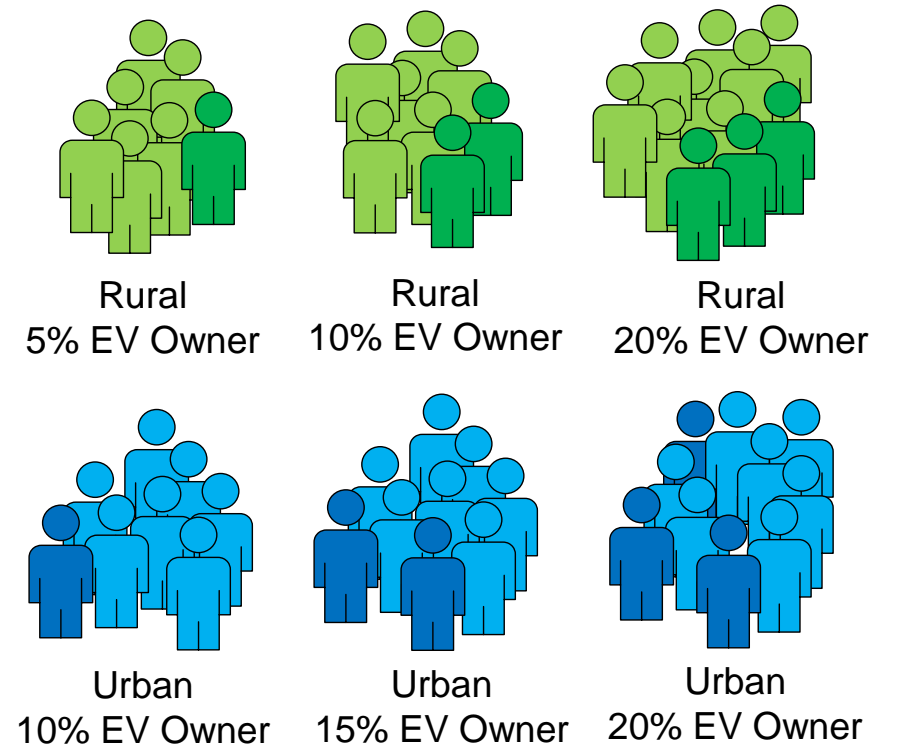
VoLL Estimation for Customer Segments

SIMPLIFIED EXAMPLE – JUST CONSIDERING RURALITY AND EV OWNERSHIP

Rural, Non-EV Owner

Rural, EV Owner

Urban, Non-EV Owner

Urban, EV Owner

Survey Population

Rural, Non-EV Owning Segment

Rural, EV Owning Segment

Urban, Non-EV Owning Segment

Urban, EV Owning Segment

▸ VoLL can be estimated for the entire survey population

▸ VoLL can also be estimated for samples of the survey population that represent different customer segments (so long as the sample contains 200+ customers)

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VoLL Estimation for Sample Populations

Rural, Non-EV Owner

Rural, EV Owner

Urban, Non-EV Owner

Urban, EV Owner

Survey Population

Rural
5% EV Owner

Rural
10% EV Owner

Rural
20% EV Owner

Urban
10% EV Owner

Urban
15% EV Owner

Urban
20% EV Owner
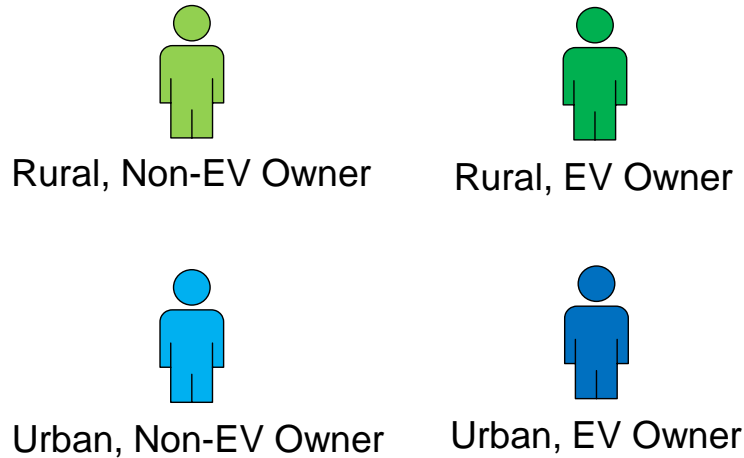
▸ VoLL can also be estimated for sample populations containing a mix of customer segments (more representative of 'real' populations)

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The VoLL Model

- A VoLL model can be trained using millions of different sample populations drawn from the customer survey
- The model can then be used to predict the VoLL for **ANY** sample population for which the VoLL indicators are known
- For example this could be:
  - The households in a Lower Super Output Area (LSOA – approx. 1500 population)
  - The households in a radius around a distribution substation
  - The households known to be served by a primary substation

VoLL Model → 18,450 £/MWh

Rural
8% EV Owner

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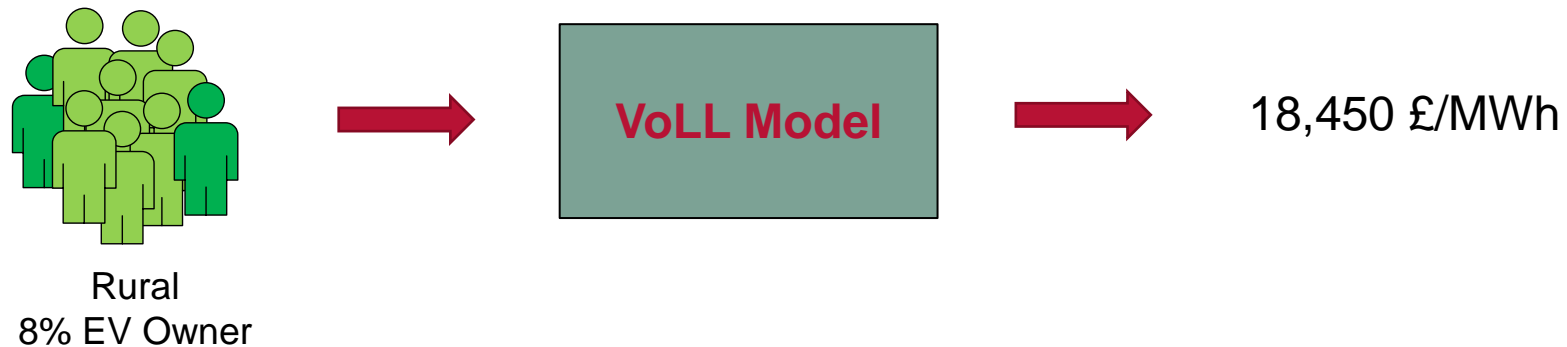
VoLL Indicator Estimation

▸ In order to estimate the VoLL for any given sample population it is therefore necessary to estimate the population's VoLL indicators

▸ The prototype VoLL model estimates VoLL at an LSOA level

▸ VoLL indicator estimates have therefore been made for each LSOA in Great Britain

▸ The table below details the VoLL indicators used for the prototype model

VoLL Indicator	Data Source	Granularity	Indicator Importance
SME Locations	ONS	Local Authority	High
Rurality	ONS	LSOA	High
Fuel Poverty	ONS	LSOA	High
EV Adoption	Open Charge Map	Charge Point Locations	Medium
Income	ONS	LSOA	Medium
Consumption	ONS	LSOA	Medium
Gas Supply	CSE	Postcode	Medium
Age	ONS	LSOA	Low

ONS = Office for National Statistics, CSE = Centre for Sustainable Energy

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Additional VoLL Indicators

- Gender and PV ownership not included as not significant in estimating VoLL
- Additional VoLL indicators not included in the prototype model include:
  - Vulnerability
    - Vulnerability data is held in the Point Service Register (PSR)
    - Not included in the prototype due to sensitivity of the data
  - Supply Reliability
    - It is theoretically possible to include this in a VoLL model, if DNO's were to provide historic data on customer interruptions
    - Not included at this stage as the practicalities of collecting and aggregating this data is too large a task for the prototype project
  - Heat Pump Ownership
    - Not included due to lack of available data on installation
- Including these additional indicators would improve the accuracy of the VoLL model (but not by an order of magnitude)
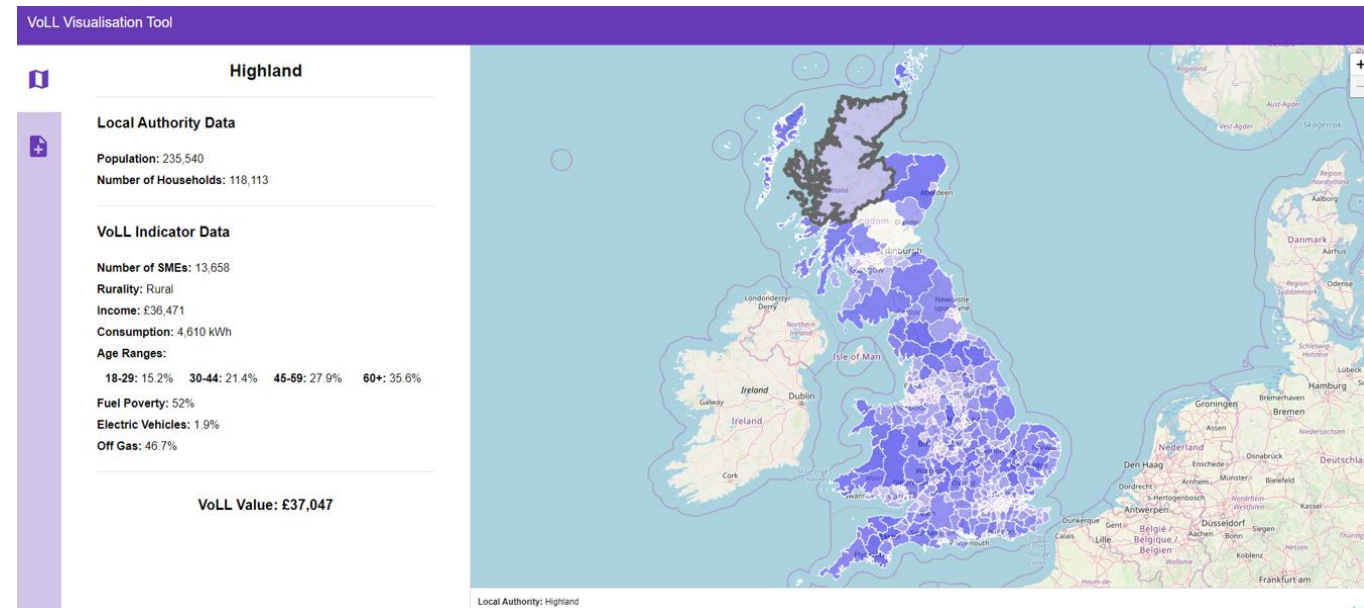
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Assessing Model Accuracy

▸ By withholding a portion of the survey data it is possible to test the accuracy of the model using data it has not 'seen' before

▸ Repeating this many times allows us to estimate how good the model is at predicting different values of VoLL

▸ Not that different from going out and collecting more survey data with which to test the model

Survey Population   Training Set   Test Set
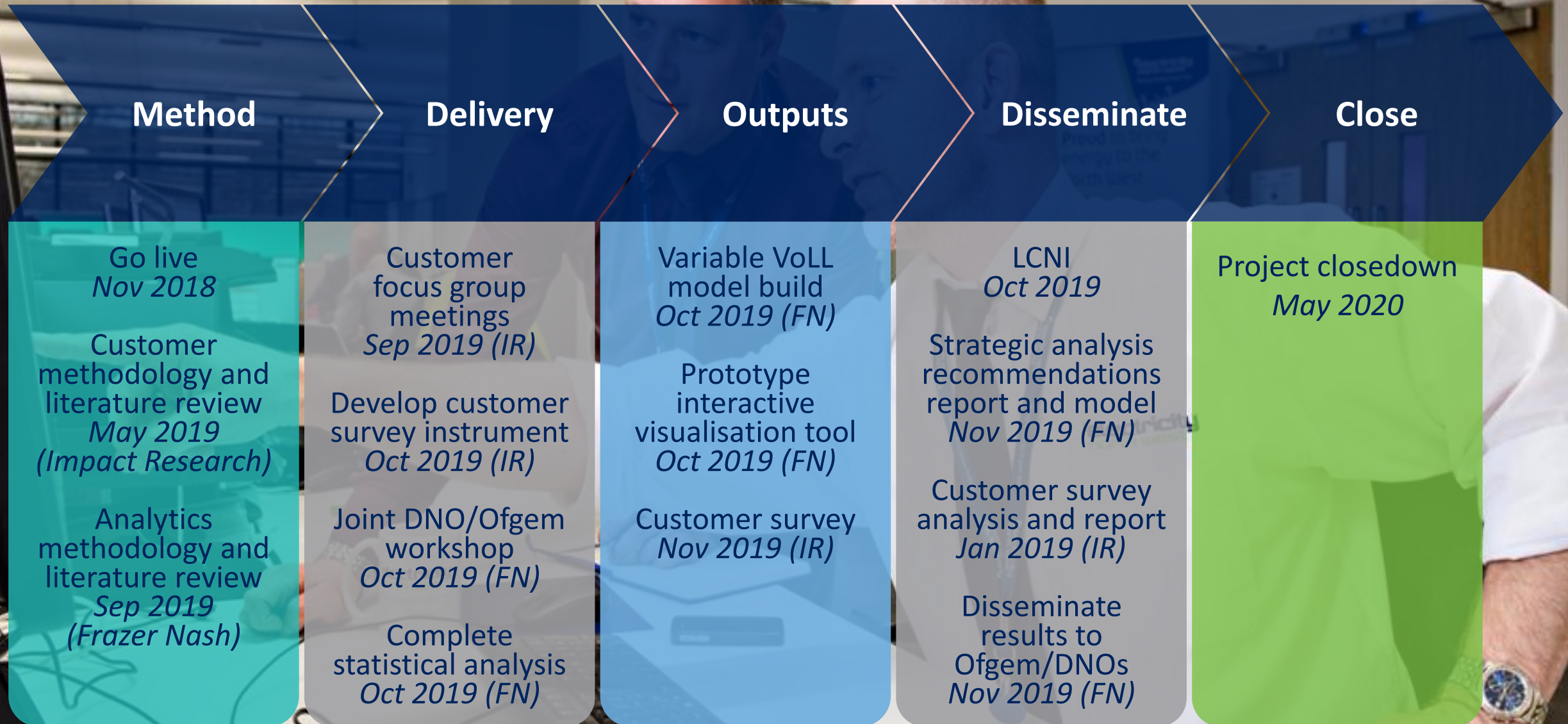
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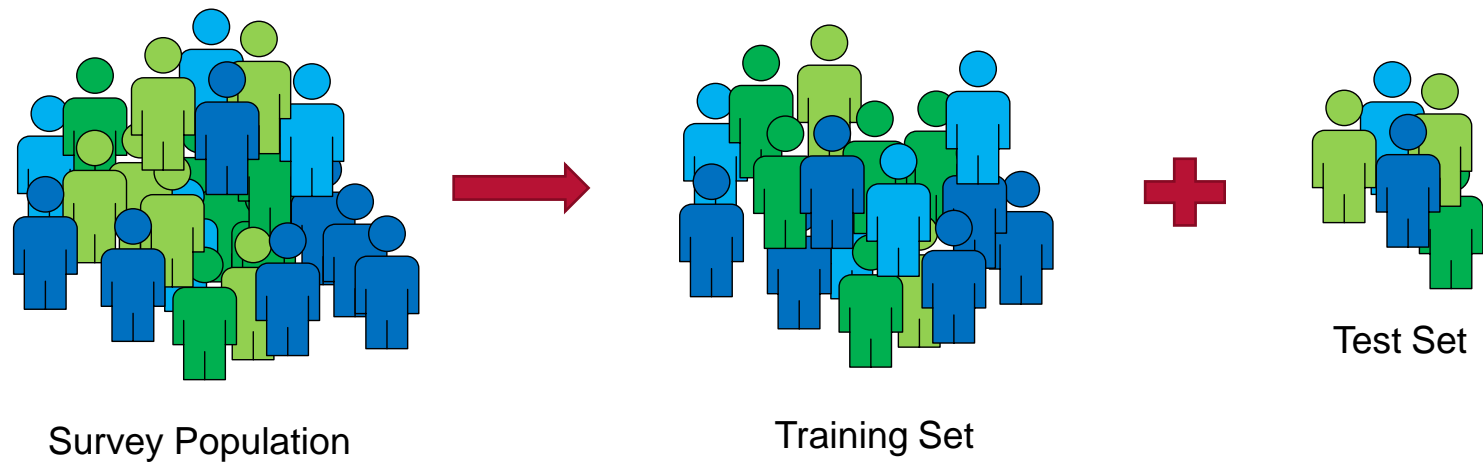
The VoLL Visualisation Tool

‣ The VoLL Visualisation Tool allows you to explore the results of the prototype VoLL model in an interactive map

‣ VoLL displayed at Local Authority and LSOA level

‣ Try it out at the ENWL stand!

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Summary of progress/next steps

Method

Go live
Nov 2018

Customer methodology and literature review
May 2019 (Impact Research)

Analytics methodology and literature review
Sep 2019 (Frazer Nash)

Delivery

Customer focus group meetings
Sep 2019 (IR)

Develop customer survey instrument
Oct 2019 (IR)

Joint DNO/Ofgem workshop
Oct 2019 (FN)

Complete statistical analysis
Oct 2019 (FN)

Outputs

Variable VoLL model build
Oct 2019 (FN)

Prototype interactive visualisation tool
Oct 2019 (FN)

Customer survey
Nov 2019 (IR)

Disseminate

LCNI
Oct 2019

Strategic analysis recommendations report and model
Nov 2019 (FN)

Customer survey analysis and report
Jan 2019 (IR)

Disseminate results to Ofgem/DNOs
Nov 2019 (FN)

Close

Project closedown
May 2020

QUESTIONS
&
ANSWERS

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