UNIVERSITY OF CAMBRIDGE

Charge-on-the-move for the UK Transport application

A National Power Infrastructure

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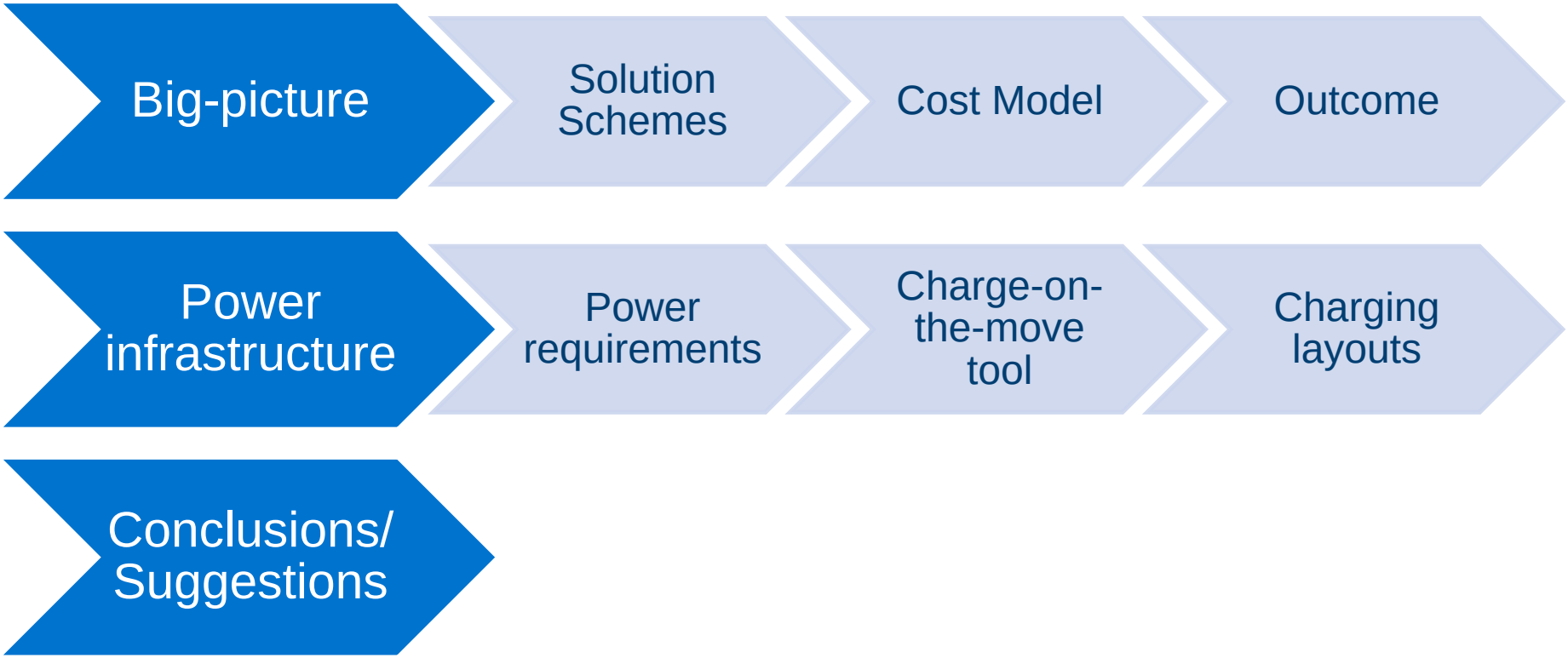
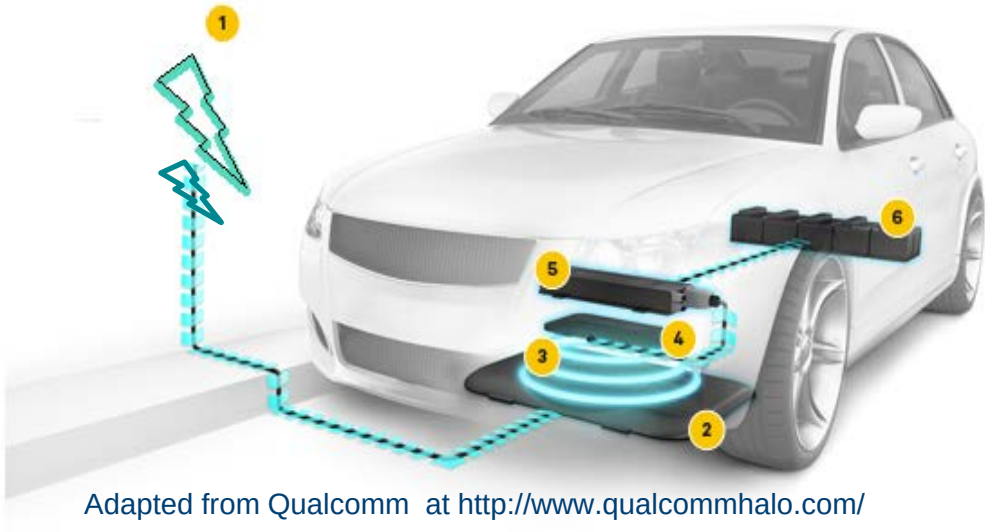
Context


Big-picture
Solution Schemes
Cost Model
Outcome
Power infrastructure
Power requirements
Charge-on-the-move tool
Charging layouts
Conclusions/ Suggestions

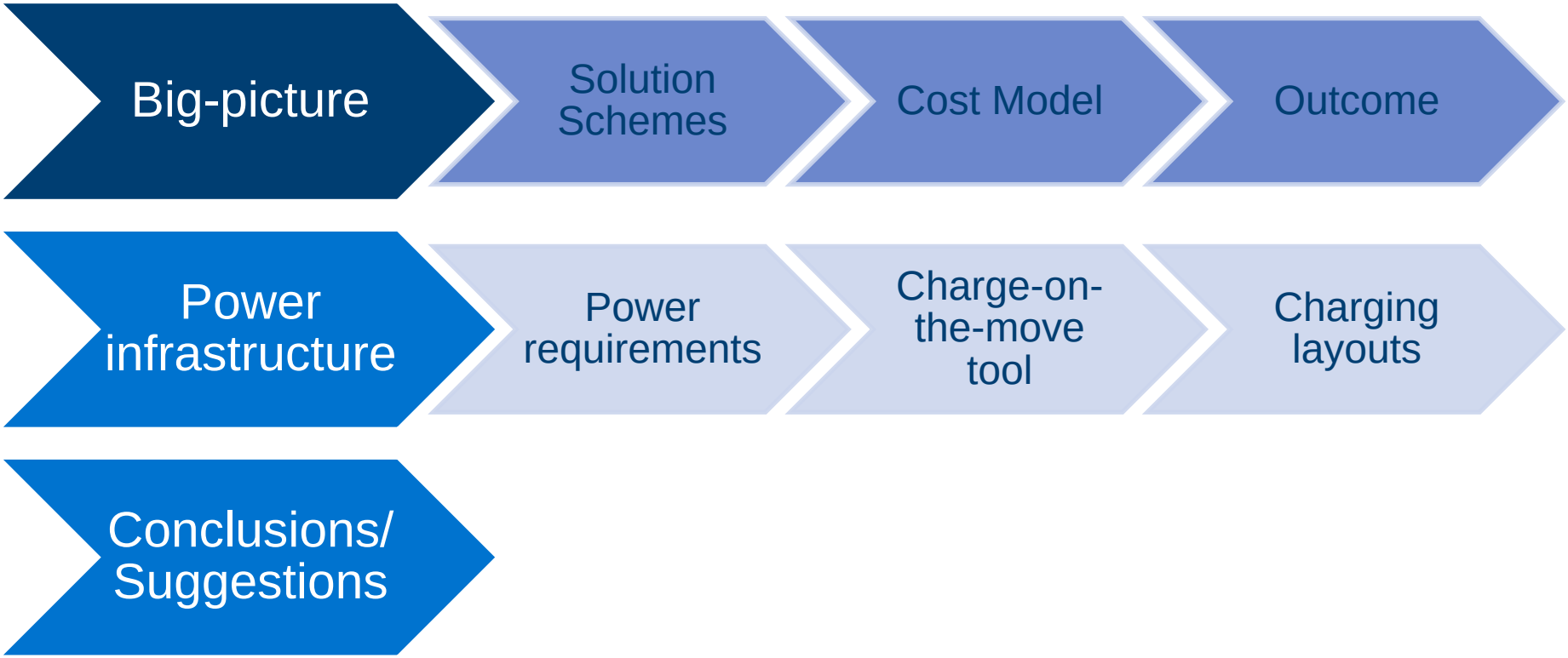
The Big-picture synopsis

- A big-picture review
- Inductive power transfer devices
- Is it based on a suitable engineering sustainable context?
- Is it technically and economically feasible at national scale?

  - Environmentally liable
  - Socially responsible
  - Technically feasible
  - Economically possible



Adapted from Qualcomm at http://www.qualcommhalo.com/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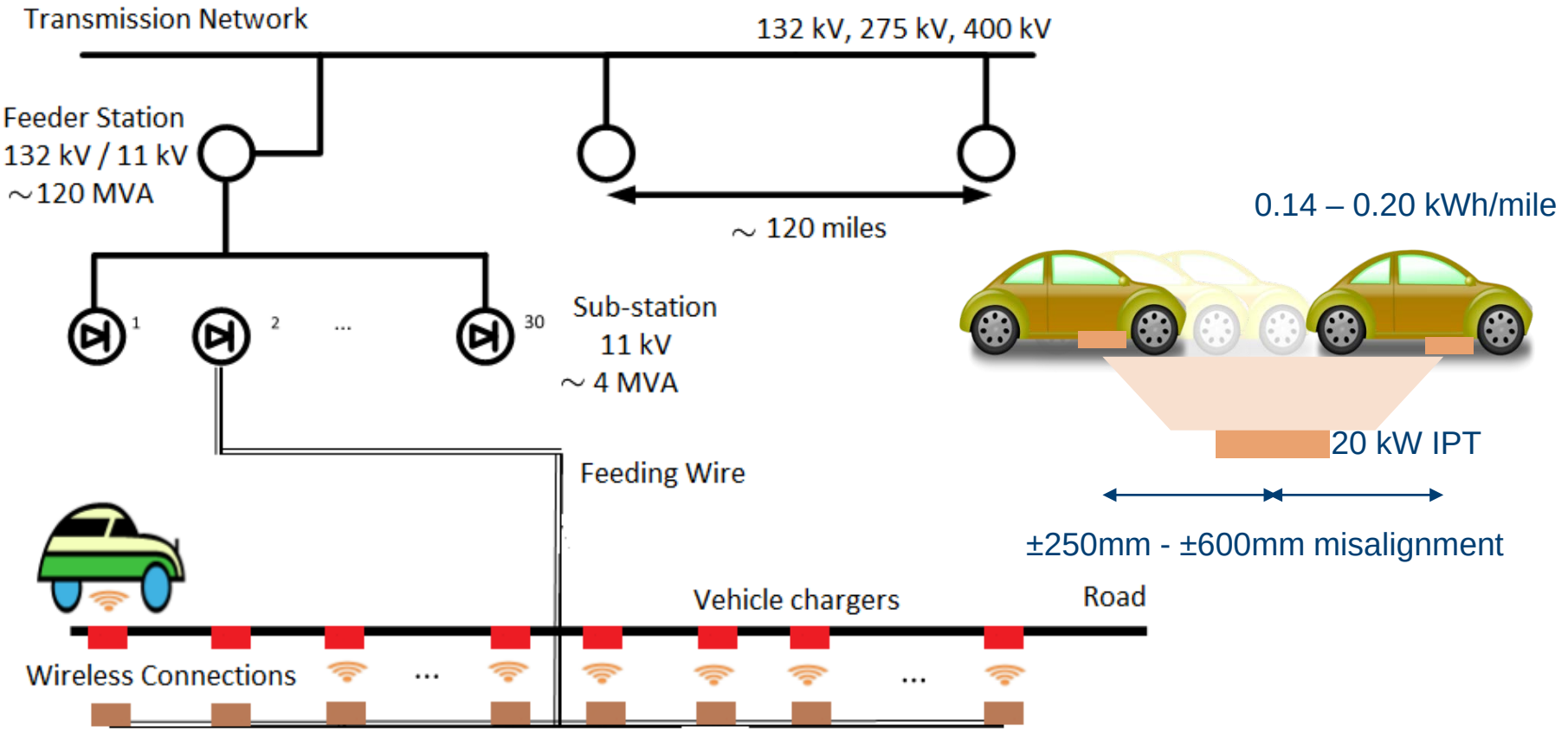
Solution Schemes

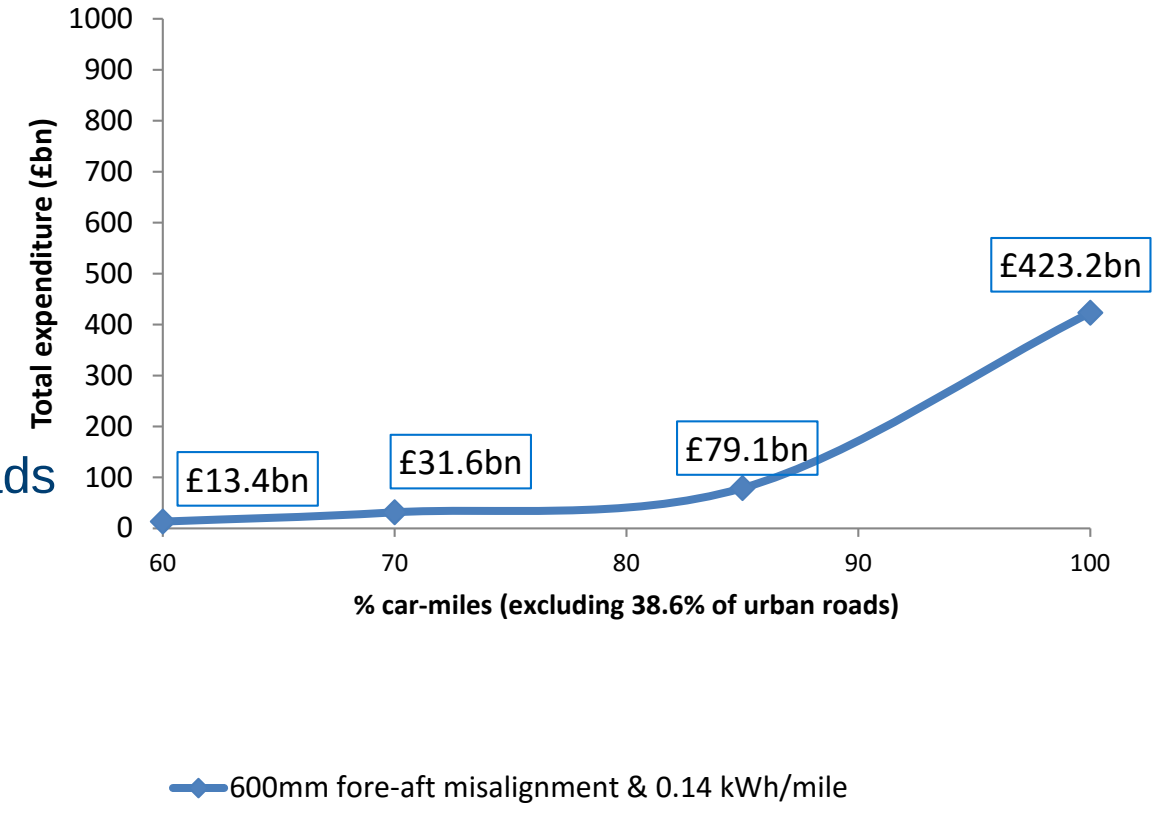


Cost model

- Purchase and installation of wireless chargers
- Cables
- Feeder stations
    - Circuit breaker
    - Connection switchgear and protection/metering
    - Transformers
- Sub-stations
    - Isolator- Circuit breaker
    - Rectifiers / Transformers
- Connections
    - Wireless connections
    - Physical connections
- Cable trenching
- Distribution designing fees
- Civil engineering fees

The Big-picture outcome

- **60% of car-miles**
  - Motorways
- **70% of car-miles**
  - Motorways
  - Rural ‘A’ trunk roads
- **85.6% of car-miles**
  - Motorways
  - Rural ‘A’ roads
- **100% of car-miles**



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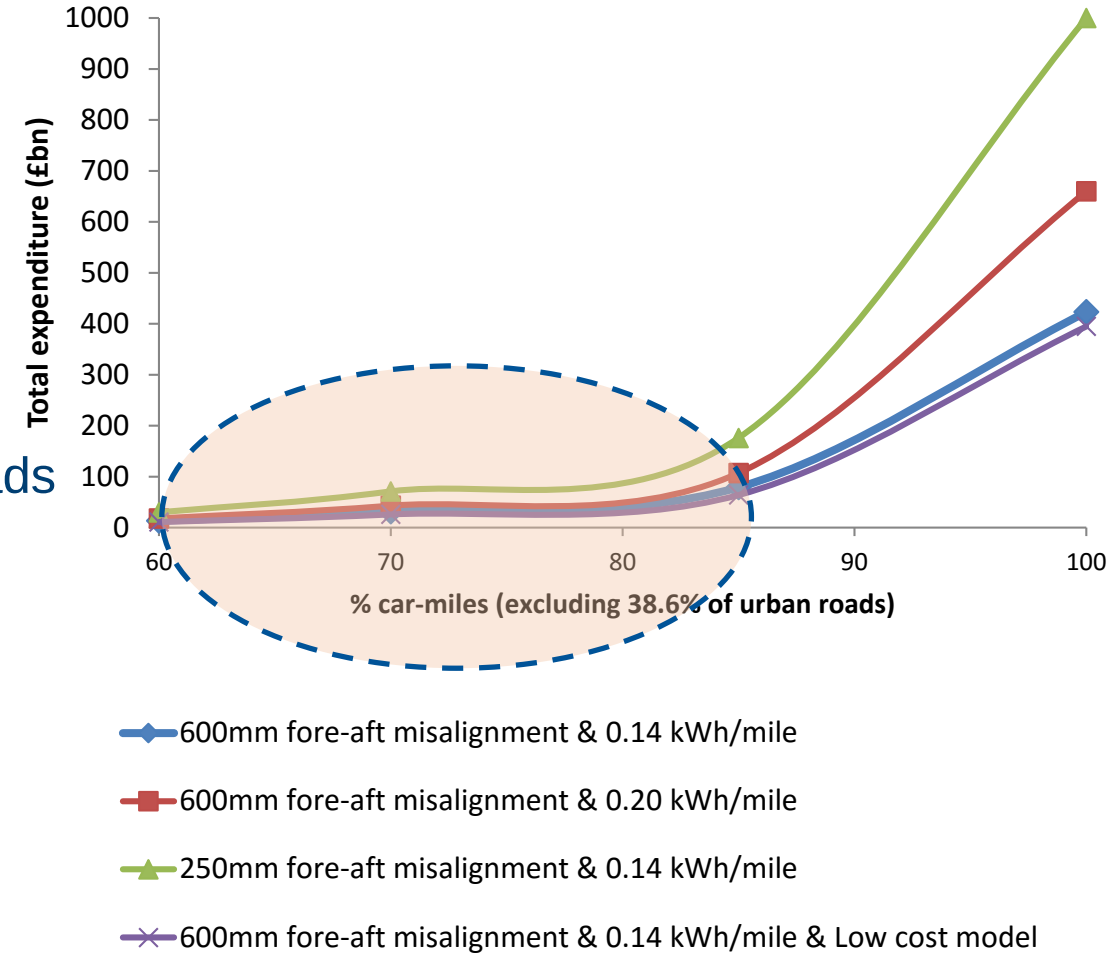

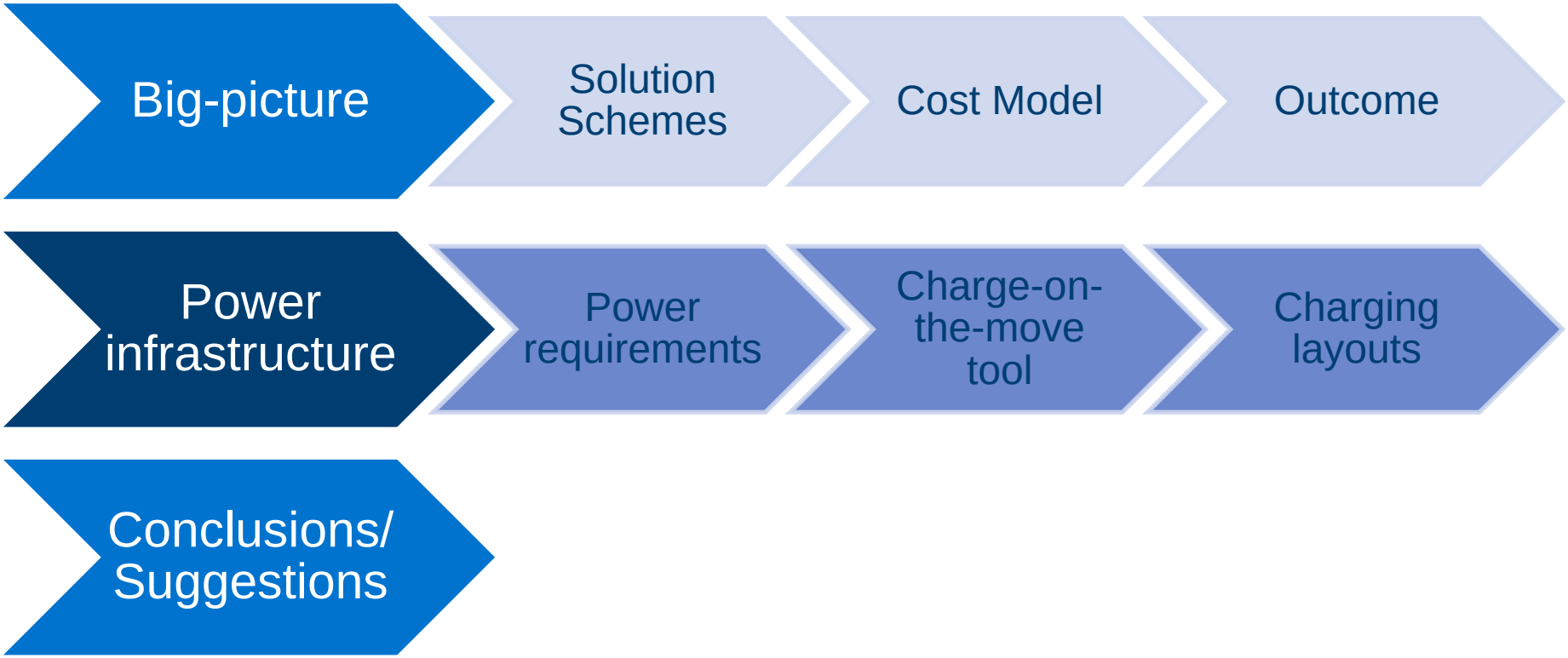
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System Characterisation

A. Power requirements of electric cars

- Advanced Vehicle Simulator – Advisor[1]
- Based on ARTEMIS driving profiles

	Motorway (kW)	Rural (kW)
Average car	***24.0***	***11.0***

B. Motor flow statistics[2] – number of cars per mile by road class and region

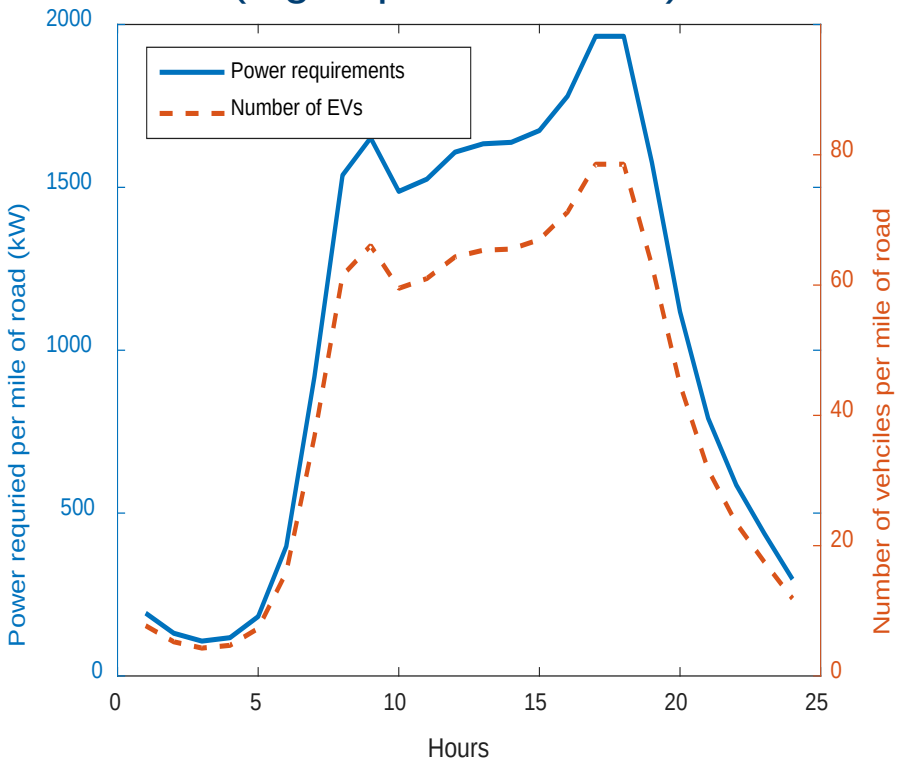
C. Share of EVs by 2050 (high, moderate, and basic uptake)

- High uptake: 90% of car market by 2050

1. National Renewable Energy Laboratory for the United States Department of Energy
2. Department for Transport – Road traffic statistics 2014

Additional power requirement for the UK

Motorways of London (high uptake in 2050)



Overall power requirements (peak GW)

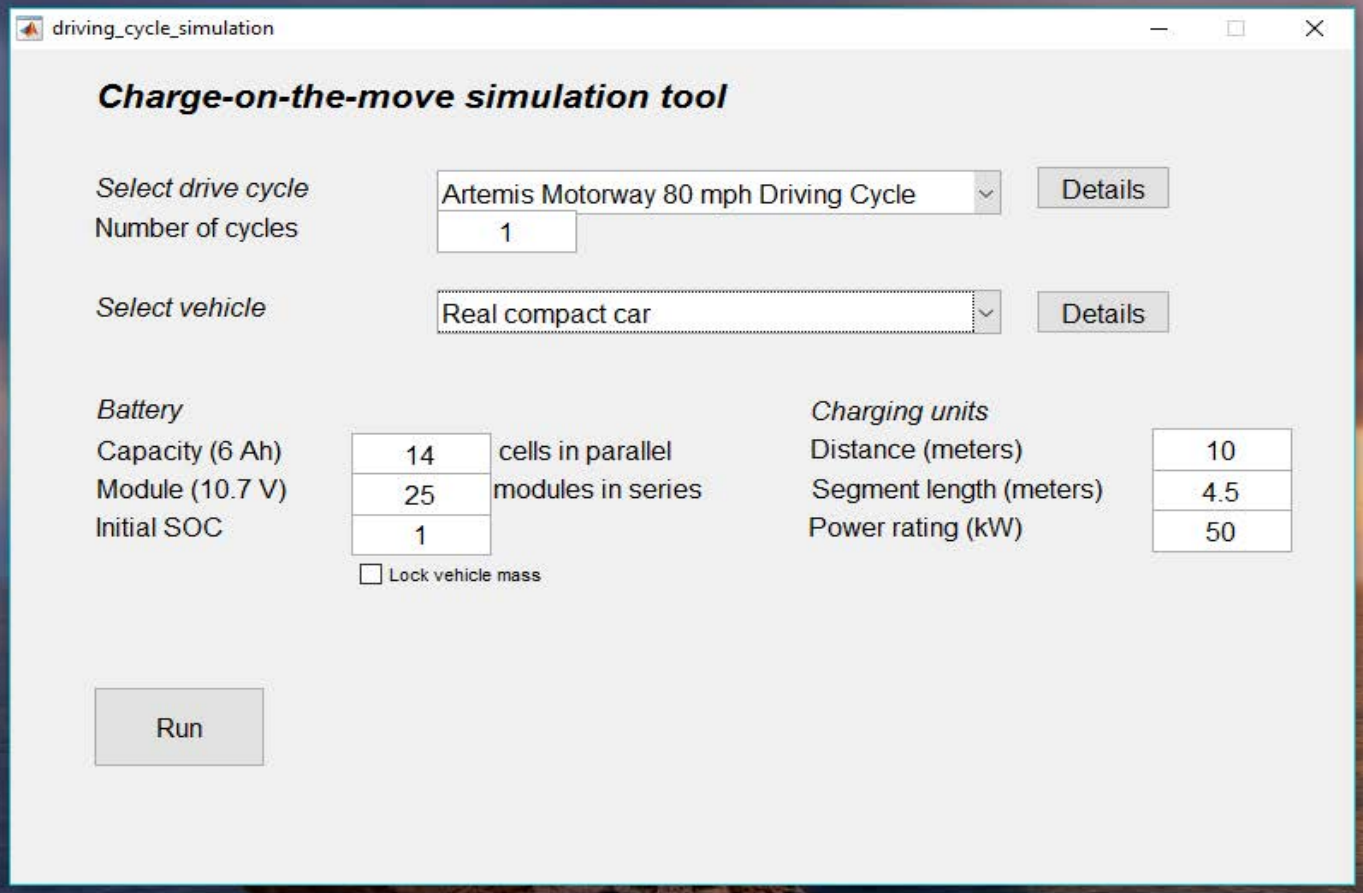
	Motorway	Rural 'A'	*Total*
England	2.8	2.0	*4.8*
Wales	0.1	0.2	*0.3*
Scotland	0.2	0.3	*0.5*
Total	*3.1*	*2.5*	***5.6***

Installed capacity in the UK[3]

- 76 GW in 2010
- 130 GW in 2050

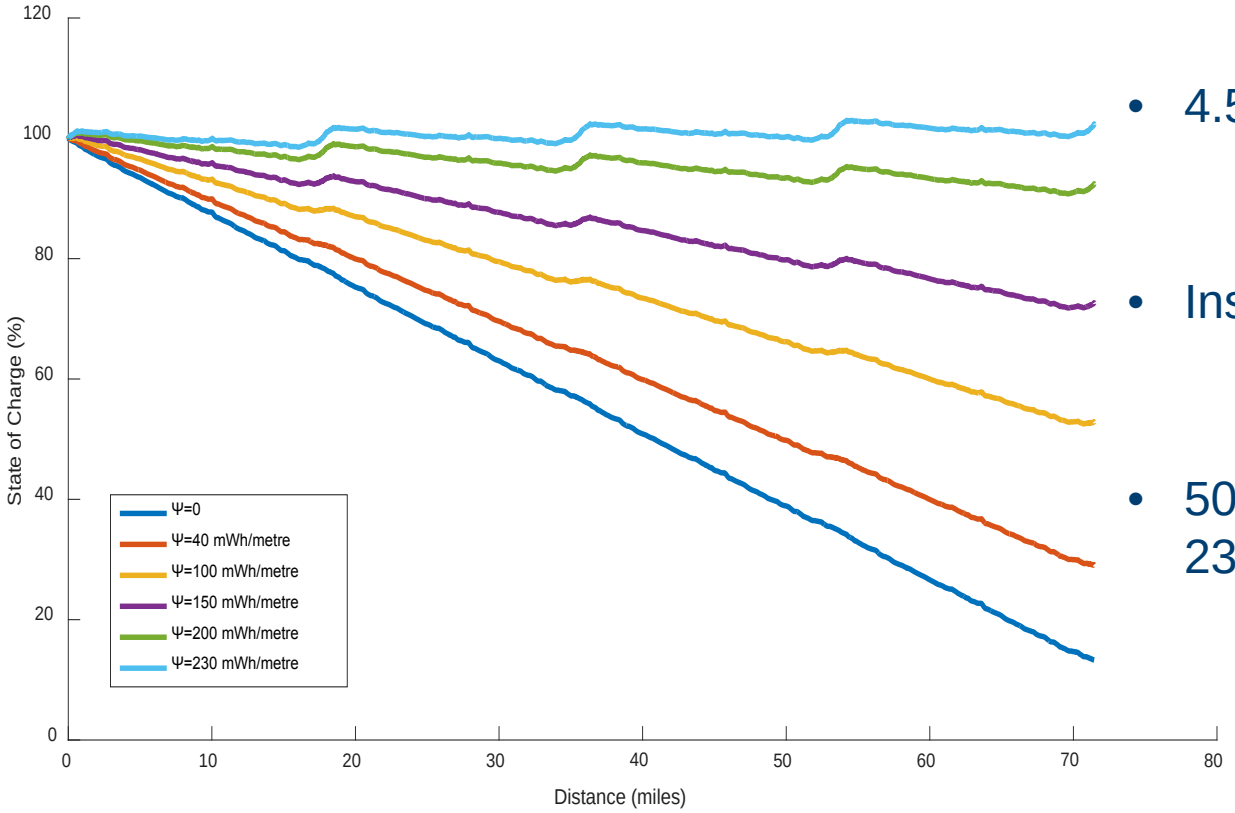
3. Pathways to 2050: Three possible UK energy strategies, British Pugwash 2013

Charge-on-the-move simulation tool

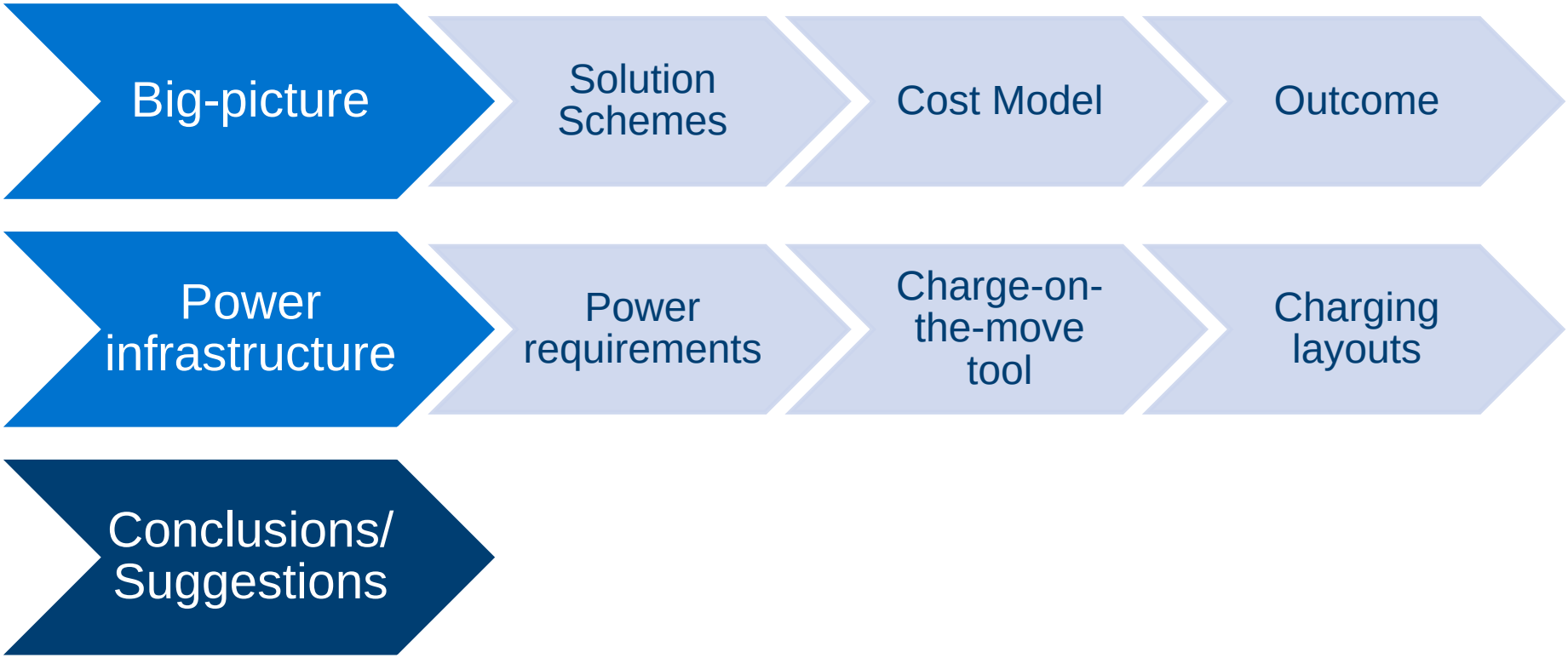


Optimal Layout – MECR for motorways

MECR: Mean Effective Charging Ratio (mWh/metre)



- 4.5 metres length charger
  - Less than 5 metres which is the average length of a car
- Installed every 10 metres
  - Minimum gap between two cars at motorways queues
- 50 kW to satisfy the 230 mWh/metre MECR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Conclusions - Suggestions

Power infrastructure

- Tools and procedures to determine performance requirements
- Average power requirements of electric cars – 5.6 GW additional load
- Charge-on-the-move simulation tool
- Determine charging layouts to achieve specific MECR

‘Big-picture’ review

- Great potential for the transport application
- A nationwide charging infrastructure looks highly possible

Charge-on-the-move cost in context

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- **70% of car-miles**
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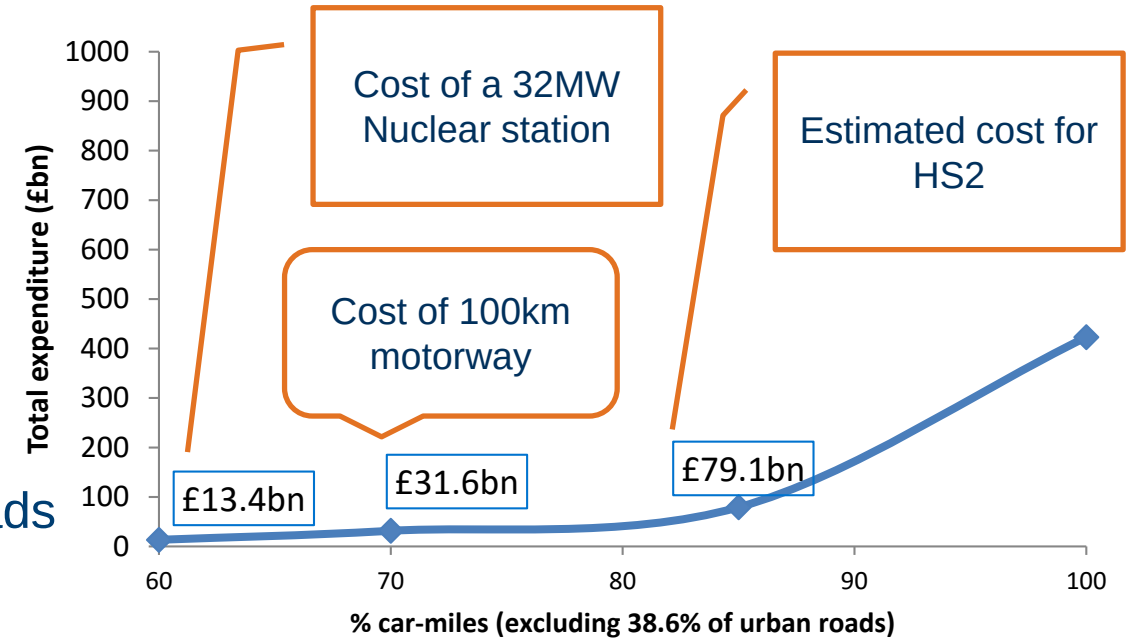

CO_2 emissions reduction

- HS2: High Speed 2 is a new high-speed rail network in the UK
- Resulting around ***3 $MtCO_2e$*** savings during the first *60 years*[4]
- 85.6% electrification of car-miles could result up to ***44 $MtCO_2$*** *in a year*

52% for passenger cars X 117 $MtCO_2$ for transport in 2013 X= ***61 $MtCO_2$***

Conventional car (European target 95 gCO_2/km): ***153 gCO_2/mile***

Electric car: 0.2 kWh/mile X 100 gCO_2/kWh = **20 gCO_2/mile**

85.6% electrification X 87% reduction from electric cars X 61 $MtCO_2$ = ***44 $MtCO_2$***

4. HS2 and the environment - Environmental Audit Committee, UK parliament website

Thank you

Source: Qualcomm at http://www.qualcommhalo.com/