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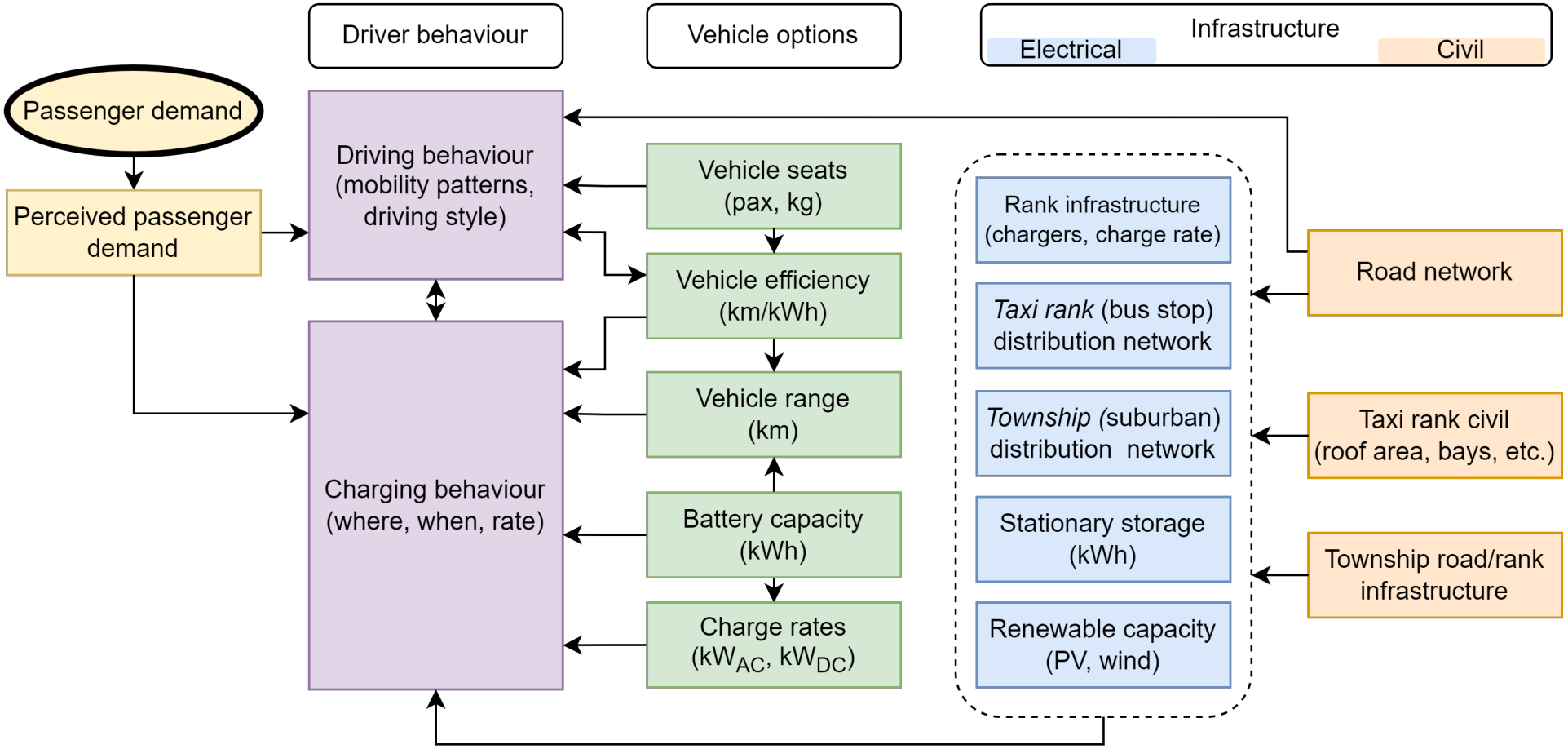
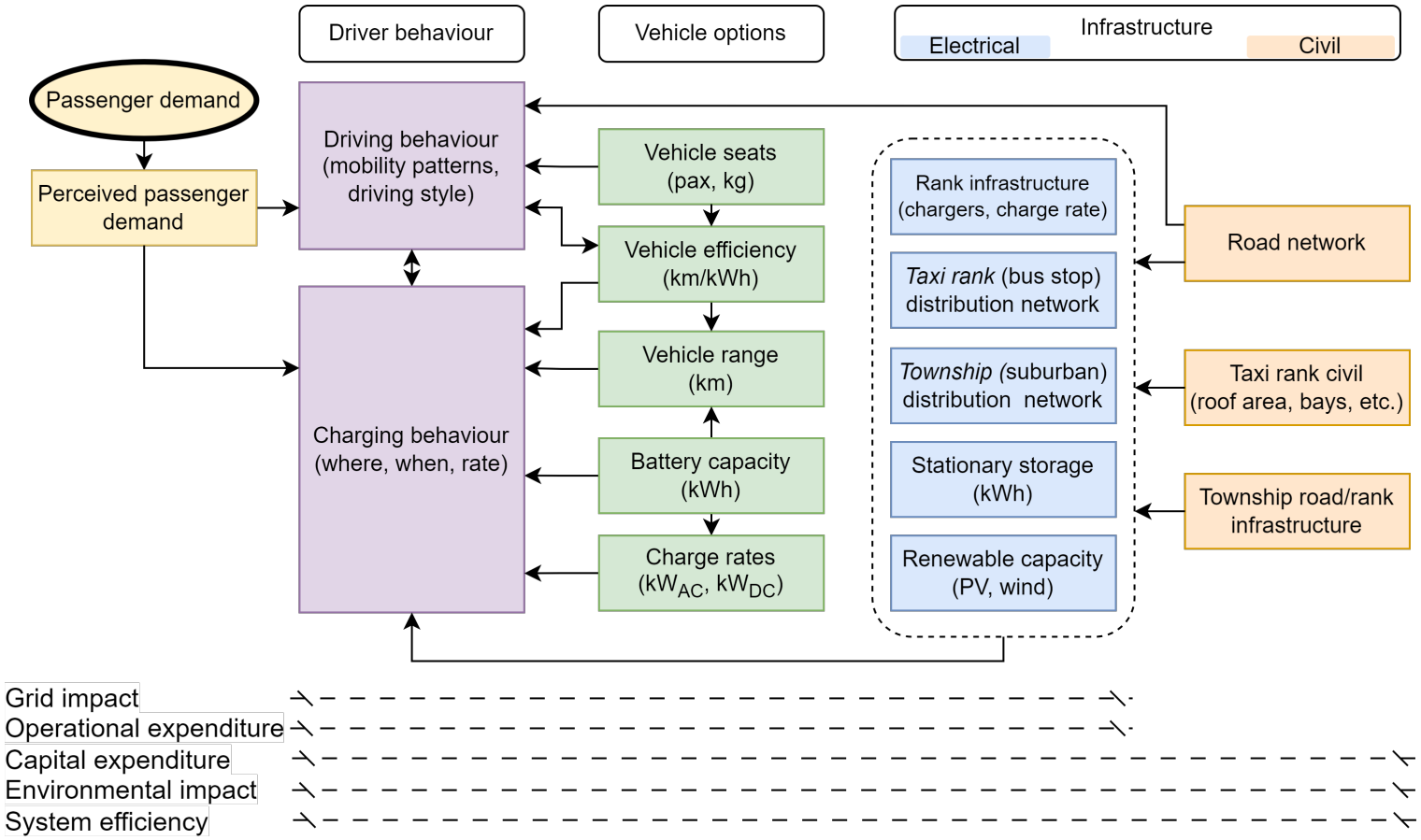
Planning for Electric Mobility in Sub-Saharan Africa

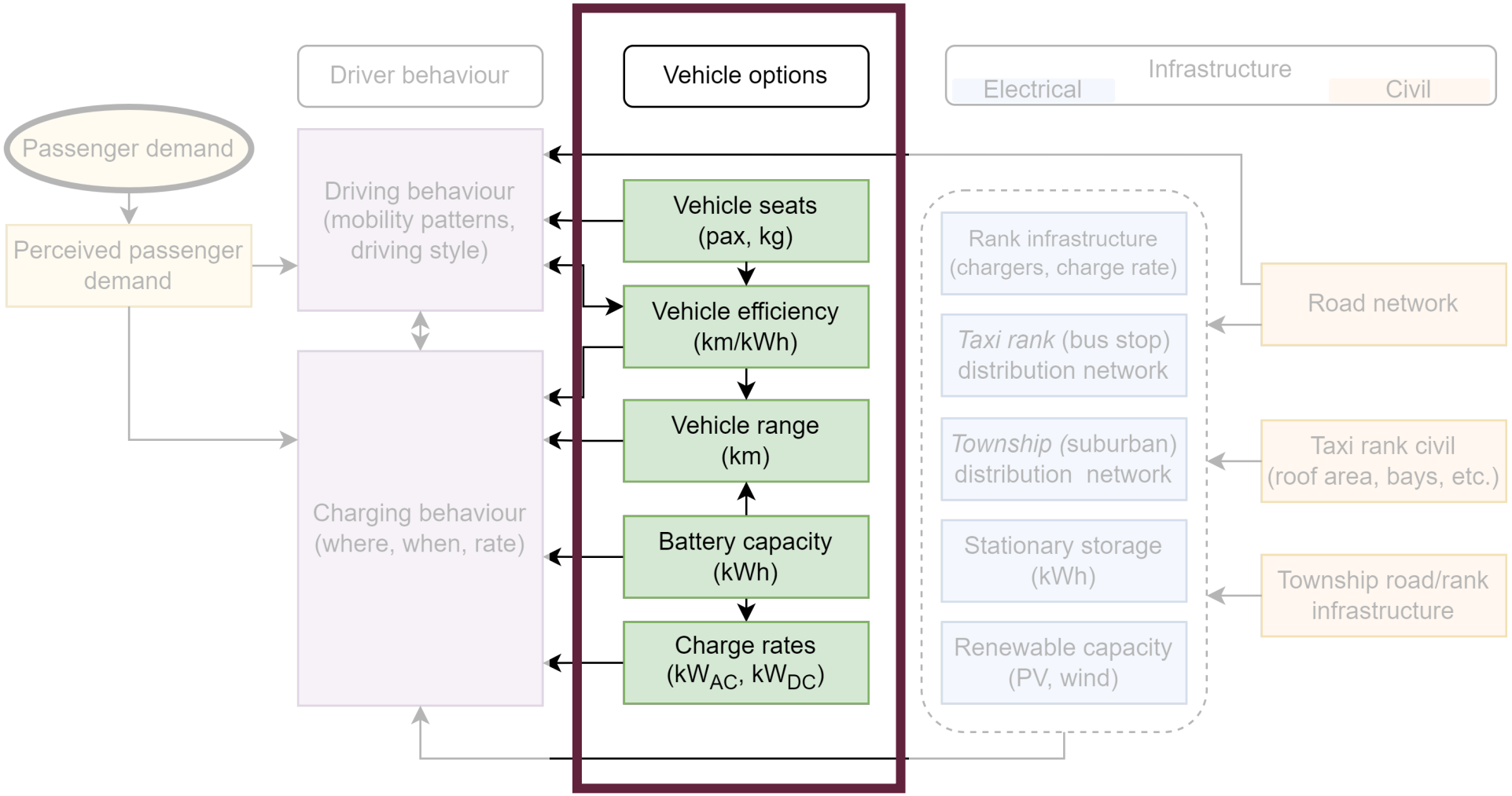
Electric mobility - A complex interdependent web



Electric mobility - Impacts

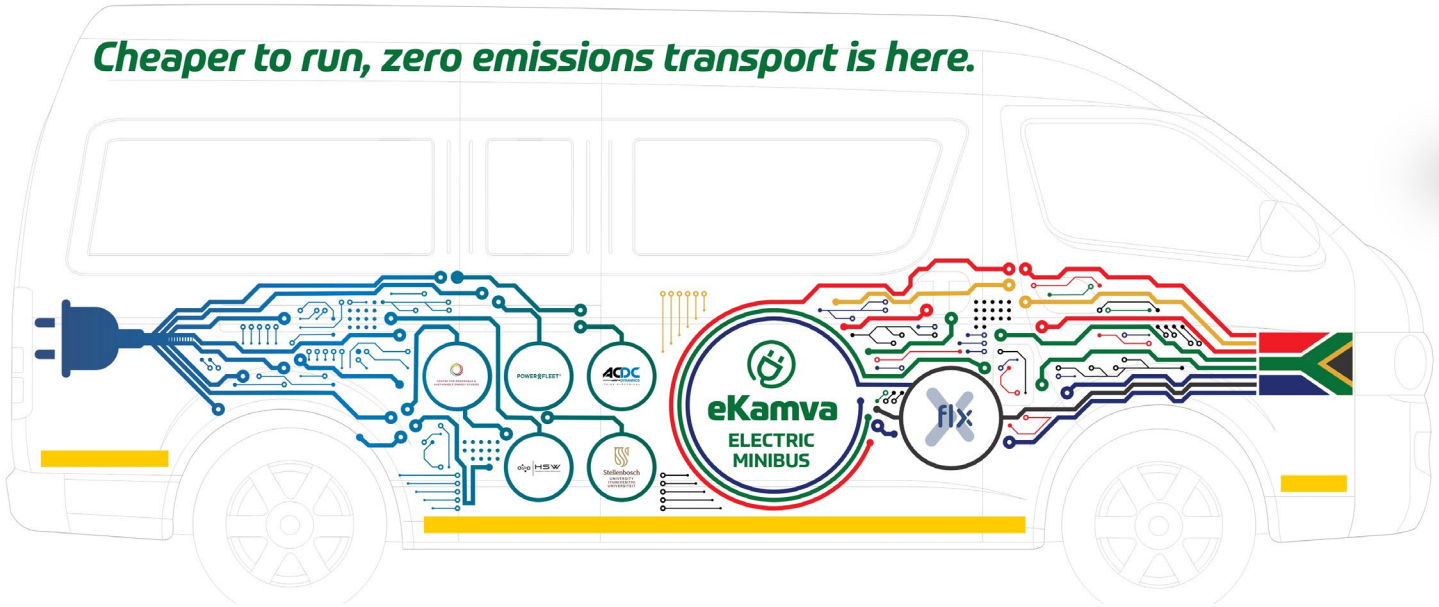


Electric mobility - Vehicles



Vehicle options - new vehicle

- Higer imported
- Not yet roadworthy



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Vehicle options - retrofit

- Quantum Ses'Fikele
- Over 1,500 km driven

Electrifying public transportation vehicles in Sub-Sharan Africa

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Operating cost per 100 km:

Petrol  R318

Diesel  R307

New EV  R79

Converted EV  R119

Running Cost per 100 km

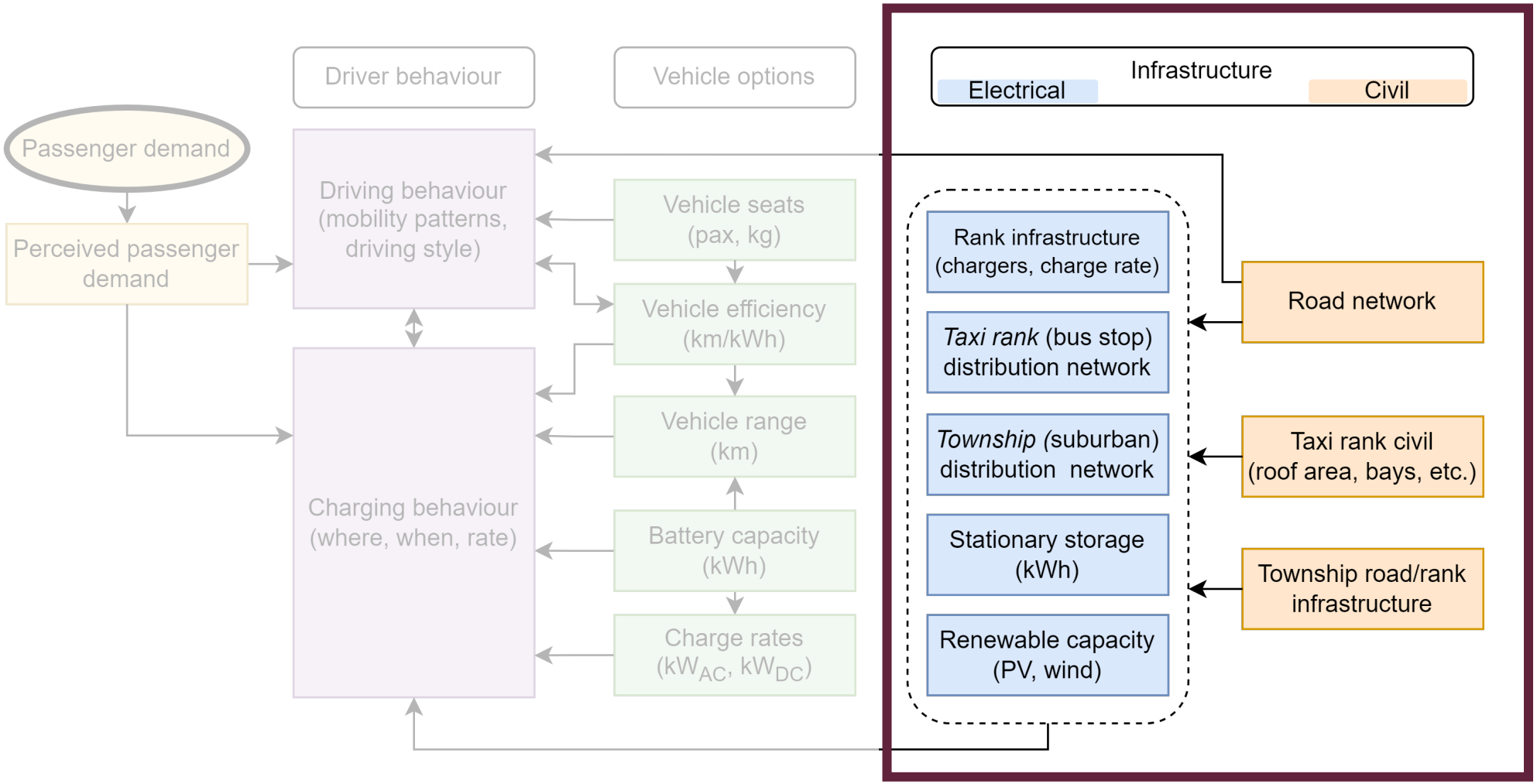
Vehicle options

	Higer	Retrofit
Model	2023	2009
Motor	90 kW / 300 Nm	90 kW / 200 Nm
Battery	70 kWh	54kWh
Laden weight	3,980 kg	3,150 kg
Cost (one)	R1 500 000	R750 000
Cost (scale)	R1 500 000	R450 000

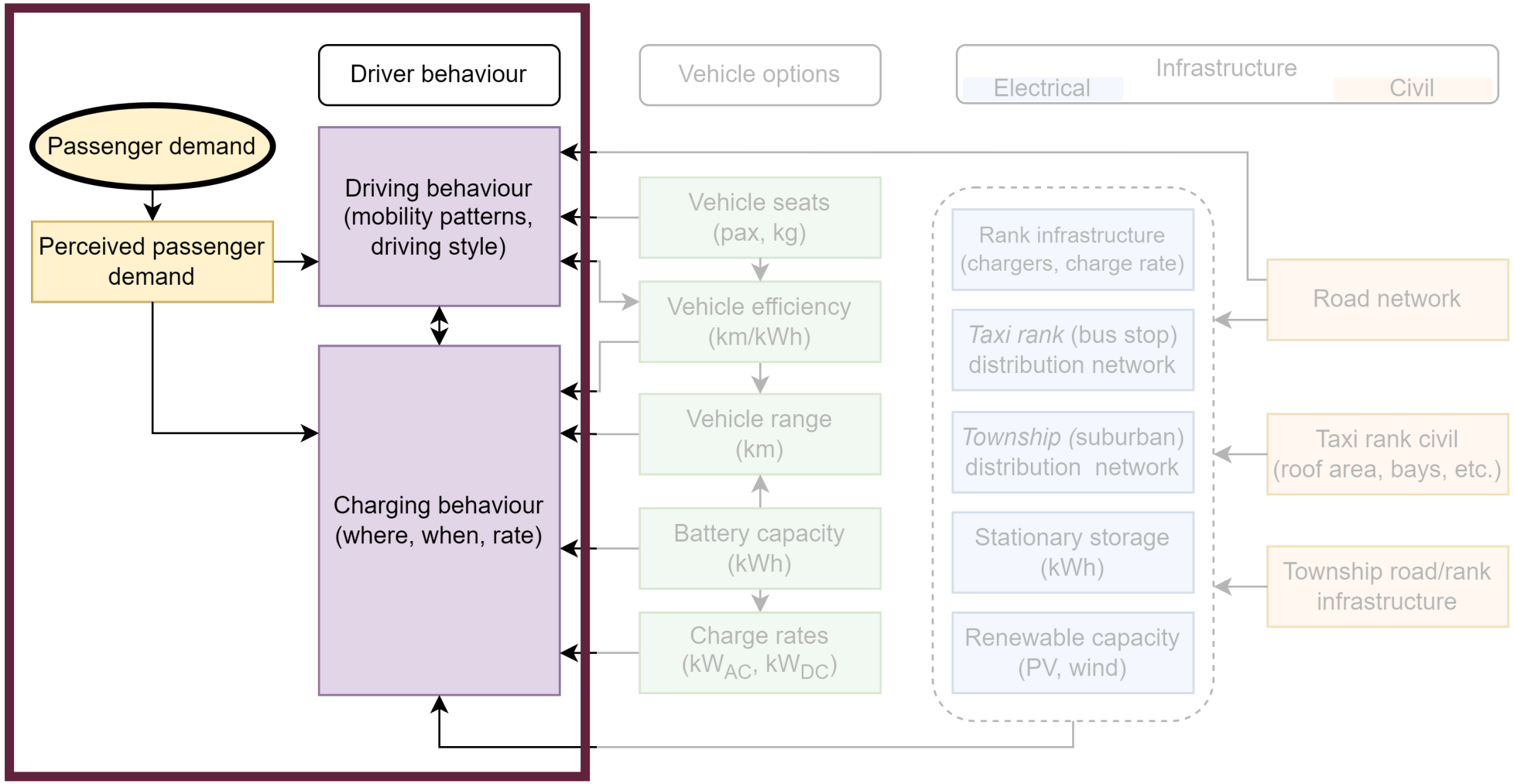
Video comparison

bit.ly/etaxicompare

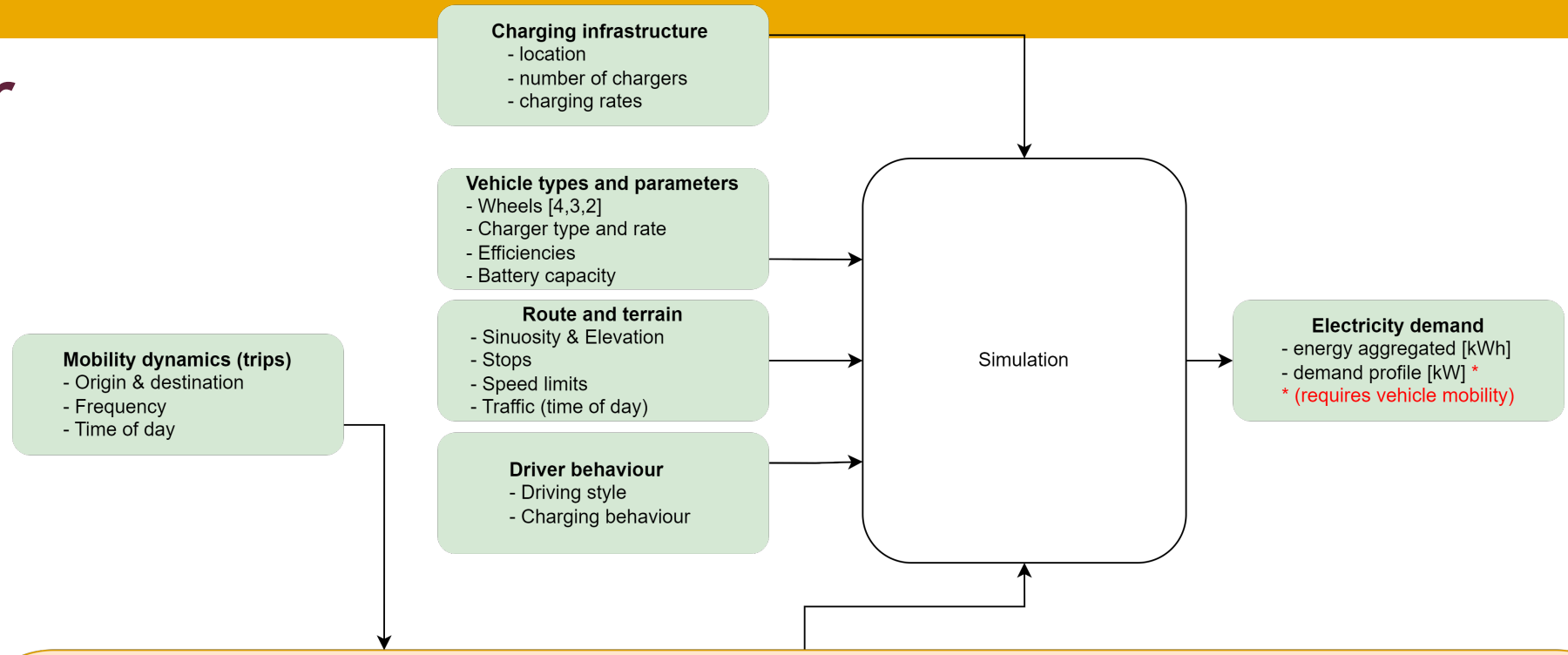
Electric mobility - Infrastructure



Electric mobility - The driver



Driver



Vehicle mobility model (locus of control)

Common assumptions:
- Vehicle close to full.
- ICE "trips" represent ground truth for passenger demand.

ICE-based as-is scenario

Questions:
- How viable are current mobility operations?
- What is the grid impact of electrification?
  + Energy required (for all vehicles).
  + Load profiles for viable vehicles.

Assumptions:
- ICE mobility maintained
- Specific vehicle strongly linked to the route.
- Rigid charging behaviour.

Examples: [Abraham, Pretorius]

Scheduled minibus taxi scenario

Questions:
- How viable are current operations if controlled?
- Mixed fleet scenarios.
- What is the grid impact of electrification?
  + Energy required.
  + Load profiles.

Assumptions:
- Centralised control over mobility.
- No linkage between specific vehicle and trip broken.
- Challenges ownership model.
- Rigid charging behaviour.

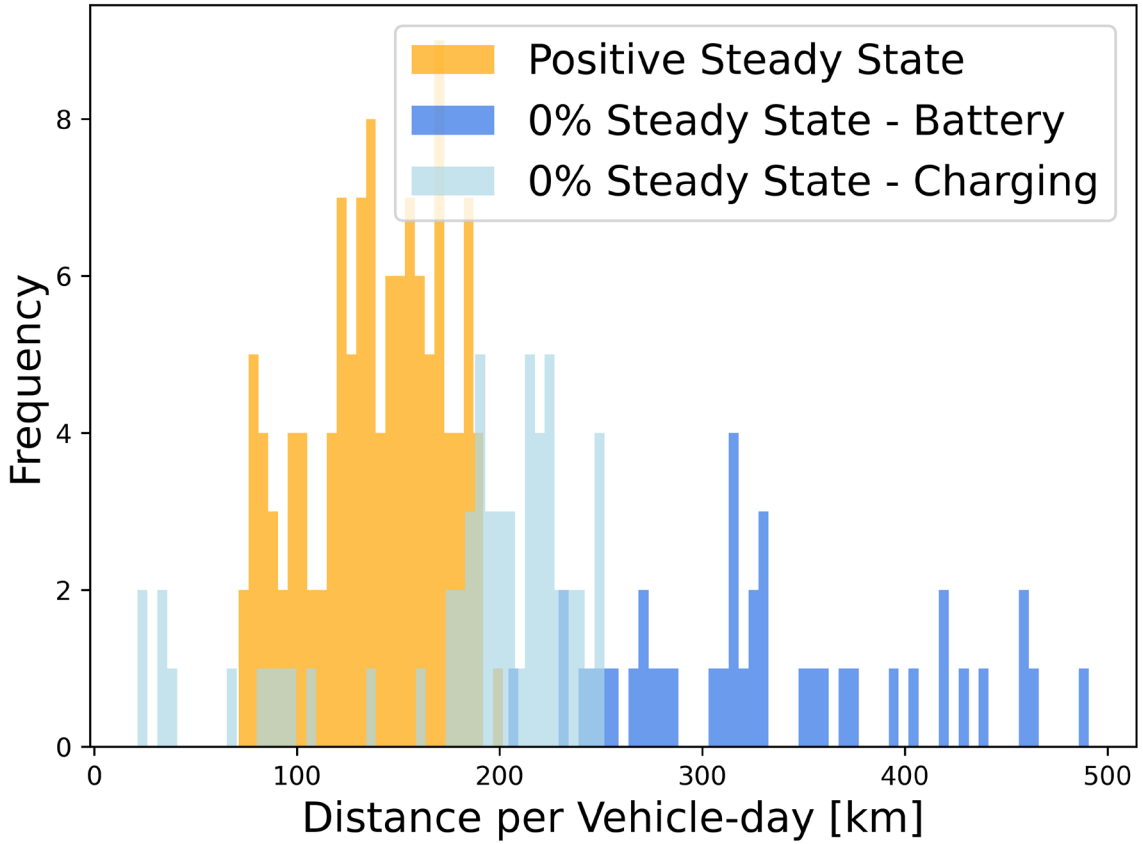
Examples: [Giliomee, Wust]

Driver decision modelling scenario

Questions:
- How viable are current operations if intelligent agents?
- Insights to driver charging behaviour.
- What is the grid impact of electrification?
  + Energy required.
  + Load profiles.

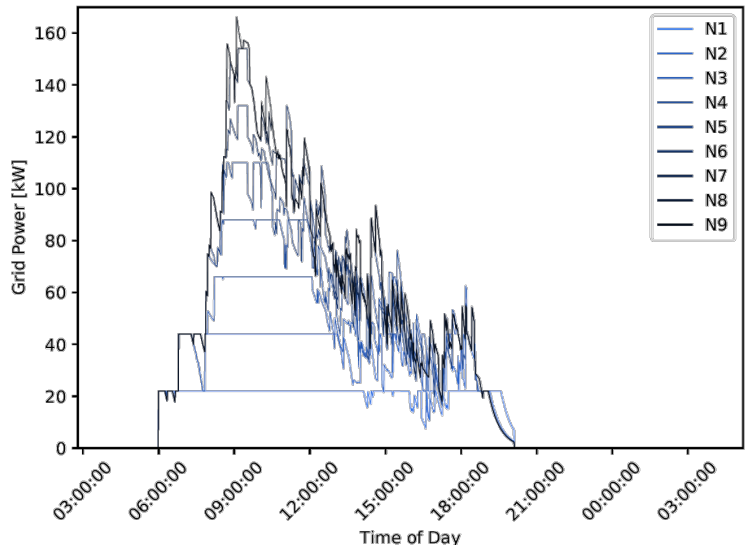
Assumptions:
- Agent-based virtual driver model.
  + start at "home base".
  + end at "home base".
  + limited to licenced routes as observed in data.
- Adaptive charging behaviour.
- Loose coupling between vehicles and trips.

Operations – as is

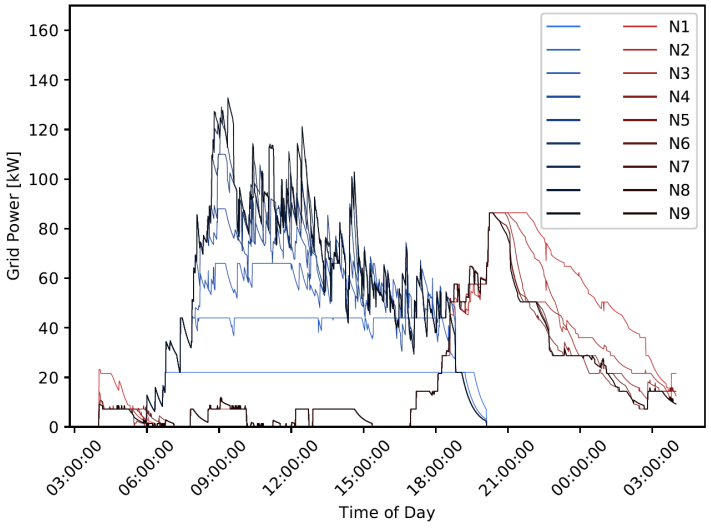


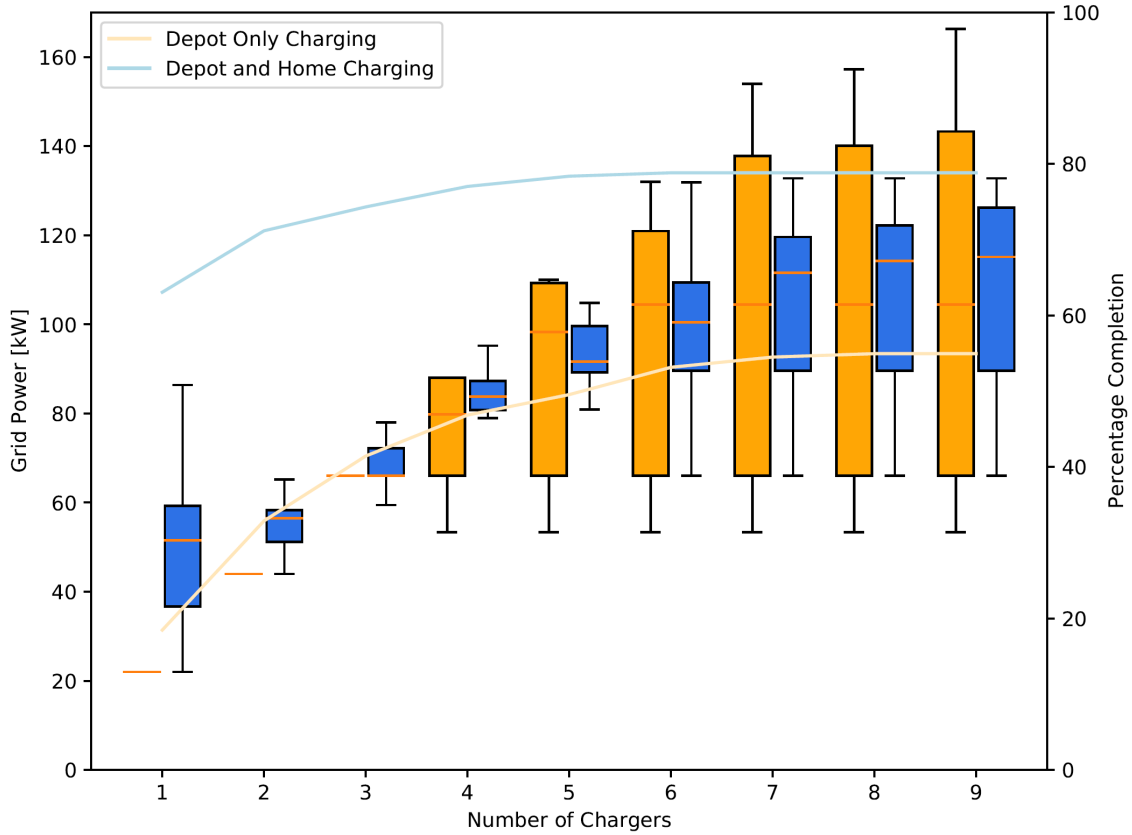
Infrastructure - grid impact

Depot only charging



Depot & home charging





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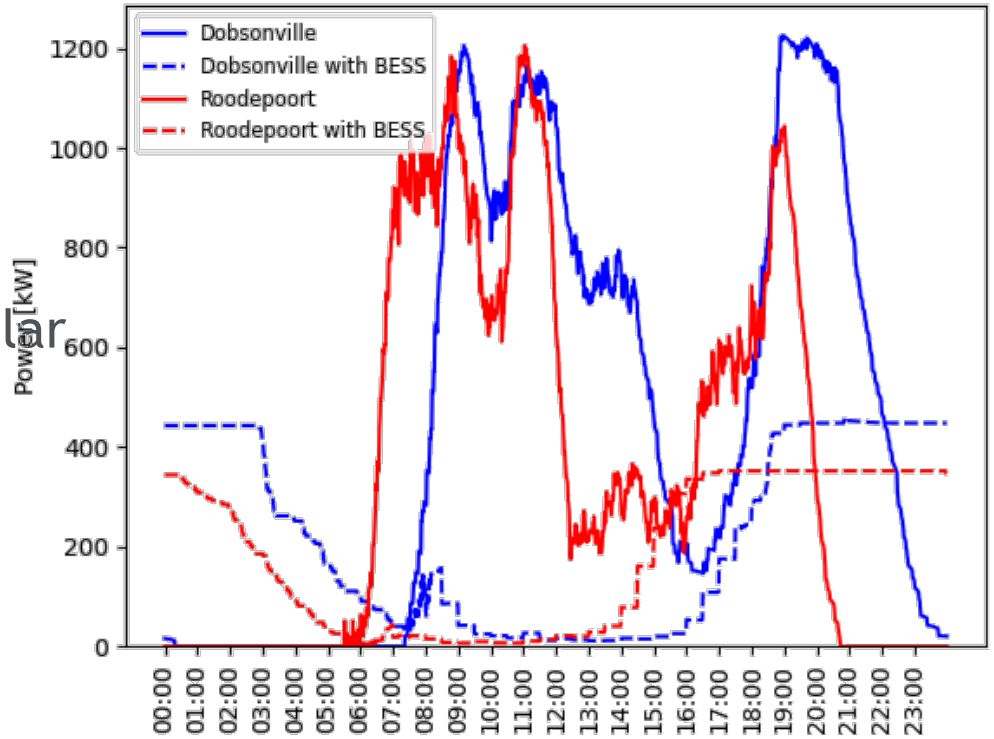
Infrastructure – grid impact with scheduling

- Power peaks overlap with problematic grid peaks
- Grid impact reduced
- Using stationary battery 60kWh/taxi, 9.5 kW_{pk}/taxi solar
- Peak load down 69%: 13 to 4 kW/taxi
- Energy down 47%: 87 to 47 kWh/taxi

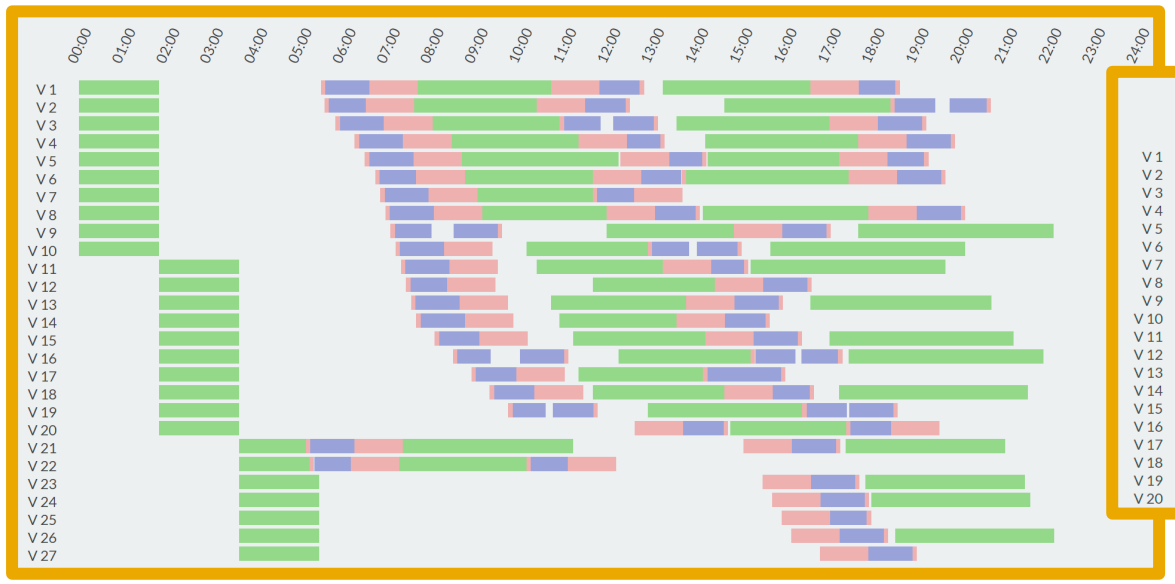


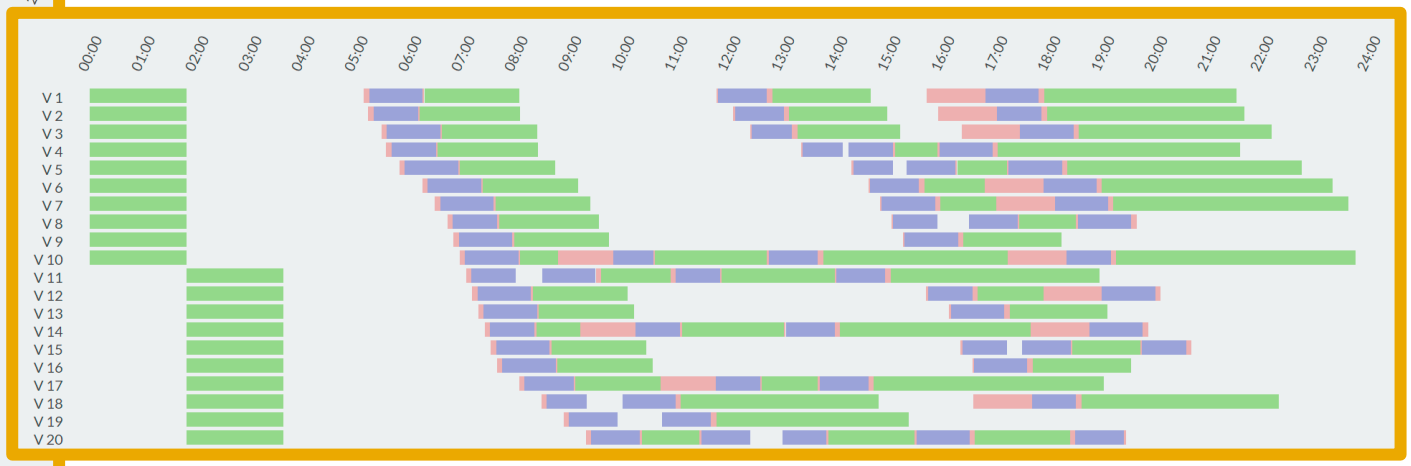
Scheduling - alternatives

Multi-Depot Charging

27 EVs (6370km)

Additional depot with 10 chargers
20 EVs (4198km)





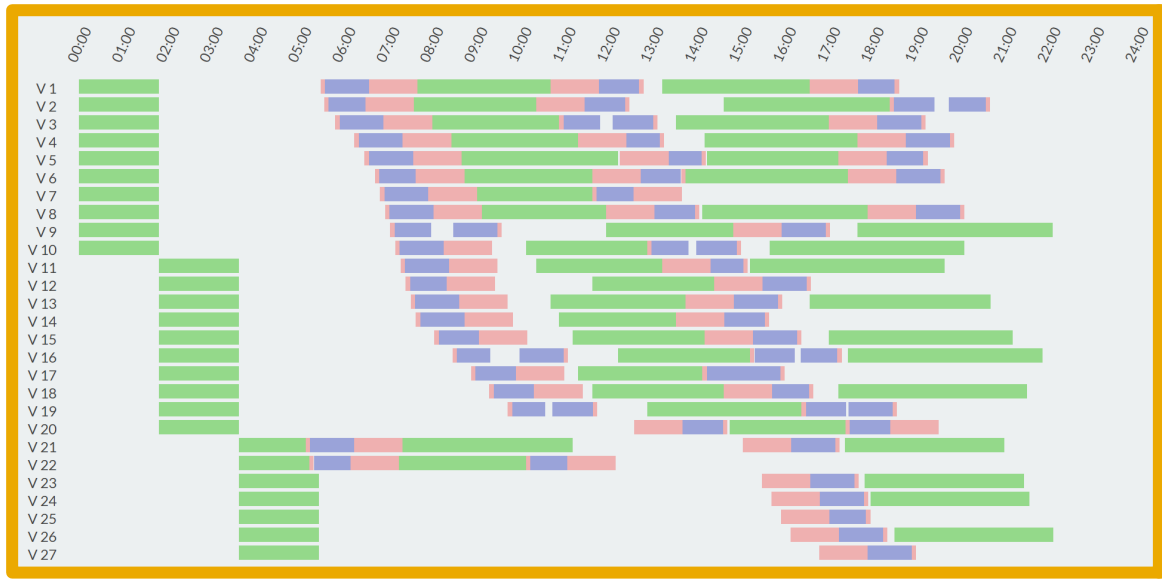
Scheduling - mixed fleets

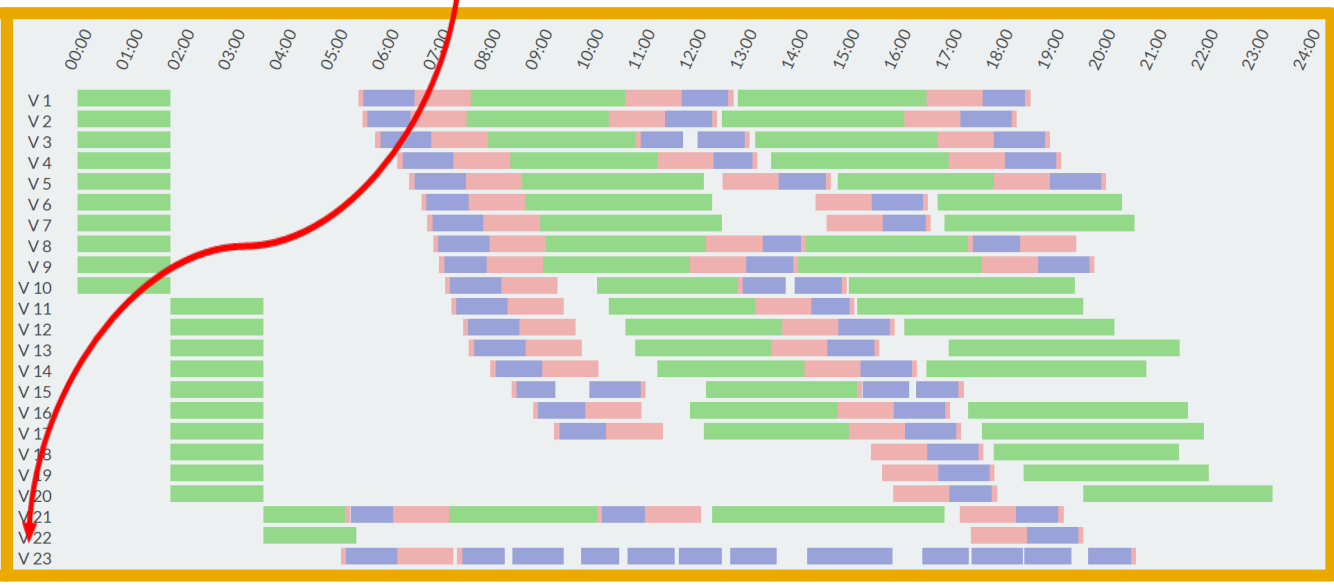
Only EVs

27 EVs (6370km)

Mixed fleet

22 EVs and 1 diesel (4198km)





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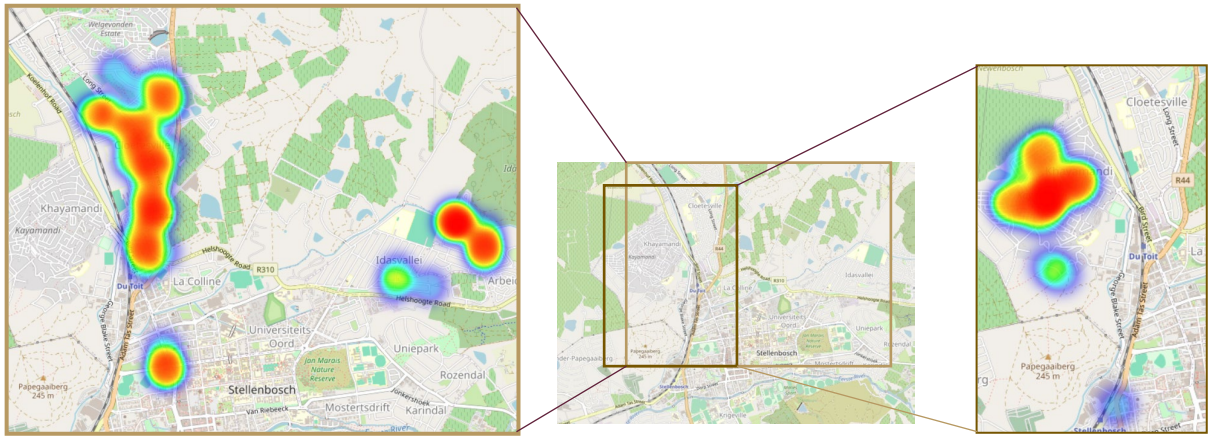
Agent-based modelling of drivers

- ??

The just energy transition

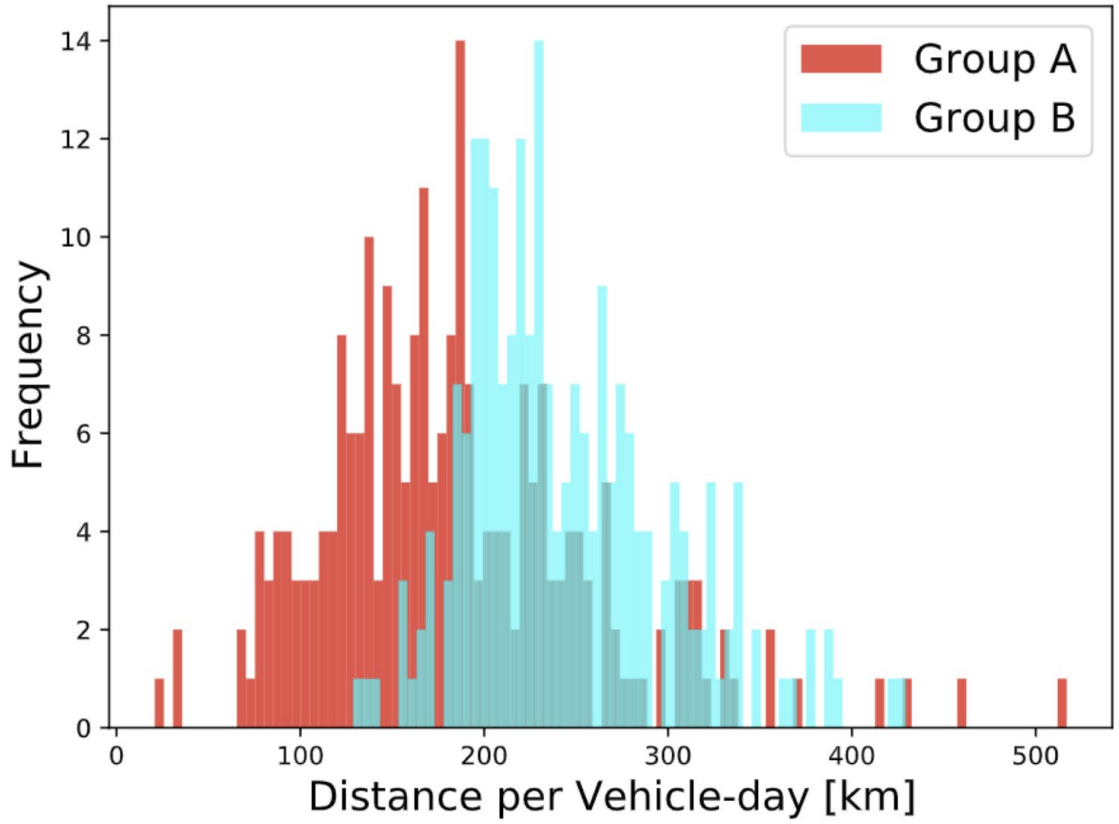
Overnight locations of taxis

“Coloured” African

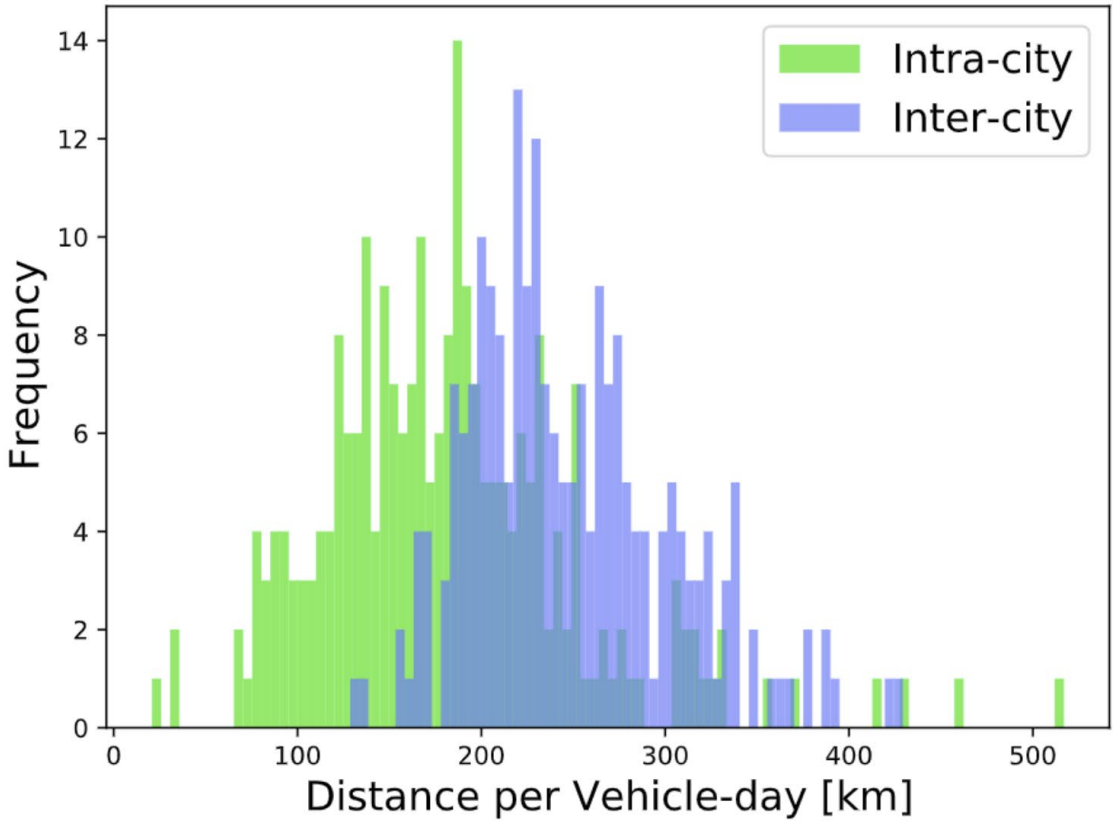


Overall			
	“Coloured”	African	Totals
Intra-city	204 (86%)	17 (19%)	221 (67%)
Inter-city	32 (14%)	75 (81%)	107 (33%)
Totals	236 (72%)	92 (28%)	328

The just energy transition



(a) Dataset vehicle-day distance distribution



(b) Trip-type vehicle-day distance distribution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Enkosi
Dankie
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Photo by Stefan Els