



UNIVERSITY OF
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Thermal Charging System for Battery Electric Vehicles

Potentially Double EV Range

Hui Cao

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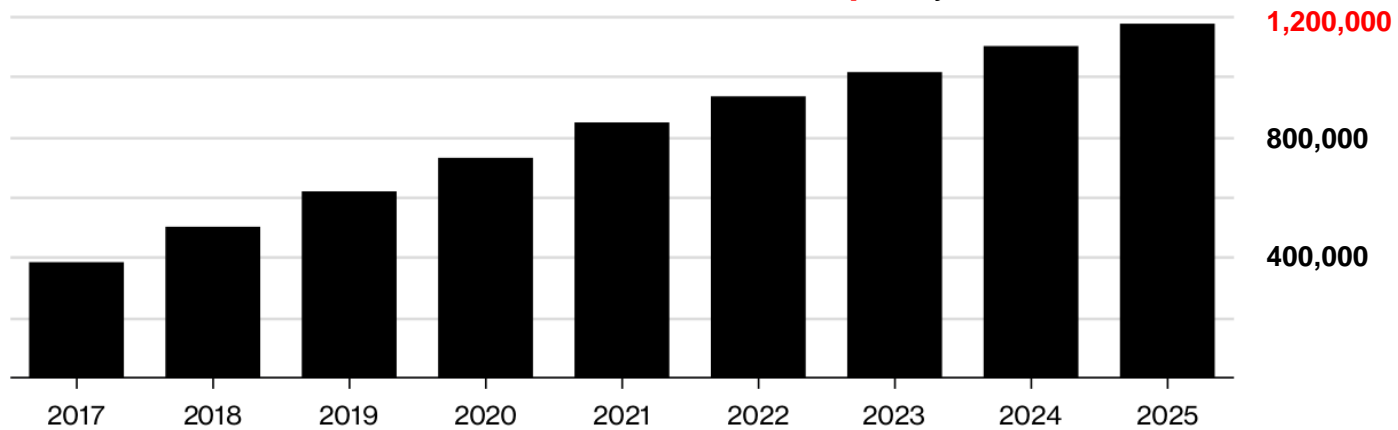
Electric transportation



City EV market is growing!!!

- In October 2017, **13 cities** signed **C40 Fossil-Fuel-Free Streets Declaration**, pledging to buy only zero-emission buses from 2025.
- **£86.1 million** London bus retrofit programme is due to be completed by September 2020.

China forecast to E-bus market to be more than **triple** by **2025**.



Source: Bloomberg New Energy Finance

Bloomberg

EV range anxiety

Problems:

1. Battery is too heavy, costly
2. Not enough charging point, too long to charge
3. Everything uses battery on a EV
 - Summer - AC consumes **15-20%** battery capacity
 - **Winter - 50% range lost due to cabin heating**

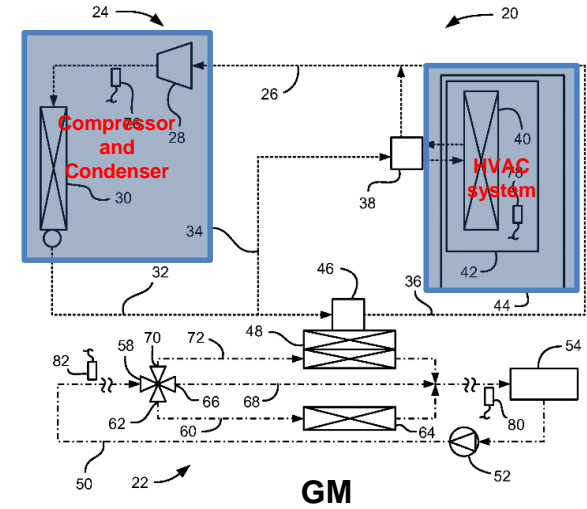
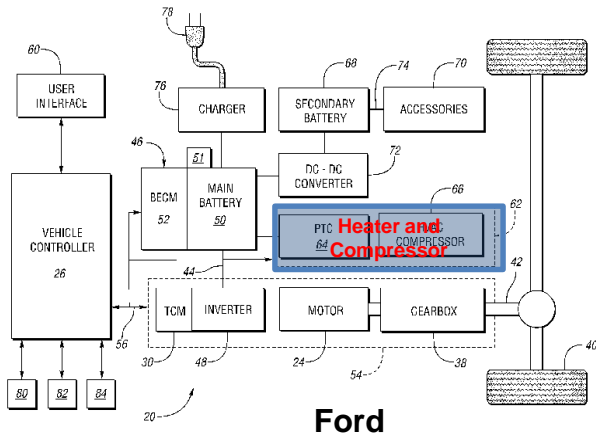
Solutions:



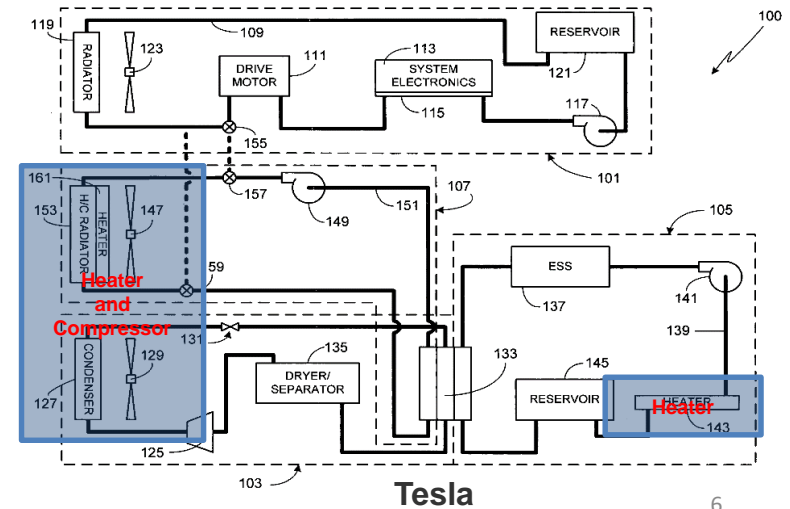
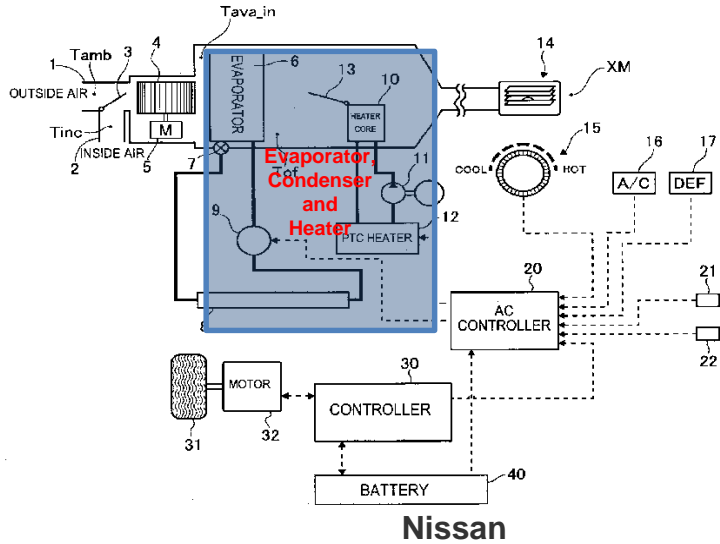
ICURe journey (Innovate UK)



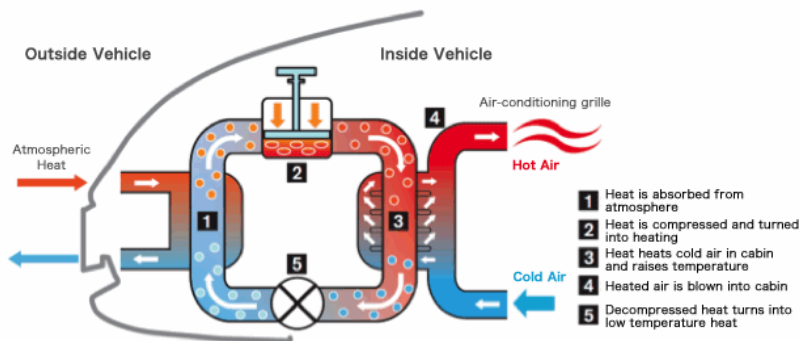
Existing heating and cooling system



Cost £500-600



Existing solutions



Nissan heat pump air conditioner (Nissan 2014)

Cost £600-700

- Improve air conditioners efficiency e.g. heat pump air conditioner or new refrigerants
- Increase cost
- Increase complexity: 3-5 evaporators, condensers, compressors
- Drain battery - not final solution

£6 billion market for EV thermal management system by 2020!!

(Source: Sealand Securities, July 2018)

Concept of system

A charging station

- with hot and cold reservoir, to be integrated with existing charging station and to charge the unit and battery together

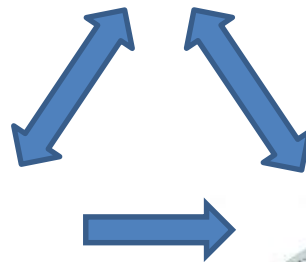


A central data storage repository

- to guide the driver to the nearest charging station with traffic/weather/charging station information

An in car thermal management unit

- to control battery and cabin temperature without consuming battery capacity



Double range in winter

University of Newcastle

150 miles

Nottingham

150 miles

Imperial college London

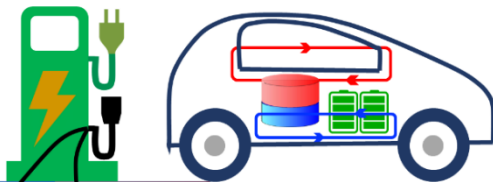


Existing system

University of Newcastle

300 miles

Imperial college London





Cold reservoir Hot reservoir

Our system

Tailored unit for customers

To deliver 8 hours heating of cabin area

Class	Cabin space (m ³)	Weight (kg)*	Size (cm)	Charge Time (minutes)	Cost for unit (£)
	2.4 - 2.8	24 - 26	up to 68×34×34	12 - 14	115 - 125
	2.8 - 3	28 - 30	up to 70×35×35	14 - 15	134 - 144
	3 - 3.3	32 - 33	up to 72×36×36	15 - 17	153 - 158
	> 3.3	35	up to 76×36×36	20	168

First target market – public utility type vehicles



Long term revenue

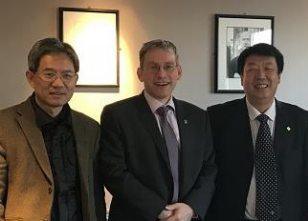


Prospective partners



Commercialisation route

Yulong Ding collaborates with CRRC (September 2017)



File patent (February 2018)

ICURe fund via Innovate UK (Hui Cao, June 2018)

£35k for market evaluation

EPSRC IAA fund (Hui Cao, November 2018)



£25k build demonstration

Patent publication WO2019/162680 (29th August 2019)

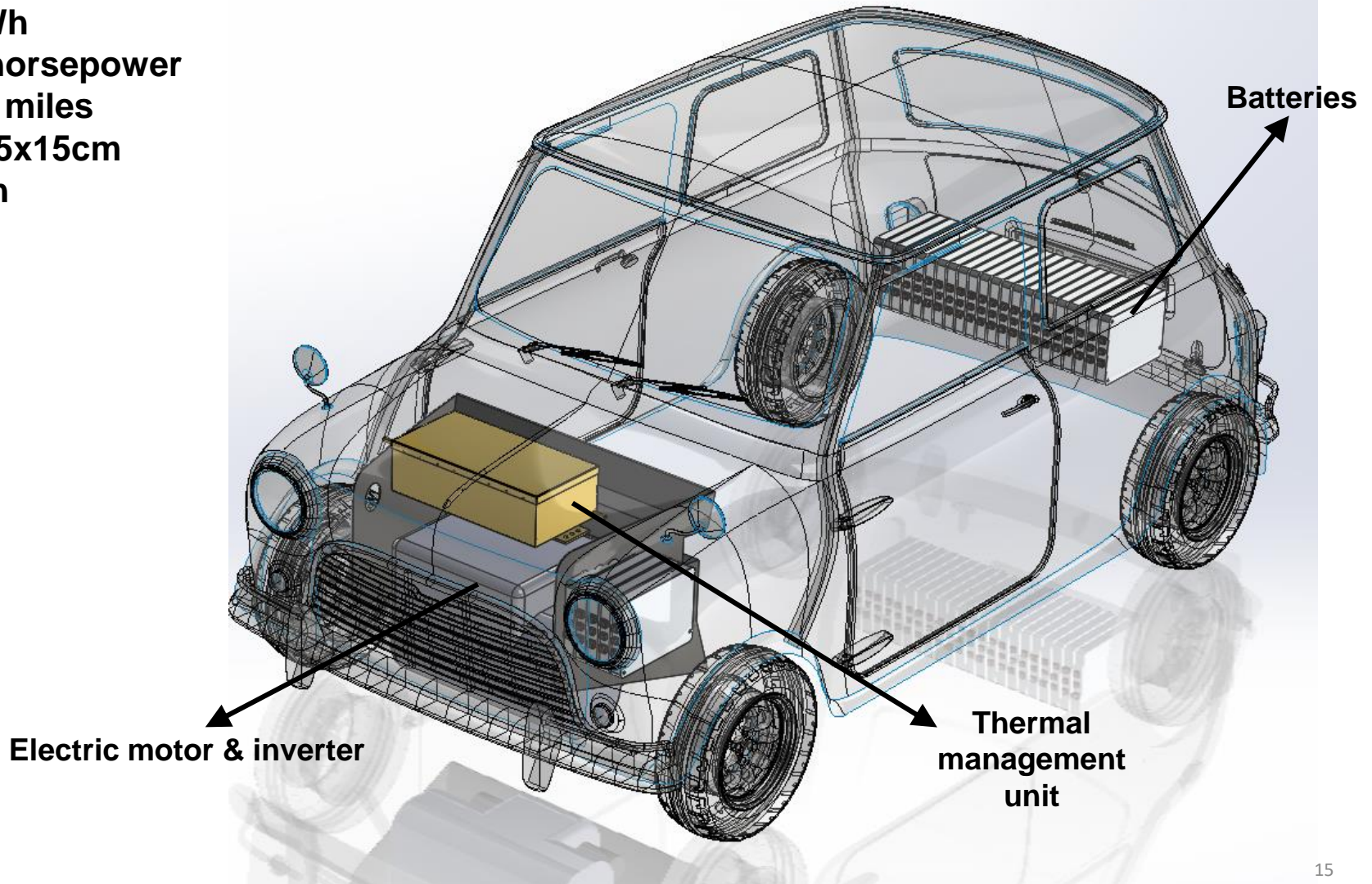
Classic Mini Cooper conversion



Partially license out

Demonstration via a battery converted classic Mini Cooper

20kWh
147 horsepower
~100 miles
50x25x15cm
1kWh



Summary

- **£6 billion** market opportunity
- Potential for good profit margin (**100% mark-up on each unit**)
- Easy for retrofitting
- OEMs in some market segments are keen to **collaborate now**
- **Right time** as EV market technology is developing

Thank you!