

Optimised Cell Layer Configurations via Modelling & Common Module Design for xEV Platforms

Fast Charging at the Li Plating Threshold

110	106	104	101	99	98						
107	104	101	99	97	96						
105	102	99	97	95	94						
103	100	98	96	94	93						
100	98	96	94	92	91						
99	96	94	92	91	90						
97	95	93				63	62	62	62	61	61
96	94	92				58	58	58	58	57	57
95	93	91				55	55	55	54	54	54
93	91	90				52	52	52	52	52	51
92	90	89				50	50	50	49	49	49
						48	48	48	47	47	47
						46	46	46	46	46	46
						45	45	45	45	45	45
						45	44	44	44	44	44
						43	43	43	43	43	43
						42	42	42	42	42	42

Ian Campbell, Krishnakumar Gopalakrishnan, Dr. Monica Marinescu,

Dr. Marcello Torchio, Dr. Greg Offer, Prof. Davide Raimondo



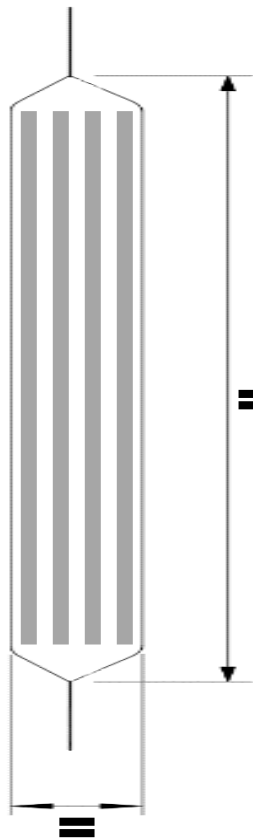
Energy & Power Balancing

Drive cycle

Acceleration

Fast charging

Range



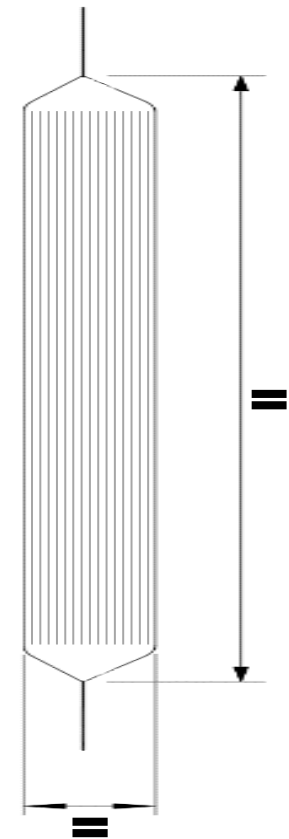
Energy dense

Rate capable

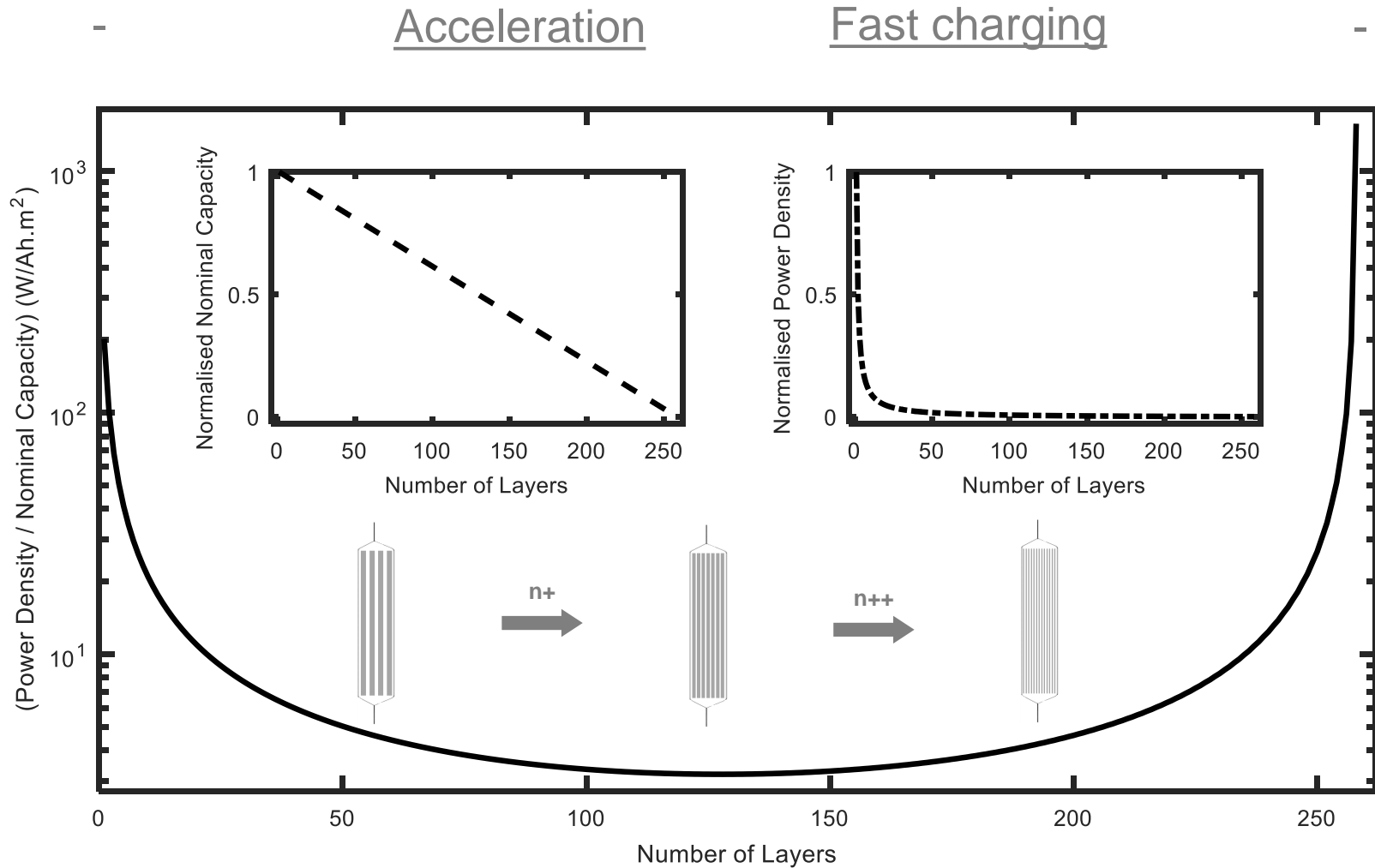
Range

Acceleration

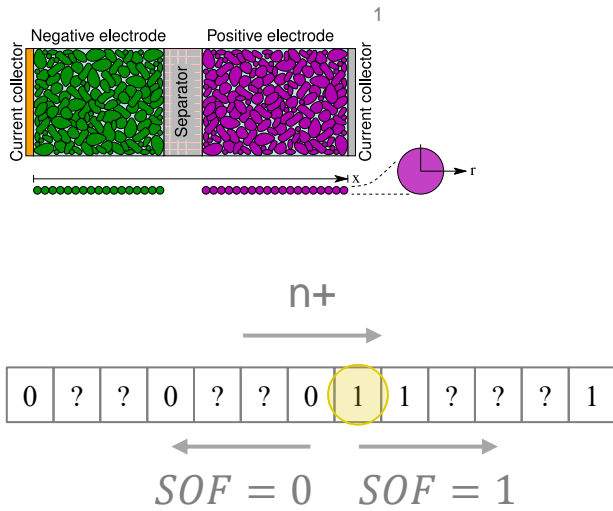
Fast charging



'Optimal' Layer Configuration



Methodology



Acceleration

$$T(t_f) < T_{max}$$

$$V(t_f) > V_{min}$$

$$z(t_f) > z_{min}$$

Fast charging

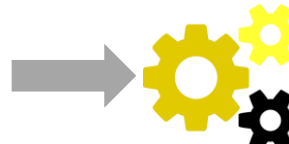
$$T(t) < T_{max}$$

$$V(t) < V_{max}$$

$$z(t) \geq z^*$$

$$C_s^*(t) < C_{s_{sat}}$$

$$t < t_{max}$$



Electrodes / diffusion

Active area

Power density

Mass

Heat capacity

¹Image from G. L. Plett, Battery Management Systems, Volume I: Battery Modeling, Artech House, Massachusetts, 1st edn, 2015, p.346



BEV Specifications

xEV

BEV

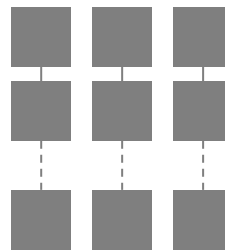
Powertrain



Acceleration > Fast charging
kW

Module configuration

8S3P



Acceleration < Fast charging
 Δt

xEV mass (w/o cells)

1,687 kg



SOC window

5 - 95 %



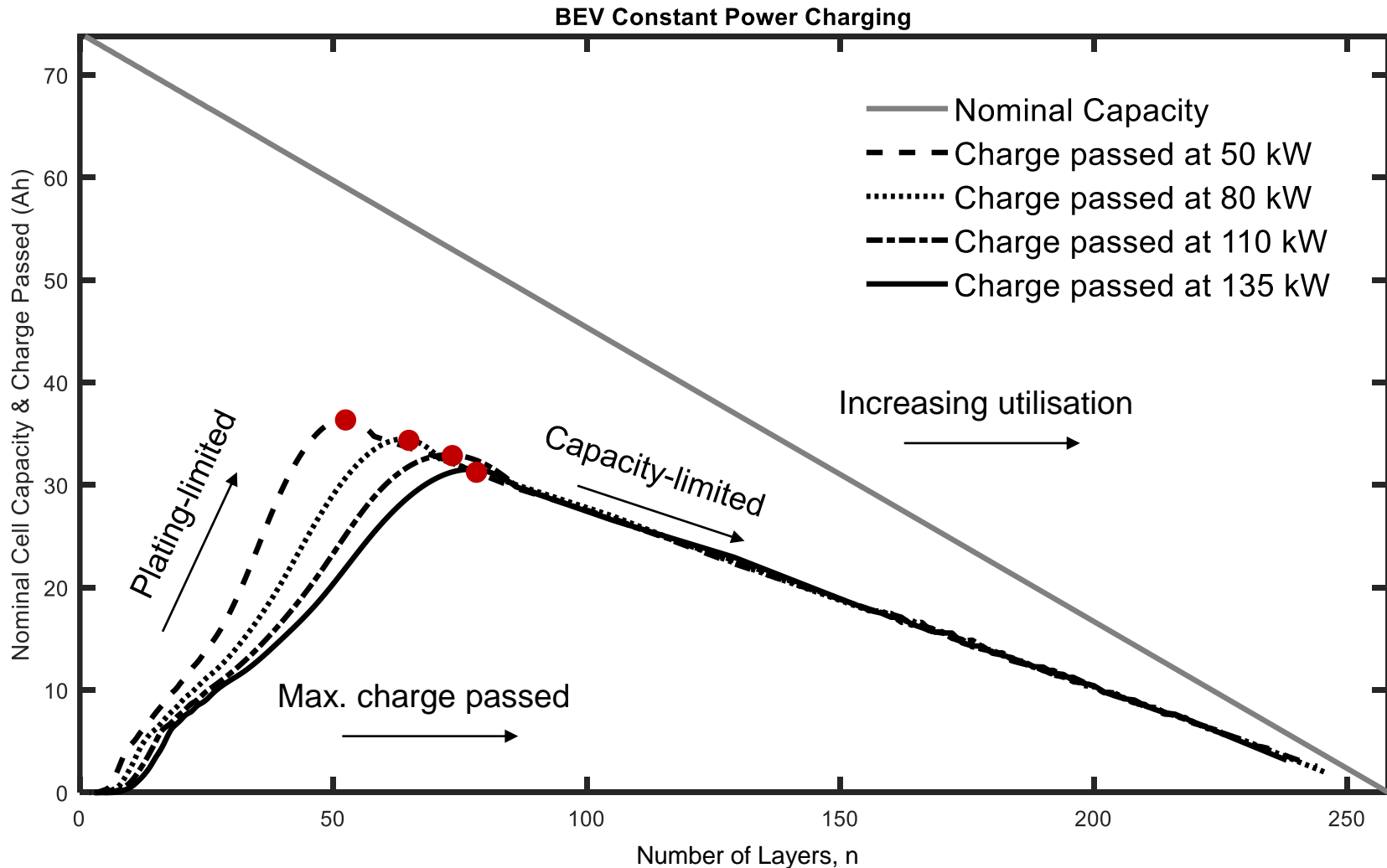
$$n_{opt}(T_{init}, T_{sink})$$

Fast charge
SOC range

20 - 80 %

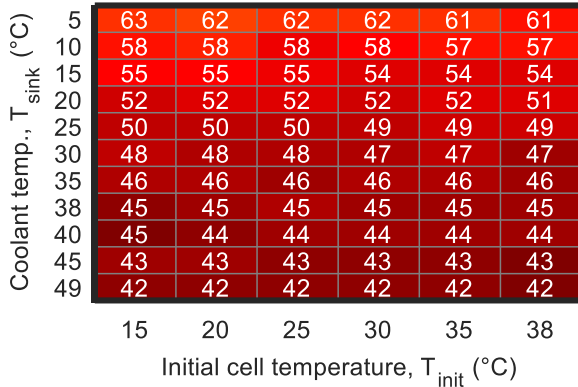


Fast Charging Limitations

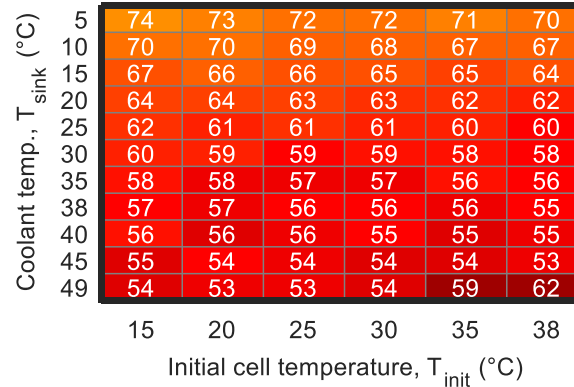


BEV Optimal Layer Configuration

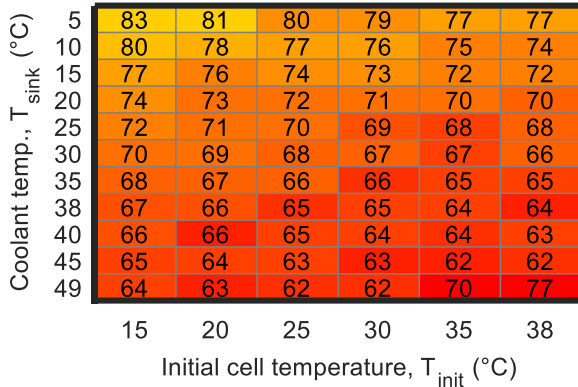
BEV Charging Power: 50 kW



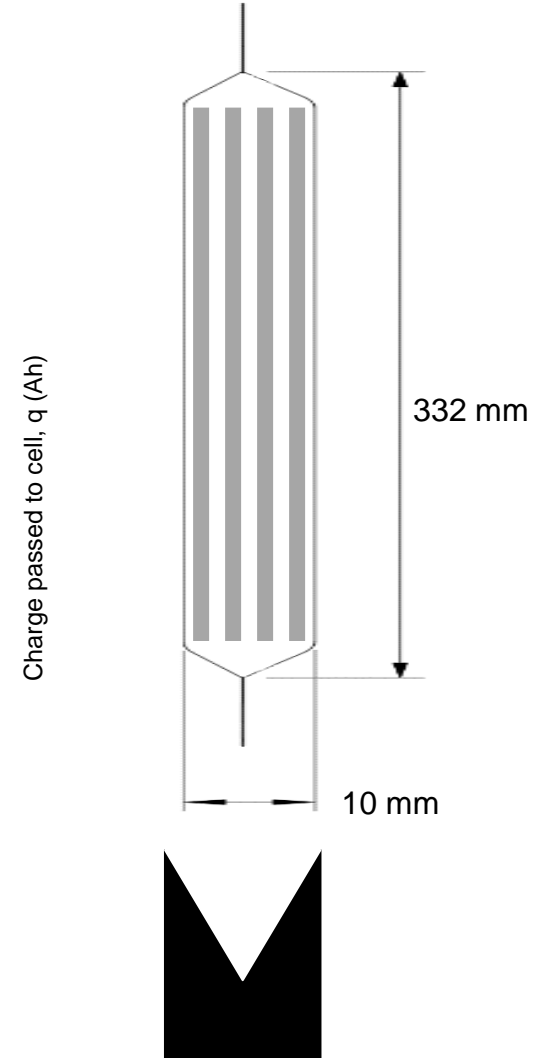
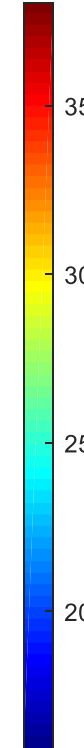
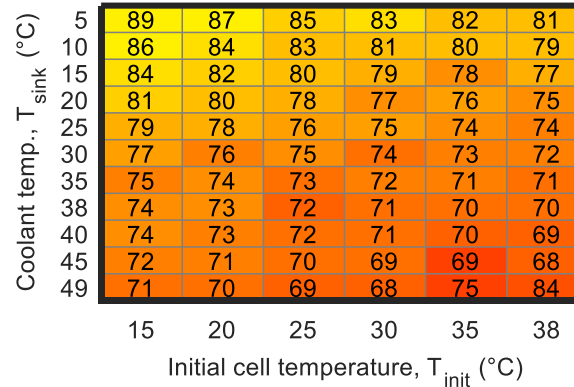
BEV Charging Power: 80 kW



BEV Charging Power: 110 kW



BEV Charging Power: 135 kW

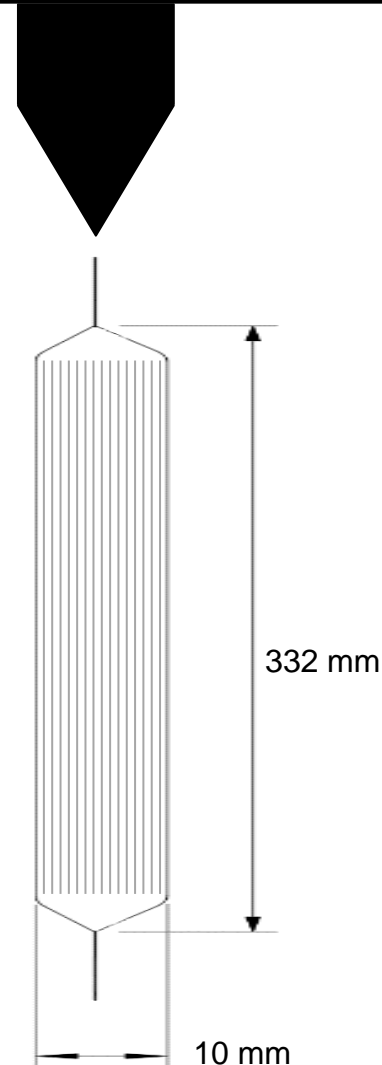
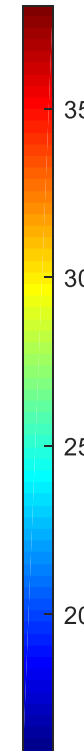
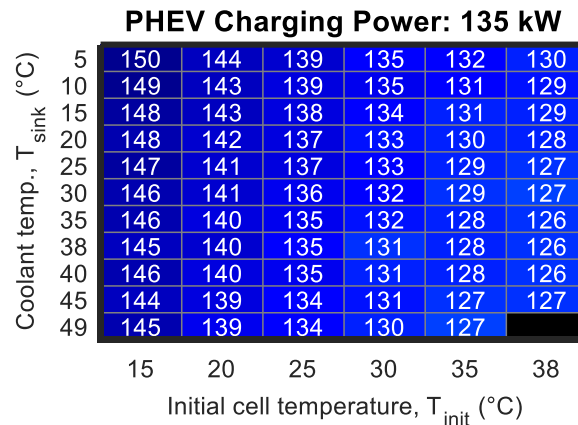
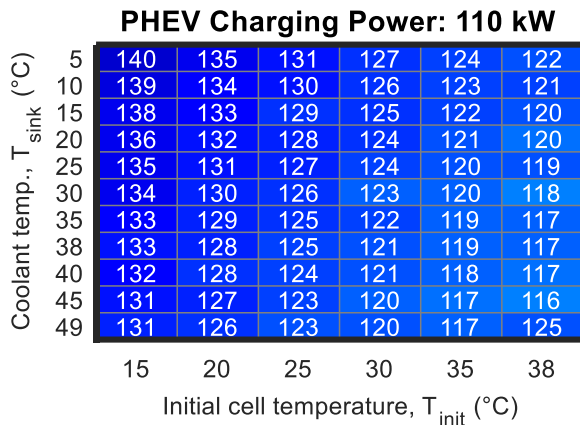
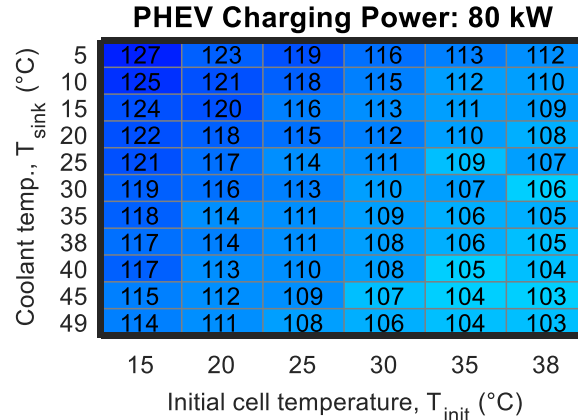
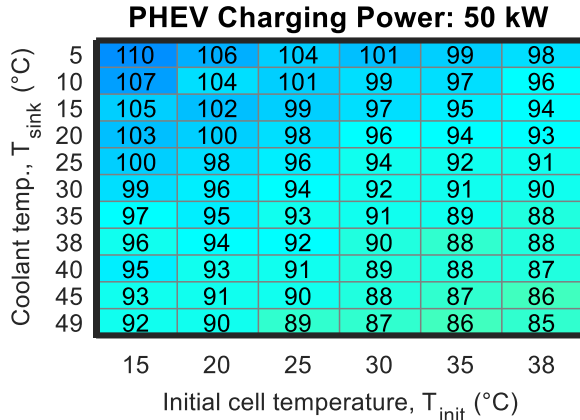


xEV Common Module Design

xEV	BEV	PHEV
Powertrain		(series)
Module configuration	8S3P 	8S1P
xEV mass (w/o cells)	1,687 kg	1,654 kg (inc. ICE)
SOC window	5 - 95 %	30 - 90 %
Fast charge SOC range	20 - 80 %	30 - 80 %



PHEV Optimal Layer Configuration



Summary



Increased EV range via model-based layer optimisation



Cost & time savings via EV common module sharing



Pursue higher diffusion rates for increased EV range (most °C)



Improve thermal management for increased EV range (high °C)



Contact & Acknowledgements

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EPSRC

Engineering and Physical Sciences
Research Council



End

End

