Battery Cell Selection Using About:Energy's Cell Database with TAITherm Webinar

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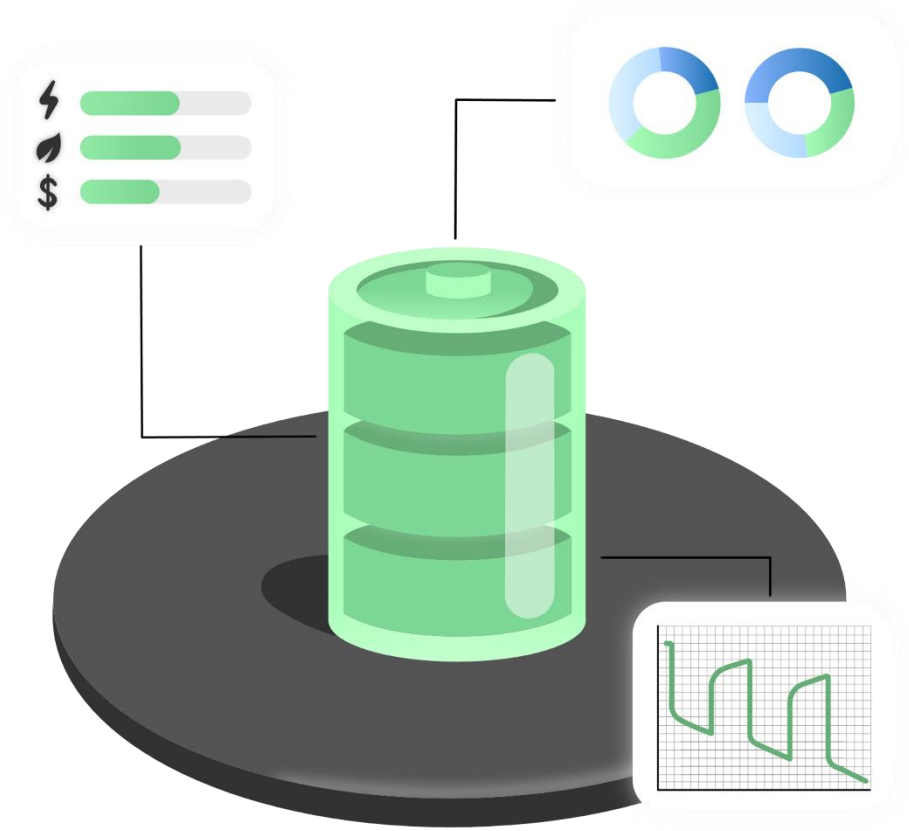
Outline

- Introduction
- About:Energy's VOLTT database
- TAITherm thermal/electrical model
- Combined simulation results
- Conclusions



VOLTT

Gavin White

CEO / Co-founder

VOLTT

Cells

Search

Dashboard
Cells
Cellector
Request

Show My Cells (Only)

Subscription

Columns 10

Manufacturer	Model	Available data	Verified	Form factor	Capacity / Ah	Max continuous discharge / A	Price / $	Positive electrode (Cathode)
About:Energy	Gen1 Demo			Cylindrical 21700	5	7.5	5.00	NMC
LG Chem	INR21700-M50			Cylindrical 21700	4.85	7.275	4.28	-
Samsung	INR21700-40T			Cylindrical 21700	4	45	11.07	-
LG Chem	INR21700-M50LT			Cylindrical 21700	4.9	14.4	7.99	-
Murata	US21700VTC6A			Cylindrical 21700	4.1	40	8.07	-
Samsung	INR18650-30Q			Cylindrical 18650	2.95	15	9.83	-
Tesla	Tesla Model Y			Cylindrical 4680	23.7	50	-	-
Panasonic	Tesla Model 3			Cylindrical 21700	4.8	21.6	-	-
Lishen	LR2170SD			Cylindrical 21700	5	9.6	-	-
Sony	US18650VTC6			Cylindrical 18650	3.12	30	-	-

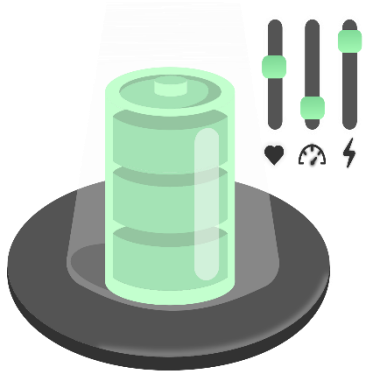
Showing 1-10 of 511 results

Previous Next

Bug Report
Settings
Logout

ABOUT:ENERGY

Select



Optimise

Benchmark

Share

VOLTT

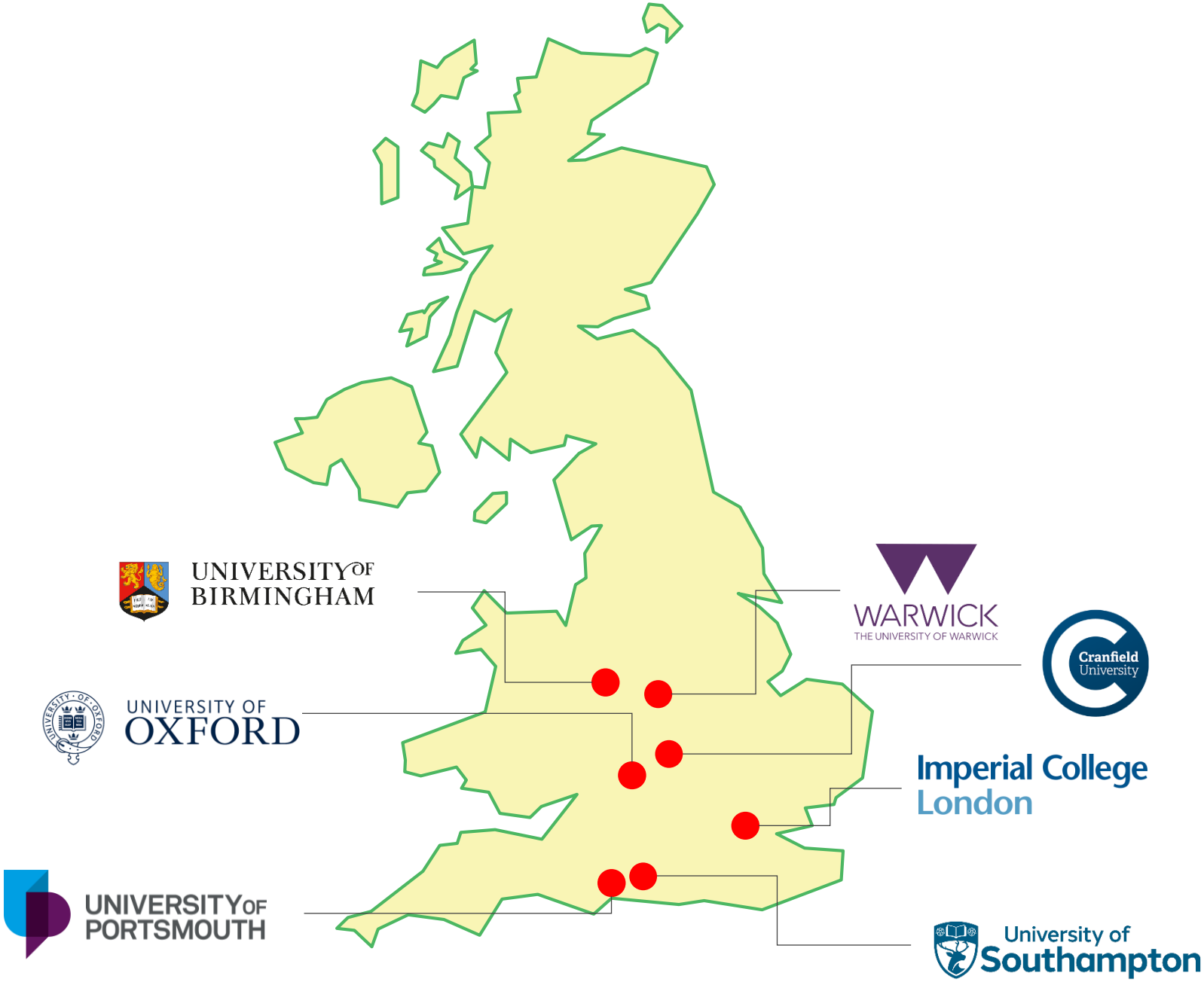
Your Virtual Lab

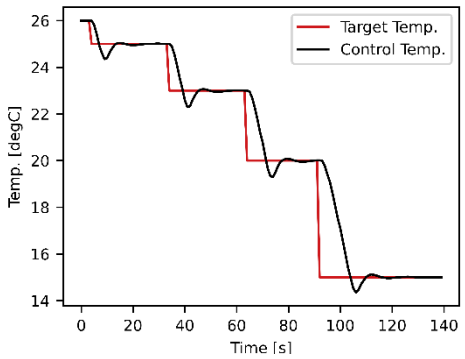
Barriers to Battery Innovation

FACILITIES

RESEARCH

EXPERTISE

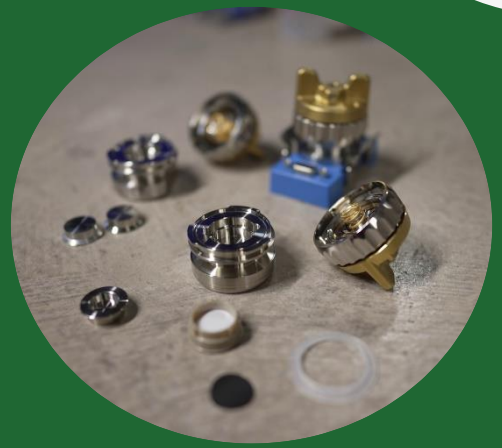

UNIVERSITY OF BIRMINGHAM
UNIVERSITY OF OXFORD
UNIVERSITY OF PORTSMOUTH
WARWICK
THE UNIVERSITY OF WARWICK
Cranfield University
Imperial College London
University of Southampton



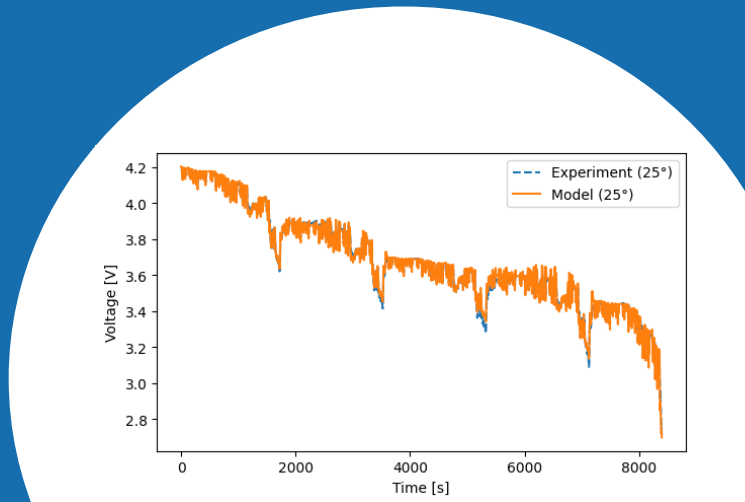
Thermal control

Cell cycling protocols

Teardown



Modelling



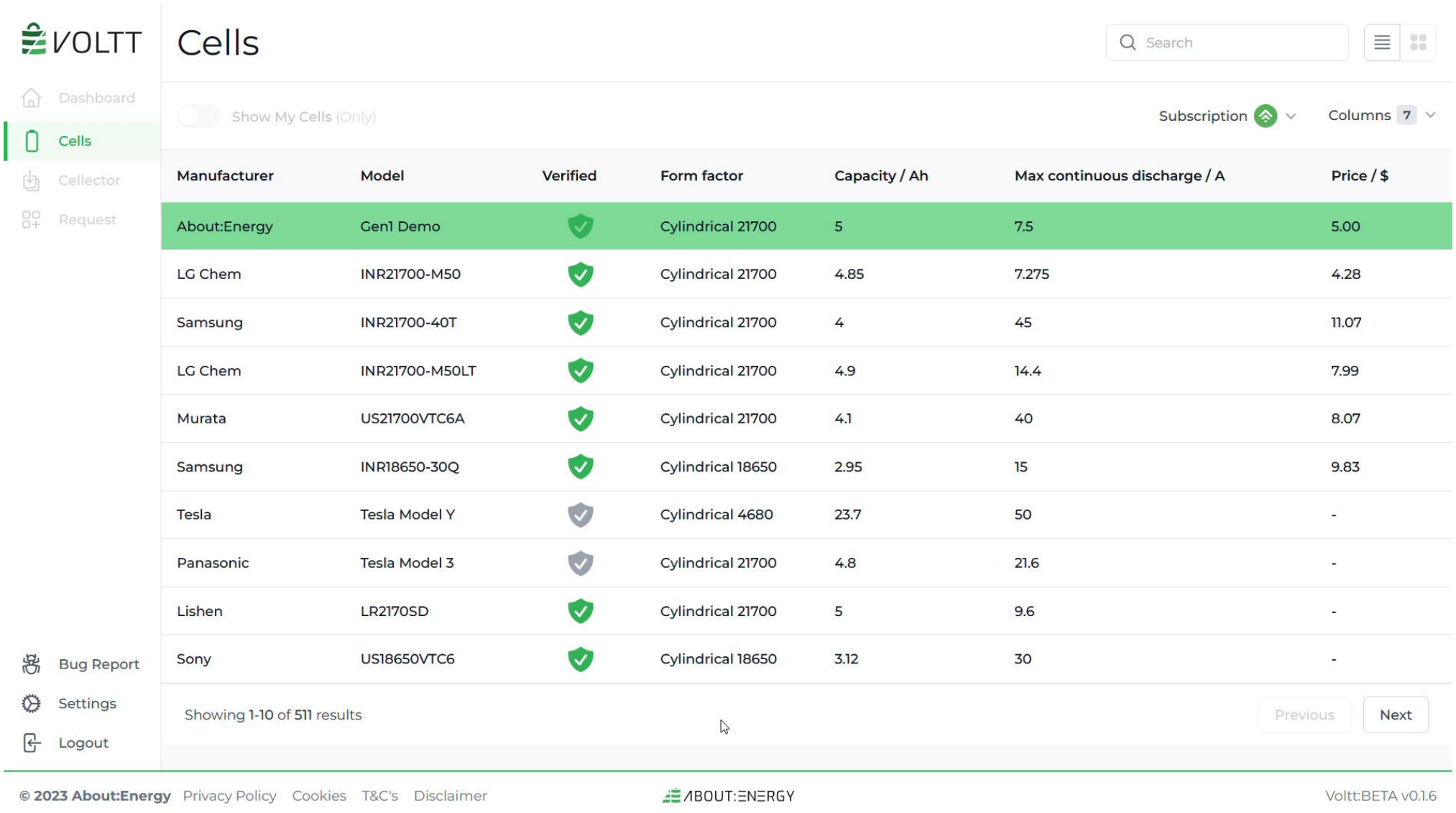
WHITE-BOX

RESEARCH-ORIENTED

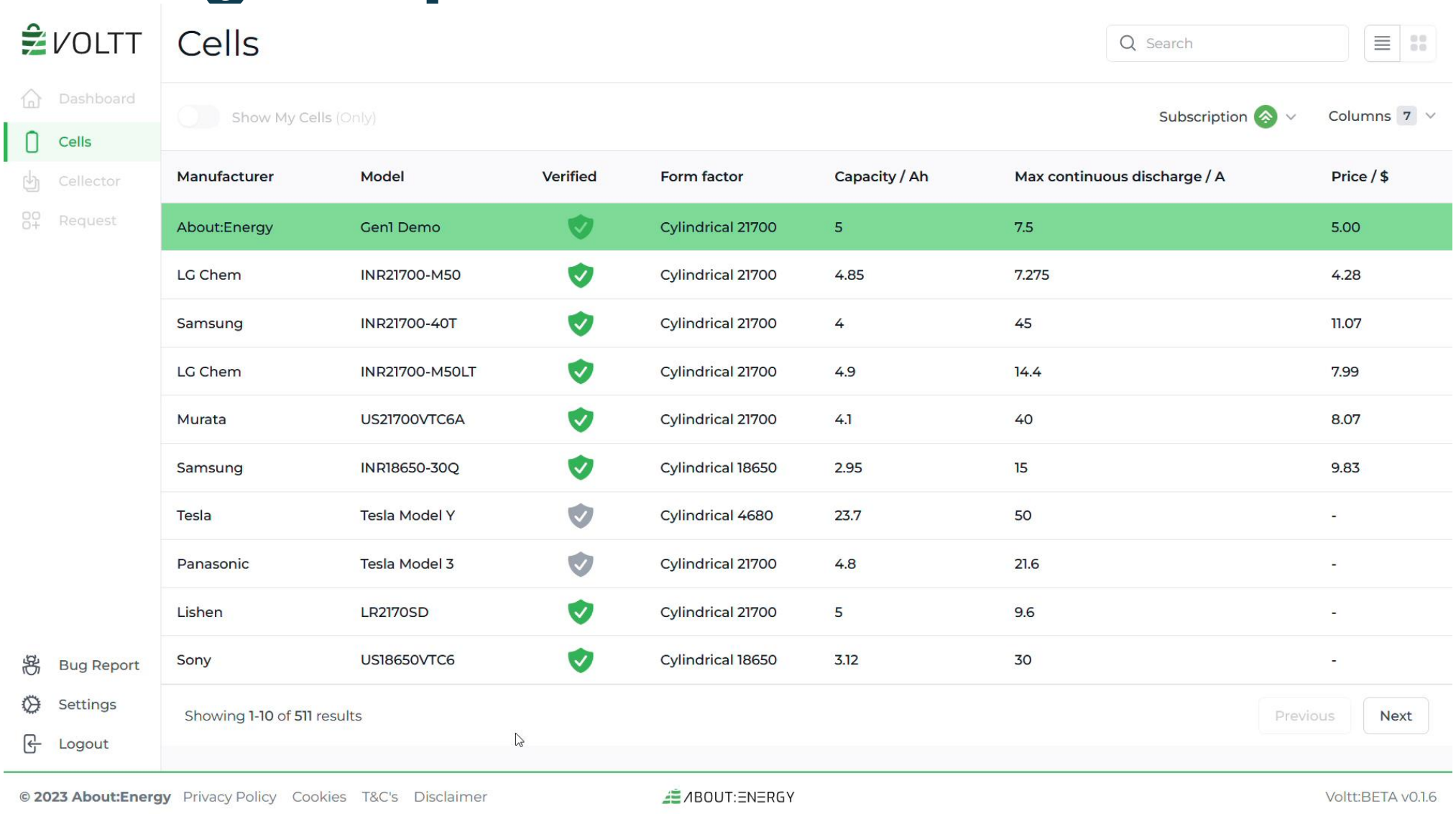
HONEST

PLATFORM-AGNOSTIC

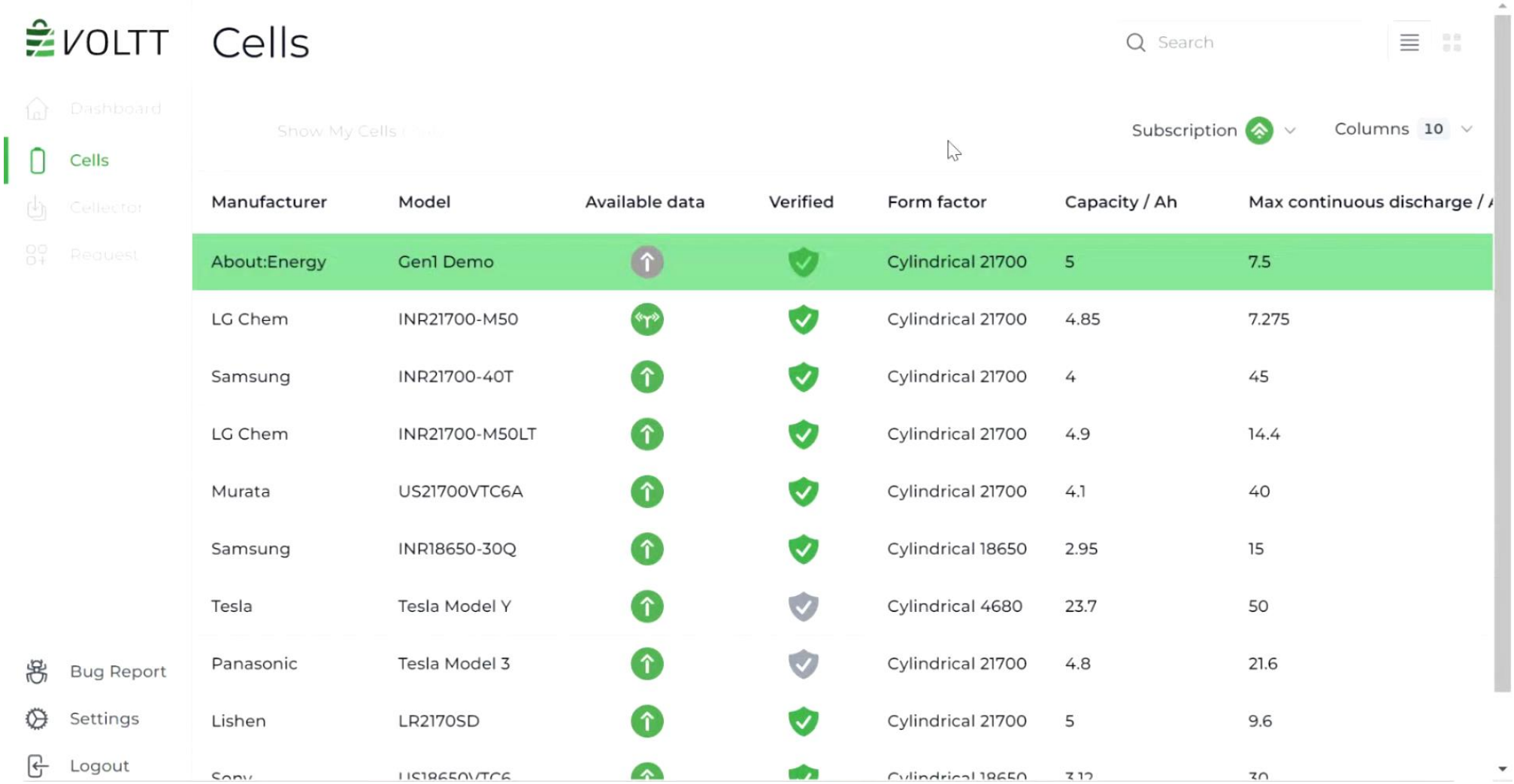
A look inside the Voltt



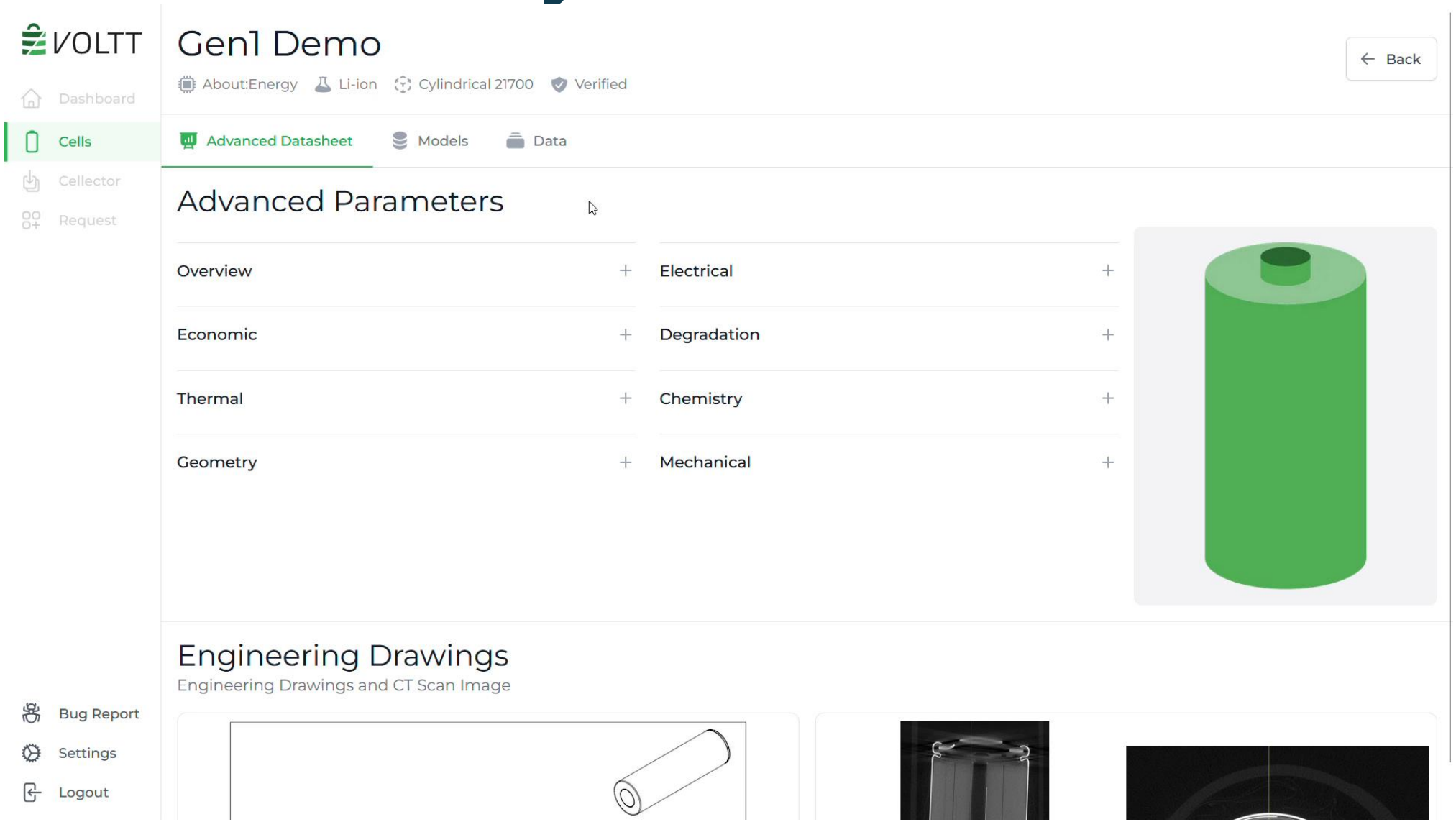
Going deeper: Advanced Datasheet



Want a battery model?



Want a battery model?



Equivalent Circuit Model

Data collected for

35+ cells

.csv .mat

SIMULINK®

COMSOL

THERMO ANALYTICS

Model flavours

- ECM:Lumped
- ECM:3D
- ECM:Lumped:Network
- ECM:3D:Network

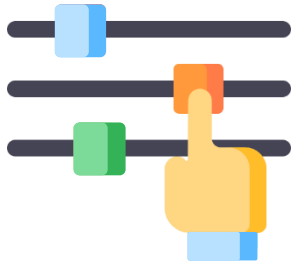
Equivalent Circuit Model

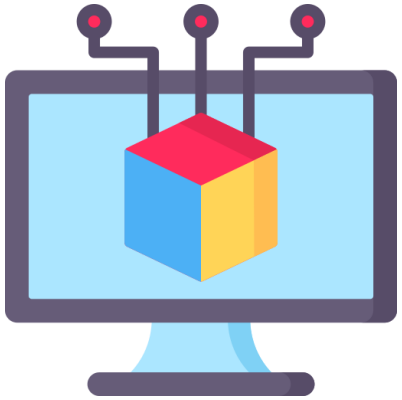
Key features

User-Friendly

White-Box

In-house parameterisation

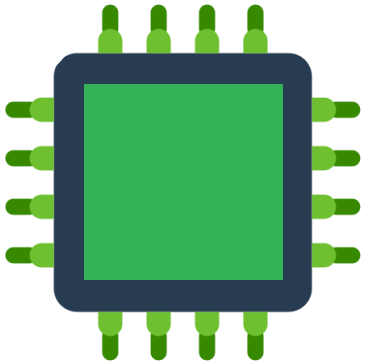




More platforms

Auto pack-generator

Coming soon



BMS compatible models

Continuous Improvement

More cells!

And even more cells!

Enter

For those **beginning** their battery **development** process

Explore

For those looking to **leverage new** technologies

Elevate

For those **positioning** themselves as industry **leaders**

Explore

Enter

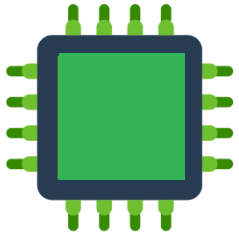
Material development

Electrode manufacturing

Cell manufacturing

Pack design

BMS



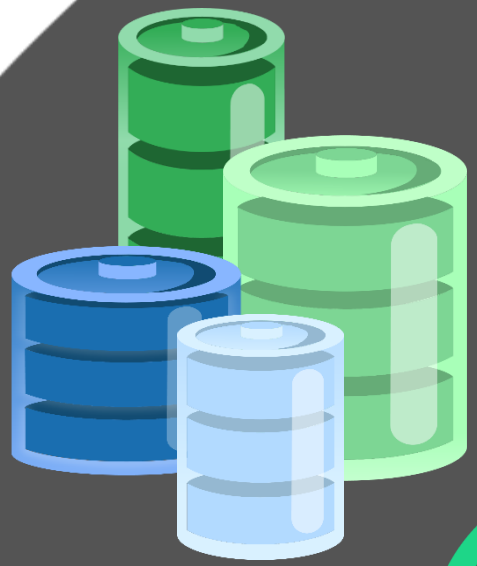
Lifetime Prediction

Recycling

Elevate

	Enter	Explore	Elevate
Electrical	✓	✓	✓
Thermal	✓	✓	✓
Electrochemical	–	✓	✓
Degradation	–	–	✓
Enterprise Solutions	–	–	✓

Continuously improving



More cells

Improved models

New products

VOLTT

Unlocking the potential of battery technology

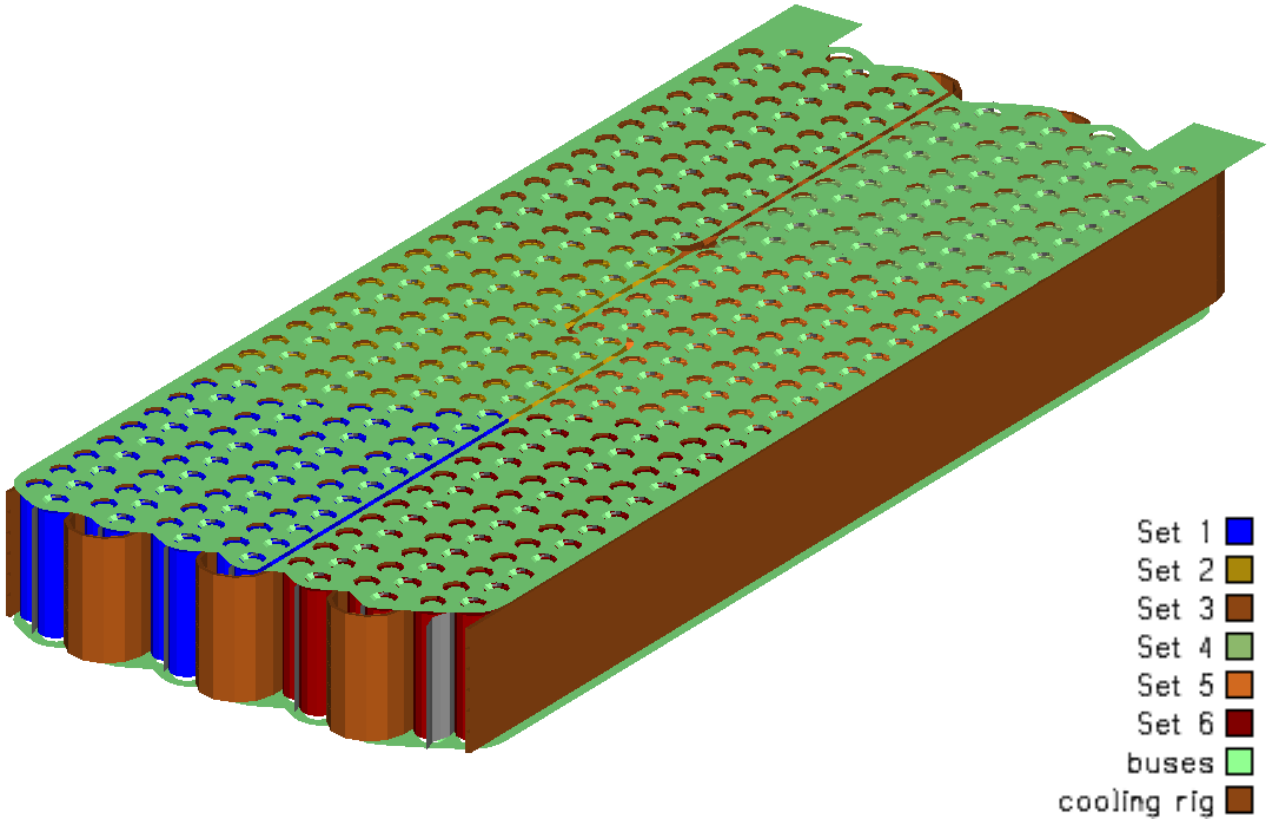
Objective

Given a five unique battery types from the VOLTT determine the difference in performance using simulation.

Battery Names
LG M50L
Samsung50S
Samsung50E
Samsung48X
Lishen LR21700SF

- Operating scenarios
  - Constant current discharge (nominal 1C)
  - Drive cycle (IEEE EV Example)
- Heat sources
  - Battery cells
  - Bus bars
- Heat Exchanger
  - Input temperature taken from measurement (IEEE EV Example)

Thermal model setup

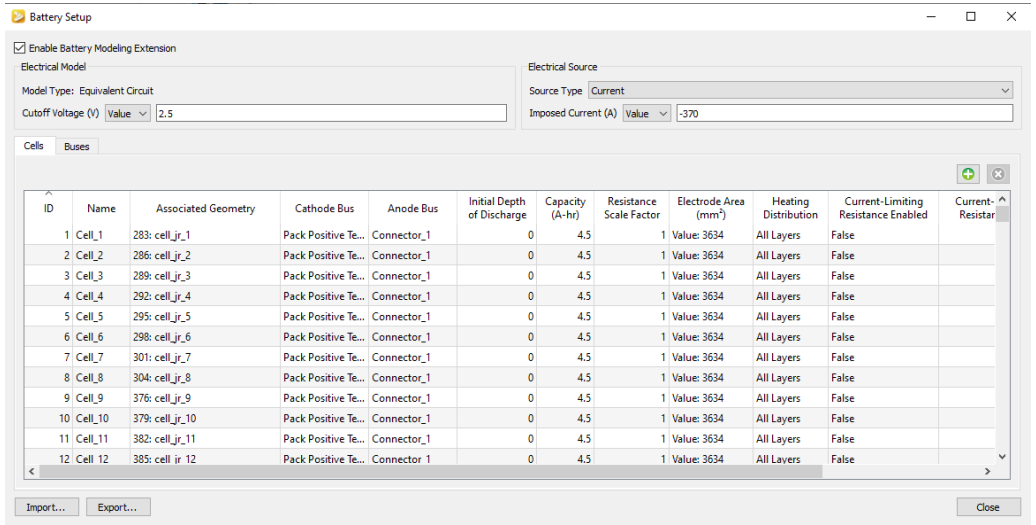


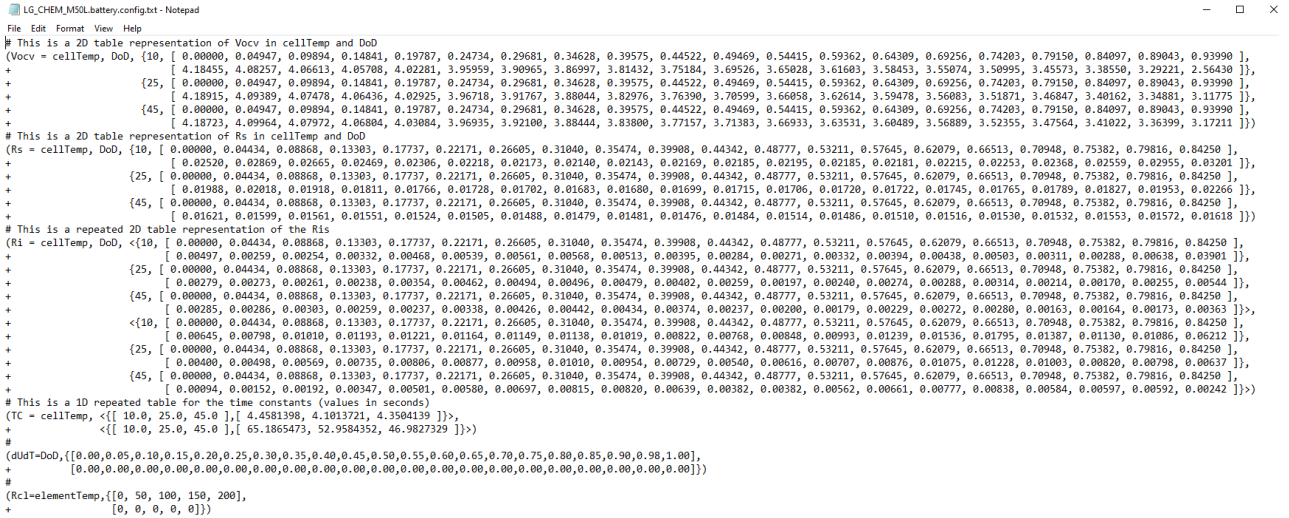
TAITherm model contains 444 cells split into 6 sets

Fluid streams are used to model cooling of the pack

Joule heating is applied to the bus geometry

Battery Setup in TAITherm





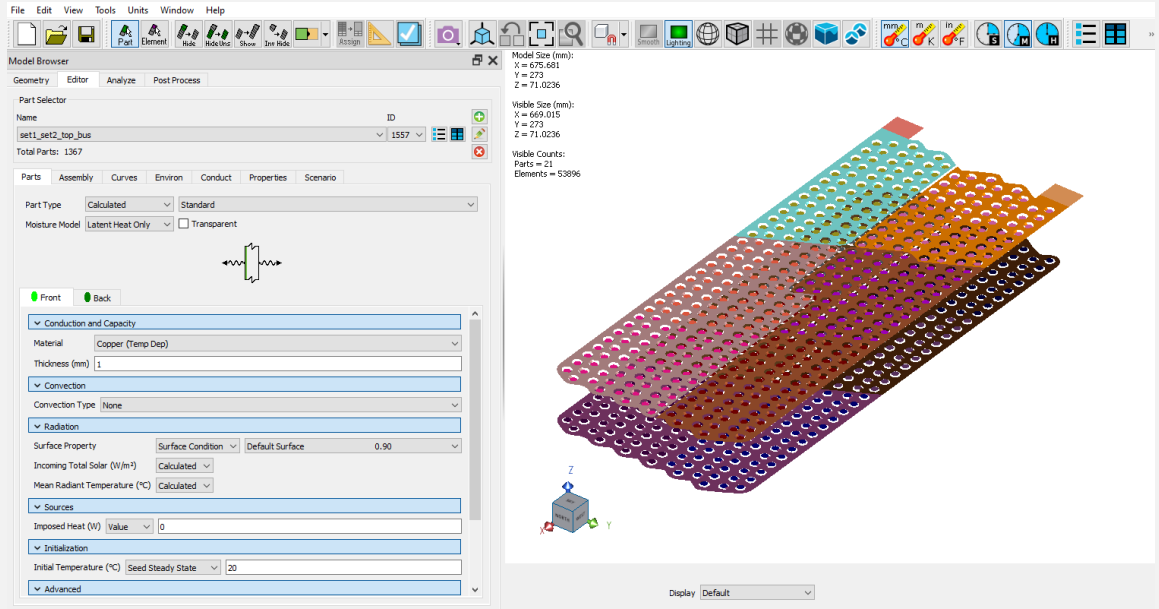
Inputs are defined in the **Battery Setup** in TAITherm and in a **battery.config.txt** file that is stored in the same directory as the TDF file.

There two inputs define the electrical set-up and cell specifics of a particular battery.

Joule Heating Setup

Thermal Model

- Continuous geometry
- Thermal boundary conditions
- Initial conditions
- Some electrical parameters, such as curves



Electrical Setup File

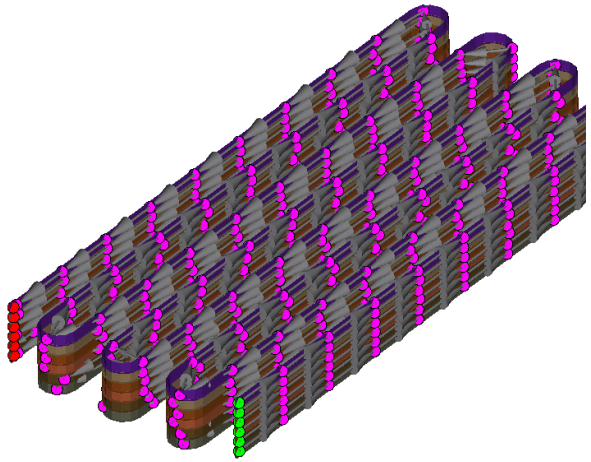
- Definition of electrical parts
- Electrical boundary conditions
- Electrical attributes
- Contact heating attributes

Section Start: Global Parameters									
Default Contact Re	1.00E-06								
Section Start: Terminal Parameters									
Set Number	Component Type	Associate	Thermal Conductivity	Electrical	Electrical	Solver Vo	Number of Insulation Layers		
1	Positive Terminal	1572	Curve: Copper, TempDep	Current	-370	0	0		
1	Negative Terminal	1567	Curve: Copper, TempDep	Voltage	0	0	0		
2	Positive Terminal	1577	Curve: Copper, TempDep	Current	-370	0	0		
2	Negative Terminal	1570	Curve: Copper, TempDep	Voltage	0	0	0		
3	Positive Terminal	1562	Curve: Copper, TempDep	Current	-370	0	0		
3	Negative Terminal	1574	Curve: Copper, TempDep	Voltage	0	0	0		
4	Positive Terminal	1575	Curve: Copper, TempDep	Current	-370	0	0		
4	Negative Terminal	1568	Curve: Copper, TempDep	Voltage	0	0	0		
5	Positive Terminal	1564	Curve: Copper, TempDep	Current	-370	0	0		
5	Negative Terminal	1573	Curve: Copper, TempDep	Voltage	0	0	0		
6	Positive Terminal	1576	Curve: Copper, TempDep	Current	-370	0	0		
6	Negative Terminal	1569	Curve: Copper, TempDep	Voltage	0	0	0		
7	Positive Terminal	1565	Curve: Copper, TempDep	Current	-370	0	0		
7	Negative Terminal	1571	Curve: Copper, TempDep	Voltage	0	0	0		
Section Start: Lead Parameters									
Set Number	Component Type	Associate	Thermal Conductivity	Electrical	Max Temp	Number of Insulation Layers			
1	Lead	1566	Curve: Copper, TempDep	5.00E+07	1000	0			
2	Lead	1561	Curve: Copper, TempDep	5.00E+07	1000	0			
3	Lead	1563	Curve: Copper, TempDep	5.00E+07	1000	0			
4	Lead	1560	Curve: Copper, TempDep	5.00E+07	1000	0			
5	Lead	1557	Curve: Copper, TempDep	5.00E+07	1000	0			
6	Lead	1558	Curve: Copper, TempDep	5.00E+07	1000	0			
7	Lead	1559	Curve: Copper, TempDep	5.00E+07	1000	0			
Section Start: Contact Parameters									
Set Number	Component Type	First Geon	Second Geometry ID	Contact Resistance					

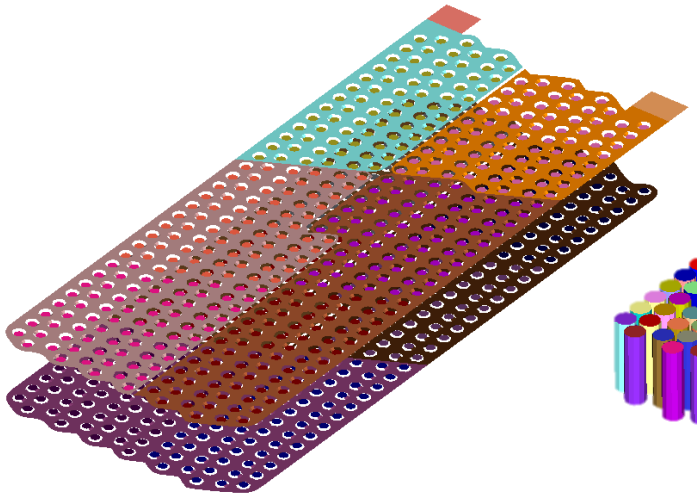
Constant current models

Imposed Current Pack	Initial Depth of Discharge	Cutoff Voltage
-370 A	0	2.5 V

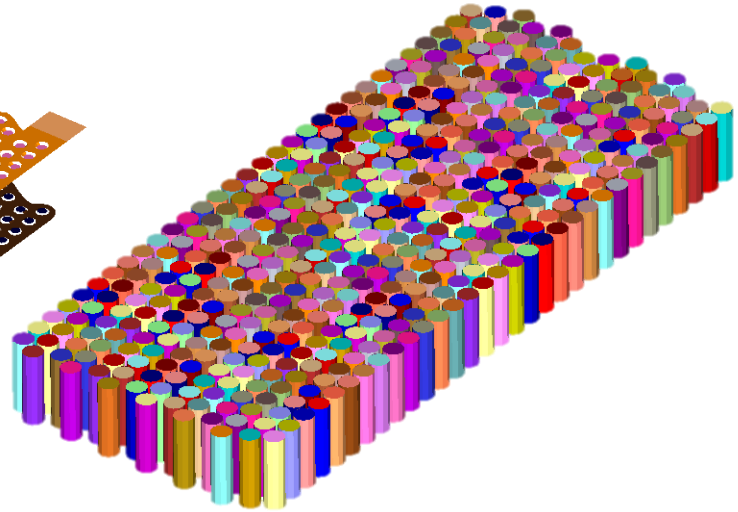
Models run until the cutoff voltage is reached.



Cooling rig with fluid streams

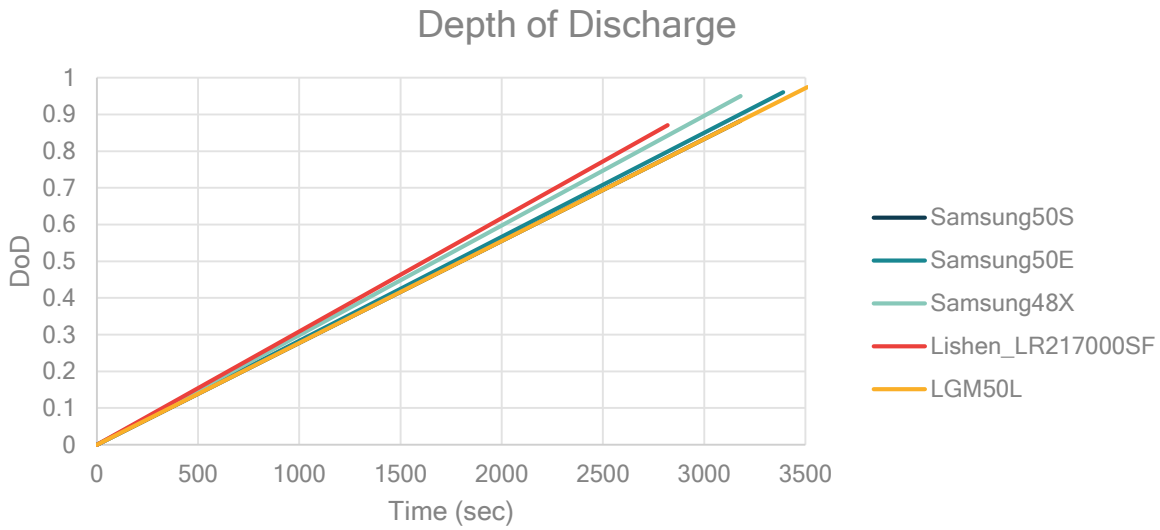


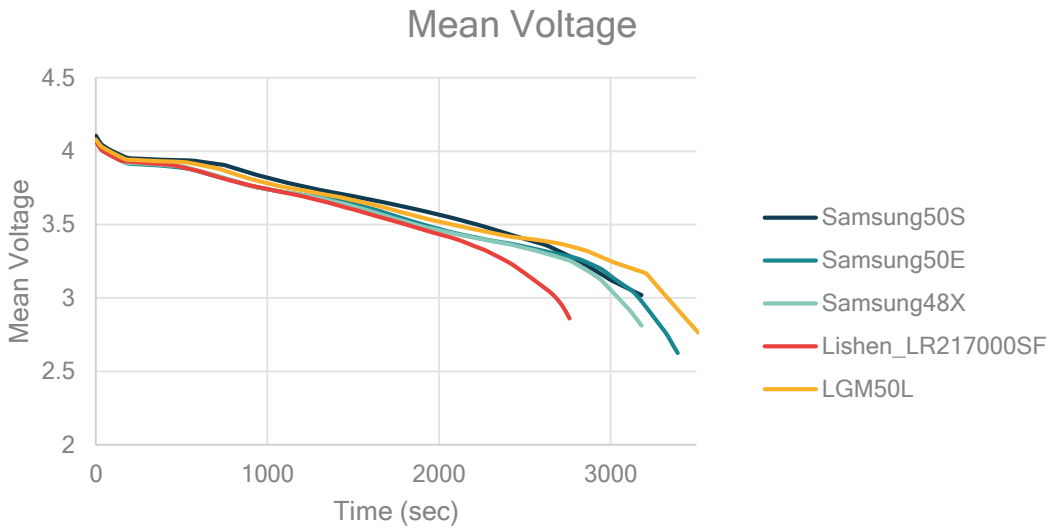
Joule Heating with bus bar geometry

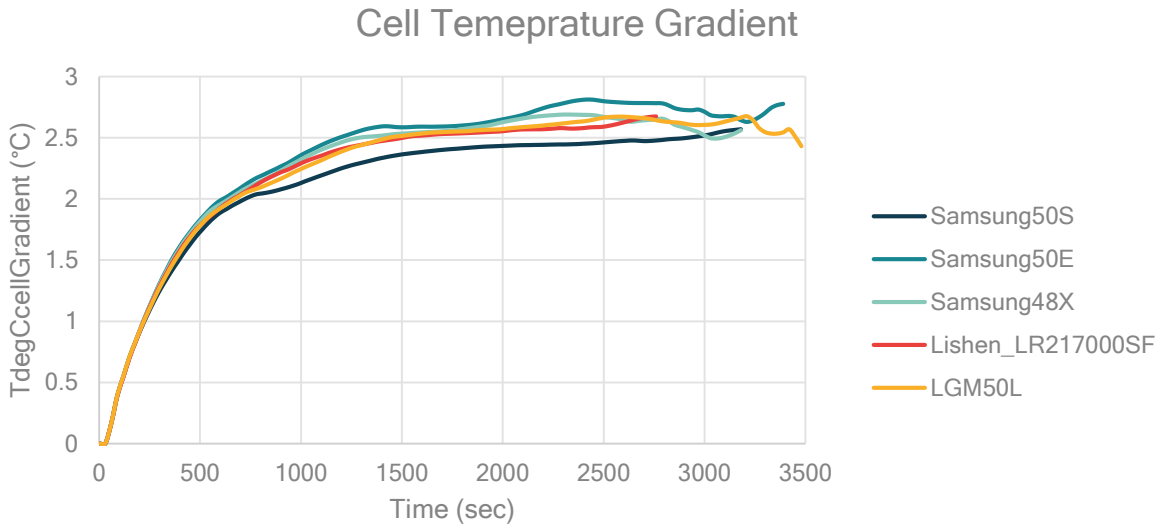


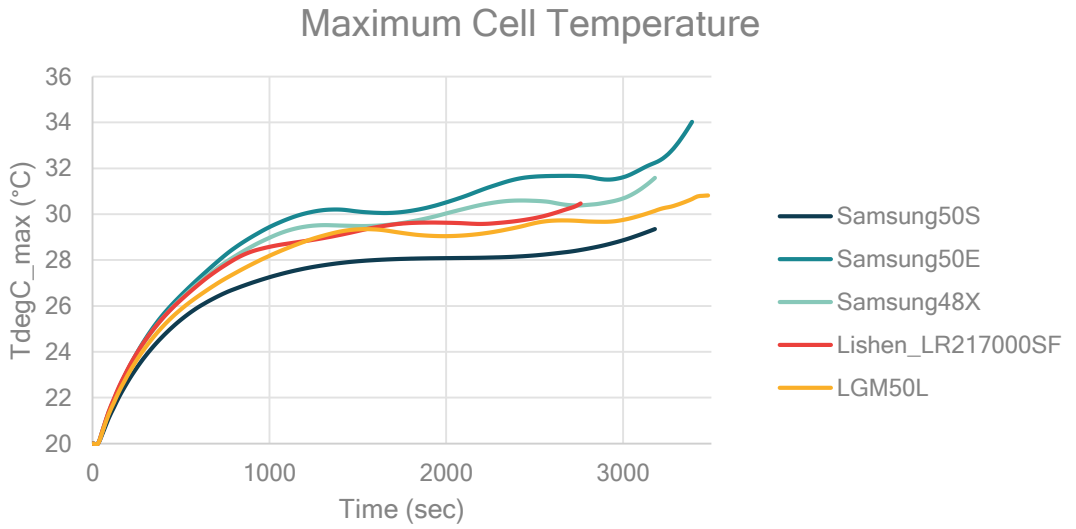
Battery Heating with cell geometry

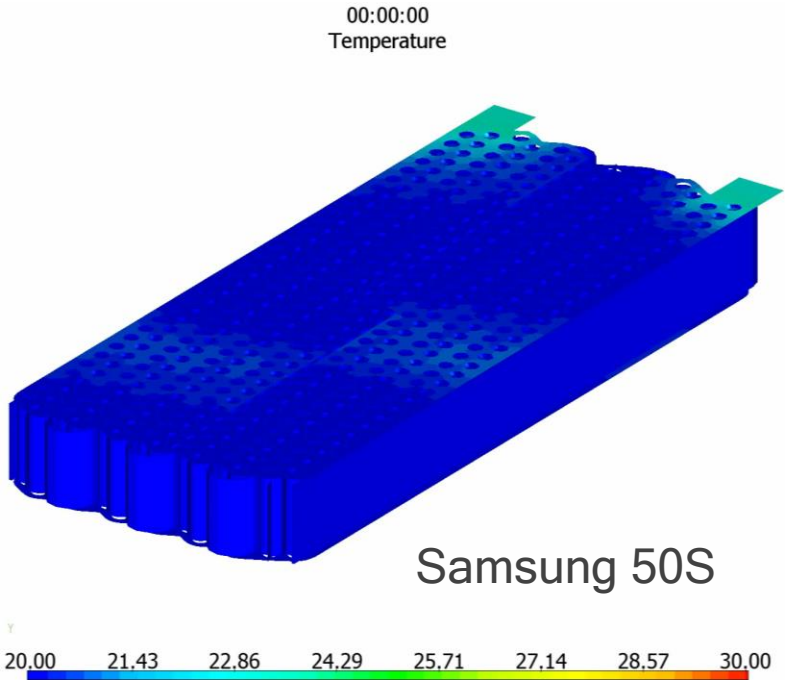
Constant Current Results

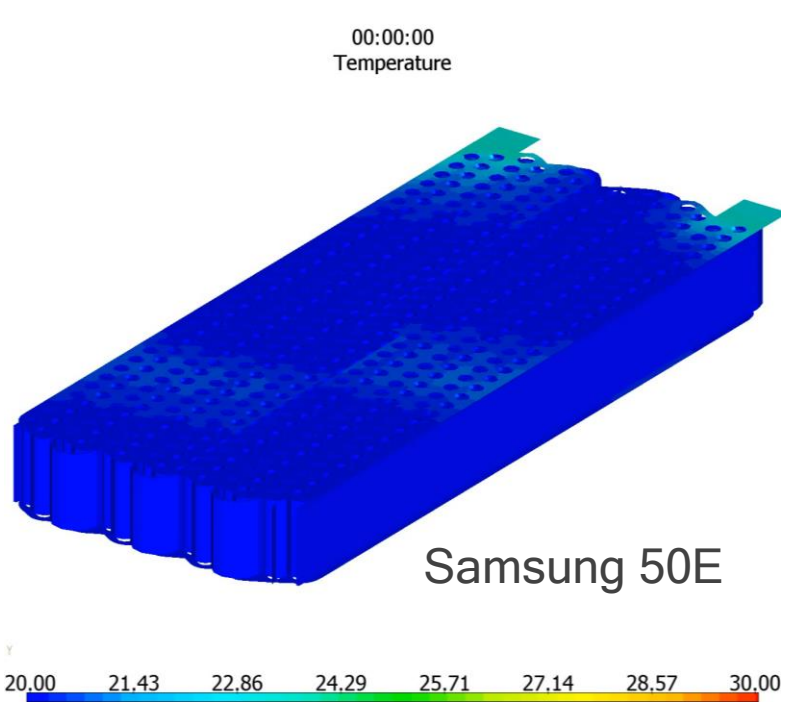


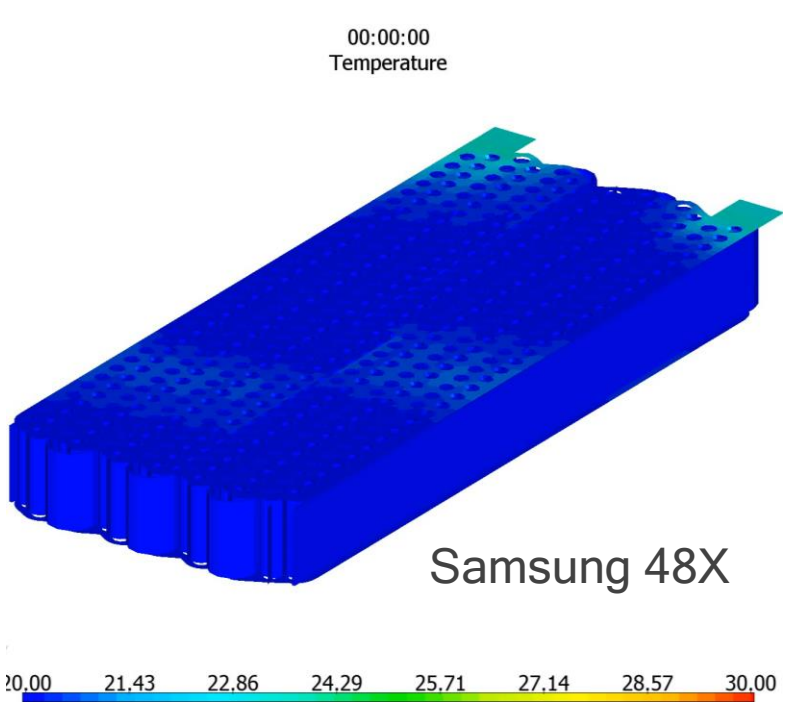


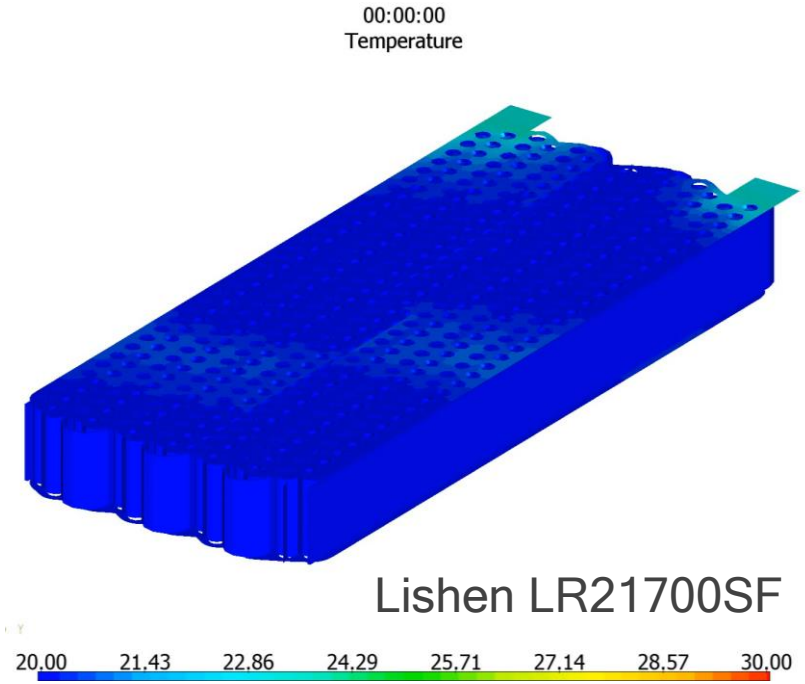


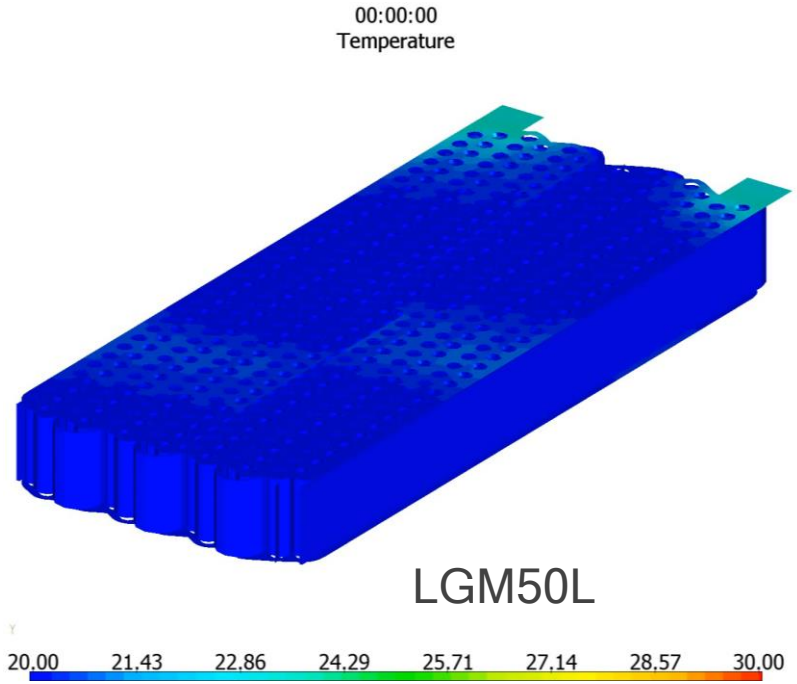




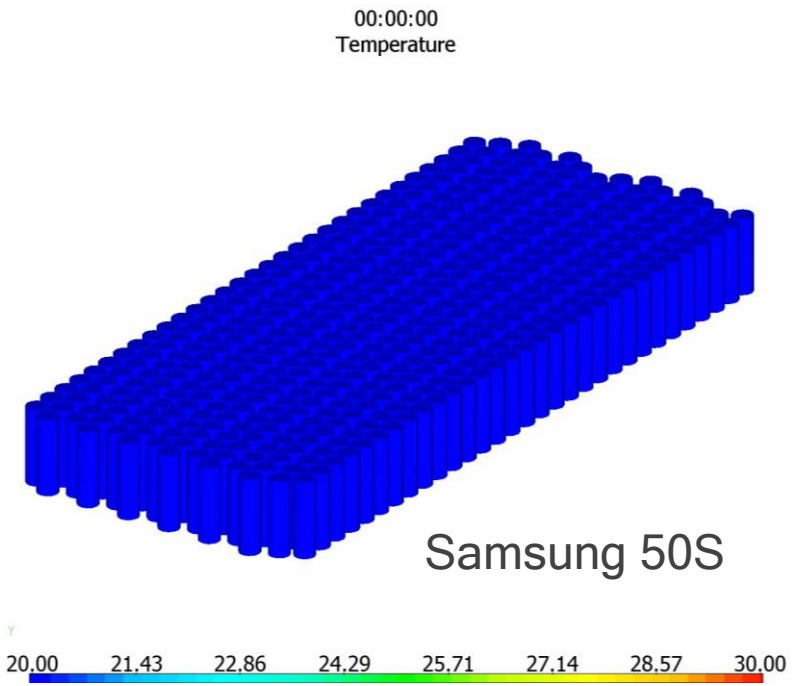


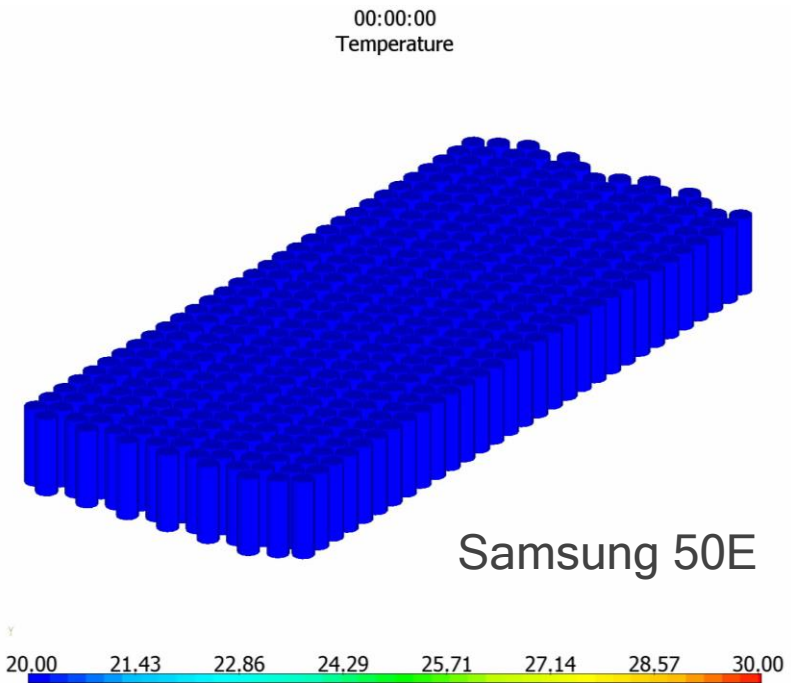


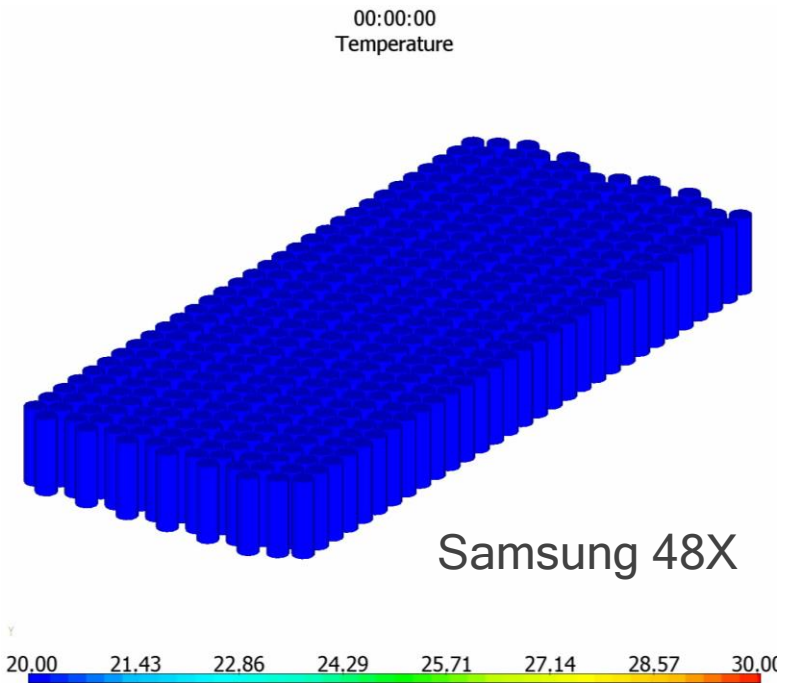


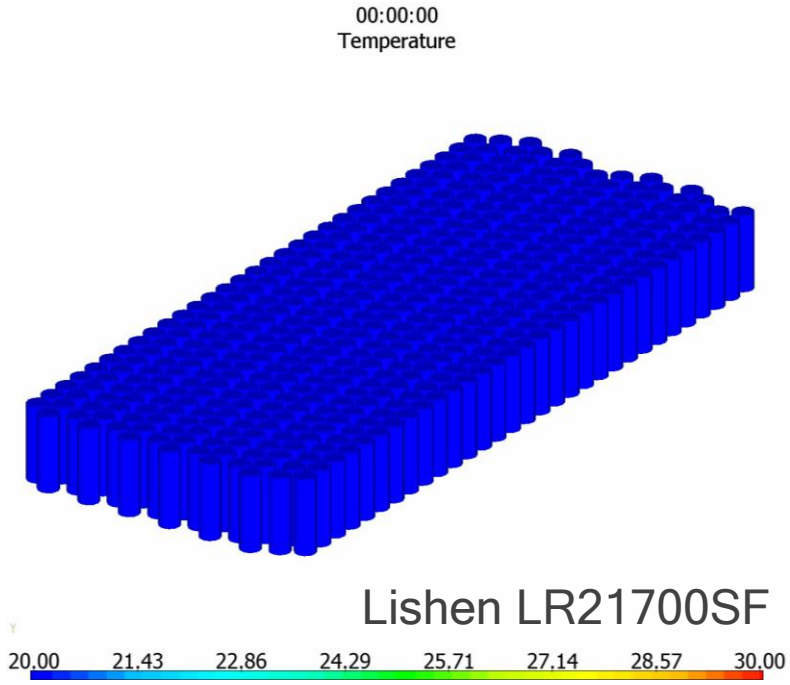


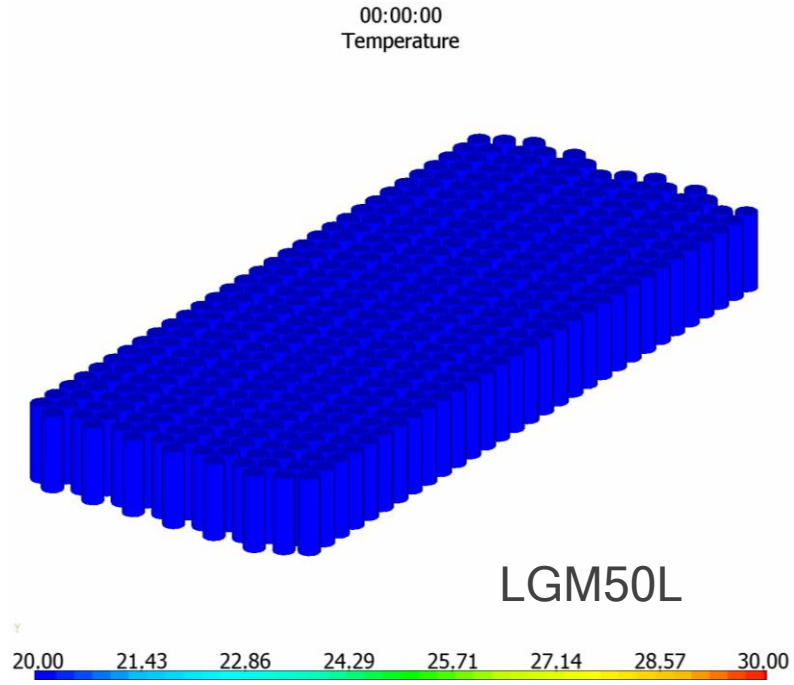
Temperature Results °C

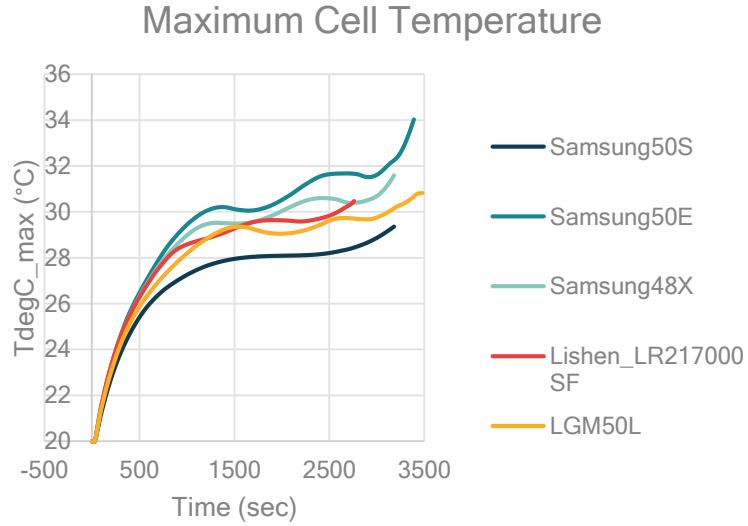












Temperature Results °C

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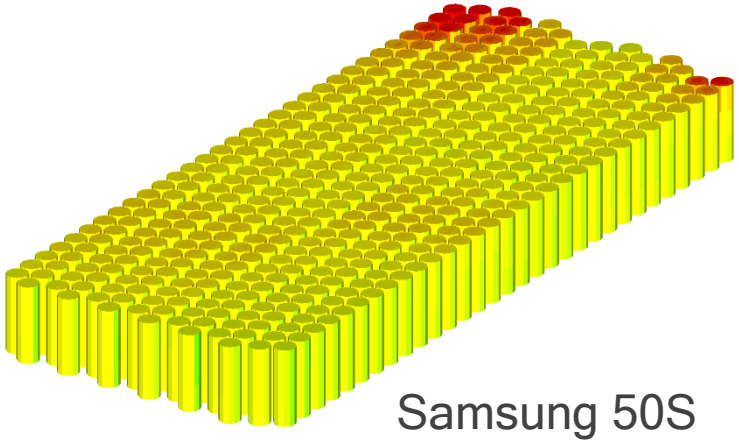
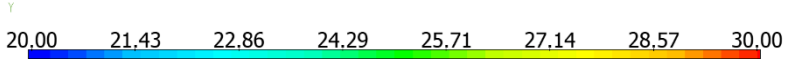
Temperature



Samsung 50S



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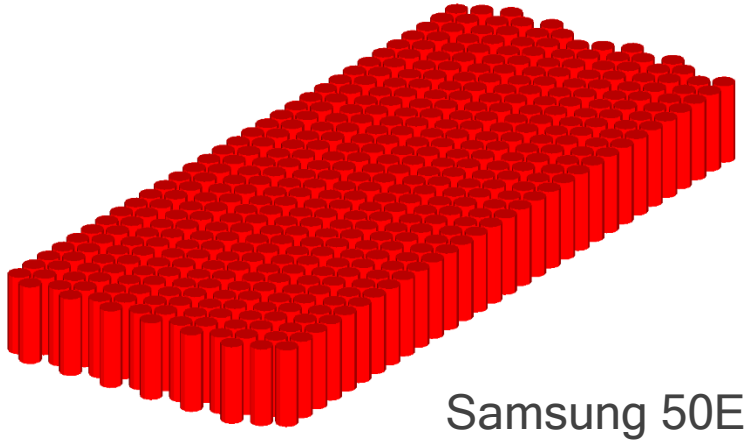
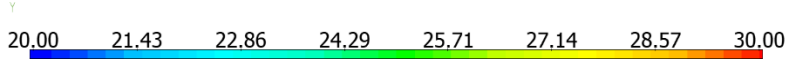


Samsung 50E



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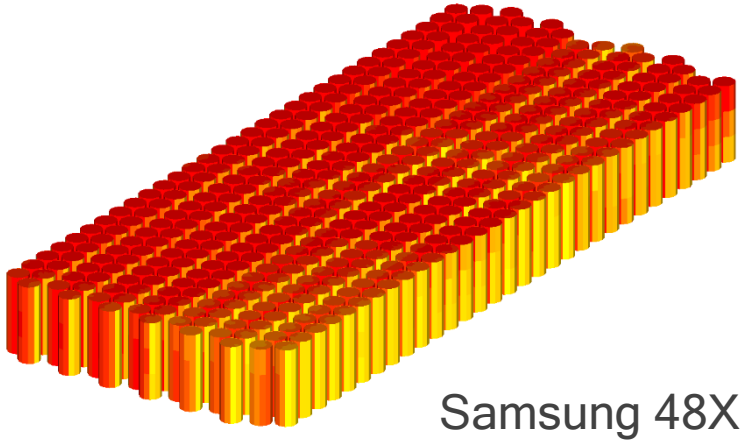
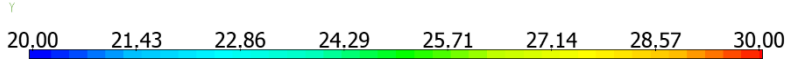
Temperature



Samsung 48X



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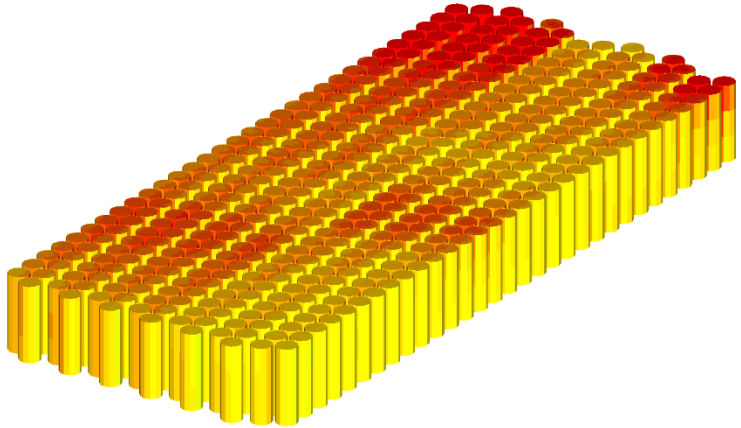
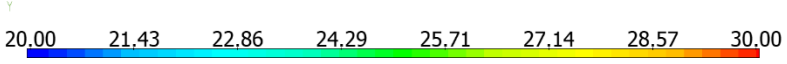
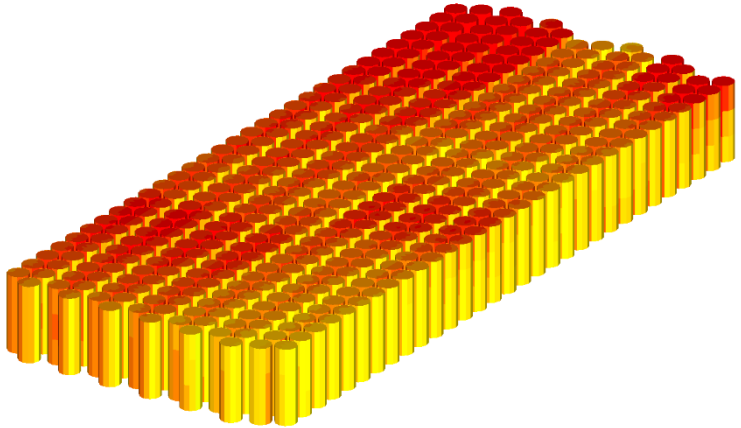


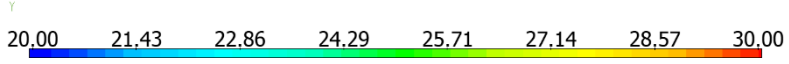
Lishen LR21700SF



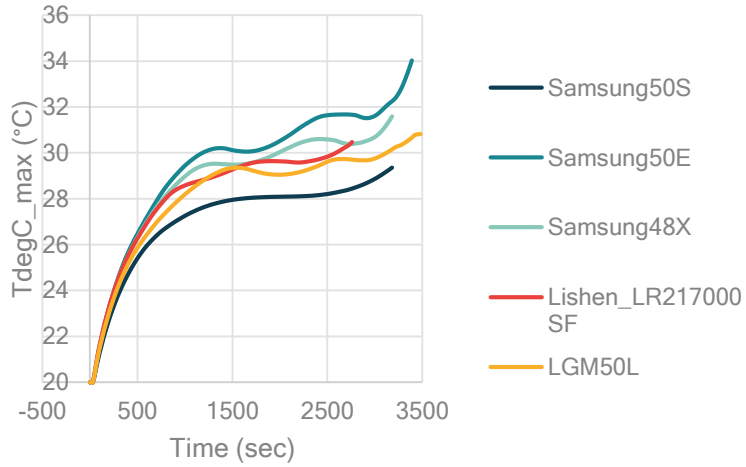
00:57:00
Temperature



LGM50L

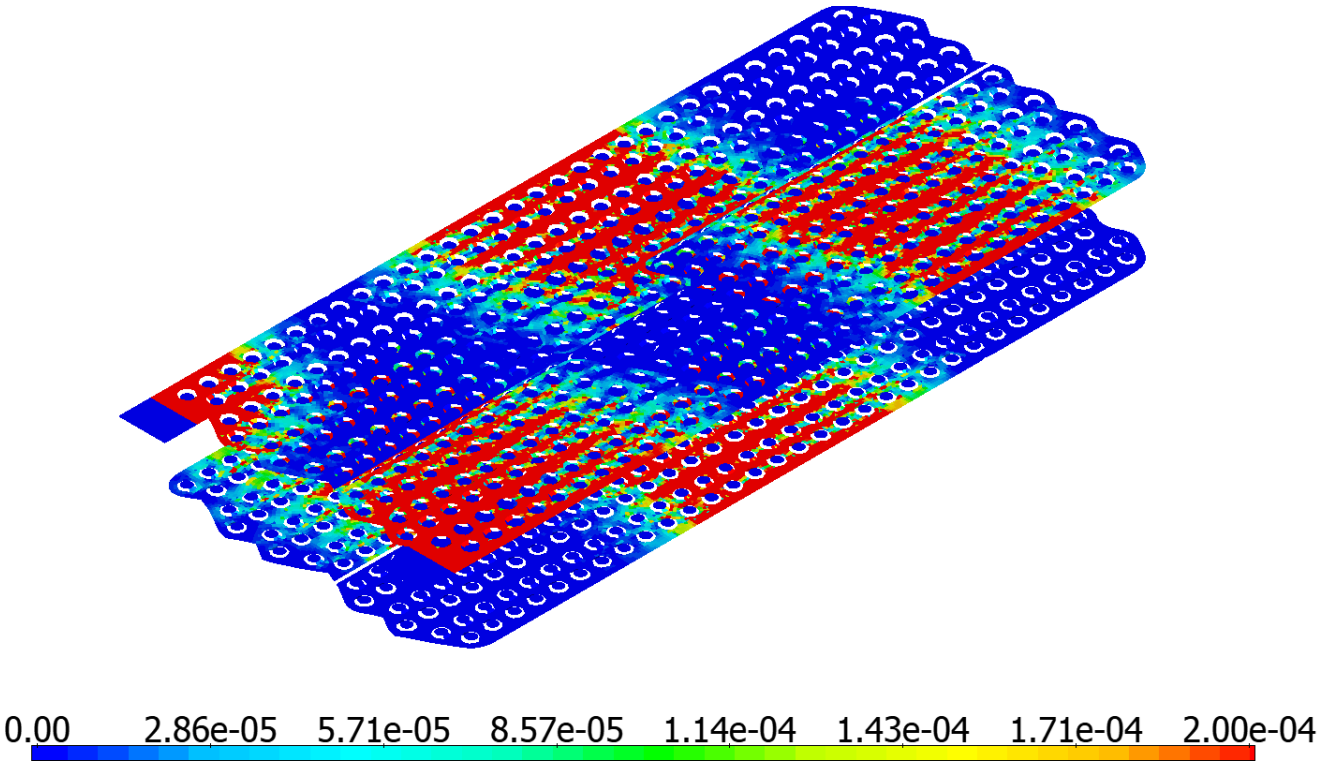


Maximum Cell Temperature



Temperature Results °C

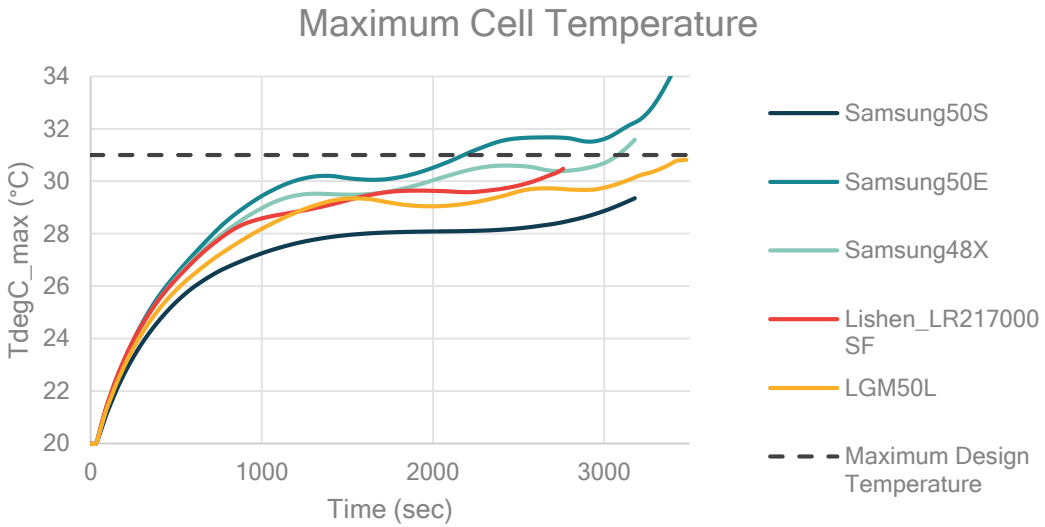
Joule Heating



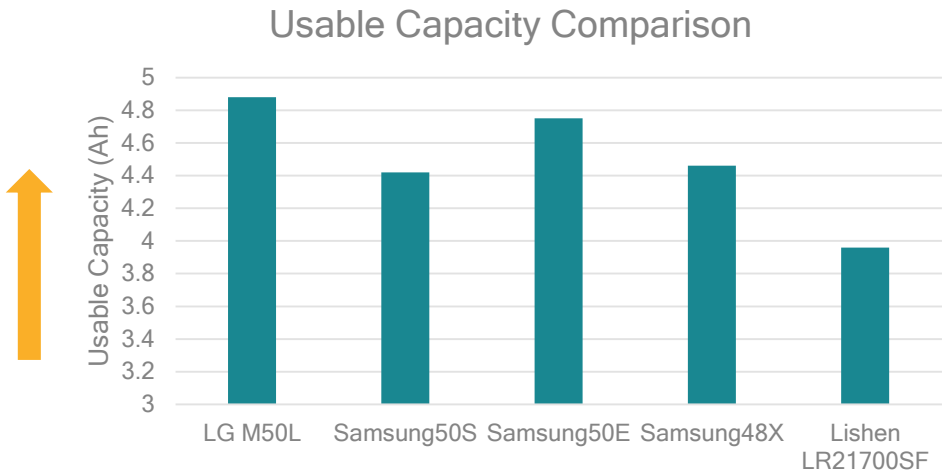
Imposed heat due to joule heating is mostly constant during the simulation. This is due to the constant imposed current in the model.

Imposed Heat Results W

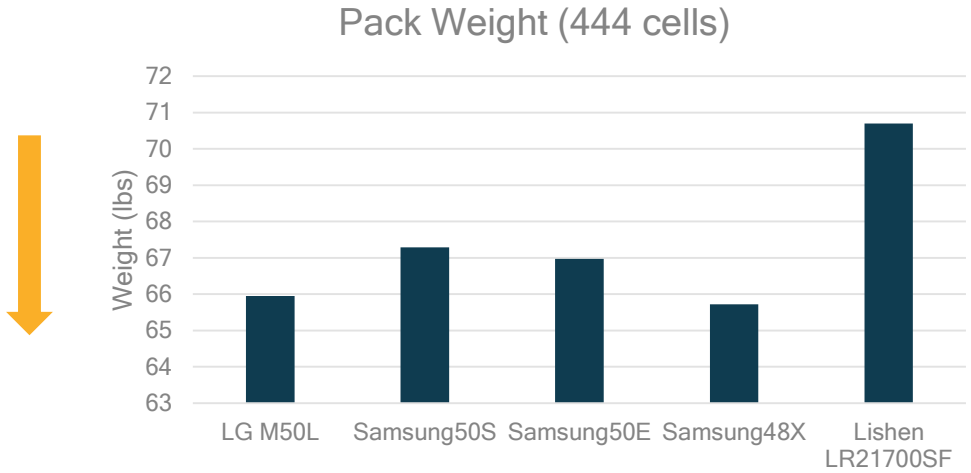
Cell Selection



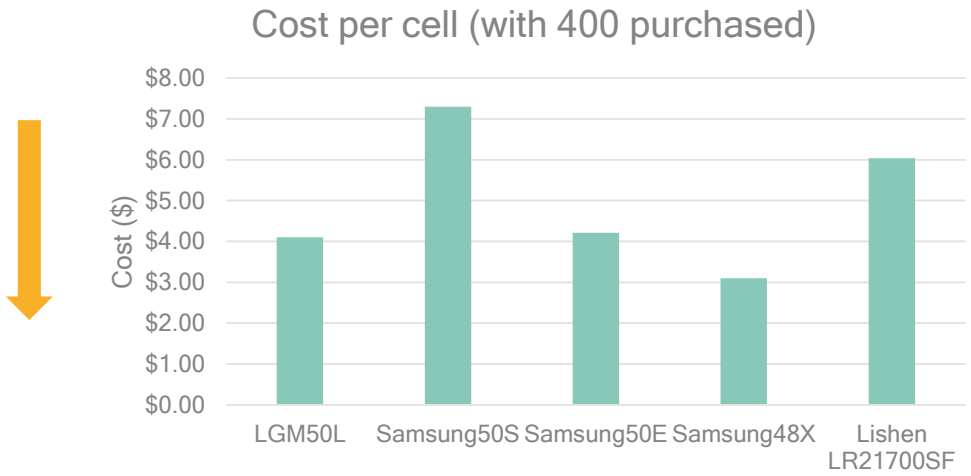
Best Temperature: Samsung 50S



Best Capacity: LGM50L



Best Weight: Samsung 48X

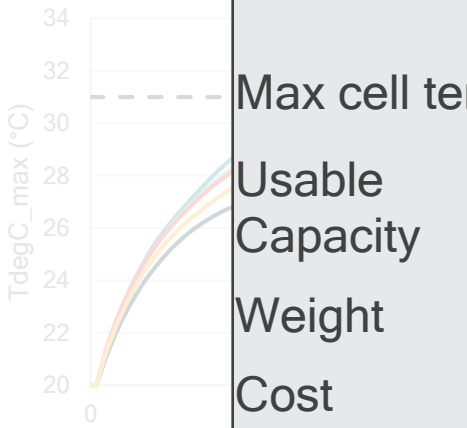


Best $: Samsung 48X

Cell Selection

Best Capacity: LGM50L

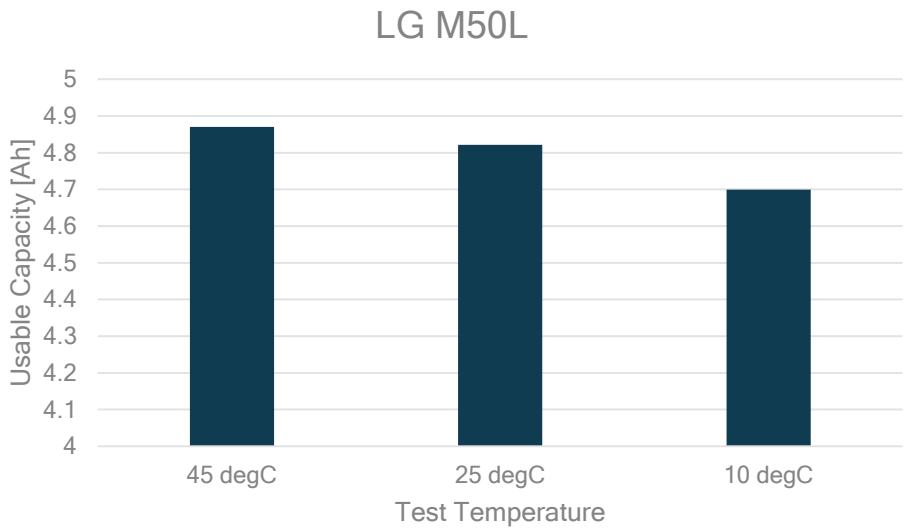
	Weight	LGM50L	Samsung 50S	Samsung 50E	Samsung 48X	Lishen LR21700SF
Max cell temp	7	5	9	1	3	6
Usable Capacity	9	9	5	8	5	3
Weight	4	8	5	6	9	1
Cost	4	7	2	7	9	3
		176	**136**	**131**	**138**	**85**



st Weight: msung 48X

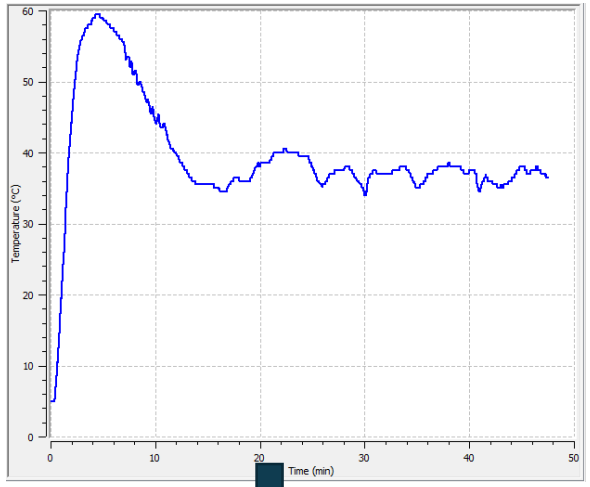
Best $: Samsung 48X

Battery Performance – Varying Temperature and Current

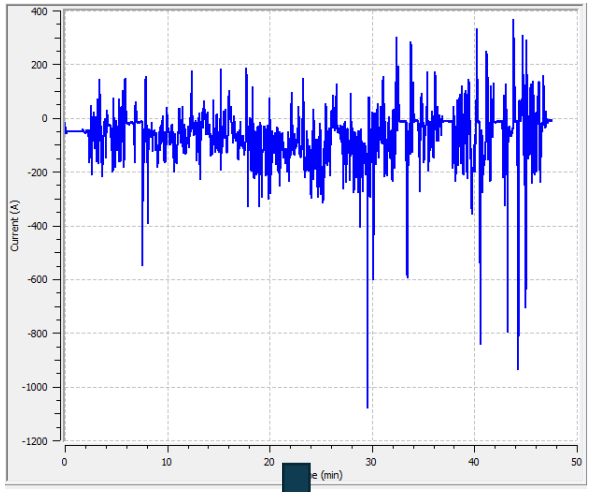


Model Drive Cycles

Heat Exchanger Temperature (°C)

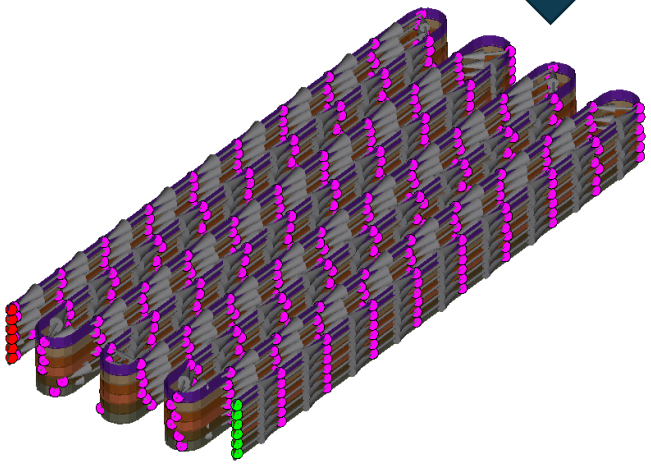


Current (A)

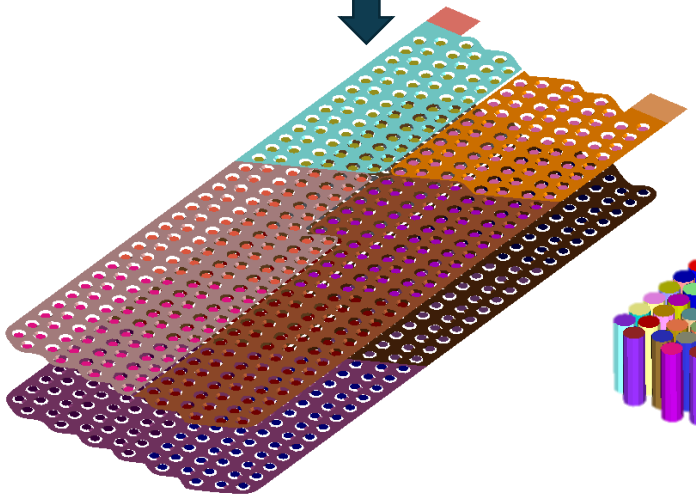


Initial Depth of Discharge

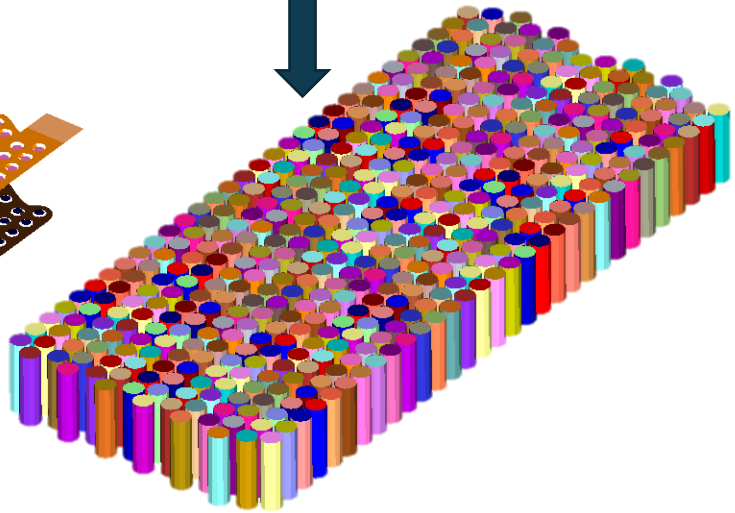
0.29



Cooling rig with fluid streams

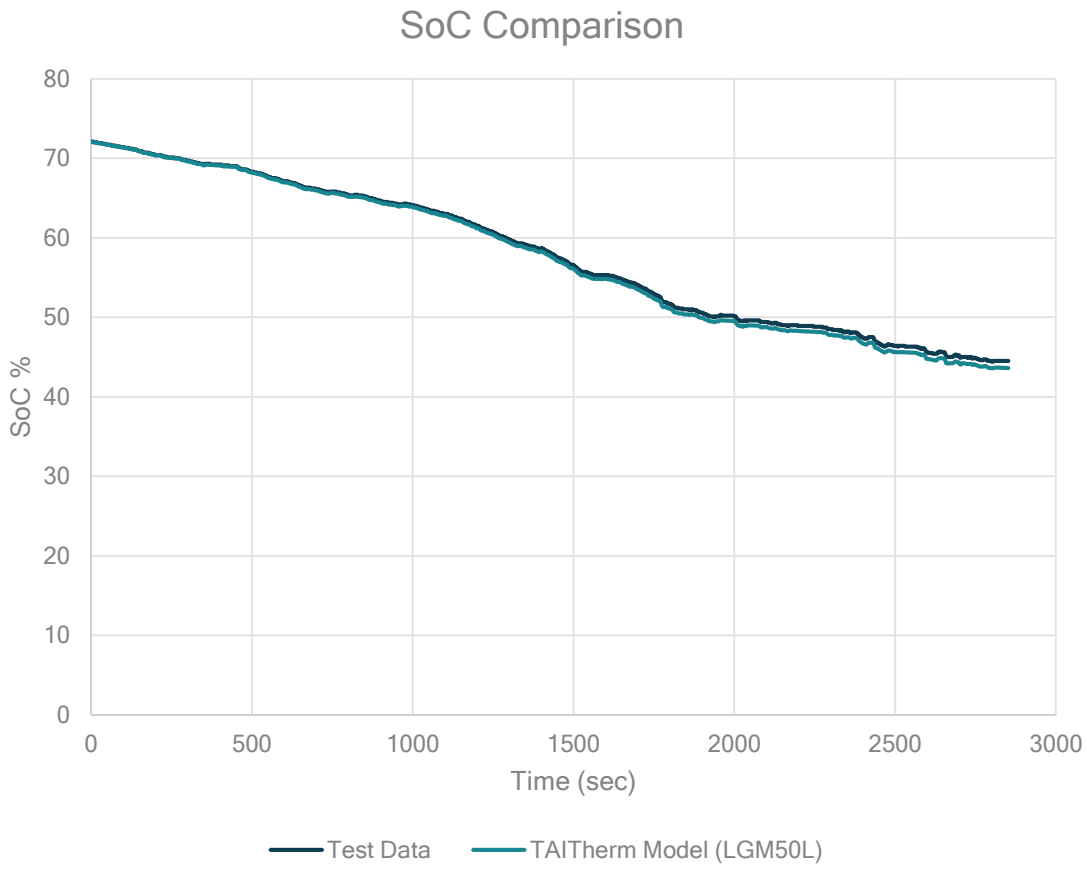


Joule Heating with bus bar geometry

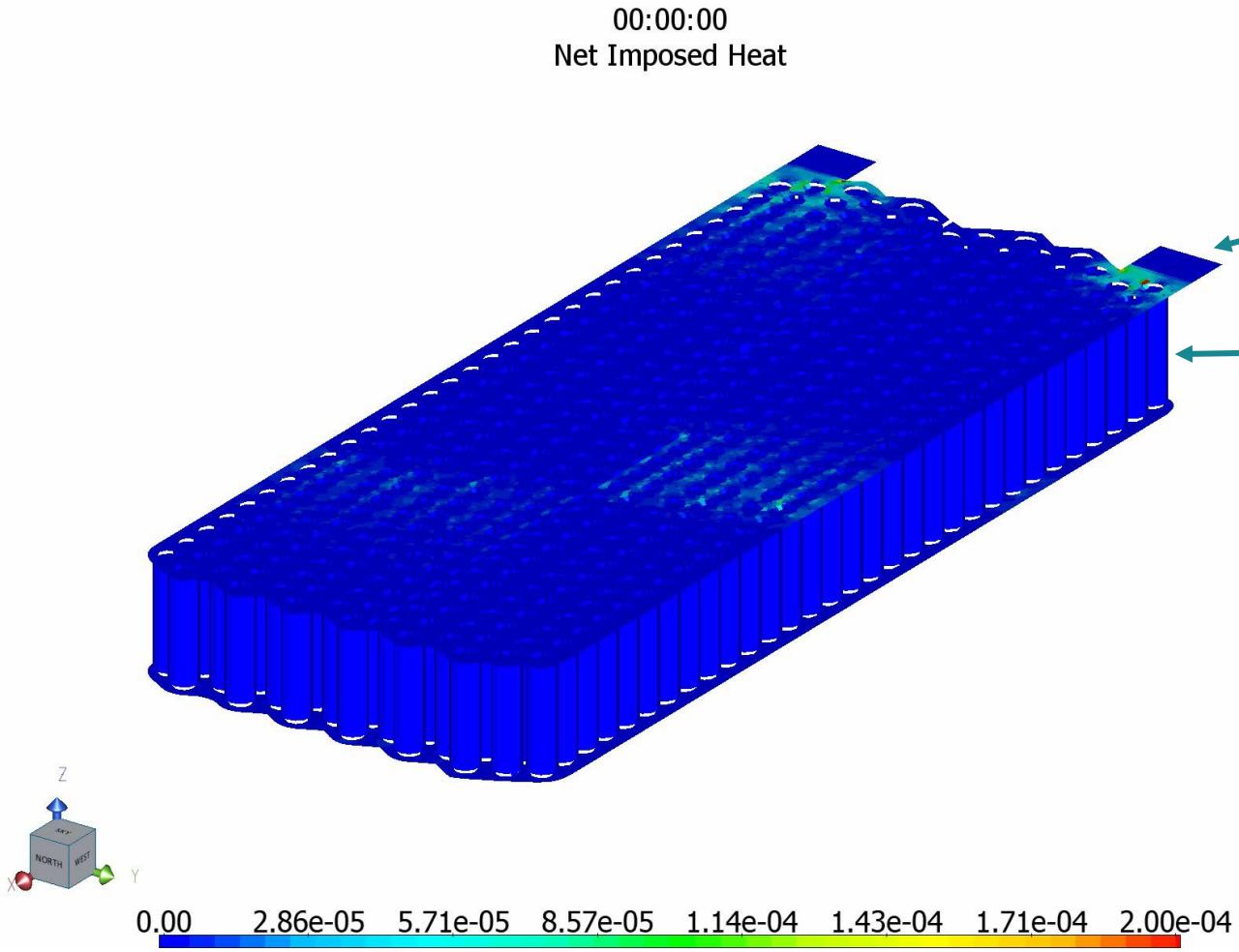


Battery Heating with cell geometry

State of Charge Comparison



LGM50L Drive Cycle Results

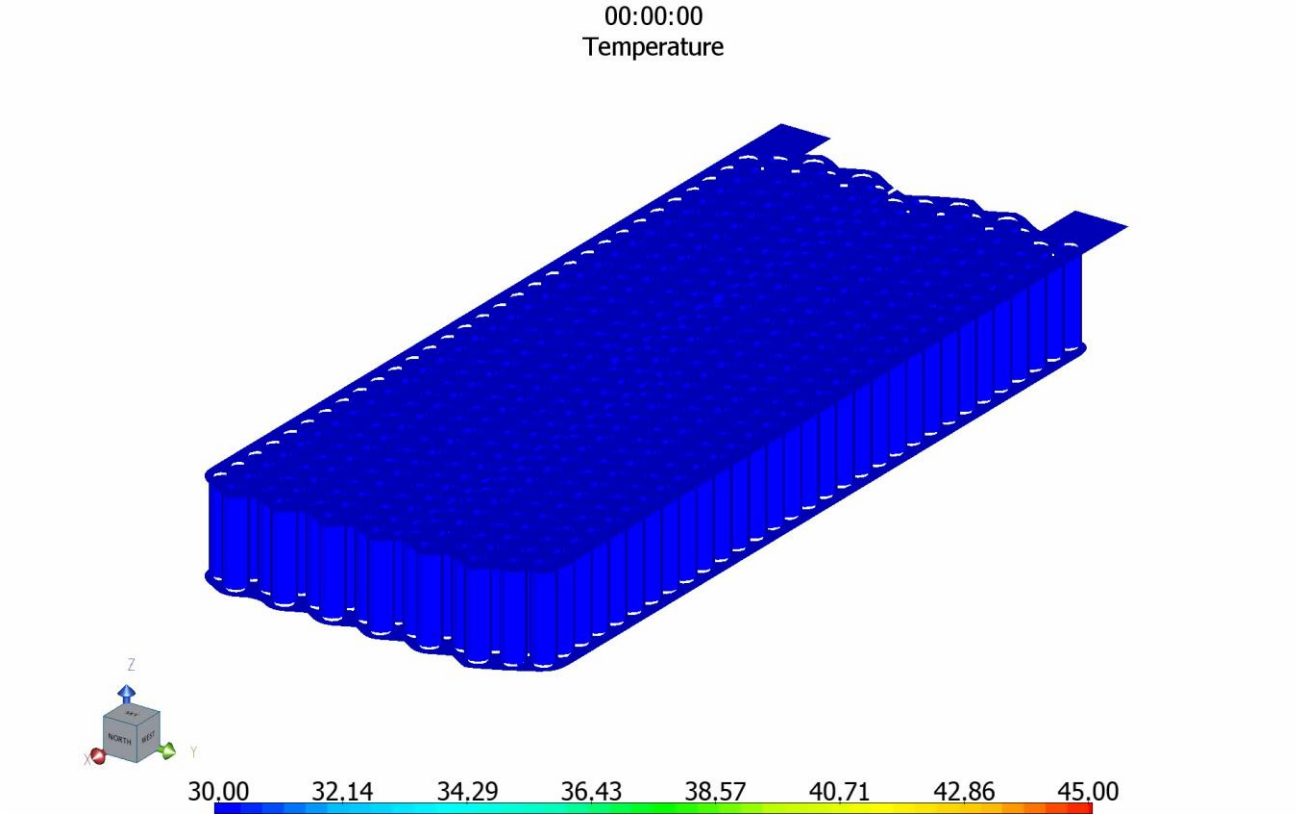


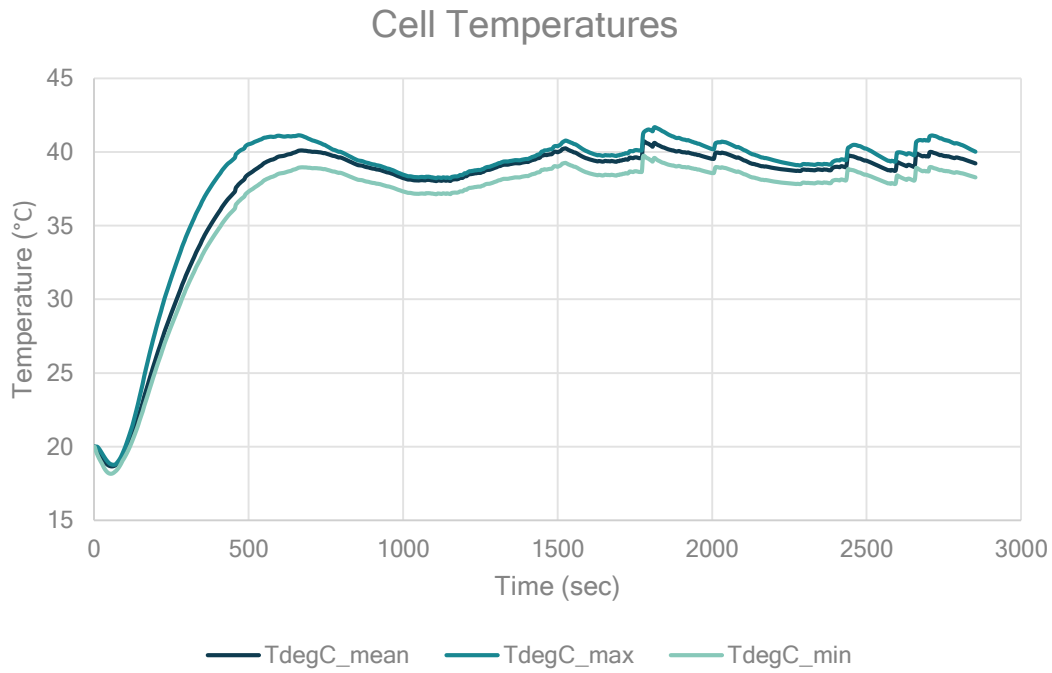
Imposed heat from joule heating on the bus geometry

Imposed heat from battery heating on the cell geometry

Imposed Heat Results W

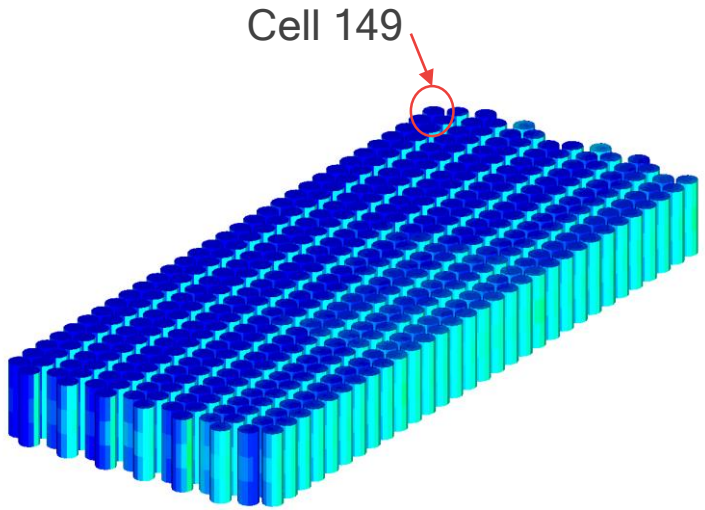
LGM50L Drive Cycle Results

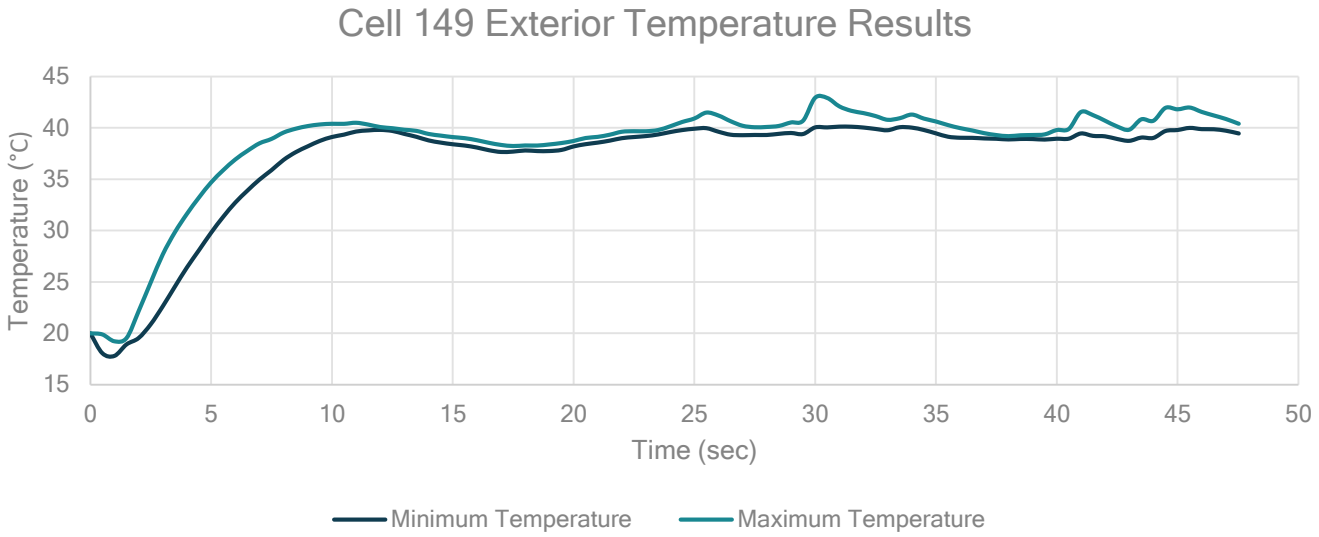


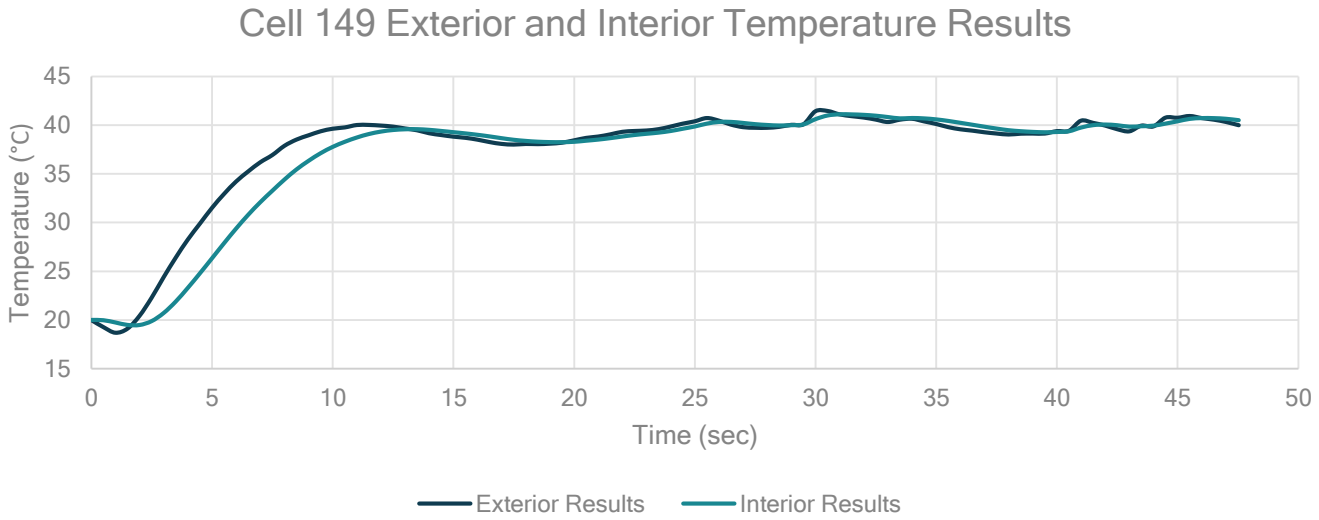


Temperature Results °C

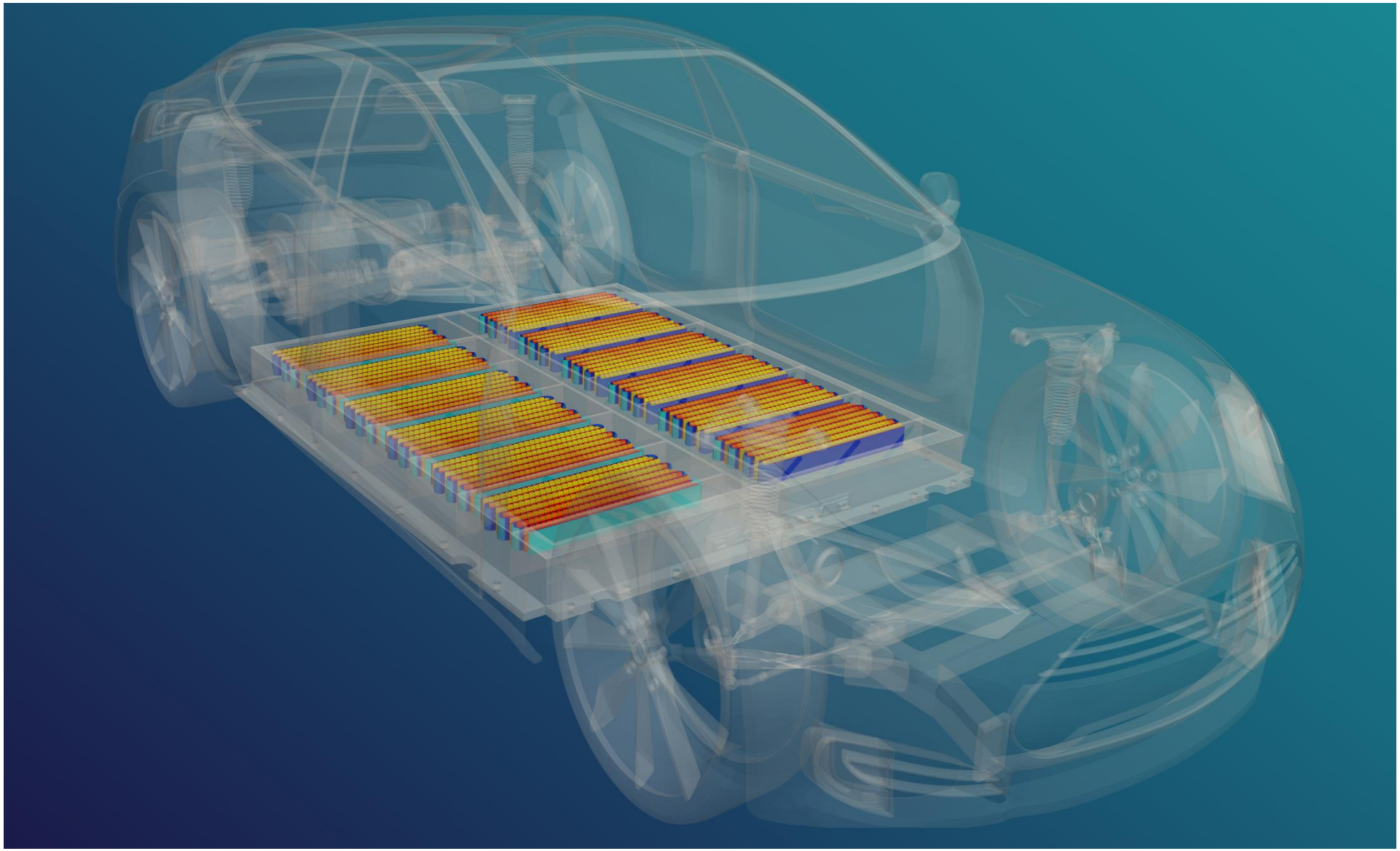
LGM50L Drive Cycle Results







Next Steps



Conclusions

- About:Energy's VOLTT database can be used with TAITherm to aide in the selection of battery cells from over 400 commercially available alternatives
- Models include thermal properties and are available in ECM, split-ECM, SPM, and DFN format
- A 3D thermal/electric battery pack model aids in the selection of cells, and is improved by considering 1D fluid streams in ribbon coolers, Joule heating in bus bars, and cell balancing in the electrical equations
- The LG M50L was chosen as the cell of choice for this application, due to the highest usable capacity, moderate weight, and reasonable price
- Come to our booth at upcoming conferences, such as SAE TMSS 2023, where we will be presenting this work in more detail!

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