

High Tech High Performance Battery Introduce Industry Solution



DATE: March 2021



INTRODUCE INDUSTRY SOLUTION

- What are we talking about? The Experience Description
- What unique value does the Industry Solution Experience deliver and what are the solution Game Changers?
- How to explain the potential gain and key measurements? Proof Points & Metrics
- Appendix: Industry Solution Glossary

Chapter 1

Table of content

- ① WHAT ARE WE TALKING ABOUT? : SOLUTION DESCRIPTION
- ② WHAT UNIQUE VALUE DOES IT DELIVER? : SOLUTION VALUE
- ③ WHAT ARE THE SOLUTION GAME CHANGERS?
- ④ HOW TO EXPLAIN THE POTENTIAL GAIN AND KEY MEASUREMENTS? : PROOF POINTS & METRICS



2

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What are we talking about? The Solution Experience Description

Q. What is the description of the industry solution?

What are we talking about? - Solution Description

High Performance Battery is a Design & Engineering solution enabling HT companies to leverage battery material designs for cell and pack engineering and better device performance. This solution will also allow HT companies and battery makers to expand their knowledge and meet other industries' needs.

- ▷ High Performance Battery covers the whole process from chemicals to system
- ▷ High Performance Battery allows multi-physics simulation at different levels

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4

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Q: What is the description of each of the industry process experiences?

High Performance Battery | 2021x on Cloud

Optimize engineering from molecule to system in designing safer, long-lasting and fast-charging batteries

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5



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High Performance Battery | 2021x on Premise

Optimize engineering from molecule to system in designing safer, long-lasting and fast-charging batteries

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7



This industry solution, High Performance Battery is a Design & Engineering solution enabling HT companies to leverage battery material designs for cell and pack engineering and better device performance.

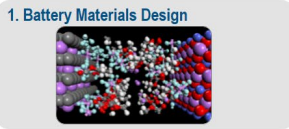
This solution will also allow HT companies and battery makers to expand their knowledge and meet other industries' needs.

- High Performance Battery covers the whole process from chemicals to system
- High Performance Battery allows multi-physics simulation at different levels

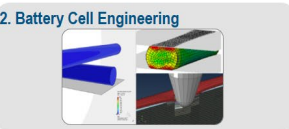
It is composed of five industrial processes:

High Performance Battery | Industry Processes

- Available On Premise (5 Industry Process Experiences) and on Cloud (4 IPEs only)



- Optimization of formula and material development and costs with Material Studio
- Prediction of cell formulation behavior with a specific battery library
- Constant evaluation of material compliance and real-time guidance into global, regional and local regulatory requirements



- Cell geometry design
- Optimization of cell thermal management, electrical losses and safety
- Simulation driven design

1. Battery Materials Design, for Material development, modelling and optimization of electrolyte formulation, which is not available on the cloud as of now,
2. Battery Cell Engineering, used to Characterize and optimize battery cell performance over a wide range of operating conditions while satisfying cost, durability, and safety requirements

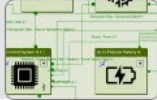
High Performance Battery | Industry Processes

3. Battery Module & Pack engineering



- Pack mechanical and electrical design
- Optimization of cell thermal management, electrical losses and safety
- Simulation driven design

4. Battery System Behavior



- Prediction of battery behavior on both cell and pack level.
- Evaluation of thermal, electrical and aging of cell with experimental data

5. Battery System Management & Integration



- Optimization of Battery Management System (thermal ...)
- Integration of battery in system device

3. Battery Module & Pack Engineering, used to Characterize and optimize battery module/pack performance over a wide range of operating conditions while satisfying cost, durability, and safety requirements
4. Battery System Behavior, for Prediction of battery behavior on both cell and pack level. Evaluation of thermal, electrical and aging of cell with experimental data
5. Battery System Management & Integration, for Battery performance analysis in overall system context: Optimization of Battery Management System


High Performance Battery | R2021x on Cloud Roles Packaging



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1. Battery Materials Design		
2. Battery Cell Engineering	Mechanical Designer (MDG-OC)	Simulation Process Engineer (SPF-OC)
	Multidisciplinary Optimization Engineer (MDO-OC)	Structural Analysis Engineer (SYE-OC)
	Multidiscipline Performance Engineer (MCK-OC)	Thermal Engineer (TME-OC)
3. Battery Module & Pack Engineering	Mechanical Designer (MDG-OC)	Simulation Process Engineer (SPF-OC)
	Multidisciplinary Optimization Engineer (MDO-OC)	Structural Analysis Engineer (SYE-OC)
	Multidiscipline Performance Engineer (MCK-OC)	Thermal Engineer (TME-OC)
4. Battery System Behavior	Battery System Engineer for High-Tech (BASPH-OC)	
5. Battery System Management & Integration	Battery System Engineer for High-Tech (BASPH-OC)	Requirements Engineer (TRM-OC)
	Multidisciplinary Optimization Engineer (MDO-OC)	Systems Traceability Engineer (TRG-OC)
	Multidiscipline Performance Engineer (MCK-OC)	Structural Analysis Engineer (SYE-OC)
		Thermal Engineer (TME-OC)

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High Performance Battery | R2021x on Cloud Roles Packaging



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1. Battery Materials Design		
Mechanical Analyst (SMU) BIOVIA Pipeline Pilot Polymer Properties User Collection Full Time (IPY) BIOVIA Notebook Base + 20 Notebook Users (NBN) BIOVIA Pipeline Pilot Lab Analytics Collection Full Time (ILA) BIOVIA Materials Studio Flexible Library + 10 Tokens (LLK)) BIOVIA Pipeline Pilot Imaging Collection Full Time (IIM) BIOVIA Pipeline Pilot Chemistry Collection Full Time (ICH) BIOVIA Pipeline Pilot Professional User Full Time (IPU) BIOVIA Pipeline Pilot Analytics and Machine Learning Collection for Application (ID4)		
2. Battery Cell Engineering	Mechanical Designer (MDG-OC)	Simulation Process Engineer (SPF-OC)
	Multidisciplinary Optimization Engineer (MDO-OC)	Structural Analysis Engineer (SYE-OC)
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		Thermal Engineer (TME-OC)

9



Q: What additional services or content are part of this industry solution?

Optional, if there are specific services or content included in this solution....

Chapter 2

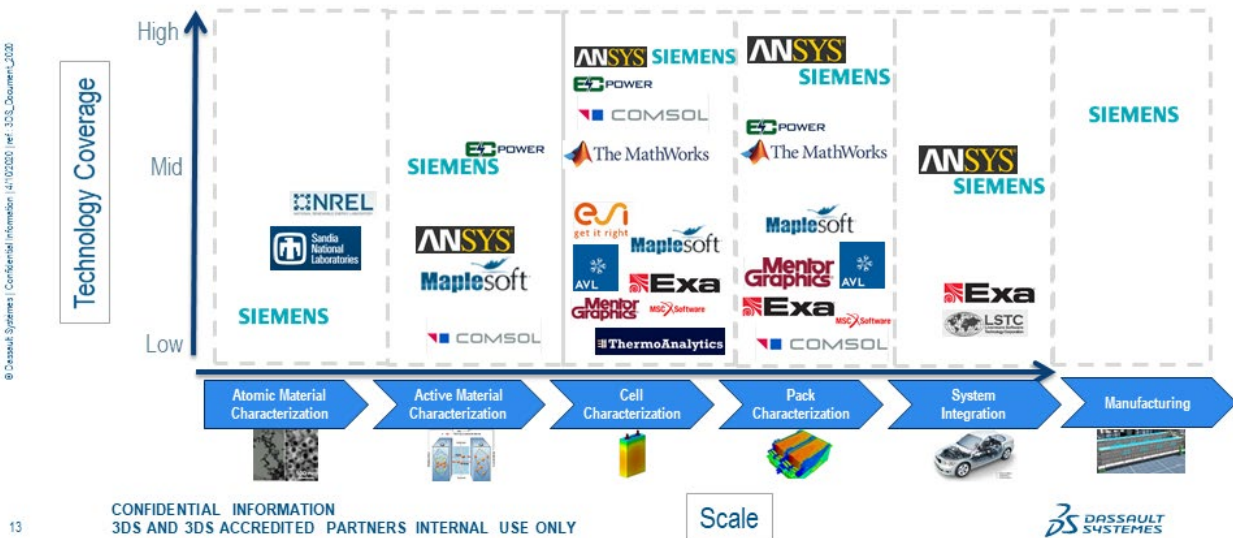
What unique value does the industry solution experience deliver?

Q. What is the value positioning statement?

High Performance Battery | Solution Value

- ▶ **Optimize your value chain** for flexibility and efficiency in **creating safe and competitive batteries**
- ▶ **Accelerate** the development of your battery formulation through **early validation of materials behavior**
- ▶ Leverage Multiphysics simulation to **ensure cell performance and safety** in abusive thermo-electrical and mechanical conditions
- ▶ Accelerate **cell and pack integration** by re-using know how for evaluating battery behavior
- ▶ Optimize battery integration by **testing battery management system and battery performance** in the whole system

High Performance Battery | Technology Assessment



13

Unique 3DS Coverage, but facing strong competition

Value Stream / ISE	IPE	Domain	Industry level Solution Providers		Battery Specialists & Incumbents		
			Dassault Systèmes	Siemens	Comsol	Ansys	Mathworks
High Performance Battery / Efficient Multi Energy Platform	Battery Materials Design	Materials Modeling	Material Studio				
	Battery Cell Engineering	Materials Data		?		GRANTA	?
		Electrochemical Engineering	3D WIP	BDS / Star CCM+	Comsol Multiphysics		1D
	Battery Module & Pack Engineering	Structural Design /simulation	Abaqus			Fluent	
		Pack Analysis	Abaqus / Exa			Fluent	
	Battery System Behavior	Cells Dynamics	Aging WIP		Comsol Multiphysics	Simpler	Legacy Equations
TBD	System	CATIA Portfolio		AMESIM	?	SCADE	1D
	Unique Battery Design Environment		Battery Design Studio	CM: Battery Module			
	Tests & Measurements	WIP (VRE)	Simcenter Testing + HW	?	GRANTA only		
Highly Flexible Manufacturing	Multiple IPEs	Operation Optimization					
	Multiple IPEs	Collaborative Operations					
	Multiple IPEs	Operation Engineering					
	Production Execution	Manufacturing Management					
	Production Quality Management	Cells finishing (Test Management)					

Legend: Best in Class (Dark Blue), Competitive (Medium Blue), Challenger (Light Blue), Poor to No Solution (Grey)

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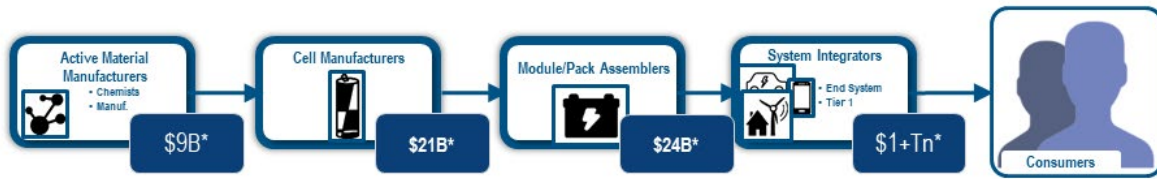
14

Collaborate with marketing and utilize the value model simple business story method to create this statement...

Q. What is the 3DEXPERIENCE platform contribution to the value?

High Performance Battery | Customer types

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10

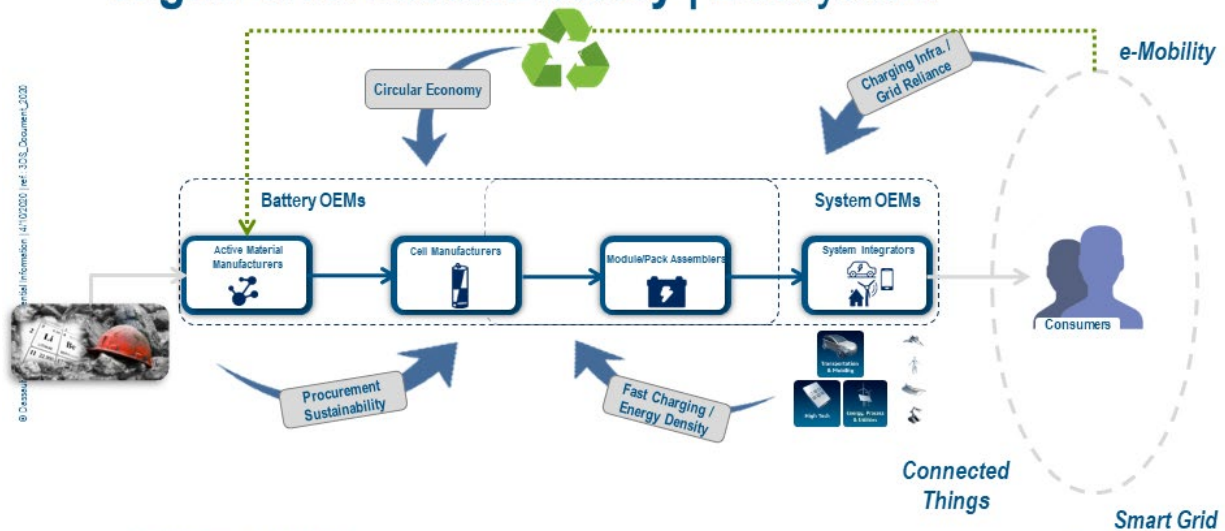
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High Performance Battery | Ecosystem

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The 3DEXPERIENCE platform specifically contributes additional value to this solution in the following manner...

What are the industry solution experience game changers?

Q. What are the industry solution experience game changers?

High Performance Battery | Differentiators

- Drive design optimization through multi-physics simulation, key metrics & parameters tradeoff
- Develop safer formulations and anticipate misuse, develop cell formulation with compliance requirements reducing disasters occurrences
- Enhance battery innovation process by simplifying collaboration between engineers, scientists, analysts
- Manage concept designs including all revisions in a centralized location, A unique platform to accompany the team from materials research to design, engineering and lab management ensuring that correct version is released to manufacturing

The customer game changers that this solution addresses are

Chapter 3

How to explain the potential gain and key measurements? Proof Points & Metrics

Q. What are the customer key performance indicators (KPI metrics) that are likely to be used in a business case to justify the solution investment?

How to explain Potential Gains | Battery KPIs

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BATTERIES KEY METRICS FOR DESIGN							
Cost	Energy Capacity	Safety	Lifespan	Power	Weight & Size	Thermal Behavior	State of Charge
<ul style="list-style-type: none"> ▶ Cost, Cost/kWh ▶ Cell (housing, materials Cost-of-Goods, manu), BMS*, Pack manu, Power Electronics, R&D... 	<ul style="list-style-type: none"> ▶ Current x Time (Ah) ▶ Depends on area of plate surface, qty and porosity of active materials, electrolyte... 	<ul style="list-style-type: none"> ▶ Shock / crash / Vibration ▶ External short ▶ Impact ▶ Overcharge, forced discharge 	<ul style="list-style-type: none"> ▶ # of cycles ▶ Life regardless of cycling regime ▶ Cycles to failure ▶ Durability 	<ul style="list-style-type: none"> ▶ Capacity offset (reduction of effective capacity if discharged at high rate) ▶ Round trip efficiency (energy % lost in a cycle) 	<ul style="list-style-type: none"> ▶ Power per unit volume/ weight ▶ Sealing ▶ Battery stack-up assembly 	<ul style="list-style-type: none"> ▶ Heat generation during operation ▶ Linked to simulation and managed by BMS* during operation ▶ Linked to safety 	<ul style="list-style-type: none"> ▶ % of available capacity ▶ Depends on battery age ▶ Control of SOC is major function of BMS*.
COMMON TRADEOFFS FOR BATTERY DESIGN				TYPICAL BATTERY TRADEOFF SPIDER (with example for a Li-NMC battery)			
<ul style="list-style-type: none"> ▶ Energy capacity vs Power capability ▶ CAPEX vs OPEX (initial price vs. maintenance) ▶ Cost vs. Performance ▶ Core Energy Storage Device vs. System/Pack 							

* BMS : Battery Management Systems

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The customer key performance indicators that this solution addresses are

Q. How are these key performance indicators (metrics) measured? (i.e. using what methods or mechanisms)?

The key performance indicators are typically measured by ...

APPENDIX-GLOSSARY

Industry solution glossary – Unique vocabulary and acronyms commonly used in the industry targeted segment, the industry solution or the business processes and operations it addresses.

- **Provide here any industry specific terms that should be understood and can help the sales be more credible with their customers**