

## EFFICIENCY ASSESSMENT REPORT

### THE LMP® TECHNOLOGY (LITHIUM METAL POLYMER)

Lithium Metal Polymer technology (LMP®)- Unique full solid-state lithium batteries High energy density, safety, robustness, no cooling system needed

**Solution ID:** 10881  
**Company:** Blue Solutions

**Country:** France  
**Export Date:** 27.05.2020

### ASSESSMENT RESULTS



**APPROVED**

#### FEASIBILITY

|                          |     |
|--------------------------|-----|
| - Credibility of concept | YES |
| - Scalability            | YES |

#### ENVIRONMENT

|                          |     |
|--------------------------|-----|
| - Environmental benefits | YES |
|--------------------------|-----|

#### PROFITABILITY

|                               |     |
|-------------------------------|-----|
| - Client's economic incentive | YES |
| - Seller's profitability      | YES |

### GENERAL COMMENTS FROM THE SOLAR IMPULSE FOUNDATION

The Solution is awarded the Solar Impulse Efficient Solution as:

- **It is fully satisfying the Eligibility Criteria** in terms of: (1) Nature of the Solution namely, physical/financial product, technology, industrial process, or service; (2) Ownership by a Member of the World Alliance for Efficient Solutions; (3) Contribution to at least one of the Sustainable Development Goals (SDGs), namely SDG 6, SDG 7, SDG 9, SDG 11, SDG 12; (4) Minimum maturity level, namely "prototype testing 1:1 in lab" (TRL 6 -7);
- **It is operating in accordance with the Solar Impulse Foundation's ethical position** as expressed by the Membership Agreement;
- **It is compliant with the conditions expressed in the "Liability Waiver Declaration"** signed by the Member in the framework of the labeling process and external reputational check;
- **It has been reviewed and pre-validated** by the Solar Impulse Foundation's team during the pre-screening stage, to ensure minimum standard of quality, in terms of relevance and completeness of the information provided in the application form;
- **It has been assigned and evaluated** according to the official "Label Standards" by three independent Experts with at least five years of Experience in one of the sectors of application of the Solution;
- **It has been assessed and formally validated (accepted)** by three External independent Experts based on the five criteria (credibility of concept, scalability, environmental benefits, client's economic incentive, seller's profitability). In particular, the three independent Experts performed valid assessments, thus provided complete and coherent answers in accordance to the official "Label Standards" and "Assessment Guidelines".
- **It received a minimum of two "YES" answers** from two different Experts on all five criteria, meaning that all the five criteria were satisfied and obtained a majority of "YES". As a result, the Solution does meet the requirements for being awarded the Solar Impulse Efficient Solution Label.

It is important to notice that, the outcome is attributed to the Solution itself and NOT to the entity submitting the Solution (the company).

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## FEASIBILITY

The Feasibility section is aimed at determining the technical viability of the idea behind the Solution, such as ensuring a Solution is feasible in the real world. This section is composed of two criteria and it considers: the technical requirements of the proposed Solution and captures its ability to be credible based on a resilient technology or concept (**Criterion 1**) and its potential to be technically scaled up and deployed in the real world (vs. in a laboratory environment) without additional constraints (**Criterion 2**).

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## EXPERTS REVIEWS

### CRITERION 1 - CREDIBILITY OF CONCEPT

Can the technology behind the Solution be constructed and operated as designed?

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YES

**First Expert justification** - As a matter of fact, the LMP technology is already constructed and operated as designed for more than 20 years. The concept is fully credible as it has already been implemented in, e.g Blue Cars in Paris or buses. The main present drawback of the technology is its relatively elevated operating temperature (around 70°C), which prevents it from being competitive vs room-temperature operating Li-Ion technologies for automotive applications under tempered climates, but which may become an asset for specific harsh environments markets that are targeted now.

YES

**Second Expert justification** - Yes, obviously since the solution is already built and deployed in small numbers. The two large solutions seems to have reasonable good size for many applications, but will also require quite a sizeable community in order not to be too big. But a smaller version is also possible with the same building blocks.

YES

**Third Expert justification** - The solution is credible because firstly it lays on physical and chemical principle very well proved and scientifically demonstrated. Secondly it is a product and currently used for mobile applications (for instance buses) as well as stationary applications (electricity storage)

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### CRITERION 2 – SCALABILITY

Is the manufacturing (if a product) or distribution (if a service) of the Solution at scale technically feasible?

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YES

**First Expert justification** - Here again, the manufacturing and distribution of the product has already been proved for more than 15-20 years: battery cell manufacturing is achieved in France and Canada, whereas distribution and implementation is achieved in many countries through a set of partnerships.

YES

**Second Expert justification** - Yes, the 7kWh base module can be scaled up in many ways - the power used to keep the battery at operating temperature may pose an efficiency problem for the smallest solutions and will always be a problem if the solutions has to be used for non-cyclic tasks. But for a daily charge/discharge pattern of a reasonable depth of discharge, the energy loss will be relative low.

YES

**Third Expert justification** - The innovator already built a semi-automatic plant that permit to produce the solid-state battery massively (large scale). The key parts are the assembling of the solid electrodes and solid electrolyte. Once this composite sheet is produced, it is quite

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straightforward to make the packaging and add the appropriate BMS (Battery Management system) for the voltage check of each cell.

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## ENVIRONMENTAL IMPACT

The **Environmental Impact section** is aimed at determining the impact of the Solution at the different phases of its lifetime: production, transportation and distribution, as well as use and disposal phase.

This section is composed of one criterion and it considers: the potential to enable a direct positive impact (**Criterion 3**) on the environment compared to the mainstream alternative identified – referring to the scope of the following elements: Energy use, CO2 emissions, Water use/materials use, Air quality, Ecosystem preservation.

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## EXPERTS REVIEWS

### CRITERION 3 - ENVIRONMENTAL BENEFITS

**Can the Solution deliver an incremental environmental benefit versus a mainstream alternative, considering the lifecycle (production, use and disposal stages) of its value chain?**

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#### YES

**First Expert justification** - The mainstream alternative is the conventional Li-Ion technology, which, thanks to Gigafactories implementations, currently spreads throughout the world for automotive and stationary applications. But conventional Li-Ion batteries ageing is indeed enhanced at elevated temperatures. A key advantage of the LMP batteries solution proposed here is its good long-term good behaviour at high temperature, which may reveal decisive in countries with elevated average temperature. Under these specific climates, there is no need to spoil electrical energy to heat LMP batteries to maintain it at 60-70°C. Moreover, the LMP batteries use Iron Phosphate as cathode material, which may also constitute an asset vs NMC based Li-Ion solutions (however, LiFePO<sub>4</sub> may also be used in conventional Li-Ion batteries operating at room temperature)

#### YES

**Second Expert justification** - The solution will have a reasonable good environmental footprint compared to deployment of fossil fueled alternatives - if the recycling of the material can be kept high. Being dependent on their own processes for this, is a weak point - both in terms of the environment but also for the commercial viability.

#### YES

**Third Expert justification** - Certainly, the solution deliver several benefits in comparison to the "standard" lithium ion battery. The main benefits of the LMP Batteries are : i) They do not contain rare earth metals, Cobalt, Cadmium Nickel and Manganese. ii) They do not contain any toxic solvents. iii) They can be much more easily recycled thanks to the use of lithium in metal.

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## PROFITABILITY

**The Profitability section** is aimed at determining the capacity of a Solution to deliver an economic incentive for the client, as well as to generate profits for the seller in a short term. This section is composed of two criteria and it considers: The capacity of a Solution to deliver an economic incentive (direct, indirect, or hidden economic savings) for the client (**Criterion 4**) compared to the mainstream alternative and the capacity of the Solution to generate profits for the seller (**Criterion 5**) in the short term, regardless of the marketing strategy and the novelty of the product.

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## EXPERTS REVIEWS

### CRITERION 4 - CLIENT'S ECONOMIC INCENTIVE

**Is the total cost of ownership of the Solution lower (or same) compared to the mainstream alternative? Please evaluate this considering potential hidden benefits for society, and foreseeable regulatory changes within 5 years.**

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#### YES

**First Expert justification** - The mainstream Li-Ion alternative solution is currently sold at around 130 Wh/kg (at cell level). But conventional Li-Ion batteries hardly stand high-temperature climates, so that their lifetime is limited in these conditions. The cost at cell level of the LMP solution proposed here is a little bit higher, but seems quite acceptable considering the battery lifetime under harsh conditions.

#### YES

**Second Expert justification** - It is a "yes" with some "buts", since the deployment of a 10+ years solution of both batteries and solar/wind renewable technologies, require a huge capital up-front. So it may be hard for local communities to find the funds to make this work from an economical point of view. It may be too dependent on incentives.

#### YES

**Third Expert justification** - Today, the TCO of the LMP Batteries is higher than the "standard" type lithium-ion battery. The main reason comes from the energy densities between the solid-state batteries and the "standard" one. In fact, the solid state battery presented by the innovator has an energy density range between 170 - 200 Wh/kg in comparison the "standard LiIon" has an energy density that range between 300 - 500 Wh/kg (at maximum more than two times the LMP). However, as pointed out on the environmental benefits, the solid-state battery is much more easily recyclable which could become a heavy argument in the next five years. For sure, the regulations concerning the recyclability of the "standard Lion" will become more stringent and the cost of recyclability will increase consequently an increase of the TCO too. Automatically the TCO of the LMP Batteries could become lower than the "standard Lion" and bring deceive advantages for the technology presented by the innovator.

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### CRITERION 5 - SELLER'S PROFITABILITY

**Could the Solution itself be profitable for the seller within 5 years, with a sale's price at which clients would buy it? Please evaluate this regardless of the marketing strategy and the novelty of the product.**

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#### YES

**First Expert justification** - The lifetime issue of Lithium-Ion batteries (conventional or LMP) is critical. Let's assume I'm a potential client, willing to buy a battery aimed at storing PV energy in a remote place located in an country knowing a harsh climate (elevated average temperature) all along the year. I would ask myself: which of these 2 solutions (conventional Li-Ion or LMP) offers to me more than 10 years lifetime without or with little maintenance ? As a matter of fact, LMP batteries may really reveal profitable, unless future major improvements in conventional Li-Ion batteries help increase their lifetime in harsh conditions. Progress is a dynamic process, and no one can tell what tomorrow will be. But the LMP technology has its chances.

**YES**

**Second Expert justification** - As stated above, the solution may be too dependent on incentives to be really profitable in smaller communities. But the cost (per kWh) is not unheard of and grid supporting operation may also be a market for the solution - in that case the modularity may be to small.

**YES**

**Third Expert justification** - The LMP Batteries in comparison to the "main stream alternatives solutions", have the following advantages: recyclability (more than 90% of the Lithium can recycled), no rare metals, no cobalt, no manganese, higher life cycles, demanding environment compatibility (more than 60°C), no cooling system needed. Even if the energy density will remain lower than "the standard Lion Batteries", the advantages of the LMP batteries will become very serious in the next five years especially for stationary applications in which higher cycles and longevity are much more crucial points than mobile applications. Additionally, the company invented (patent pending) a new way to recycle the Lithium that will allow to reduce the CAPEX and OPEX of their technology in the future. Consequently, the innovator will make profit with his proprietary technology in less than three years.

The information set out above, is solely for the purposes of information and the Solar Impulse Foundation does not provide any guarantee as to its authenticity, completeness or accuracy. This information is the direct outcome of the assessment performed by external non-remunerated experts that volunteered to review your solution submission form following the application of the Efficiency Assessment Process of the Solar Impulse Efficient Solution Label Standards. This information is shared to you as it might be of value for you to get the feedback provided on your application – regardless of the outcome of the general selection process.

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