WaveTech

Innovative BARS® Technologies: Second Life for Stationary AGM VRLA Batteries With Premature Capacity Loss

21-st Asian Battery Conference and Exhibition, 2-5 September 2025 | Kota Kinabalu, Borneo

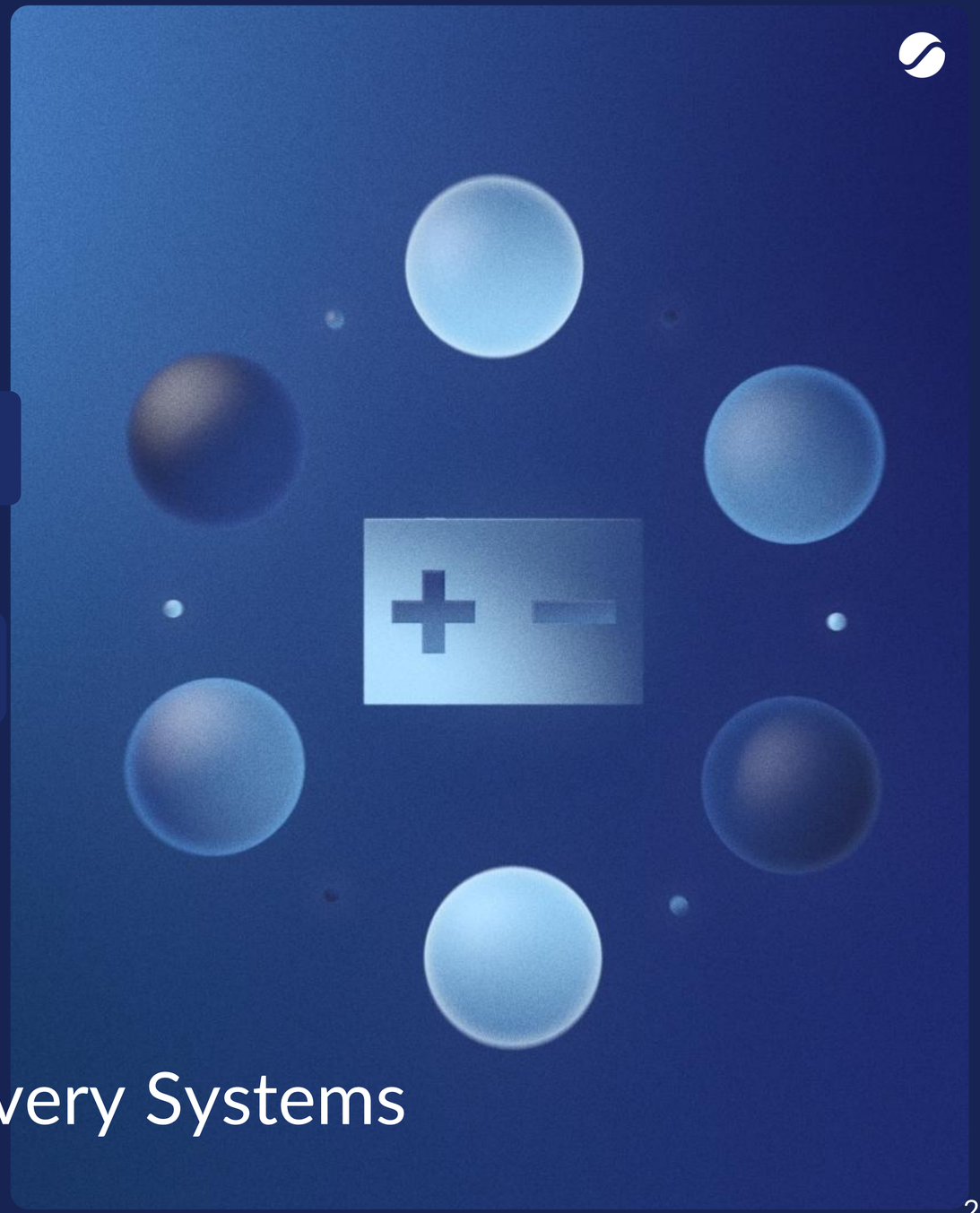
We develop battery technologies with the goal to realize the full potential of every battery

We are creating solutions that extend life and reduce costs. They can be integrated across various stages of the battery lifecycle - from factory through end-of-life

Today we are presenting to your kind attention the BARS – our solution **against aging for extending battery life** by environmentally friendly treatment.

BARS was developed by the **R&D center of WaveTech GmbH in Sofia, Bulgaria.**

BARS = Battery Assessment and Recovery Systems



To Enhance Battery Performance for Energy Storage

1. **Applications**: **stationary** UPS, data centers, Telecom, renewables, BESS, energy distribution,
   motive power (forklifts, golf carts),
   transportation (electric bikes, scooters, rickshaws, SLI, auxiliary, others.
2. **Types of batteries which can be rejuvenated**:
   a) AGM VRLA (Valve-regulated Lead-acid),
   b) Gel VRLA – development going on,
   c) LFP lithium-ion – successful testing going on,
   d) Vented Lead-acid (flooded) – in the close future,
   e) Zinc and Sodium based – possibly in the future.
3. **Process control**: fully automated, programmable,
4. **Cloud BMS and data processing**: data acquisition and uploading, data processed by our own algorithms, data science and AI used for optimization.

Why do batteries lose capacity in time, how can BARS help

a) **Aging is: a set of** natural reversible and irreversible changes inside the cells (material structure, chemical composition); as well as loss of water or electrolyte; corrosion, development of thermal issues, passivation, electrolyte stratification, etc.

b) **Aging is usually slow** at proper charge and discharge, and at normal conditions – cells are designed by manufacturers to reach and exceed their **design life which is usually long**!

c) **In real life, however,** issues with charge/discharge, operating temperature, and similar, happen. The power performance of the battery declines before the end of design life. Two types of aging occur:

- **Irreversible:** corrosion, water loss, cracks, TRA,
- **Reversible:** sulfation, porosity and surface area loss, electrolyte stratification, IR,

REM: BARS technology can recover damage caused by reversible aging.

BARS Components and Features:

1. **BCAT test systems** (hardware & software) for battery condition assessment,
2. Digitally controlled **charge and discharge** units,
3. Electronic BEAT ® devices to apply **CCT® technology** to the batteries,
4. Safe **container** for the batteries in process,
5. **Programming pad** for entering of recovery parameters,
6. **Library** with stored sets of recovery / test procedures; and a data base,
7. **BMS** for data monitoring and uploading.

The Main work parameters of a **BARS are:**

1. **Work cycle duration:** up to 24 hours (16.5 h typical),
2. **Battery size (12 V):** between 5 Ah and 200 Ah,
3. **Number of batteries** processed per cycle: 2, 4, 16 (now 40 in preparation),
4. **Success of recovery:** **up to 85% observed so far,**
5. **Electric power used:** 3.4 kWh for a set of 16 batteries, 213 Wh per battery,
6. **Power supply**: grid, PV system, genset,
7. **Recovery efficiency:** up to 100% of the nominal value,
8. **Life after rejuvenation:** up to the **design life** value, or more.

BARS work mechanisms

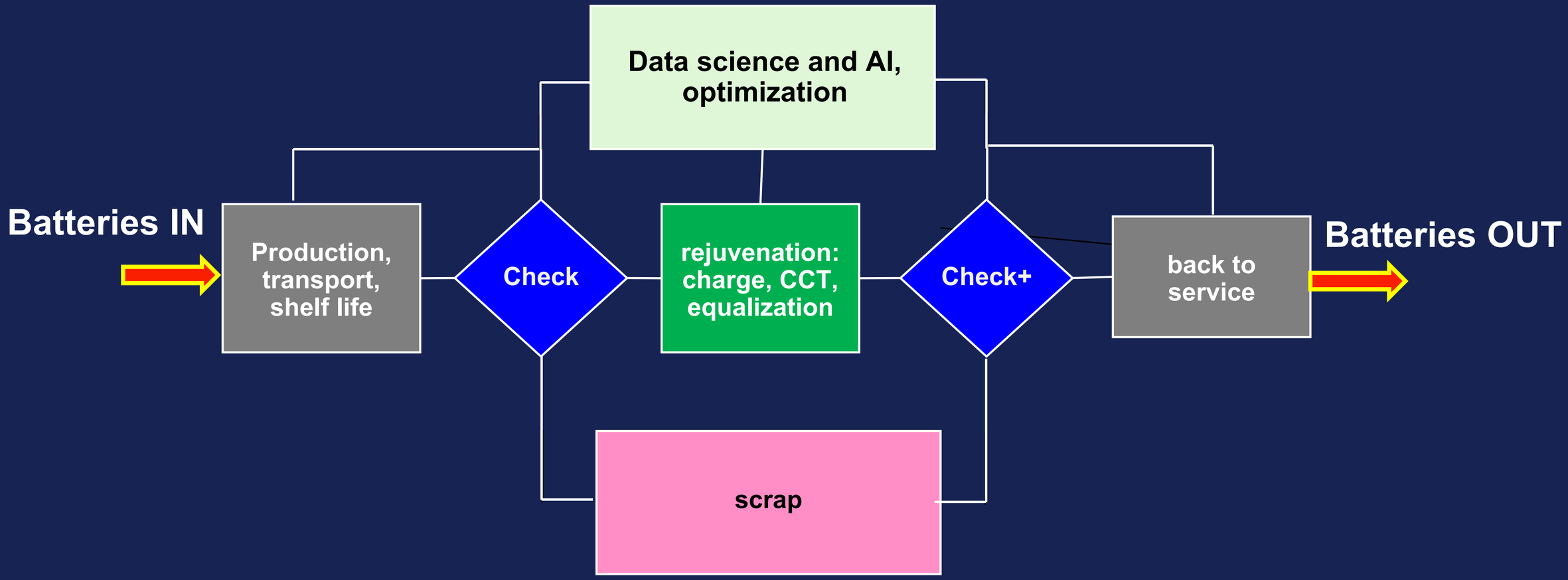
1. Optimized transportation of ions in the active material's pores and in the bulk of the cells,
2. Reduced oversaturation of sulfate ions near reaction sites, reduced concentration gradients,
3. Increased rate of nucleation and enhanced porosity of active materials,
4. Reduced charge polarization and time, lower heat evolution,
5. Removal of electrolyte stratification.

BARS machines currently in operation: **for 176 batteries at the same time:**

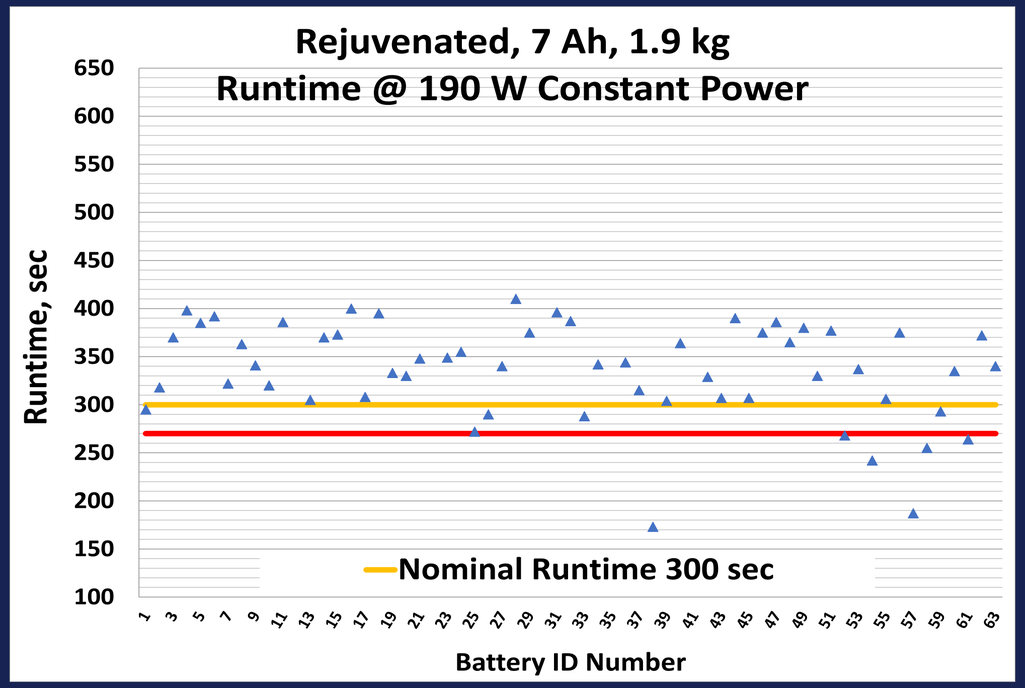
1. **Bulgaria**: 40 channels for large (35-230 Ah) batteries,
   80 channels for small (5-10 Ah) batteries,
2. **The Ntehrlands**: 40 channels for small (5-10 Ah) batteries,
3. **Norway**: 16 channels for small (5-10 Ah) batteries.

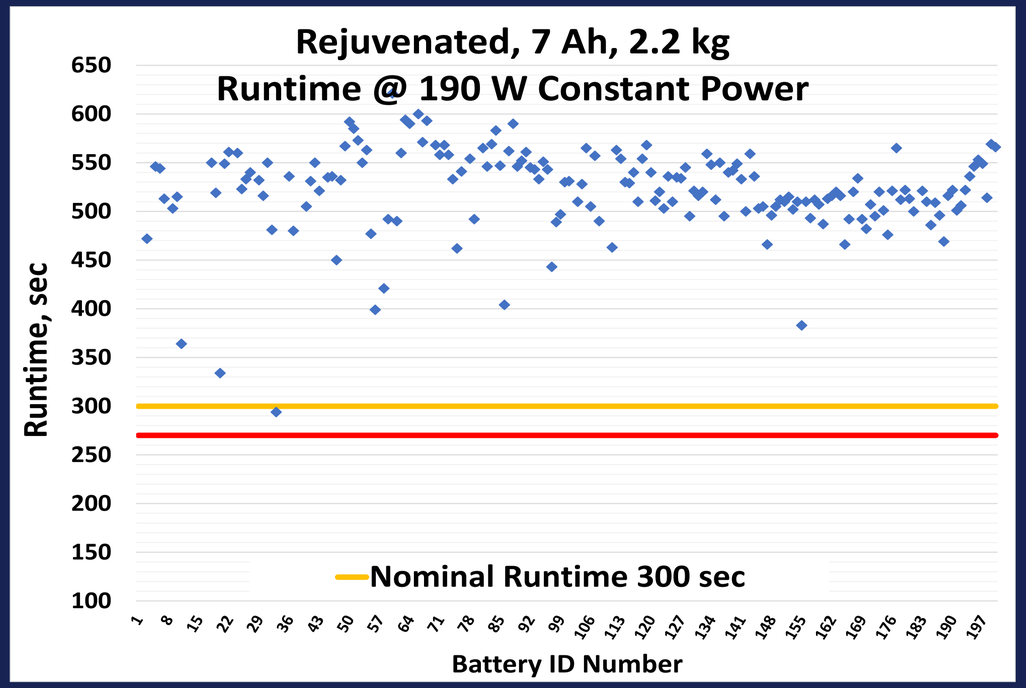
How is BARS Operation Organized?

Functional Diagram



Runtime After Rejuvenation, 7 Ah Batteries by two manuf's:

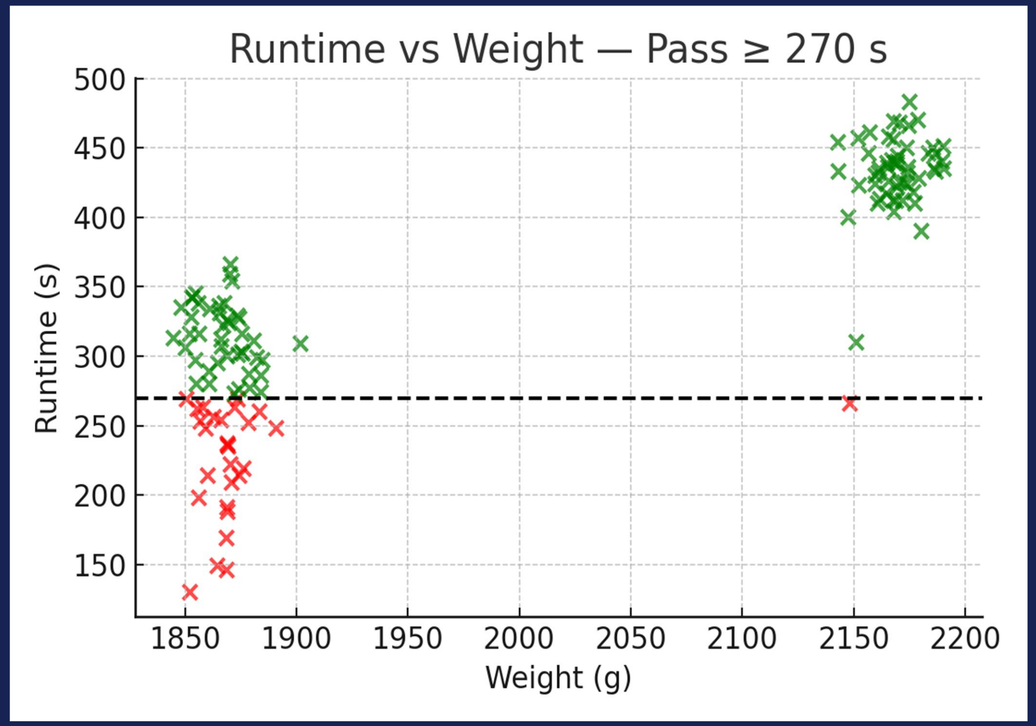


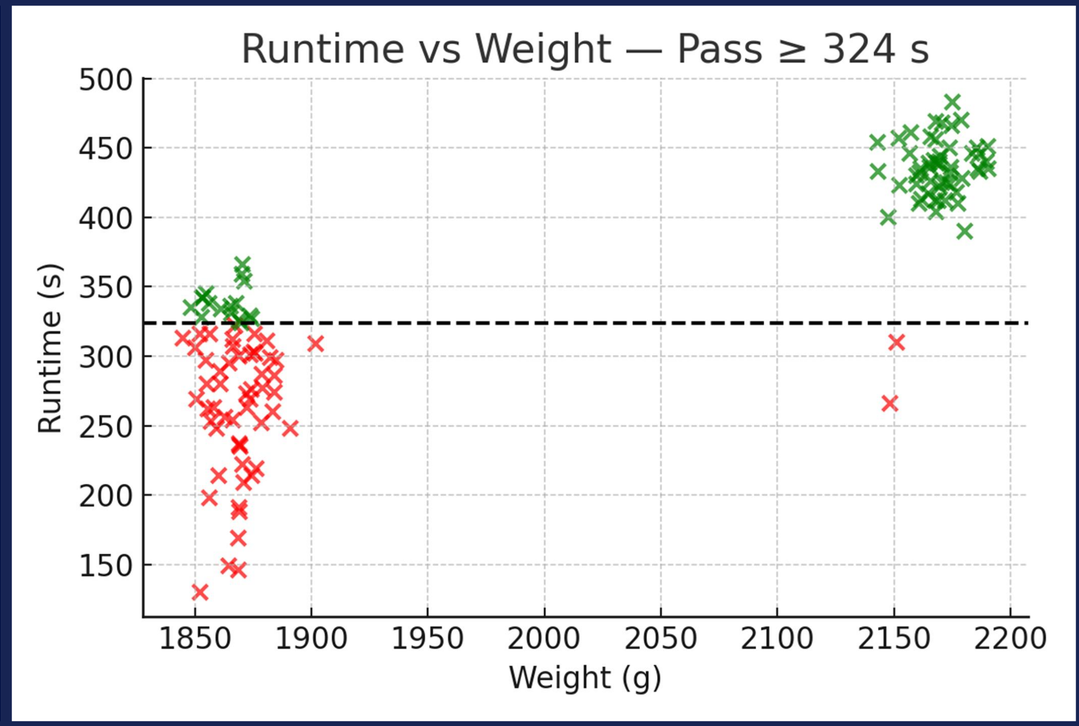


Yellow line: 300 s (benchmark), **Red line: 10% tolerance acceptable**

Two sets of 7 Ah batteries from different manufacturers with weights of : **a) 1.9 kg, b) 2.2 kg.**
Most of the "heavy" batteries exceed the 300 s threshold. Some of the "light" ones did not.

Effect of Battery Weight on Runtime After Recovery





Green points: success), **Red points: failure**

Two groups of 12V_7Ah batteries from two manufacturers.
Most “heavy” batteries exceed the 270 s and 324 s thresholds. Most “light” ones failed.
This illustrates the importance of battery weight, cell design, and other parameters.

For more details about rejuvenation of AGM batteries please have a look at the video clip attached to this presentation!

Results of recovering the performance of LFP lithium-ion batteries will be presented separately.

Thank You!

Questions:

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