2019 NAATBatt INTERNATIONAL ANNUAL MEETING & CONFERENCE

Blockchain for Electric Vehicle Battery Lifecycle Management

An opportunity for NAATBatt & EV Battery Lifecycle Stakeholders

EVERLEDGER

Session Overview

1. What is blockchain?
2. What data is required across the battery lifecycle to optimize management?
3. What data do key stakeholders want to share and consume?
4. How can blockchain best support stakeholder engagement?
5. Opportunity for NAATBatt and its members

What is Blockchain?

Blockchain is a distributed ledger that maintains a continuously-growing list of records called blocks secured from tampering and revision without the need for a central authority.

- Digitization leads to less admin work and consistent data tracking
- Immediate data access for permissioned parties
- Global and scalable to support worldwide partnerships and communication
- Secure and irrefutable

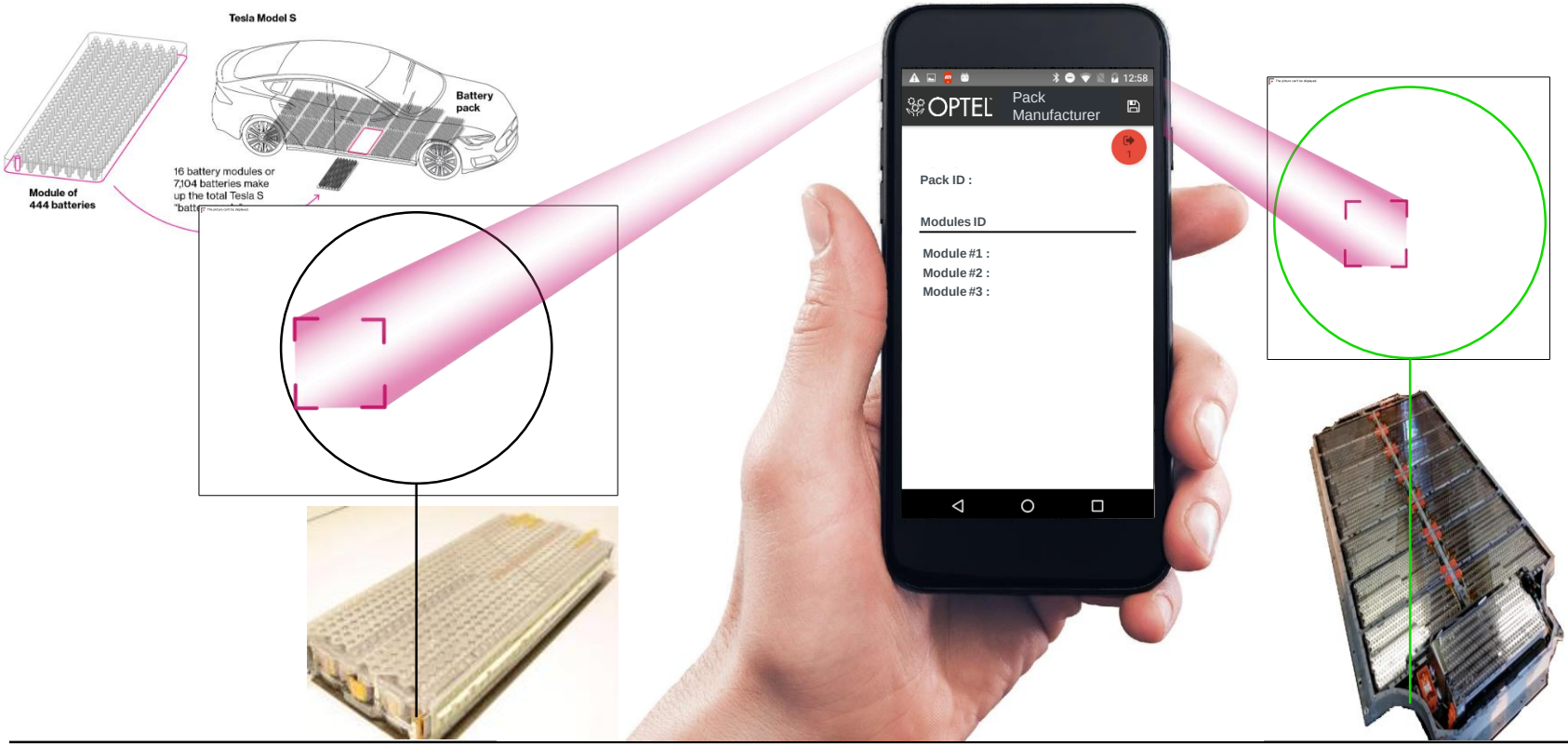
Security

Scalability

Immutability

Speed

Battery Traceability @ Pack Manufacturer



EV Battery Circular Economy Challenges

#1 Challenge: Data visibility:

- Safety information
- Repair and disassembly instructions
- Has the battery been properly serviced and repaired?
- Has the battery been in an accident?
- Has BMS "odometer" been tampered with?
- Have repurposing activities been properly executed?
- Has the battery title transferred to the repurposer?
- Are replacement batteries/parts authentic?
- Have end-of-life batteries been responsibly managed?
- Do I have an accounting of critical metals for recapture and remanufacturing?

Opportunities With EVB Lifecycle Tracking

EV Market Traction

OEMs can assuredly warrant used EVBs with full lifecycle data
Increased resale $$ = Increased new car sales $$$

Follow and capture valuable/critical resources:

- **2025: 3.4 million packs** will retire
  - **29,920,000 - 224,740,000 pounds recyclable cobalt**
    - **$865 million to $6.5 billion in cobalt value**

Cost of recycling:

- **2025: 3.4 million packs @ $1,000/pack for recycling + packing and trans at $1,000 - $2000/pack**

Reuse before recycling:

- Lower capex for storage batteries:
  - **High quality 2nd life packs are available today for roughly $100/kWh or less**
  - **New storage batteries are in the area of $300/kWh or less**
- **Postpone recycling costs**
- Reuse supports **corporate sustainability**
- **Green branding** for OEMs and battery storage companies

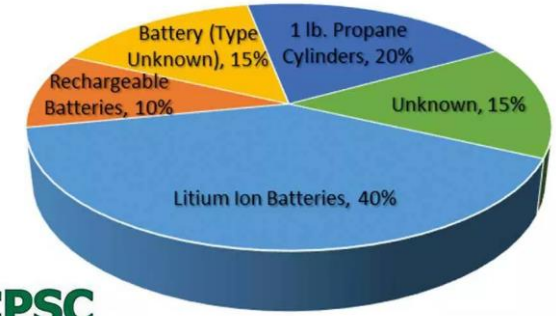
Risks and Losses Without Lifecycle Tracking

- **Shortages** in new battery **metals/minerals supply**
  - **Co supply deficit to increase 83% by 2020**
  - **Global Li demand to triple by 2020 and existing mines to deplete by 2050**

- **Counterfeit batteries & components**
  - Substandard batteries **higher risk for thermal runaways**
  - **Importers are considered 'manufacturers'** and exposed to manufacturer liability
  - Risk to **brand integrity**
  - **Loss of revenue**

- Q1 2018: **93% increase in recycling/scrap facility fires** over Q1 2017
  - Hazardous heavy metals **harm human and health and the environment**
  - **Electrolytes release** hydrogen fluoride, chlorine and other **toxic gasses when burned**
  - **Blockchain = Know Your Recycler**

Sources of Fires at Waste Management Facilities



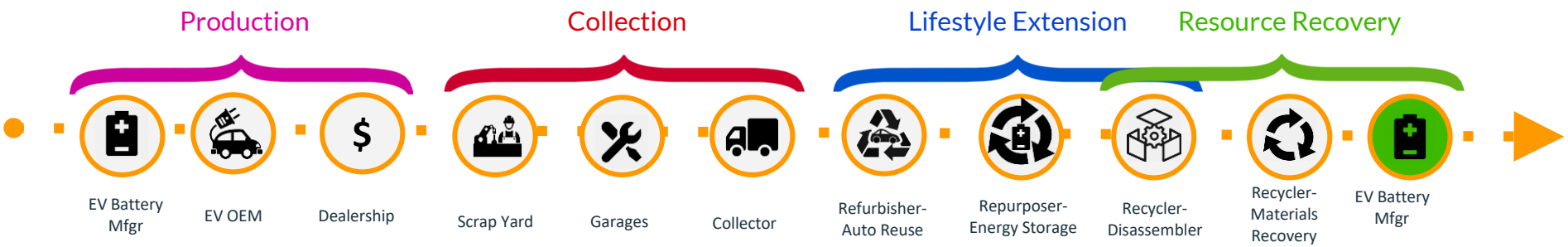
CPSC California Product Stewardship Council

Note: *Above are ALL LIBs, not only EVBs*

EV Battery Lifecycle Stakeholders

NAATBatt INTERNATIONAL **Sponsored Blockchain Platform**

Battery Lifecycle Data



CATL

Ford

ISRI Institute of Scrap Recycling Industries, Inc. Voice of the Recycling Industry™

terrapure

INDIE POWER SYSTEMS

RETRIEV TECHNOLOGIES

Li-Cycle™

EVERLEDGER

Opportunity for NAATBatt and Members

- NAATBatt can sponsor the industry-wide blockchain platform
  - Member responsibilities distributed on a decentralized network
- Participants pay a small transaction fee for data
  - NAATBatt member discount
    - Attract new members
- NAATBatt shares revenue with blockchain provider
  - NAATBatt derives a new source of revenue to support activities
  - Blockchain provider develops and maintains the platform

EVERLEDGER

Company Overview

Founded in 2015, Everledger is an independent emerging technology enterprise focused on addressing real-world challenges through breakthrough solutions to deliver positive social, economic and environmental impact.

We began with the diamond sector using digital ID and blockchain to identify and track sustainable diamonds from mine to market. For assets that are not uniquely identifiable we couple blockchain technology with auto-ID and advanced material science to connect the asset to the blockchain.

Unique to Everledger is our deep industry experience in the sectors we support that provides the dimension and passion to deliver successful solutions.

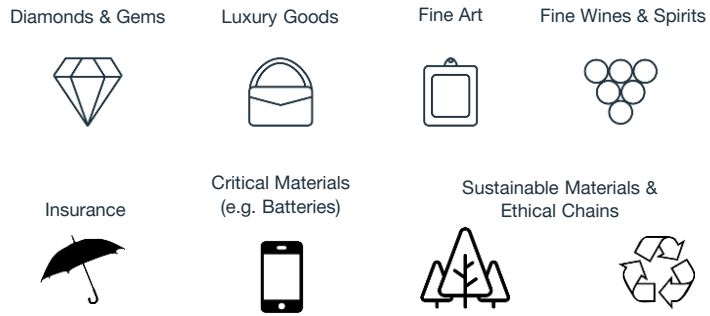
Company Facts:

- HQ in UK, 5 major offices globally w/70+ employees
- Series A round $10.4 million (February 2018)

Awards:

2018: Advance Global Australian Awards - Technology & Innovation (Founder & CEO Leanne Kemp) / Barclays Entrepreneur Awards (Founder & CEO Leanne Kemp) / WEF Tech Pioneer - World Economic Forum Tech Pioneer / IBM Champion (Founder & CEO Leanne Kemp) / Women in IT Awards - Innovator of the Year London (Leanne Kemp)
2017: NTT Data Global Open Innovation Business Contest 5.0 - Winner (London)
2016: Digital Top 50 Awards Presented by Google, Rocket Internet & McKinsey / London Innovators Penrose Award - Innovator of the Year / Asia Insurance Technology Awards (Hosted by Celent) - Best Newcomer

Industries & Markets



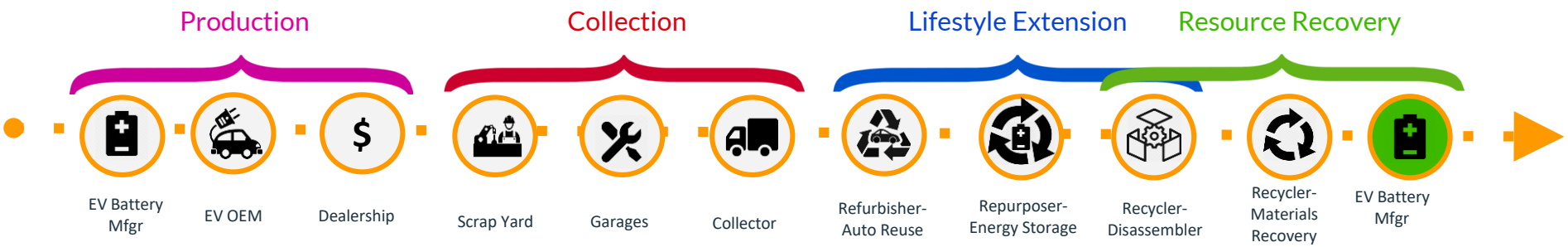
Partners & Clients

HYPERLEDGER
BARCLAYS
IBM
THOMSON REUTERS
SAP Ariba
BRINKS
applieddnasciences
SAP
ORACLE
GIA
aws
r3
silicon craft
AVERY DENNISON

EV Battery Lifecycle Stakeholders

NAATBatt INTERNATIONAL **Sponsored Blockchain Platform**

Battery Lifecycle Data



CATL

Ford

ISRI Institute of Scrap Recycling Industries, Inc. Voice of the Recycling Industry™

terrapure

INDIE POWER SYSTEMS

RETRIEV TECHNOLOGIES

Li-Cycle™

Contact

Lauren Roman - Director Business Development - Metals & Minerals Ecosystem

+1 973.224.7632

Lauren@everledger.io

everledger.io

Addendum

Implementing a NAATBatt INTERNATIONAL Sponsored Data Platform

1. Identification of industry leaders from ~3 positions in the EVB lifecycle to fund a pilot demonstration
2. Determine goals and key features needed for the pilot
3. Construct a SOW with NAATBatt and pilot sponsors
4. Develop and launch pilot, share results with other stakeholders
5. Invite all other stakeholders for input
6. Expand key features that meet the needs of all relevant stakeholders
7. Construct a new SOW for industry-wide platform
8. Onboard industry participants

Risk, Challenges & Opportunities: Production

Battery OEM
Dealership

EV OEM

Risks and Challenges

- Producer responsibility schemes
- Counterfeit batteries
- Warranty authentication
- Low EV resale values due to new EV incentives and lack of battery history for consumers
- Safety during battery life
- Liability for subsequent uses
- Recycled content goals
- Secure metals supply

OPPORTUNITIES

- Digital identity supports lifecycle accountability
- EV OEMs have data to warranty used batteries/drive up resale values
- Parts authentication prevents counterfeits
- Battery history enables battery life extension or new lifecycle
- Validation/certification of refurbishment, recycling by authorized parties only
- Transfer of title/ownership
- Recapture and reuse of critical metals

Risk, Challenges & Opportunities: Collection

Garage/Repair Collector/Consolidator

Scrap Yard

Risks and Challenges

- Regulations require packing and shipping only by trained technicians
- Where to source?
- Severe high voltage safety issues
- How should this be properly stored and shipped?
- Is it under warranty?
- Where do I ship it?
- Who will pay for it?
- How is it paid for?

OPPORTUNITIES

- NFC tag on battery provides URL to user with all of the critical battery information from the manufacturer
- System prompts user to upload required information
  - Condition report
  - Shipping document

Risk, Challenges & Opportunities: Lifecycle Extension

Refurbisher:

Aut se

ID of p tially reusable batteries

Recycler:

Repurposer:

Energy Storage

Risks and Challenges

- What is the chemistry?
- Can it be repaired and reused?
  - Has it been in an accident? Flood? Other?
- Can it be maintained/refurbished for continued use?
  - How has it been serviced to date?
- Can it be repurposed for energy storage?
  - Transfer of title/liability to “new” manufacturer
- Must it be sent for recycling?
  - Where? Who pays? Is recycler certified?

OPPORTUNITIES

- Digital ID provides user access to manufacturer battery data, maintenance records, insurance events, battery and vehicle sensor readings (i.e. airbag deployment/other)
- Title transfer for batteries repurposed for a non-EV usage (i.e.: energy storage) can be validated and recorded on blockchain
- Financial transactions recorded
- Responsible recycling verified

Risk, Challenges & Opportunities: Resource Recovery

Recycler:
EV Battery Manufacturer
Di mbly
Conte

Recycler:

Materials Reco

Recycled

Risks and Challenges

- Safety precautions
- Tools/equipment required
- Worker training/certification requirements
- Identification of parts for return to manufacturer
- Responsible recycling
- Tracking and recording of critical metal content for OEMs

OPPORTUNITIES

- Lifecycle safety management
- Battery manufacturer capture of parts for refurbishment/reuse
- Longevity of critical metals supply
- Protection of OEM brand integrity
    - Validate recycled content claims
    - Sustainability commitments

Public vs. Private Blockchains

Public

- Anyone willing to host a node is able to
- Consensus is performed through incentivisation through either a Proof of Work or Proof of Stake mechanism
- Current consensus mechanisms (Proof of Work) require a high amount of energy to process mining equipment
- No transactional privacy

Private

- Invitation-only permissioned network
- Designed for enterprises
- Certificate authority can delegate permissions and responsibilities to relevant stakeholders
- Only the entities transacting will have access to permissioned information
- Consensus achieved among participants; not through intensive computing algorithms

BMS Data vs. Blockchain Data

BMS

- Key health parameters
  - Failure prediction
- Usage history -
  - # of cycles
  - Operating extremes
- Charge holding capacity
- Maintenance indicators
- Individual module health
- Cell balancing data

Battery ‘Passport’ or Digital Identity

- Battery chemistry
- Parts authentication
- Safe handling instructions
- Designated repair/refurb/recycling entities
- Shipping events/documents
- Maintenance, repair, repurposing activities
- Insurance events - Accidents, exposure to floods, fire/other
- Info on parts return to OEM/manufacturer
- Mass balance on metals recovery