



Aalto University  
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# Turning industrial waste streams into affordable renewable energy storage

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*ETS Innovation Fund Workshop Brussels 17 February 2017*

# 1. Our concept

**Cu**



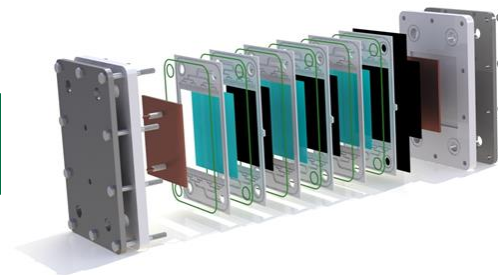
**Copper  
scrap**



**$\text{CuCl}_2 + \text{HCl}$**



**PCB etching  
waste**



**Redox flow  
battery module**

**= All Copper Redox Flow Battery\*  
(CuRFB)**

## 2. State-of-the-art and cost

- **Battery charging:**
  - Anode:  $\text{CuCl}^+ + \text{e}^- \rightarrow \text{Cu}^0$  (Copper electroplating)
  - Cathode:  $\text{CuCl}^+ \rightarrow \text{CuCl}^{2+} + \text{e}^-$  (Liquid phase)
- **Performance of laboratory scale short stacks:**
  - 1000+ charge/discharge cycles completed
  - Electrochemical efficiency 70%
  - Energy density comparable to Vanadium batteries
- **Costs:**
  - Recycled raw materials 50 €/kWh
  - System cost 100 €/kWh in large volumes

