



Aalto University
School of Chemical
Engineering

Turning industrial waste streams into affordable renewable energy storage

Dr. Pertti Kauranen

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

