Innovate UK

Project Lead: JIVA

ReCollect

Efficient Manufacturing of Recyclable Composite Laminates for Electrical Goods

Partners

JIVA

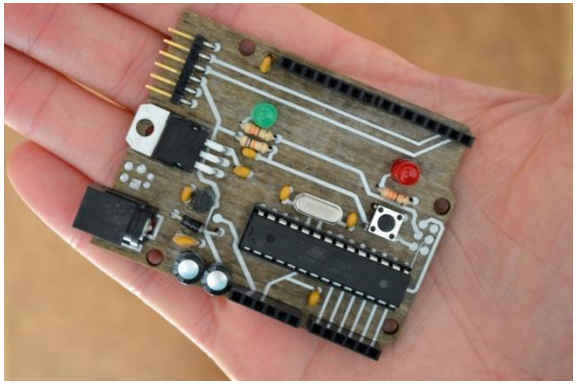
- A start-up reducing the impact of the fastest growing waste stream in the world using naturally derived products.
- The inventor of Soluboard® – a patented, competitively priced and fully recyclable printed circuit board substrate to rival the industry standard.
- Jiva will lead the specification and development of the thermoplastic input materials, as well as the conversion of the substrates into working circuit boards.

Coventive Composites

- An independent provider of services relating to composite materials.
- They offer a comprehensive range of capabilities that include materials & process development, pilot-scale manufacturing and prototyping.
- Coventive Composites will focus on the development of commercially-viable, scalable manufacturing processes for converting raw materials into substrates.

Institute of Circuit Technology

- The Institute of Circuit Technology (ICT) will support dissemination and stimulate wider UK industry feedback on the developments.



Start Date:	1st October 2019
Duration:	30 months
Budget:	£800,000

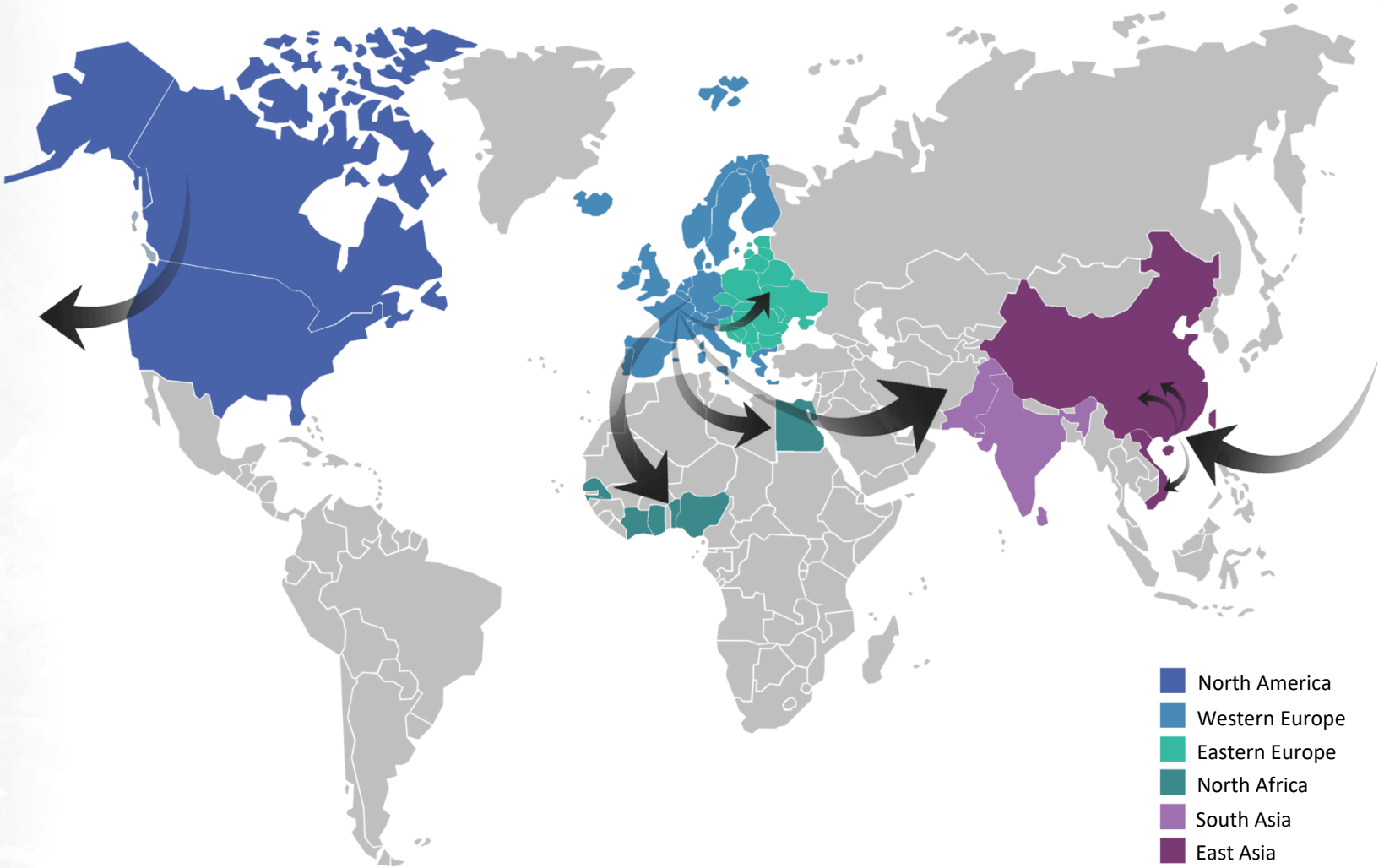
Partners:	Jiva Materials
	Coventive Composites
	Institute of Circuit Technology

Summary

- The project focuses on an alternative way of managing end-of-life circuit boards by removing PCBs made from difficult-to-recycle fibreglass-epoxy from the supply chain.
- The primary aim of this project is to demonstrate the feasibility of producing Soluboard® in high volumes within the UK and show that Soluboard® can match the performance of CEM-1 and FR-4.
- This will be completed using a novel process in development by Coventive Composites which allows the continuous production of sheet material.
- The secondary aim of the project is to investigate the ability to chemically protect Soluboard® and allow it to be used in the existing aqueous processes of PCB manufacture.

Problem

Problem


North America
Western Europe
Eastern Europe
North Africa
South Asia
East Asia

UN Global E-Waste Report 2019

E-Waste Generated (per person)	
Global Average	7.3 kg
EU Average	16.2 kg
China	20.2 kg
USA	21.0 kg
UK	23.9 kg
Norway	26.0 kg

Collection Rate: 55.0%

Collection Rate: 71.0%

- The UK population is 10 x that of Norway, so the total untreated e-waste of the UK is 727 KT compared to 40 KT in Norway.

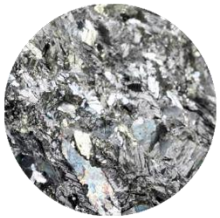
Problem

Waste PCBs

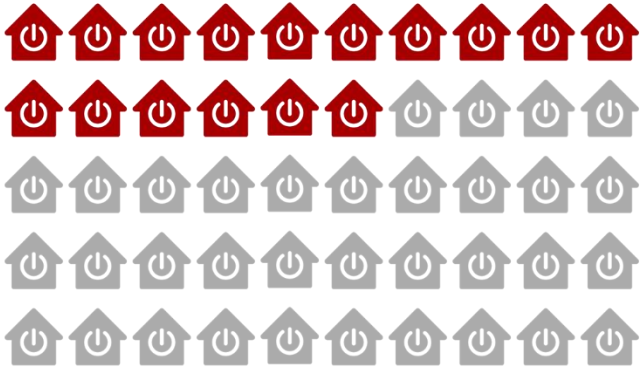
Components

Gold

Silver



Palladium



32%

of all e-waste consists of small domestic equipment

Source: The Global E-Waste Monitor 2020

E-Waste Inquiry

Purpose

Exploring how UK could reduce its environmental impact, create economic opportunities + maintain access to critical materials by better managing and minimising e-waste.

Implementing a Circular Economy for Electronic Goods

- How can the UK Government support a move towards a circular economy for electronics?
- Why does recovering materials from electronic waste pose a significant challenge?
- What support is required to facilitate the adoption of recovery technologies?

UK's Electronic Waste Sector

- Are UK Waste Electrical and Electronic Equipment (WEEE) collection targets achievable?
- What action can the UK Government take to prevent illegal exporting of e-waste?
- How can the UK public awareness of e-waste recycling be improved?

Witnesses

- Gurbaksh Badhan - Chair at National Association of Waste Disposal Officers
- Phil Conran - Chair at Approved Authorised Treatment Facilities Forum
- Louise Grantham - Representative at Waste Electric and Electronic Equipment Scheme Forum
- Eva Gouwens - CEO at Fairphone
- Kevin Consindine - Head of Sustainability at Samsung
- Andrew Mullen - Head of Quality and Sustainability for the UK and Ireland at Beko
- Matthew Manning - Compliance and Recycling Operations Manager at Dixons Carphone

Soluboard®

International Patent: WO 2018/234801

Dissolves in hot water

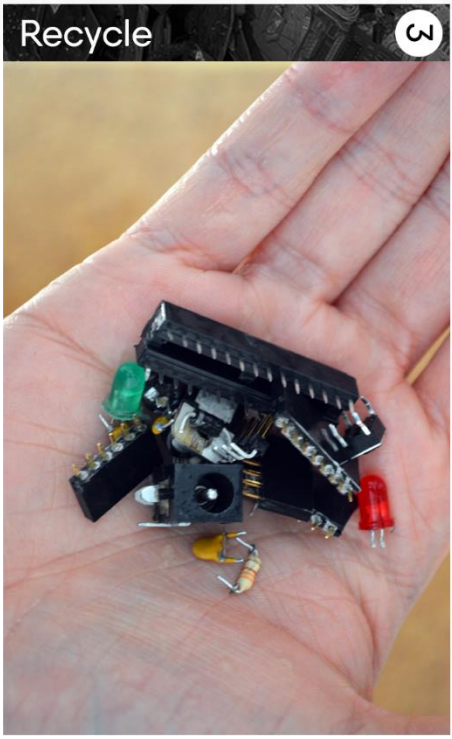
Recyclable components

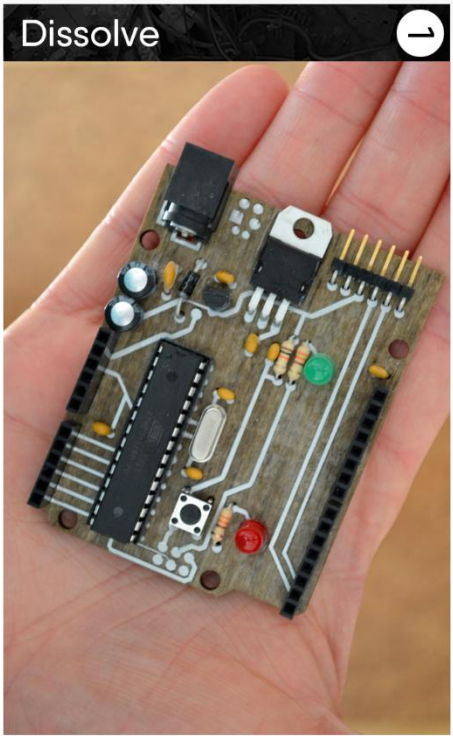
Biodegradable + non-toxic

Comparable to market leaders

Solution

Recovery





Target

A Soluboard® PCB has a

60%

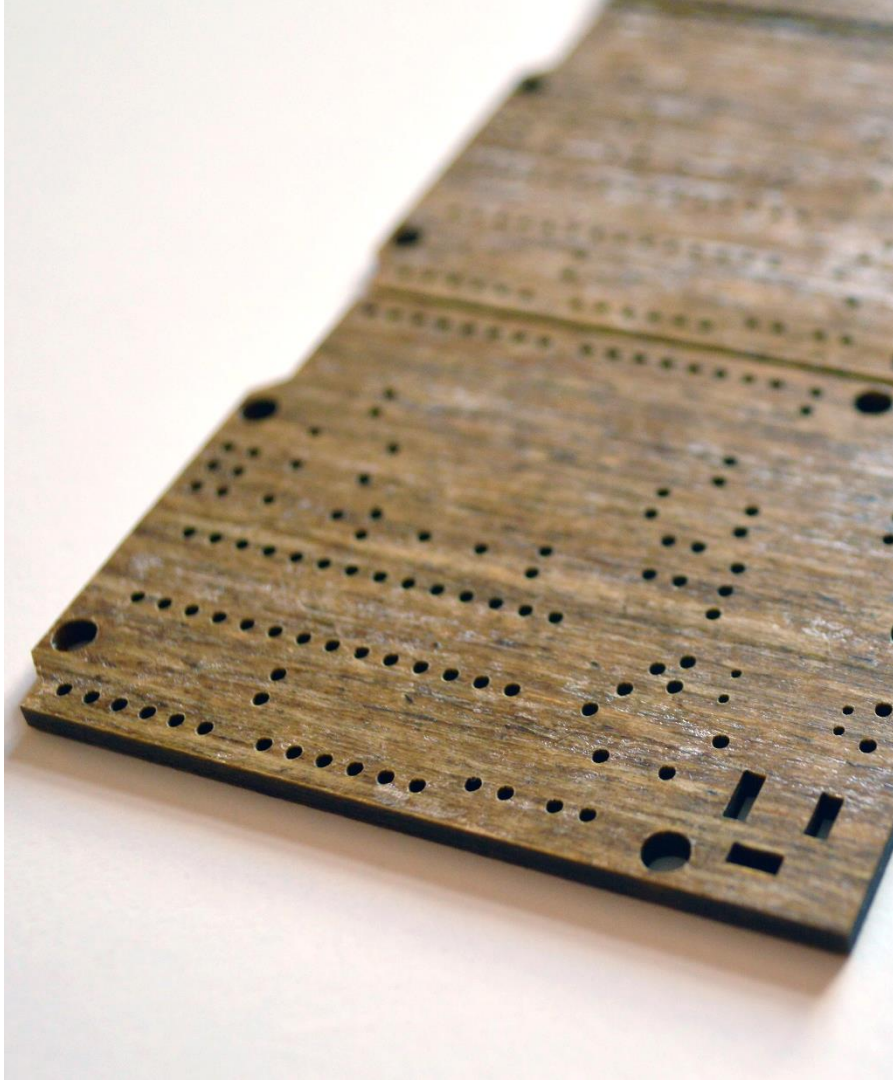
lower carbon footprint compared to a standard PCB

Source: Environmental Resources Management 2020

Carbon Savings

- The carbon footprint of one square metre of Soluboard® is equivalent to 7.1 kg CO2e.
- The carbon footprint of one square metre of standard FR-4 PCB is equivalent to 17.7 kgCO2e.
- The total net saving is 10.51 kg CO2e – this is a 60% reduction in carbon footprint per square metre.
- The plastic saving per square metre of Soluboard® compared to FR-4 is equivalent to 620 g/m².

Source: Environmental Resources Management 2020



Testing & Progress

- Testing + preparation of MSDS ongoing - expected H1 2021.
- Additive + subtractive Processing Guidelines in development.

<u>Highlights:</u>

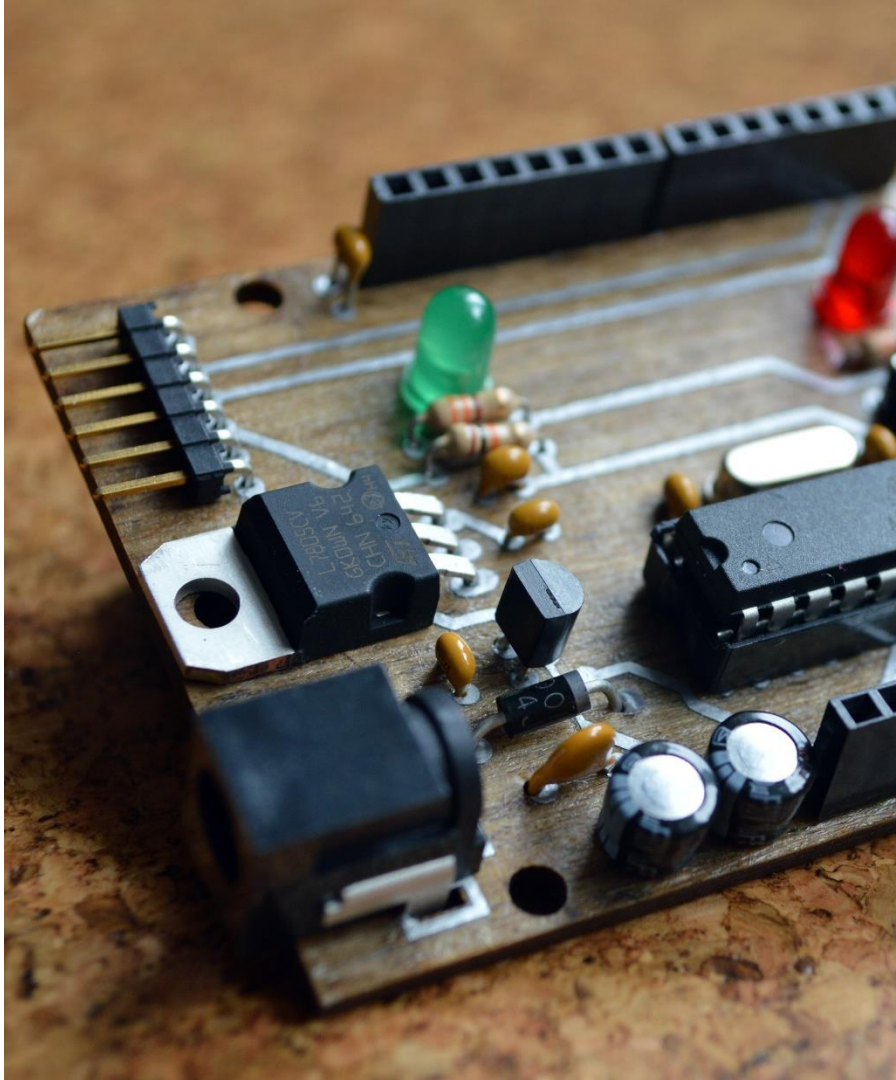
- Thermal conductivity comparable to FR-4:

  0.256 W/mK @ 22 °C

- Electrical properties comparable to CEM-1 + FR-4:

  CTI PLC 0 @ 600 V

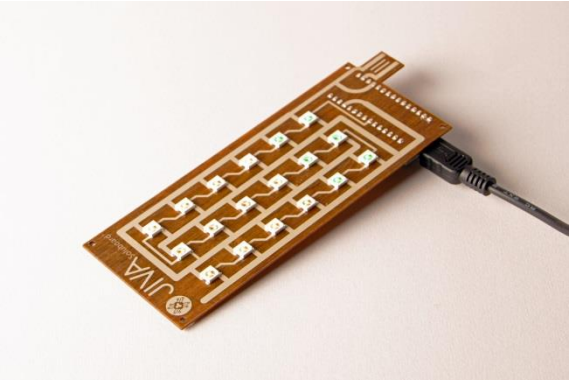
- Flame retardance in-line with UL 94 V0 rating.
- Mechanical properties comparable to CEM-1.

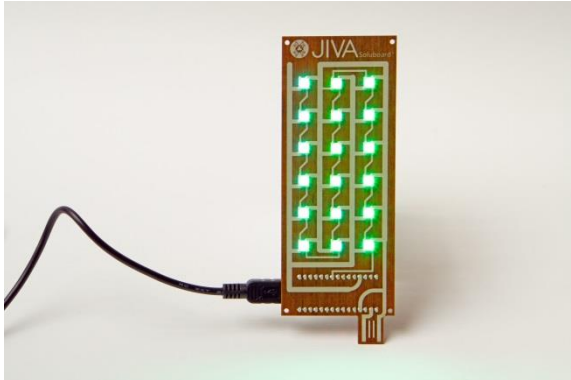


Testing Data

Soluboard® Testing Data									
Specifications									
Test No.	Characteristic	Unit	Conditioning	Test Method	FR-4	Spec	CEM-1	Spec	Soluboard®
1	Volume Resistivity	Mohm-cm	C-96/35/90 (Time/Temp/RH)	2.5.17	5E8 - 5E9	> 5E6	4.60E+09	> 1E6	2.65E+06
2	Surface Resistivity	Mohm	C-96/35/90	2.5.17	5E6 - 5E7	> 1E5	4.20E+08	> 1E4	3.84E+04
3	Permittivity (1 MHz)	-	C-24/23/50	2.5.5.9	4.5 - 4.7	< 5.4	4.4	< 5.4	5.47
4	Permittivity (1 GHz)	-	C-24/23/50	2.5.5.9	4.0 - 4.2	-	-	-	4.13
5	Loss Tangent (1 MHz)	-	C-24/23/50	2.5.5.9	0.01 - 0.016	< 0.035	0.03	< 0.035	0.044
6	Loss Tangent (1 GHz)	-	C-24/23/50	2.5.5.9	0.01 - 0.016	-	-	-	0.047
7	Arc Resistance	SEC	D-48/50+D-0.5/23 (Time/Temp)	2.5.1	> 120	> 60	-	-	65
8	Dielectric Breakdown	KV	D-48/50	2.5.6	> 60	> 40	> 60	> 40	32
9	Moisture Absorption	%	D-48/50	2.6.2.1	0.05 - 0.10	< 0.35	< 0.15	< 0.5	
10	Flammability	-	D-48/50	UL94	94V0	94V0	94V0	94V0	94V0
11	Peel Strength (1 oz)	lb/in	288°Cx10" (Solder Floating)	2.4.8	8 to 12	> 6	11	> 6	
12	Thermal Stress	SEC	288°C (Dipping)	2.4.13.1	> 200	> 10	> 80	> 40	
13	Flexural Strength (LW)	N/mm²	A	2.4.4	480 - 550	> 415	300 - 400	> 242	142
14	Flexural Strength (CW)	N/mm²	A	2.4.4	415 - 480	> 345	200 - 300	> 172	96
15	Dimensional Stability (X-Y axis)	%	E-0.5/170 (Time/Temp)	2.4.39	0.005 - 0.030	< 0.05	< 0.065	0.11 (Max)	
16	Glass Transition Temperature	C	DSC	2.4.25	140 +/- 5	N/A	100	N/A	126
17	Z-axis (Before Tg)	ppm/C	TMA	2.4.24	50 - 70	N/A	-	-	
18	Z-axis (After Tg)	ppm/C	TMA	2.4.24	250 - 350	N/A	-	-	
19	Punchability	kg/cm²	ASTM D-732 (Shear Strength)	ASTM D-732	-	-	900	N/A	227
20	Comparative Tracking Index	V	C-96/20/65	ASTM D-3638	600	PLC 0 (> 600)	> 600	N/A	PLC 0 (600V)
C= Humidity Conditioning; D= Immersion Conditioning in Distilled Water; E= Temperature Conditioning									

Market





- Annual demand for FR-4 glass-epoxy circuit boards is 18.8 billion m², growing at 4.5% per annum.
- The FR-4 market can be segmented into 2.8 billion m² of single/double-sided boards – Jiva's target market.
- 485 million household appliances sold globally in 2017. This is 14.6 million m² of laminate with a value of £220M.
- Jiva predicts a realistic addressable market of 17 million m² (£250 million). This estimate is based on:
  - The overall market opportunity for single/double-sided FR-4 boards;
  - The obligations, willingness and capability to manage white goods at end-of-life;
  - Territorial accessibility considerations;
  - Market inertia in transitioning from an incumbent technology.
- Jiva is targeting a 5% share by 2027, translating to 0.85 million m² of Soluboard worth £13 million.

Postcode Lotteries

- Finalist in the Postcode Lotteries Green Challenge.
- One of the largest annual competitions for sustainable entrepreneurship.
- Results to be aired on Dutch TV in February 2021.

  - First Prize: €500k
  - Second Prize: €200k
  - Runners Up: €100k

THANK YOU

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Work Packages

- WP1 - Commercialisation

Focusing on the specific market requirements of white goods and the coordination of dissemination and exploitation activities.

- WP2 - Raw Materials

Optimisation of the natural fibre reinforcements to meet processing and performance requirements for Soluboard manufacture.

- WP3 - Substrate Manufacture

Evaluation of thermoplastic sheet extrusion and fabric impregnation process and testing of the resulting substrates against FR-4.

- WP4 - PCB Production

Assessment of circuitry application to the substrate produced using the conventional copper etching process and silver printing.

- WP5 - Case Studies

Design, manufacturing and evaluation of fully functioning populated PCBs as specified by the end customer.

- WP6 - Project Management

Overall coordination, administration, monitoring and planning of the project.

Impacts

Environmental & Social

- Analysis has shown that large household appliances i.e. white goods are the largest contributor to UK e-waste at 320 KT per year.
- The electronic components that PCBs are populated with often contain toxins, such as lead, cadmium and mercury.
- The Global E-Waste Monitor 2019 report states that of the 53.6 Mt of e-waste generated globally, only 9.3 Mt was documented as collected and recycled - less than 20%.
- Jiva will push for the safe recovery of e-waste and address directly the environmental issues it can cause.

Economic

- The current cost of landfill is £91.35 per tonne. This is a significant non-productive cost to the UK economy when dealing with e-waste.
- The UK is now far behind Europe for natural fibre production, with minimal flax grown and only 800 hectares of hemp grown compared to 33,000 hectares in Europe.
- A demand for natural fibre reinforcements for use in PCBs could help invigorate the UK rural economy.