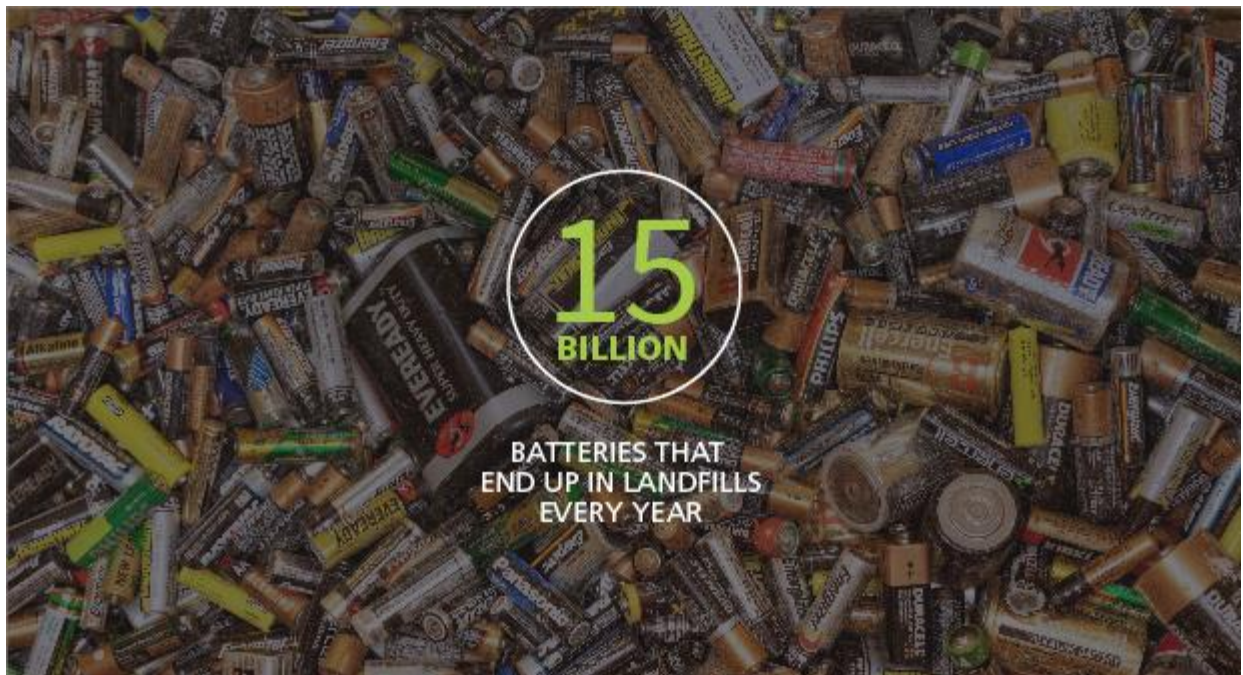# airy

Battery-less smart home monitoring

SUMMARY

Airy provides **battery-less**, wireless home monitoring solution through sensors that can be mounted on the door or window frame to harvest electrical energy from the mechanical impact produced in the normal operation.

PROBLEM

Yes. More than 15 billion batteries end up in landfill every year in the US. Unlike other trash, batteries contain many hazardous heavy metals like nickel, cadmium, and cobalt and corrosive acids that eventually leach into the environment and contaminate the air, water, and land. Mining and production of these heavy metals for use in batteries also has an enormous environmental and health impact.

Rechargeable batteries offer a sustainable alternative, but because they have lower charge capacity than single-use AA/AAA cells, they are not suited for applications where minimal maintenance is the norm and expected. For example, wireless door and window security sensors. They are magnetic reed sensors and last a couple of months on a single AA battery. Since an

average home may require 6-8 of these devices, security sensors send a reasonable share of batteries to the landfill. Also, it is a hassle to change the batteries in the security sensors periodically, something many users forget (only to find the hard way). It requires un-sticking the sensor, prying open the battery cover, remove the existing battery, installing a new battery, sticking the sensor back to the frame and grudgingly discarding the old battery in trash.

If home security sensors are made **battery-less**, fewer batteries will be needed, and users will find them easier and more convenient to use.

Current wireless door and window sensors are two-part, magnetic reed sensors. The sensor is triggered when the two parts separate. Depending on frequency of operation (RF, Zigbee or Z-Wave), they may use 5-6 AA or AAA batteries annually, and an average home has half a dozen sensors installed. Moreover, battery change is a hassle and users often forget. Image from vivint.com.

SOLUTION

Airy presents **battery-less** door and window sensors for home security applications. Our compact sensor design features a **micro, energy-harvesting, electromagnetic generator** that generates electrical energy upon mechanical actuation.
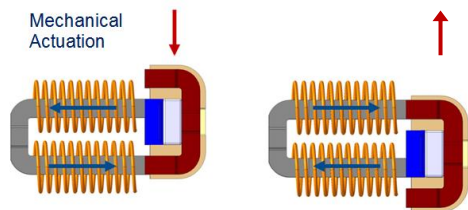
(left) Mechanical actuation moves a permanent magnet which results in change in magnetic flux in the coils thus creating electric impulse. The electric impulse powers a RF radio that transmits a coded message (ZF AFIM 5002, right). Another message is sent when the spring-loaded magnet retracts. Images from zf.com.

The Airy sensor includes the generator and a custom RF (433MHz) transmitter and features a ¼ in. shaft is protruding from the sensor case (like a push button on a ballpoint pen, see figure below). The sensor is mounted with two screws on the door jamb or the window sill with the shaft facing the door. The process of door (or window) closing pushes the shaft which actuates the generator and produces the electrical pulse. The electrical pulse (about 10mW) is conditioned and powers the RF transmitter to send out a unique, coded message. The shaft is spring loaded (unlike the push button on the ballpoint pen which is monostable) and gets released when the door is opened (figure below). This generates another voltage pulse prompting the RF transmitter to send the coded message for 'Open.'

Transmission Range – We have measured about 400 ft. line of sight and about 150 ft. indoors (through drywall and between floors). We anticipate full coverage for 2500 sq. ft. multi-floor townhome.
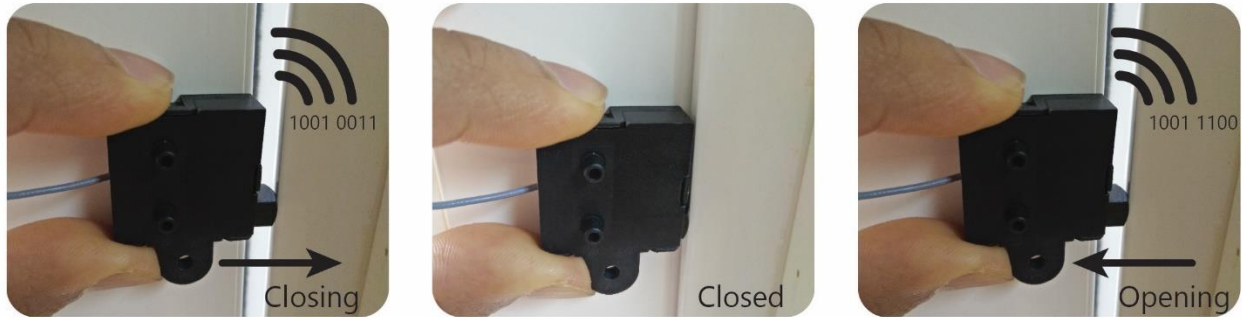
Here the sensor (black) is mounted on a sliding window. Two screw holes are provisioned in the case to ensure the sensor does not get dislodged due to heavy operation. The shaft protrudes from the right side of the case. (left) As the window is closed, the shaft gets pushed-in and actuates the generator. The RF transmitter gets powered and sends the coded message for 'close' (e.g. 1001 0011). (middle) While the window remains closed, the sensor remains inactive. (right) When the window opens, the spring-loaded shaft is released. This re-actuates the generator to power the RF transmitter and send the coded message for 'open' (1001 1100). In this example, 1001 is the unique sensor ID, and the last four bits are the code for open/close. The pink wire is the antenna. We plan to wrap it inside the case in the next prototype.

A **central control unit (Hub)** receives the coded message from the sensor and relays it to the Airy Cloud service over home Wi-Fi. The cloud service sends a notification to the homeowner through the Airy Smartphone App. Hence, the event of a door opening or closing can be monitored wirelessly and without needing batteries. The concept can be extended to monitoring windows and cabinets for the intrusion.
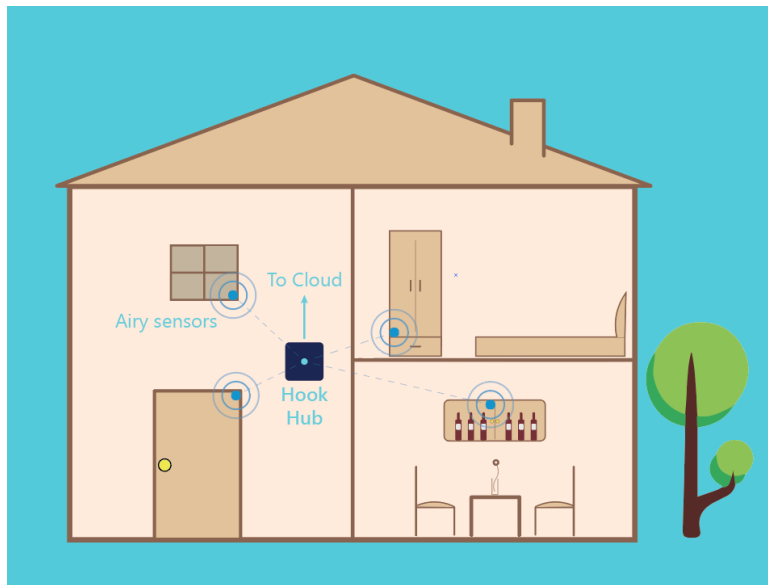
*Airy sensors can be installed to monitor **doors** (single, double and sliding), **windows** (horizontal and vertical), and **closets** and **cabinets** (liquor, jeweler etc.) for operation. The sensors send the signal wirelessly to the central Hub. The Hub relays the commands to the cloud which sends it to the user's Smartphone.*

*We chose to operate at 433MHz because our first product – the Hook Hub (now on Amazon) – is a 433MHz – to – WiFi hub. This way we can extend the capabilities of the Hook Hub from home **control** to home **monitoring** and provide further value to the existing customers while inviting new.*

EXPERT TEAM – *WITH REAL PRODUCT EXPERIENCE AND AMBITION*

Max, Ani, Rahil and Robert with the 2nd place award at the EIC 2015 for the Hook Smart Home Hub. *With your help, we took Hook from EIC success to Kickstarter, BPC, and now the #11 ranked smart home hub on Amazon. We now have more than 3000 daily active users who have automated their homes on a budget.*

In 2015, this amazing EIC community enabled us to turn an idea into an actual product on Amazon. Coming back to EIC to launch our latest project is both exciting and nerve racking. We have poured our hearts, minds, and weekends into this project, and we are excited to hear what you think about it.

Rahil Jain is on his final leg of the Ph.D. program in Electrical Engineering at UW and leads the hardware design effort at the company (Hack-a-Joe Labs LLC). **Robert** Moehle has since graduated with his MBA from UW and is now the business manager. **Max** Wheeler, also an ex-UW, is the product designer and **Ani** Goel heads the software team responsible for the App and cloud services. Each of us from different backgrounds, we hold a shared purpose to enable a smart(er) home that is affordable and sustainable.

MARKET

Smart home is a **$8B Market** and is expected to grow to $20B by 2020 (25% CAGR; Source: Business Insider report April 2016). In terms of users, US currently has about **7M smart home users** (source: Consumer Intelligence Research Partners report Nov 2016). Our addressable market is about **half**, which represents the market segment willing to pay a premium for **battery-less** convenience and sustainability.

COST

The generator is the most expensive part and costs $7.92 in bulk (based on the quote from ZF for 5k quantity shipped to Shenzhen). The circuit boards parts, fabrication, and assembly is estimated at $1-2 and the plastic enclosure may cost $0.5 including tooling. **We plan to sell the sensors for $30 (3x)** individually for the existing Hook hub users, or as a set with the Hook Hub (one Hub + six sensors for $220).

CUSTOMER PROFILES

Ruth is a **senior** living with her husband. Ruth had Airy sensors installed on their windows and doors to feel secure in their home. Ruth choose Airy because she did not want to go through the **physical toll of changing the batteries** with traditional home sensors. She also gave App access to her daughter so that she can know when her parents are home, or in case of an emergency. *Image from express.co.uk*

Adam is a **nature enthusiast** and lives to reduce his carbon footprints. He recycles everything he could and hates any time something ends up in trash, especially batteries filled with nasty chemicals. Adam chose Airy because the smart home sensors are **battery-less**. He also appreciates the safety and convenience of smart home monitoring while conserving the beautiful planet Earth. *Getty Images*

COMPETITION

The idea of remote home monitoring is not new; however, our technology (**battery-less** sensors) represents a significant breakthrough. Our competition can be categorized into two classes: direct and indirect competitors.

Direct Competition:

DIY smart home monitoring solutions from Samsung Smartthings, Wink, Iris, Wally, SimplySafe and Vivint smart home. These sensors are battery-powered magnetic reed sensors, typically cost $20-35 and work on Zibgee and ZWave protocols. There is only one-time setup cost.

Indirect Competition:

Wired home security solutions from ADT, AT&T, Xfinity and other companies who offer 24 x 7 home security and surveillance services. These subscription-based services are expensive ($50/month or higher) and require contracts. Their market-share continues to decrease as customers favor contract-less offerings from our direct competitors.

GO-T0 MARKET PLAN (one-year)

We will validate the idea through **EIC**. Based on the feedback, we will change the design and/or market approach and will participate in **BPC** with the goal to generate traction and buzz (and get some funding as well). We will launch on **Kickstarter** by Summer to raise pre-orders and fund the manufacturing run. We will fulfill the pre-orders by holidays and introduce Airy sensors on **Amazon Prime**, and B&M stores like **Home Depot** and Lowes before holiday season 2018.

CASH FLOW FORECAST
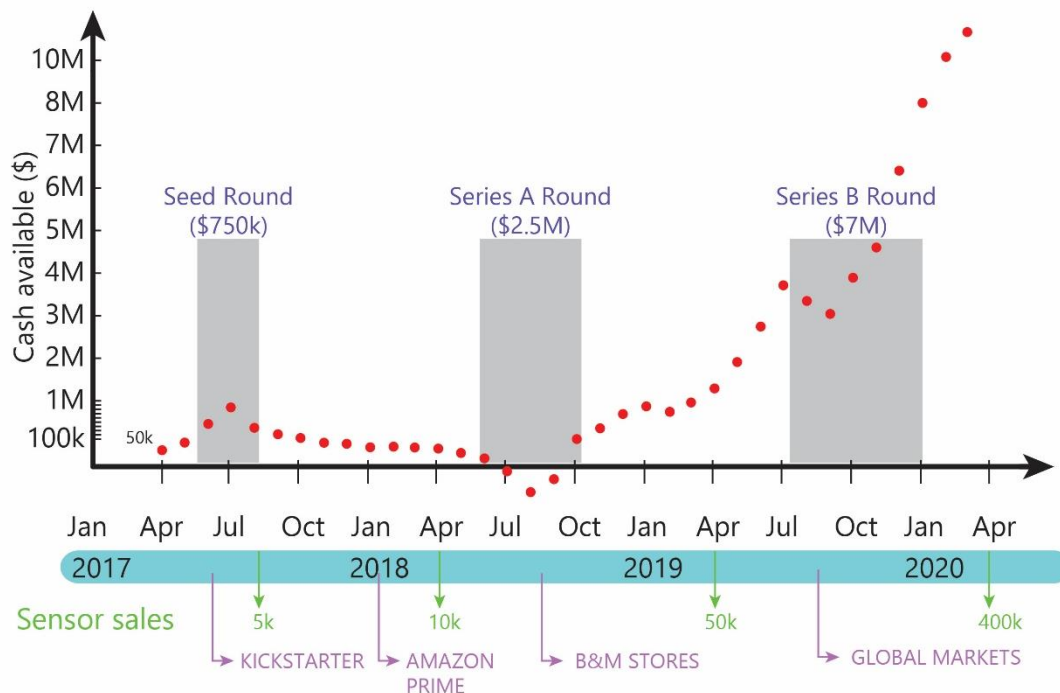
By Apr-May 2017, Post EIC and BPC, we anticipate $50k cash on hand. We aim to raise a $750k SEED round at a valuation of $1.5M in July 2017 (post-Kickstarter Success). We will invest the funds in tooling, manufacturing of the sensors and building the Airy Team. We will come back in a year at a 3-4x valuation to raise $2.5M SERIES A needed to scale Airy to B&M stores. We anticipate being cash positive with cash in-flow from the sensor, hub sales and premium service (24x7 monitoring, exclusive App features) subsrciption. We will be raising $7M+ SERIES B funding by late 2019 to propel Airy into other global markets.

WHAT'S IN THE NAME?

Airy means carefree – like the namesake **battery-less**, maintenance-free, sensors. In addition, Airy *breathes* environmental-friendly, which is the purpose that drives our creativity.

WHY NOW?

These micro electromagnetic generators that powers (literally!) an Airy sensor have been recently introduced by ZF (formerly Cheery Switches). Door and window sensors are ideal implementations as their operation provides necessary mechanical stimulus for electrical power generation. Competing energy-harvesting techniques like Solar are not ideal for indoor application. They often need large surface areas to generate enough electrical energy, thereby making them unaesthetic and difficult to hide from sight (which is essential for security applications like door window sensing). Piezoelectric does not generate enough power to transmit RF messages through walls and ceiling in the house. Additionally, the patent covering this technology 'Battery-less

sensor used in security applications' (US 5572190) has expired and now the idea and the technology are prime for commercialization.

DEMOS PLANNED

Our goal for the product is a sensor enclosure that could be adapted to a variety of applications like swing doors, slider doors, vertical and horizontal sliding and swinging windows, and cabinets (liquor, jewelry). At the EIC, we will have an interactive display of sensors mounted on miniature doors and windows, their integration with the existing Hook Hub and the smartphone App that shows the current state (open or close) of the doors and windows. We have received prototype funding ($2,200) to build the demos.

PROTOTYPES
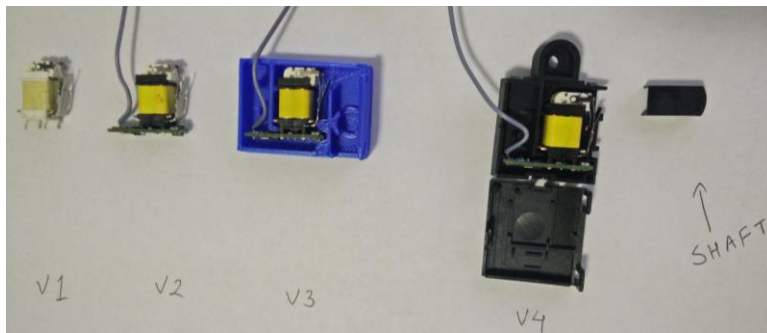
We are still tweaking the designs but we are getting close. More information with videos and demonstrations at www.airyliving.com