

Hardware, Apps, and Surveys at Scale: Insights from Measuring Grid Reliability in Accra, Ghana

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Accra, Ghana



Measuring electricity reliability in Accra

- Ghana Power Compact \$498 million investment from US Federal Government
- Compact aims include reducing power outages, and stabilizing voltage
- Dumsor occurred from 2013 until 2015 due to under generation
- Current power situation could improve

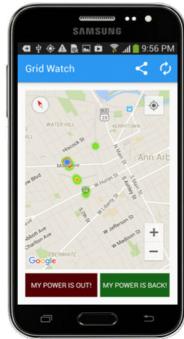


Deployment Methodology

Measurements

- When does the power go out?
- Where does the power go out?
- How long is the power out?
- What equipment on the grid failed?
- Is voltage stable?
- Economic impacts?

Instruments



App

Location,
Power state,
Time



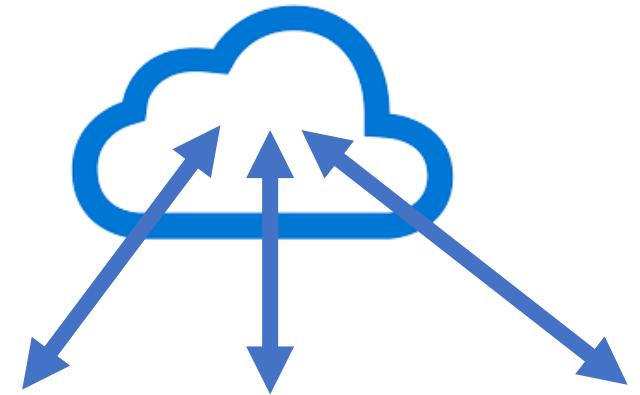
Plug Load

Location,
Power state,
Time,
Voltage,
Frequency



Survey

Supporting Services



Incentive System

Deployment Management

Data Insight System

Outline

- Introduction
- Small scale deployment
- Medium scale deployment
- Large scale deployment
- Conclusions

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Small-scale: The first deployment

- Deployment goal: Do the sensors work?
 - GPS fix
 - Operated at 240v/50hz
 - Connects to cellular network



12 Plug-load sensors used in small scale deployment

Going beyond consumer needs

- Limit of 3 SIM cards due to security concerns

MTN fights simbox fraudsters

2 min read

383 16



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MTN Ghana in collaboration with an anti-fraud team made up of the Criminal Investigations Department (CID) of the Ghana Police Service, National Communications Authority (NCA) and other telecom service providers have nabbed two suspects engaged in a SIM Box syndicate operating in Dome –Pillar 2, Accra.

CNR CITI NEWSROOM

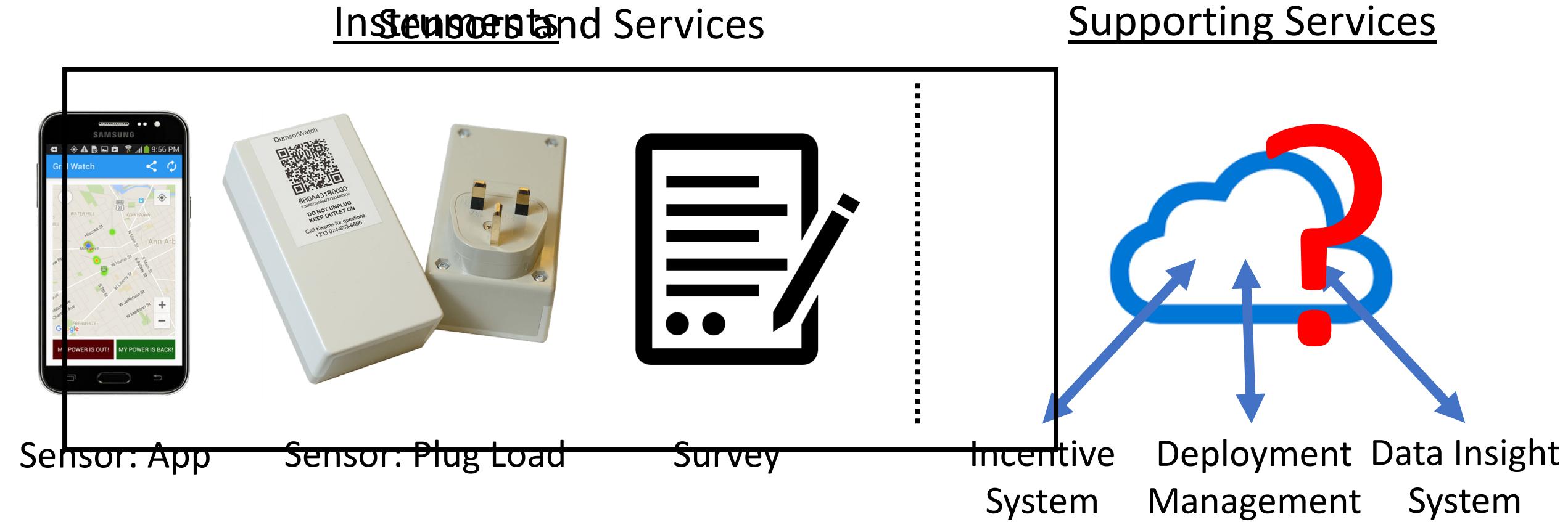
HOME BUSINESS POLITICS SHOWBIZ SPORTS ODD BUT TRUE OPINION RELATIONSHIP INFOGRAPHICS

Gov't to clamp down on SIM card fraudsters

Posted by Godwin Akweiteh Allotey | Date: Apr 1, 2019 6:56am



Lesson: The deployment is the system



Outline

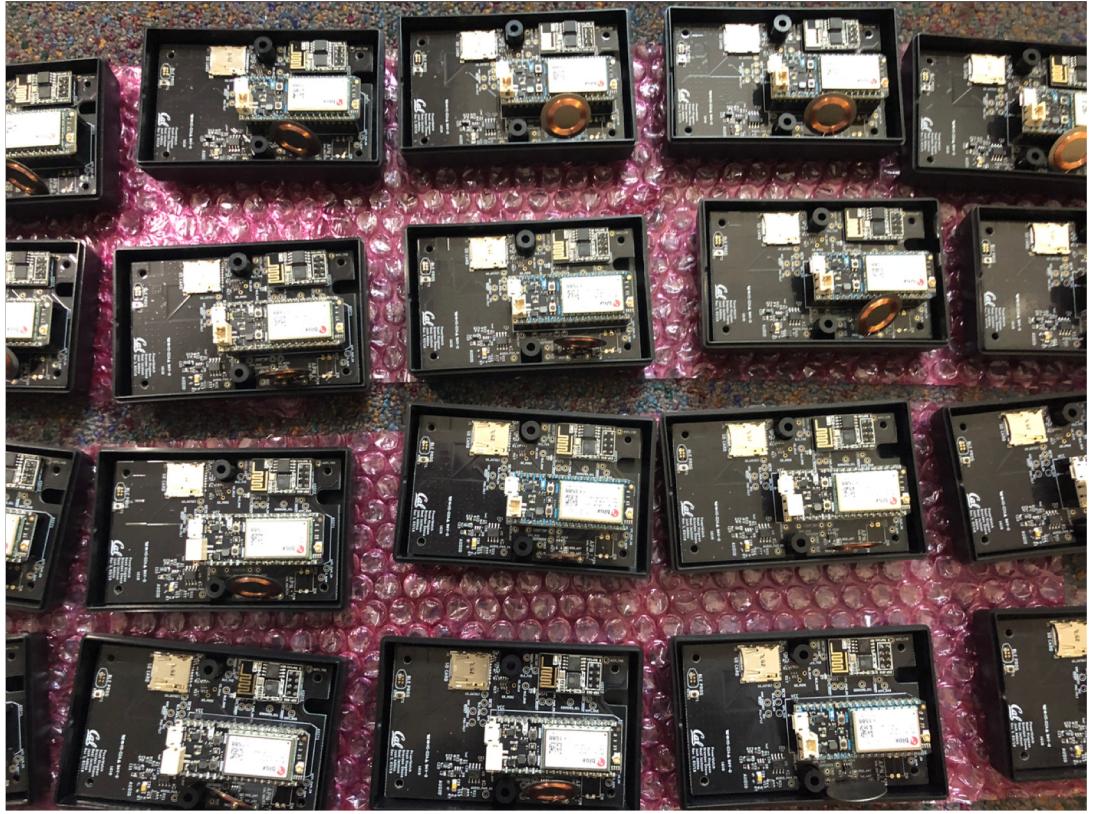
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Medium-scale: The second deployment

- Goal: Measurements power quality in a single district of Accra
- 2,000 app downloads and short surveys
- 165 plug-load installations and long survey
- Fully implemented deployment methodology



20 of the 165 plug-load sensors deployed at medium scale

Local insight is critical for participant recruitment

- Talking with local people helps understand how to legitimize our work in Accra



ACCRA
METROPOLITAN
ASSEMBLY

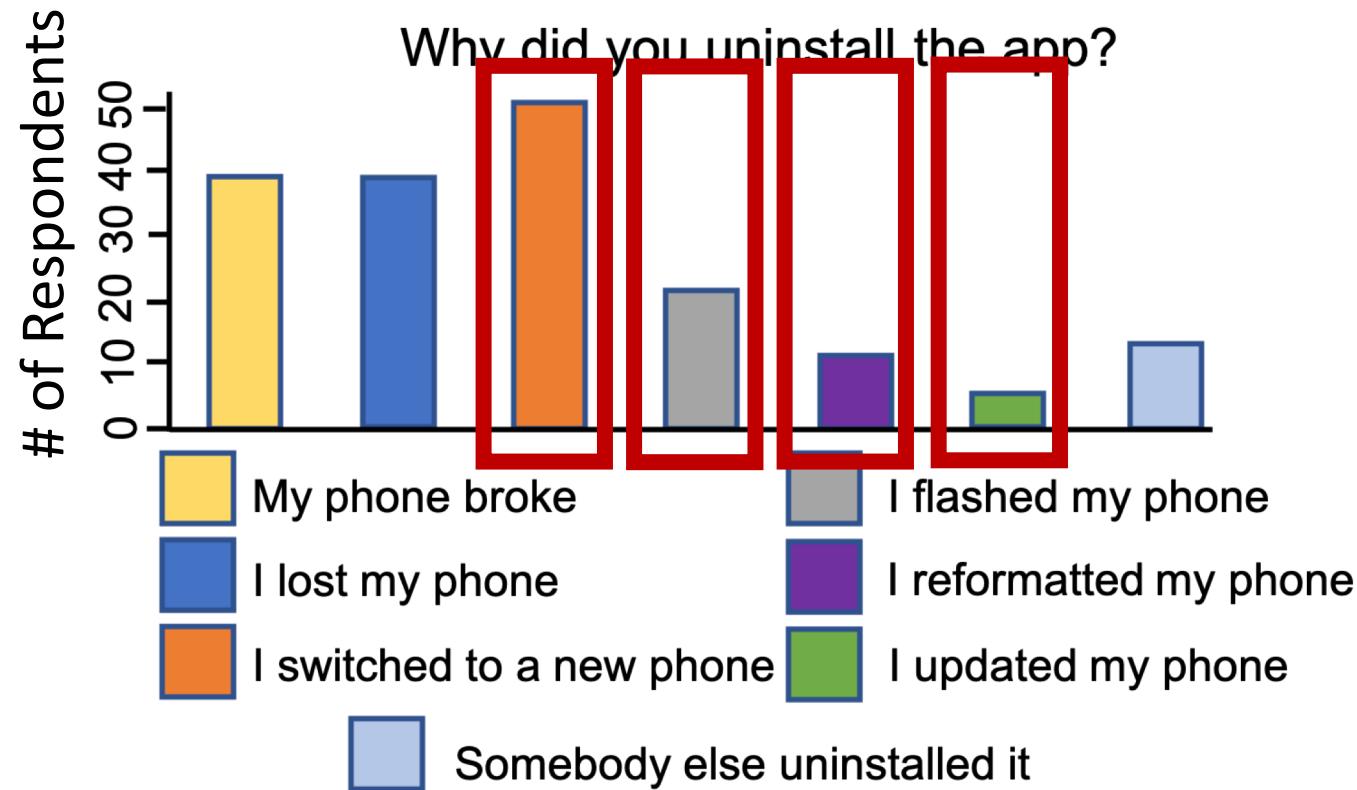
Assembly permission was
important



Kelvin, a team lead, and the other field officers in the red,
Dumsorwatch uniforms

Participant behavior is unexpected

- Sensors depending on participant behavior require flexibility



Scale doesn't bootstrap trust

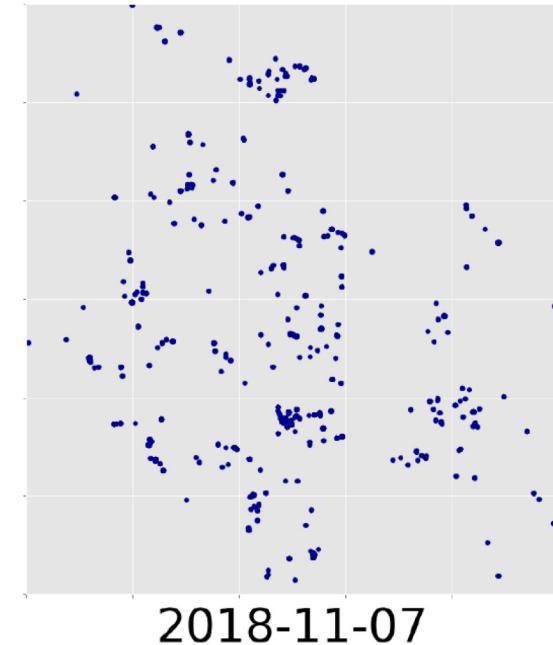
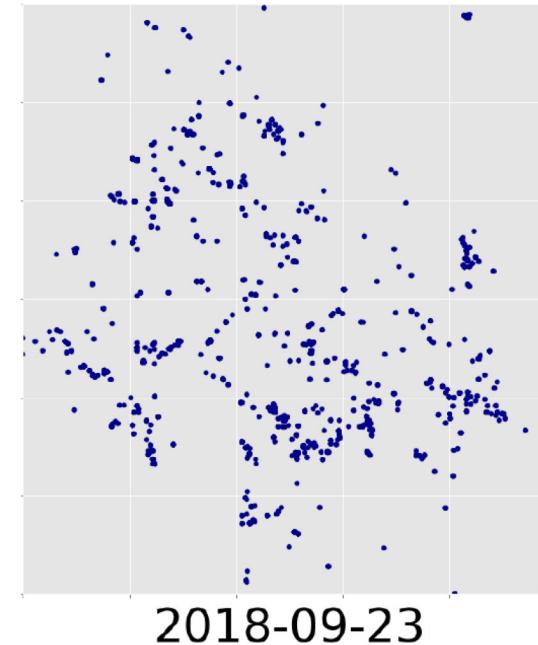
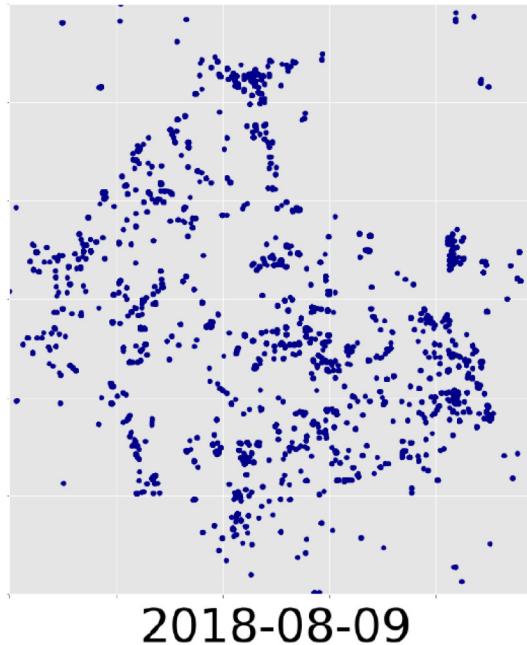
- Local resources were made available slowly
- Acquiring resources required in-country presence



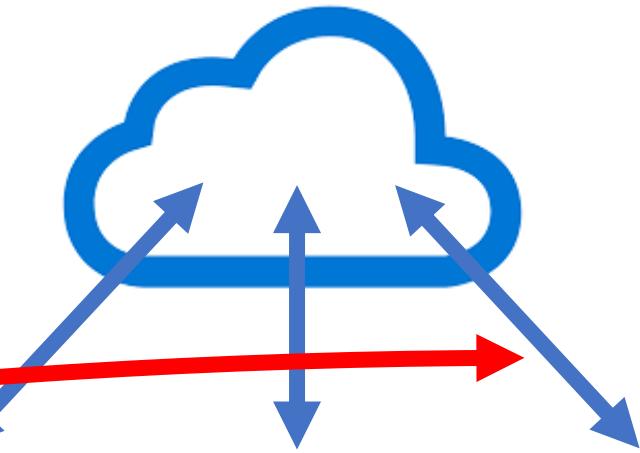
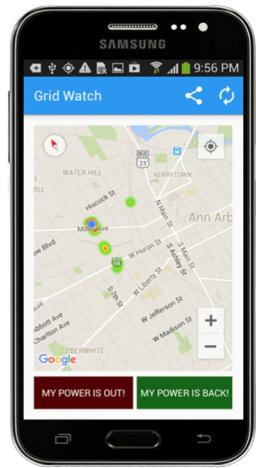
400 MTN prepaid SIM cards acquired after months of effort

Each subsystem matters at scale

- Research systems are not deployment ready
- Software bugs, missed payments meant high attrition

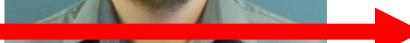
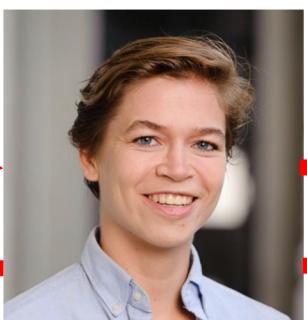


Lesson: Information flow is critical



Incentive
System

Deployment Data Insight
Management System



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Large-scale: The third deployment

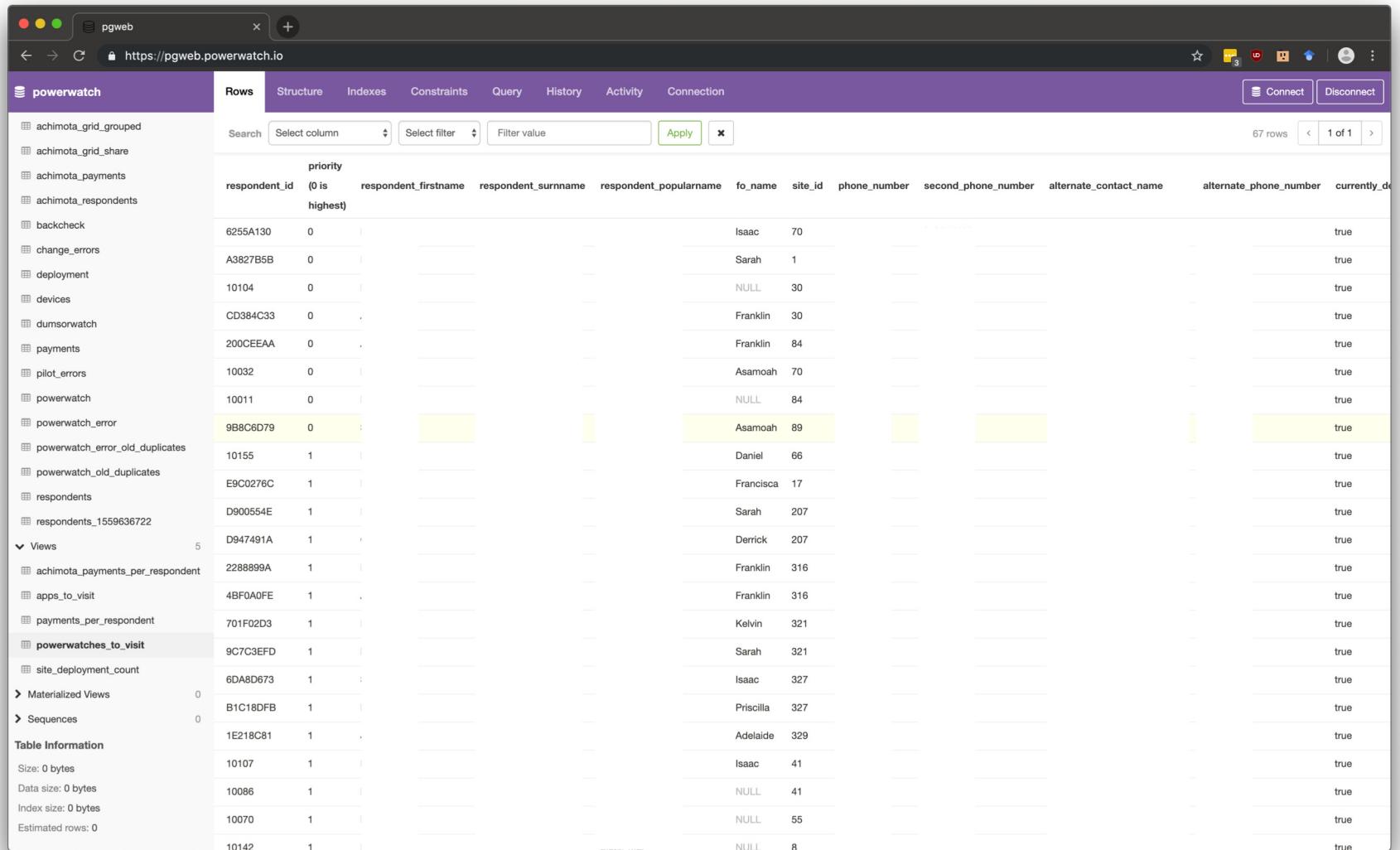
- Goal: Measurements power quality in two more districts of Accra
- 1,400 app downloads and short surveys (total 3,400)
- 292 plug-load installations and long survey (total 457)



A shelf of assembled plug-load sensors

Automating deployment management

- At scale, lots of state is always in flux
- Input errors are more common and have a big impact
- A single, safe interface for all non-expert users



The screenshot shows a web-based PostgreSQL interface called pgweb. The main window displays a table titled 'powerwatch' with various columns: priority, respondent_id, respondent_firstname, respondent_surname, respondent_popularname, fo_name, site_id, phone_number, second_phone_number, alternate_contact_name, alternate_phone_number, and currently_de. The table contains 67 rows of data, with the first few rows shown below:

priority	respondent_id	respondent_firstname	respondent_surname	respondent_popularname	fo_name	site_id	phone_number	second_phone_number	alternate_contact_name	alternate_phone_number	currently_de
	6255A130	0					Isaac	70			true
	A3827B5B	0					Sarah	1			true
	10104	0					NULL	30			true
	CD384C33	0					Franklin	30			true
	200CEEA	0					Franklin	84			true
	10032	0					Asamoah	70			true
	10011	0					NULL	84			true
	9B8C6D79	0					Asamoah	89			true
	10155	1					Daniel	66			true
	E9C0276C	1					Francisca	17			true
	D900554E	1					Sarah	207			true
	D947491A	1					Derrick	207			true
	2288899A	1					Franklin	316			true
	4BF0AOFE	1					Franklin	316			true
	701F02D3	1					Kelvin	321			true
	9C7C3EFD	1					Sarah	321			true
	6DA8D673	1					Isaac	327			true
	B1C18DFB	1					Priscilla	327			true
	1E218C81	1					Adelaide	329			true
	10107	1					Isaac	41			true
	10086	1					NULL	41			true
	10070	1					NULL	55			true
	10142	1					NULL	8			true

On the left side of the interface, there is a sidebar with a tree view of database objects, including tables like 'achimota_grid_grouped', 'achimota_grid_share', 'achimota_payments', 'achimota_respondents', 'backcheck', 'change_errors', 'deployment', 'devices', 'dumoswatch', 'payments', 'pilot_errors', 'powerwatch', 'powerwatch_error', 'powerwatch_error_old_duplicates', 'powerwatch_old_duplicates', 'respondents', 'respondents_1559636722', and various views and sequences. Below the sidebar, there is a section titled 'Table Information' with details about the table size and estimated rows.

Deployment management in practice



Using the Deployment Management System in the field

Administrative hurdles at home

- Universities move slowly
- Financial agility is key
- Conforming to University policy can be hard
- Financial concerns, even with full funding, caused large delays

Laboratory as a factory

- Assembly too small for traditional factory
- 10 undergraduates, 98% yield



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Conclusions

- Scale requires automating interfaces and information flow
- Test local assumptions early
- Deploy

<u>Scale</u>	<u>Districts</u>	<u>Plug-load Sensors</u>	<u>DumsorWatch App</u>	<u>Deployment Date</u>	<u>Number of FOs</u>
Small	0	12	5	May 2018	0
Medium	1	165	2000	Aug 2018	11
Large	2	293	1400	Feb 2019	14
Total	3	457	3400		

Thank you!

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JOIN DUMSORWATCH!!!
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