A2E ACCESS TO ENERGY INSTITUTE I

#StopGuessing

Clean-E-Cooking: Revealing Opportunities

January, 2022
A2EI Webinar
Nora Schürhoff & Elliot Avila

#StopGuessing

#1 Introduction to A2EI

#2 Overview of Smart Meters

#3 Research Background

#4 Discussion of Results

#5 Q&A

#6 Sneak Previews

#1 Introduction

#1 Introduction to Access to Energy Institute

A2EI

A2EI is a non-profit, R&D platform addressing topics of access to energy access, clean cooking, and income-generation through technology innovation and research.

Our approach is data-focused, open-source and collaborative.

Supported by

IKEA Foundation

STICHTING DOEN NATIONALE POSTCODE LOTERIJ

FMO Entrepreneurial Development Bank

Good Energies POWER FOR A BETTER WORLD

#1 Why Clean-E-Cooking?

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Clean cooking has tremendous ecological and socio-economic impact potential

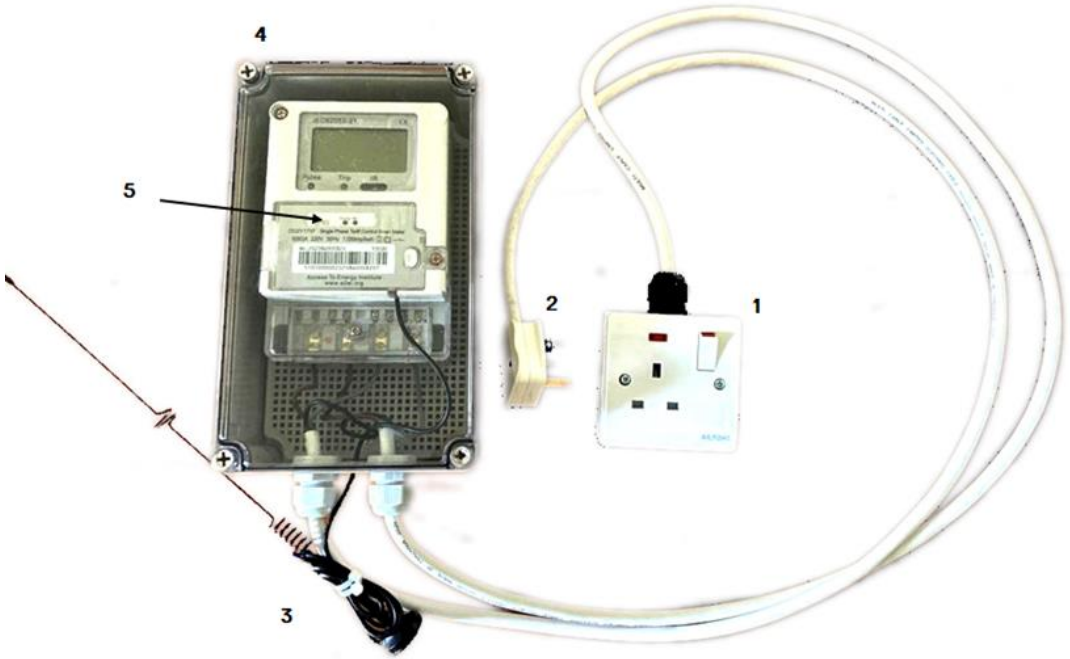
Electric cooking technologies can enable #CleanCooking to be a reality for millions of people. But how do we get there?

#StopGuessing leads to #StartCleanCooking

#2 Smart Meter Data

#2 A2EI Smart Meters – What are they?

A2EI



Legend	
1	Socket
2	Plug for wall
3	Antenna
4	Smart Meter
5	LED Indicators

Smart meters are installed in between monitored appliance and the grid.

#2 Smart Meter Data

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	A	B	C	D	E	F	I	J	K	L	M	N
1	account_id	meter_r	region	region_timezone	event_time_utc_st	event_time_utc_en	event_duration	event_energy_start	event_energy_	event_energy	event_current_max	event_count
2	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-06-01 05:10:00	2020-06-01 05:22:19.	12.33	20.94	21.10	0.16	4.22	1
3	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-11-30 16:30:00	2020-11-30 17:59:40.	89.67	21.10	21.85	0.75	4.12	2
4	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-01 10:22:40	2020-12-01 10:30:00+	7.33	21.85	21.95	0.10	4.16	3
5	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-02 15:58:49	2020-12-02 16:40:00+	41.17	21.95	22.36	0.41	4.14	4
6	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-03 17:45:54	2020-12-03 18:35:00+	49.08	22.40	22.85	0.46	4.09	5
7	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-05 07:10:00	2020-12-05 08:25:00+	75.00	22.85	23.28	0.43	4.11	6
8	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-05 08:40:00	2020-12-05 09:00:00+	20.00	23.29	23.41	0.12	4.08	7
9	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-05 16:48:15	2020-12-05 18:25:00+	96.75	23.43	24.36	0.93	4.08	8
10	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-07 10:00:00	2020-12-07 11:10:00+	70.00	24.36	24.85	0.49	4.02	9
11	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-07 15:55:00	2020-12-07 16:55:00+	60.00	24.86	25.33	0.47	4.10	10
12	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-09 14:55:00	2020-12-09 15:00:00+	5.00	25.45	25.49	0.04	4.13	11
13	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-09 15:12:05	2020-12-09 15:30:00+	17.92	25.52	25.61	0.09	4.12	12
14	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-09 16:00:00	2020-12-09 16:25:00+	25.00	25.61	25.71	0.10	4.11	13
15	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-10 06:10:00	2020-12-10 06:50:00+	40.00	25.71	26.11	0.40	4.18	14
16	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-10 09:20:19	2020-12-10 09:50:00+	29.67	26.11	26.29	0.18	4.03	15
17	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-10 10:50:00	2020-12-10 11:10:00+	20.00	26.30	26.53	0.23	4.13	16
18	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-10 14:56:30	2020-12-10 17:00:00+	123.50	26.56	27.89	1.33	4.14	17
19	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-11 06:35:20	2020-12-11 07:50:00+	74.67	27.93	28.69	0.76	4.15	18
20	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-11 09:20:00	2020-12-11 09:45:00+	25.00	28.74	28.91	0.17	4.13	19
21	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-11 10:06:30	2020-12-11 11:50:00+	103.50	28.94	29.68	0.74	4.07	20
22	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-11 17:37:05	2020-12-11 18:00:00+	22.92	29.71	30.01	0.31	4.13	21
23	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-12 05:14:45	2020-12-12 06:20:00+	65.25	30.06	30.63	0.57	4.18	22
24	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-12 09:56:30	2020-12-12 10:55:00+	58.50	30.63	31.33	0.70	4.12	23
25	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-12 12:25:19	2020-12-12 12:35:00+	9.67	31.33	31.44	0.11	4.12	24
26	214	546365	TZ cooking pilot	Africa/Dar_es_Salaam	2020-12-12 15:05:54	2020-12-12 15:30:00+	24.08	31.48	31.63	0.15	4.13	25

Data is uploaded to database, processed, analyzed, and converted into .csv files for more analysis by partners and the public.

#2 Measuring Appliance Characteristics

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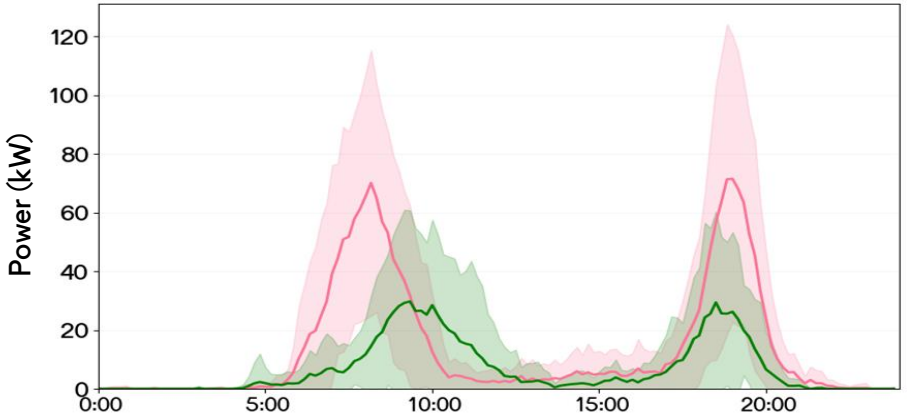
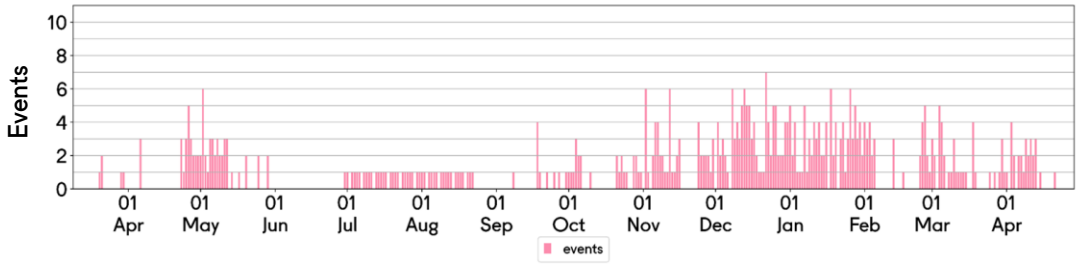
Smart meters can be used for high-resolution monitoring of appliances to understand usage patterns and user behavior.

Ex: developing load profiles to understand how much power is consumed throughout the day

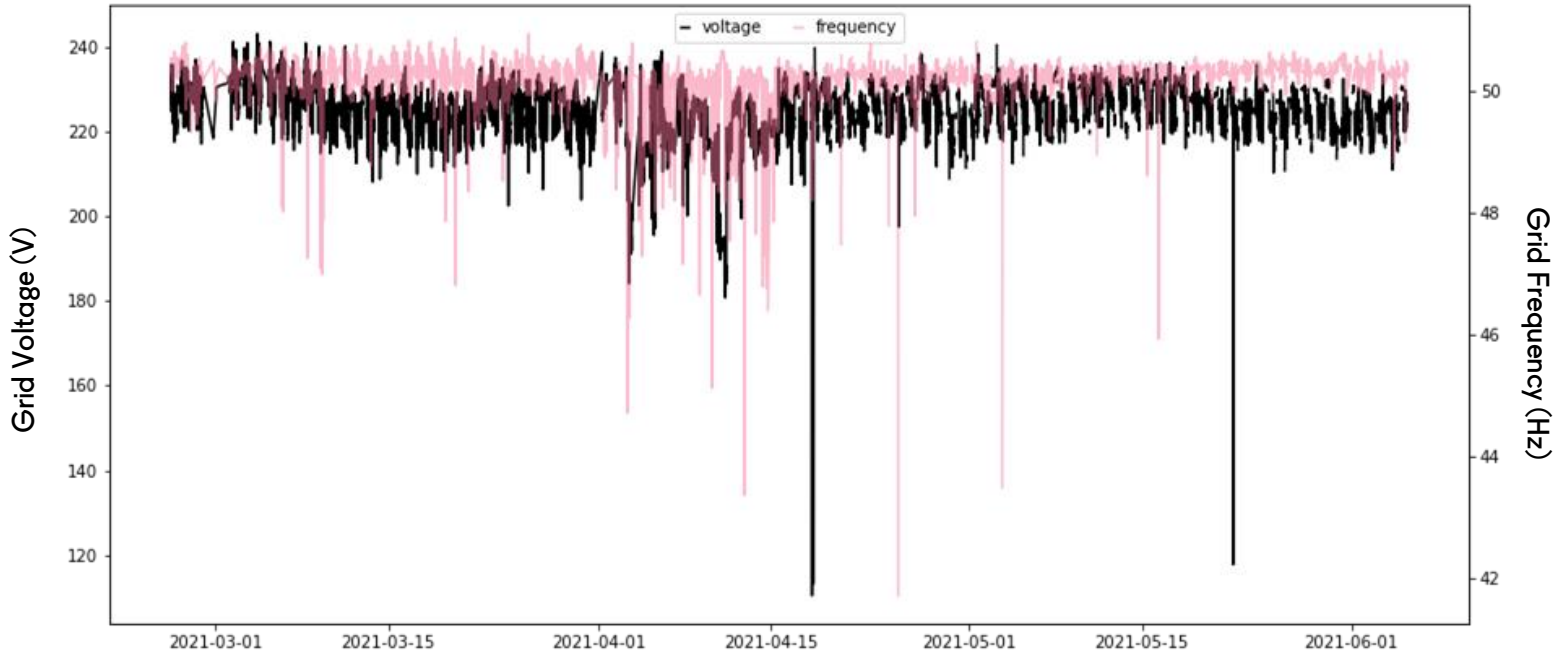




Ex: monitoring household utilization over long time periods to estimate demand

#2 Measuring Grid Characteristics

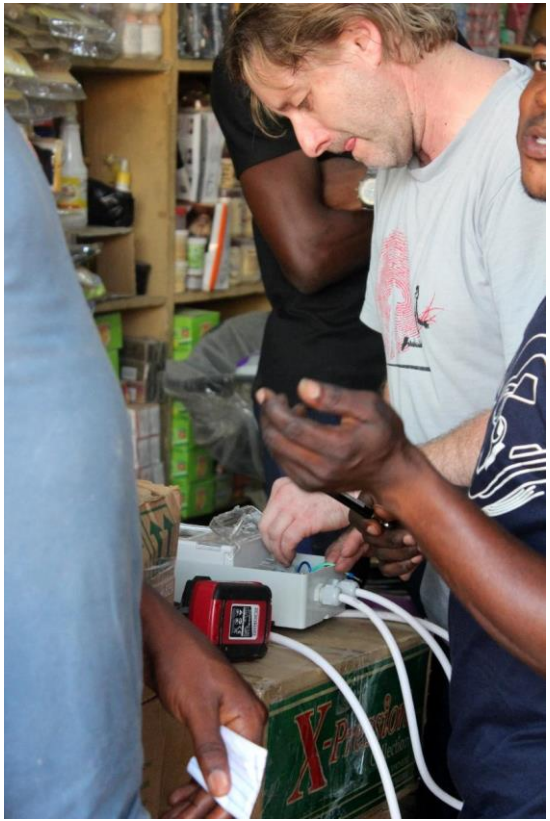
A2EI



The same smart meters can also be used for monitoring grid voltage and frequency to understand electricity availability/quality

#2 Smart Meter Features

A2EI



Remote monitoring of any AC electric appliances (EPC, hotplate, etc.) and/or the grid

High fidelity data on energy, power, frequency, voltage, up to 1 minute resolution

Plug-and-play: easy to install

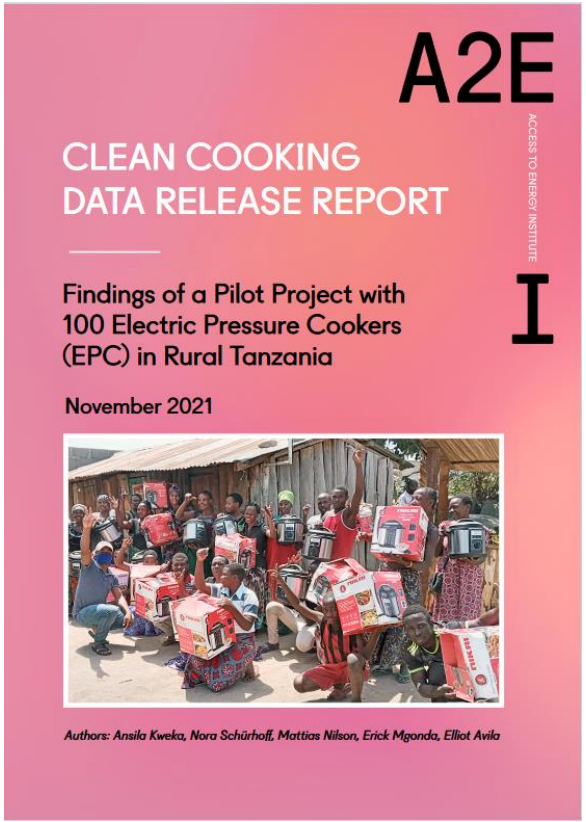
Internal back-up storage

Automated data analysis

2 years of field validation

#2 Today's Topic: Data Release

A2EI



A2EI has released an open-source dataset collected by smart meters during a pilot conducted in Tanzania that includes:

347,529 data points

18,142 cooking events

The summary report and dataset are available on A2EI's website.

First in a series of data releases and publications that will be made open access this year.

#StopGuessing and #StartCleanCooking

#3 Research Background

#3 100 EPC Project Overview

A2EI

- 100 households at six different mini-grid villages in Tanzania
- Electric pressure cookers (EPCs) connected to smart meters
- Duration: March 2020 – April 2021
- Tariff:
  - March – September: >$1/kWh
  - October – April: $0.04/kWh
- Grid Restrictions: January – April 2021

Pilot Partners

NEXLEAF ANALYTICS

Biomass Cookstove Monitoring

MECS Modern Energy Cooking Services

Cooking Diary Data Collection

PowerGen

Community Outreach and HH Energy Consumption

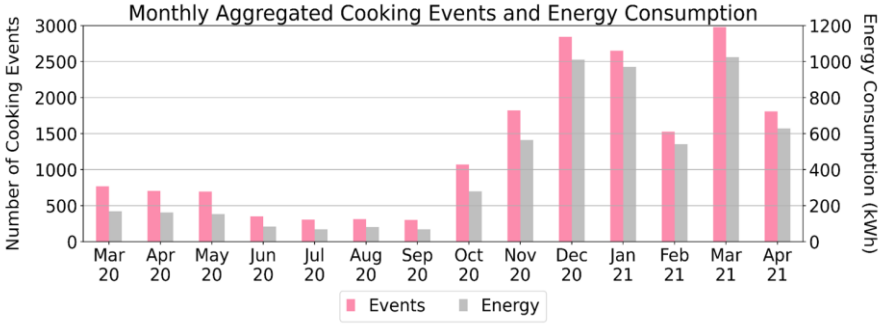
#3 Research Questions

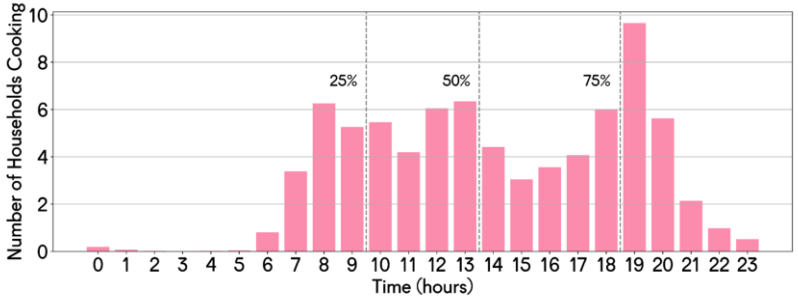
A2EI

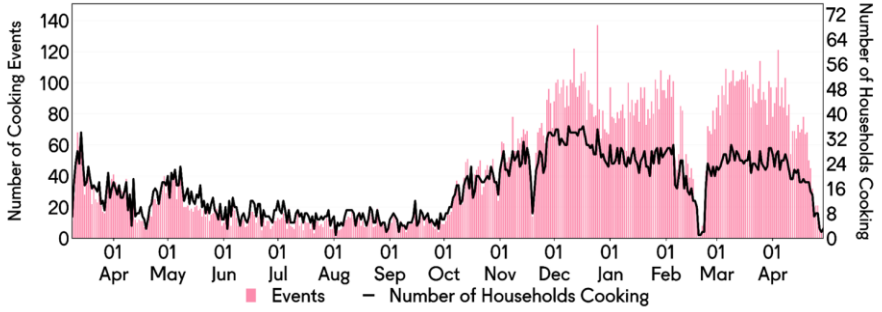
Main question: Are electric cooking appliances the future of clean cooking?

Additional questions:

1. How did individuals cook with the EPC?
2. What did EPC cooking look like at the community level?
3. How did representative users cook?
4. How did cooking behavior change when the price dropped?
5. What was the effect of cooking on the grid?



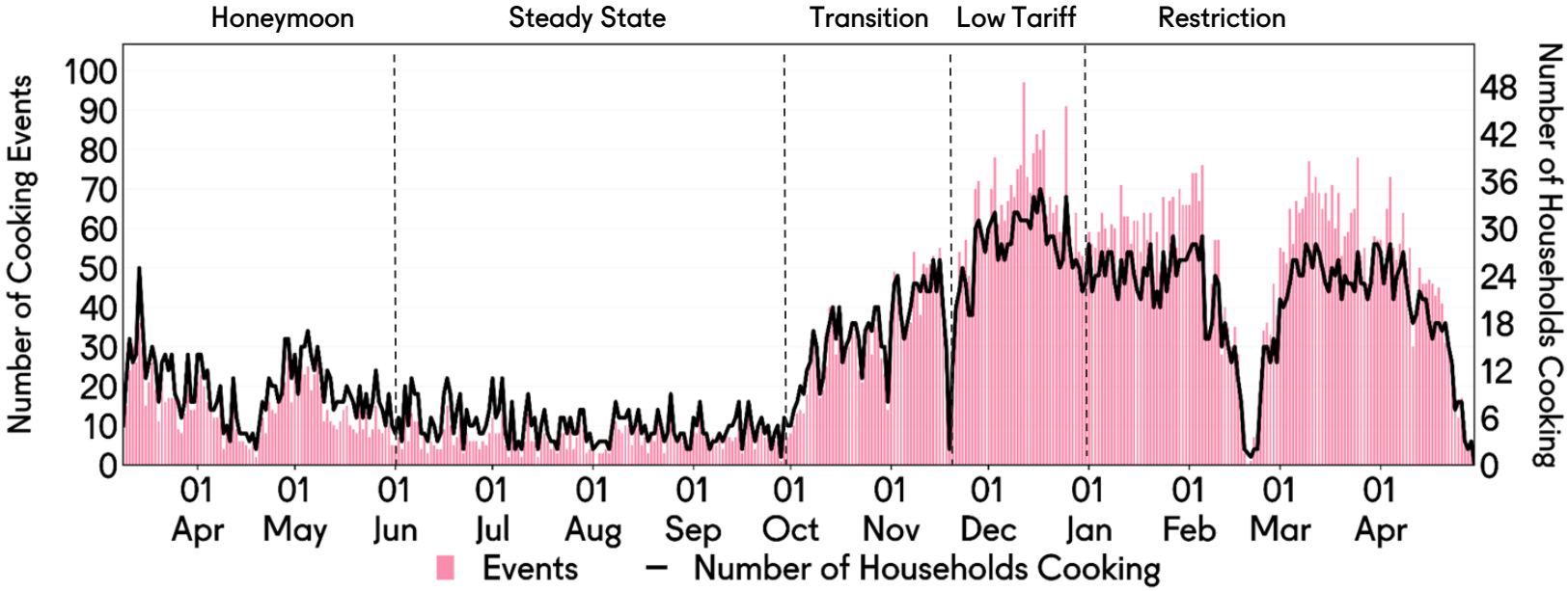




#4 Discussion of Results

#4 Changes of Cooking Behaviour after Price Drop

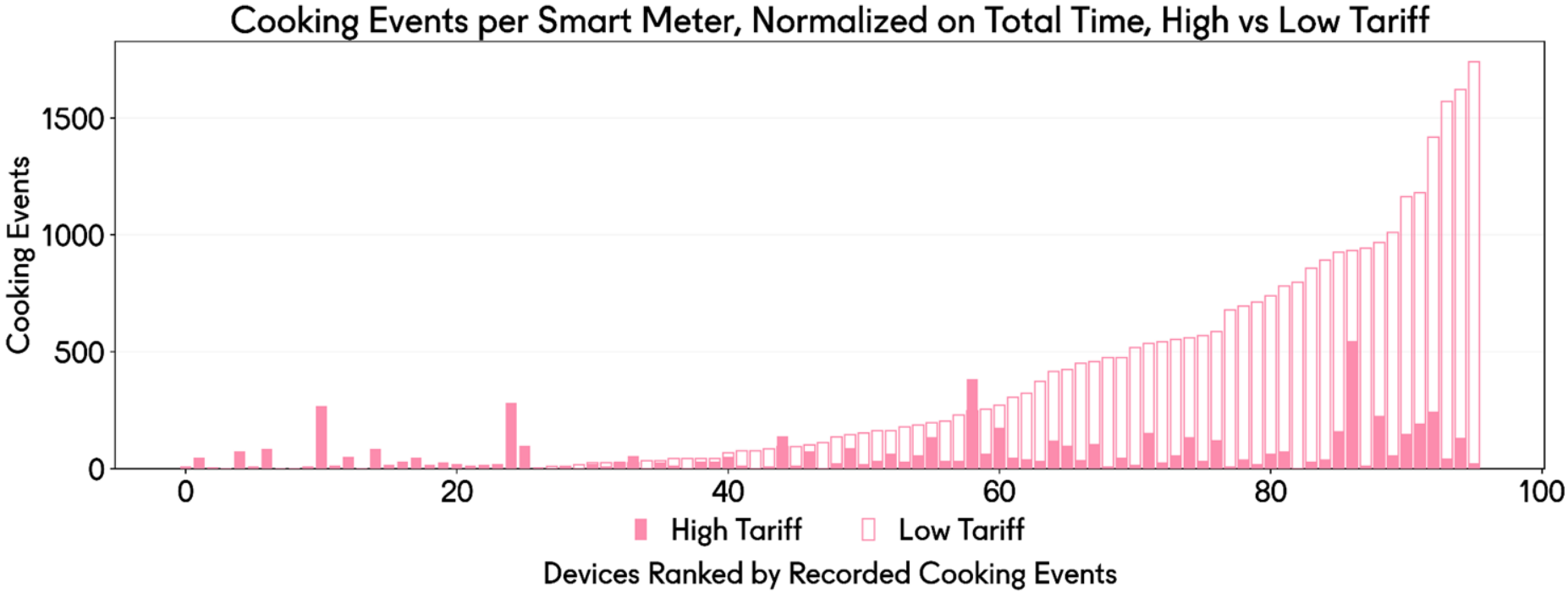
A2EI



- Oct 5 - Nov 18: Transition to low-cost cooking across sites
- Nov 19 - Dec 31: Cooking at $0.04/kWh across all sites. Most interesting phase.
- Jan 01 - Apr 24: Power restrictions at several sites.

#4 How did Individuals Cook with the EPC?

A2EI

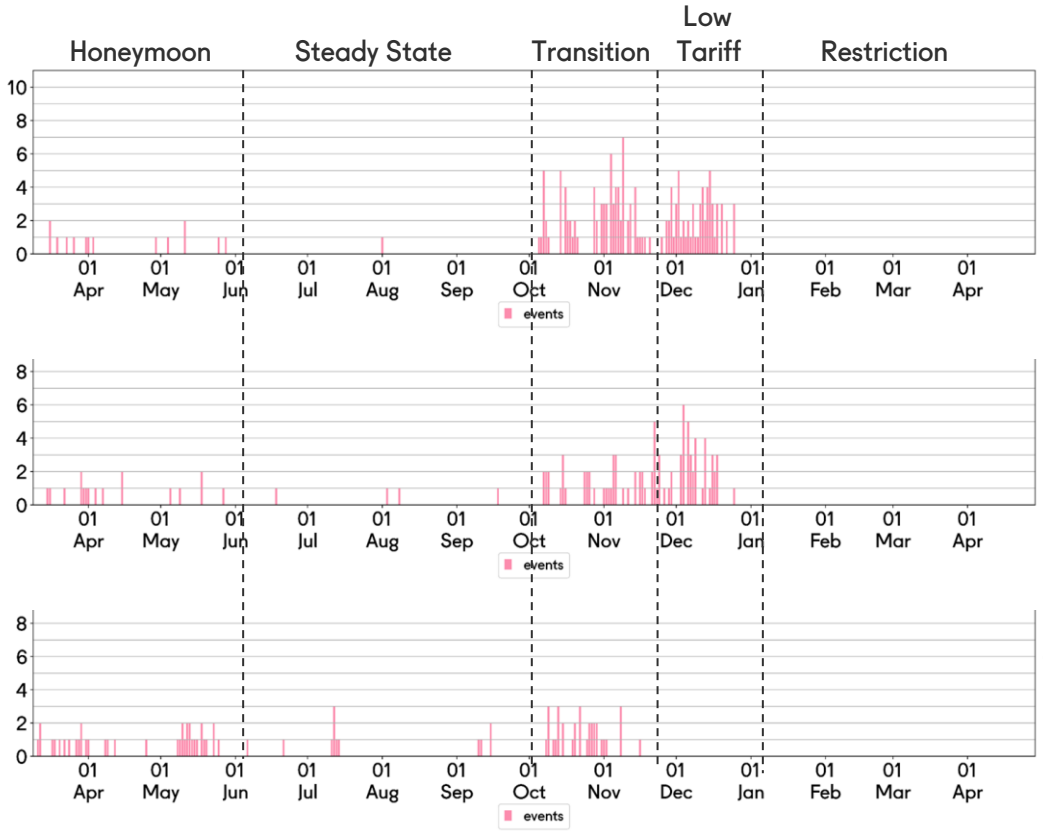


- Normalized total number of cooking events: 6072 with 93 active meters
- Normalized total number of cooking events: 30787 with 70 active meters

#4 Representative Users from Last Report

A2EI

- At Low Tariff period Low User (I) became champion, leading to price sensitivity hypothesis
- Found that reduction in price does not affect certain users more than others
- All three users stopped cooking in Jan 2021 due to restrictions
- All three users found only on mainland sites



#4 Users with Less Restrictions

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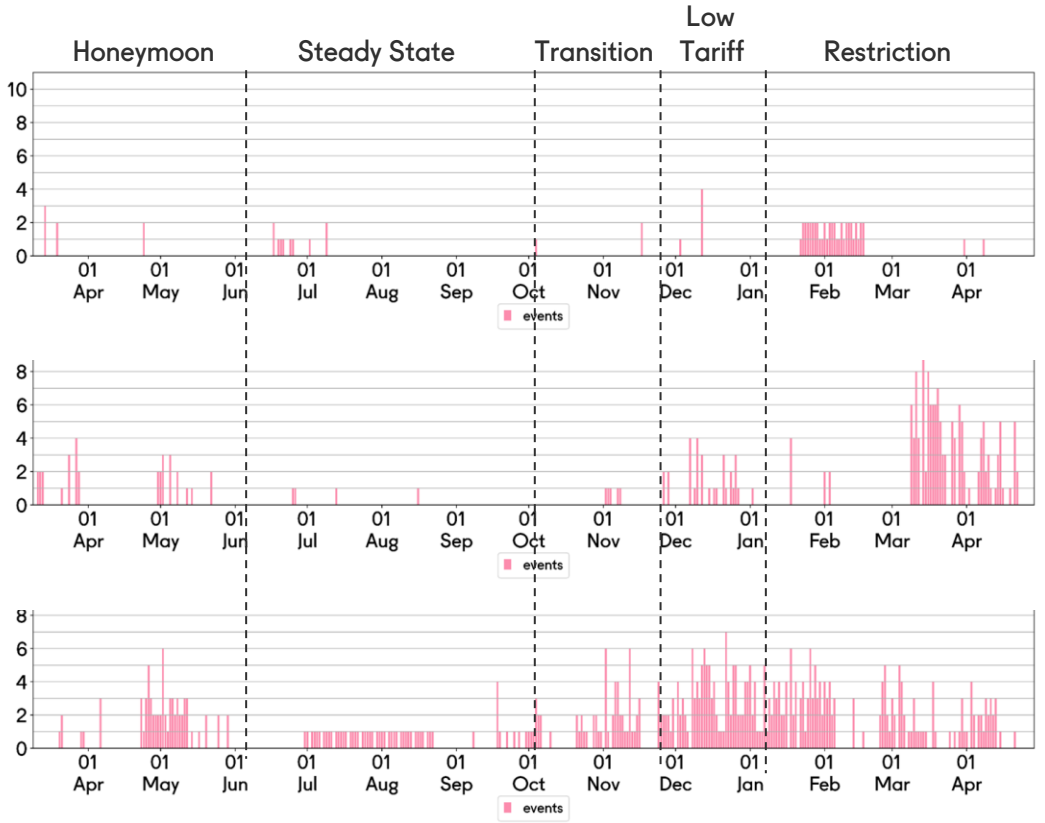
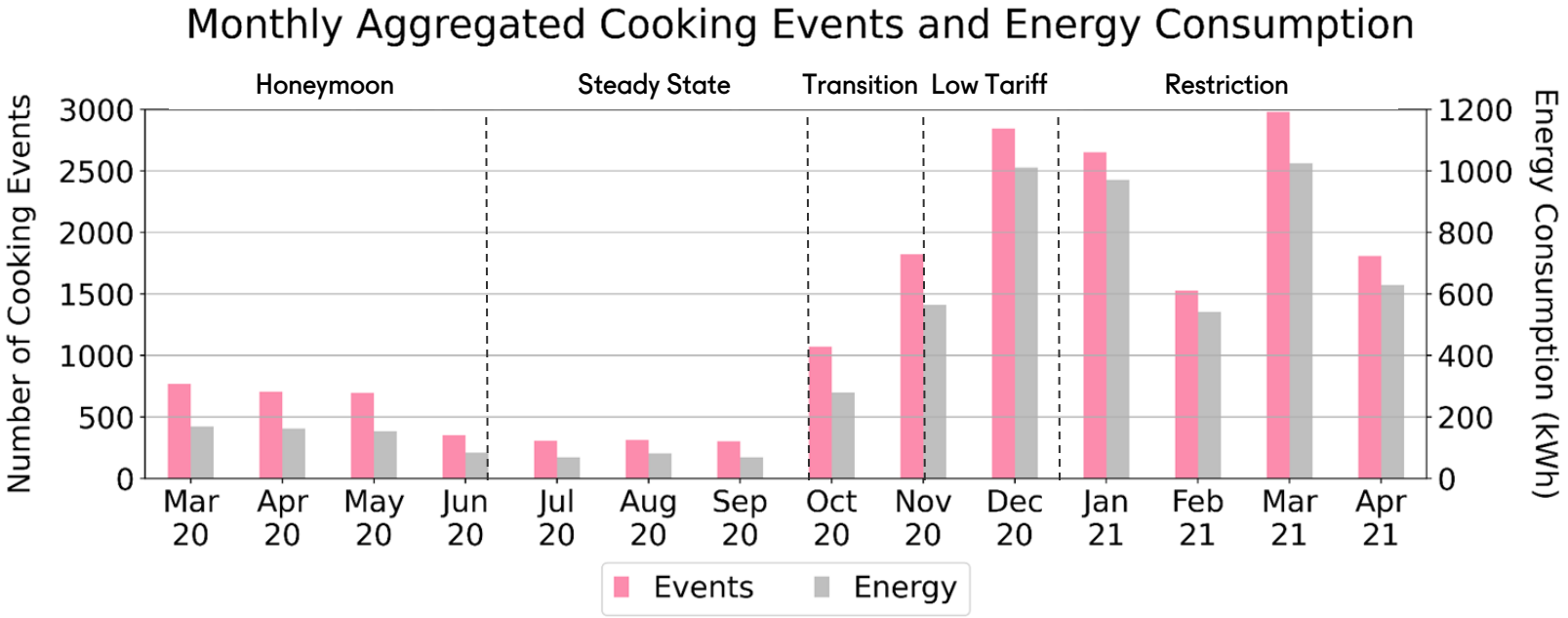
- Island households show different patterns than mainland
- High User (II) cooked more from November till February
- Low (II) and Medium (II) cooked more unevenly
- In Low Tariff High User: Average 2 cooking events, up to 6 per day
- Grid unavailability and load restrictions



#4 EPC Cooking At Community Level

A2EI

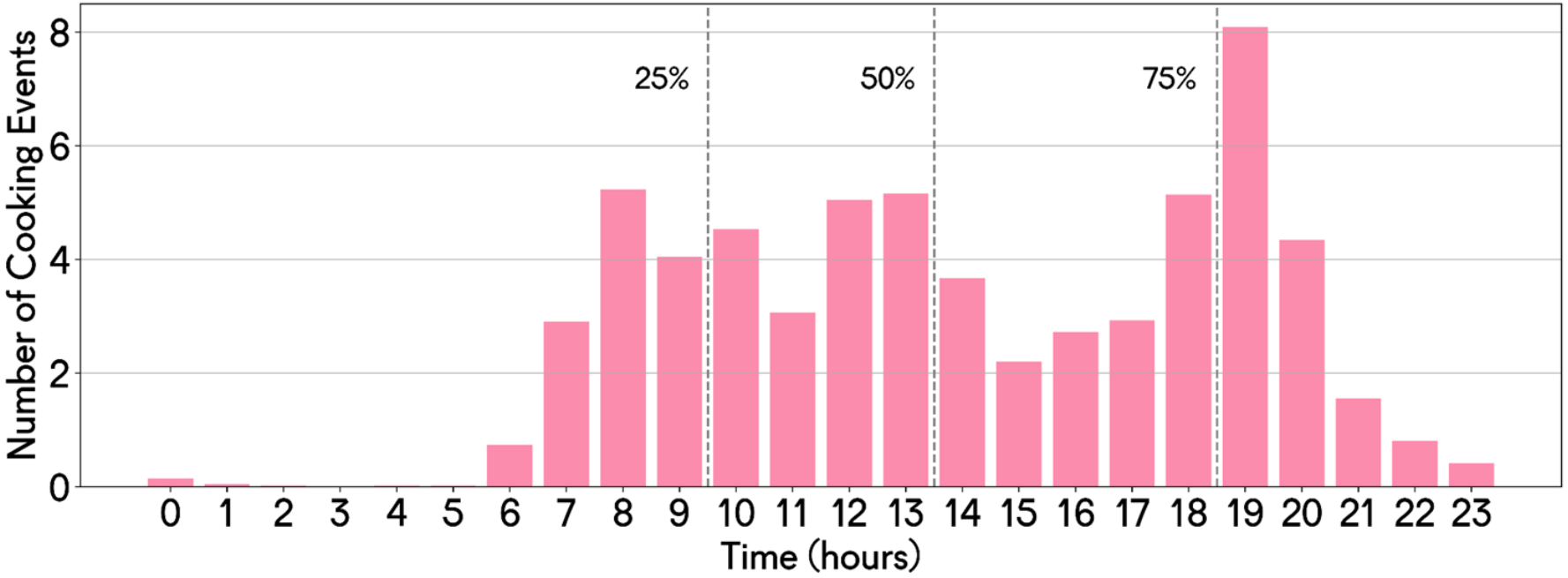


- Increase from Oct onwards, which might have continued without restrictions
- Traditional cookstove usage reduced by 164 minutes per household per day
- Total of CO_2 emission reduction of 21 kg per day

#4.2 Effects of Electric Cooking on the Grid

#4 What was the Effect of Cooking on the Grid?

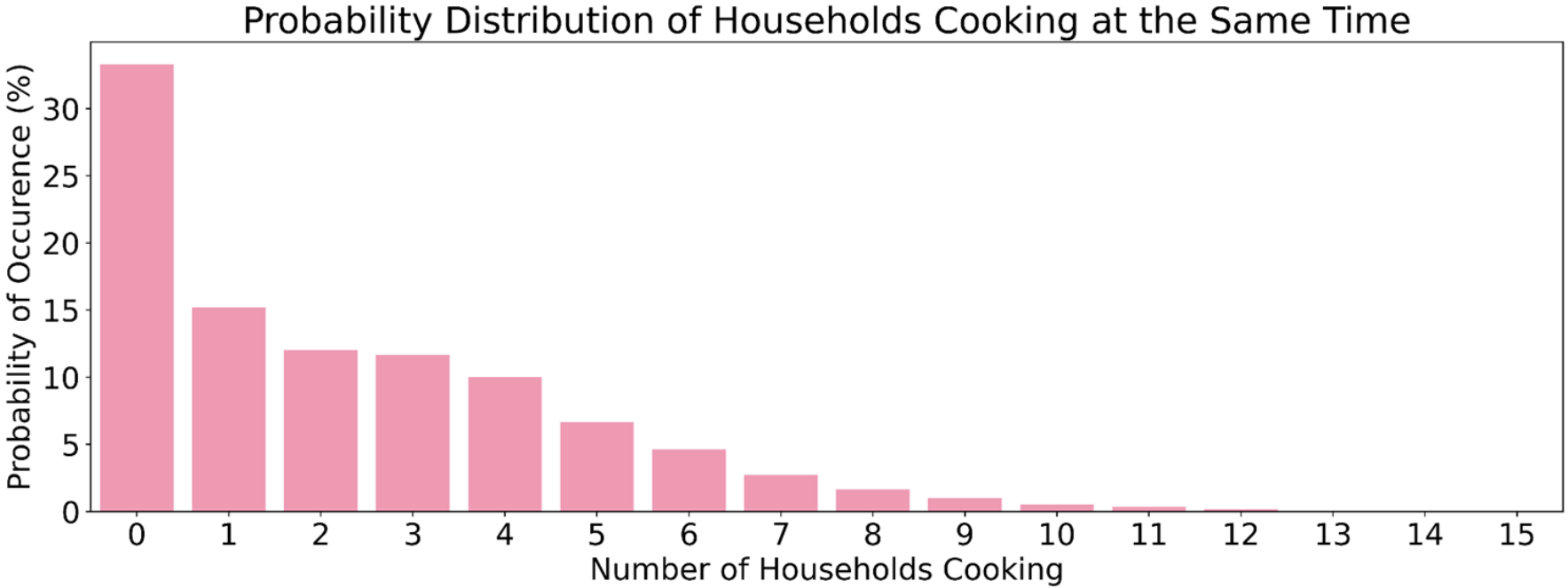
A2EI



- 17% of cooking during the night (before 8am or after 8pm)
- 50% between 10 am and 7pm
- Designing systems and understanding back-up options needed

#4 What was the Effect of Cooking on the Grid?

A2EI



- Highest number of households cooking simultaneously was 15
- The given grid would be able to provide the needed power for electric cooking for all connected households in 98% of times

#2 What was the Effect of Cooking on the Grid?

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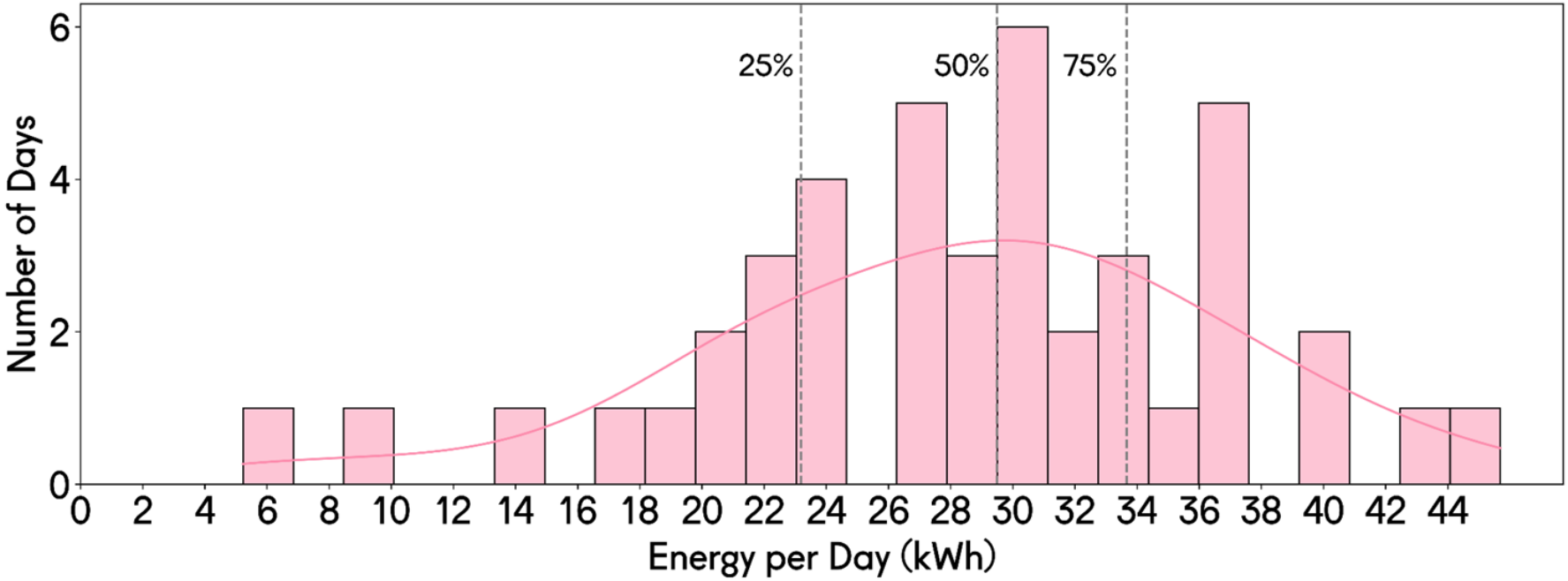


- In 50% of days less than 29kWh was consumed in one day
- Even maximum of 44kWh could be provided by given mini-grid
- Useful for designing mini grid systems which must generate sufficient energy

#4 Conclusions

A2EI

- Households loved using the EPC: used 2.9 times per day when used and up to 12 times per day maximum
- Traditional cookstove usage reduced by 164 minutes (60%) per day amongst active users
- Lowered emissions: 21kg CO_2 per day reduced in Low Tariff Period; Overall lower indoor CO and PM rates despite fuel stacking
- Current mini-grids can support electric cooking for all connections in 98% of times

#5 Q&A

#6 Sneak Previews

#6 A2EI's Clean-E-Cooking Program

A2EI

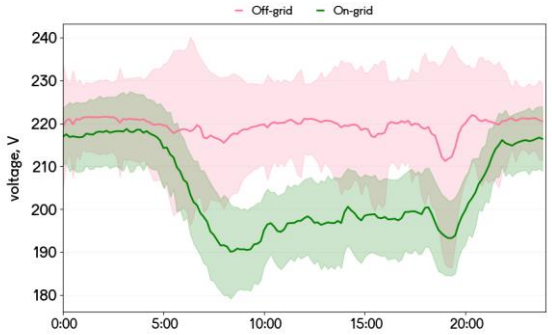
A2EI's clean-e-cooking program is:

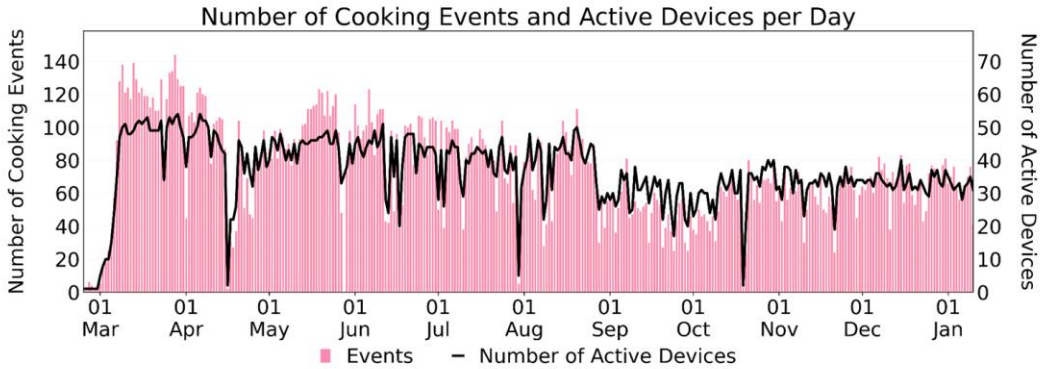
- Collecting electric cooking data in over 1300 households
- Releasing large, open-access datasets on electric cooking
- Publishing findings and sharing results with the public

#6 Sneak Preview: PAC and PEEDA Projects in Nepal

A2EI

- 220 meters are gathering data in on and off-grid sites
- >6 month of data
- Impact on grid effects, cost implications, time savings, energy and fossil fuel usage will be investigated





#6 Sneak Preview: CREEC Project in Uganda

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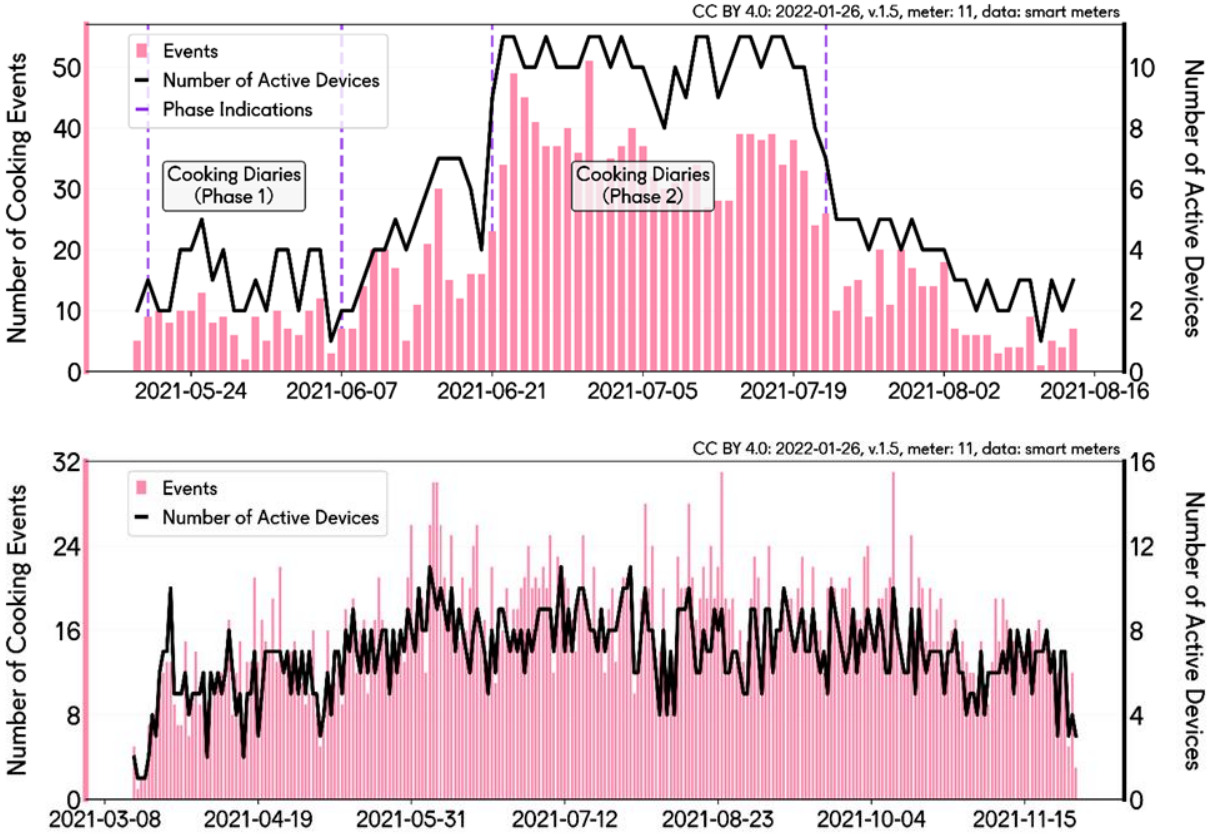
- What happens when you introduce electric cooking appliances into households in Kampala and ask them to use them as much as possible?
- Cooking with EPC went from 0% -> 43% of total!
- 4 households switched completely to e-cooking; each consuming more than 2 kWh with the EPC per day



Want to learn more?

Get the data, read the full report, and read our paper in Energies.

Sign up for new data releases, webinars, and publications on our website.

Share feedback on this webinar!

For additional questions and enquiries, contact:

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THANK YOU

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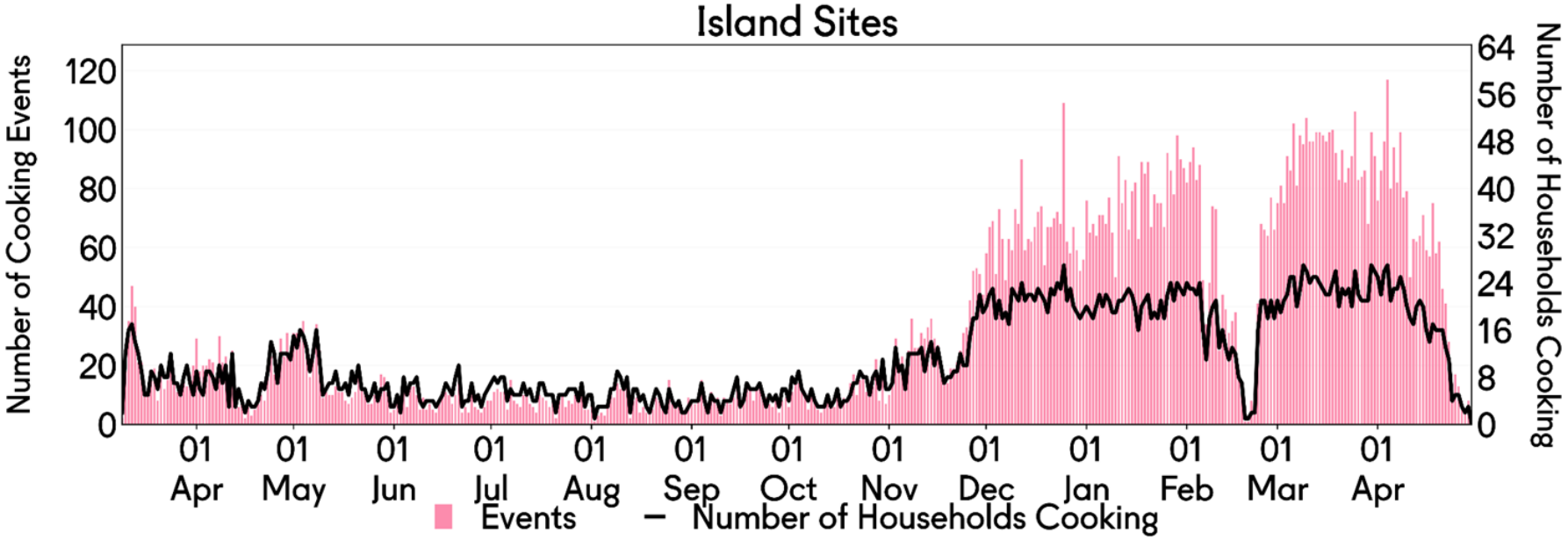
Island Sites
Number of Cooking Events
Number of Households Cooking
120
100
80
60
40
20
0
64
56
48
40
32
24
16
8
0
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
01 Feb
01 Mar
01 Apr
Events
Number of Households Cooking

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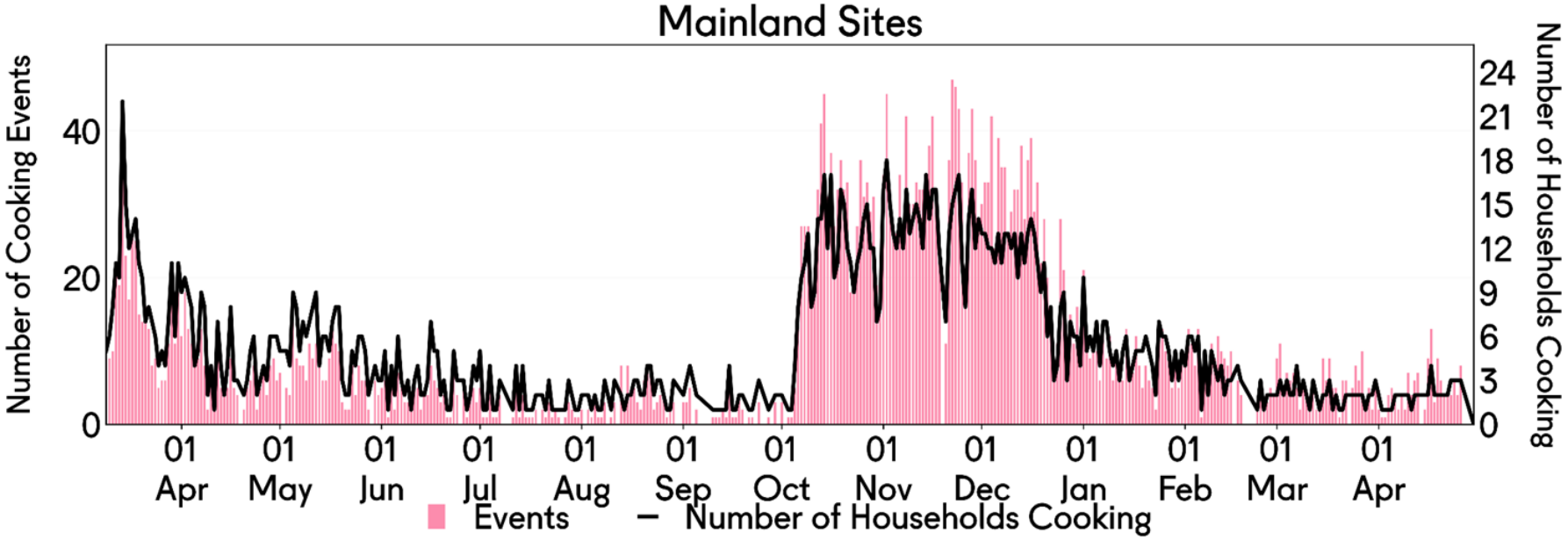
Mainland Sites
Number of Cooking Events
Number of Households Cooking
0
20
40
0
3
6
9
12
15
18
21
24
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
01 Feb
01 Mar
01 Apr
Events
Number of Households Cooking

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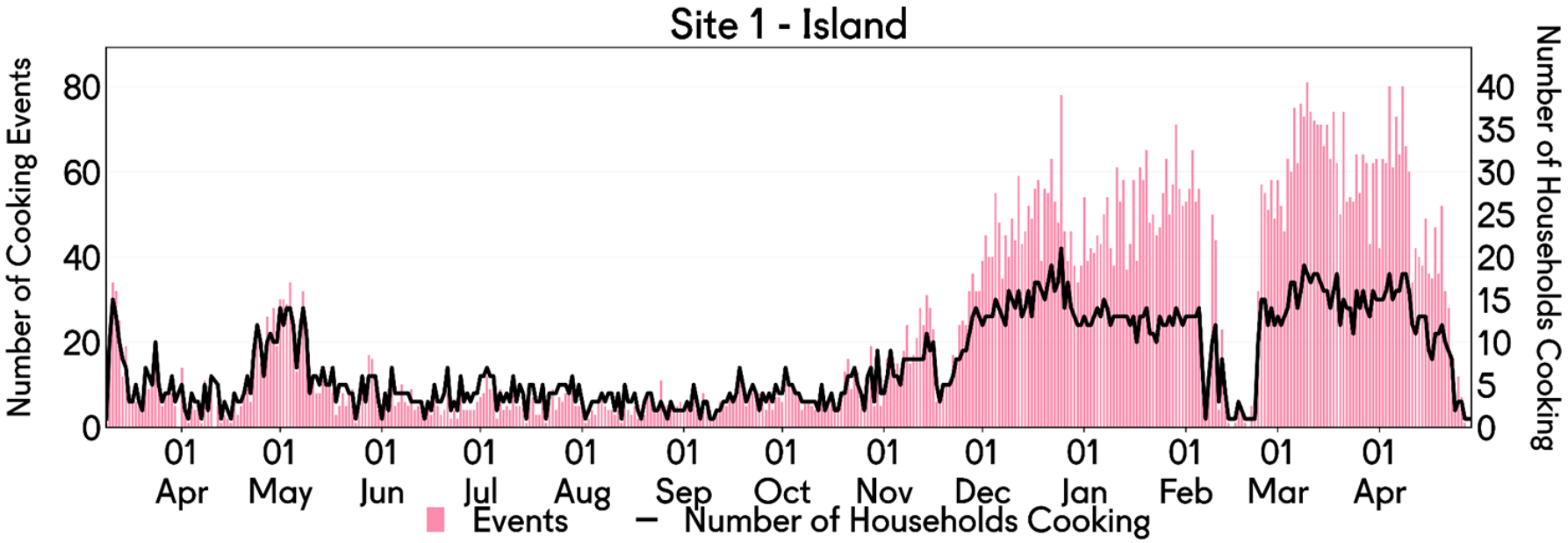
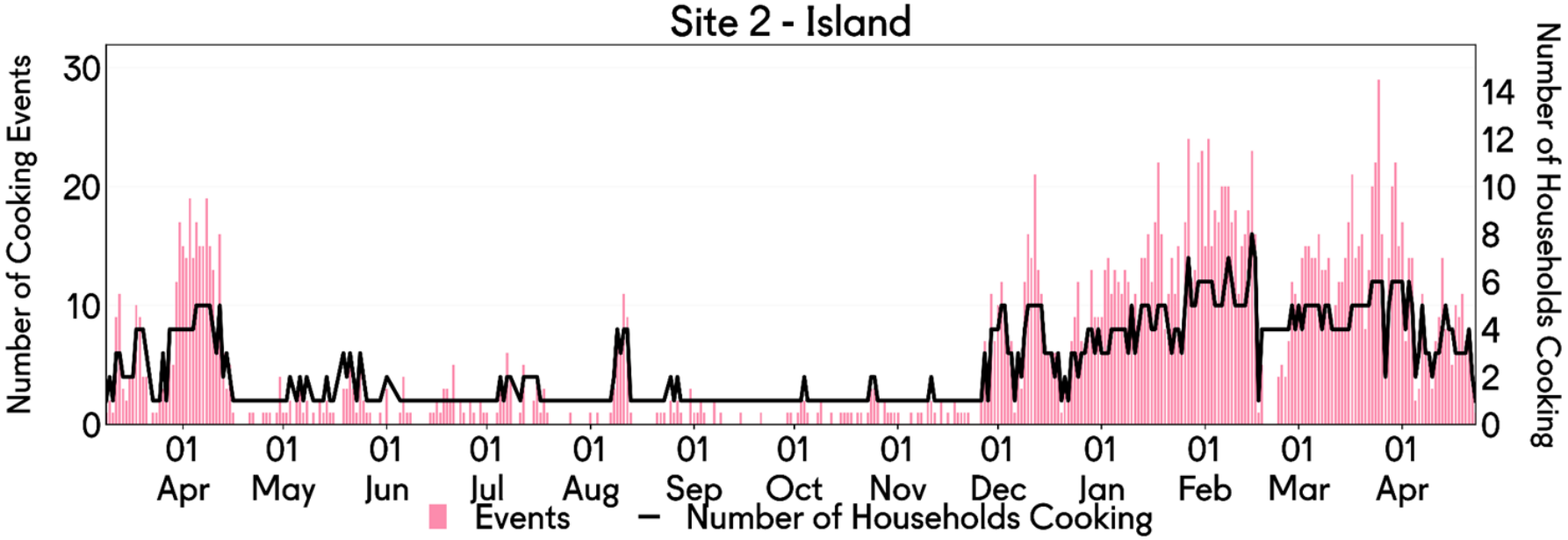

Site 1 - Island
Number of Cooking Events
Number of Households Cooking
0
20
40
60
80
0
5
10
15
20
25
30
35
40
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
01 Feb
01 Mar
01 Apr
Events
Number of Households Cooking

A2EI


Site 2 - Island
Number of Cooking Events
Number of Households Cooking
30
20
10
0
14
12
10
8
6
4
2
0
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
01 Feb
01 Mar
01 Apr
Events
Number of Households Cooking

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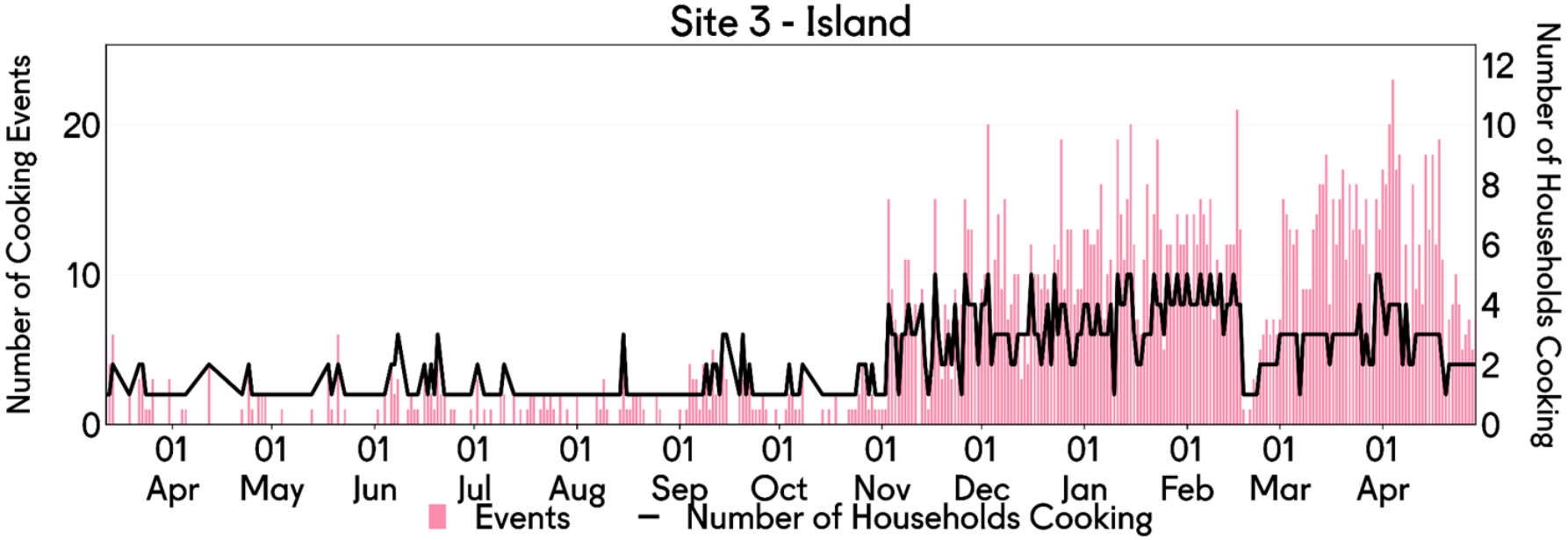
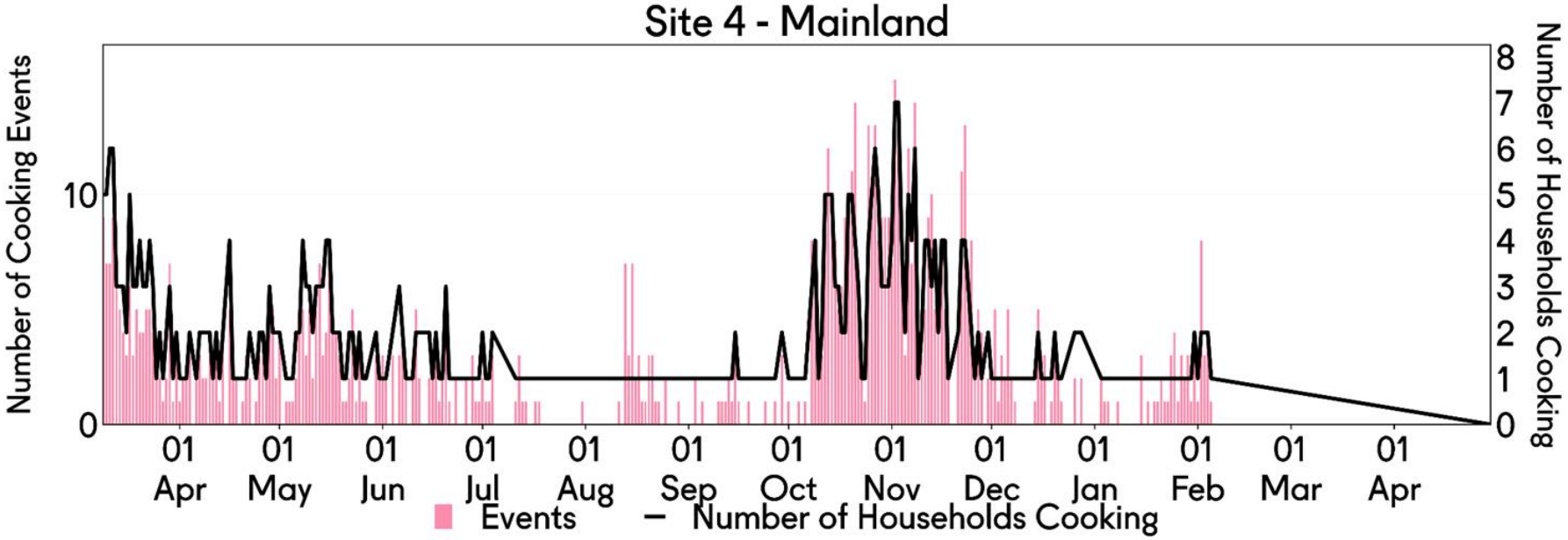
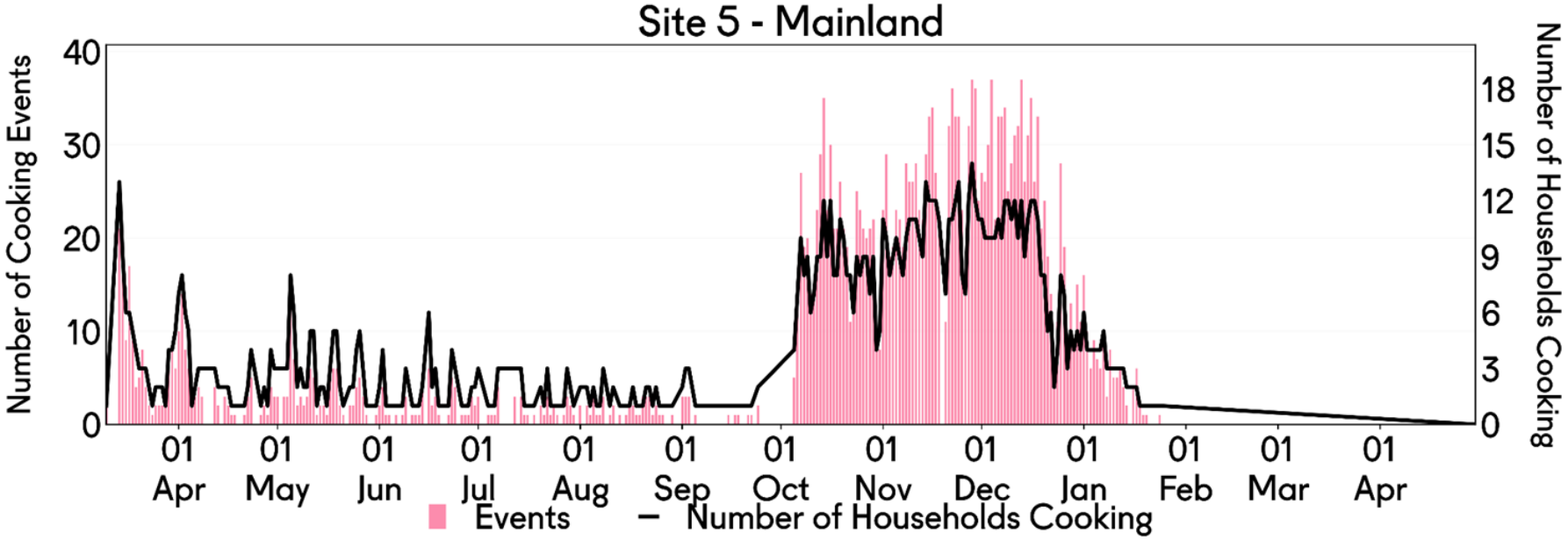
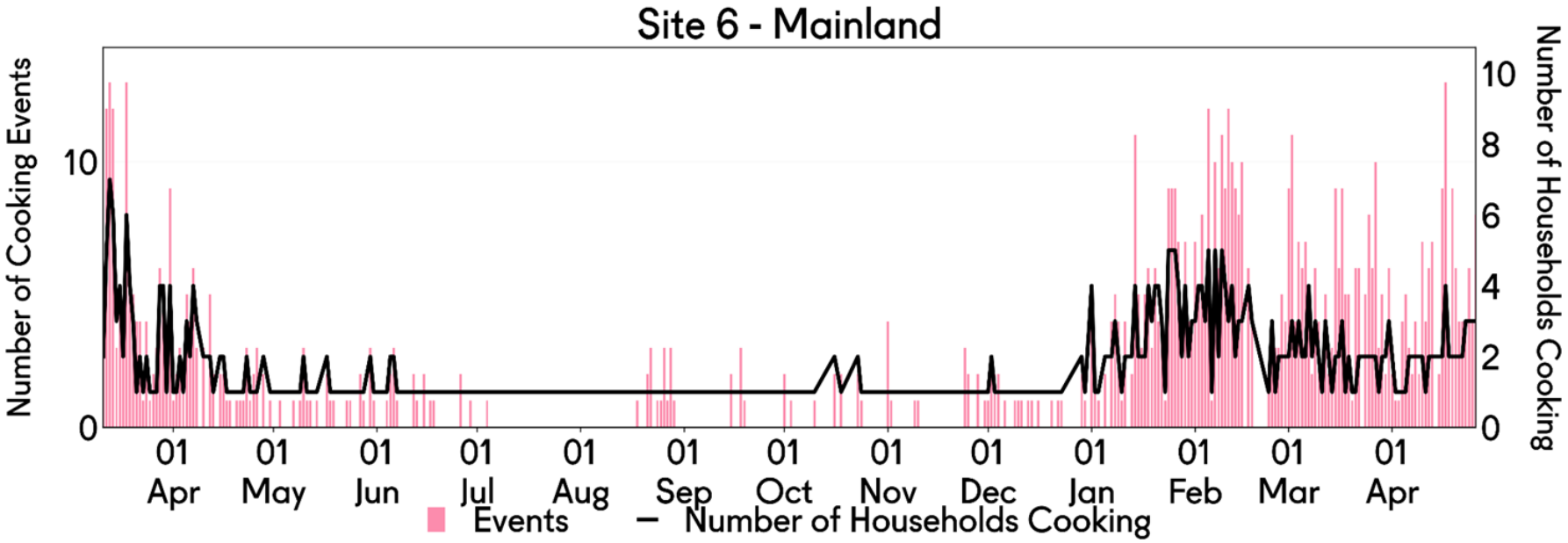

Site 3 - Island
Number of Cooking Events
Number of Households Cooking
0
10
20
0
2
4
6
8
10
12
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
01 Feb
01 Mar
01 Apr
Events
Number of Households Cooking


Site 4 - Mainland
Number of Cooking Events
Number of Households Cooking
10
0
8
7
6
5
4
3
2
1
0
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
01 Feb
01 Mar
01 Apr
Events
Number of Households Cooking

A2EI


Site 5 - Mainland
Number of Cooking Events
Number of Households Cooking
0
10
20
30
40
0
3
6
9
12
15
18
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
01 Feb
01 Mar
01 Apr
Events
Number of Households Cooking

A2EI


Site 6 - Mainland
Number of Cooking Events
Number of Households Cooking
10
0
10
8
6
4
2
0
01 Apr
01 May
01 Jun
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov
01 Dec
01 Jan
01 Feb
01 Mar
01 Apr
Events
Number of Households Cooking