

# Removing Arsenic from Contaminated Drinking Water in Rural Bangladesh: Recent Fieldwork & Policy Implications



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UNC Environmental Symposium

Safe and Sustainable Drinking Water in Developing and  
Developed Countries: Where Science Meets Policy

November 5-6, 2008

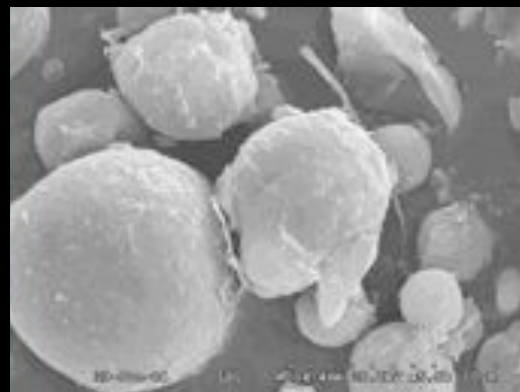
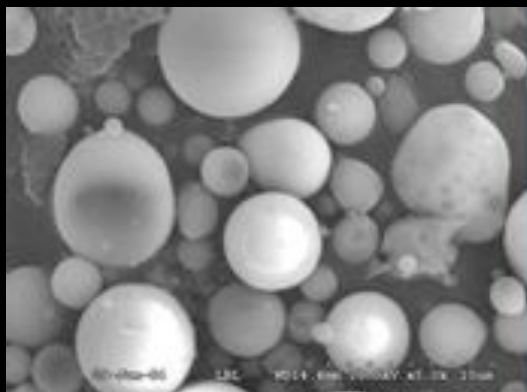
# Outline



- ARUBA – Arsenic Removal Using Bottom Ash
- Preliminary Fieldwork
- Waste & Policy Issues
- Improving Arsenic Removal Capacity
- Implementation
- Current Work & Future Plans
- Comparing ARUBA & ECAR

# ARUBA – Arsenic Removal Using Bottom Ash

Bottom ash, waste from from coal-fire power plants, coated with rust (ferric hydr(oxide))



- Simple process at atmospheric pressure and room temperature
- Inexpensive, readily-available chemicals ( $\text{FeSO}_4$  &  $\text{NaOH}$ )



- Bottom ash: \$4/ton

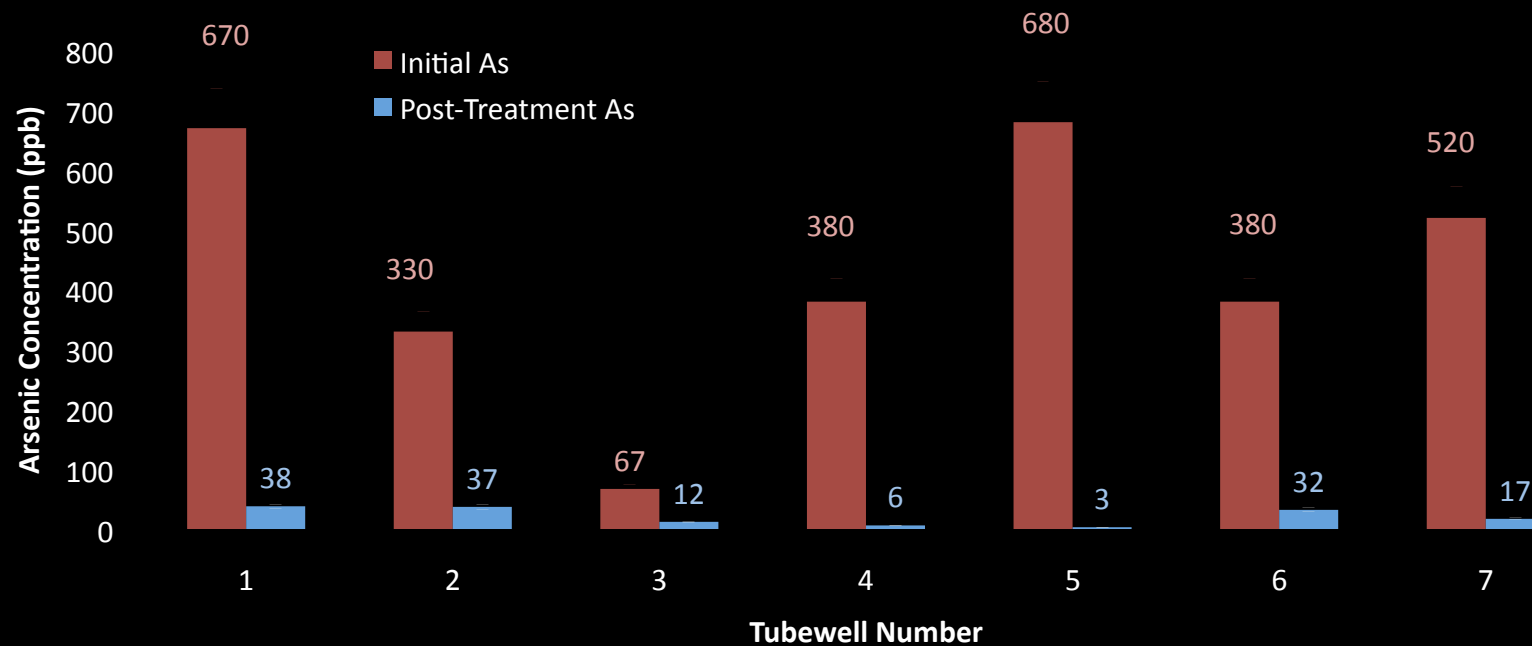
- Large surface to volume ratio minimizes media required & waste
- Spent ARUBA is US EPA approved for disposal in municipal landfill

# Preliminary Fieldwork

Results from Jessore and Sonargaon Districts  
March-April 2007



Initial and Post-Treatment Arsenic Concentrations  
ICP-MS Arsenic Measurements



# Arsenic Removal Capacity

Defined: milligrams arsenic removed per gram  
ARUBA added (mg-As/g)

Laboratory Results: 0.96 mg-As/g

Preliminary Field Results: 0.03 – 0.16 mg-As/g

Why the difference?

1. Capacity is a function of initial concentration
2. ARUBA is less effective at removing As(III)
3. Ions such as phosphate and silicate compete with arsenic for adsorption sites



# Arsenic Removal Capacity

Given preliminary field results ...

- Raw material costs: \$0.40/household/year
- Estimated total costs: \$15/household/year
- ARUBA required: 250 g/household/day

That's ...

~36.5 metric tons of waste/village/year

*Assuming 400 ppb water, 10 liters of drinking water/person/day,  
5 people/household, 400 households/village.*



# Waste & Policy Issues



Arsenic removal waste is regulated differently in Bangladesh

→ Must be packed in plastic and buried in concrete-lined pits far from human habitation

ALL arsenic removal systems produce waste

...yet most organizations disseminating household filters do not address the waste problem.

Two Tasks ...

1. Improve ARUBA's arsenic removal capacity
2. Develop an appropriate implementation plan

# Three Ways to Improve Capacity

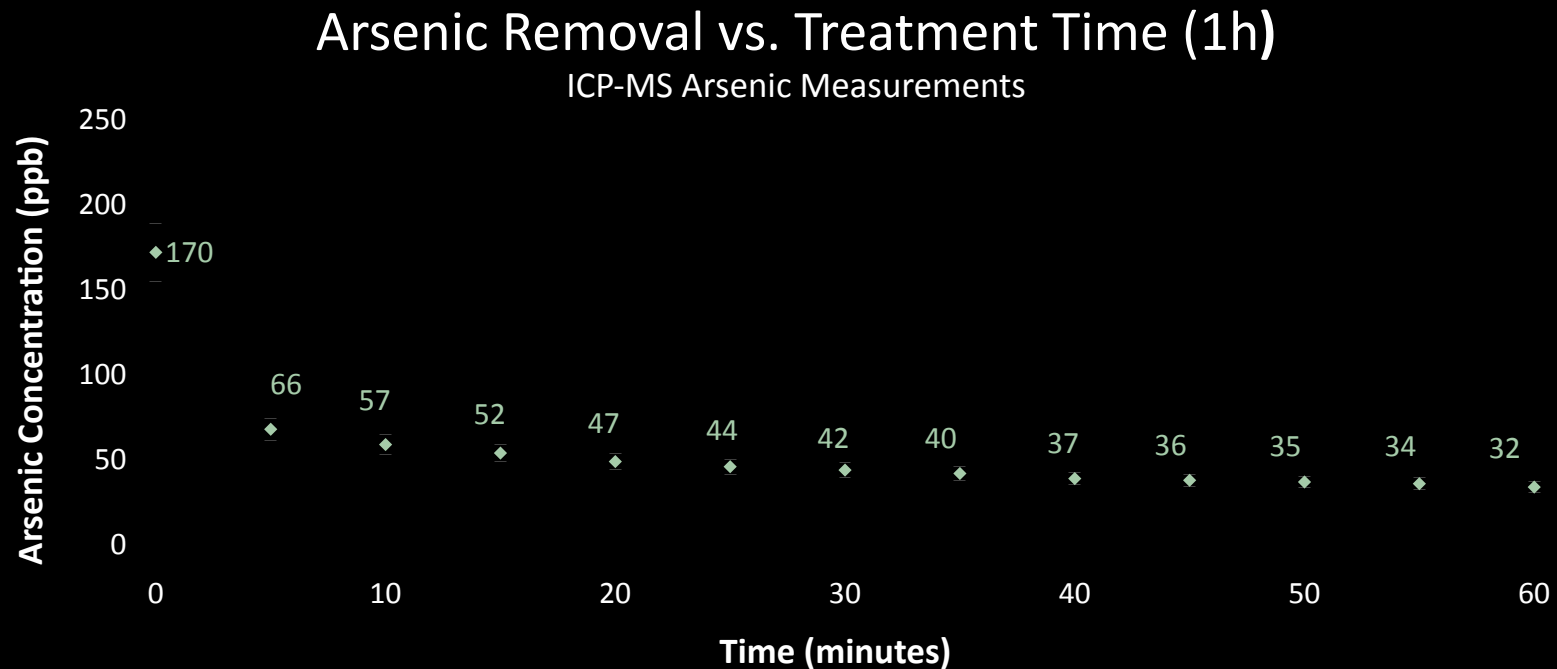
1. Understand ARUBA's kinetics
2. Fractionated dosing
3. Water storage before treatment





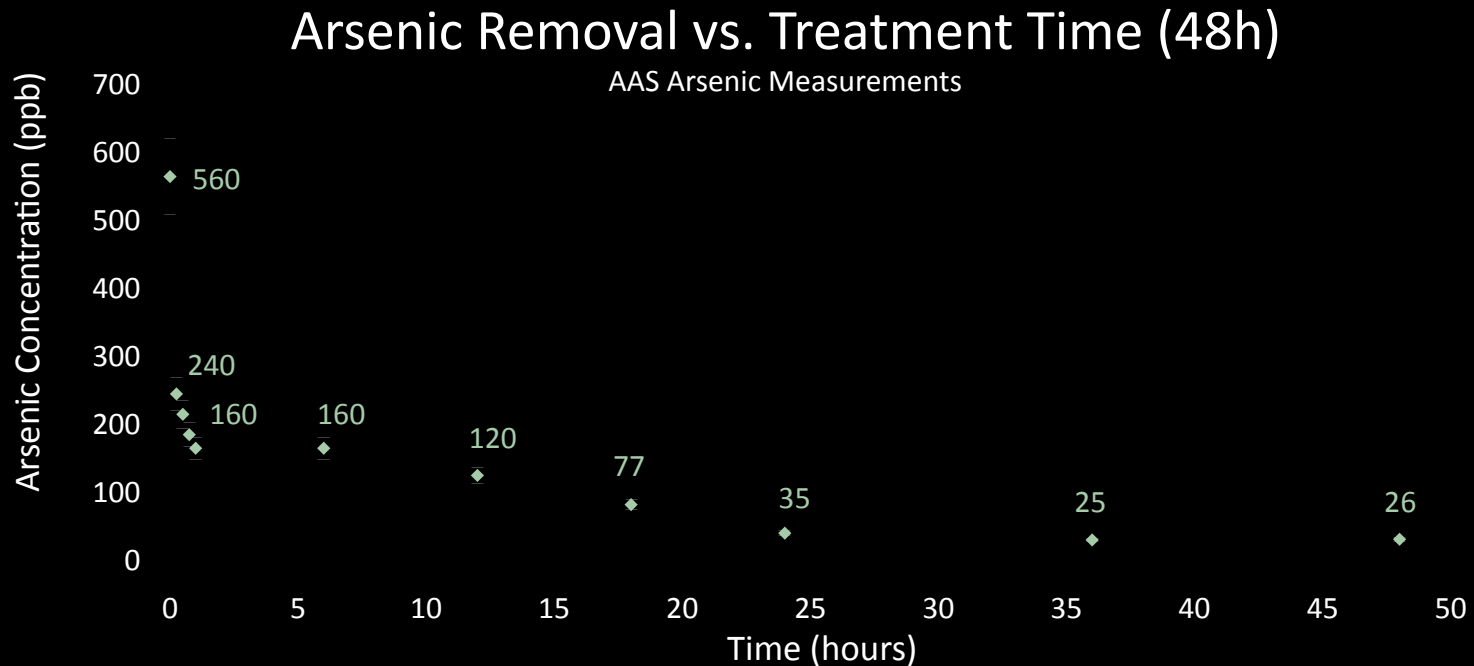
# 1. Improving Capacity: Kinetics (1h)

Results from Sonargaon District, July 2007



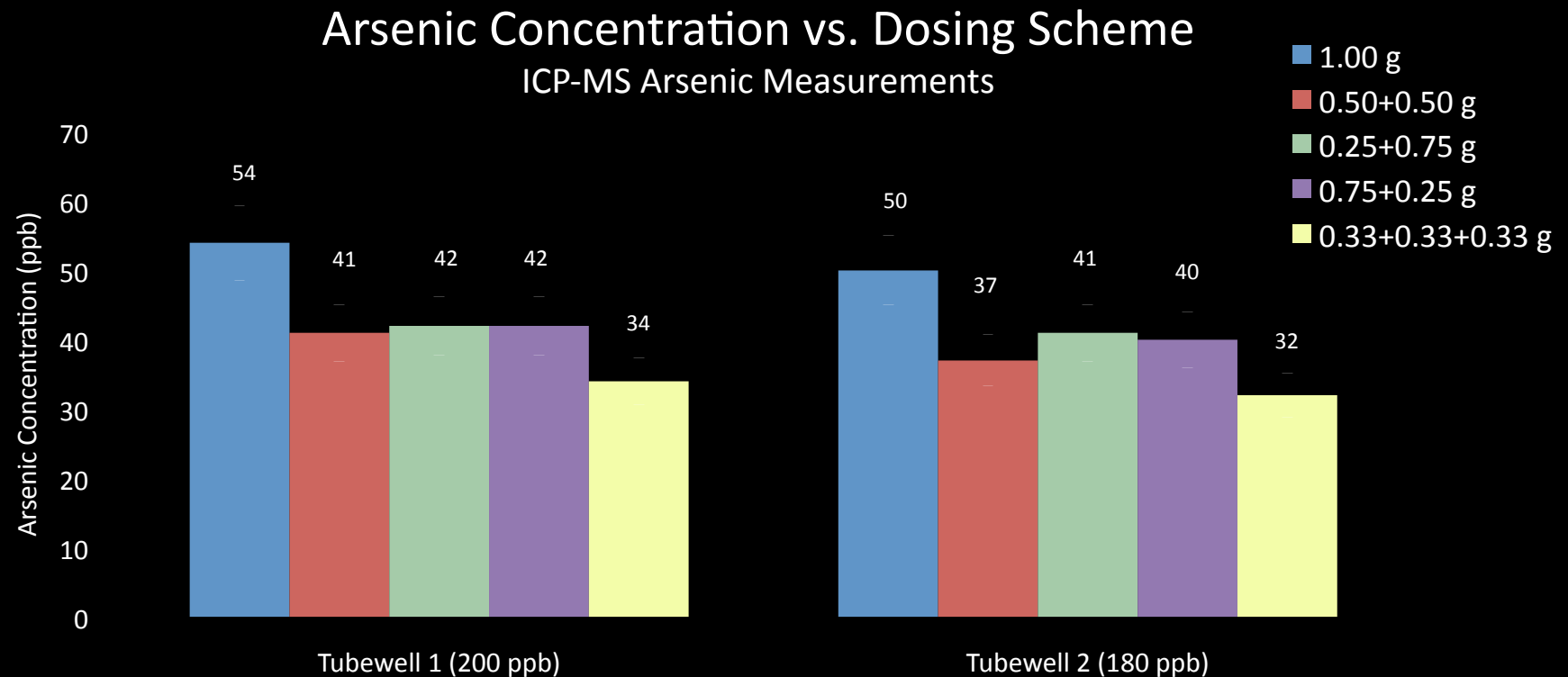
# 1. Improving Capacity: Kinetics (48h)

Results from Munshigonj District, June 2008



# 2. Improving Capacity: Dosing

Results from Sonargaon District, July 2007

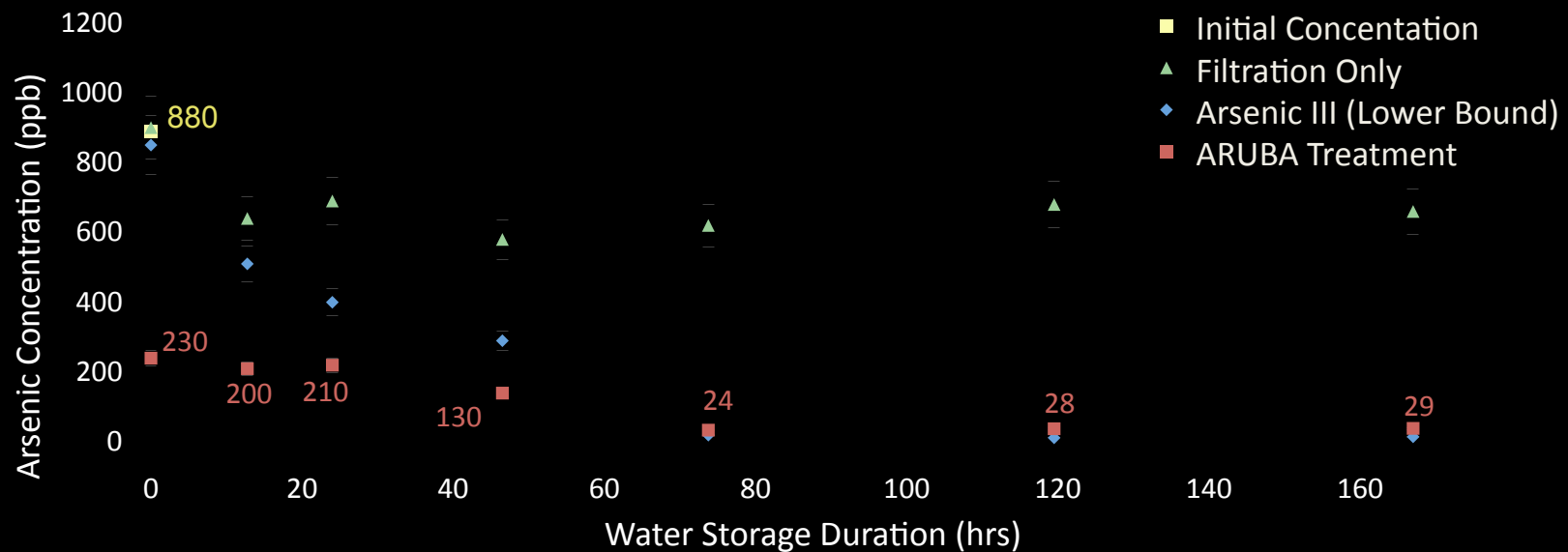


# 3. Improving Capacity: Storage

Results from Munshigonj District, June 2008

## Effect of Pre-Treatment Water Storage Duration

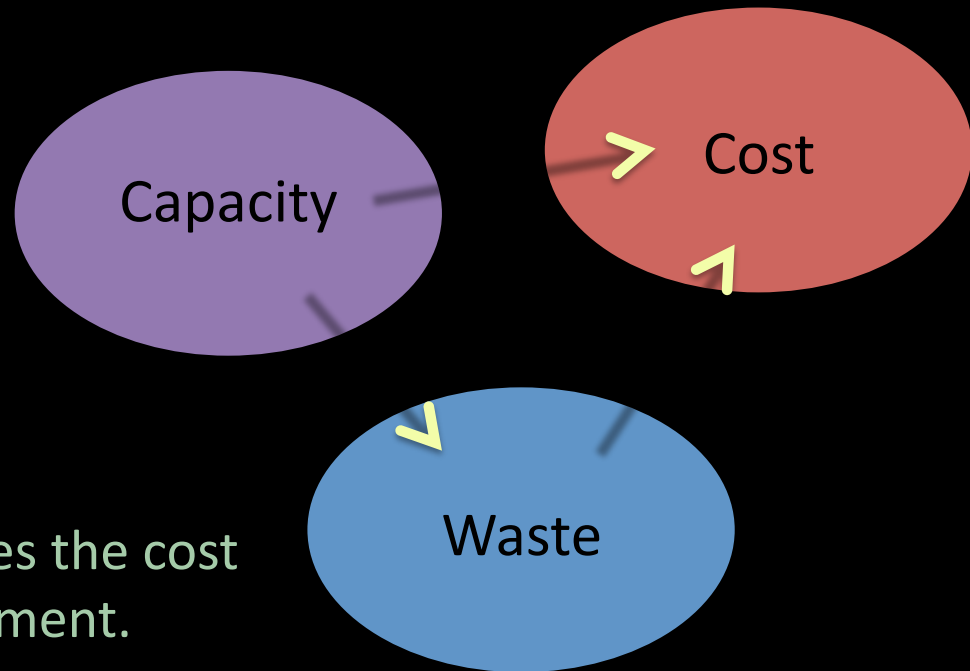
Combined AAS Arsenic and ICP-MS Arsenic Measurements



# Tradeoffs: Capacity, Waste, & Cost

Goals ...

- Minimize cost
- Minimize waste
- ?? Maximize capacity ??



Maximizing capacity increases the cost and/or difficulty of treatment.

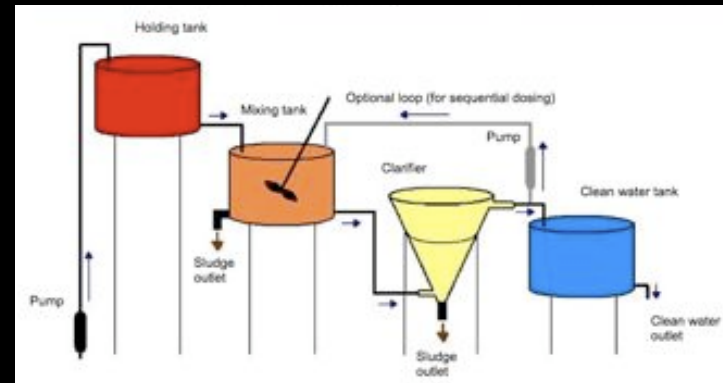
However, community-scale implementation increases the feasibility of capacity-improving methods.

# Technology Implementation

In a 2003 World Bank study, 72% of Bangladeshi villagers interviewed preferred a community safe water source to household filters.

## Community-scale water treatment ...

1. Is convenient to users
2. Facilitates waste management
3. Allows implementation of capacity-improving methods
4. Ensures water quality can be monitored
5. Increases feasibility of local water management



# Current Work & Future Plans

## Summer 2008 ...

- 10 liter/hr prototype designed, constructed, & analyzed
- 100 liter/hr prototype designed & constructed
- Group conducted 650+ person survey on arsenic



## Currently ...

- Testing 100 liter/hour prototype at BUET
- Looking to license technology  
(US & International patents through LBNL)



# Comparing ARUBA & ECAR

Two complementary technologies...

pros

## ARUBA

Low-cost  
Scalable  
Doesn't require electricity  
Proven in Bangladesh  
Easy to use



## ECAR

Low-cost  
Scalable  
Produces less waste  
Highly effective in testing  
Low-level supply chain

Requires electricity  
Uncertainty (younger tech)





# Acknowledgements

UC Berkeley Blum Center for Developing Economies  
National Collegiate Inventors and Innovators Alliance (NCIIA)  
UC Berkeley Bears Breaking Boundaries Contest  
UC Berkeley Big Ideas Marketplace  
Lawrence Berkeley National Laboratory (LBNL)  
Bangladesh University of Engineering and Technology (BUET)  
Iqbal & Kamal Quadir  
The Khan Family  
Bangladesh Rural Advancement Committee (BRAC)



Mahbuba Iasmin Ahmad  
Dr. A.B.M. Badruzzaman  
Dr. Lara Gundel  
Nadia Madden  
Melissa Quemada

Dr. Alice Agogino  
Yola Bayram  
Tasnuva Khan  
Heena Patel  
Mehmet Seflek

William Babbitt  
Dr. Raymond Dod  
Kosar Jahani  
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