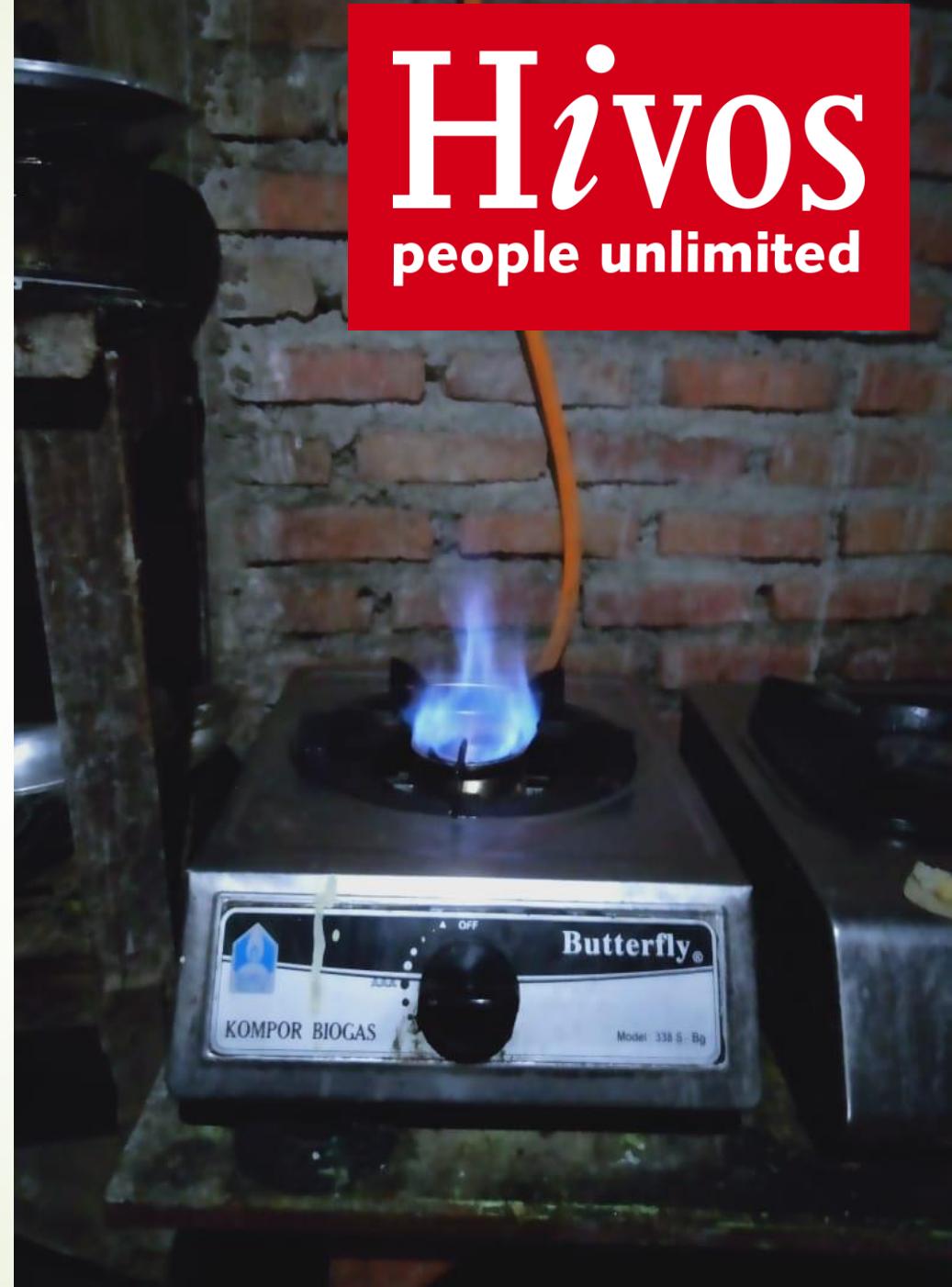


Biogas as an energy solution in Indonesia

R. Sean Fitzpatrick

SU-re.co
sustainability & resilience

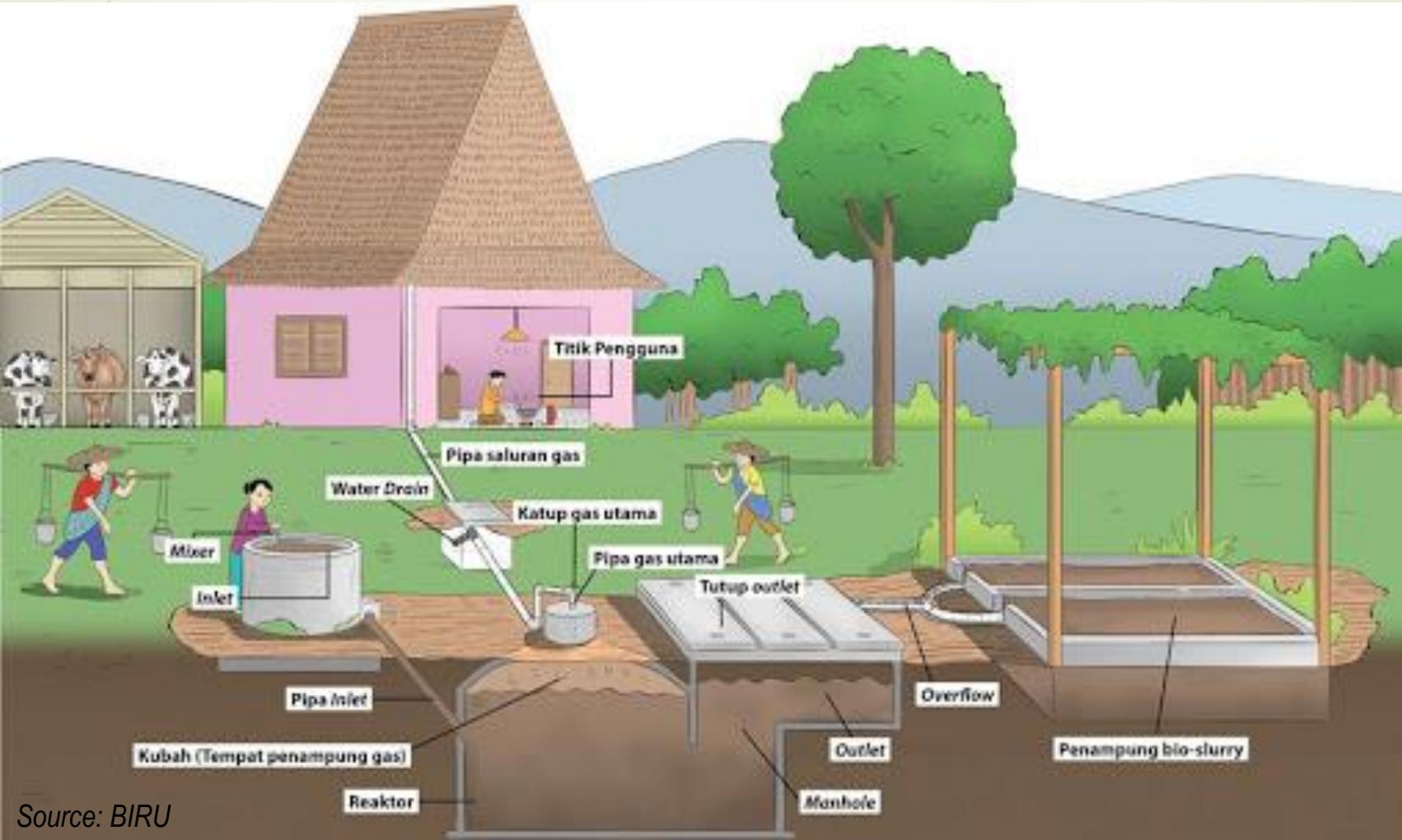




Background

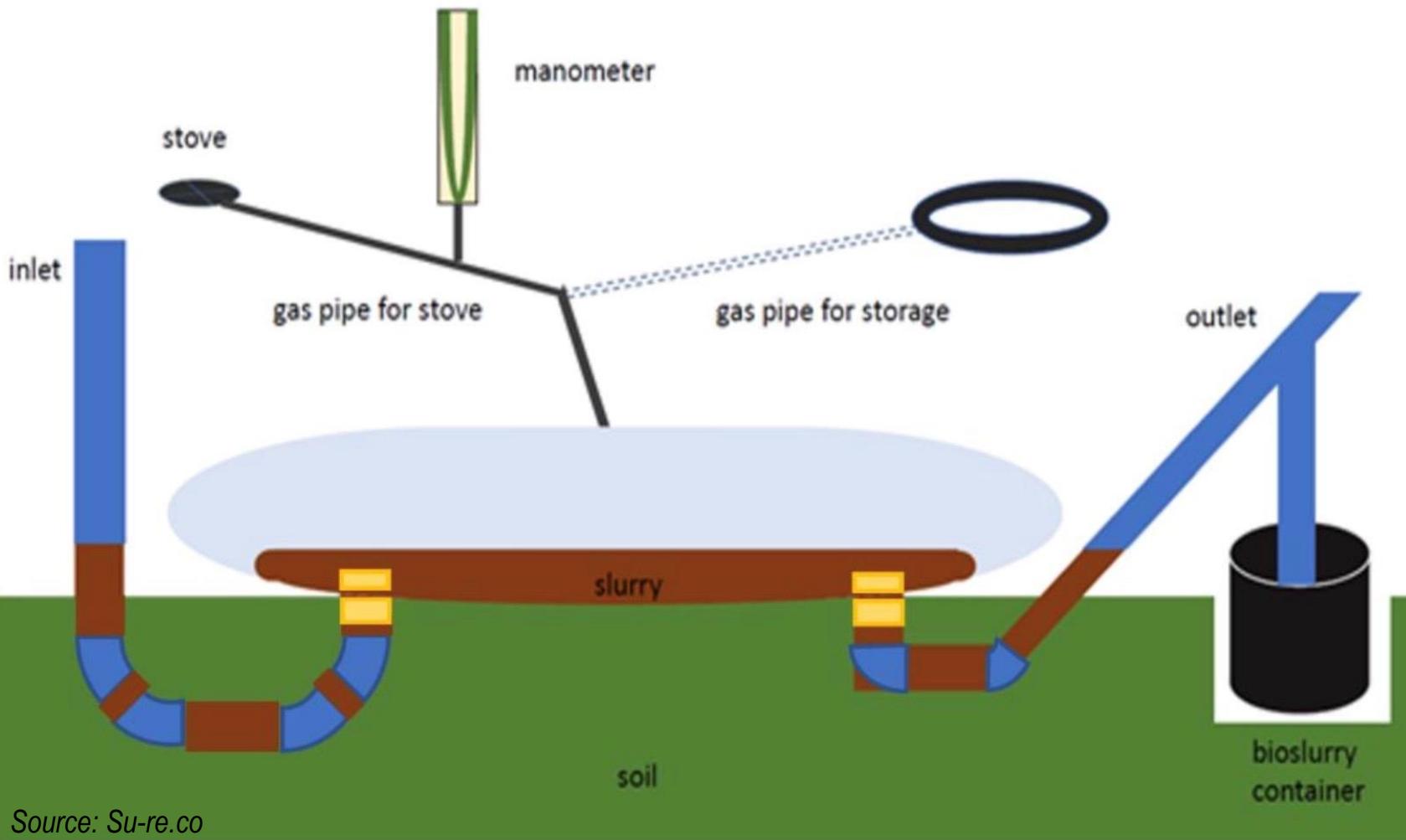
- ▶ 40% of global population continues to rely on solid state fuels
 - ▶ One of leading causes of emissions
 - ▶ Up to 54% of deforestation
 - ▶ 4.3 million premature deaths from IAP/year (WHO)
- ▶ Cookstove interventions
 - ▶ Distribute “improved” charcoal/wood burning stoves or LPG
 - ▶ All solid fuels exceed WHO AQG

Fixed Dome Digester



Source: BIRU

Bag-Style Digester



Biogas as cookstove intervention

- ▶ Numerous co-benefits
 - ▶ Free, clean, renewable energy
 - ▶ Production of bio-slurry
 - ▶ Efficient waste management
 - ▶ Cost and time savings
 - ▶ Health and social benefits



Biogas strategy for Indonesia

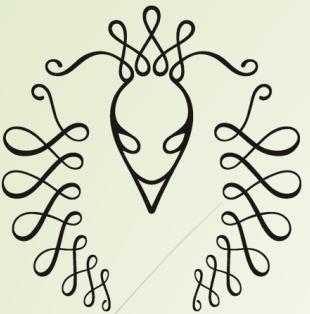
- ▶ Indonesia is 5th largest country by population, 8th largest GHG emitter
- ▶ Long reliance on fossil fuels
 - ▶ World's largest exporter of coal
- ▶ Increasing cultural acceptance in SEA
 - ▶ 250,000 biogas digesters in Vietnam
 - ▶ Compare to ~24,000 in Indonesia, which has 2x greater population



Project Objectives

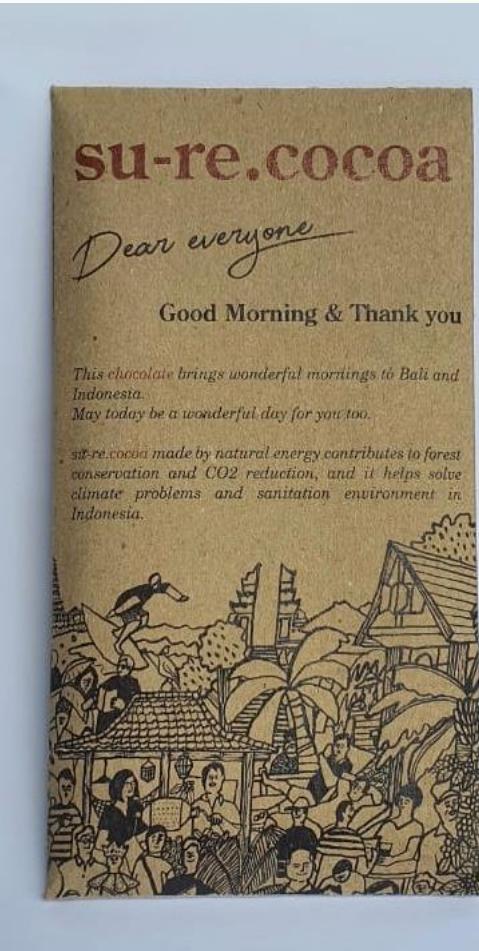
- ▶ Past problems and new developments
 - ▶ Solutions to scale
- ▶ Add to limited data on biogas combustion metrics
- ▶ Gold Standard and Emissions Reductions
- ▶ FIRR and NPV of different models
 - ▶ Other ways to increase value
- ▶ Final recommendations

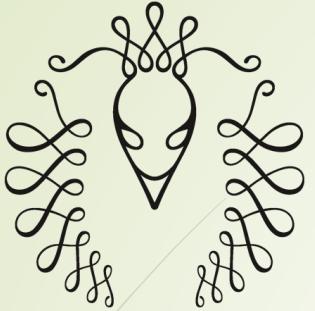




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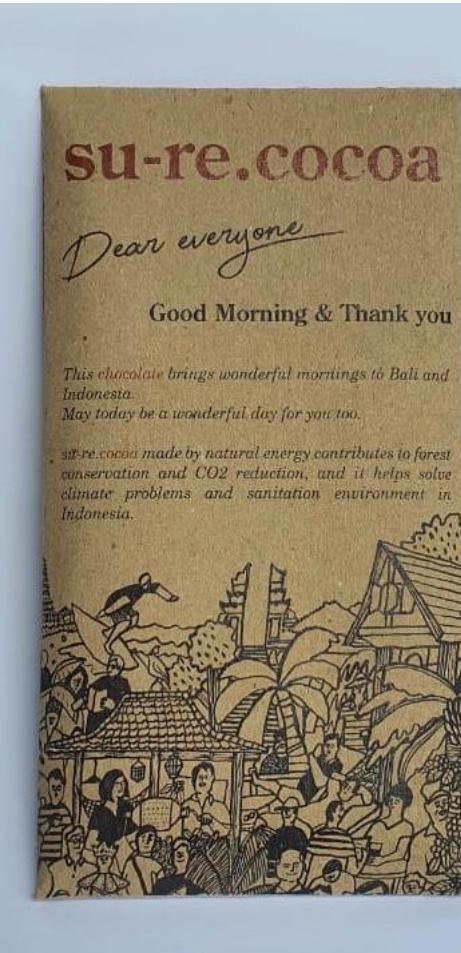
sustainability & resilience





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Water Boiling Test (Bag-style)



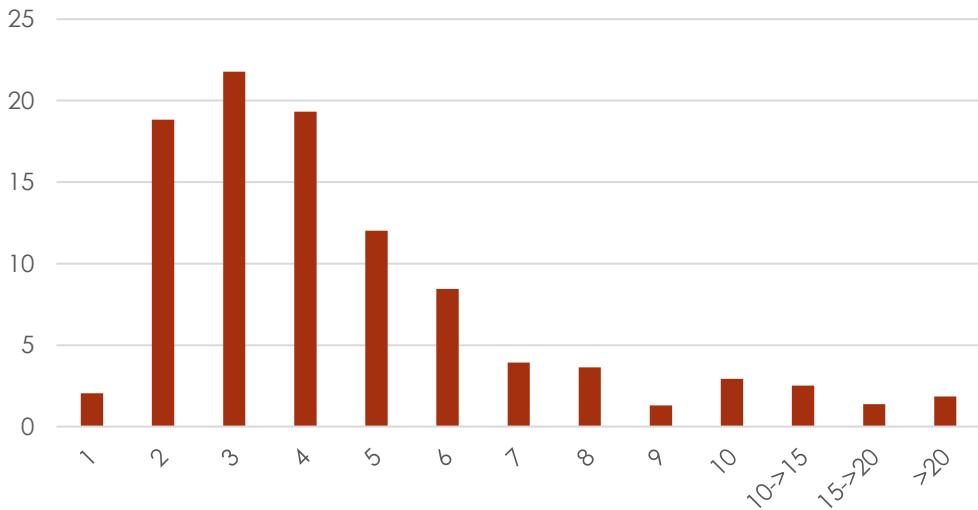


Water Boiling Test (Bag-style)

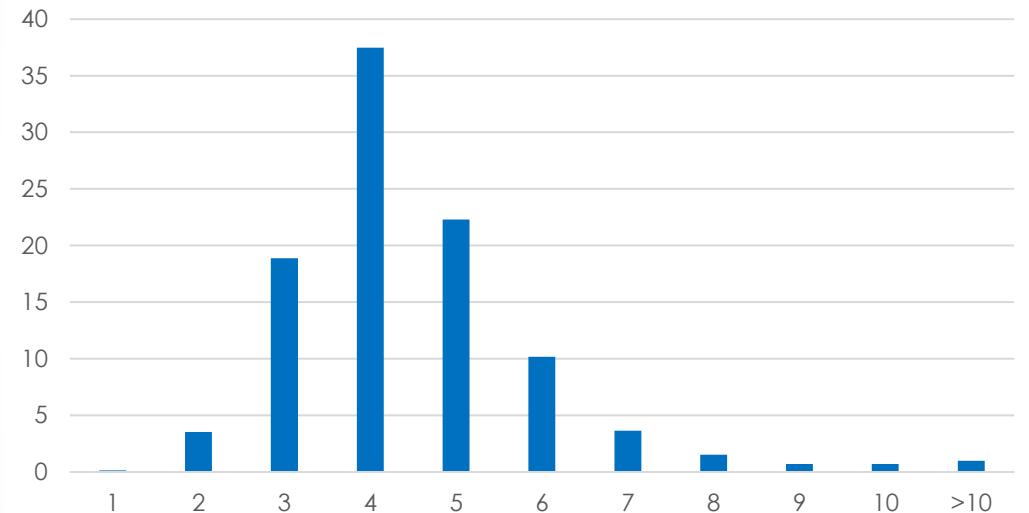


Database Analysis

Number of Cattle



Number of People



Functioning	Non-functioning	Technical Issue	Non-Technical
63.6%	36.4%	21.5%	78.5%

Biogas User Survey

Date		
Name of Interviewer		
Village ID		
Household ID		
GPS coordinates (if possible)		
Age/Gender in household	<i>Child <14</i>	
	<i>Women >14</i>	
	<i>Men 15-59</i>	
	<i>Men >59</i>	
Primary Income Activities (circle)	<i>Farming</i>	
	<i>Wage Labor</i>	
	<i>Shopkeepin<i>a</i></i>	
	<i>Other</i>	
If Farming, what crops are grown?		
Number and type of livestock		
Who is the primary cook?		
Cooking done indoors/outdoors/both?		
Kitchen <u>separate</u> from main house?		

Types of Stove in Household	Frequency of Use	Daily/monthly expenditure on fuel (cost or time spent collecting)
Stove type 1- Biogas		
Stove Type 2-		
Stove Type 3-		



Need for proper sizing

Gas production/waste input		Waste Production/livestock		
		Source	Pt (kg/d)	VS (kg/d)
$G = C \times Vd \times S \times (k / (1 + kR))$		Cow	10	1.42
Simplified to (IRENA 2016):		Calf	5	0.5
$G = (Y \times Vd \times S) / 1000$		Pig	5	1
and,		Buffalo	14	1.94
$S = VS (\text{kg}) / Ft (\text{m}^3)$				
and,				
$R = Vd (\text{m}^3) / Ft (\text{m}^3)$				
Where,				
$G = \text{gas production (m}^3/\text{day)}$		Cow	4	
$Vd = \text{volume digester (m}^3)$		Calf	0	
$Y = \text{yield factor (@ set T and R)}$		Pig	0	
$S = \text{Concentration(VS) of input (kg/m}^3)$		Buffalo	0	
$Ft = \text{total feedstock input/day (m}^3)$				
$R = \text{hydraulic retention time (d)}$				
$Pt = \text{total production (kg/d)}$				
$VS = \text{volatile solids (kg/d)}$				
Avg. stove consumption=0.35m ³ /h				
Avg. annual temperature (T)= 26 C				
Density manure=400kg/m ³				
		Total	0.1	5.68
			So,	S=
				56.8

	G (m ³ /d)	1.2703
Stove	Max h use	3.6
Water Heater	Max h use	0.8

Need for proper sizing

# Cows	2 m ³		3 m ³		3.5 m ³	
	Q (m ³ /d)	h use/day	Q (m ³ /d)	h use/day	Q (m ³ /d)	h use/day
8					1.86	5.3
7					1.86	5.3
6			1.59	4.6	1.61	4.6
5			1.38	3.9	1.42	4.1
4	1.06	3.0	1.21	3.5	1.27	3.6
3	0.812	2.3	0.985	2.8	0.964	2.8
2	0.656	1.9	0.712	2.0	0.730	2.1
1	0.417	1.2				

Hivos

people unlimited

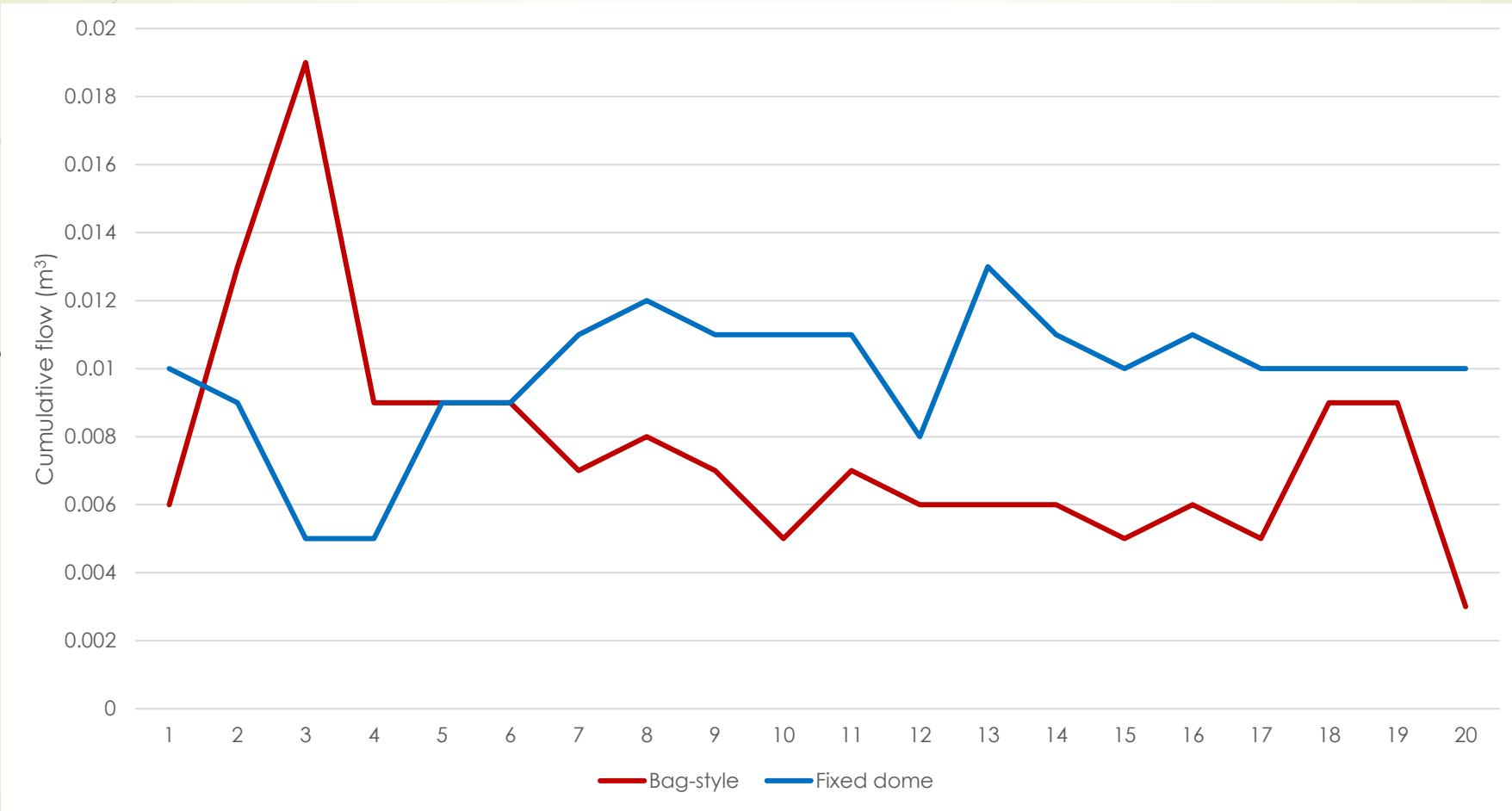




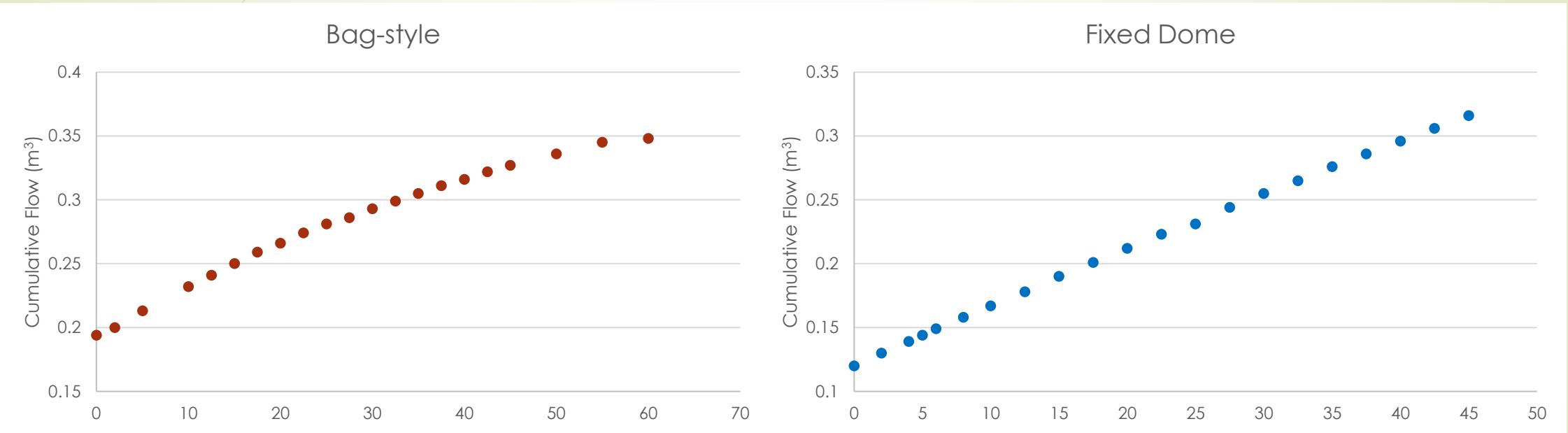
Water Boiling Test (Fixed dome)



Data- Water Boiling Test



Data- Water Boiling Test



► PVC bag-style digester

► h_c - 29.4%

► CE- 49.6%

► Fixed dome digester

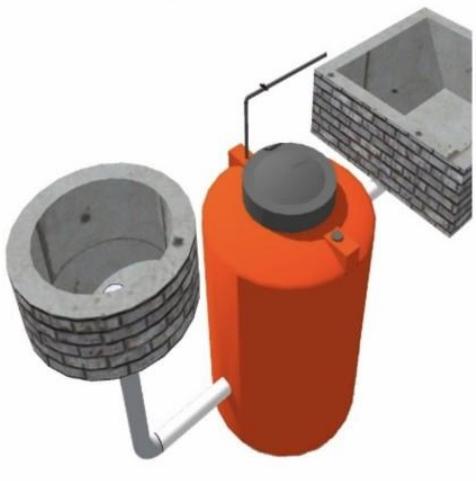
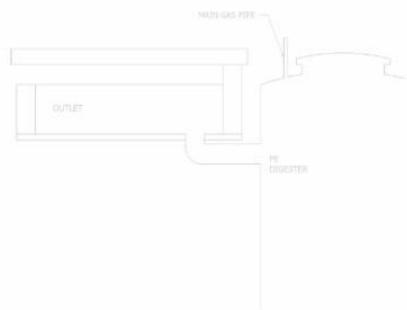
► h_c - 36.5%

► CE- 44.1%



Bridging the Finance Gap

- ▶ >1,000 applicants waiting in S. Sulawesi
- ▶ Cost fixed dome: 10 million IDR
- ▶ Subsidy: 4 million IDR
- ▶ Farmer WTP: 3 million IDR



Bridging the Finance Gap

- ▶ >1,000 applicants waiting in S. Sulawesi
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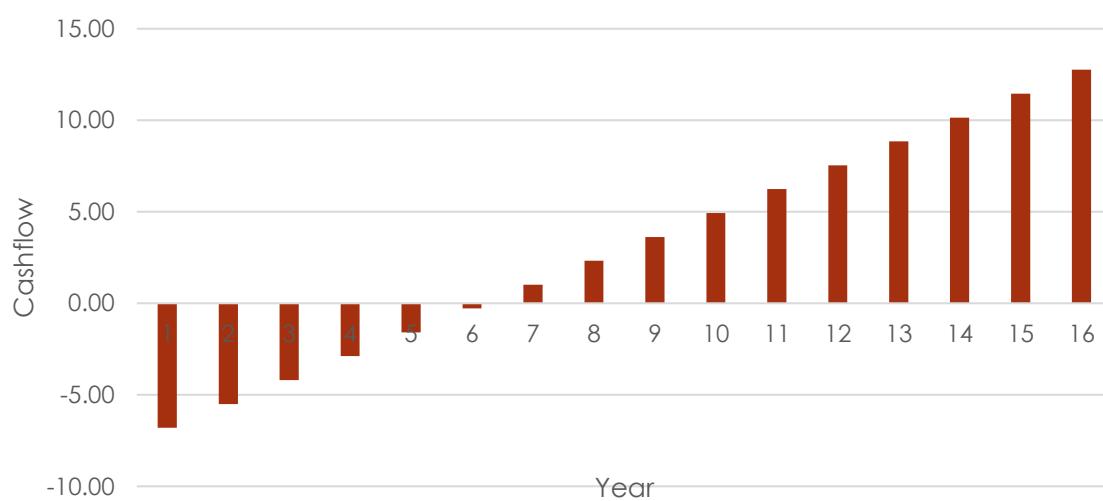
- ▶ Alternative 3.5 m³ PE design
 - ▶ Cost: 6.5 million IDR
- ▶ Su-re.co (or other) 2 m³ design
 - ▶ Cost: 3.2 million IDR

Financial Analysis

► 3.5 m³ PE digester

► NPV- 19.2 million IDR

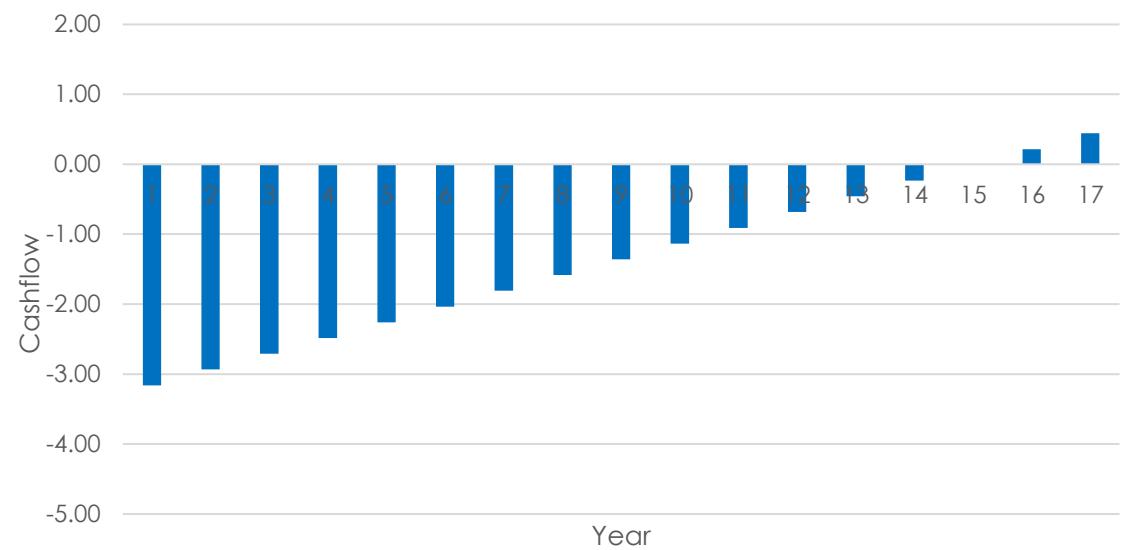
► FIRR- 23%



► 2 m³ PVC bag digester

► NPV- 1.34 million IDR

► FIRR- 8%



Next Steps

- ➡ Hivos/Su-re.co MoU (PT Swen)
- ➡ Finalize 2 m³ design
- ➡ Test fiberglass models
- ➡ Solutions to scale
- ➡ Encourage entrepreneurship





Thanks!
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Hivos
people unlimited