

# Development and Application of Biodigester Technology

## Advances from Latin America and the Caribbean

### Panelists:

Mariela Pino: General Coordinator RedBioLAC

Sam Schlesinger: Program Manager Ecuador, Green Empowerment

Jaime Martí-Herrero: Biodigester expert, CIMNE and Ikiam University

### Thematic Discutant:

Willington Ortiz: Regional Coordinator LAC, WISIONS Initiative, Wuppertal Institute

### Moderator:

Carmen Dienst: Head of Research Unit „International Energy Transitions“, Wuppertal Institute

# Technology

## Advances from Latin America and the Caribbean



**Mariela Pino,**  
General Coordinator  
RedBioLAC



**Carmen Dienst**  
Head of Research Unit  
„International Energy Transitions  
Wuppertal Institute



**Sam Schlesinger**  
Ecuador Program Manager  
Green Empowerment



**Willington Ortiz**  
Regional Coordinator LAC  
WISONS Initiative  
Wuppertal Institute



**Jaime Martí Herrero,**  
Research Associate  
CIMNE and Ikiam University

# Development and Application of Biodigester Technology

## Advances from Latin America and the Caribbean



# Development and Application of Biodigester Technology

## Advances from Latin America and the Caribbean

### Moderator:

#### Carmen Dienst

Head of Research Unit „International Energy Transitions“

Wuppertal Institute



# Development and Application of Biodigester Technology

## Advances from Latin America and the Caribbean

### Panelist:

**Mariela Pino,**

General Coordinator

RedBioLAC

- Working Experience at national biogas programs in Cambodia, Vietnam, Mexico and Chile.
- Member of Zero Waste Alliance.
- Agricultural Engineer from University of Chile and Master Degree in Technologies and Natural Resource Management in the Tropics from the University of Applied Sciences in Cologne, Germany.





Latin American Biogas Network

## OBJECTIVES

1. Promote contact and collaboration
2. Exchange information, lessons learnt and experiences
3. Identify and overcome technical, environmental, social and economic barriers
4. Generate alliances which facilitate the adoption of technology
5. Propose projects, mechanisms and ideas to disseminate technology
6. Promote advocacy and influence policies related to biodigesters

## OUR VISION OF THE WORLD

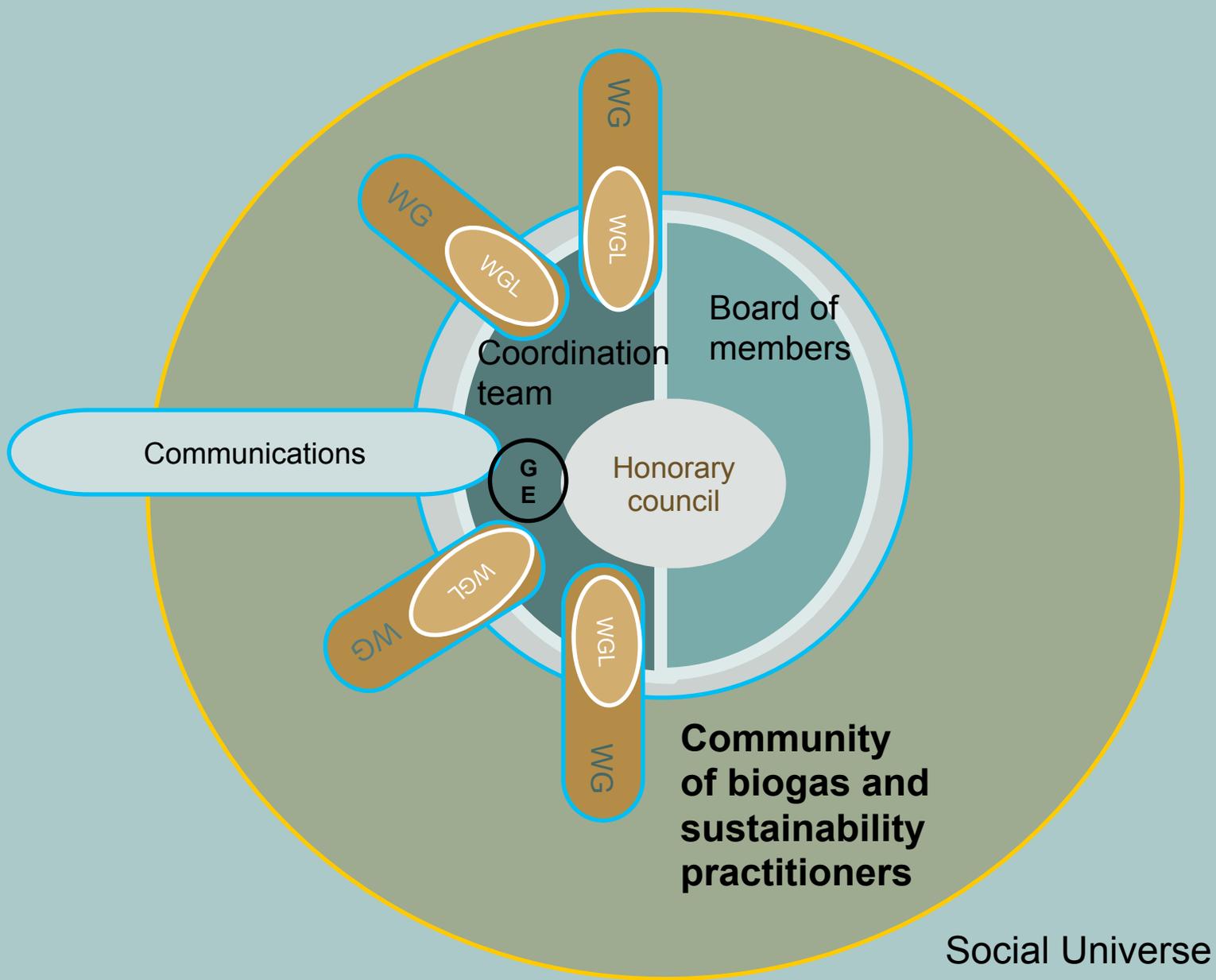
A resilient Latin America and the Caribbean where the universal use of biodigesters contributes to a better quality of life.

# OUR MAIN ACTIVITIES

1. Yearly event & congress in different countries
2. Online & in person training
3. Open library with technical, academic and educational documents, videos and webinars
4. Students exchange among members
5. Regular online conferences of experts (Webinars)
6. RedBioLAC Magazine & booklets publication
7. Mailing list for communication (1,000 people)
8. Social media and website
9. Working groups around specific topics



# OUR ORGANIZATIONAL STRCUTURE



## BOARD 2019



Fernando Acosta  
(Perú)



Ricardo Steinmetz  
Embrapa  
(Brasil)



Mariano Butti INTA  
(Argentina)



Adrián Sandí  
Asobiogás  
(Costa Rica)



Guillermo Zinola  
NETUM  
(Uruguay)



Yuditanduly Acuña  
U El Bosque  
(Colombia)



Alex Eaton  
Sistema Bio  
(México)



Jaime Martí  
CIMNE/  
Ikiam  
(Ecuador)



Lylian Rodríguez  
UTA  
Foundation  
(Colombia)



Joaquin Viquez  
(Costa Rica)

## HONORARIUM BOARD

## COORDINATION

### Communication



Leidiani Mariani  
(Brasil)

### General



Mariela Pino  
(Chile)

### Institutional



Gloria Pedraza  
(Colombia)

WE DEMOCRATIZE THE ACCESS TO INFORMATION  
AND CAPACITY BUILDING, & FOCUS ON SYNERGIES  
AMONG DIVERSE WORLDS



ENCOURAGE PRACTITIONERS TO WORK AND RESEARCH ON SPECIFIC TOPICS FOR A COMMON GOAL THROUGHOUT L. AMERICA: SOUTH TO SOUTH COLLABORATION





AND WE ARE PROUD OF PROMOTING  
A.D. FOR TREATMENT OF ORGANICS  
**RESIDUES.** BUT NO ENERGY CROPS,  
NOR DIOXINE PRODUCTION



WE SERVE THE HIDDEN GAP, BUT ARE ALSO AWARE OF THE CURRENT GLOBAL NEEDS AND CLIMATE AMBITIONS

WE CARE OF OUR INCREASING REGIONAL RATE OF URBANIZATION: STARTED RURAL AND DOMESTIC, BUT ADDED THE URBAN CHALLENGES INTO OUR FOCUS, AND PRODUCTIVE SCALES



THANKS FOR YOUR  
ATTENTION



**CUBA 2019**

Join our discussion! [www.redbiolac.org](http://www.redbiolac.org) [info@redbiolac.org](mailto:info@redbiolac.org)



Perú Biored  
Círculo de biogás y  
biometano Universidad  
Agraria La Molina  
Centro de investigación y  
desarrollo para el sur

**WORKING  
FOR  
AREQUIPA  
2020**

# Development and Application of Biodigester Technology

## Advances from Latin America and the Caribbean

### Panelist:

**Jaime Martí Herrero,**

Research Associate CIMNE and Ikiam University

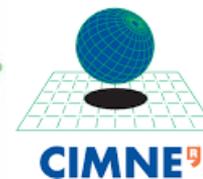
- Working experience on biodigesters since 2001
- Coordination of biogas project in Bolivia with 750 biodigesters in collaboration with German Technical Cooperation
- Author of two booklets and scientific articles on the subject.



# Los cost digesters in LatinAmerica

Jaime Martí Herrero  
tallerbiogas@hotmail.com

**IKIAM**   
UNIVERSIDAD REGIONAL AMAZÓNICA



**What is the technology  
of low cost digesters?**

## Low technological input digester

Fixed dome – Chinisse digester  
Floating drum – Hindu digester

No active heating or mixing  
Water dilution (1:1)  
Buried



## Low technological input digester

**Low investment**

**Decentralization**

**Local use of effluent and biogas  
(heating)**



## Comparison of biogas development from households and medium and large-scale biogas plants in rural China

Zilin Song<sup>a,b</sup>, Chao Zhang<sup>a</sup>, Gaihe Yang<sup>a,b,\*</sup>, Yongzhong Feng<sup>a,b</sup>,  
Guangxin Ren<sup>a,b</sup>, Xinhui Han<sup>a,b</sup>

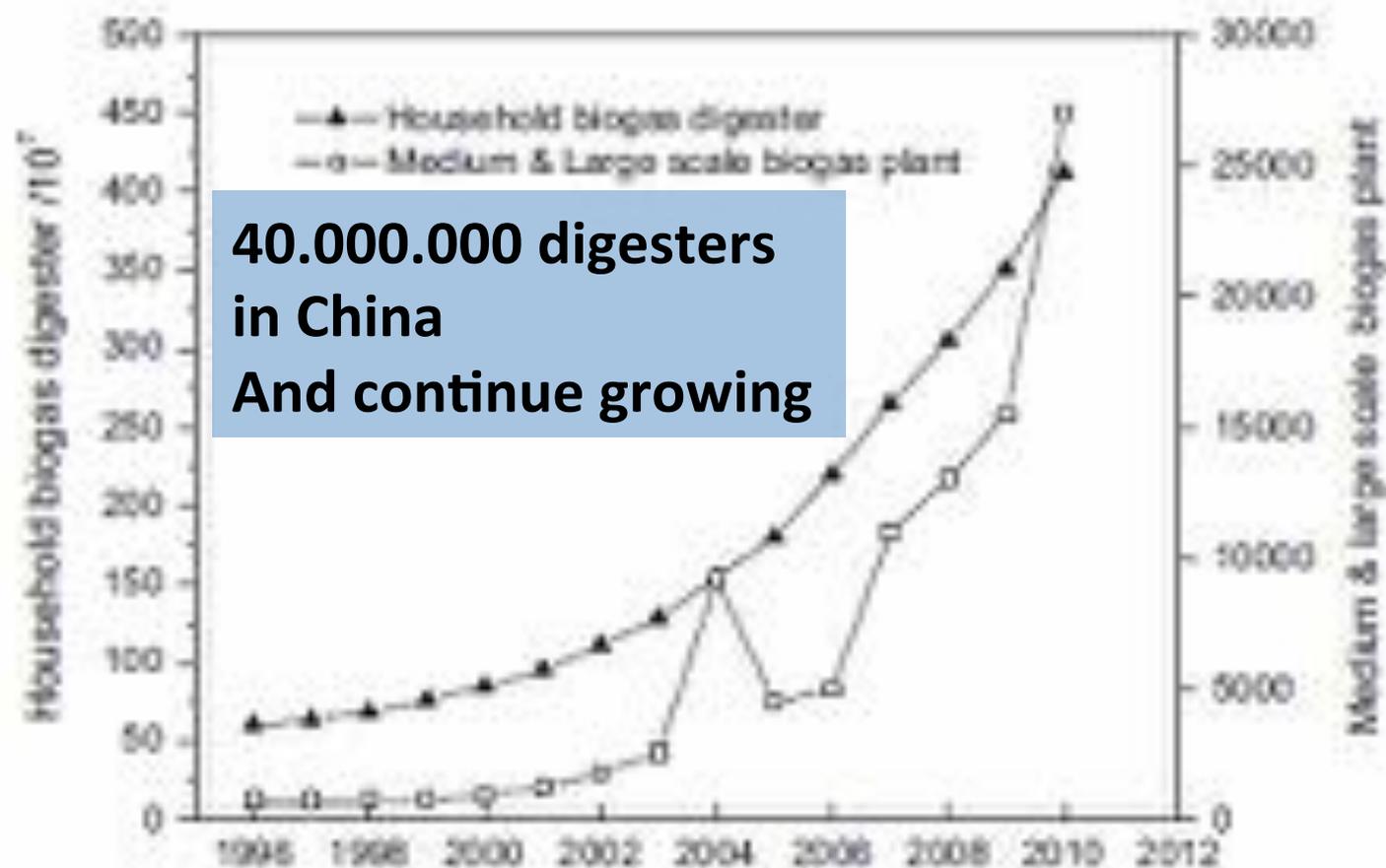


Fig. 3. The development of household biogas and medium and large-scale biogas plant in China from 1996 to 2010 [11].

## Low technological input digester

China 43.000.000 units (2014)

India 4.750.000 units (2014)

Nepal 330.000 units (2015)

VietNam 183.000 units (2014)

Kenya 16,419 units (2017)

Ethiopia 13,585 units (2017)

Tanzania 13,037 units (2017)

Burkina Faso 7,518 units

(2017)

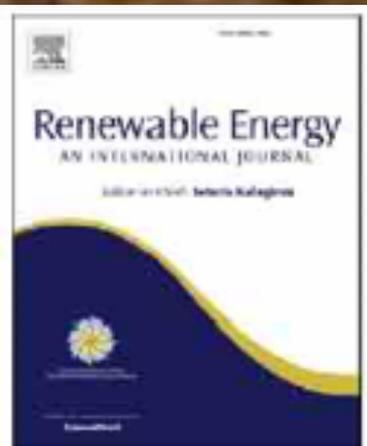
Uganda 6,504 units (2017)

## What about Latin America?

Biogas: Developments and perspectives in Europe

Nicolae Scarlat\*, Jean-François Dallemand, Fernando Fahl

*N. Scarlat et al. / Renewable Energy 129 (2018) 457–472*

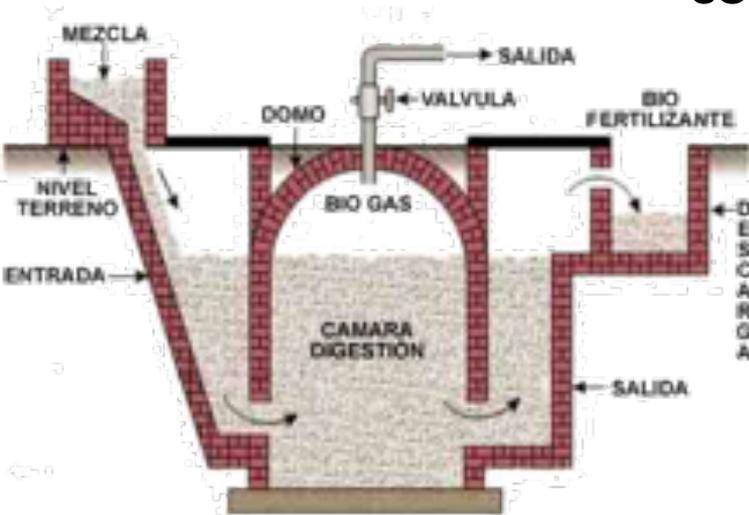


# Why not Fixed dome digesters in Latin America?

There were experiences in the whole continent in 70s and 80s

but too expensive

Lack of following up



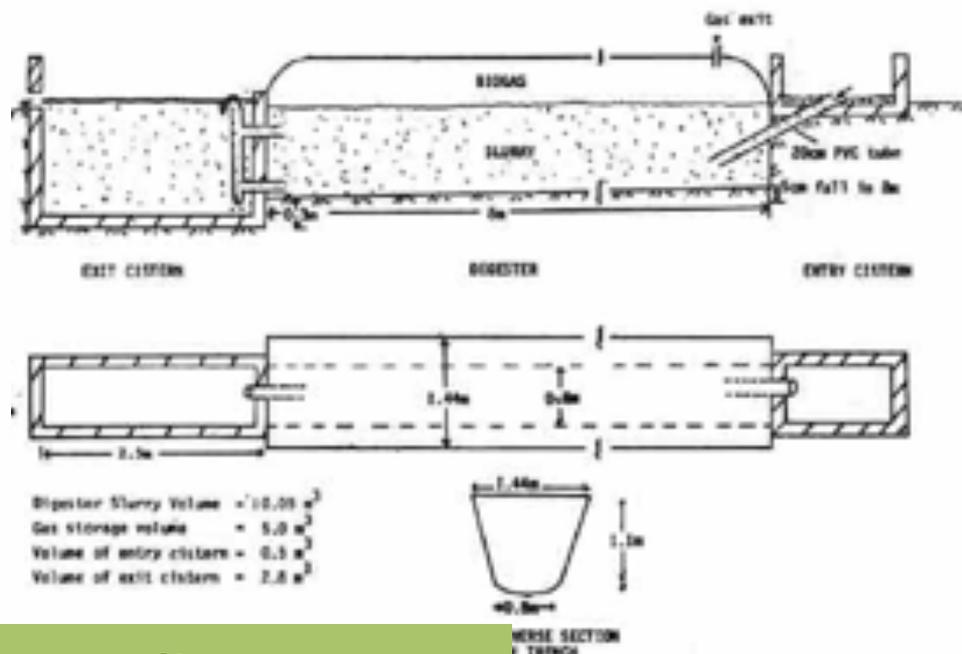
80s new model:

Low cost plastic digester

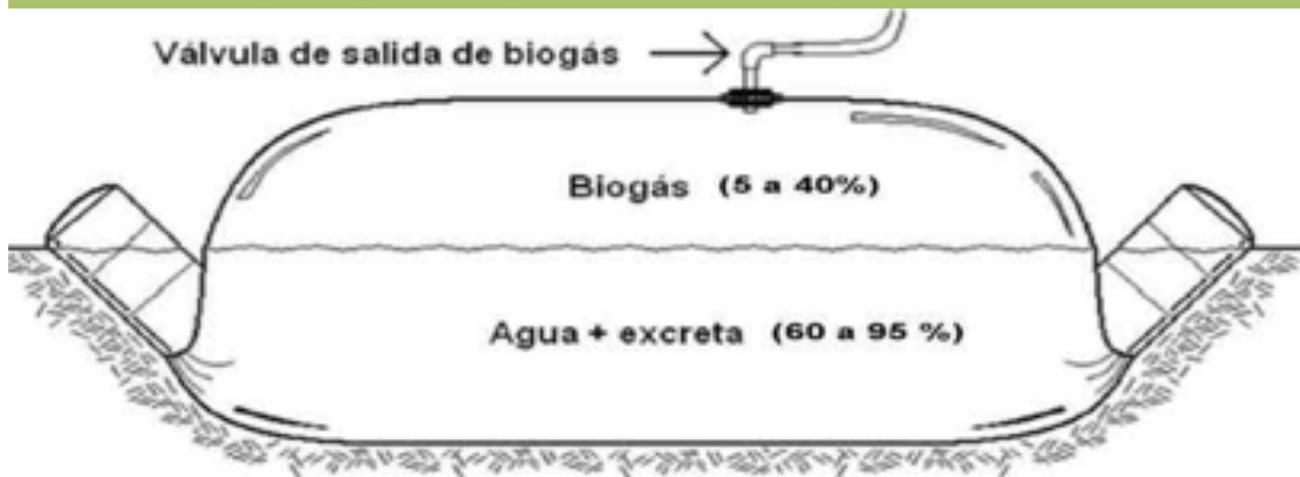
Plate 1:  
"Red-Mud" PVC digester



1" PVC digester

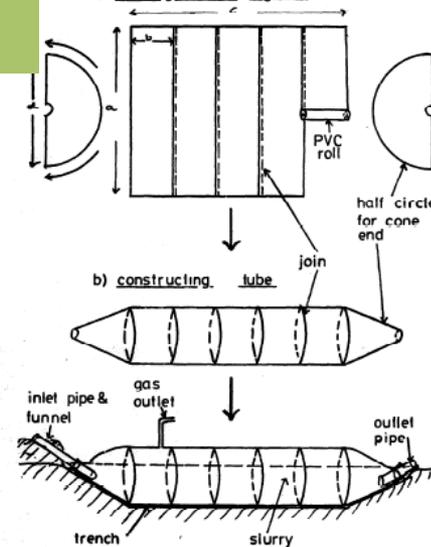


Based in the red mud PVC taiwaneses digester  
 But using regular greenhouse plastic



**PISO A NIVEL**

Fig 2 Construction of tube biogas digester  
 a) welding sheets together



Low technological input digester

“Just right  
technology”

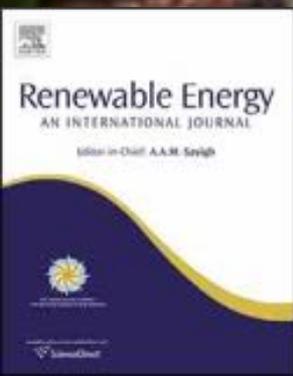
Tubular/plastic/balloom digester

No active heating or mixing  
Needs more water (1:3)  
Semi-buried

Low cost tubular digesters as appropriate technology for widespread application: Results and lessons learned from Bolivia

Jaime Martí-Herrero <sup>a,\*</sup>, Maria Chipana <sup>b</sup>, Carlos Cuevas <sup>b</sup>, Gabriel Paco <sup>c</sup>, Victor Serrano <sup>d</sup>, Bernhard Zymla <sup>e</sup>, Klas Heising <sup>e</sup>, Jaime Sologuren <sup>b</sup>, Alba Gamarra <sup>f</sup>

*J. Martí-Herrero et al. / Renewable Energy 71 (2014) 156–165*



## Low technological input digester

Can be adapted to cold climate regions using solar passive heating design

$T = \text{Maximum of ambient}$

## Low technological input digester

Can be adapted to cold climate regions using solar passive heating design

$T = \text{Maximum of ambient}$

Towards thermal design optimization of tubular digesters in cold climates:  
A heat transfer model

Thibault Perrigault<sup>a</sup>, Vergil Weatherford<sup>b</sup>, Jaime Martí-Herrero<sup>a,\*</sup>, Davide Poggio<sup>c</sup>

*T. Perrigault et al. / Bioresource Technology 124 (2012) 259–268*





**LAC has contributed the development of plastic tubular bdgs(also VietNam)**



<http://redbiolac.org>

**RedBioLAC**  
**Red de Biodigestores**  
**para Latino América**  
**y el Caribe**





# Cuba 2019

<http://www.encuentroredbiolac.com/>



2009, Perú

2010, Costa Rica

2011, Mexico

2012, Nicaragua

2013, Honduras

2014, Colombia

2015, Chile

2016, Costa Rica

2017, Argentina

2018, Brasil



# Tubular digester



**Cidelsa en Perú**



**Coplastgroup en Perú**



**Biobolsa México**



**Terrazonet Colombia**

**Viogaz en Costa Rica Biosinergia Costa Rica**



**Disambiental Colombia**

**Ecuador**



**BiodigestoresEcuador**



**BiodigestoresMudolIntag**

## Tubular digester



Also big digesters, Colombia



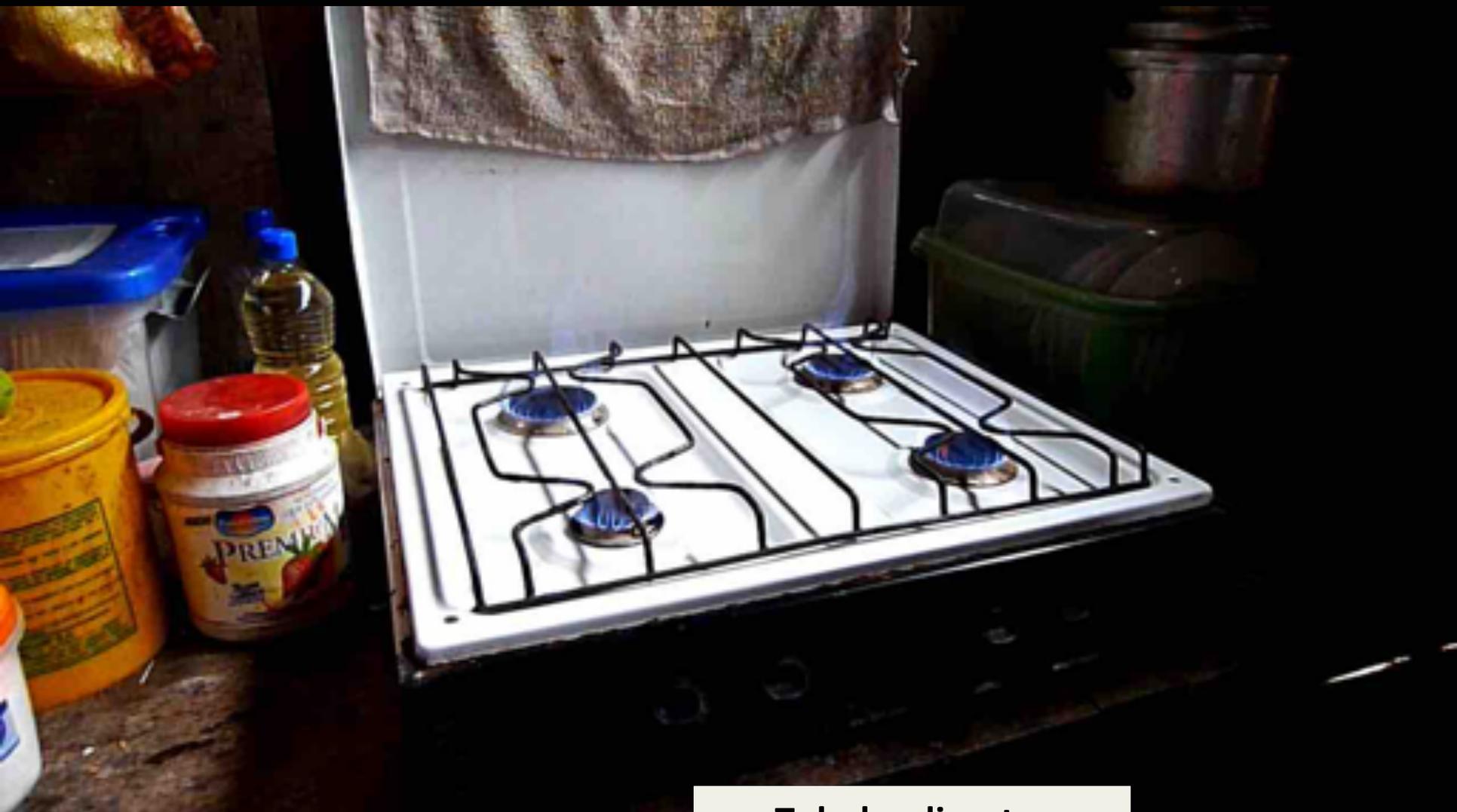
**Tubular digester**

**Easy to learn how to install**

**Materials are available in local markets**

**Biogas and effluent use to be used locally**





**Tubular digester**



**BDGs sencillos - bajo requerimiento tecnológico**

**También dependen de subsidios**

**Los PNBs exitosos en Asia y Africa,  
por evaluar en LAC**

**De uso para cocina, fertilizante y  
mitigation ambiental → [Step forward to productive biogas](#)**





Santa Rosa, G. Parra Ecuador, 2015



Santander, Finca TOSOLY, Colombia, 2015

# Presurización y uso de biometano como sustituto de combustibles fósiles en el sector agrícola en Arequipa, Perú

José Godofredo Peña Davila<sup>1</sup>, Jorge Castro Valdivia<sup>2</sup>, Sergio Mestas Ramos<sup>2</sup>, Fernando Mejía Nova<sup>1</sup>, Luz Cárdena Herrera<sup>1</sup>, Francisco Roque Rodríguez<sup>2</sup>, Juan Reategui Ordoñez<sup>2</sup>, Irina Salazar Churata<sup>1</sup>

1. Instituto de Investigación y Desarrollo para el Sur, Perú. 2. Universidad Católica de Santa María, Perú.

jgpenad@gmail.com



Figura 5. Tractor de 2 ruedas con motor de gasolina adaptado para funcionar con biometano.

Farm  
machinery

**BDGs sencillos - bajo requerimiento tecnológico**

**También dependen de subsidios**

**Los PNBs exitosos en Asia y Africa,  
por evaluar en LAC**

**De uso para cocina, fertilizante y  
mitigation ambiental → paso a usos productivos**

**→ wastewater treatment, organic solid urban  
waste, industrial wastes....**





Varios bdgs en serie



Bioresource Technology 167 (2014) 87–92

Contents lists available at ScienceDirect

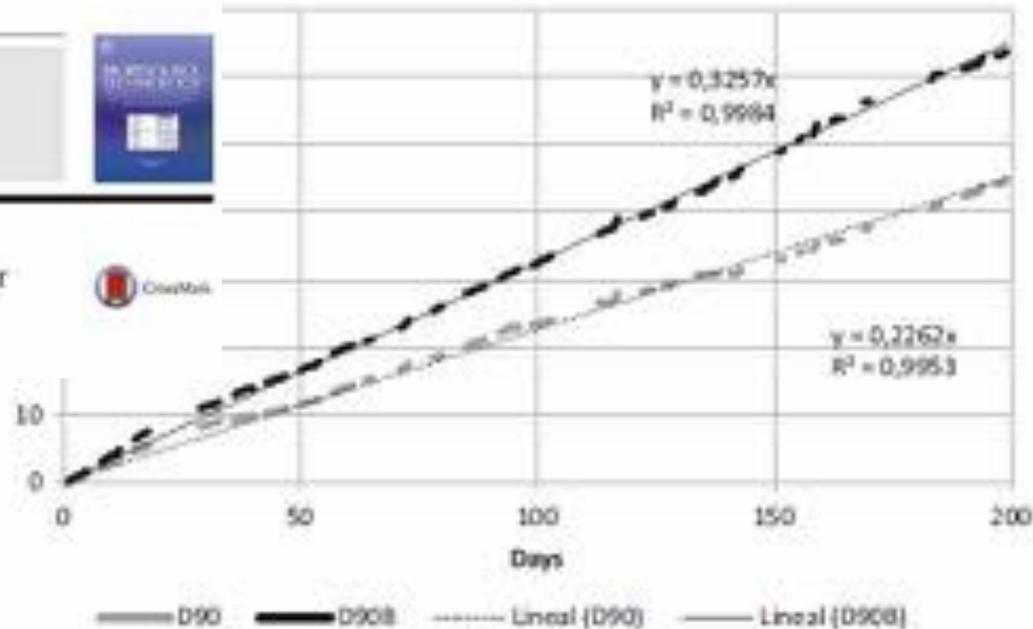
Bioresource Technology

Journal homepage: [www.elsevier.com/locate/biortech](http://www.elsevier.com/locate/biortech)



### Improvement through low cost biofilm carrier in anaerobic tubular digestion in cold climate regions

J. Martí-Herrero<sup>a,\*</sup>, R. Álvarez<sup>b</sup>, M.R. Rojas<sup>b</sup>, L. Aliaga<sup>c</sup>, R. Céspedes<sup>d</sup>, J. Carbonell<sup>e</sup>



### Bolivia, CIB3

- Cow manure: water(1:3)
- 124 d HRT
- **Biofilm (+50% biogas)**



## Evaluation of the low technology tubular digesters in the production of biogas from slaughterhouse wastewater treatment



J. Martí-Herrero <sup>a, b, \*</sup>, R. Alvarez <sup>c</sup>, T. Flores <sup>d</sup>

**Three digesters in series**

**The first digester with chopped up bottles**



**Fig. 1.** The three tubular digesters in series, monitored in the Cochabamba slaughterhouse, at 2572 m above sea level (Martí-Herrero et al., 2016).













## Three material alternatives:

- Greenhouse plastic
  - (cheaper, “do it your self, **but delicate** )
- PVC geomembrane
  - (prefabricated, very flexible, long lasting , **but protection from sun and big biogas bells**)
- Poliethilene Geomembrane
  - (prefabricated, long lasting, resistant **but not much flexible**)

Biogas reservoir



Biogas reservoir



Biogas reservoir



Stoves can be adapted

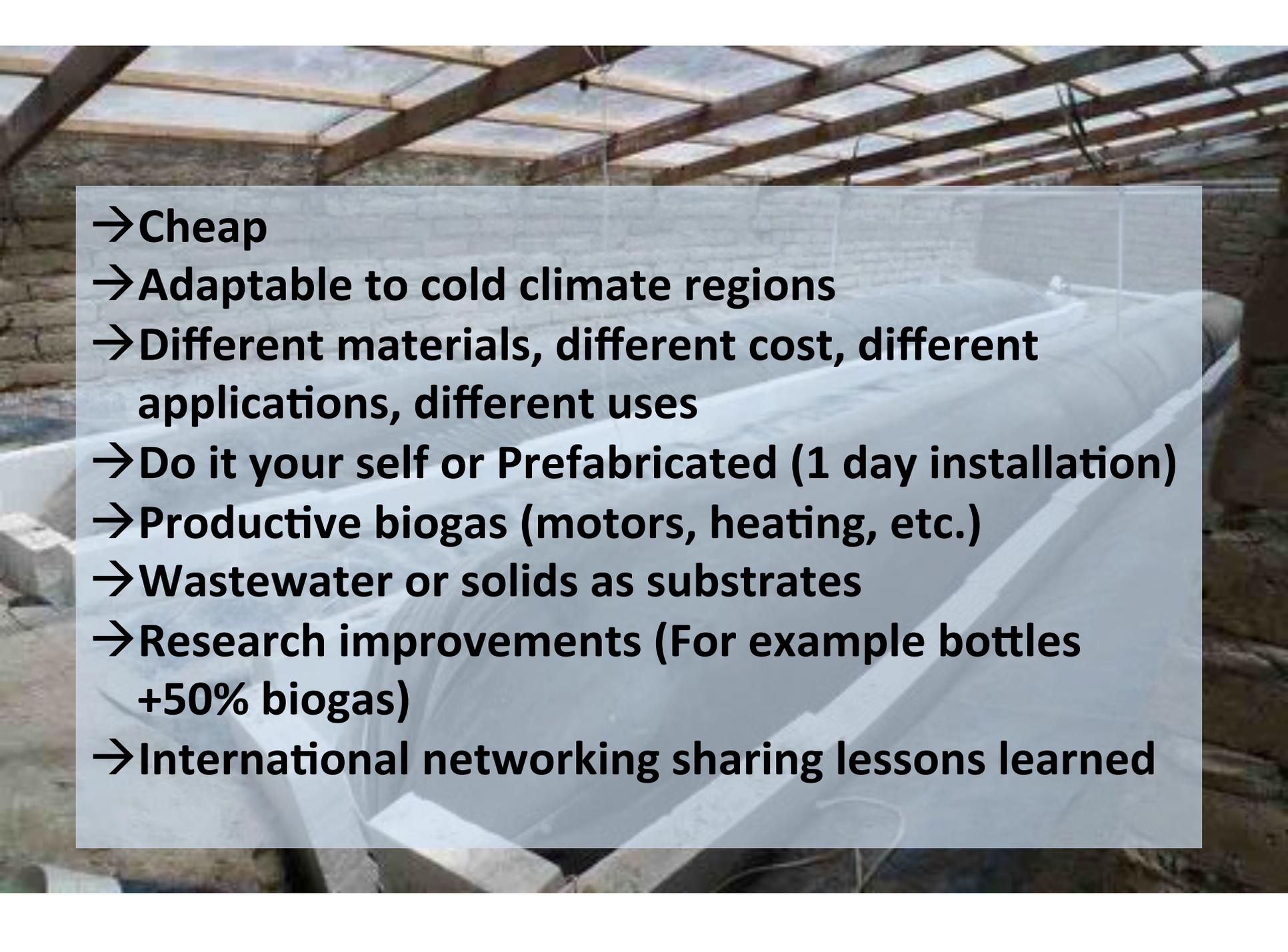


Stoves can be adapted



Stoves can be adapted



- 
- Cheap
  - Adaptable to cold climate regions
  - Different materials, different cost, different applications, different uses
  - Do it your self or Prefabricated (1 day installation)
  - Productive biogas (motors, heating, etc.)
  - Wastewater or solids as substrates
  - Research improvements (For example bottles +50% biogas)
  - International networking sharing lessons learned

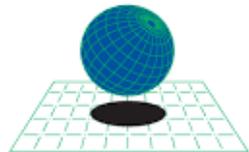
<http://www.beegroup-cimne.com/biodigesters/>



@probandox2

[tallerbiogas@hotmail.com](mailto:tallerbiogas@hotmail.com)

**IKIAM**   
UNIVERSIDAD REGIONAL AMAZÓNICA



**CIMNE**



**beegroup**



# Development and Application of Biodigester Technology

## Advances from Latin America and the Caribbean

### Panelist:

#### **Sam Schlesinger**

Ecuador Program Manager  
Green Empowerment

- Several years of experience organizing community development projects in Costa Rica, Nicaragua and Ecuador.
- Practical experience in clean water and renewable energy systems, training programs and rural logistics to the management of Green Empowerments projects in Ecuador.





# Baseline Comparisons

- China: 1.39 billion population, 40 million biodigesters
- India: 1.34 billion population, 5 million biodigesters
- Latin America: 640 million population, 15 thousand biodigesters (installed)



# Regional Precedents

70's-80's: Introduction of technology through universities  
-Functional models, but ignore setting

90's-early 00's: Transition to tubular models, universal “pilots”  
-Underestimation of the challenges posed by BGD

Mid 00's-2010: Recognition of challenges  
-Introduction of new materials, links between actors

Last decade: Networking and national-level efforts  
-Variety of strategies and outcomes





# Colombia: Grassroots Consolidation

- Early introduction and consistent promotion
- National-level network which goes beyond BGD
- Variety of grassroots implementing organizations with autonomous technical capacity







# Costa Rica: Impetus from Environmental Policy

- “Incubator” at Earth University

- Business-focused approach w/o intentional market development

- No tailored biodigester policy, but regulations and civil society push potential clients towards adoption



# Mexico: Social Enterprise with International Support

- National Program-level impacts w/o actual program
- Mix of subsidized (smaller) digesters and market-based installations
- Program support for novel promotion/education programs





# Bolivia: Technological Adaptation through National-level Efforts

- Adaptation of technology to unfriendly climate
- National-level program w/o strategy for long-term sustainability or replicas
- Effort complicated by “competition” from subsidized LPG





# Nicaragua: Adaptation of National Programs

- Attempt to import successful practices from other continents
- Need to adapt both technology and financial structure
- Development of market for accessories/applications of biogas



BIOLAS  
NICARAGUA



# Regional Strategies

- South-South multi-disciplinary collaboration
- Simultaneous push for national-level programs and grassroots efforts
- Integration of biodigestion into curricula
- Push for public policy that promotes technology without suffocating dissemination and innovation

# Development and Application of Biodigester Technology

## Advances from Latin America and the Caribbean

### Thematic Discussant:

**Willington Ortiz**

WISIONS Research Associate

Wuppertal Institute

Germany



# Panel Discussion



**Mariela Pino,**  
General Coordinator  
RedBioLAC



**Carmen Dienst**  
Head of Research Unit  
„International Energy Transitions“  
Wuppertal Institute



**Sam Schlesinger**  
Ecuador Program Manager  
Green Empowerment



**Willington Ortiz**  
Regional Coordinator LAC  
WISIONS Initiative  
Wuppertal Institute



**Jaime Martí Herrero,**  
Research Associate  
CIMNE and Ikiam University



## Development and Application of Biodigester Technology Advances from Latin America and the Caribbean

# Wrap-up & Conclusion