EGEDA
under EWG-APEC

Asia-Pacific
Economic Cooperation

IRENA
International Renewable Energy Agency

Exercise 2. Estimating and conversion - Biogas

The 18th APEC Workshop on Energy Statistics

Joint APEC-IRENA Workshop on Renewable Energy Statistics

15-17 December 2020

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Outline

1. What is biogas?
2. Biogas technologies
3. IRENA Biogas data for APEC region
4. Basic assumptions
5. Data validation example- verifying consistency.
6. Exercise 2: Estimating and conversion –Biogas
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What is "Biogas"

Biogas is a mixture of **Methane, CO_2** and other gases in small quantities, arising from the anaerobic fermentation of biomass and the gasification of solid biomass. Includes:

Prefabricated biodigester, tubular model – Peru

Source: https://www.cidelsa.com/en/lp/biodigestores-productivos/

- landfill gas
- sewage sludge gas
- other biogases from anaerobic fermentation
- and biogases from thermal processes

Biogas technologies

Landfill gas recovery system

The 46-MW Puente Hills landfill gas-to-energy facility owned by the Sanitation District of Los Angeles County, USA

https://www.powermag.com/the-clean-and-dirty-of-landfill-gas-power/

Biogas from sewage sludge

Biodigester in the wastewater treatment plant of the city of Urumqi in China

https://www.veolia.com/en/solution/sewage-sludge-green-energy-biogas-wastewater

Biogas technologies

Large scale biodigester

Biodigester in Malaysia -Palm Oil Mill Effluent treatment

https://www.wateronline.com/doc/pome-dome-success-andia-s-biogas-digester-mixing-system-malaysia-0001

Small scale biodigester

Fixed dome

Floating drum

Bag digester

IRENA Biogas data for APEC countries

IRENA has two separate datasets:

- Biogas in energy balances from standard questionnaires
- Biogas for energy access in the off-grid Data Base. It includes Household digesters – capacity, production, numbers of users, plus digesters used for off-grid electricity.

https://www.irena.org/Statistics

Basic default assumptions

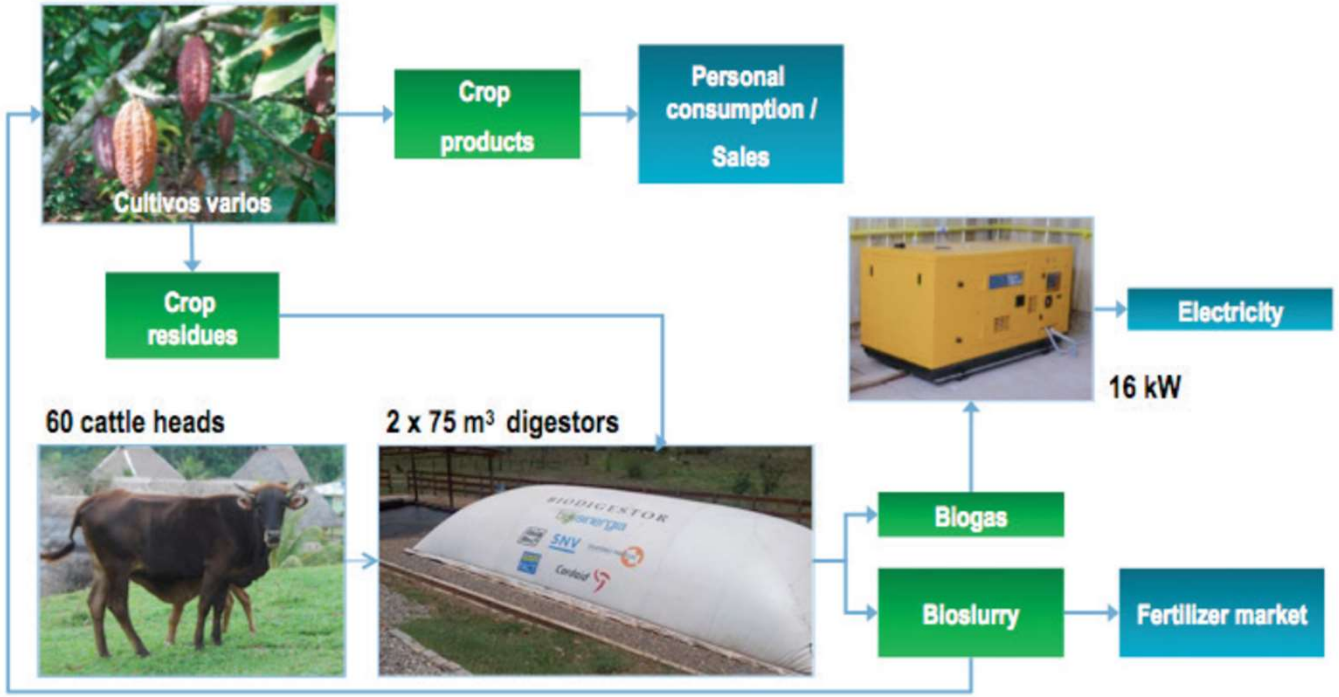
- Plant volume to daily gas production in small biodigesters:

Plant Type	Multiplier: total plant volume to daily gas production
Fixed dome plant	0.33
Floating drum plant	0.50
Balloon/ bag digester	0.42

- 1m3 biogas generates 2kWh electricity. (In terms of energy content, this reflects the process efficiency).
- Methane content is about 65% of biogas, but it can also vary according to the anaerobic digestion process parameters.

Example 1. Verifying consistency

- The purpose of this exercise is to take reported data, from a project to provide electricity access to the community of Santa Rosillo in the Peruvian Amazon; **calculate the annual electricity generation and verify data consistency.**



Source: PER BIO synergy project SNV

Example 1. Verifying consistency

Given information	
Digester capacity (m3)	150
Gas production (m3/day)	18
Generator capacity (kW)	16
Annual electricity generation (kwh/year)	?

Source: PER BIO synergy project SNV

The generator was sized to meet the peak demand in 2021.

- Annual generation = 18 x **2** x 365 = **13,140 kWh/yr**
- Full generation capacity = 16 x 8760 = 140,160 kWh/yr
- Capacity utilisation = 13,140/140,160 = **9.4%**

Main assumption: 1m3 biogas generates 2kWh of electricity

Exercise 2. Estimating and conversion Biogas

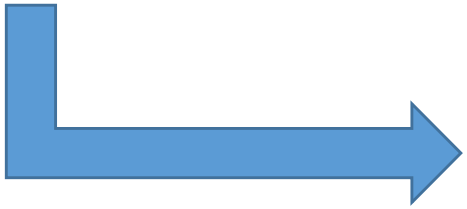
- The purpose of this exercise is to take raw data from a project monitoring report and **estimate the production and consumption of biogas energy,** to complete an energy balance based on this data.

- This exercise is based on data from the Indonesia Domestic Biogas Programme BIRU Program.

Source: https://www.biru.or.id/tentang-program-biru

Exercise 2. Estimating and conversion Biogas

Given information	
Year	2017
Total number of plants installed	21,316
Percentage of non functioning plants	5%
Average plant size (m3)	12
Plant Type	Fixed dome
Factor (Total volume to daily gas production)	0.33
Methane content in biogas	65%
Methane energy content (MJ/m3)	34

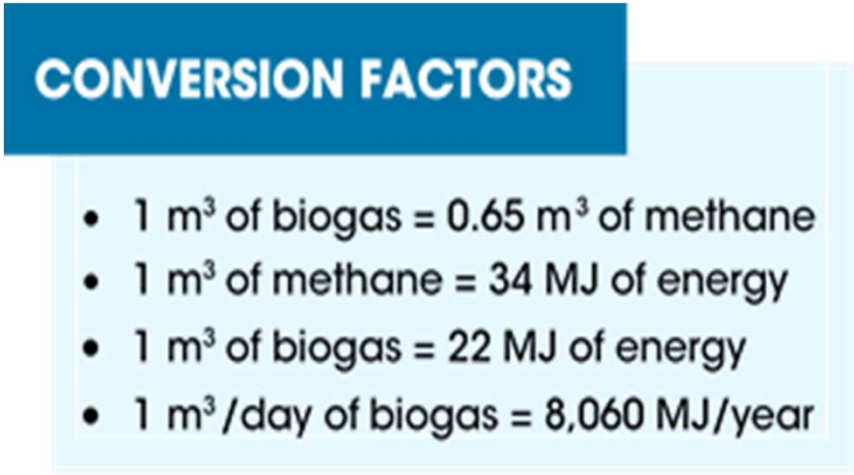


NATIONAL ENERGY BALANCE		
Supply and consumption 2017		Other biogases from anaerobic digestion TJ
Production	(+)	**653.4**
Imports	(+)	
Exports	(-)	
Stock changes	(+)	
International Bunkers	(-)	
Domestic supply	(=)	
Transfers		
Statistical Differences		
Power plants		
CHP plants		
Commercial heat plants		
Charcoal production		
Biomass pellet and briquette production		
Other transformation		
Energy sector and own use		
Distribution losses		
Total final consumption		
Industry sector		
Transport sector		
of which road transport		
Commercial and public services		
Residential		**653.4**
of which traditional uses		
Other		

Exercise 2. Estimating and conversion Biogas

Assumptions:

- For this exercise, we assume that the average digester size is 12m3
- 95% of the units installed, reported to be still working in 2017 according to the BIRU Programme website.
- Basic default assumptions



Exercise 2. Estimating and conversion Biogas

1. In total **21316** plants had been installed by the end of 2017
2. Assume that 95% are functioning → *20250 plants functioning*
3. Average size of 12m3 → daily gas production for fixed dome plants = *0.33 x volume(12m3) = 4 m3 biogas/day*
4. Total annual biogas production = *20250* 4 * 365 = 29565291.7 m3 Biogas/year*
5. Biogas is 65% methane → *19217440 m3 of methane*
6. 1m3 of methane contains 34 MJ of energy → total production of **653.4 TJ**
7. It can be assumed that all consumption is residential

Summary: Basic estimation process

1. Convert digester numbers to capacity assuming average size
2. Accumulate over time, accounting for durability/use (if census data is not available)
3. Estimate gas production based on default assumptions from biodigester volume to daily gas production
4. Estimate electricity generation from gas production if necessary
5. Depending on information available, work backwards from electricity data
6. In general, check for consistency between capacity and production in the system

4. Work on Exercise 2 with Vietnam's data

Thank you for your kind attention

https://www.egeda.ewg.apec.org/
https://irena.org/