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# Energy Systems for Developing Regions


**Group 5**

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# Structure of the presentation

Assessing the social, political, economic impacts of renewable energy systems in developing regions

| | |
|---|---|
| Developing countries | • Indonesia<br>• Bolivia |
| Developing market | • Fuel cells |
| Developing economic sector | • Agriculture<br>• Dairy sector |


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Developing countries : Indonesia

# Business Model for Decentralised Power Generation in Rural Indonesia

**Nursita S. Pramono**

Poster #37

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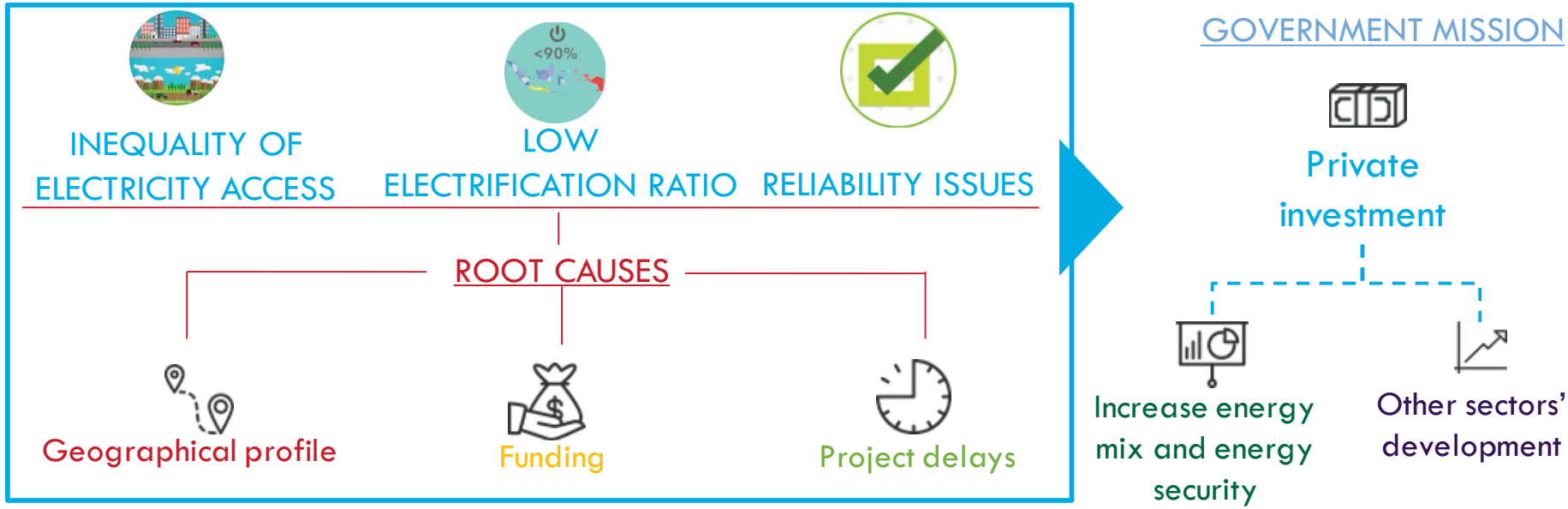
Developing countries: Indonesia/Bolivia
Developing market: Fuel cells
Developing economic sector: Agriculture/Dairy sector

# Background: Indonesia's Problem in Electricity Sector




A BUSINESS MODEL focused in RURAL AREAS that applies to DECENTRALISED POWER GENERATION and RENEWABLE ENERGY (RE) and enables OTHER SECTORS' DEVELOPMENT

# Criteria for Business Model

Policy
Basic theory
Today practice

LITERATURE REVIEW

Government
Business Pract.
Local Community

INTERVIEW

## VALUE PROPOSITION

Electricity for rural areas that emphasises on the impacts on local community improvement

## CUSTOMER INTERFACE

Distribution company

## INFRASTRUCTURE

Machines, devices, and activities

## REVENUE MODEL

Commercial price based on value proposition

# Developing business model

RESOURCE INVESTIGATION

Demand, available resources, potential development and cost components

**IMPACT ASSESSMENT**

MULTI-CRITERIA, adapted from SUREDSS

- Physical
- Financial
- Natural
- Social
- Human

CHOOSING RESOURCE

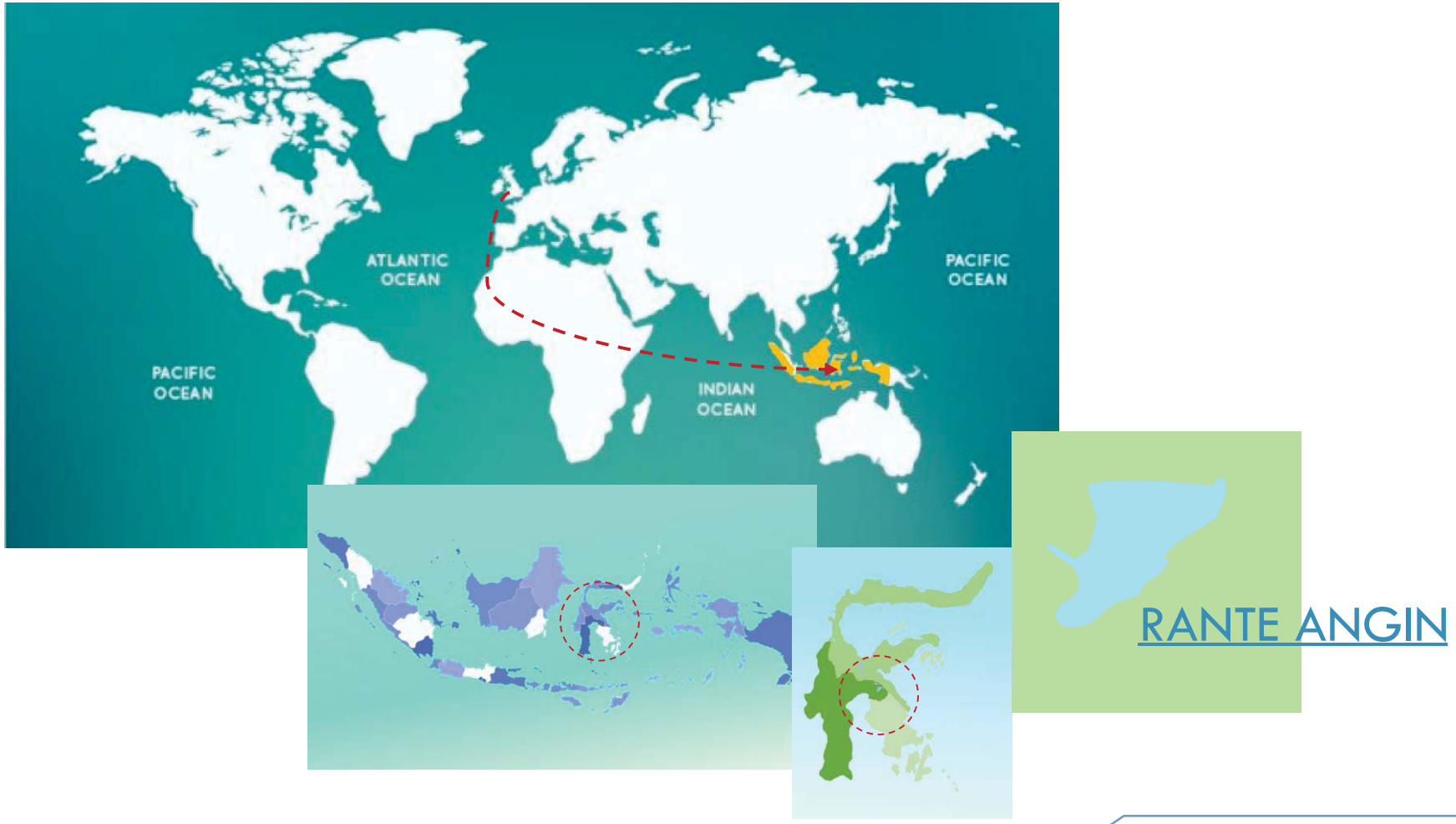
Based on the biggest impacts

FINANCIAL ASSESSMENT

Financially viable or not

MOST SUITABLE RESOURCE OF TECHNOLOGY IN THE TARGETED VILLAGE

# Case Study: Electrifying Rante Angin



# Case Study: Electrifying Rante Angin

**ISOLATED**
By the side of Towuti lake and surrounded by conservation forest

**NEED IMPROVEMENT**
No health service, no street lighting, limited information access, etc.

**DIESEL GENERATOR**
Operates only 13hrs/day and frequently fails

**RANTE ANGIN**

**AVAILABLE RE RESOURCES**

SOLAR

BIOGAS (rice husks)

MICROHYDRO

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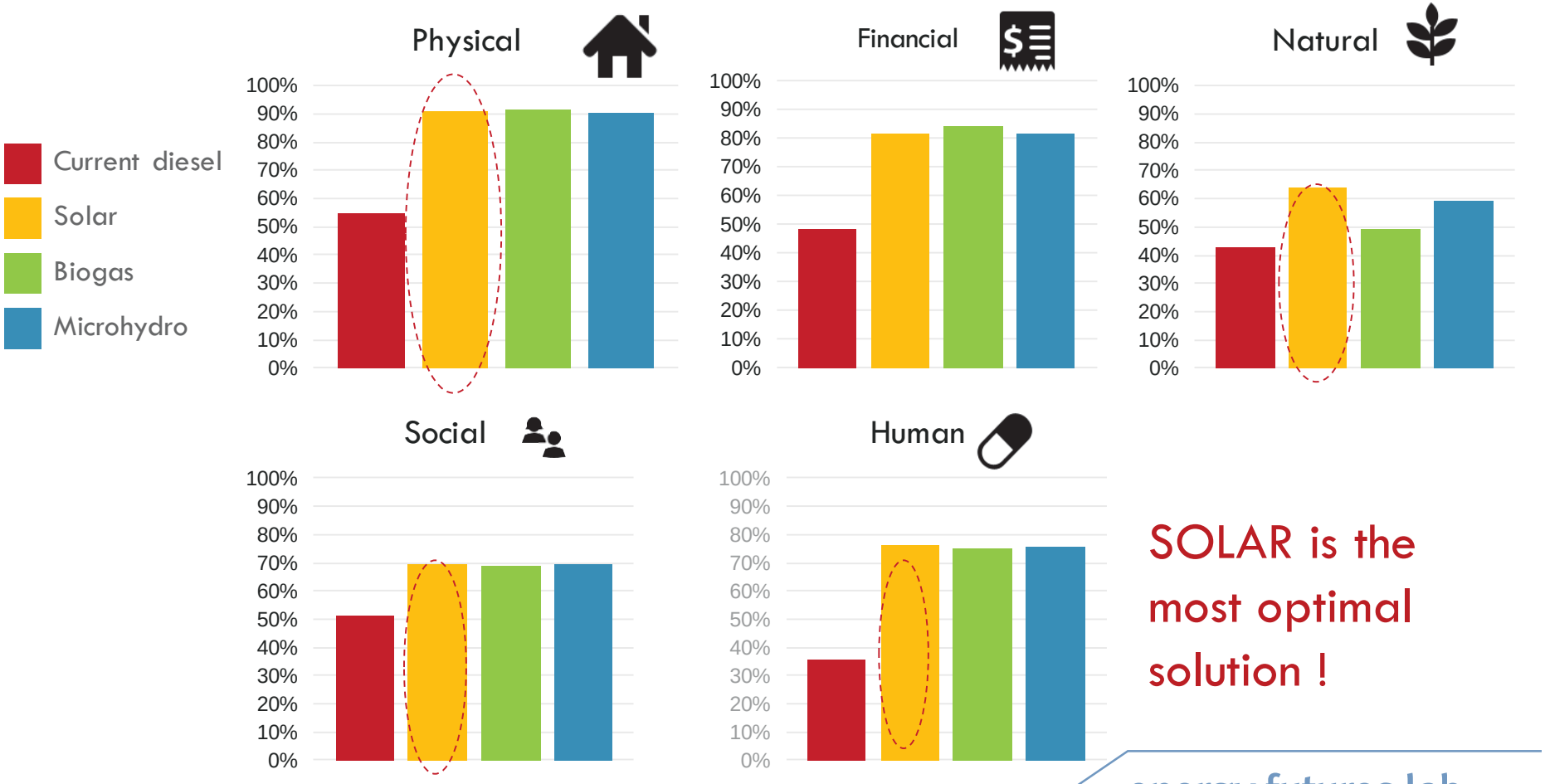
Developing countries: Indonesia/Bolivia
Developing market: Fuel cells
Developing economic sector: Agriculture/Dairy sector

# Results




SOLAR is the most optimal solution !

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# Results

PV + BATTERY
1,577 kWp
Impacts all sectors, especially human and natural impacts

ECONOMICALLY FEASIBLE (in 20 years)
0.12 USD/kWh
Rate of return > 10 %
Net Present Value > 0
Payback Period 14 years

CAN HELP PRIVATE COMPANIES TO ESTABLISH A BUSINESS USING DECENTRALISED POWER GENERATION IN RURAL AREAS, WHICH SUPPORTS LOCAL LIFE QUALITY IMPROVEMENT

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Developing countries : Bolivia

# Distributed electricity generation from renewable energy in grid-connected rural villages

## The case of Bolivia

**Simon Meunier**

Poster #36

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# Situation in grid-connected villages in developing countries

Transmission and distribution system

- Electricity from fossil fuels
- Electricity losses in the Transmission and Distribution (T&D) system

- High impact of electricity generation on global warming
- Electricity too expensive for the inhabitants of the village which therefore restricts electricity use

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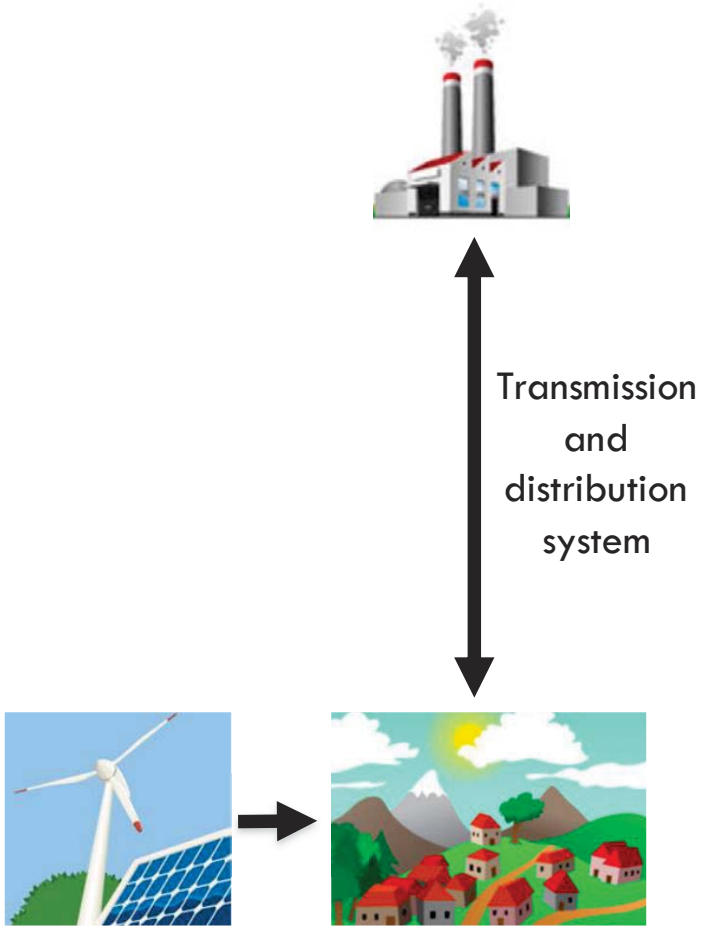
Developing countries: Indonesia/Bolivia
Developing market: Fuel cells
Developing economic sector: Agriculture/Dairy sector

# Solution : Distributed Electricity Generation (DEG) from Renewable Energy (RE) ?




- More electricity comes from renewable sources
- Less energy goes through the T&D system so less losses

- Lower impact of electricity generation on global warming
- Possible lower price of electricity in the village which may increase electricity use

# Aim & Approach

## Aim : Quantifying the potential impacts of developing DEG from RE

## Approach :

- 2 scenarios to be compared:

Baseline scenario : Only the Grid

VS

Alternative scenario : DEG from RE

- Scenarios compared along two parameters :

1. Cost of providing electricity to the village
2. Impact on global warming

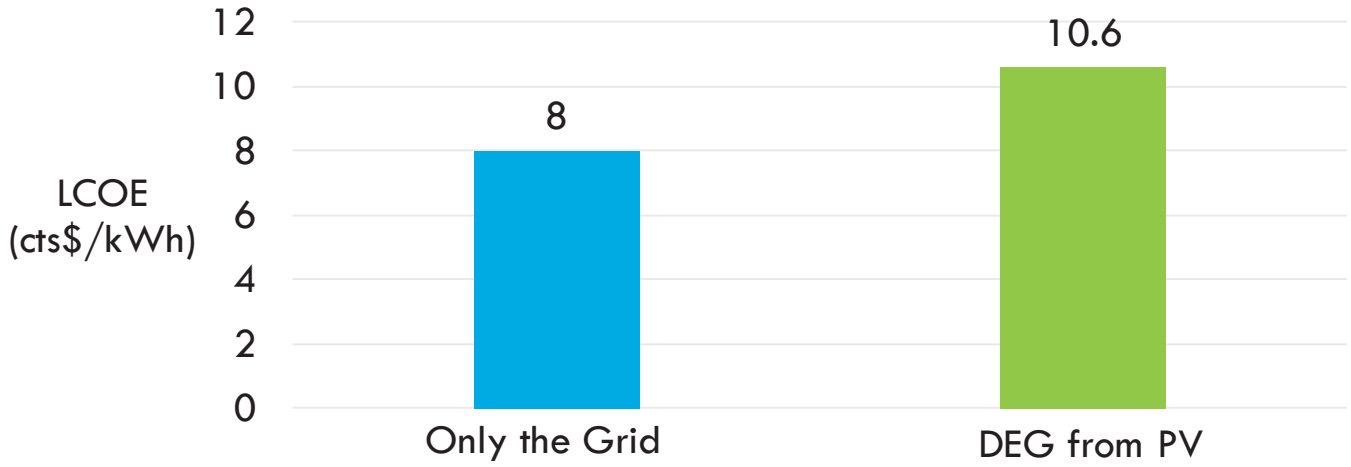
# Case study : Totora


45 Household surveys realised in Totora

- Photovoltaic (PV) energy is chosen in the case of DEG

# Results

## Cost of providing electricity to the village




DEG from PV is more expensive than only the grid

## Impact on global warming

96 $tCO_2eq$ saved yearly by using DEG from PV instead of only the grid

→

45 % reduction of the impact on global warming by using DEG

# Conclusion

## Currently

| Aspect | Economic | Global warming |
|---|---|---|
| **Most beneficial solution** | Grid | DEG |

Currently, the motivation for DEG from RE is environmental

## In the future : A possible economic motivation ?

Cost of many RE technologies ↘

→

Price of Electricity - DEG from RE < Price of Electricity - Grid Only

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Developing market : fuel cells

# Do fuel cells present a solution for backup power for telecoms ?

## Case studies of Ghana, Japan and Brazil

**Claire Burtin**

Poster #34

# Context and objectives

1 What is BUP ? Why is it important ?

**'Ensure the continuous supply of power for sensitive loads during outages'**

**Telecoms**
Data centres
Banks
Hospitals
Companies

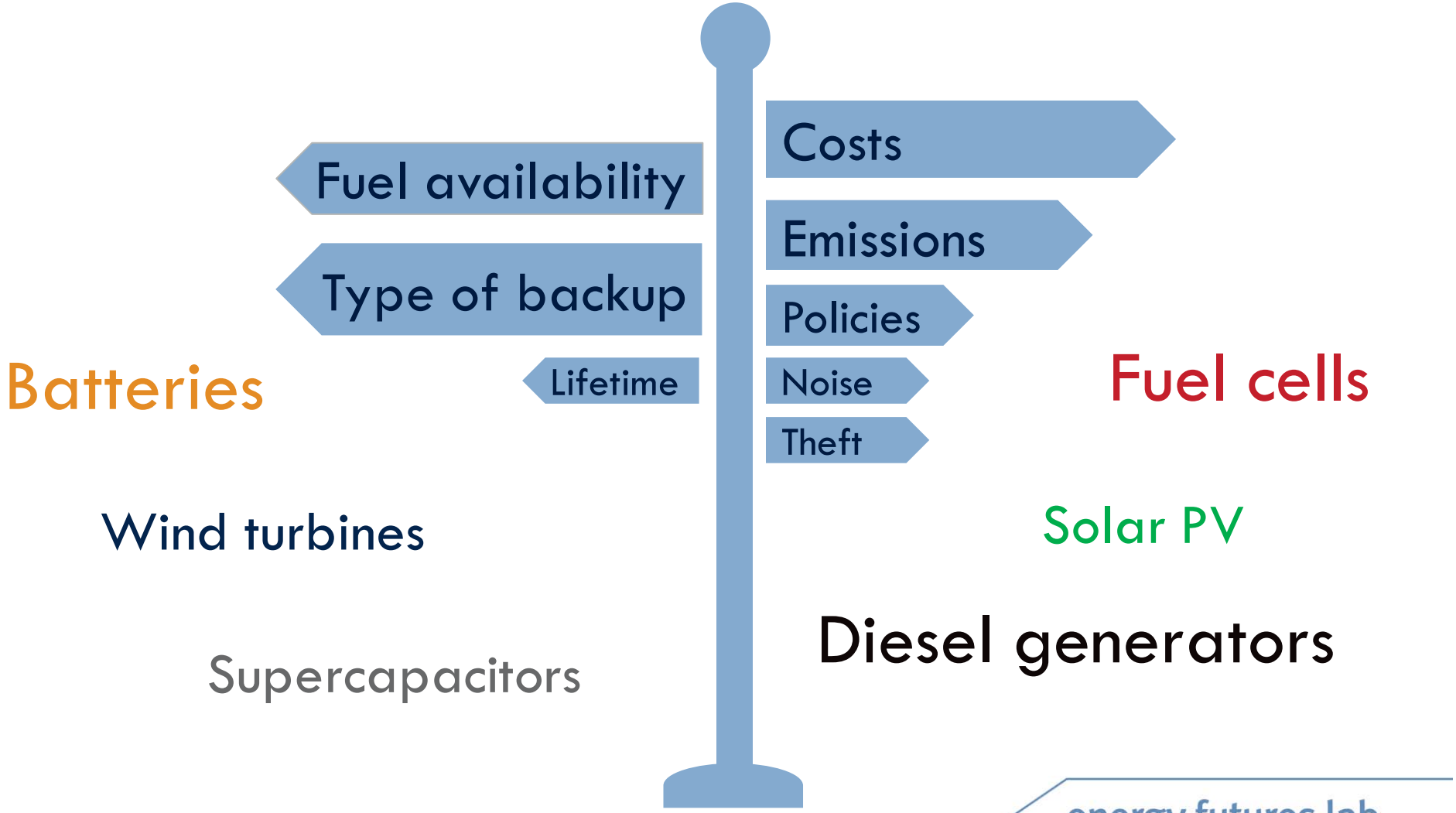
Cost of downtime **$9,000/min**
**in data centre**

Loyalty Security Social

2 How to choose a backup power solution ?

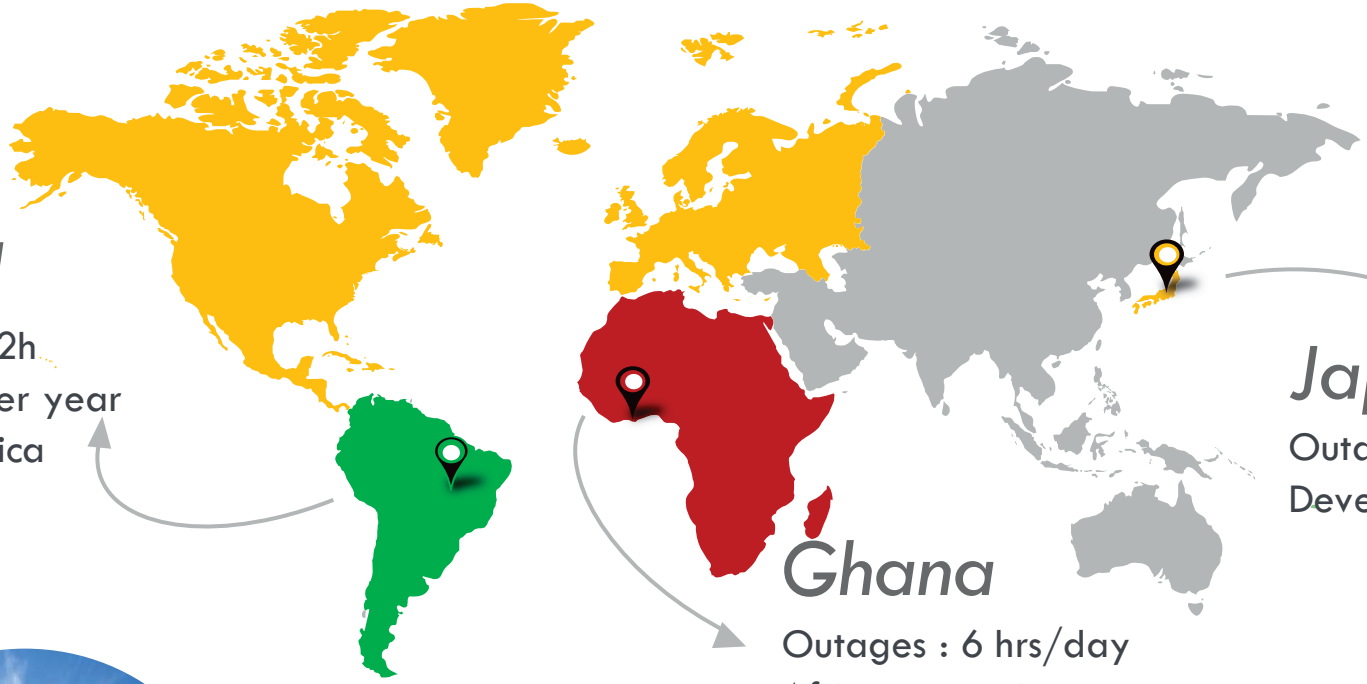
3 Where fuel cells ARE the best solution?

# How to choose a Backup Power solution ?



Developing countries: Indonesia/Bolivia
Developing market: Fuel cells
Developing economic sector: Agriculture/Dairy sector

# Case studies : Ghana, Japan and Brazil



## *Brazil*

Outages : 2h
10 times per year
Latin America

## *Japan*

Outages : 10 min/yr
Developed countries

## *Ghana*

Outages : 6 hrs/day
African countries

*Parameters for the case studies:*

Telecom sector
Continuous load 3kW
Pre-selection of technologies

15-year-project
HOMER Software

# Results

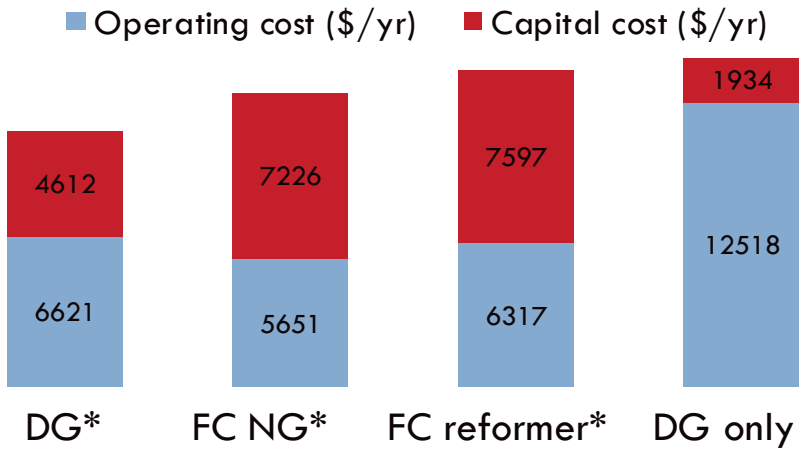
## *Brazil and Japan*

**Batteries and PV** : cheapest and clean technologies

Subsidies needed to make FC competitive : $5,000-10,000/kW

Markets not suitable for fuel cells

## *Ghana*




Annualized costs of operation and capital for different solutions.

* = includes PV and batteries

**Fuel cells compete with DG**

FC are cleaner

DG are cheaper

Potential market for fuel cells

# Conclusions

| | Japan | Brazil | Ghana |
|---|---|---|---|
| Outages | short | medium | long & frequent |
| Country representative of | N.America Europe | Latin America | Africa |
| Potential market for FC | ✗ | ✗ | ✓ |

Telecoms market in Africa ~300,000 sites by 2020

BUT issues with supply chains for hydrogen

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Developing economic sector : Agriculture

# Policy designs for Renewable Energy in the UK Agribusiness

**Dimitrios Vardouniotis**

Poster #39

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# Aim & Background

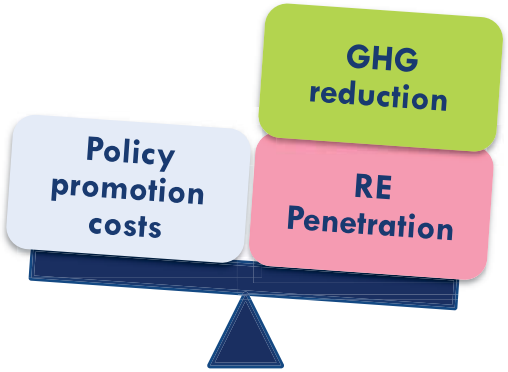
# Approach

*How can the unique features of agriculture influence the energy future of the UK?*

*The System Dynamics (SD) model resembles a 'policy laboratory'*

*Trial & Error approach to achieve the desired results*

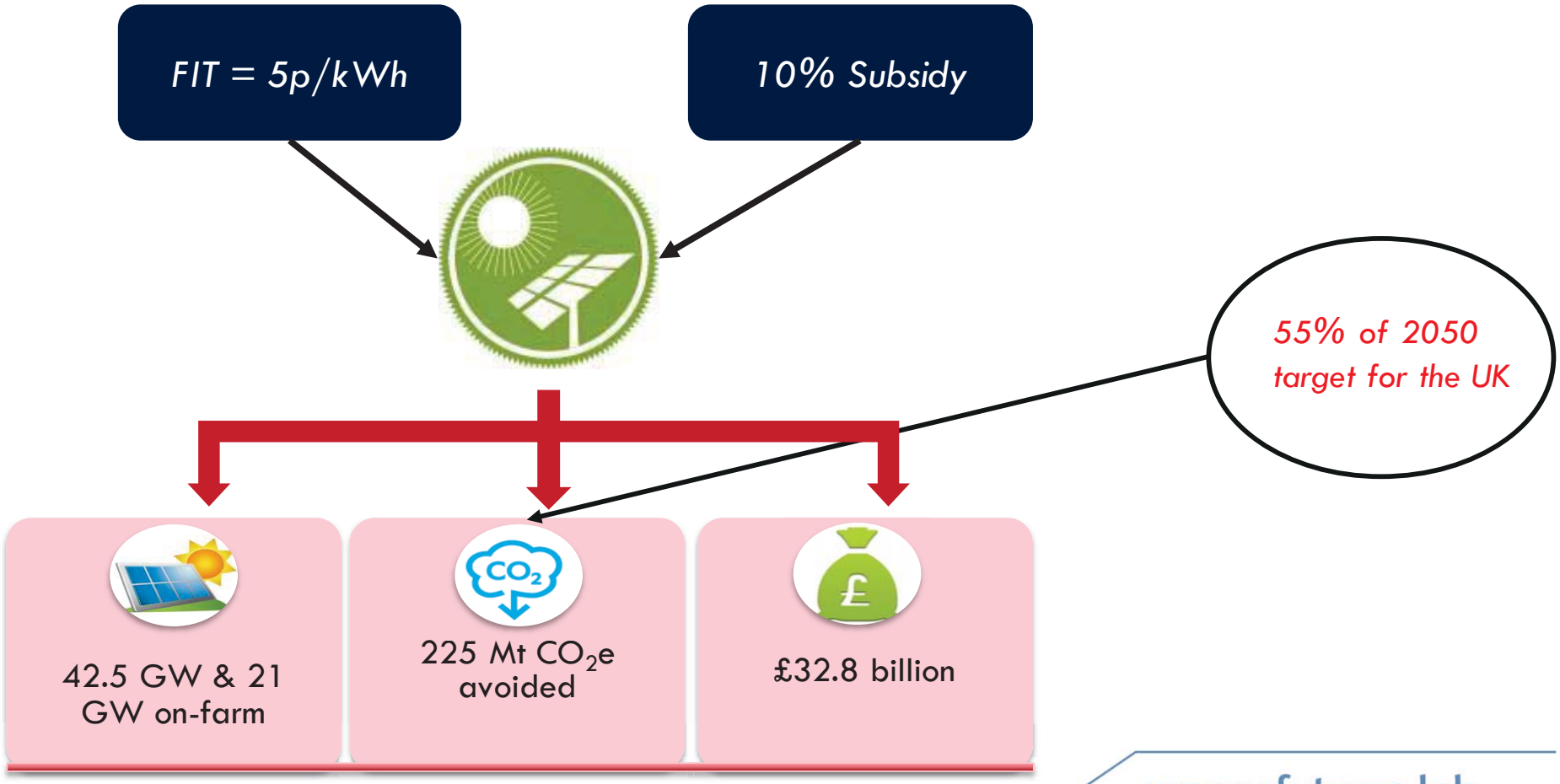
A successful policy aims to find the right balance between the outcomes.



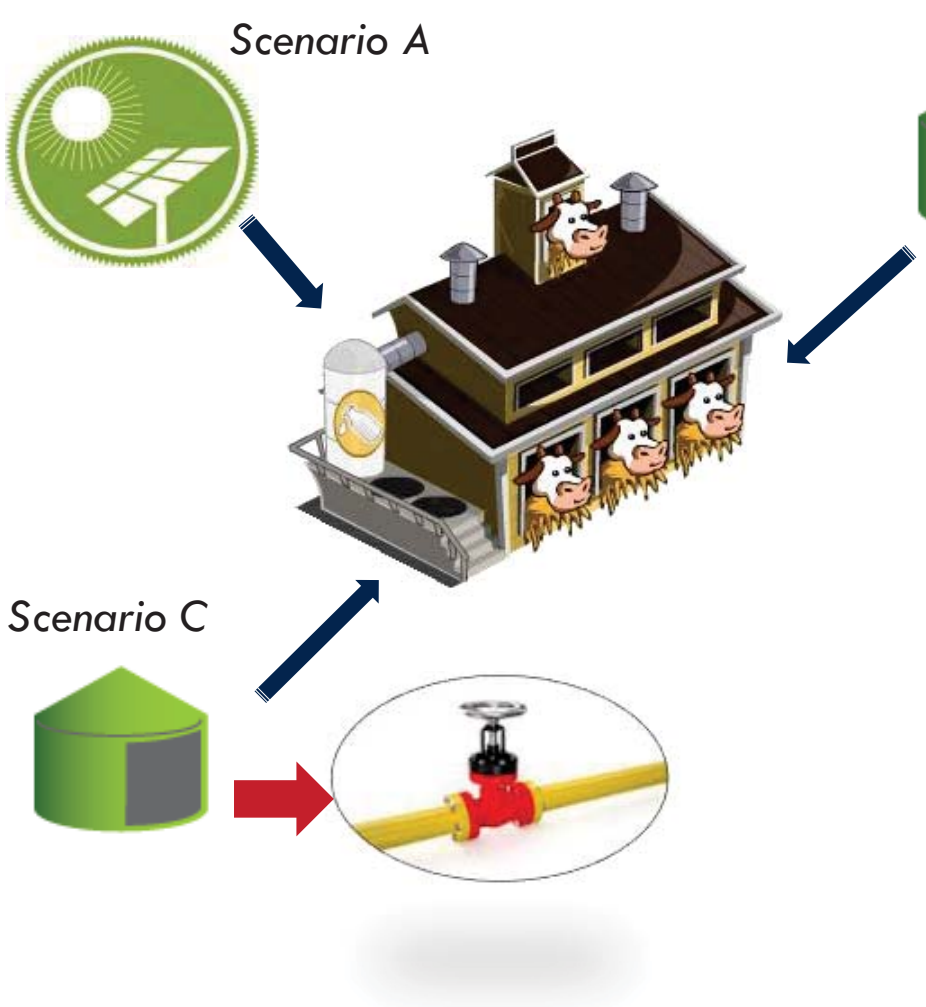
# Results

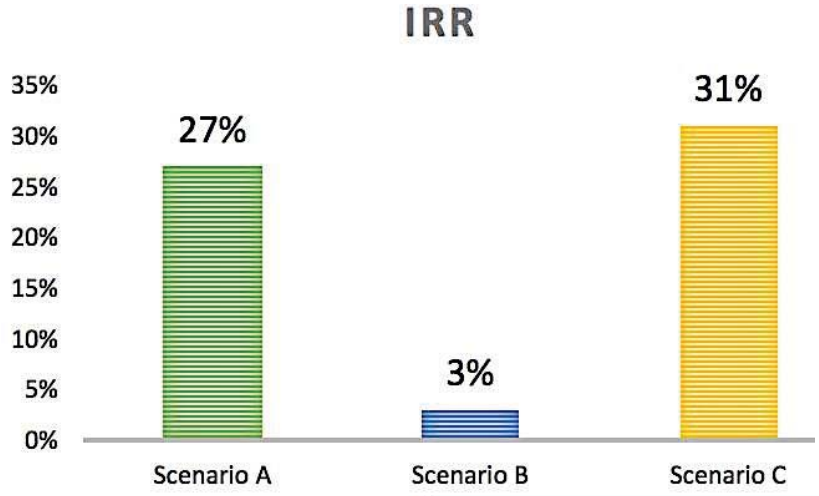
➢ **An example of successful policy (Solar PV)**

*FIT = Feed-in Tariff*



# Case study results and conclusions




*IRR = Internal Rate of Return*

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Developing economic sector : Dairy sector

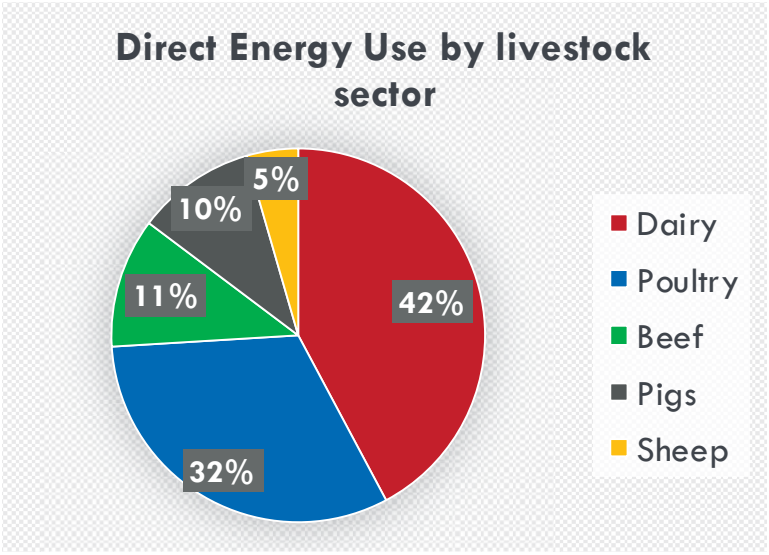
# The potential of renewable energy deployment in the UK dairy sector

**Artemis Pountoureli**

Poster #38

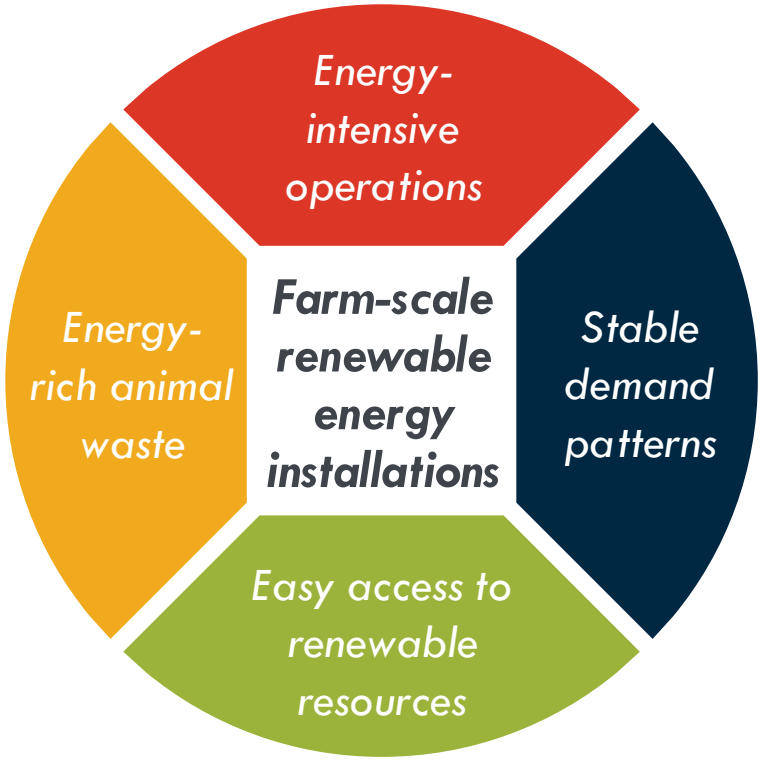
# UK dairy industry

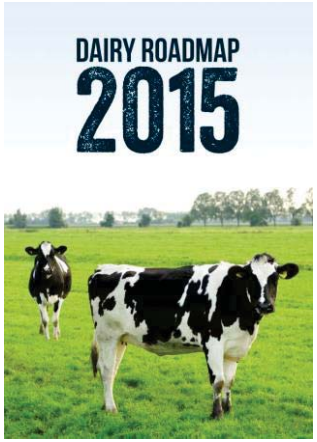
- **Largest agricultural sector** (17% share of total agricultural production by value)
- **Most energy-intensive livestock sector** (3,012 GWh p.a.)




# Farm-scale renewables

Could farm-scale renewable energy installations be the **solution** to the increasing energy costs?




**Renewable intensification**

40% increase in the share of renewables

**Decarbonisation**

30% reduction in GHG emissions over the 1990 levels.

# Scope of research

*To what extent are such installations **feasible**?*

*Simulations*

*HOMER software*

*Which is the **optimal technology**?*

*Optimisation*

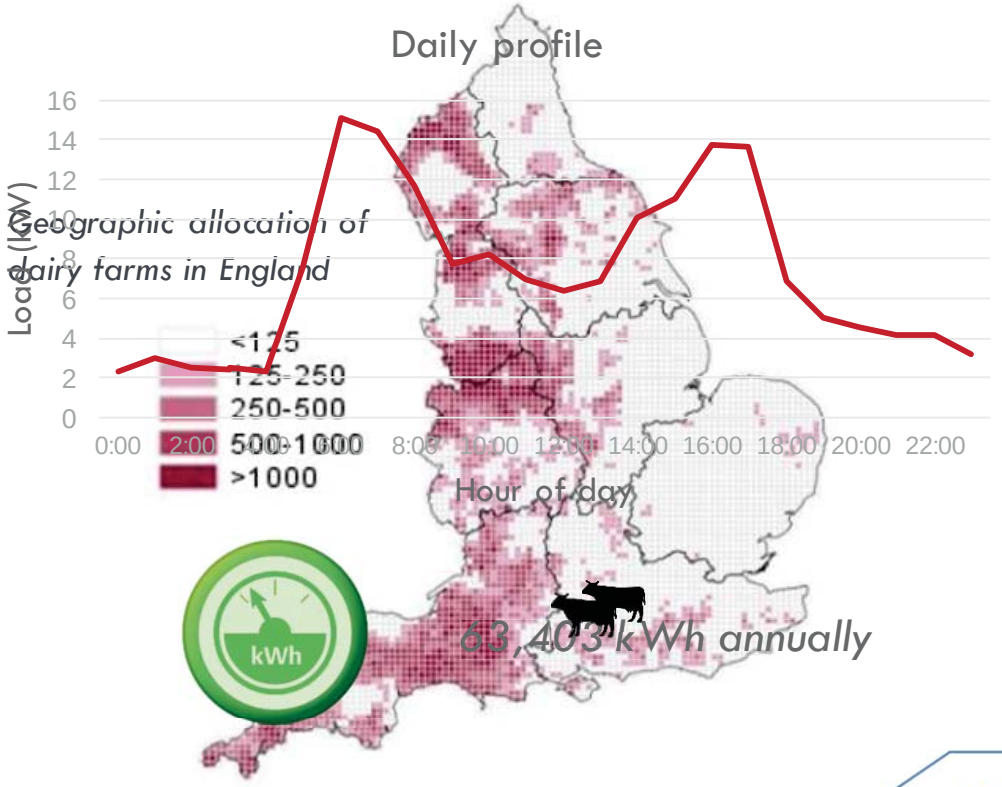
*What **affects** it?*

*Sensitivity analysis*

# Case study

*The technology selection depends on each farm's assets and needs*. ***No such thing as a "one solutions fits all".***

- 150-cow dairy farm located near Reading



# Case study - Results

➢ **Comparison** between the **optimal system** and the **baseline scenario**

| System Configuration | Total electricity produced (kWh/year) | Net Present Cost (£) | Emissions (kg CO2/year) |
|---|---|---|---|
| Baseline  | - | 87,269 | 25,968 |
| 20 kW AD  | 175,200 | 67,048 | - 43,644 |

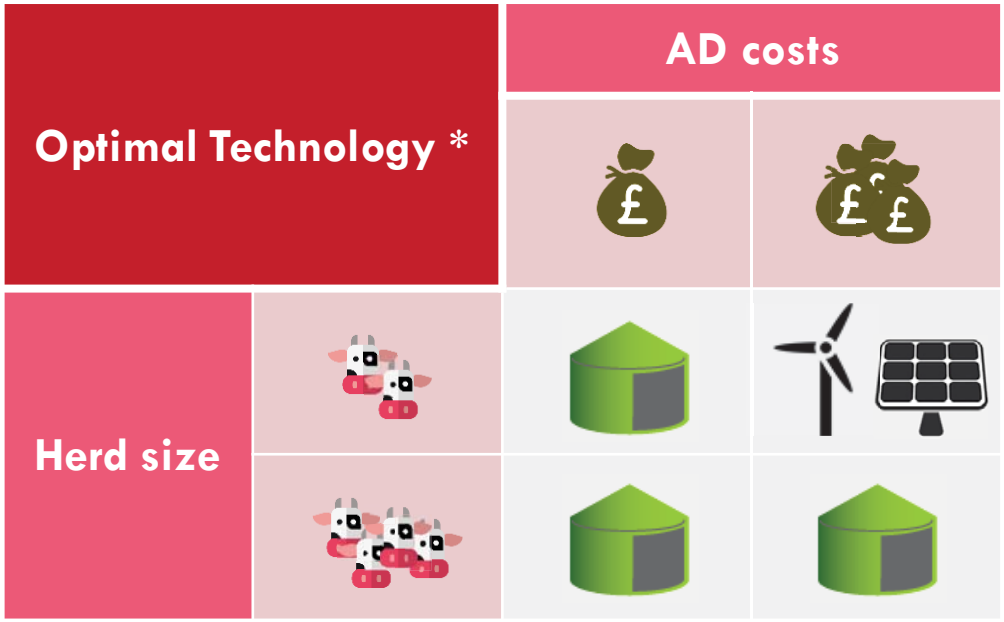
*23% lower than baseline*

*2.7 times less than baseline*

*Displacement of energy costs and grid emissions!*

# Extrapolation of results - Conclusions

*Case study farm* → *Aggregate of UK dairy farms*




**As reported for the majority of the respective variable combinations*

*... **BUT** the final decision depends strongly on the **main aim of the investment**.*

# Conclusion of the presentation

*Not only can renewable energy contribute to the attainment of environmental goals but it can also stimulate the social and economic growth of developing regions.*

| | |
|---|---|
| Developing countries | **Indonesia:** Nursita S. Pramono, poster 37<br>**Bolivia:** Simon Meunier, poster 36 |
| Developing market | **Fuel cells:** Claire Burtin, poster 34 |
| Developing economic sector | **Agriculture:** Dimitrios Vardouniotis, poster 39<br>**Dairy sector:** Artemis Pountoureli, poster 38 |

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**Images and icons:**

Britannica Online for Kids (2016) http://kids.britannica.com/comptons/art-118470

Pie Chart, Icon made by Madebyoliver from www.flaticon.com

Telecom tower, http://serenergy.com/demo/forside-test/telecom-power/

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# Thank you !

# Questions ?

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