

# CE+T Partner Forum 2023

Case study presentation Turbulent

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# Overview

- Introduction Turbulent
- On/off-grid system
- 115kW project Philippines
- Future project: 75kW South-Africa

# **INTRODUCTION TURBULENT**

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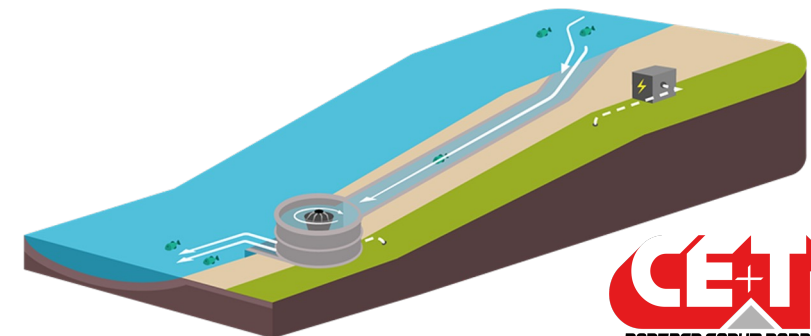
# TURBULENT introduction

- Founded in 2015
- Offices and workshop in Leuven, Belgium
- 15 employees
- Micro-hydro **vortex** turbines
- Modular, standardized **power range: 15 kW – 70 kW**
- Suited for rivers and canals with low head



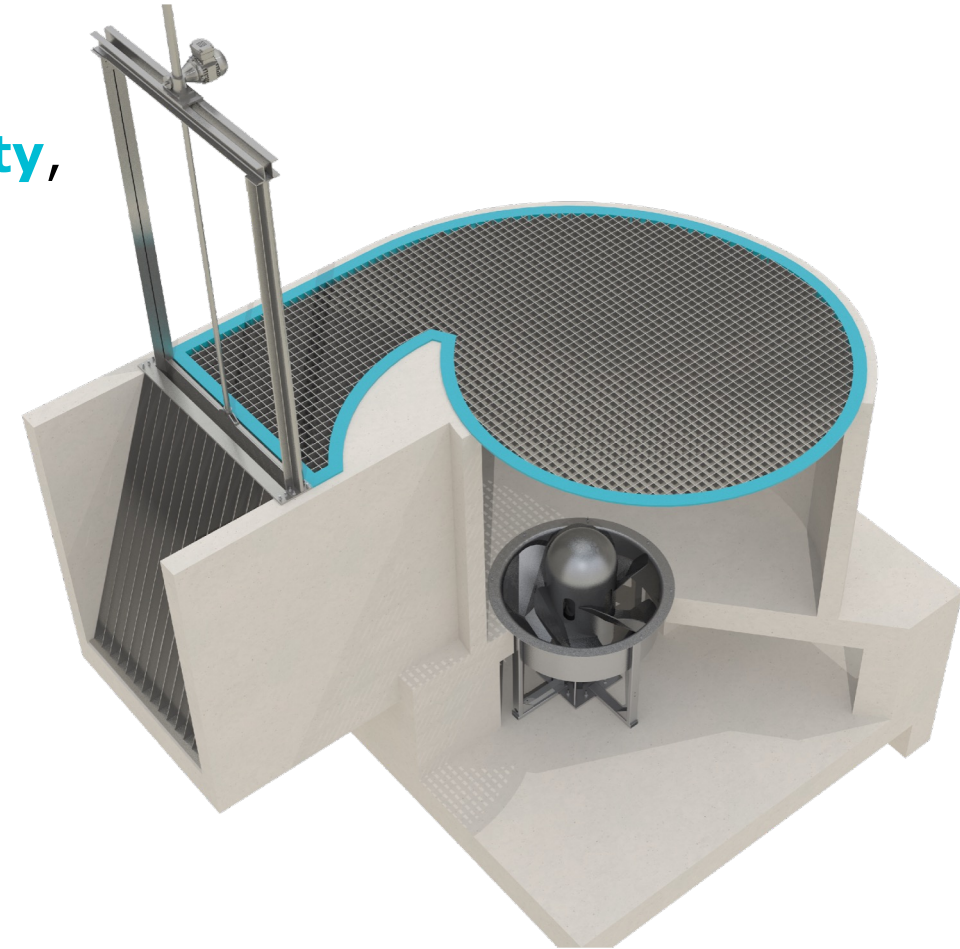
  
Flow  
1,5 - 5 m<sup>3</sup>/s

  
Head  
1,5 – 3 m



# **TURBULENT** introduction

- Ingenious design of a vortex generating basin creates a **perfect balance** between **efficiency**, **sustainability**, **simplicity** and **environmental friendliness**.
- **Continuous** Energy
- Automated sluice gate for flow control
- **On**-grid, **off**-grid and now developing **on/off**-grid



**HIGH ROI**  
**LOW LCOE**



**LOW**  
**MAINTENANCE**  
**HIGH LONGEVITY**



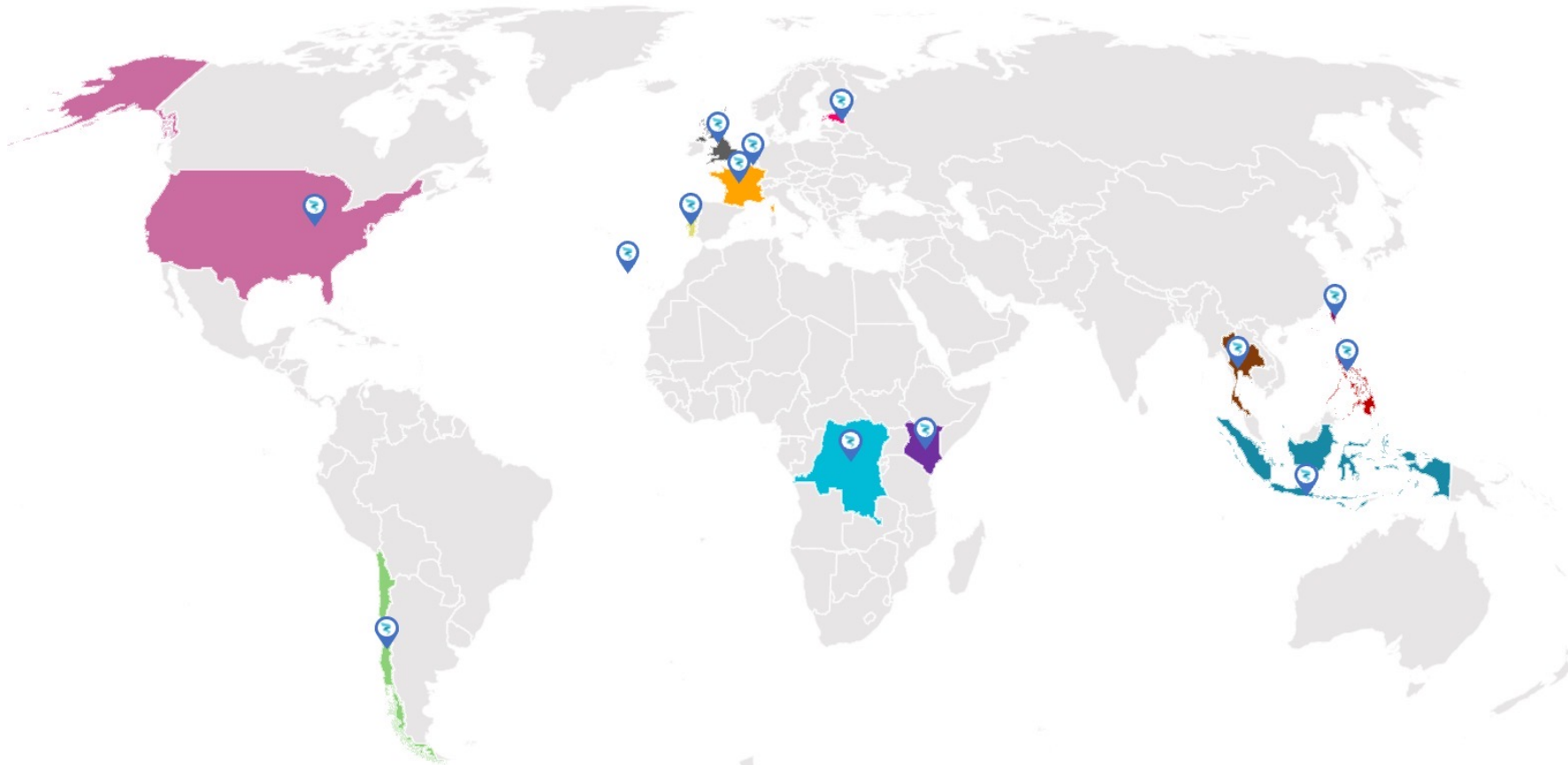
**FISH**  
**FRIENDLY**



**EASY CIVIL**  
**WORKS**

# TURBULENT introduction

## ○ Turbulent projects:



- FR: Versailles (5.5kW)  
FR: Eparcy (30 kW)
- Otepää, Estonia (5.5 kW)
- Bali, Indonesia (13 kW)
- Chile (15 kW)
- PT: Vale das Lobas (5 kW)  
PT: Azores (2x30 kW)
- Mindanao, Philippines (140 kW)
- Idaho, USA (35 kW)
- Kenya (110 kW)
- Thailand (50 kW)
- Congo (30 kW)
- Taiwan (160 kW)
- UK (8KW)
- Belgium (15KW)

# ON/OFF-GRID

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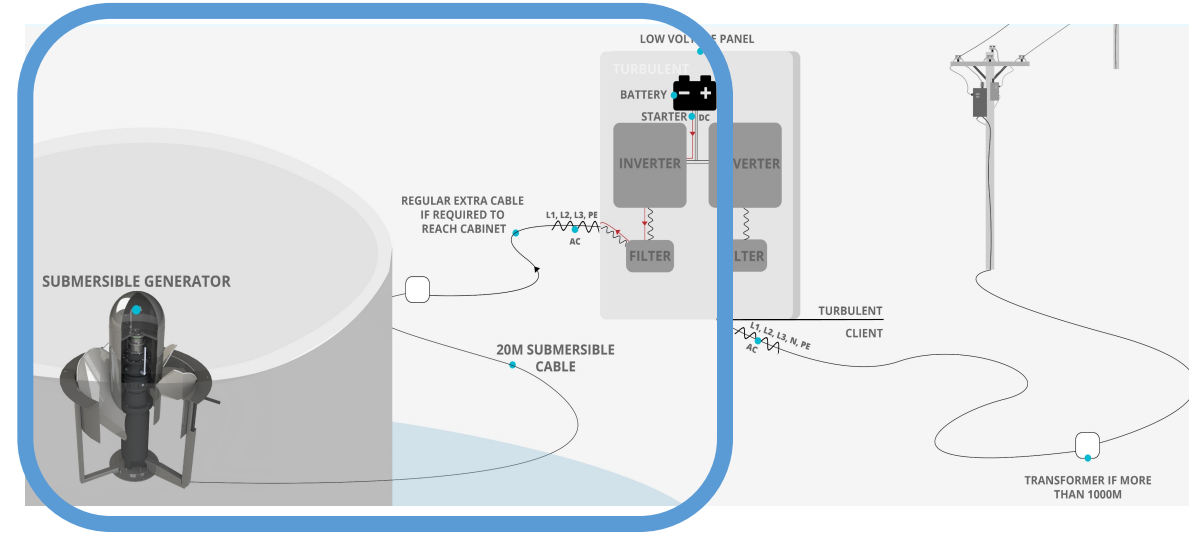


# On/off-grid development

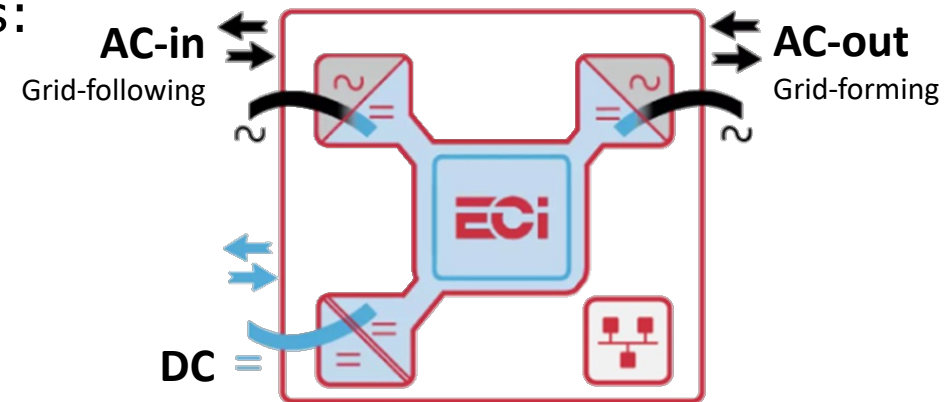
- Many requests from clients connected to unstable electricity grids
  - New solution to ensure power 24/7 AND sell surplus energy back to grid
  - On-grid solution needs a grid connection to operate
  - Off-grid can be on/off-grid with **switch** (no UPS) but only **3-phase**
- System with a **smooth** on/off-grid transition for **single** and 3-phase

# On/off-grid development

- Off-grid system: 2 VFD's with DC link
  - Keep generator side power electronics



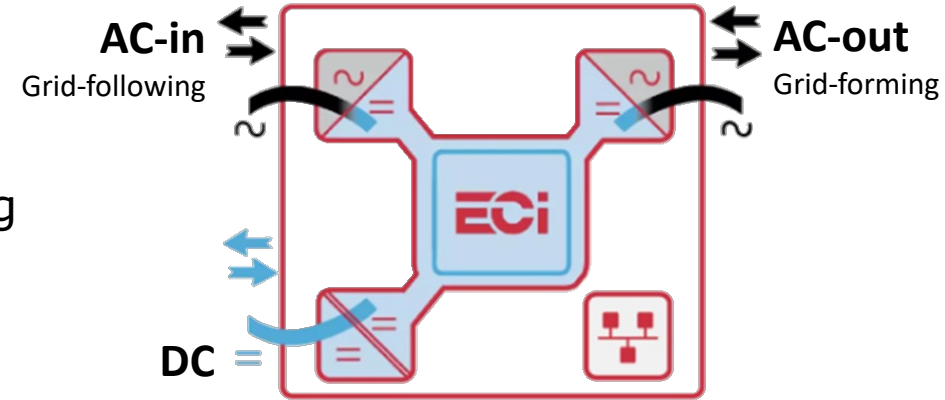
- Combined with CE+T Sierra multidirectional converters:
  - DC input from turbines to:
    - AC-out connection: Priority to customer loads
    - AC-in connection: Energy surplus to local (unstable) grid



# Sierra multidirectional converters

Unique advantages:

- Multidirectional
  - Uninterrupted supply from grid-forming to grid-following
  - Grid feed-in
- Modular
  - Expandable, single or 3-phase
  - Rackable in standard cabinets
- Flexibility: 230-277VAC, 50/60Hz
  - Can be used worldwide
- Inview controller
  - Monitoring interface



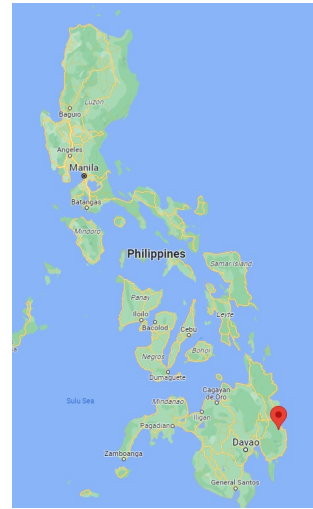
# **115KW PROJECT PHILIPPINES**

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# 115kW project Philippines

## Current situation:

- Unreliable **single** phase grid-connection
- 115kW available
- Local village only consumes  $\pm$  15kW



## Requirements:

- Off-grid capability: 24/7 power to local village
- On-grid capability: Sell surplus energy to grid

## Project proposal:

→ 1x45kW + 1x70kW turbine in combination with 46x2,5kW Sierra modules

# 115kW project Philippines

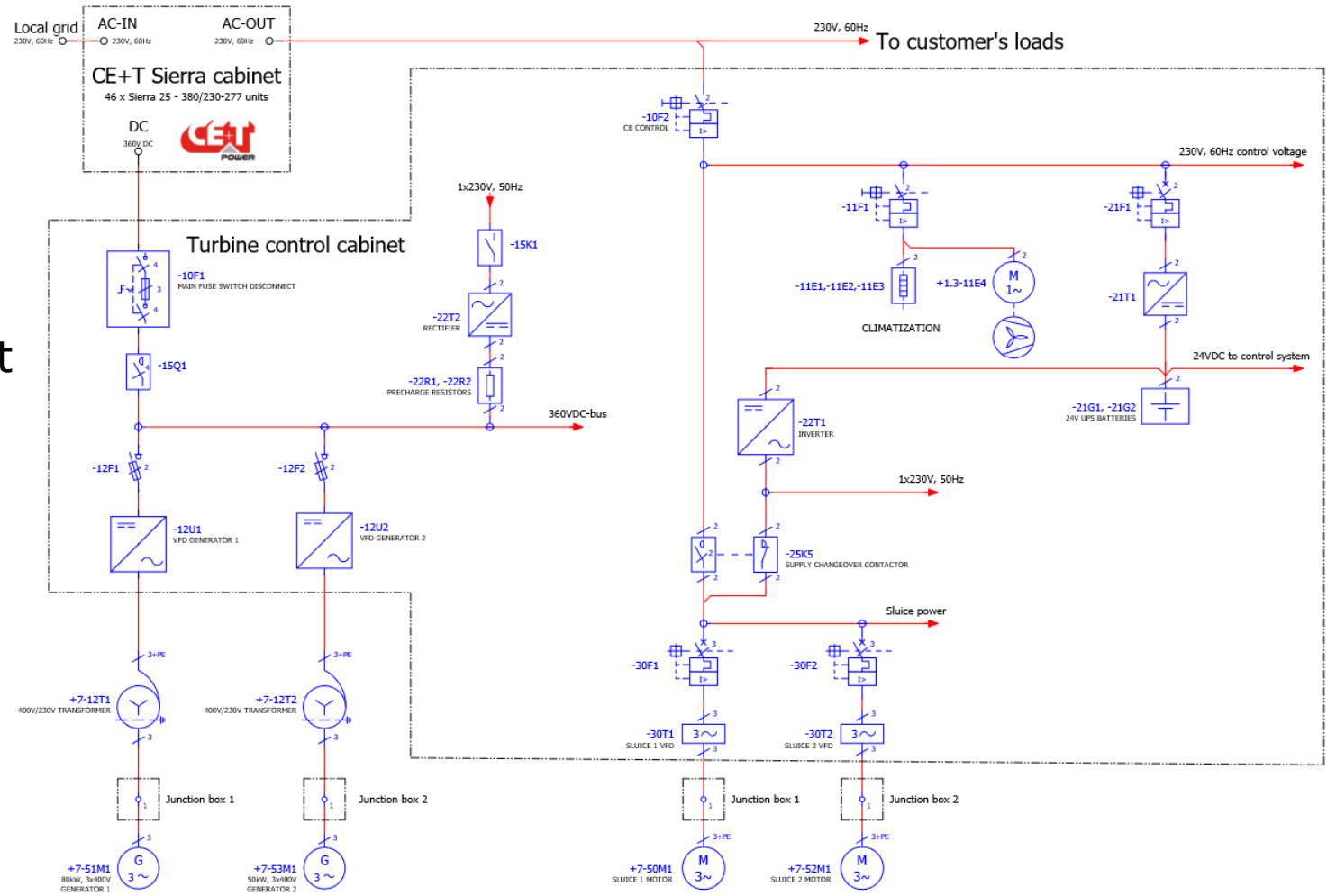
## Design challenges:

- 115kW 230V single-phase
  - Grid VFD's are three-phase
    - Single-phase connection of Sierra modules
  - Single-phase 230V → Sierra DC is 380V but standard 3x400VAC VFD needs 540-800VDC
    - 3x230VAC VFD's + 230V/400V transformers
- Village must always have power
  - Start-up without grid
    - Blackstart precharge circuit
    - AC-out connection of Sierra's is grid-forming
- Fast ROI, sell surplus energy to grid
  - AC-in connection of Sierra's is grid-following
- Capacity can be expanded in the future
  - Modular connection Sierra modules

# 115kW project Philippines

## Turbulent side:

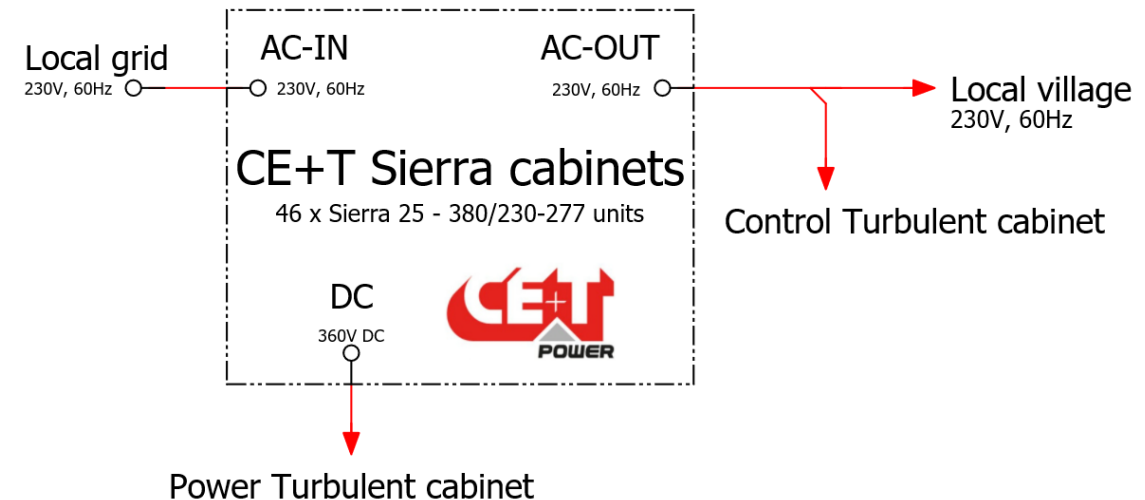
- Power:
  - 3x400V generators
  - 400V/230V transformers
  - 3x230V Frequency drives
  - 360V DC-link to CE+T cabinet
- Control:
  - AC-out CE+T cabinet
  - Climatization
  - 24VDC UPS
  - Precharging DC-link
  - Sluice control



# 115kW project Philippines

## CE+T side:

- 3 cabinets:
  - Cabinet 1: Protection + Manual by-pass
  - Cabinet 2: Main cabinet with modules, controller & synchronization rack
  - Cabinet 3: Secondary cabinet with modules
- 46 x Sierra 25 380 modules:
  - DC-link to Turbulent cabinet
  - AC-in connection to local 230V 60Hz grid
  - AC-out connection to local village





# 115kW project Philippines

- Current status:
  - Design verification on scaled-down test setup:
    - 2 x Sierra converter (total 5kW)
    - 3kW 3x230V generator
    - 3x230V VFD
    - Power control verified: Priority to AC-out, surplus to AC-in
    - UPS verified: AC-out remains live if AC-in disconnects
  - Remote monitoring
    - CE+T Inview S monitoring
    - Modbus connection to controller Turbulent
    - Successfully pushed Sierra data to Turbulent's IOT platform
  - Production on-hold due to local permitting delays.

# **FUTURE PROJECT: SOUTH-AFRICA**

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# Future: 75kW project South-Africa

## Current situation:

- South-Africa grid load-shedding (up to 12h) + coal based
- Farm uses diesel generators during blackouts  
→ 764 ton CO<sub>2</sub>/year

## Requirements:

- Off-grid capability: Irrigation for farming and flood control
- On-grid capability: Sell surplus energy to grid when available

## Project proposal:

- 2x30kW + 1x15kW turbine with on/off grid setup (30x2.5kW Sierra modules)
- Combined with 200kW solar (Irritech)



**Thank you  
for your attention**

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