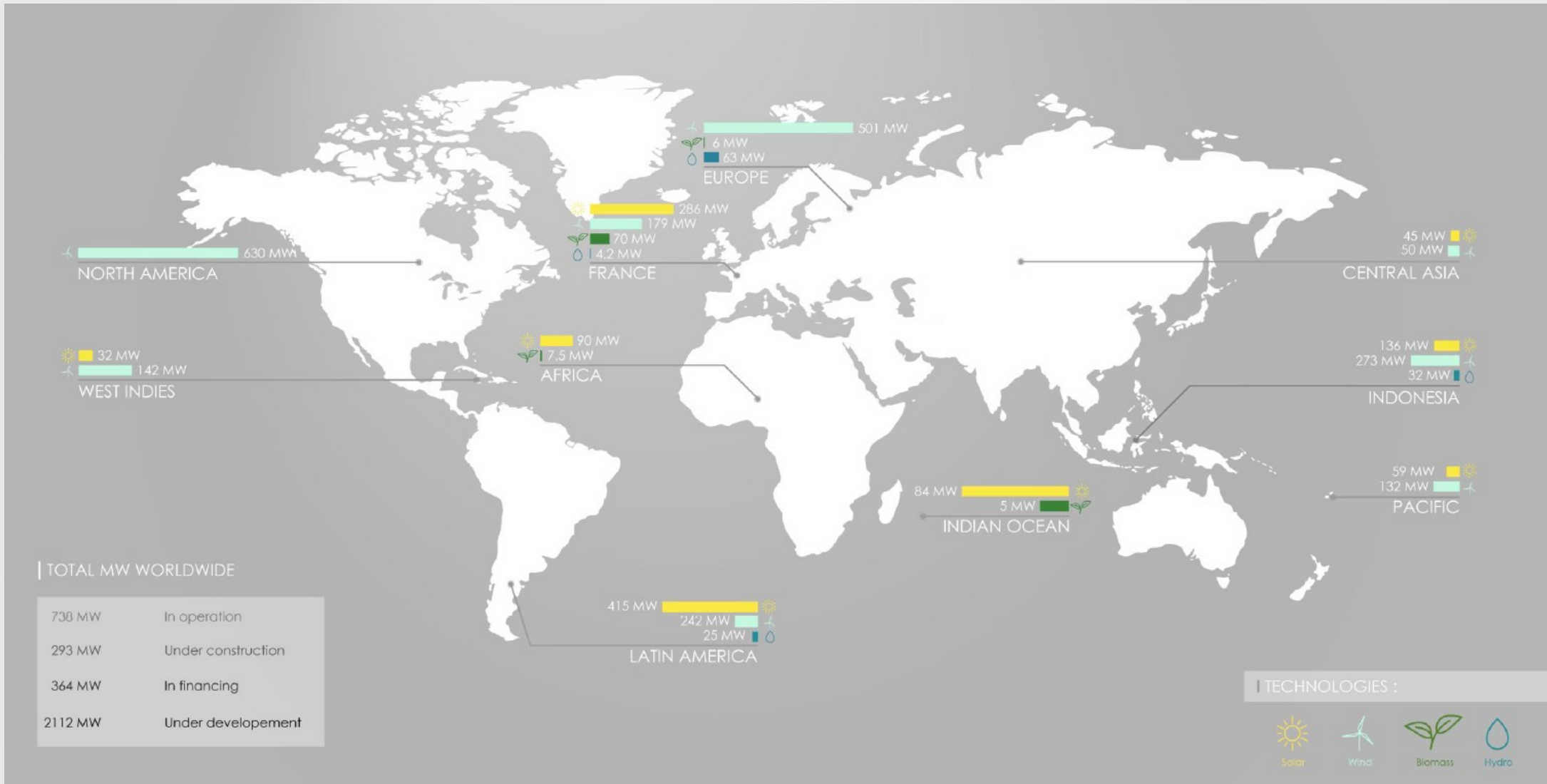


# Soluciones móviles de energía y sistemas híbridos – GEM®

4to Encuentro internacional de energías renovables  
SER Colombia - BARRANQUILLA  
13-03-2020



# | 1. AKUO Energy un Jugador Global



# COMO LLEVAR SOLUCIONES SOLARES A ZONAS NO INTERCONECTADAS?

- Instalación



- Mantenimiento



- Huracan MARIA en Humacao – Puerto Rico

- Integración con sistemas híbridos

- Movilidad

# | TENEMOS UNA SOLUCIÓN

Akuo desarrolló una solución para proyectos en ZNI





# GREEN ENERGY IN MOTION GEM®

Una solución verde, modular y portátil



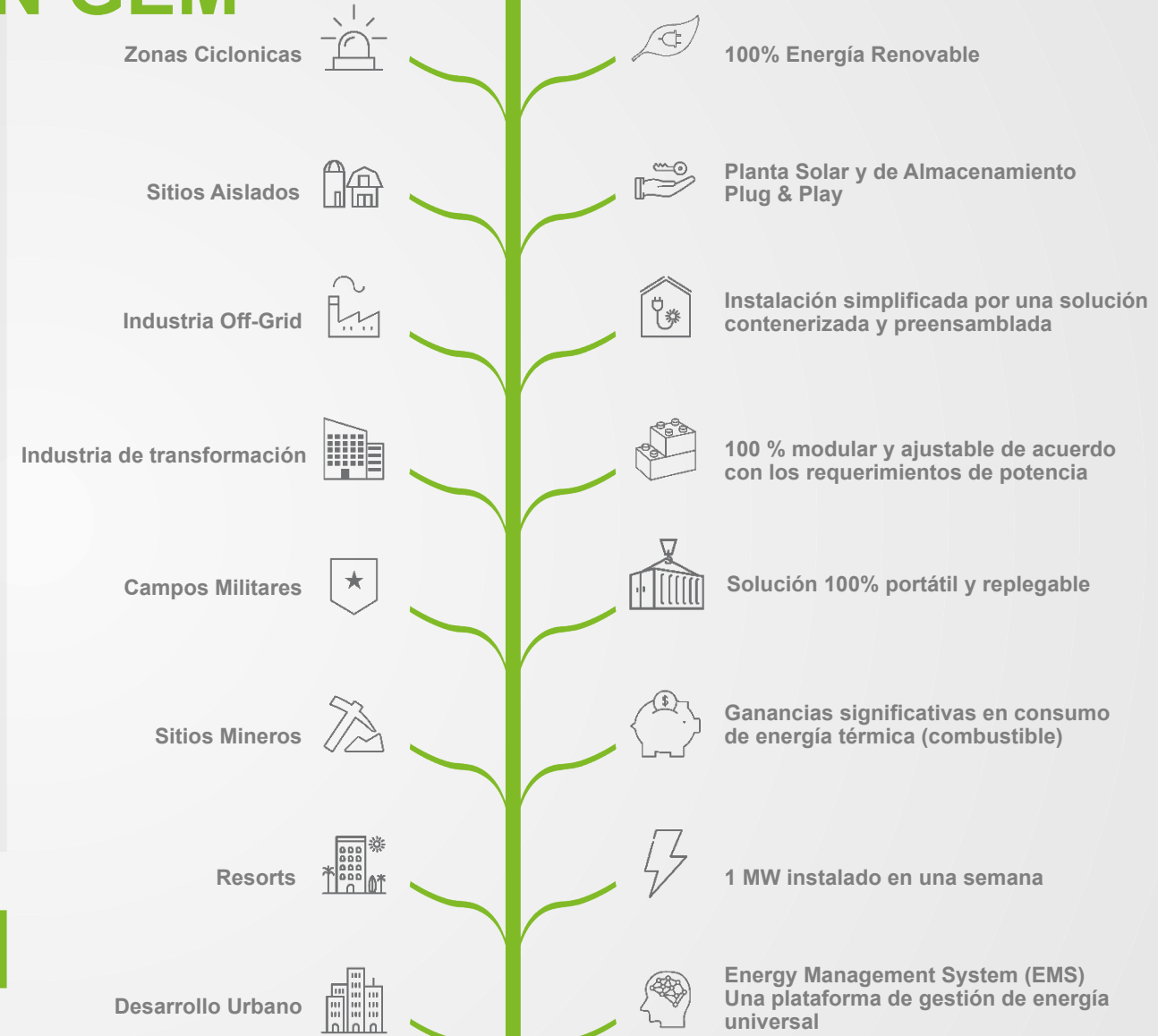
Solar GEM®



Storage GEM®



EMS  
Energy Management System

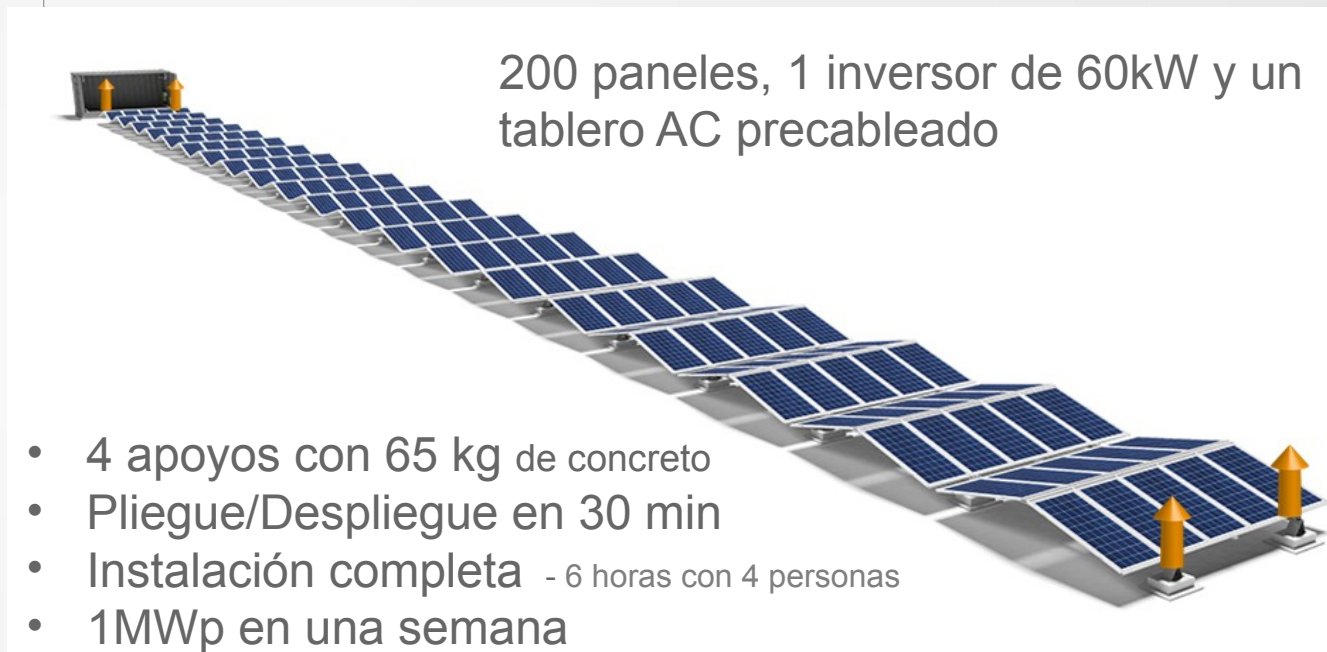


Nosotros diseñamos, instalamos y operamos el sistema,  
Ustedes disfrutan la energía renovable.

# Solar GEM<sup>®</sup>

Innovación por naturaleza

**Solar GEM<sup>®</sup> 20** : 74kWp en un contenedor estándar de 20 pies



# Storage GEM<sup>®</sup>

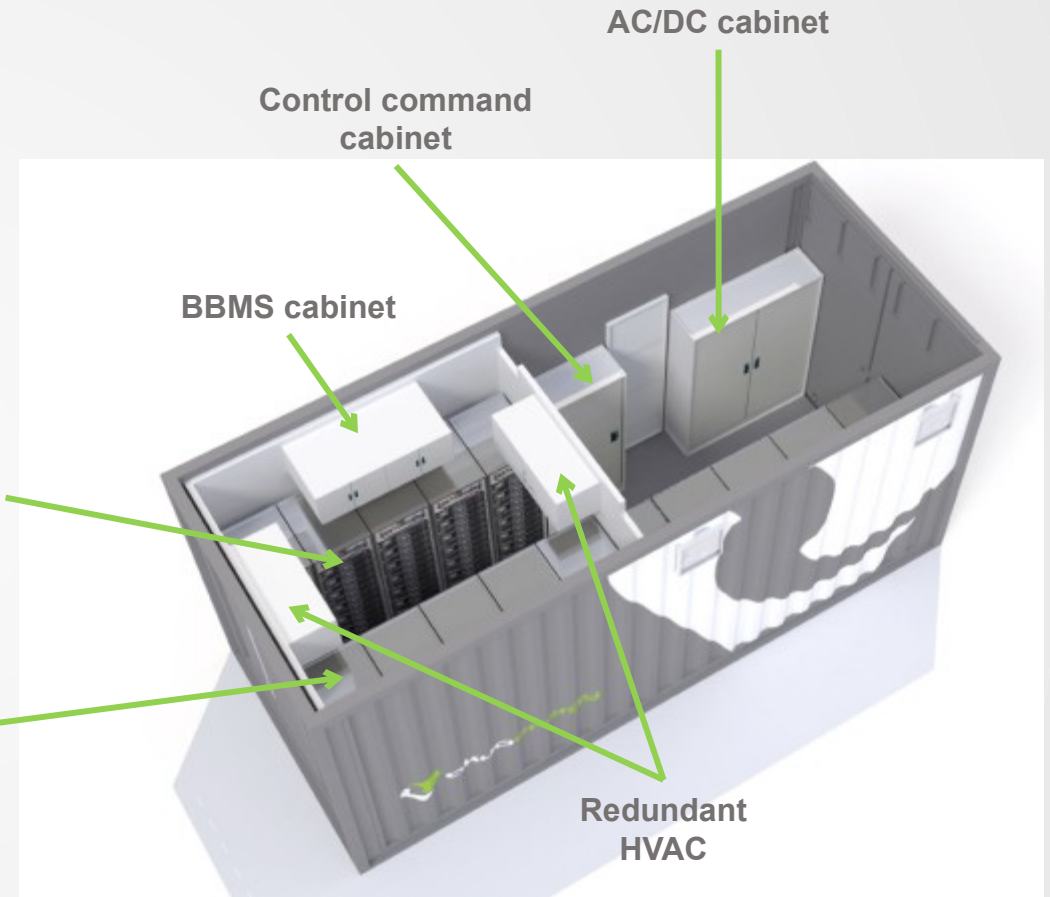
Innovación por naturaleza

**Storage GEM<sup>®</sup>** : 100kWh - 1,2MWh en contenedor estándar de 20 pies  
1MWh – 3.8MWh en contenedor estándar de 40 pies



Battery racks

Inverters

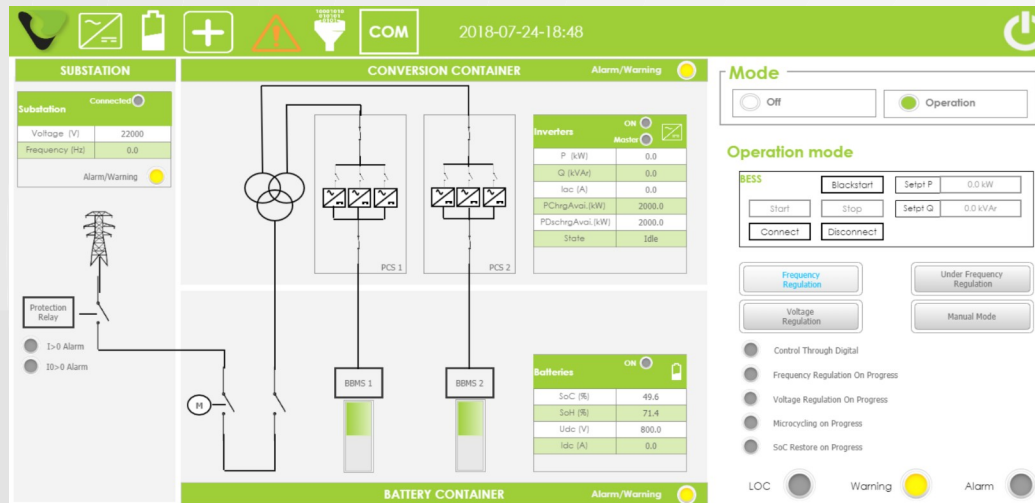


- Garantía de la batería 10 años
- Instalación completa en 2 días con un equipo de 2 personas



# EMS Smart Energy Management System by AKUO

Innovación por naturaleza



## Funcionalidades on-grid :

Aislamiento de la fuente de producción de energía renovable

Regulación de frecuencia (< 100 ms)

Regulación de tensión (<100 ms)

Curtailment (limitación de producción)

## Funcionalidades off-grid :

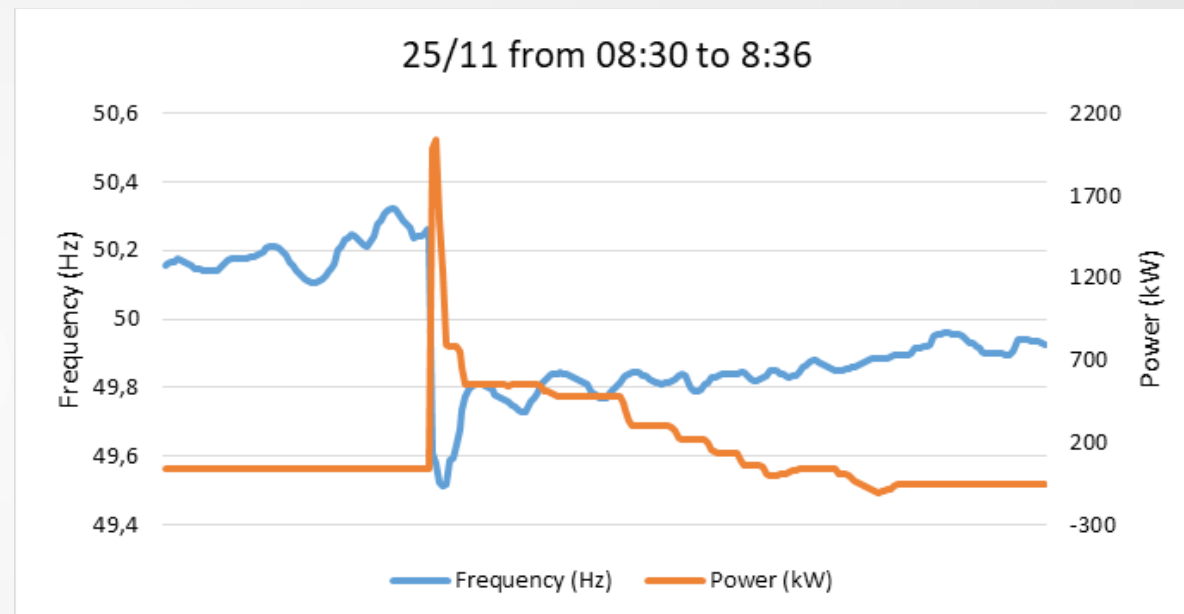
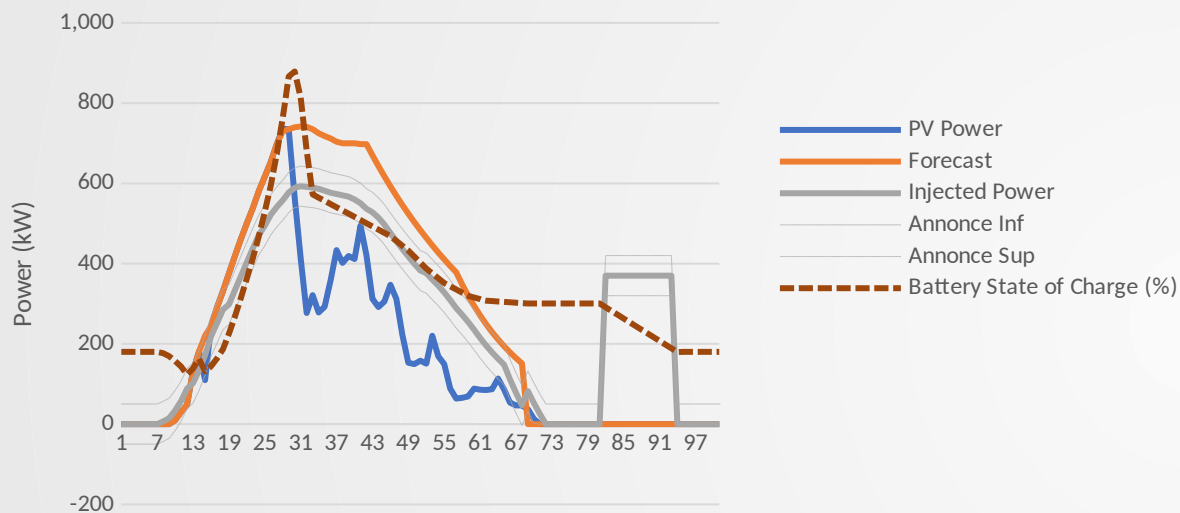
Transición on/off automática y sin desconexión

Maximización de la fuente renovable

Optimización del factor de carga de los generadores Diesel para una vida útil mas larga

# EMS APADTADO A CADA SOLUCIÓN

## Storage Specification CRE ZNI3



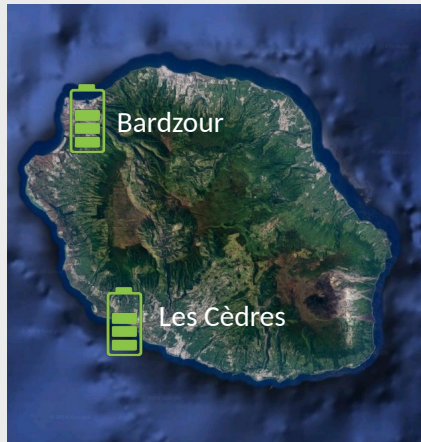
### Sistemas off-grid

- Obligación de almacenamiento e inyección en horas pico
- Forecast de la demanda y la generación a partir de un sistema de machine learning

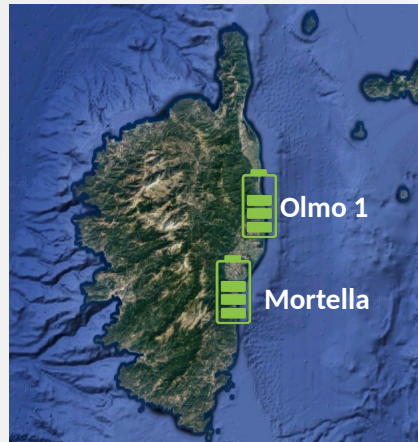
### Sistema on-grid para regular frecuencia

# 34 MWh EN OPERACION EN 2018

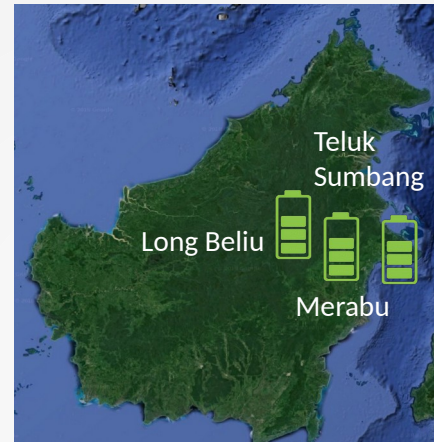
Reunion island 18 MWh



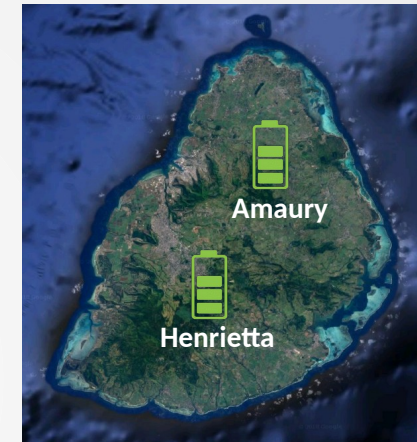
Corsica island 11 MWh



Indonesia 2MWh



Mauricius island 2 MWh



Union island 1 MWh



## Solar + storage plant CRE ZNI

- Integración de energía renovable en la red
- Forecasting de la producción y del consumo un día antes de acuerdo a lo especificado por el operador de red

## MCA Indonesia

- ZNI
- Electrificación rural para 3 poblaciones
- Construcción de todo el sistema de distribución

## CEB Mauricius

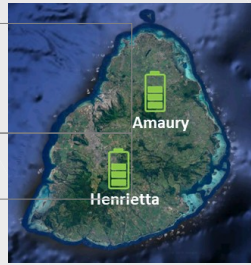
- Regulación de voltaje y frecuencia
- Limitación de producción
- Island context

## Vinlec : Union island

- PV + storage
- Instalación de sistema híbrido con integración de generación Diesel existente
- EMS controla toda la isla

# ZOOM PROYECTOS CONECTADOS A LA RED

Servicios auxiliares para la isla mauricio



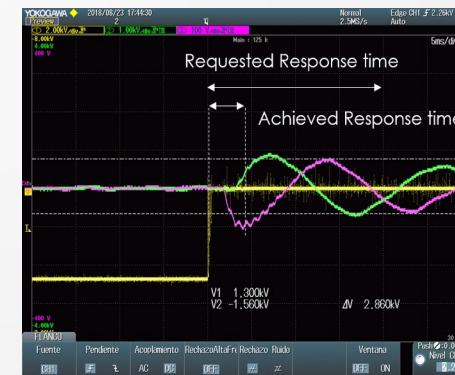
## AMHE Amaury & Henrietta

**Technology** 4MWp / 2MWh (Storage GEM®) shared in two sites

**Commissioning** July-2018

**Project type** Frequency regulation

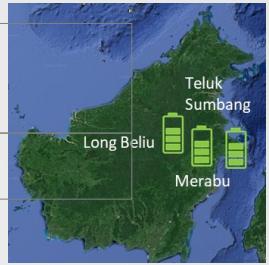
**Client** CEB



Time response < 5 ms  
≡ World record

# ZOOM PROYECTOS NO CONECTADOS A LA RED

Electrificación rural de 3 poblaciones, licitación de Millenium Challenge Account (MCA) Indonesia



## MCA Indonésie

<b>Technology</b>	2 MWp de Solar GEM® con 2,1 MWh Storage GEM® y plantas diesel compartidas entre los 3 sitios
<b>Commissioning</b>	Mar-2018
<b>Project type</b>	EPC, operación de las plantas por parte de la comunidad
<b>Client</b>	MCA



Ofrecemos un servicio completo, desde las encomiendas hasta la operación



# GEM<sup>®</sup>

Easy & Quick installation



74 kWp in 6 hours\*

1MWp in a week

40 -60% en ahorro de diesel

4 años para pagar el proyecto



Ivan Nunez

[nunez@akuoenergy.com](mailto:nunez@akuoenergy.com)

Maria del Pilar Toro

[thernadez@akuoenergy.com](mailto:thernadez@akuoenergy.com)



# Back-UP Hybrid case study

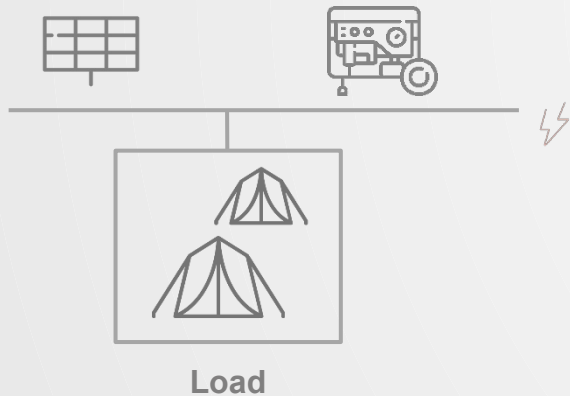


# STORAGE SIZING USER CASES

Hypothesis: Average Load = 1MW / Diesel price = 1,1\$/L / Project life = 15 years

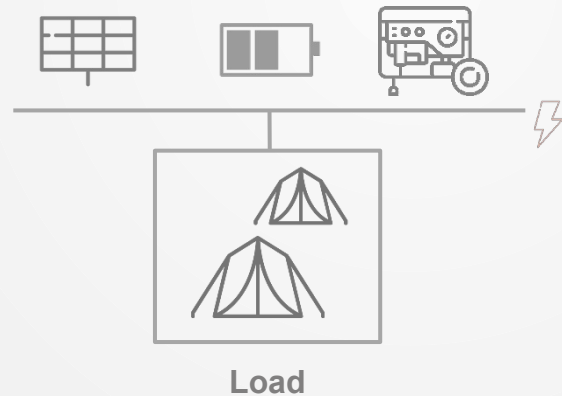
1

PV standalone  
1,5MW



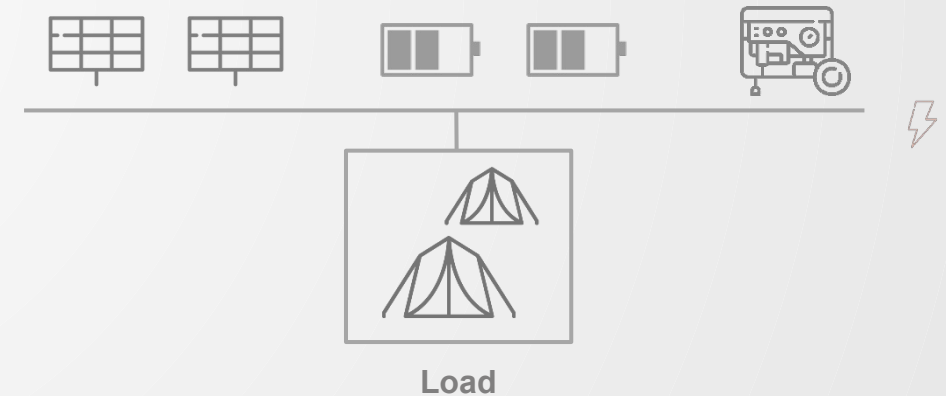
2

PV 3MW +  
Storage 3MWh

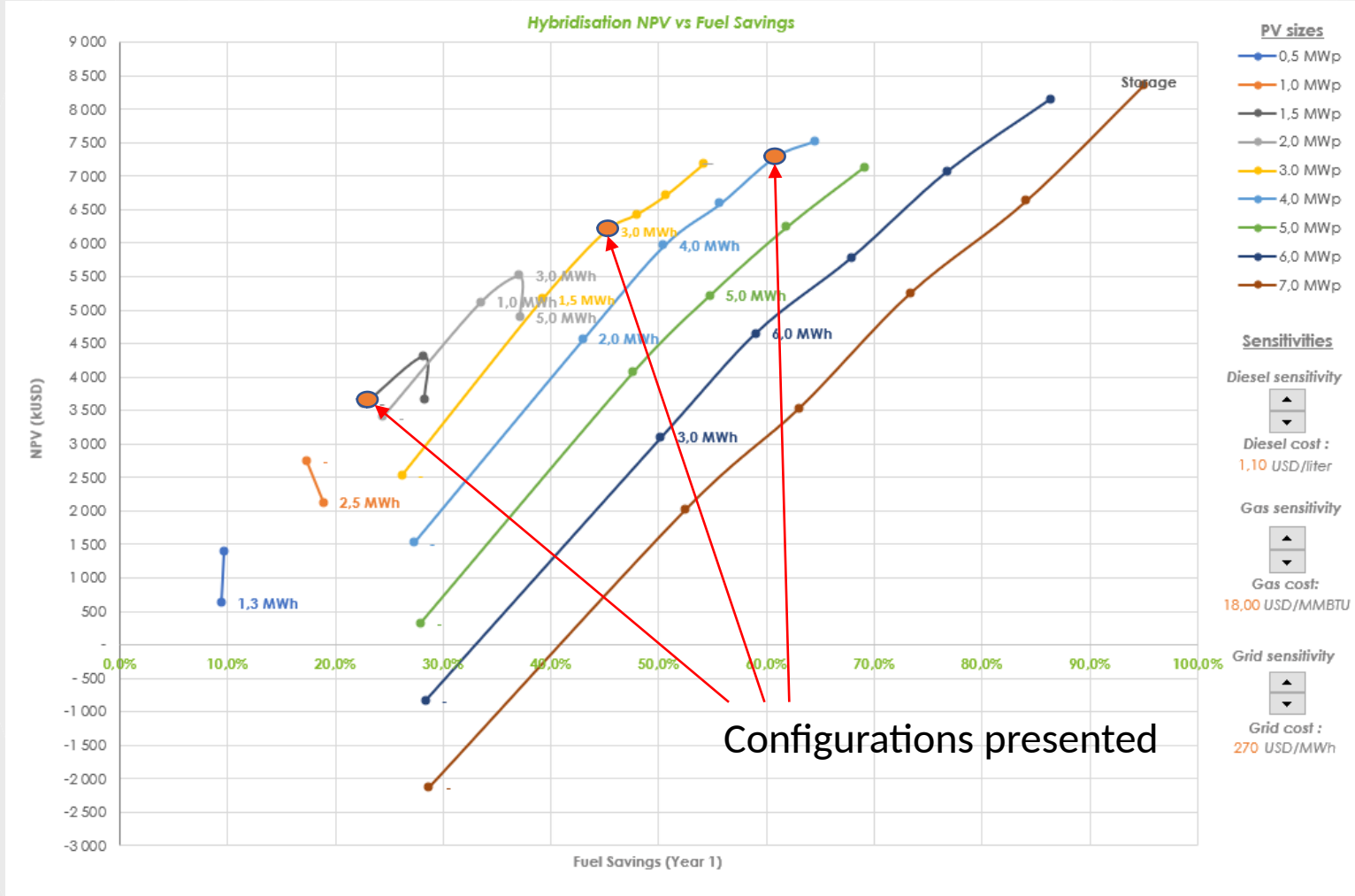


3

PV 4MW +  
Storage 8MWh



# STORAGE SIZING USER CASES



**Hypothesis:**

Average Load = 250kW

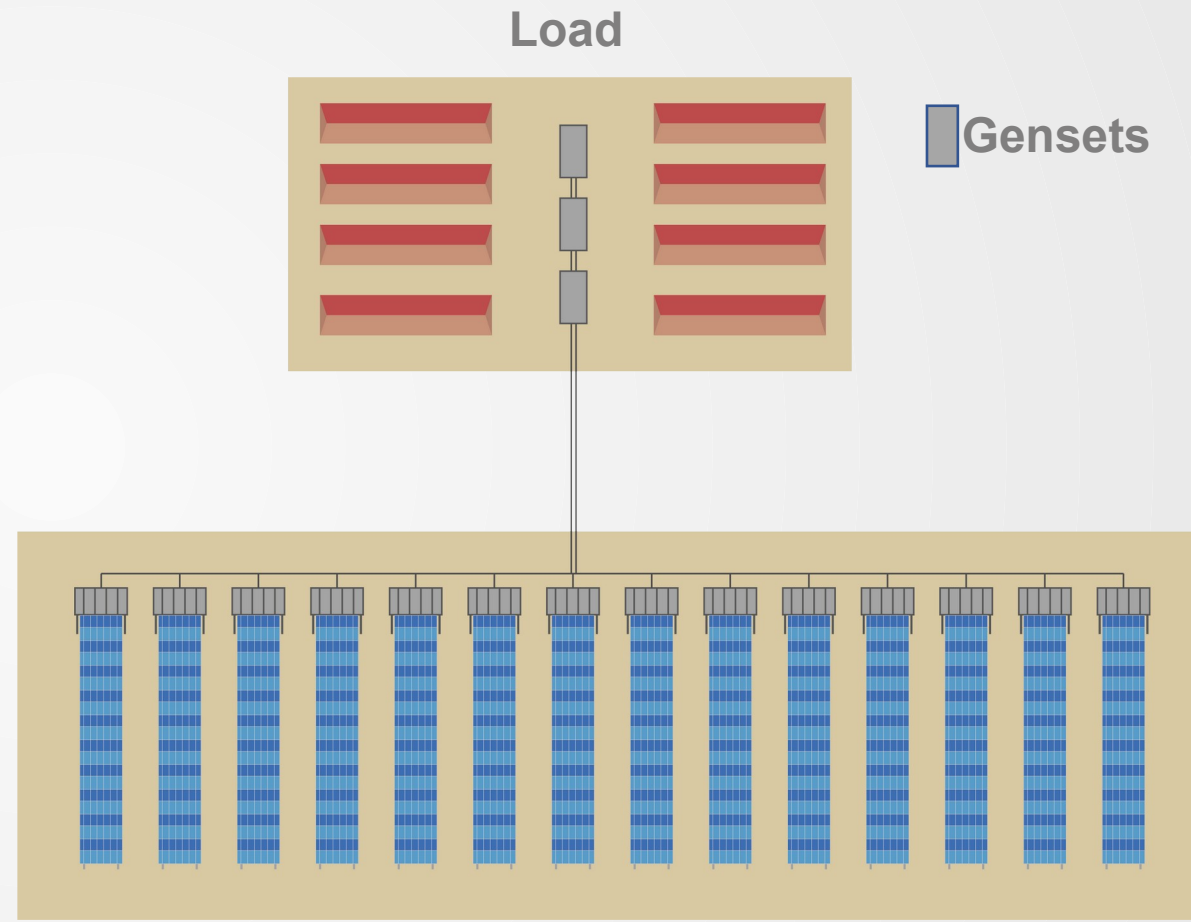
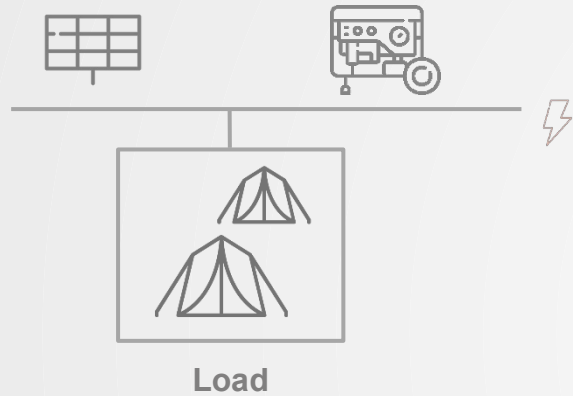
Diesel price = 1,1\$/L

Project life = 15 years

Discount rate = 6,5%

Solar production = 1600kWh/kWp

# CASE 1 : PV STANDALONE 1,5 MW



- Footprint 1,3 ha
- Fuel savings 22 %
- Payback time 3-4 years
- NPV 3.8M\$

21 Solar Gem connected to Genset

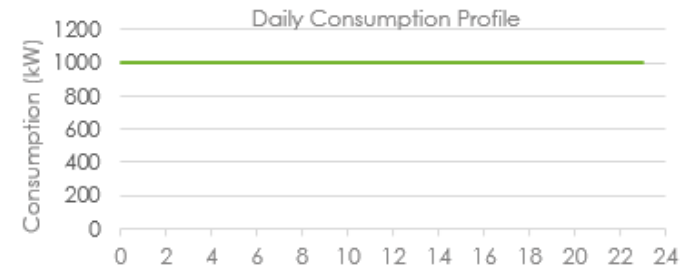
# CASE 1 : PV STANDALONE 1,5 MW

## INPUTS

Consumption	8 760	MWh/year
PV Yield	1 700	kWh/kWp
Location	Indonesia	
Diesel Cost - DDP	1,10	USD/liter
Fuel Cost Indexation	3,0	%
Project Term	15	years

Scenario n° - PV - Storage - Fuel Savings

Selected Scenario **05 - 1,5 MWp - 22,6%**



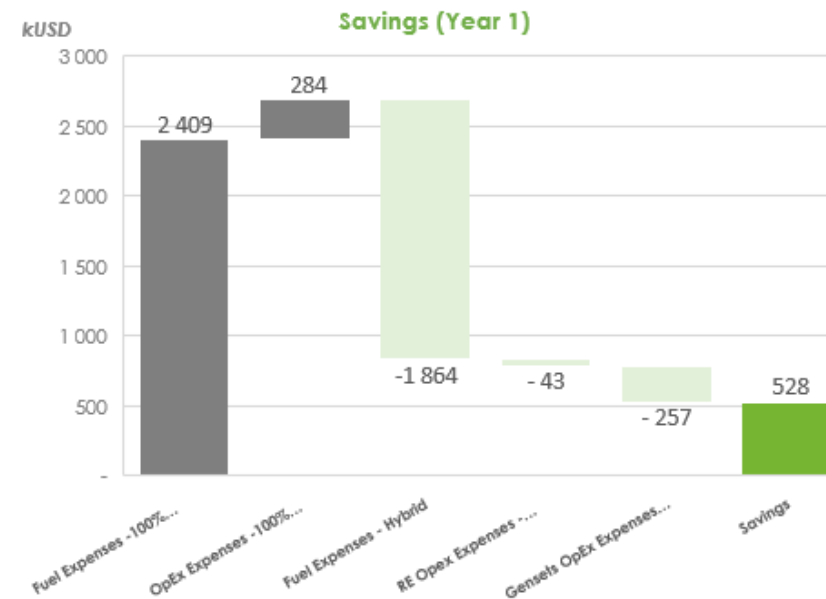
## OUTPUTS

### System CapEx

PV Capacity	1,50	MWp
Nb. Solar GEM®	20	
Storage Capacity	-	MWh
Nb. Storage GEM®	-	
GEM® Footprint	11 765	sqm
<b>CapEx - GEM® Product (EXW)</b>	<b>1 332</b>	<b>kUSD</b>
Solar GEM® (EXW)	1 332	kUSD
Storage GEM® (EXW)	-	kUSD
Installation & Commissioning	653	kUSD
<b>CapEx - Total GEM® System</b>	<b>1 985</b>	<b>kUSD</b>
CapEx - Genset	-	kUSD
<b>CapEx - Total system</b>	<b>1 985</b>	<b>kUSD</b>

### Savings (Year 1)

Fuel Savings	22,6	%
Fuel Savings	495	kL
Fuel Savings	545	kUSD
OpEx Savings	-17	kUSD
<b>Total Savings</b>	<b>528</b>	<b>kUSD</b>

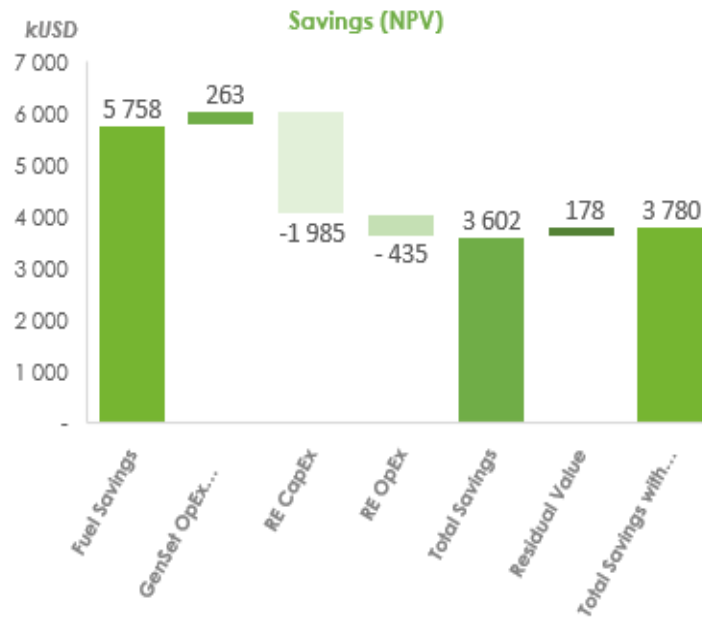


# CASE 1 : PV STANDALONE 1,5 MW

Savings (NPV over 15 years)

Fuel Savings	5 758	kUSD
GenSet OpEx Savings	263	kUSD
RE CapEx	-1 985	kUSD
RE OpEx	-435	kUSD
<b>Total Savings</b>	<b>3 602</b>	<b>kUSD</b>
Residual Value	178	kUSD
<b>Total Savings with RV</b>	<b>3 780</b>	<b>kUSD</b>

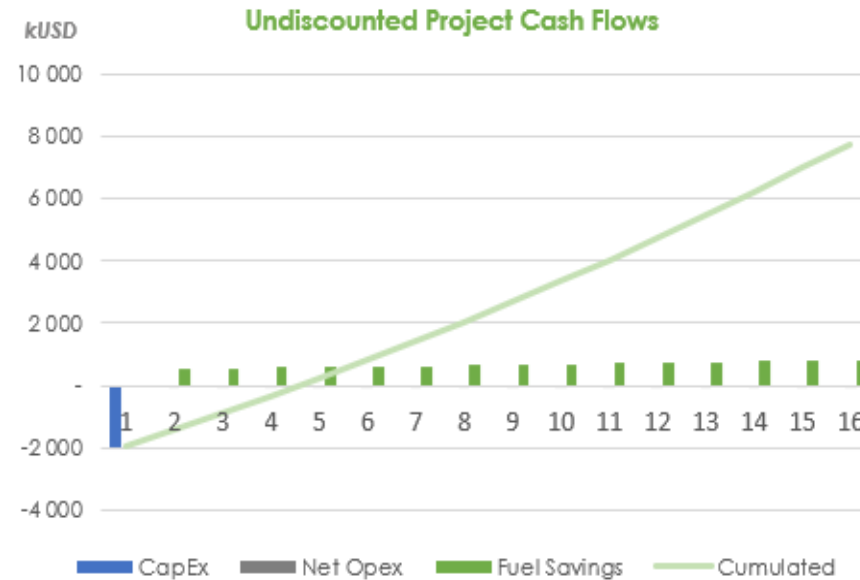
Average Fuel Savings (15 years) 22,4%



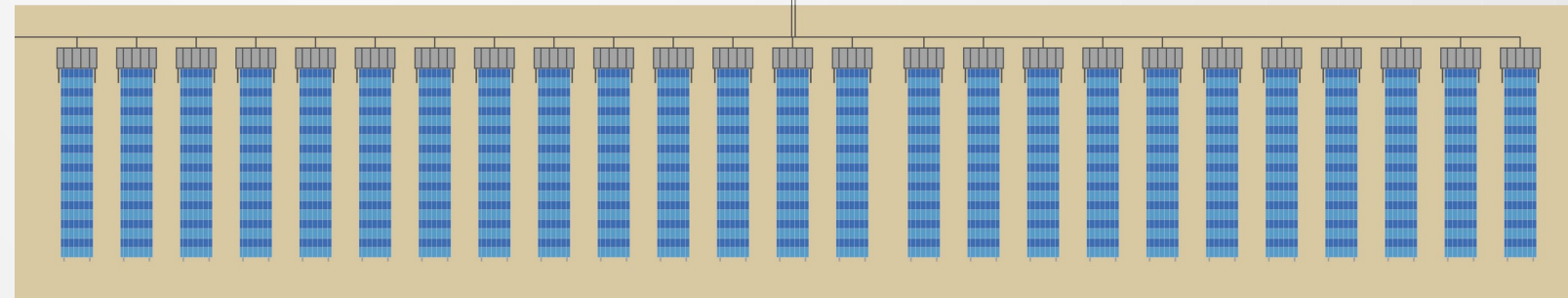
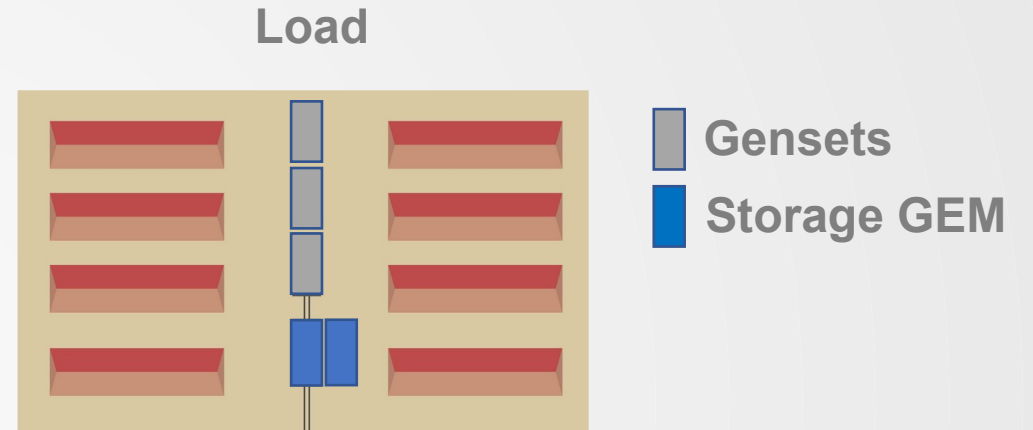
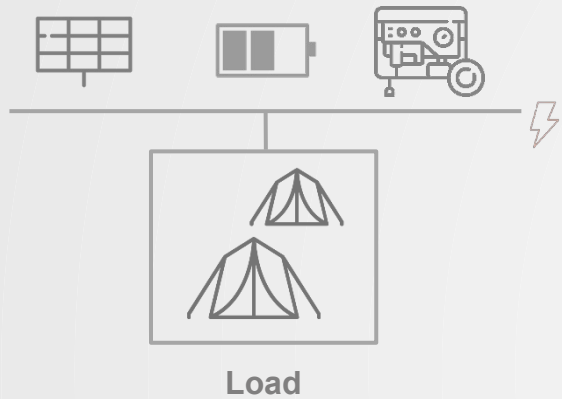
Savings (Constant Currency over 15 years)

Fuel Savings	10 035	kUSD
GenSet OpEx Savings	453	kUSD
RE CapEx	-1 985	kUSD
RE OpEx	-749	kUSD
<b>Total Savings</b>	<b>7 753</b>	<b>kUSD</b>
Residual Value	533	kUSD
<b>Total Savings with RV</b>	<b>8 286</b>	<b>kUSD</b>

Payback Year CapEx - Total GEM® system 3 - 4 years



# CASE 2 : PV 3 MW + STORAGE 3 MWh



41 Solar Gem connected to Storage GEM and EMS

- Footprint 2,4 ha
- Fuel savings 45 %
- Payback time 4-5 years
- NPV 6.6M\$



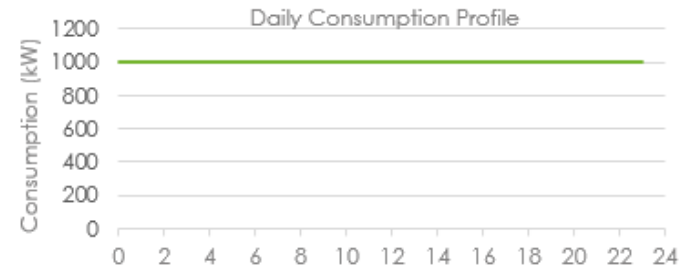
# CASE 2 : PV 3 MW + STORAGE 3 MWh

## INPUTS

Consumption	8 760	MWh/year
PV Yield	1 700	kWh/kWp
Location	Indonesia	
Diesel Cost - DDP	1,10	USD/liter
Fuel Cost Indexation	3,0	%
Project Term	15	years

Scenario n° - PV - Storage - Fuel Savings

Selected Scenario **14 - 3 MWp - 3 MWh - 45%**



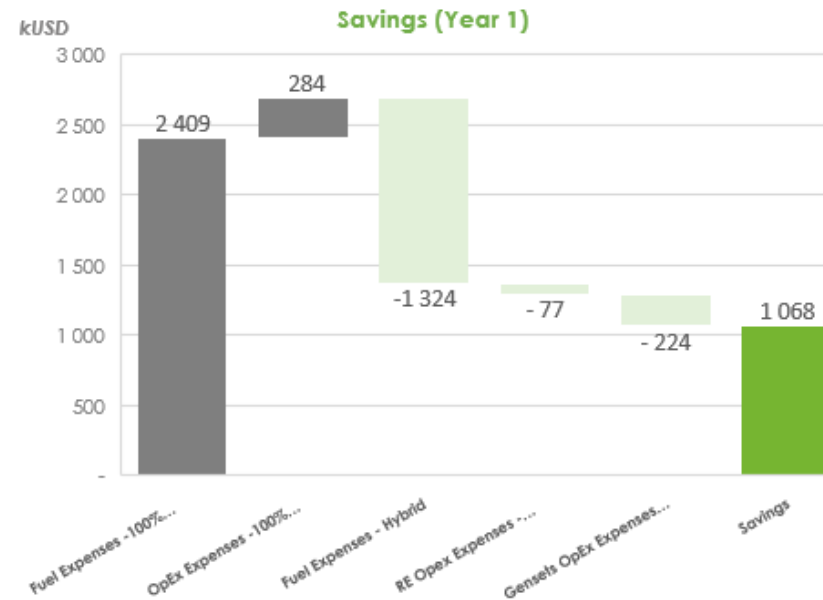
## OUTPUTS

### System CapEx

PV Capacity	3,00	MWp
Nb. Solar GEM®	41	
Storage Capacity	3,00	MWh
Nb. Storage GEM®	4	
GEM® Footprint	24 198	sqm
<b>CapEx - GEM® Product (EXW)</b>	<b>3 608</b>	<b>kUSD</b>
Solar GEM® (EXW)	2 731	kUSD
Storage GEM® (EXW)	877	kUSD
Installation & Commissioning	1 263	kUSD
<b>CapEx - Total GEM® System</b>	<b>4 871</b>	<b>kUSD</b>
CapEx - Genset	-	kUSD
<b>CapEx - Total system</b>	<b>4 871</b>	<b>kUSD</b>

### Savings (Year 1)

Fuel Savings	45,0	%
Fuel Savings	986	kL
Fuel Savings	1 085	kUSD
OpEx Savings	-17	kUSD
<b>Total Savings</b>	<b>1 068</b>	<b>kUSD</b>

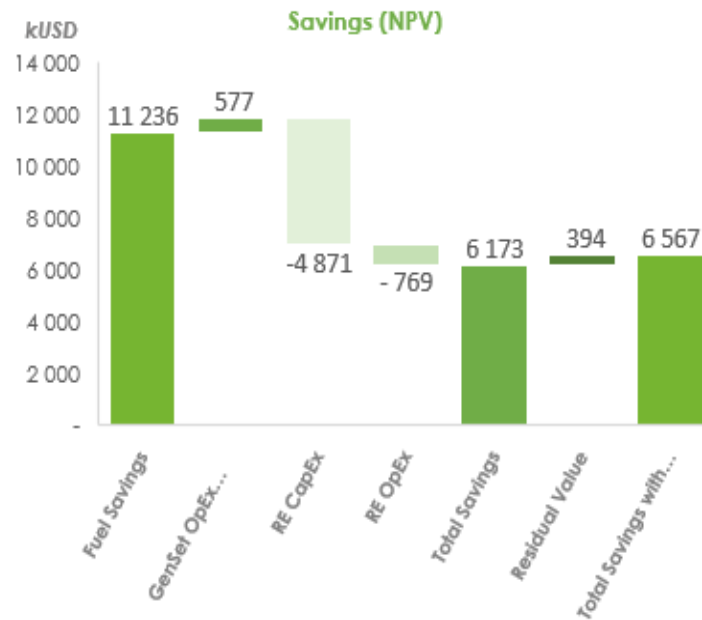


# CASE 2 : PV 3 MW + STORAGE 3 MWh

Savings (NPV over 15 years)

Fuel Savings	11 236	kUSD
GenSet OpEx Savings	577	kUSD
RE CapEx	-4 871	kUSD
RE OpEx	-769	kUSD
<b>Total Savings</b>	<b>6 173</b>	<b>kUSD</b>
Residual Value	394	kUSD
<b>Total Savings with RV</b>	<b>6 567</b>	<b>kUSD</b>

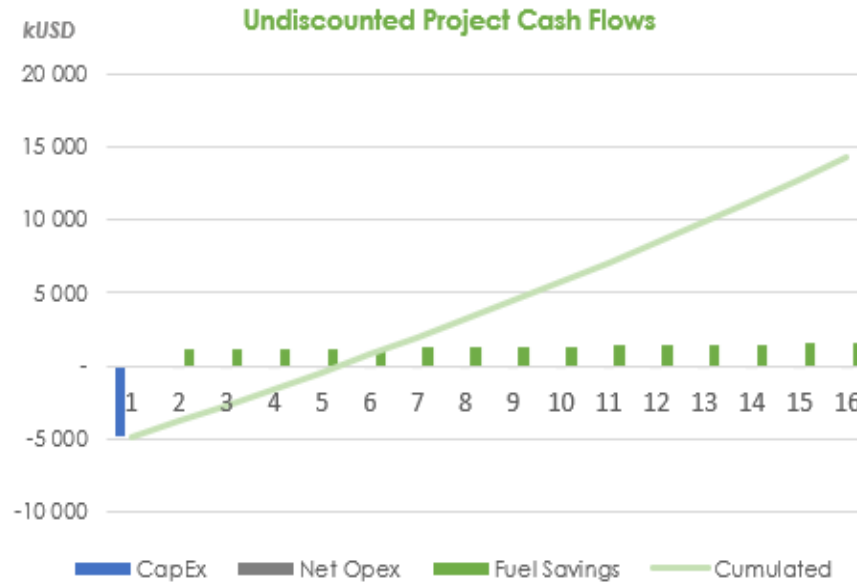
Average Fuel Savings (15 years) 43,6%



Savings (Constant Currency over 15 years)

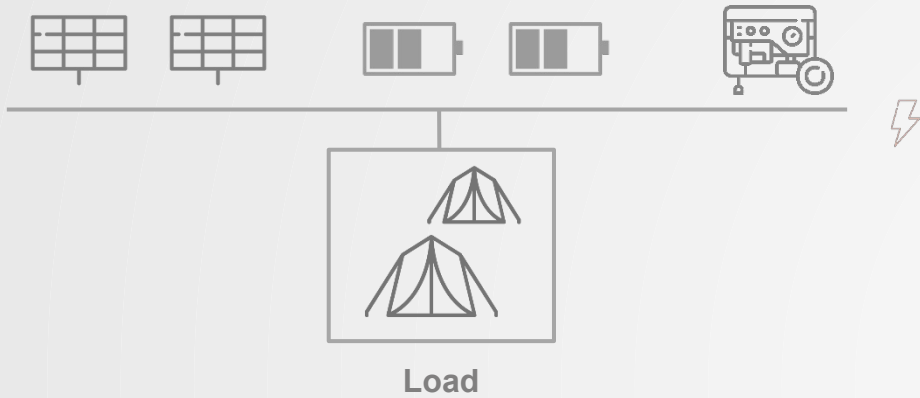
Fuel Savings	19 496	kUSD
GenSet OpEx Savings	988	kUSD
RE CapEx	-4 871	kUSD
RE OpEx	-1 325	kUSD
<b>Total Savings</b>	<b>14 288</b>	<b>kUSD</b>
Residual Value	1 180	kUSD
<b>Total Savings with RV</b>	<b>15 468</b>	<b>kUSD</b>

Payback Year CapEx - Total GEM® system 4 - 5 years

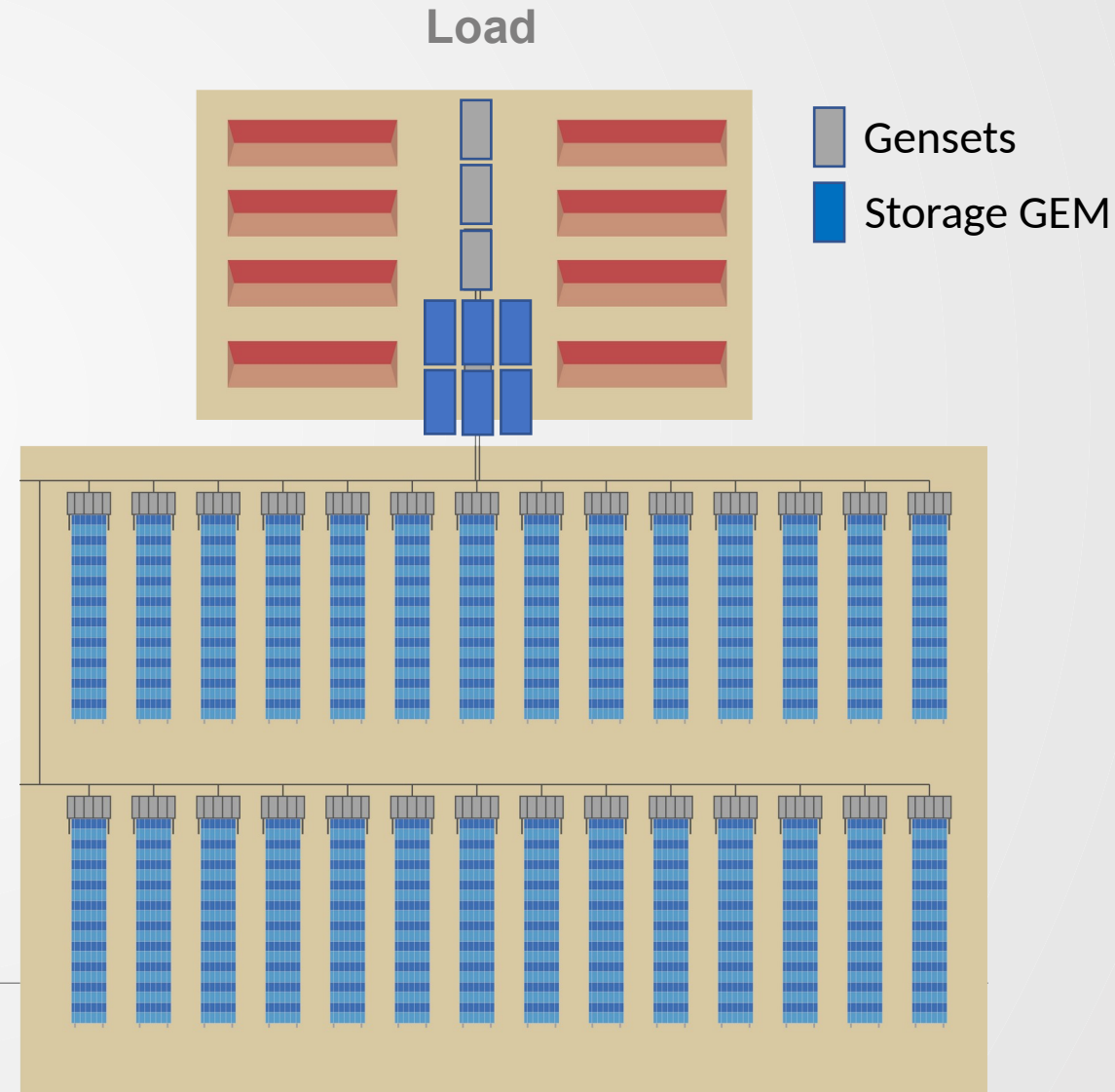




# Case 3 : PV 4 MW + Storage 8 MWh



- Footprint 3,3 ha
- Fuel savings 61 %
- Payback time 4-5 years
- NPV 7,8M\$



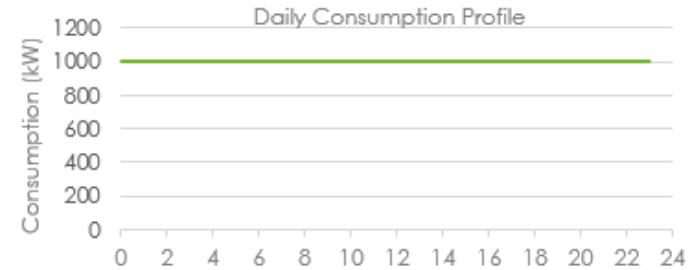
# Case 3 : PV 4 MW + Storage 8 MWh

## INPUTS

Consumption	8 760	MWh/year
PV Yield	1 700	kWh/kWp
Location	Indonesia	
Diesel Cost - DDP	1,10	USD/liter
Fuel Cost Indexation	3,0	%
Project Term	15	years

Scenario n° - PV - Storage - Fuel Savings

Selected Scenario **22 - 4 MWp - 8 MWh - 60,7%**



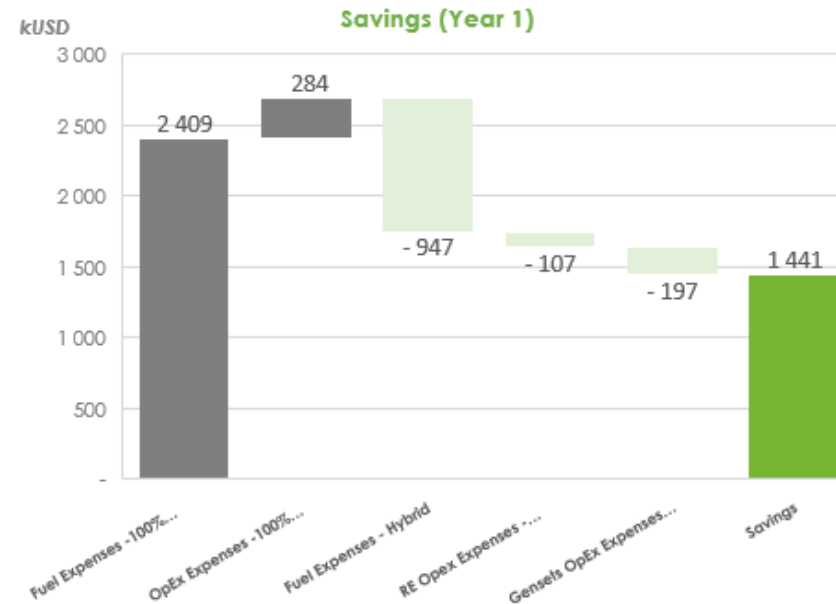
## OUTPUTS

### System CapEx

PV Capacity	4,00	MWp
Nb. Solar GEM®	54	
Storage Capacity	8,01	MWh
Nb. Storage GEM®	-	
GEM® Footprint	31 765	sqm
<b>CapEx - GEM® Product (EXW)</b>	<b>5 583</b>	<b>kUSD</b>
Solar GEM® (EXW)	3 596	kUSD
Storage GEM® (EXW)	1 987	kUSD
Installation & Commissioning	1 691	kUSD
<b>CapEx - Total GEM® System</b>	<b>7 274</b>	<b>kUSD</b>
CapEx - Genset	-	kUSD
<b>CapEx - Total system</b>	<b>7 274</b>	<b>kUSD</b>

### Savings (Year 1)

Fuel Savings	60,7	%
Fuel Savings	1 329	kL
Fuel Savings	1 462	kUSD
OpEx Savings	-21	kUSD
<b>Total Savings</b>	<b>1 441</b>	<b>kUSD</b>

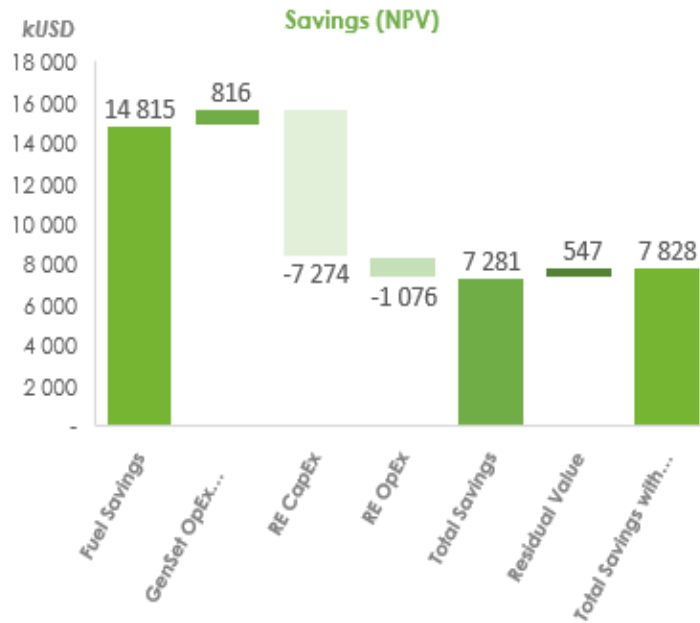


# Case 3 : PV 4 MW + Storage 8 MWh

Savings (NPV over 15 years)

Fuel Savings	14 815	kUSD
GenSet OpEx Savings	816	kUSD
RE CapEx	-7 274	kUSD
RE OpEx	-1 076	kUSD
<b>Total Savings</b>	<b>7 281</b>	<b>kUSD</b>
Residual Value	547	kUSD
<b>Total Savings with RV</b>	<b>7 828</b>	<b>kUSD</b>

Average Fuel Savings (15 years) 57,3%



Savings (Constant Currency over 15 years)

Fuel Savings	25 576	kUSD
GenSet OpEx Savings	1 387	kUSD
RE CapEx	-7 274	kUSD
RE OpEx	-1 854	kUSD
<b>Total Savings</b>	<b>17 834</b>	<b>kUSD</b>
Residual Value	1 637	kUSD
<b>Total Savings with RV</b>	<b>19 471</b>	<b>kUSD</b>

Payback Year CapEx - Total GEM® system 4 - 5 years

