# 3rd International Hybrid Power Systems Workshop

## Tenerife/Spain


E.Vales

Vergnet S.A


2018-05-09

# Contents



# Vergnet presentation

# Vergnet company

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- 365 MW installed (Wind and PV) in 40 countries

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Saying an hybrid grid is a grid with renewable energy is not enough,

Connecting a 500kW solar plant to a 5MW diesel grid is not what we call hybridization at VERGNET.

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- Grid safety
- Power quality (Harmonics, flicker)

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## Grid security can be an issue when adding renewables

- Shord circuit power can be too low to trip existing protections
- Specific grid protections have to be designed and properly set

# Projects insights

# Power hybrid systems by Vergnet

Vergnet has a long experience in connecting unpredictable renewable energy producers to weak grids: first installation of wind turbines on an small island diesel grid in 1989.

| Date | Name | Location | Renewables P | Diesel P | Grid P | Remark |
|---|---|---|---|---|---|---|
| 2018 | Amdjaras | Chad | 1.1 MW wind | 500 kW | 700 kW | 300 kW/2.5 MWh storage Grid forming |
| 2018 | Yap | Micronesia | 1.5 MW wind & PV | 3x1.6 MW | grid 2MW max | |
| 2017 | Kiffa | Mauritania | 1.3 MW PV | | | |
| 2015 | Bonriki | Kiribati | 1.3 MW PV | 5 5MW | | |
| 2013 | Nouadhibou | Mauritania | 4.4 MW wind | 16 MW | | |
| 2013 | Devil's point | Vanuatu | 3.5 MW wind | | | |
| 2011 | Marsabit | Kenya | 0.5 MW wind | 2.4 MW | | |
| 2009 | El Toqui | Chile | 1.5 MW wind | 6 MW | | |
| 2007 | Coral Bay | Australia | 825 kW | | | Low load diesel + Flywheel (Powercorp) |
| 2005 | Les Saintes | French Carribean | 1.9 MW | | | |

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- Utility agreeded on a downgraded $\cos\phi$

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## SNIM iron ore terminal

More than 12 Mt of ore per year is transported by train from the mines to Nouadhibou harbor to be loaded and exported by sea.

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An EPC tender was issued in 2010.

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- Simulation campaign addressing all possible cases
- Diesel-Wind power plant operating rules definition from analysis of simulation results

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Customer did not allow a full automation of diesel Genset so operating values are set by operators, a set of operating rules were defined to set the wind power plant power level according to grid state.

# Nouadhibou, Mauritania — Results

We define the penetration ratio $r$ by :

$$r = \frac{P_W}{P_L} \times 100 \qquad (1)$$

Where $P_W$ is wind power, $P_L$ is load power.

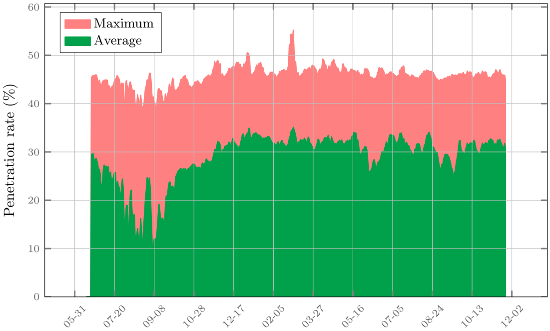
"$\triangle$" represents cases with a blackout risk due to lack of spinning reserve
"$\ominus$" represents impossible cases.

| Load (kW) | Nb running groups | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| 1000 | *20.0%* | $\ominus$ | $\ominus$ |
| 1500 | *46.7%* | $\ominus$ | $\ominus$ |
| 2000 | 38.3% | *20.0%* | $\ominus$ |
| 2500 | 30.6% | *36.0%* | *4.0%* |
| 3000 | 25.5% | *46.7%* | *20.0%* |
| 3500 | 21.9% | 43.7% | *31.4%* |
| 4000 | 19.1% | 38.3% | *40.0%* |
| 4500 | $\triangle$ | 34.0% | *46.7%* |
| 5000 | $\triangle$ | 30.6% | 45.9% |
| 5500 | $\triangle$ | 27.8% | 41.7% |
| 6000 | $\triangle$ | 25.5% | 38.3% |
| 6500 | $\triangle$ | 23.5% | 35.3% |
| 7000 | $\triangle$ | 21.9% | 32.8% |
| 7500 | $\triangle$ | 20.4% | 30.6% |
| 8000 | $\triangle$ | 19.1% | 28.7% |
| 8500 | $\ominus$ | $\triangle$ | 27.0% |
| 9000 | $\ominus$ | $\triangle$ | 25.5% |
| 9500 | $\ominus$ | $\triangle$ | 24.2% |
| 10000 | $\ominus$ | $\triangle$ | 23.0% |

Achievable long term penetration ratio

# Nouadhibou, Mauritania — Results

very good results are achieved thanks to exceptional site conditions.




1.5 year daily penetration record, 7 days average

- Wind power plant output: 19 GW h $year^{-1}$
- Fuel savings : 4800 t $year^{-1}$
- Pollution avoided ($CO_2$, $NO_x$, $SO_2$): 11 500 t $year^{-1}$

# Yap, F.S.Micronesia — Commissionned 2017

## Tender citation

*“The goal for integration and control system is to achieve highest possible renewable energy penetration, while maintaining power system stability and electric energy supply reliability at the same time. To ensure this, the integration and control system will take control over all other components in Yap power system, scheduling of diesel generators, and dispatching wind and solar generation. . . ”*

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## Architecture

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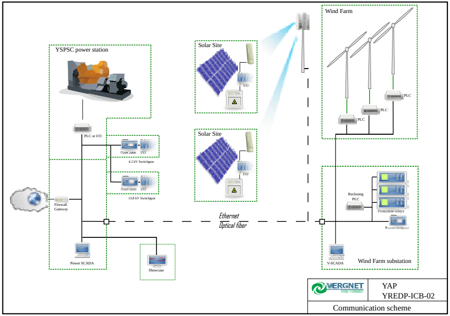
- 3 wind turbines

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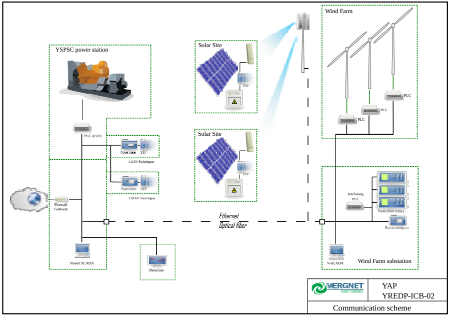
- 3 wind turbines
- Automation of Gensets



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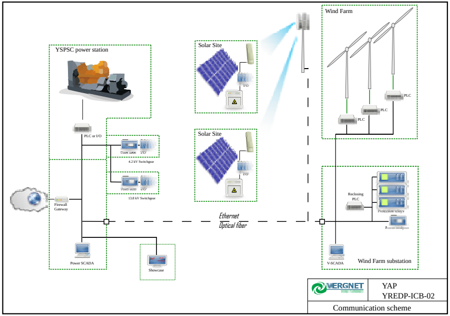

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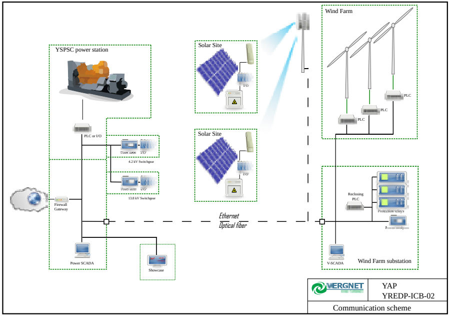

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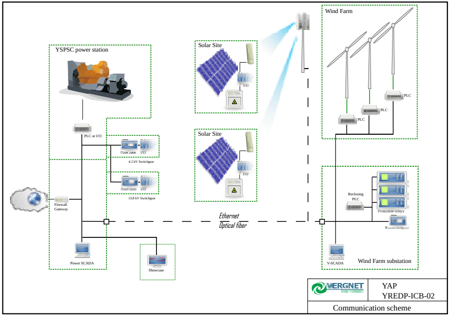


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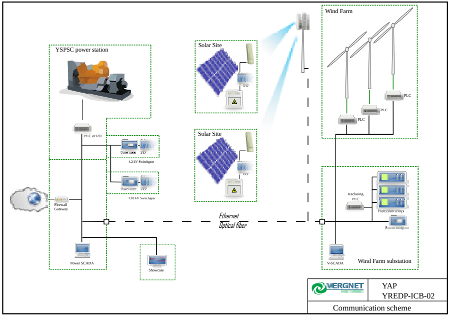

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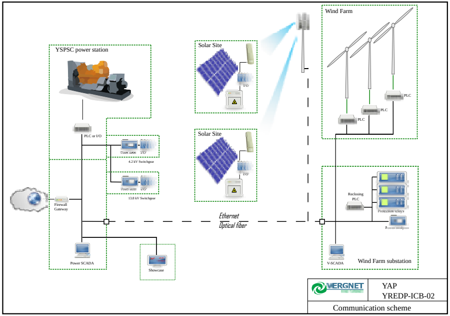
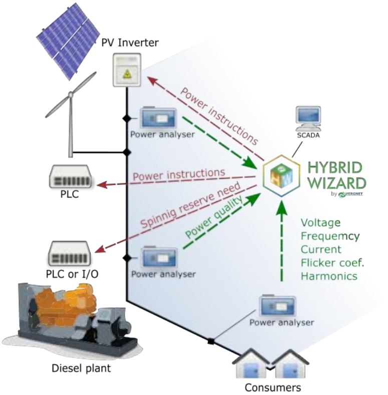



Grid study similar as *Nouadhibou* was performed.

# Yap, F.S.Micronesia — Hybrid Wizard

## Controller



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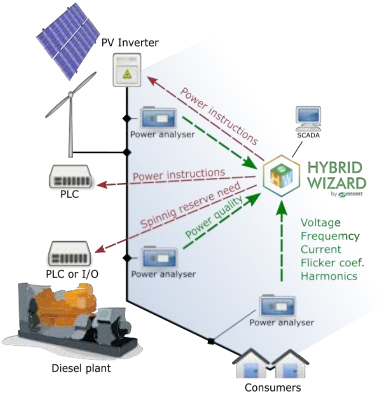

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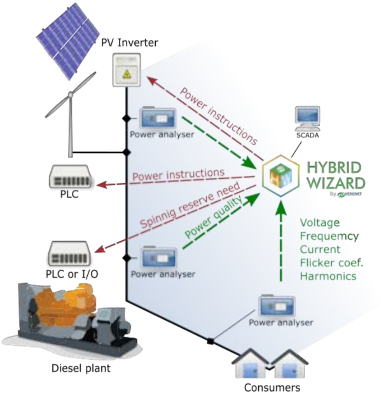


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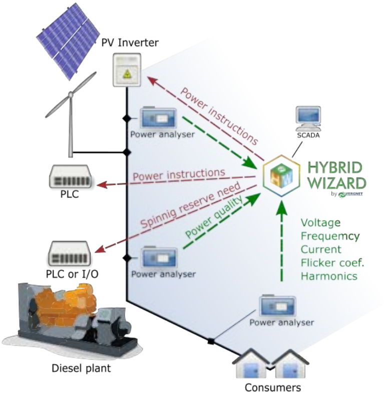

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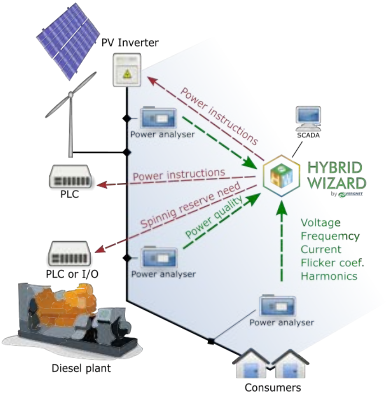

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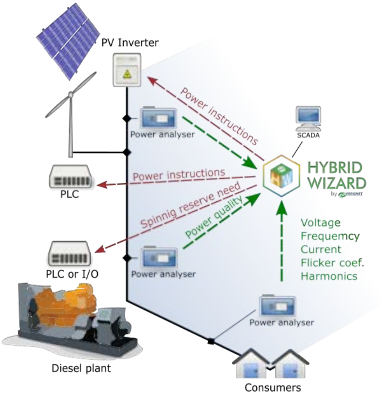
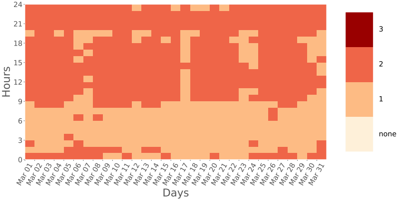
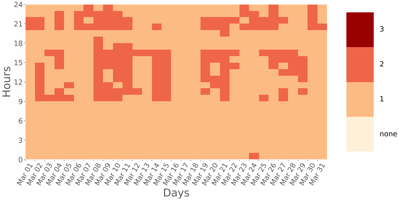


# Yap, F.S.Micronesia — Studies

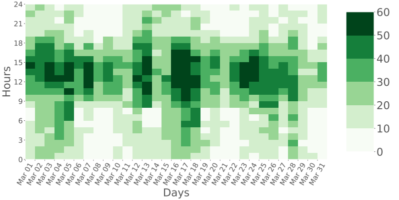
## Expected performances

At bid time a simple load flow study was performed to assess performances

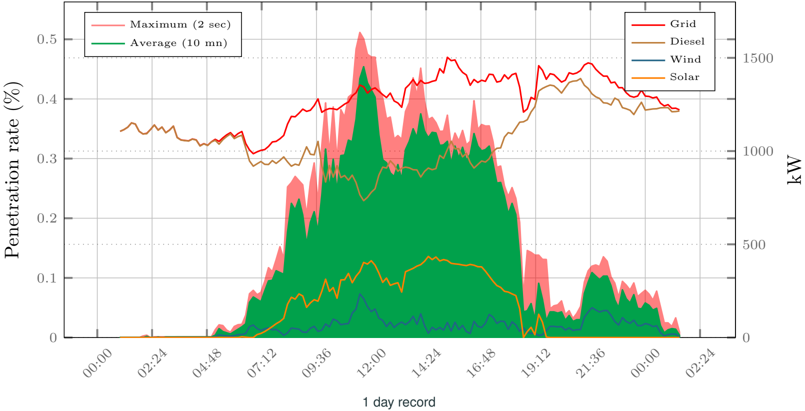



Above is heat map of connected diesels without and with renewable energy. Below is expected penetration rate. Data is on one month to remain legible.




# Yap, F.S.Micronesia — First results




- Wind power plant output: 2.1 GW h year$^{-1}$
- Solar power plants output: 1.2 GW h year$^{-1}$
- Expected Fuel savings: 730 t year$^{-1}$

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- Take Operation & Maintenance into account since the very beginning of the project.

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- Preparation work from a consultant is paramount in tenders, for mutual agreements, companies must be competent or subcontract.
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    - If knowhow is not already present, include a capability building programme

# Thank you for your attention