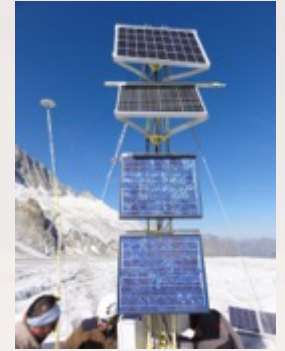


Solutions for energy units in extreme environments



OLIVIER GILBERT
ENERGIE-SERVICE (FORMER CNRS)
AN EPOS & ACTRIS & ANAEE CONTRIBUTION

Bruxelles, June 2019



Supporting environmental research
with integrated solutions
- **the Earth is our lab**



A COMMON KNOWLEDGE ON ENERGY

« *The more we share, the better we are* »

→ Presentation of a shared technical work done within the ENVRI+ network.

As all Research Infrastructures (RIs) are working on Earth sciences (atmosphere, seismology, biology, oceanic observation, glaciology,...) : they need **energy** to run their on-site measurement stations.

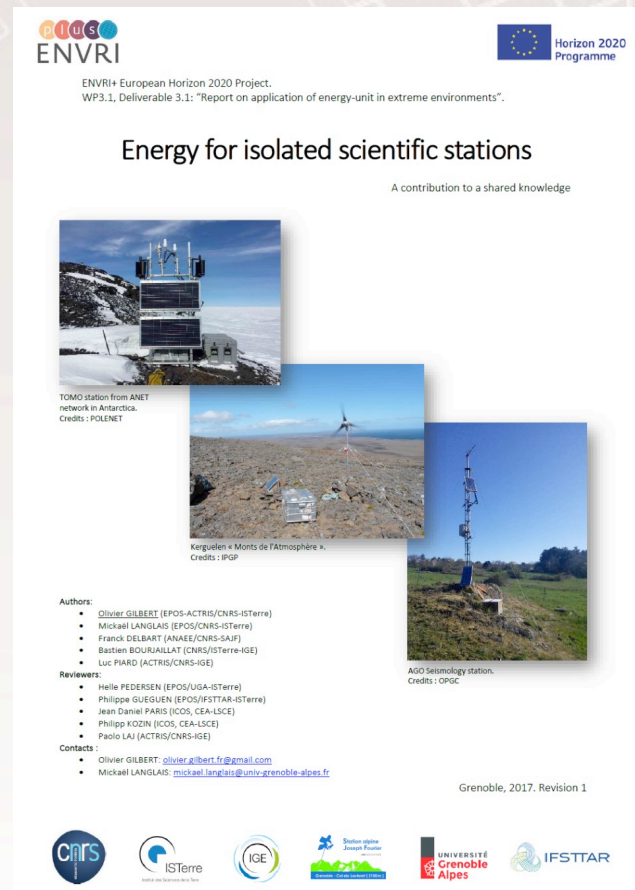
Every laboratory, every technical team, produced its own technical solutions to fit their special needs (extremely cold, strong winds, volcano, deep ocean,...)

So inside the ENVRI network :

- We gathered those knowledges
- We selected the most common requirement
- We tried to improve technical systems
- We spread results and common knowledge to everyone (built by everybody, for everyone)



H2020 Project



Deliverable D3.1 :
*Report on application of energy-unit
in extreme Environments*

Project Number: 654182

DIFFERENT SCIENCES, DIFFERENT NEEDS

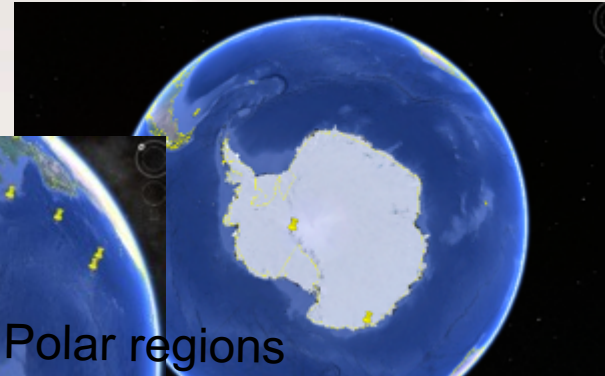
- Scientific measurement stations from all over the Earth. Terrestrial and oceanic sites.



Volcano



Polar regions



Deep forest



→ We focused on 25 isolated scientific stations representative of larger networks (1 typical of each RI) facing very different environmental conditions.



[And more...]

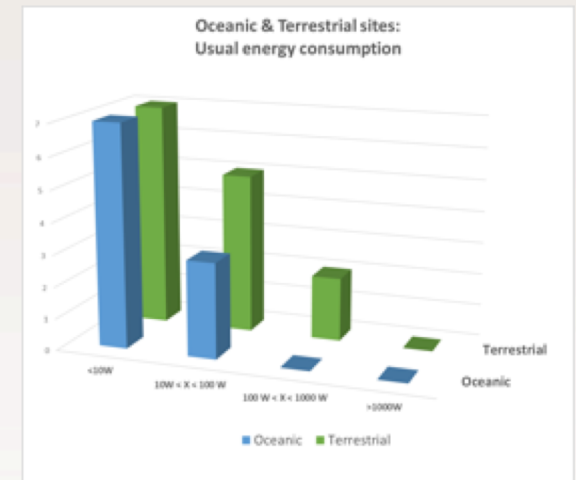
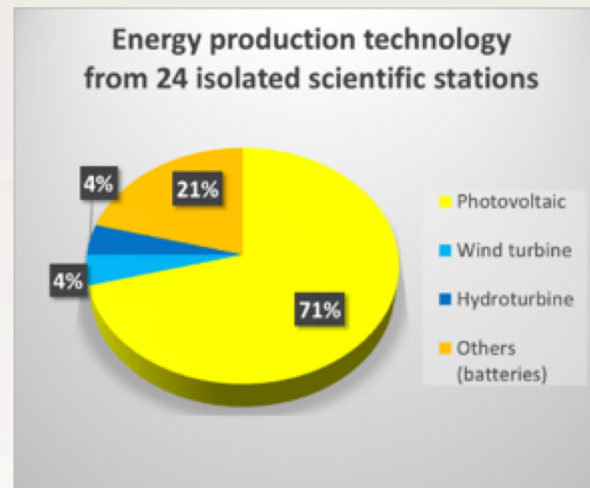
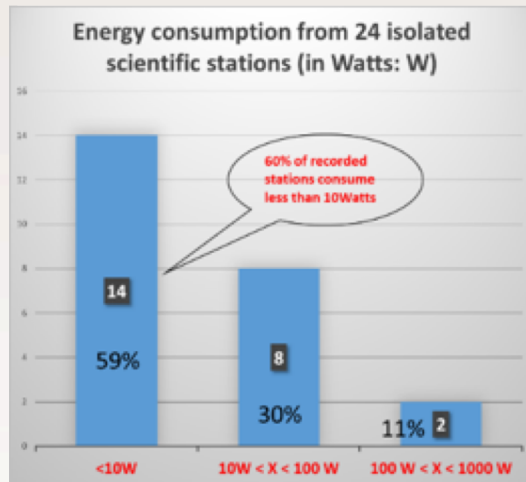


H2020 Project

Project Number: 654182

FIRST: WE ASK

- What do you need ? In terms of energy consumption.
- What do you usually use ? to produce and store this energy.

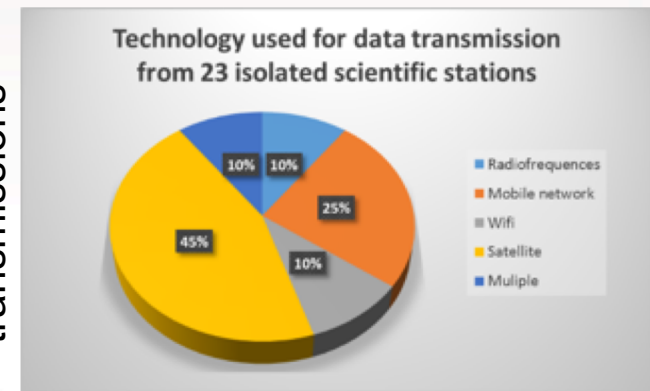


Average needs on energy :

- ~ 10W
- Solar panels, windturbines,
- Lead-acid and lithium batteries



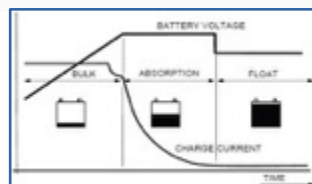
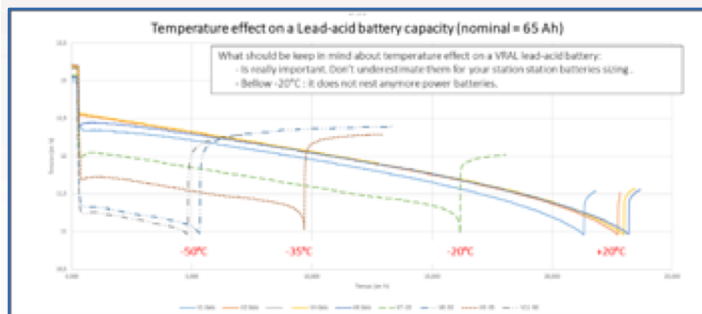
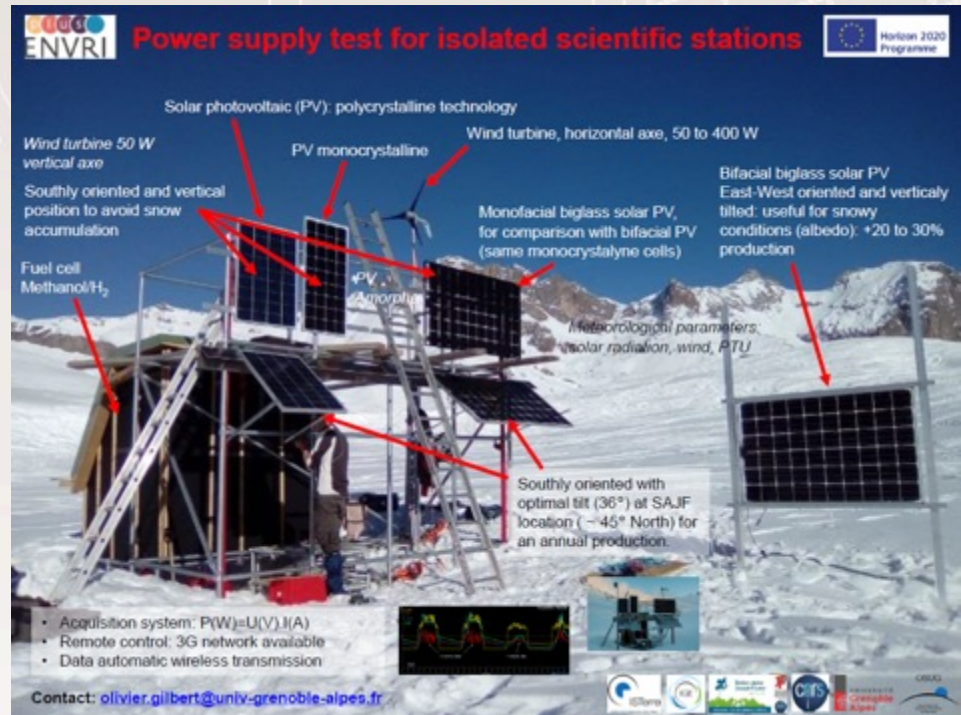
Also ask on data transmissions



H2020 Project

WE TESTED AND IMPROVED

- The most used solutions to fits the most current needs, on :
 - Energy production
 - Energy storage
 - Energy regulation
 - Consumption minimization
- Under cold, snow and wind.









WE GATHERED

- Technical informations on energy for autonomous stations, and data tele-transmission.
- ➔ A catalogue of operational solutions : 1 page = 1 operational solution, with technical contacts for more information.
- ➔ What you should know if you need an autonomous energy system.

ENVRI Environmental Research Infrastructure for Volcanic Risk Assessment

Examples of energy supply systems from isolated scientific measurement stations

General information: Name of the scientific station: Research infrastructure/laboratory: Measured parameters: Location: Contact (email): Website:	Stressographic station, Merapi Volcano (Indonesia) LNU-CPQC pressure, temperature, humidity measurement, digital single lens reflex camera, video, thermal camera Indonesia t.kellison@luniv.fr http://www.luniv.fr/indonesi.../kellison/	
Energy supply: Energy consumption: Energy production:	10V x 1 x 100 W Photovoltaic, 200Wp 2 mono-crystalline solar panels (100W x 2)	
Energy storage:	100 Ah x 1 x 1000 Ah Lead acid	
Telecommunications: Network architecture:	VHF	
Modem:	digital rocket m2 The distance between the station and the server is nearly 20 km. WiFi (IEEE 802.11g), WiFi (IEEE 802.11n), WiFi (IEEE 802.11ac)	
Others information:	2 stress stations on Merapi (Indonesia) or Merapi volcano (Indonesia), powered with 4 solar panel, each with 100 W. Lead acid batteries for communication, pressure, temperature, humidity measurement, digital single lens reflex camera, video, thermal camera. The station takes photos, thermal image x 1 time per day and takes video every hour and send data to server. There is 2 same station at the bottom of the volcano. The distance between the station and the server is nearly 20 km.	

2017 E. Tena, Grenoble
elena.gibet@univ-grenoble-alpes.fr

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Catalogue



H2020 Project

ENVRI Environmental Research Infrastructure for Volcanic Risk Assessment

Examples of energy supply systems from isolated scientific measurement stations






General information: Name of the scientific station: Research infrastructure/laboratory: Measured parameters: Location: Contact (email): Website:	Kangaroo Point de l'Observatoire P2P Atmospheric ion, cobalt, aluminum and dust Kangaroo Point (Australia) kangaroo@p2p.fr http://www.p2p.fr	
Energy supply: Energy consumption: Energy production:	10V x 1 x 100 W Photovoltaic, 200Wp 2 mono-crystalline solar panels (100W x 2)	
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Telecommunications: Network architecture:	VHF	
Modem:	digital rocket m2 The distance between the station and the server is nearly 20 km. WiFi (IEEE 802.11g), WiFi (IEEE 802.11n), WiFi (IEEE 802.11ac)	
Others information:	Great measurements of atmospheric ion, cobalt and aluminum derived Aur deposition at Kangaroo Point C'est une station de mesure qui permet de mesurer la teneur en ions de l'air (PM-10) avec une consommation continue de 100 W, soit plus de 10 kWh annuels. L'alimentation est assurée par une batterie 100 Ah et une alimentation à la batterie (charge des batteries) 100 W.	

2017 E. Tena, Grenoble
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ENVRI Environmental Research Infrastructure for Volcanic Risk Assessment

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elena.gibet@univ-grenoble-alpes.fr

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Data sheets

Project Number: 654182

WE SHARED BACK



ENVRI+ European Horizon 2020 Project.
WP3.1, Deliverable 3.1: "Report on application of energy-unit in extreme environments".



Energy for isolated scientific stations

A contribution to a shared knowledge



TOMO station on ANET network in Antarctica.
Credits: POLNET



Kerguelen « Monts de l'Atmosphère ».
Credits: IGP



AGO Seismology station.
Credits: OPGC

Authors:

- Olivier GILBERT (EPOS-ACTRIS/CNRS-ISTerre)
- Mickael LANGLAIS (EPOS/CNRS-ISTerre)
- Franck DELBART (ANAE/CNRS-SAIF)
- Bastien BOURAILLAT (CNRS/ISTerre-IGE)
- Luc RIARD (ACTRIS/CNRS-IGE)

Reviewers:

- Helle PEDERSEN (EPOS/USA-ISTerre)
- Philippe GUEGUEN (EPOS/IFSTTAR-ISTerre)
- Jean Daniel PARIS (ICOS, CEA-LSCE)
- Philipp KOZIN (ICOS, CEA-LSCE)
- Paolo LAI (ACTRIS/CNRS-IGE)

Contacts:

- Olivier GILBERT: olivier.gilbert.fr@gmail.com
- Mickael LANGLAIS: mickael.langlais@univ-grenoble-alpes.fr

Grenoble, 2017. Revision 1



IV. Lead-acid batteries

Batteries
Mainly on lead-acid ones, with few advice for Lithium based.
Technical advice summary for on-site direct use

These documents have been made to summarize advice for Research Infrastructures on energy issues. Mainly for non-experienced users to gain time, benefiting from others experience. For more details, you can refer to the complete deliverable energy report. Visit ENVRI Community website: <http://envri.eu> or contact: envri@envri.eu

Lead-acid batteries

- **What does C10, C20, C100 mean?**
 - Example: C10 = 10 Ah means that the battery can deliver 10 Ah if you fully discharge it in 10 hours.
 - C20 = 10 Ah means can deliver 10 Ah in 20 hours. C100 is the common standard (1 day).
- **Charge**
 - If possible: use a 10% to 20% C20 current (charge available).
 - Batteries can be charged 1 time (charge for more days).
 - Example: for a 80 Ah battery, charge with 8 to 20 A current.
- **Discharge**
 - Do not discharge more than 50% of C₁₀ or under 50.5 V. To keep your batteries in a good (good) for years. For a 80 Ah, consider 40 Ah available for your installation using. This will influence on its life time. There is a standard available system for a thousand for 100 full-gas.
 - When voltage decrease, acid will be change in water. Sulfate crystals will be formed (sulfate) for this water, and will block electron movement possibilities in the electrolyte. Enhancing loss of capacity. This is the main reason for a battery to be drained (over used).
 - To avoid this sulfation phenomenon, batteries need to be recharged at least every 6 months, and every time voltage will drop under 52 V.
- **Short lead** (for internal use) (State of Health):
This chart and empirical test allowed you to have a global overview of the internal battery (Health). That represents its internal use due to sulfation. After a complete charge and a 4800 h battery voltage. Refer to the table below.

V [V]	Battery State of Health (%)	Comments
13.0 V	100%	OK for full-scale use
12.8 V	50%	To be used in laboratory
12.6 V	0%	End of life

Suggestion for a safe and careful label management:

ENVRI

II. Wind turbines

Wind turbines (WT)
Technical advice summary for on-site direct use

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- Examples of used small horizontal or vertical axis WT for scientific stations (from exhaustive list):
 - Horizontal axis: Proton 600, 300
 - Vertical axis: Proton 600, 300

III. Photovoltaic solar panels

Solar panels
Technical advice summary for on-site direct use

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In 2017, the most common technologies available on market are: Monocrystalline Silicon (PERC), European Photovoltaic Industry Association, and PERC, National Renewable Energy Laboratory (NREL).

- Silicon crystals (90% of worldwide market): mono or polycrystalline. Typical efficiencies goes from 12 to 18%.
- Thin film: Silicon or Cadmium Telluride (CdTe), copper indium gallium selenide (CIGS)... Typical efficiencies goes from 5 to 12%.
- Multi-junction cells: like Indium gallium arsenide, Germanium... Typical efficiencies goes from 25 to 40% (but most of them are not in field process).

Most terrestrial and space scientific stations used **monocrystalline technologies**. In this case, better choose **monocrystalline** technology rather than polycrystalline.

Photovoltaic cell technology	Typical efficiency of commercial solutions (2017)	Available on market?
Silicon crystals	12 to 18%	Easy (90% of world market)
Thin film	5 to 12%	Yes
Multi-junction	25 to 40%	Depending, No, or not easily

- For high mountain alpine (30°) tilted sites with regular snow deposition, put them in **vertical**.
To avoid snow deposition, avoid falling rocks...
- Differences in terms of produced power between vertical and "normal oriented" are small as solar angles are usually overcast. Moreover, you will benefit from a higher albedo effect (snow light reflection on snow) in winter where you will have less rain.
- Use a double independent batteries block:
 - 1 for acquisition (primary)
 - 1 for transmission (secondary)
- Prefer **MPPT** charge controller rather than PWM ones. Especially for a 100 W installation.
- **Warning**: The following table is a suggestion for a "typical" 10 W consumption (24h) with the following restrictions:
 - Your constraints are:**
 - Scientific acquisition < 5 W
 - Transmission < 5 W
 - Sun light > 3000 h/year (average in France metropolitan, adjust for your situation and 5 hours of efficient use per day (as a minimum for winter time))
 - 5 days autonomy wanted
 - Discharge batteries rate = 50% (eg for a 100 Ah, count on 50 Ah)
 - Suggested solar array sizing**
 - 500 W solar panels
 - 300 Ah batteries
 - 50 Ah for acquisition
 - 80 Ah for transmission
 - Charge controller: Max current = 10 A (generally in 12V/24V)

Available on-line @:

<http://www.envriplus.eu/wp-content/uploads/2015/08/D3.1.pdf>



H2020 Project

Project Number: 654182

THANK YOU FOR YOUR ATTENTION

« *Not to reinvent the wheel* »
→ The power of a network.

For more information or technical assistance :

Olivier GILBERT

Energie-Service

→ contact@energie-service.info

→ olivier.gilbert.fr@gmail.com



H2020 Project



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