Electro Power Systems



Self-recharging *fuel cell system designed for the Telecom Operator which eliminates backup logistics thus significantly lowering Operators Op-Exe's*



June 10th 2011

GSMA Associate Member



Value proposition

- ✓ ElectroPS products allow end-users to get rid of batteries and gensets thus **eliminating: fuel logistics, heavy maintenance, frequent substitution, fuel price uncertainty**.

From expensive logistic and maintenance



To peace of mind and savings



In brief

- ✓ Founded Jan. 2005, HQ in Torino, factory in Aosta. EPS designs and manufactures innovative fuel cell systems for back-up power applications.
- ✓ **Lead by co-founders, VC-backed, several awards, growing revenues, increasing orders from returning customers, global installation base (Europe, Americas, Asia) and big market to win.**



Global Cleantech 100

GLOBAL MOBILE AWARDS 2010
EMEA TOURNAMENT
CATEGORY WINNERS

GSMA
Associate Member

- ✓ 2009 The Guardian "**Global Cleantech 100**". World Finalist at 2010 GSMA Mobile Innovation Grand Prix and Winner the EMEA leg of in the category "**Most Innovative Product Enabling a Greener World**".

REFERENCES


中国移动通信
CHINA MOBILE


TELECOM
ITALIA


国家电网公司
STATE GRID
CORPORATION OF CHINA


AIRWAVE


viom
NETWORKS


Digicel
jamaica




vodafone


ERICSSON


LANSING
MICHIGAN


MTN
everywhere you go




orange
& france telecom




e·on


autostrade per l'italia


TeliaSonera


TOTAL


seas nve


BT


Galten Elværk


HADELAND
Energi


smat
gruppo


SardegnaRicerche


REGIONE
PIEMONTE


EGEA
L'ENERGIA DEL TUO TERRITORIO

Installation TETRA Germany







Germany

Backup system for telecommunication equipment of German Police
DC and AC (online UPS and inverter for air conditioning)

Hydrogen cylinders automatic switch.

Installation Norwegian Broadband operator

Norway

Electro X demonstrates its capability to operate in extreme environments











Installation Danish Broadband operator



Denmark

Electro X demonstrates its low footprint and installation flexibility





Installation Power Utility China

Harbin, Heijlongjang

Electro X demonstrates its capability to substitute huge footprint 220Vdc battery banks in a voltage switching station.







Installation China

Henan

Electro X demonstrates its capability to operate under stressing blackout conditions: 141 blackouts for more than 9000min total running time since February (1 single blackout lasted 43hours)





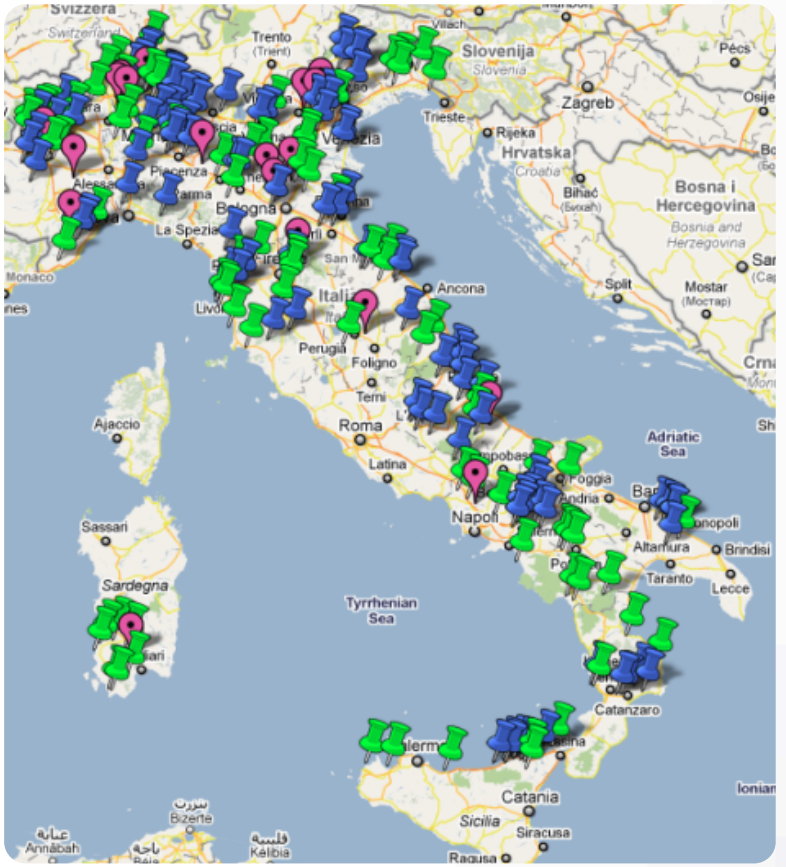


Wide scale deployment Telecom operator

Italy

Wide scale 300+ units deployment completed in 2009.
200 more units (6 and 12kW) have been installed in 2010.



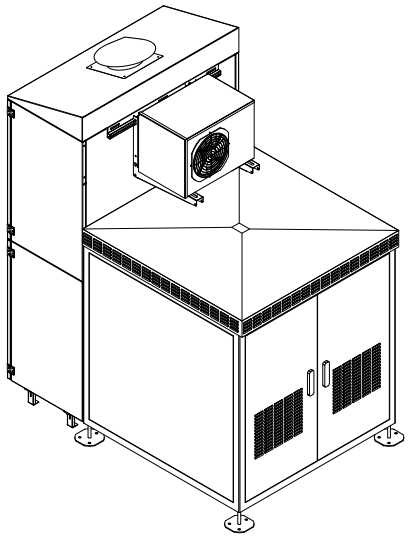


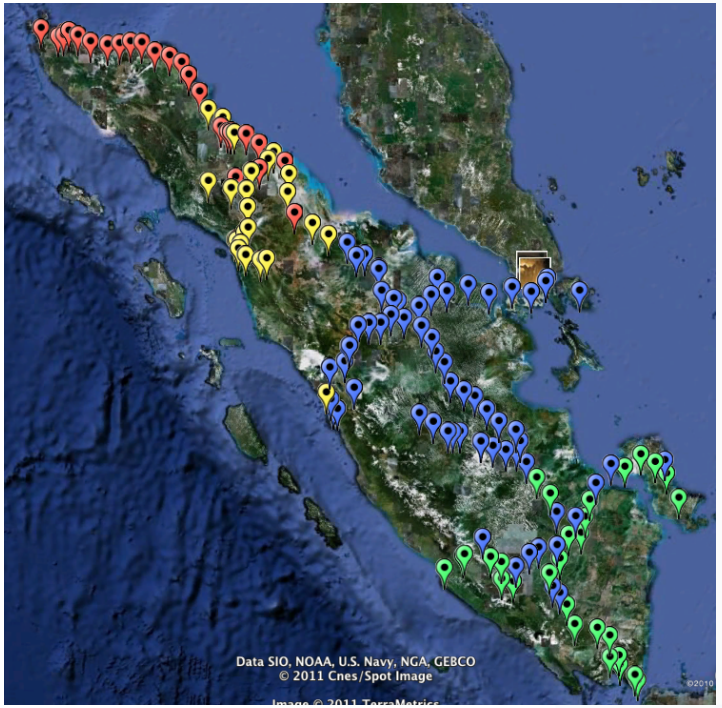
Wide scale deployment in remote region

Sumatra - Indonesia

Wide scale 250+ units deployment due to be completed by end 2012.
Remote area with limited infrastructure posed logistical and deployment challenges.







ELECTROSELF™ installed in a Jamaican raw land site









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ELECTROSELF™ installed on Indian rooftops



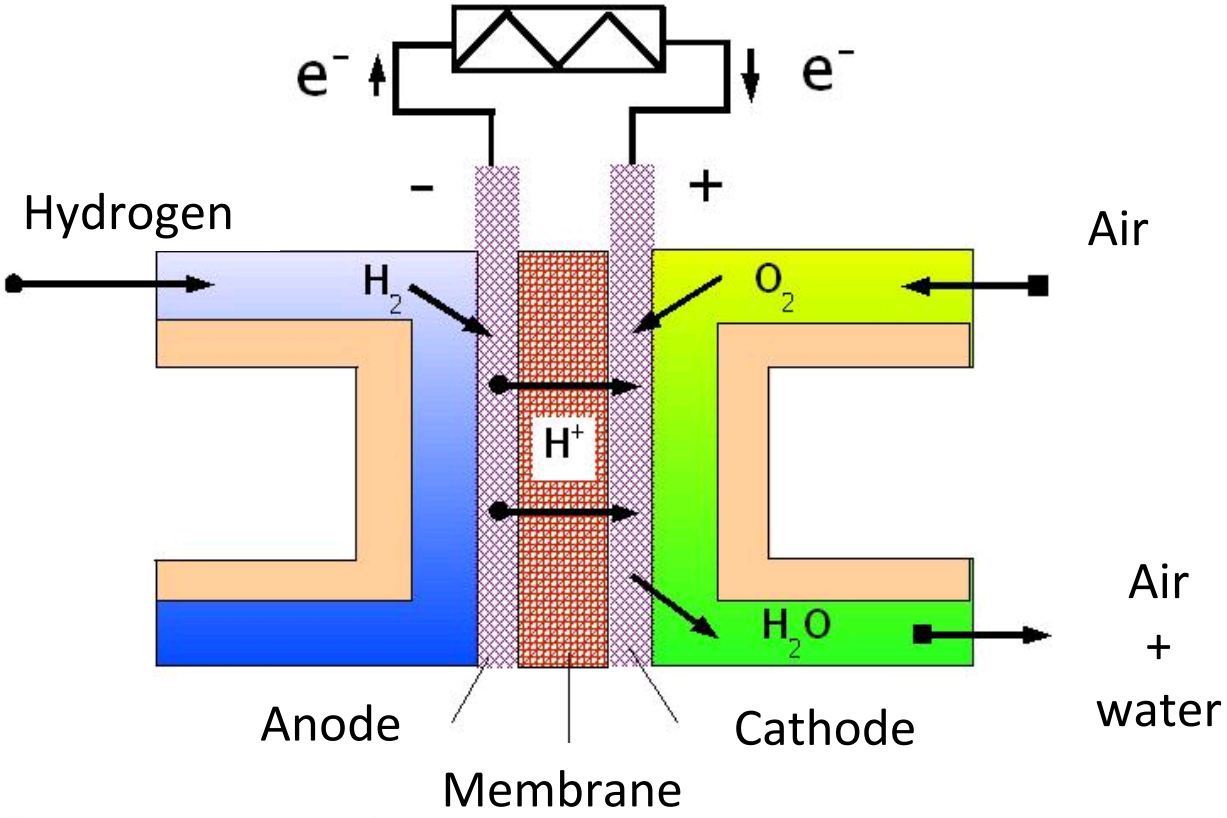


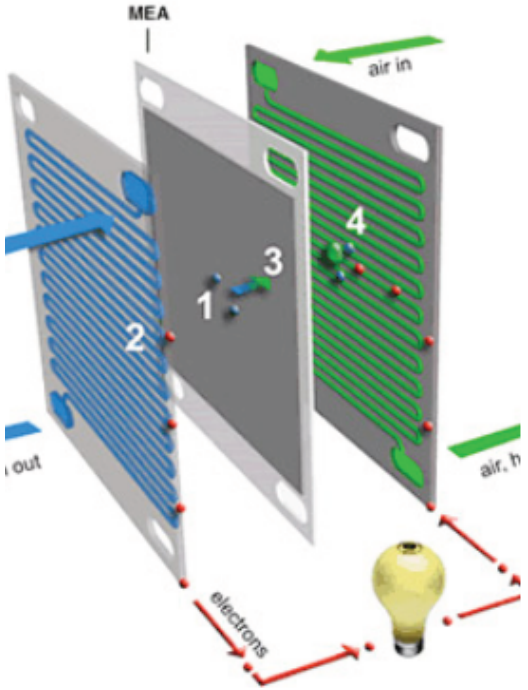




How do Fuel Cells Work ?

It's a Electro-chemical reaction !

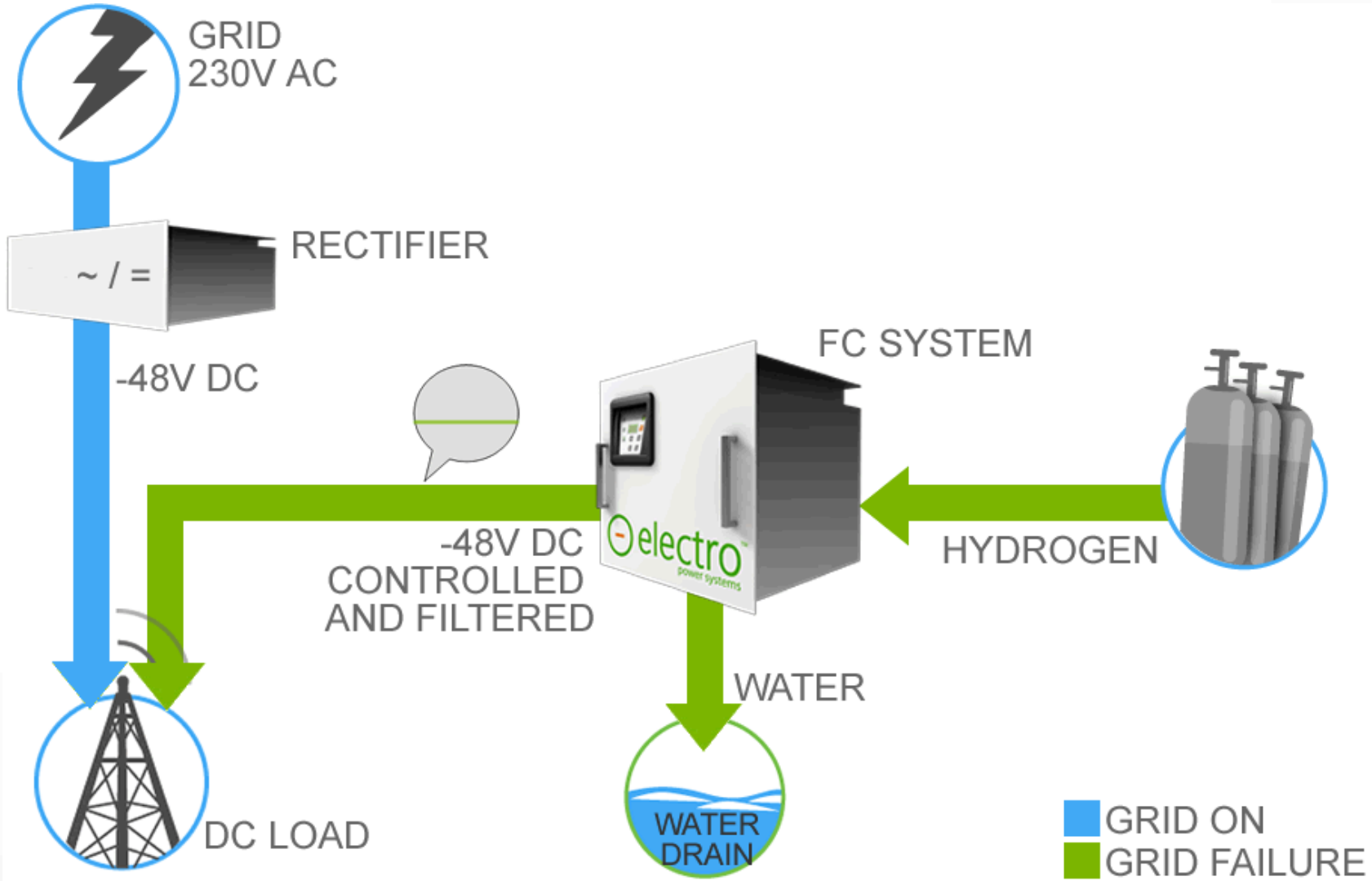




$$H_2 \rightarrow 2H^+ + 2e^-$$

$$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$$

How our fuel cell systems work:

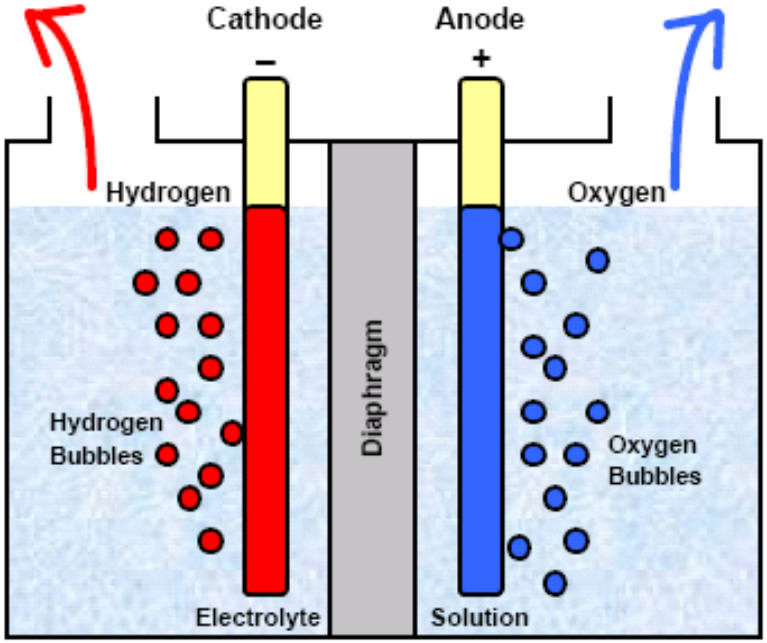


INTRODUCING ELECTROSELF™

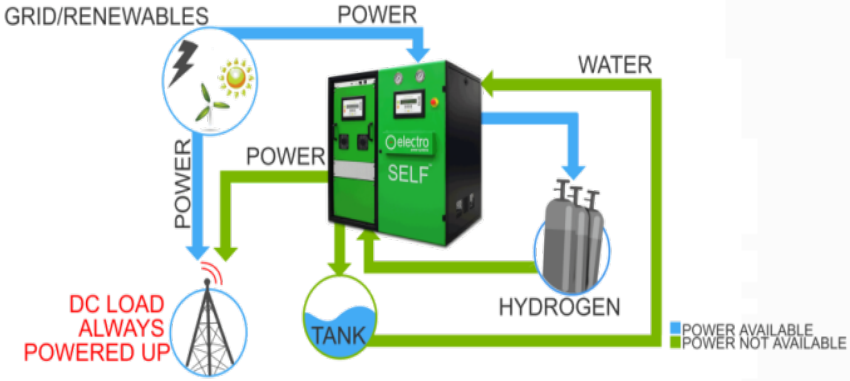
- ✓ It's the world's first entirely self-recharging hydrogen fuel cell.
- ✓ It changes the economics of backup power making fuel cell **adoptable everywhere**.
- ✓ It enables greener networks in developing markets.
- ✓ Designed to optimize and extend both renewable and grid power.
- ✓ Deployments in EU, Asia and Americas.
- ✓ CE certified.
- ✓ **Product evolution: next generation of self-recharging fuel cell will dramatically reduce the time for cylinder refilling.**



How the ElectroSELF works !

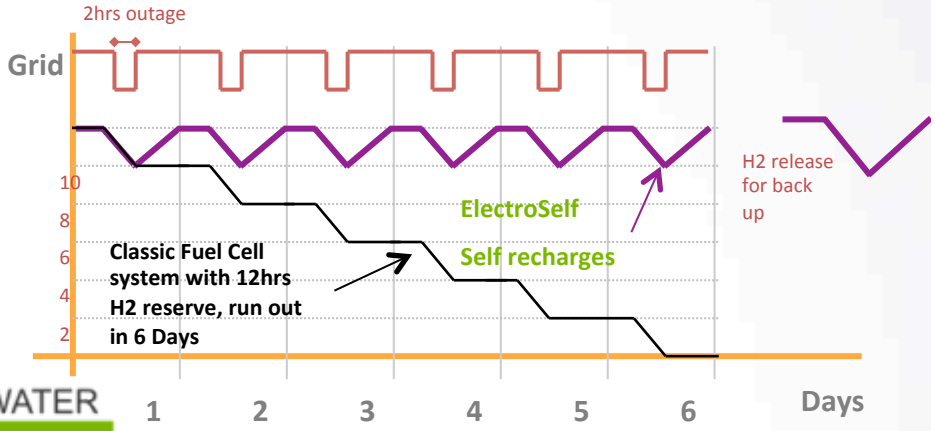


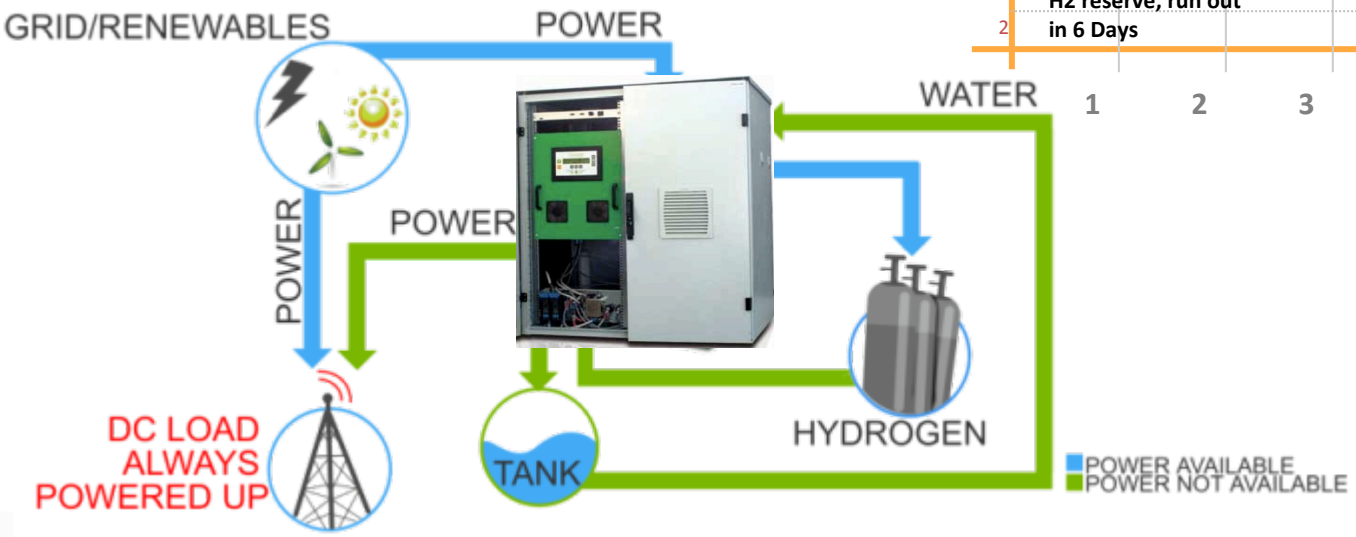
Standard Electrolysis





HOW DOES IT WORK?





- ✓ ElectroSelf™ is a closed system which is completely self-recharging.
- ✓ It engages automatically whenever external power fails.
- ✓ Whenever power is available it automatically generates its own hydrogen (and oxygen) from water.

Strictly confidential

Product family

- ✓ **Fuel cell systems for backup power**. The optimal solution for applications with **long non frequent blackouts** when fuel logistic is not an issue. **Four** power sizes:
  - 1,5 kW (Electro1,5)
  - 3 kW (Electro3)
  - 6 kW (Electro6)
  - 12 kW (Electro12)

- ✓ **Self-recharging fuel cell systems**. The optimal solution for **frequent blackouts** or for **off-grid applications integrated with renewables**. **Four** power sizes:
  - 1,5 kW (ElectroSelf1,5)
  - 3 kW (ElectroSelf3)
  - 6 kW (ElectroSelf6)
  - 12 kW (ElectroSelf12)

- ✓ With each product we also provide **gas storage solutions** and **Remote Monitoring and Control**

- ✓ **Same footprint for each power size** thanks to our Core Module Technology.







Technological features (1)

- ✓ Advanced proprietary liquid-cooled stacks. ***Benefits:***
  - **Less footprint, less costs,** less ventilation required (thus **indoor installations** always possible).
  - Less subsystems to control and lower risk of failure than paralleled systems (i.e. **higher reliability**).
  - The **greatest** power output **scalability** (the bigger the power output, the lower the €/kW ratio).
- ✓ Hydrogen re-circulation and two shut off valves. ***Benefits:***
  - **Higher flexibility and easier installation** (the safety area is in the orders of cm, not meters).
  - **Increased safety** (no hydrogen discharge in the air).
  - **Higher efficiency** (less hydrogen consumption).
- ✓ Highest power density and multiple voltage output. ***Benefits:***
  - You **need less footprint (i.e. less costs and more flexibility) to install the power needed**.

Technological features (2)

- ✓ An on board control panel with 30 parameters that can be set on-site without a dedicated PC. ***Benefits:***
  - **Flexibility**
  - **Easier installation**
  - **User friendly**
- ✓ Patented start and stop procedure. ***Benefits:***
  - **No hydration issues** (no need for periodic startup maintenance).
  - **Higher stack lifetime** and **reliability**
  - **Unlimited** number of **start-and-stop cycles**.
- ✓ DOX platform. (leveraging direct oxygen injection). ***Benefits:***
  - **doubled stack power density**, reduced BOP, **simpler and cheaper products**. The system can **work at any air quality condition**.

Remote Monitoring

POTENTIAL FREE CONTACTS

✓ The basics built in every EPS power system

✓ Quick integration with existing monitoring solution based on digital IOs

SMS MONITORING

✓ Real time alarm delivery direct to maintainers

✓ Status information to optimize maintenance and massively reduce the MTTR

✓ Works on any GSM network: no physical connection required

TCP/IP CONTROL AND MONITOR

✓ Proactive monitoring solution

✓ Flexible solution to integrate the site monitoring to your own NMS

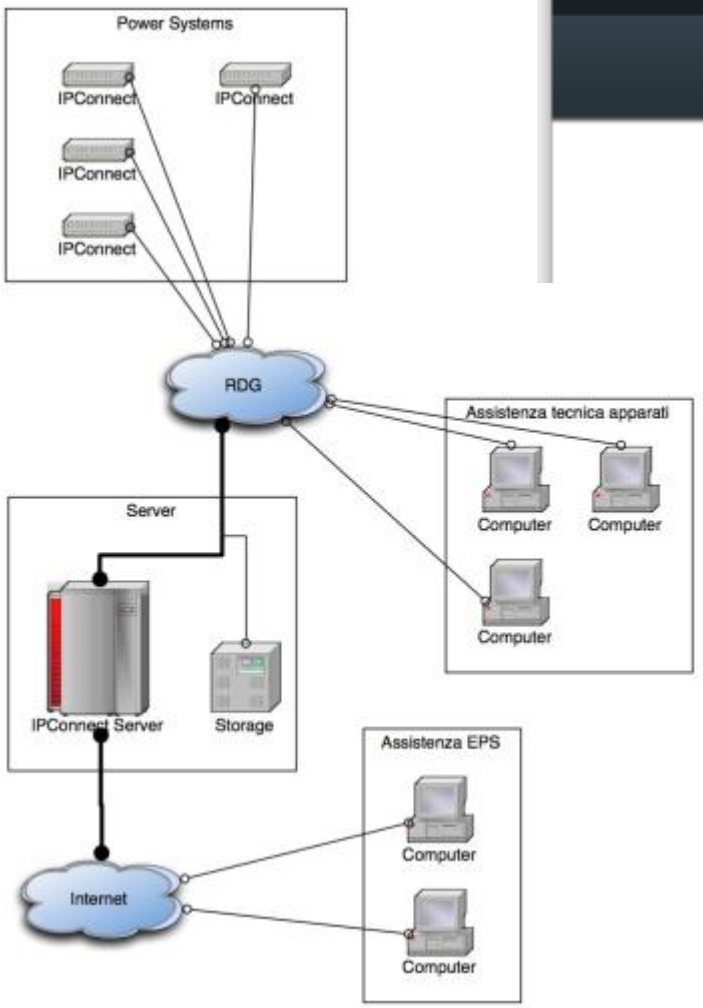
✓ Full control of power system's functionality from your subsidiary

✓ Local storage of activity information

✓ Can deliver additional site's information

WEB BASED REMOTE MONITORING AND CONTROL

✓ Examples







Unit subsystems are controlled through a single screen interface

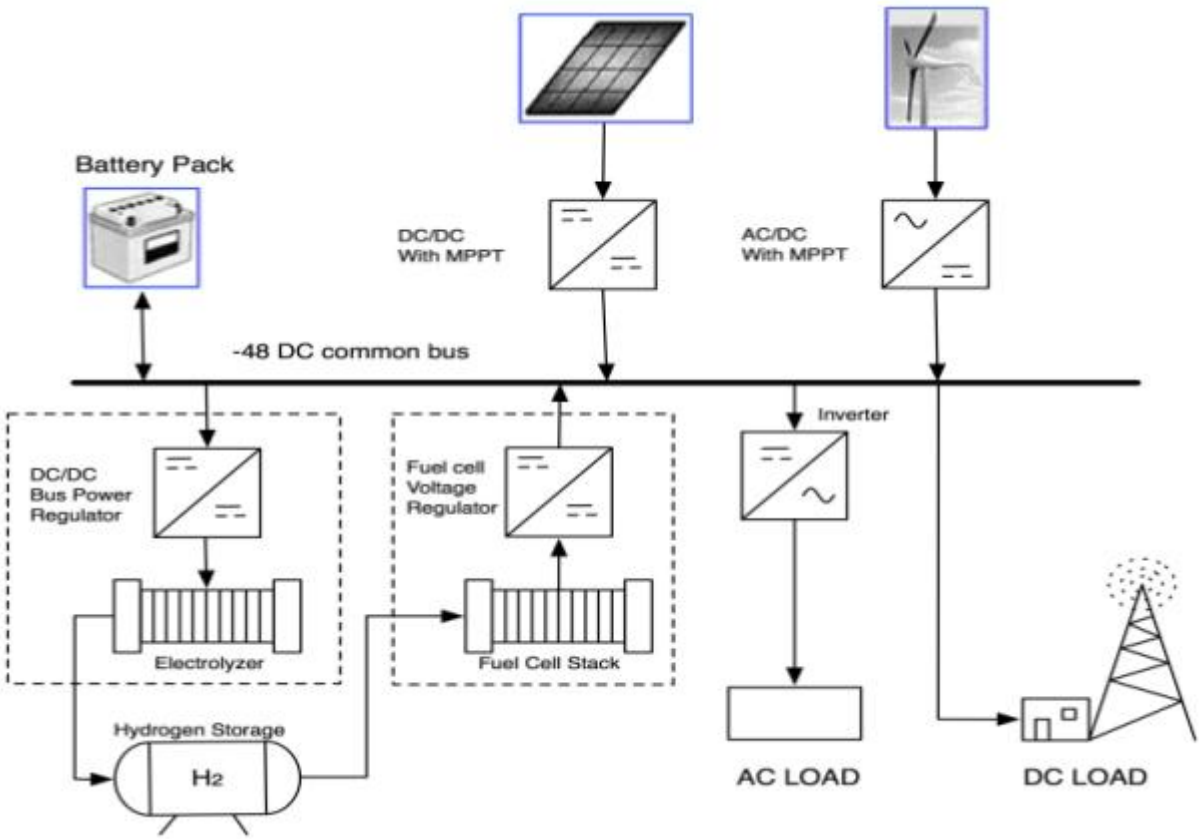
Wide set of warnings and alarms for immediate diagnostic

Real time measurement allow remote test and control of Electro6

Configurable parameters to adapt to site specific customer needs

electroSelf and renewables

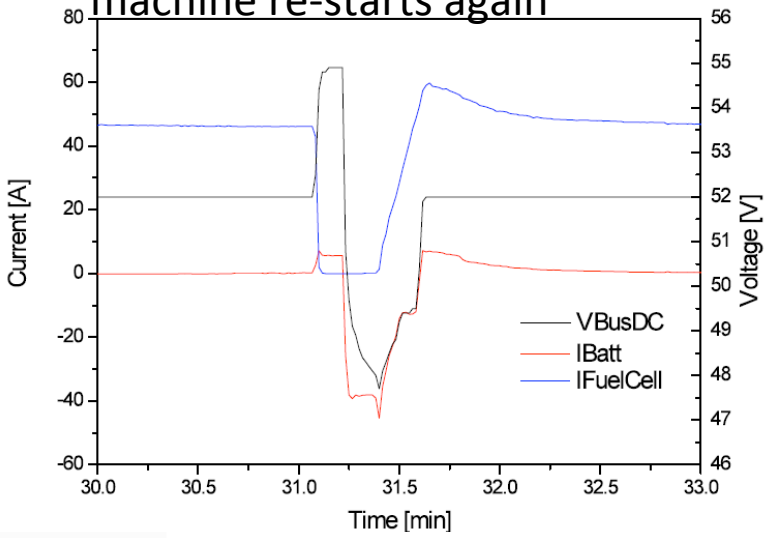
✓ Copes well with "unstability" of renewable sources



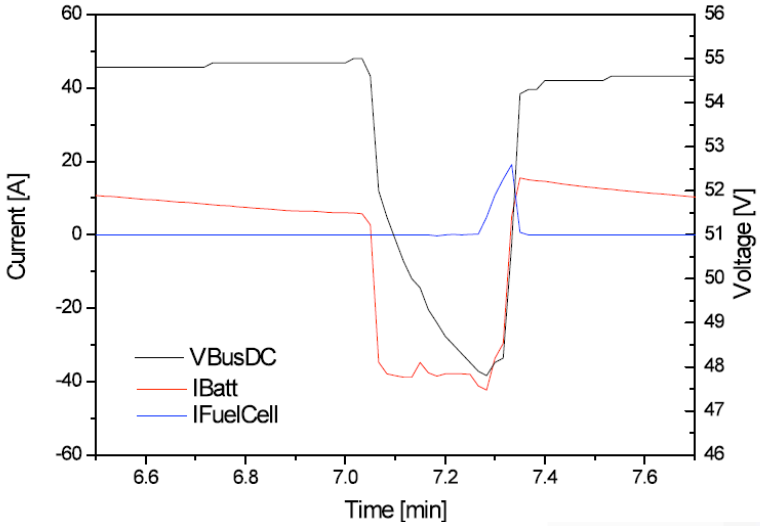
Electroself – Provides Reliable power under stress

Start –ups during grid restore and Shut-downs during grid outage

Grid fault during shut-down: machine re-starts again



Grid restore during start-up:



Sample Implementations and how to size the system

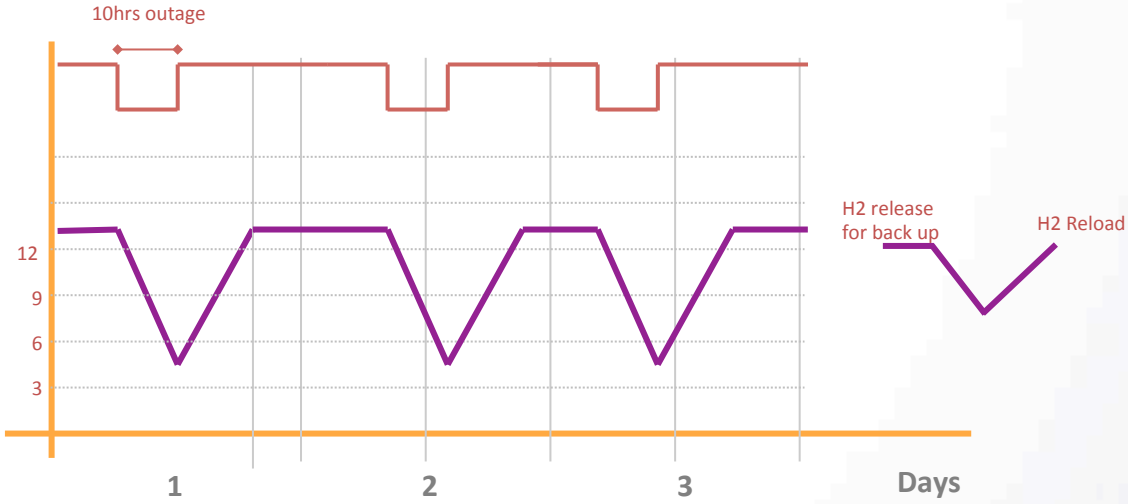
How to calculate the number of bottles needed

- ✓ Assumptions – Storage
  - Bottled Hydrogen from a hydrogen supplier is typically 10000 liters of Hydrogen pressurized at 200 bar.
  - Therefore one supplier bottle will provide 12kW hours of electricity.
- ✓ Hydrogen Production
  - The Electroliser produces hydrogen at 150 bar pressure therefore 1 full bottle of hydrogen will provide 10.5 kW hours of electricity
  - 1000 liters per hour Electro1000
  - 1 liter of Water = 1.5kW/Hour

Sample of System Implementation 1.

- ✓ 1,5kW total power with 10 hour daily outage
  - ElectroSelf1,5: H2 consumption at full power is: 1.400 Lit H2
  - with a 10 hour outage total consumption will be: 14.000 Lit H2
  - Requires 2 Tank (50 lit/150bar): each tank provides approx 7.000 Lit H2
  - Electrolyzer 1000: to recharge 10 hours at 1,5kW 14.000/1.000 = 14 hours

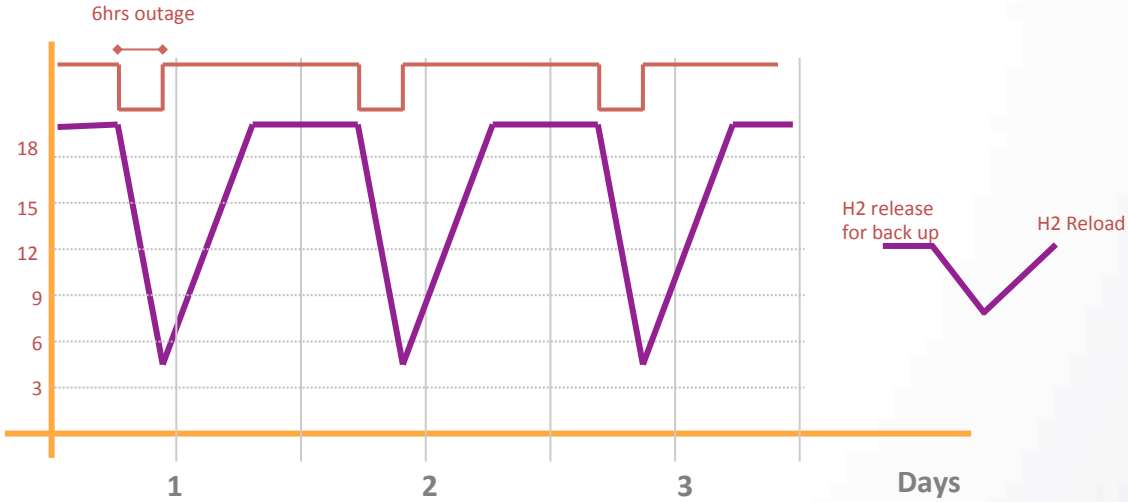




Sample of System Implementation - 2

- ✓ 3kW total power with 6 hour daily outage
  - ElectroSelf3: H2 consumption at full power: 2400 Lit H2
  - with a 6 hour outage tot consumption will be: 14.400 Lit H2
  - Requires 3 Tank (50 lit/150bar): each tank provides approx 7.000 Lit H2 total
  - Electrolyzer 1000: to recharge 10 hours at 3kW 14.400/1.000 = 14,5 hours





Typical Deployment for any Operator

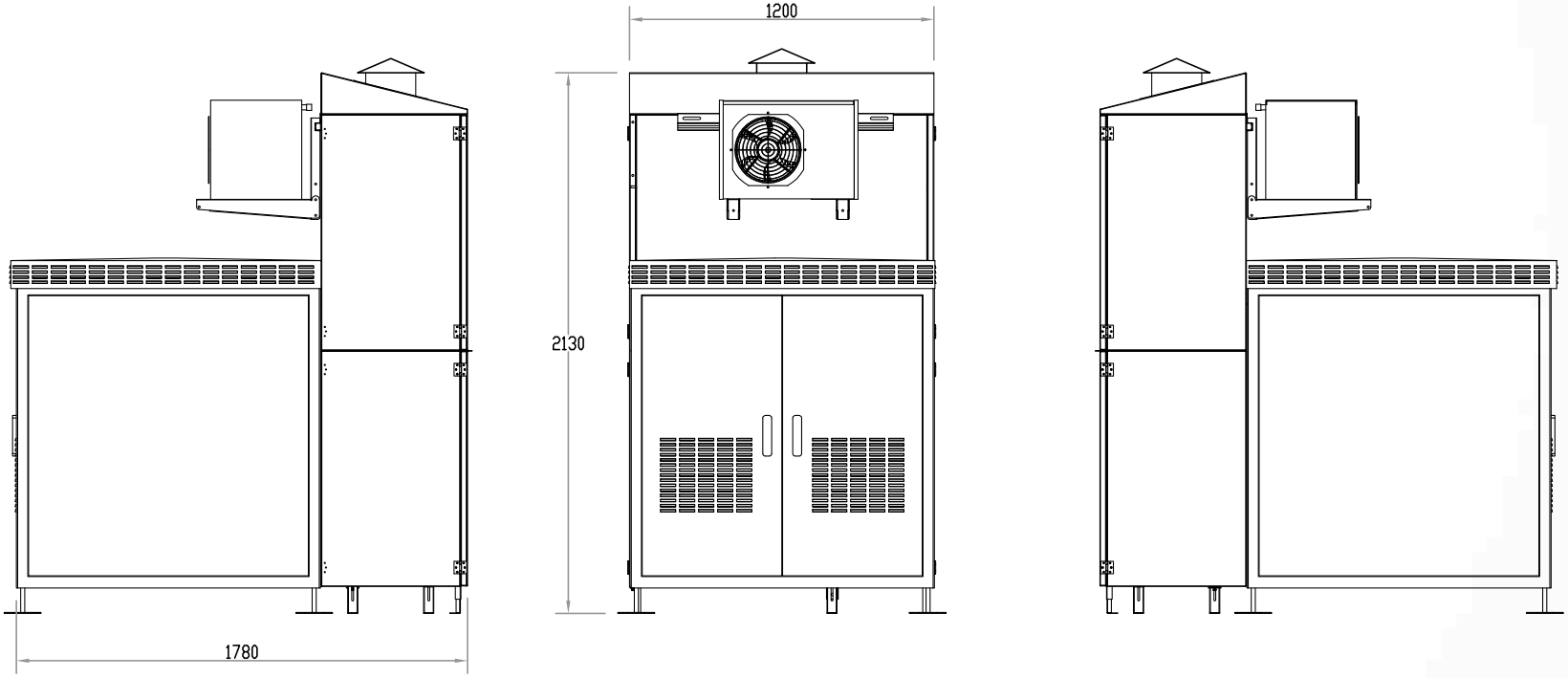
ELECTROSELF™ OUTDOOR site or Roof Top Deployment

- ✓ It's the world's first entirely self-recharging hydrogen outdoor fuel cell.
- ✓ Dimensions are: 1300(width)*900(depth)*1500(height)
- ✓ Can accommodate 6 bottles in secondary cabinet behind



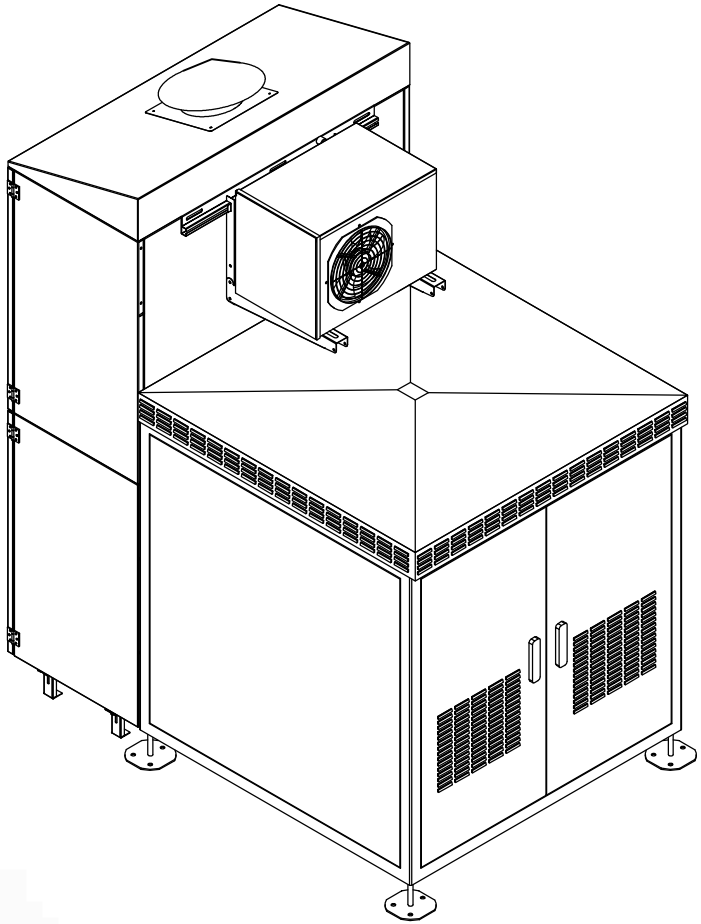


ELECTROSELF™ OUTDOOR Cabinet



Strictly confidential

ELECTROSELF™ OUTDOOR Greenfield
Deployment on roof top or pedestal



Typical Steps ?

- ✓ Our approach ….



- ✓ Customer relation begins with a presentation of our value proposition during an initial contact.
- ✓ It evolves with a business case that captures the reasoning for choosing our products.
- ❑ **Only when the business case is validated by the customer, we get into field trials**.
- ❑ The next step is the early adoption (small scale) that preludes… to big (and returning) orders.

- ✓ You provide answer some questions and we provide the Business Case and TCO summary.

Electro Power Systems

Sample Business Case Analysis



Business Cases Simulation

- ✓ 5 cases are simulated assuming a blackout pattern of 4h, 6h, 8h, 10h and 12h per day over a 5 year period
- ✓ power size of 1.5 kW is assumed
- ✓ ElectroSELF solutions are compared to Traditional deployment for each case
- ✓ Batteries + Diesel integrated solution is considered as Traditional infrastructure

Data-fill the figures and we will provide a customized TCO for your network !

Case	Daily Outage	Yearly Runtime
1	4	1,460
2	6	2,190
3	8	2,920
4	10	3,650
5	12	4,380

Traditional backup systems Vs ElectroPS
Cost elements considered for TCO calculations

✓ Traditional

- CapEx:
  - Battery packs purchase
  - Diesel genset purchase
  - Installation costs
- OpEx:
  - Battery periodic replacement
  - Annual Ordinary maintenance for Batteries+Diesel Genset
  - Fuel consumption
  - Cost of Fuel Delivery
  - Impact of theft
  - Fuel price increases

✓ ElectroPS

- CapEx:
  - System purchase
  - Installation costs
  - Periodic stack replacement (if any)
- OpEx:
  - Remote maintenance
  - Yearly on site visits
  - Electricity consumption to generate hydrogen

Batteries + Diesel Generator Vs EPS Assumptions

Paramaters	Value
Time span for TCO calculation	
Genset Purchase & Installation	
Battery Bank Cost (800AH)	
Fuel Costs (Inc, Delivery to site)	
Genset Monthly Maintenance costs	
Expected Battery Replacement (Av.)	

Cost values for traditional Backup systems

Parameter	Value
Batteries maintenance costs	
Diesel overhaul cost	
Diesel consumption	
Theft of Genset or Battery	
Theft of Fuel	
Fuel price increase (5% per year)	

Additional Assumptions (if Available)

- ✓ Valuation for space and weight savings
- ✓ Valuation for battery disposal

TCO Values – Case 1 - 4 Hours

TCO Values – Case 2 - 8 Hours

TCO Values – Case 3 - 12 Hours

Conclusions

- ✓ ElectroSelf has a growing economical advantage with growing kWh per year to be generated. The more hydrogen you, use the greater the savings over Traditional Technology
- ✓ In terms of Total Cost of Ownership adoption, the ElectroSELF immediate savings are made in year one over Traditional Technology
- ✓ In term of Opex cost savings alone, The ElectroSELF costs are recouped in anywhere between one to two years, given the used assumptions made.

- ✓ Conclusion is a valued proposition to generate economical **savings** while **reducing $C0_2$ emissions.**

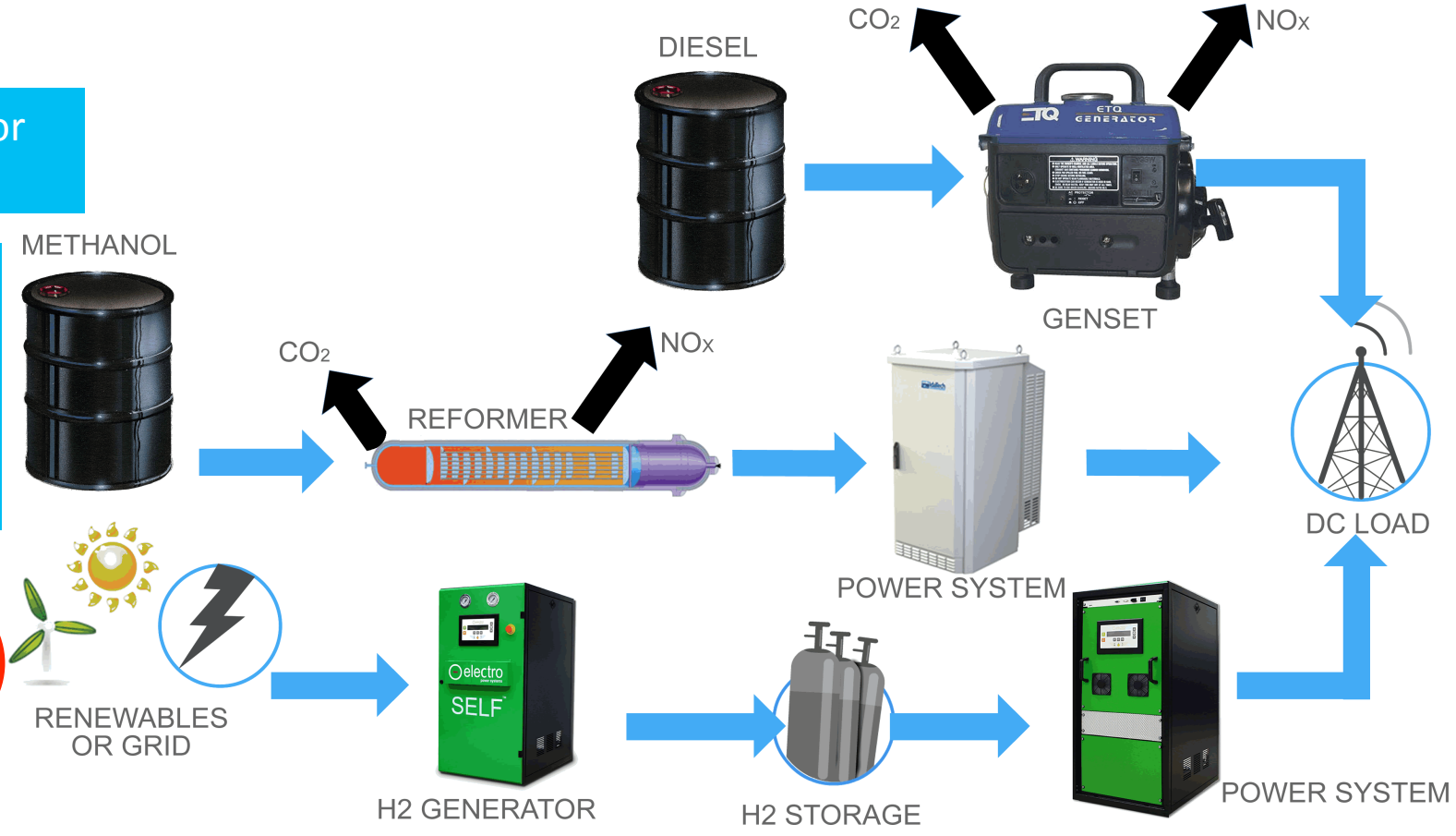
Typical cost to produce energy

Diesel generator
1.4 $ ltr

Methanol-driven FC system
1.1 $ ltr
(varies!!)

ElectroPS
0.09 $

ElectroPS wins OpEx



Why should ElectroPS replace your Backup System?

- ✓ Plug and play with easy installation
- ✓ 100% Clean and reliable technology
- ✓ Virtually unlimited autonomy
- ✓ Flexibility and modularity
- ✓ Real Time diagnostics
- ✓ Reduces business continuity costs related to:
  - ✓ Periodic batteries replacement and disposal
  - ✓ Maintenance activities
  - ✓ Diesel related maintenance and consumption costs
  - ✓ Low efficiency traditional technologies
  - ✓ Space issues

Electro Power Systems SpA
www.electroPS.it

Mark Shiels
mark.shiels@electrops.it
Skype: mshiels
M +6012 299 6333


Our premises in Torino

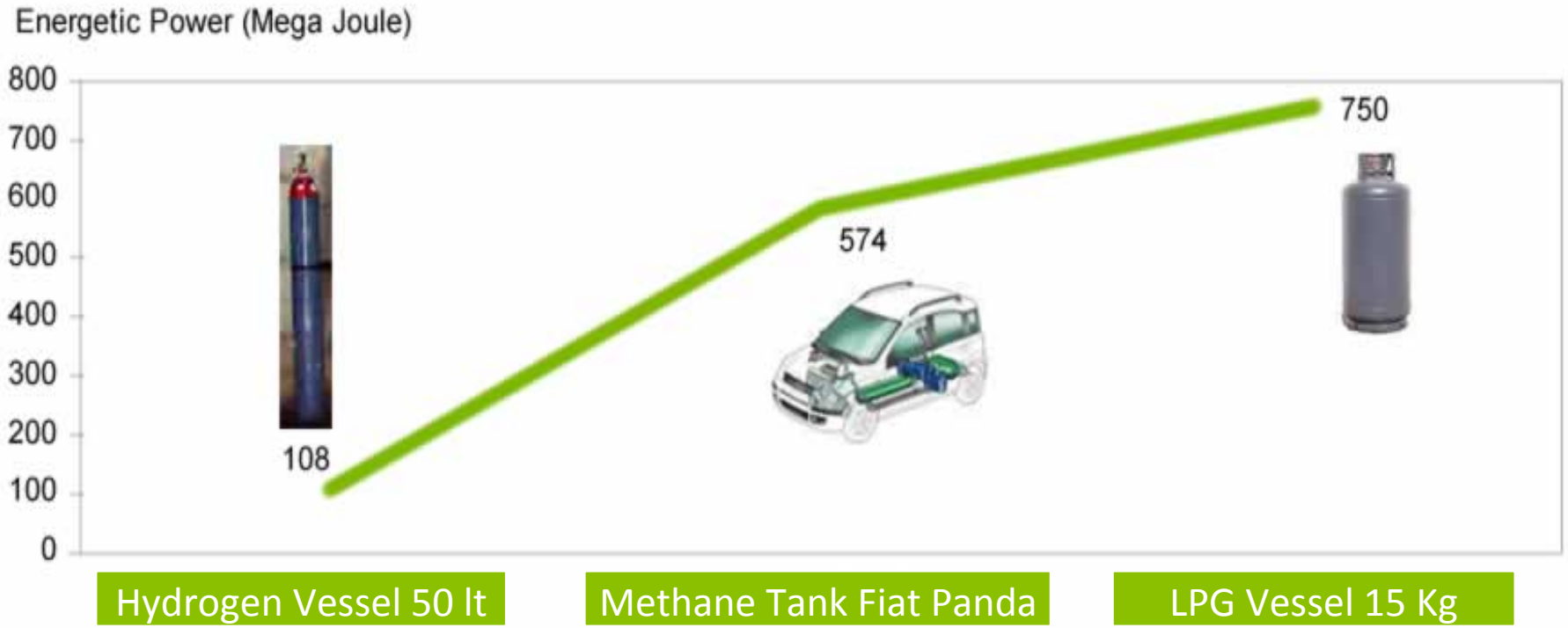
Via Livorno, 60
10144 TORINO
T +39 011 2258211


Our factory in Aosta

Via Lav. Vittime Col du Mont, 24
11100 AOSTA
T +39 0165305515

Ancillary Slides

Hydrogen: Energetic Power



As natural gas, methane and LPG also Hydrogen is a technical gas and has to be handled accordingly; well known and established rules and norms are to be respected.

HYDROGEN VESSEL SAFETY

- ✓ High pressure cylinders are always protected by a metal cabinet.
- ✓ Gas vessels (both cylinders and tanks) are manufactured to resist impacts according to specifications defined by European International Gas Association (see table from EIGA 100/03 standard) or other local associations.
- ✓ Moreover hydrogen vessels must fulfill additional requirements in the processes of heat treatment.
- ✓ For example an hydrogen cylinder **can absorb the blow of Milwaukee Kango 900S demolition hammer** (impact strength 7-27 J/cm^2).

I only like this picture because I want XL Axiata to make Bayu do this as part of the trial !

Cylinder diameter mm	>140
Direction of testing	Transverse
Width of test piece, mm	>5 to ≤7.5
Mean of 3 specimens	Impact strength 35 J/cm^2
Individual specimen	Impact strength 28 J/cm^2



CO_2 FOOTPRINT ANALISYS LEGACY SOLUTIONS VS. ELECTROSELF™

CO_2 intensity per unit of energy of diesel generator in conjunction with a battery set considering maintenance and refueling	
Diesel generator conversion factor per liter	2.639 kg CO2/liter
Diesel generator conversion factor per kWh	0.263 kg CO2/kWh
Diesel energy content	10.024 kWh/liter
Diesel effciency	10.1%
Refuelling and transport*	0.299 kg CO_2/kWh
Air conditioning for keeping batteries at 21°C	0.164 kg CO_2/kWh
CO_2 emissions per kWh	**3.070 kg CO_2/kWh**



3.070 kgCO_2/kWh

**Additional, indirect emissions according to travelfootprint.org+ 1 travel each week*

CO_2 intensity per unit of energy of ElectroSelf™	
Electricity conversion factor	0.44 kg CO_2/kWh
ElectroSelf™ efficiency	33%
CO_2 emissions per kWh	**1.333 kg CO_2/kWh**



1.333 kgCO_2/kWh

CO_2 FOOTPRINT ANALISYS: CONCLUSIONS

- ✓ There are some issues, related to the use of diesel generators, which results in CO_2 emissions even if the exact calculation is not available. These issues include fuel replacement due to thieves. Even without calculating these issues, **ElectroSelf™ has a lower environmental impact than legacy solutions**.

- ✓ ElectroSelf™ CO_2 footprint is affected by the dirty energy sources which are heavily used in India. Since the Government is working on cutting CO_2 emissions from electricity production, it is reasonable to expect a **decrease of ElectroSelf™ CO_2 footprint** while those of diesel generators will remain the same or even get worse.

- ✓ Moreover with ElectroSelf™ there are no emissions at the source of use therefore **NO_x and SO_x are removed** and the system operates silently (**no noise pollution**).