



EFOY Pro Fuel Cells

Reliable Off-grid Power for remote applications in cold climates

SFC
ENERGY

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SFC Energy AG
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Business Development Manager



I. SFC - World leading manufacturer of fuel cells

II. The EFOY Pro fuel cell technology

III. Reference case: Alfred Wegner Institute

IV. FourStone's " - 50°C enclosure"

Core and Target Markets

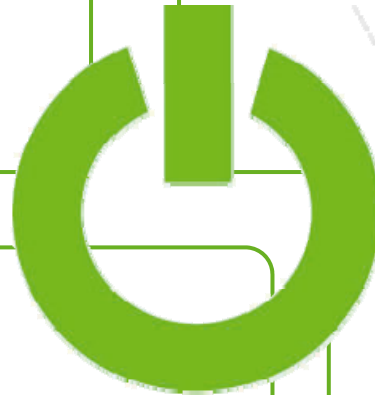
Leisure

Comfort and autonomy for:
Motor Homes, Cabins and Boats



Remote Industry

Dependability and Low Maintenance Cost for:
Traffic Technologies, Security, Environmental Monitoring



Defense

Weight Saving for:
Portable Power Supply



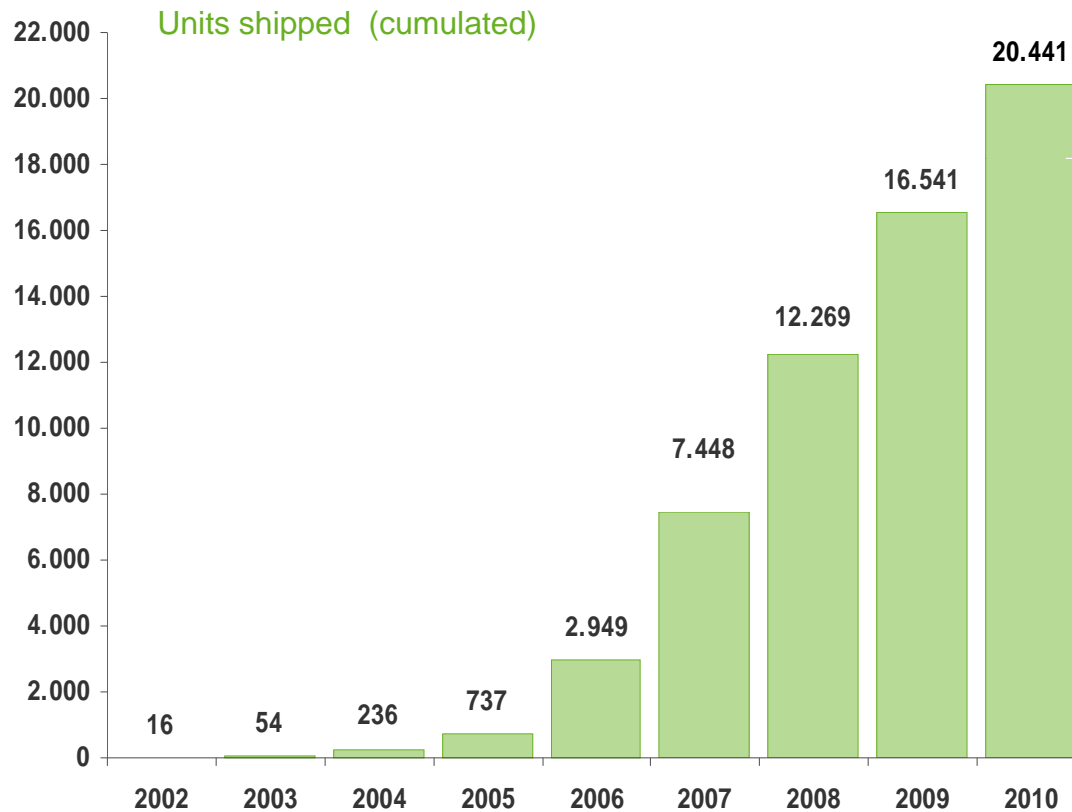
Mobility - APU

Reliability of On-Board Power for:

Special Purpose Vehicles

Market Traction

- As of today, more than 20,000 fuel cell systems shipped
- > 8 million operating hours in end user environments
- Fully functional fuel infrastructure established in core markets



SFC Awards (2002-2009)



Promobil Beste Marken (2009)



MMM Award (2009)



Wearable Power Prize (2008)



Deloitte's Fast 50 List (2008)



Frost & Sullivan's Market Leadership Award (2008)



Industriepreis Energie (2008)



Promobil Beste Marken (2008)



Technology Pioneer (2005)



Top 100 Innovators Red Herring (2004, 2002)



SailOvation Award (2004)



DAME Innovation Award (2004)



Inspire Technology Award (2004)



IF Design Award (2004)



F-Cell Award (2004)



German Founders' Prize (2003)



Business Leader Energy (2002)



Best High-Tech Company in Energy Field (2002)

Tech. challenge:

- 🔌 The Defense Department figures the typical soldier could be carrying around 20 pounds' worth of power on a 96-hour mission.
- 🔌 contest in 2008, to see who could trim that burden the best.
\$1 million goes to the folks who can come up with "a wearable system that provides 20 watts (avg.) of electrical power for 96 hours, weighs less than 4 kilograms (8.8 pounds)
- 🔌 169 teams originally signed up for the Pentagon's million-dollar, wearable power competition.
- 🔌 The field has been winnowed to just 48 teams
- 🔌 Even though no limitations of power solution to be used, in the end there were four fuel cell systems among the top five winners
- 🔌 SFC and its Partner DuPoint won 1st and 3rd prize with two different SFC systems



Wearable Power Prize (2008)

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One of many examples:

- 🔌 Sensors and communication equipment at remote locations
- 🔌 No access to the electricity grid
- 🔌 Solar panels do not provide sufficient energy



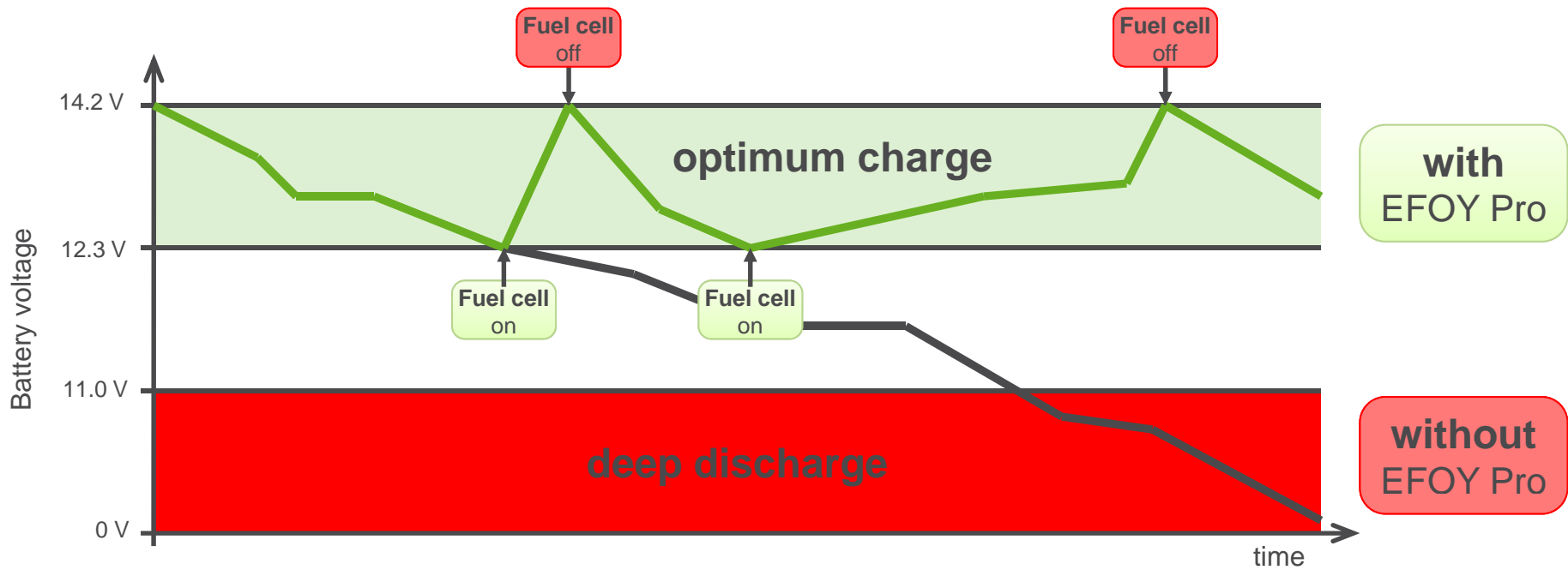
The fuel cell technology

Our proposal:



Pro Series
Made by SFC

The fuel cell technology



Advantages of EFOY fuel cells

Photovoltaic



- Weather dependability
- Limited availability

Generator



- Hazardous emissions
- High-maintenance
- Noisy & heavy

Battery



- Low capacity
- Heavy
- Short life time
- Not suitable for winter

EFOY fuel cell



Quiet



Lightweight and compact



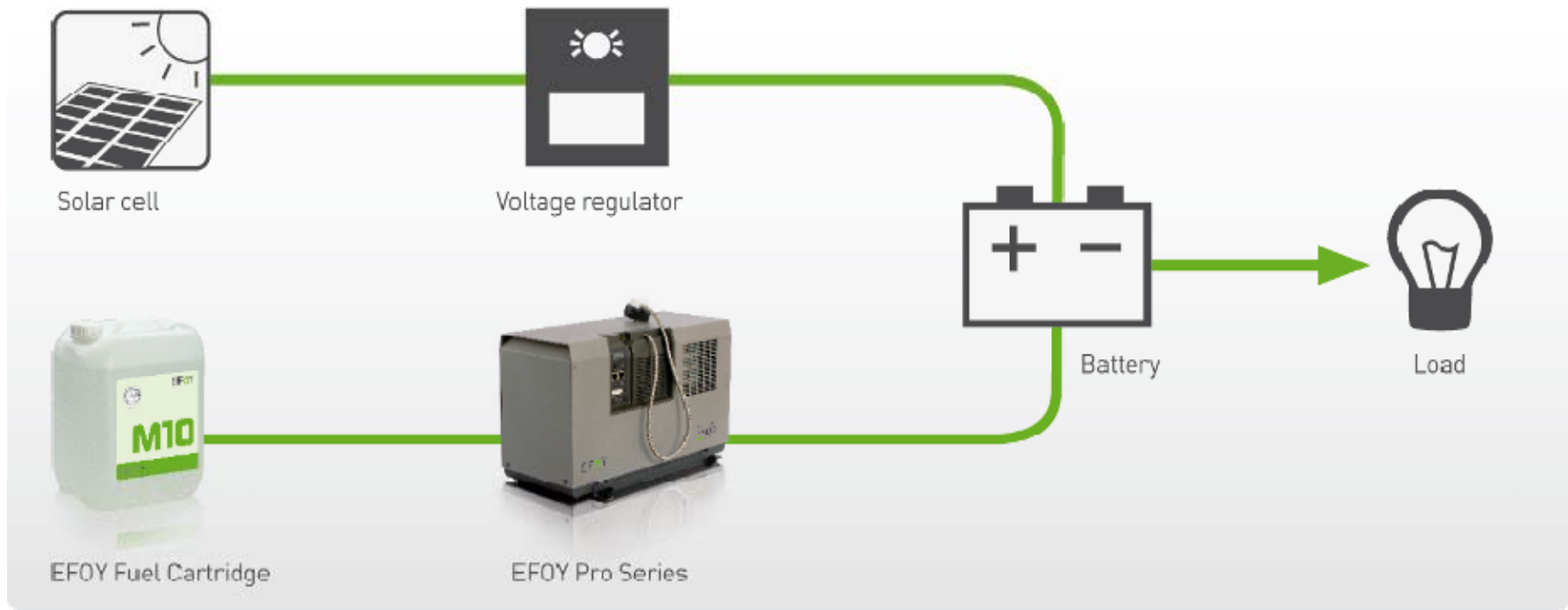
100 % availability, highest energy density results in long autonomy



Robust and maintenance-free



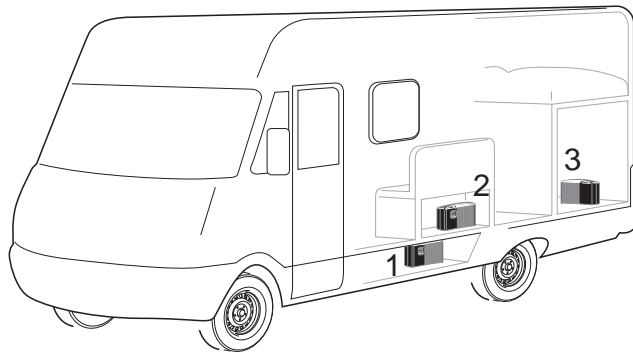
No hazardous emissions



- 🔌 Easy Integration: Plug & Play solution
- 🔌 Backup for solar energy systems

Installation of the EFOY Fuel Cell in Motor Homes

- EFOY Fuel Cell in the side compartments



- EFOY Fuel Cell inside the motor home



Simple installation of the EFOY Fuel Cell

Application Scenarios in cold climates



Base Transceiver Station (Austria) with 4 EFOY Pro 1600

The fuel cell technology

	EFOY Pro 600	EFOY Pro 1600	EFOY Pro 2200
Max. Energy Output	600 Wh/day	1,560 Wh/day	2,160 Wh/day
Nominal Power	25 W	65 W	90 W
Nominal Current @12 V / 24 V	2.1 A / 1.05 A	5.4 A / 2.7 A	7.5 A / 3.75 A
Operating Temperature	-20 to +45 °C (-2 to +113 °F)		
Methanol Consumption	0.9 l/kWh		
Dimensions (l x w x h)	433 x 188 x 278 mm (17 x 8 x 11 in)		
Weight	ca. 8 kg (18 lbs)		



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Case Study: PALAOA observatory, Antarctica



PALAOA, worldwide unique underwater acoustic observatory, celebrates its 5th anniversary – live sounds of seals and whales from Antarctica

EFOY fuel cell was part of it at the very first beginning

Case Study: PALAOA observatory, Antarctica

The acoustic observatory has been continuously recording sounds under the ice near Neumayer Station since 28 December 2005. It provides the world's longest time series of civilian acoustic measurements



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Alfred Wegener Institute for Polar and Marine Research
Ocean Acoustics Group
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The recordings are made year-round and enable comparisons of the acoustic environment between years.

In terms of energy, PALAOA is self-sufficient:

Solar Cells and a Wind Generator supply the observatory with renewable energy 90% of the time.

During the months of **darkness** in the Antarctic winter and at temperatures **down to -50°C**, the **EFOY Pro fuel cell** springs into action on **windless days** to guarantee continuous operation.

Challenges

- ❏ Unattended site that's expected to operate year round
- ❏ Remote access and control of the system

Problems:

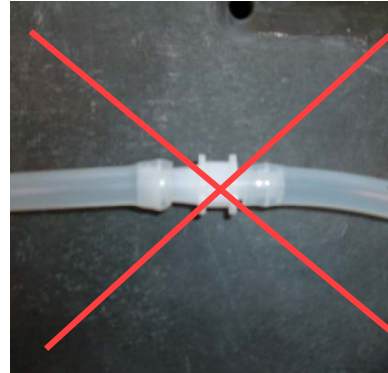
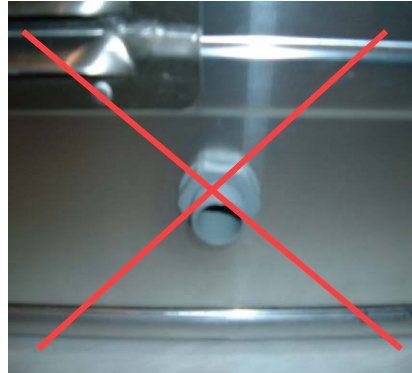
- ❏ Frozen exhaust hose
→ fuel cell stops operating
- ❏ Frozen fuel cell stack



Solutions and improvements making the EFOY fuel cell running at low temperatures

- ❏ PLC controlled heat tape at the end of the exhaust hose
- ❏ Ethernet interface and W-lan remote control
- ❏ Insulated exhaust hose

Avoiding Low Temperature Errors



- ❌ Short and vertical exhaust tube outlet
- ❌ Sufficient space between exhaust outlet and ground in order to avoid ice growing up to the exhaust
- ❌ Insulation of the exhaust hose and EFOY Pro's enclosure
- ❌ More space between EFOY Pro and enclosure (air as insulation)
- ❌ Avoiding cold wind blowing direct at the heat exchanger
- ❌ No exhaust made of metal fittings or metal fittings around the silicon tube



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Major customers and clients include:

- Suncor Energy
- Shell Oil and Gas
- Alberta Sustainable Resources
- National Research Council of Canada
- Hancock Wildlife Foundation
- Pacific Wild
- Many more

Challenge:

- **0% down time** is very critical for Oil & Gas clients in regards of costs
- **0% down time** is important for Research Institutes in regards of data availability
- Main requirement by FourStone's customers:

environment friendly off-grid power solution for temperature down to -50°C



Mobile Video Detection System for Remote Areas

- ⦿ **Power demand:** 60-90 watts nominal
- ⦿ **Voltage:** 24 VDC
- ⦿ **Solar Power:** Four (4) 225W photovoltaic modules

**Shell Energy Project,
Albian Sand Mine
Near Fort McMurray, Alberta**

The Challenge:

- 🔌 Temperatures average -19°C in winter
- 🔌 lowest recorded -50.6°C, (-58°F).
- 🔌 Short Summer, less sun hours/day
- 🔌 Solar panels do not provide nominally 60-90 W

Climate data for Fort McMurray

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average low °C (°F)	-24 (-11)	-19.8 (-3.6)	-13.2 (8.2)	-3.3 (26.1)	3.3 (37.9)	7.9 (46.2)	10.2 (50.4)	8.6 (47.5)	3.3 (37.9)	-2.2 (28)	-12.8 (9)	-21.4 (-6.5)	-5.3 (22.5)
Record low °C (°F)	-50 (-58)	-50.6 (-59.1)	-44.4 (-47.9)	-34.4 (-29.9)	-13.3 (8.1)	-4.4 (24.1)	-3.3 (26.1)	-2.9 (26.8)	-15.6 (3.9)	-24.5 (-12.1)	-37.8 (-36)	-47.2 (-53)	-50.6 (-59.1)
Sunshine hours	81.7	119.4	171.8	222.9	276.5	267.5	285.5	259.5	156.9	120.7	70.2	63.8	2,096.4



- ❶ EFOY Pro fuel cell being deployed and set up in temperatures down to $-44\text{ }^{\circ}\text{C}$
- ❷ Hybrid systems: Solar + EFOY Pro fuel cell
- ❸ Continuous 65W + Solar power
- ❹ Sold ~ 20 of these Rev 3 systems to date and of the last units (rev 3), none have failed in temps as low as -48 in Ft. Mac Murray, Canada



Rev 3 Enclosure Specifications:

- ⌚ Air flow, thermal and waste product management (water and CO2)
- ⌚ Exterior temperature operation range: -50°C to + 40°C
- ⌚ PLC controlled vents according internal and external temperatures
- ⌚ Ethernet interface for remote control

R&D of FourStone's enclosures has been supported by:

- ⌚ The University of Alberta
- ⌚ NAIT Applied Research and Development
- ⌚ MITACS (federally and provincially funded research network)
- ⌚ NRC-IRAP (Industrial Research Assistance Program)
- ⌚ NSERC (Natural Sciences and Engineering Research Council of Canada)

Application Scenarios: Remote Sensors



Landesamt für Natur,
Umwelt und Verbraucherschutz
Nordrhein-Westfalen



Avalanche Detection (Switzerland)



Water Flow and Gauge Measurement (Germany)

Application Scenarios: Remote Sensors



Meteorological Station
(Greece)



Seismological
Measurements (France)



Ultrasonic Flow and Water Level
Measuring (Germany)

Application Scenarios: Telecommunication



Base Transceiver Station (Austria)



Internet via Radio Link Mast, EFOY Pro in Insulated Outdoor Box (Norway)

Application Scenarios: Telecommunication



Base Transceiver Station
TETRA Radio (Italy)



Repeater Stations
EFOY Pro in Insulated Outdoor Box (Norway)



Thank you for your attention!



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