

EFOY Pro Fuel Cells

EFOY fuel cell operation in artic environments

8th Annual Polar Technology Conference

SFC Energy Inc.

Frank Heid

Vice President

Agenda

I. SFC - World leading manufacturer of fuel cells

II. The EFOY Pro fuel cell technology

III. Reference case: SRI International

IV. Commercially proven -40° C operations

SFC Energy Group

Facts and figures

- **SFC Energy**
  - Founded in 2000
  - Sole company developing, producing and selling **commercially available DMFC products**
  - 95 employees in the two locations Brunnthal (D) and Rockville (USA)
- **PBF Group**
  - PBF was founded 1999 as MBO from Philips Electronics
  - PBF develops, manufactures, and markets **power supplies and higher level power management solutions**
  - 100 employees in the two locations in Almelo (NL), and Cluj (RO)
  - Acquired by SFC Energy AG in 2011

Fuel Cell Market Traction

Over 24,000 fuel cell systems shipped

Market Segments

Consumer

- Caravanning
- Marine
- Cabins

Industrial

- Oil & Gas
- Traffic Management
- Wind Industry
- Environmental Data
- Telecommunication
- Surveillance (commercial)

Defense & Security

- Armed Forces
- Homeland Security
- Law Enforcement

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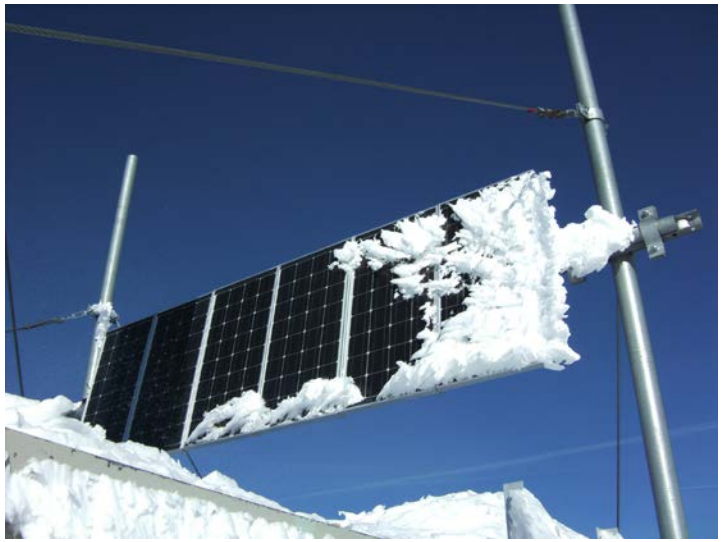
Off-grid and Mobile Energy Supply

Reliable off-grid and mobile energy supply can be difficult and costly

- Solar panels often do not provide sufficient energy and are weather dependant
- Using batteries only limits autonomy and increases personnel costs
- Generators are noisy, not economically-friendly and produce high maintenance-costs

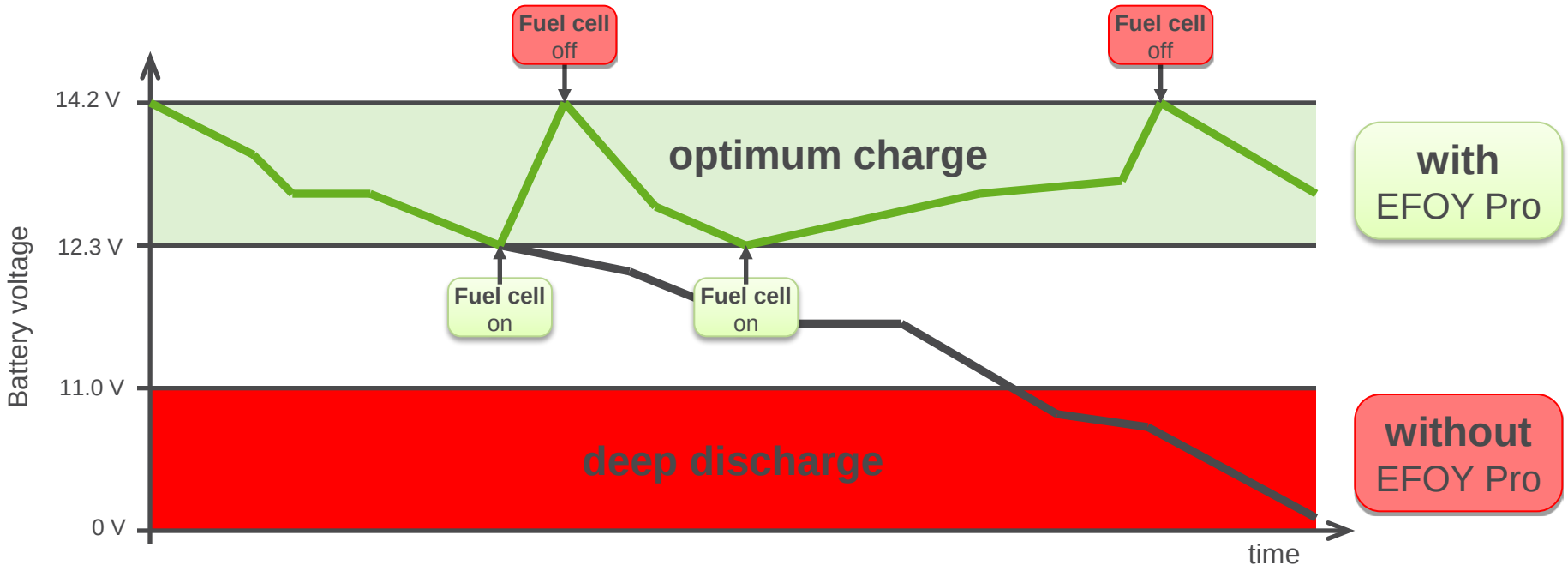


Reliable and economically-friendly energy supply can save costs and time

The fuel cell technology

Pro Series
Made by SFC

The fuel cell technology



The fuel cell technology

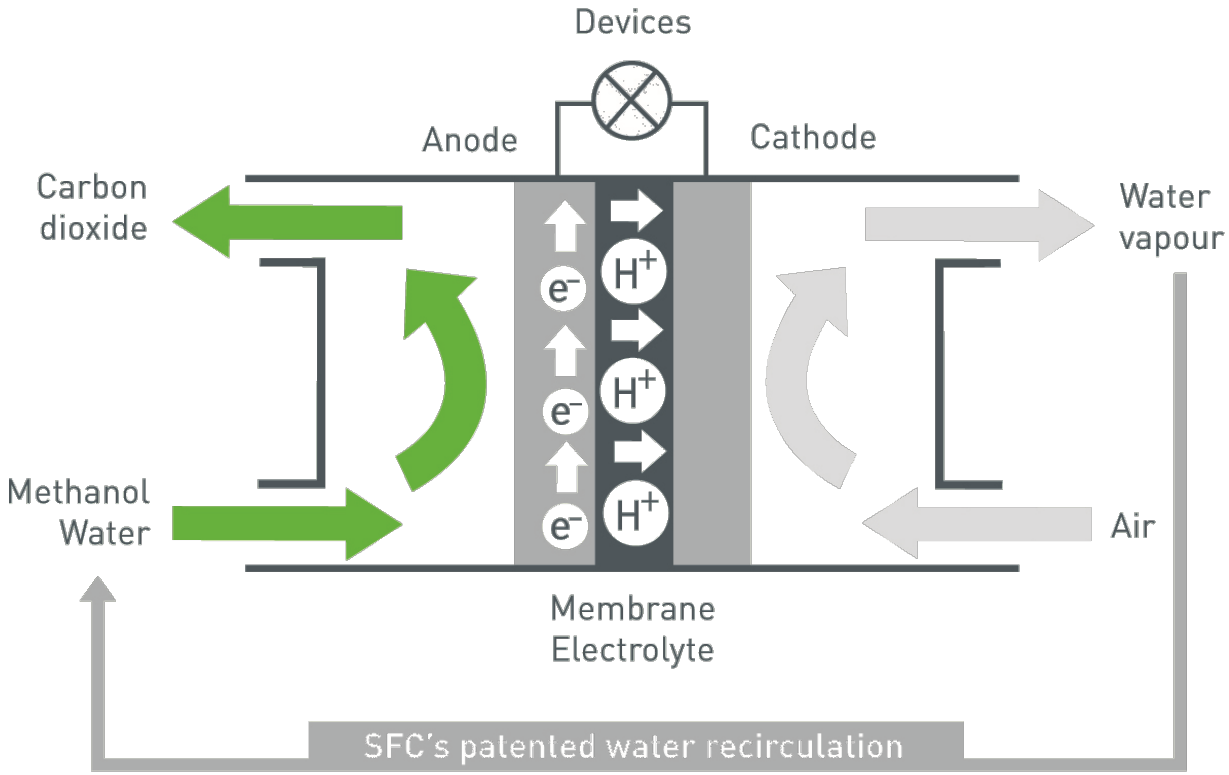


Diagram of a direct-methanol fuel cell

Methanol + Oxygen → Carbon dioxide + Water vapor

$2\ CH_3OH + 3\ O_2 \rightarrow 2\ CO_2 + 4\ H_2O$

EFOY Fuel Cartridges: Advantages

That delivers **10 kWh** electricity

Methanol

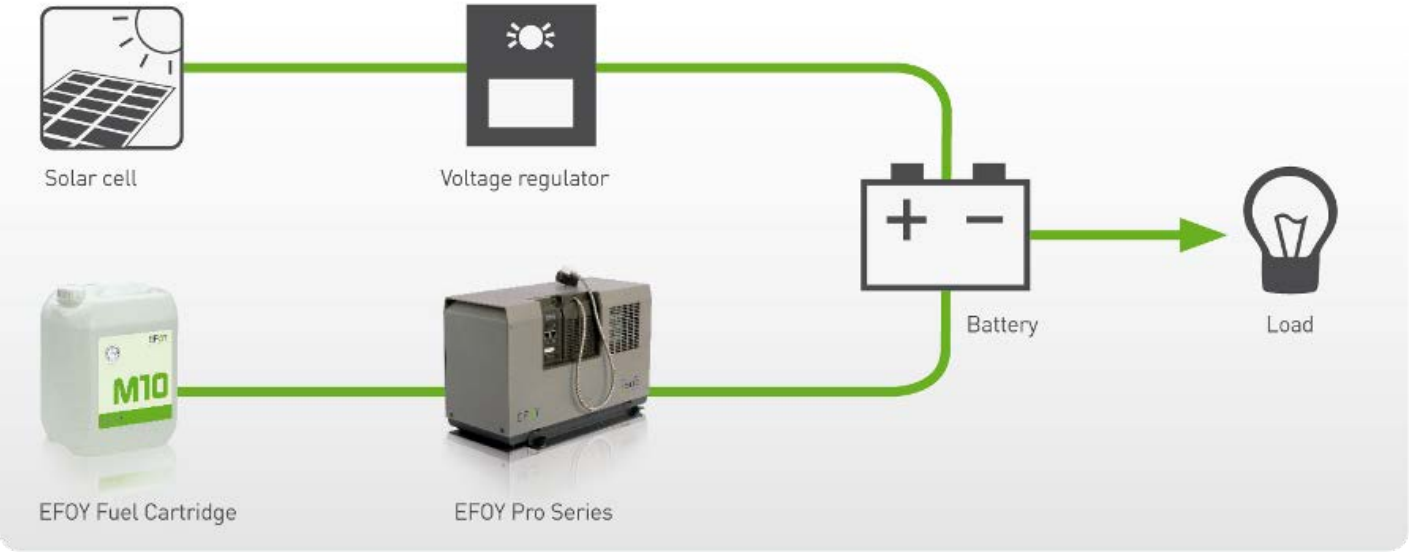
Lithium Batteries

Lead-Acid Batteries

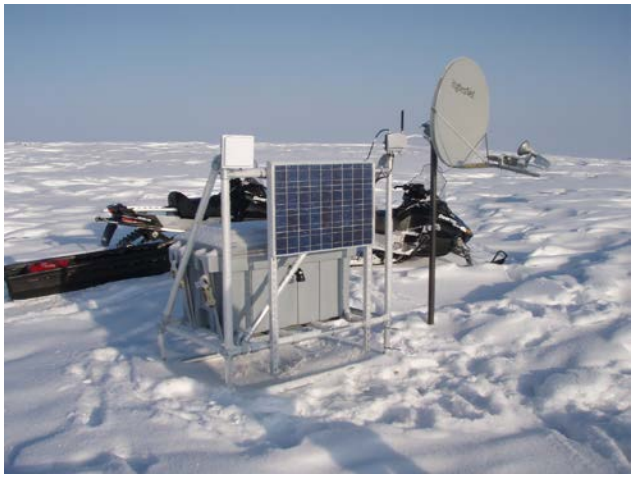
Weight:	8 kg	110 kg	270 kg
Volume:	10 l	120 l	

Empamle: 10W application (24 h operation) runs 259 days without any user intervention with 56 l Methanol

EFOY Pro fuel cells + photovoltaic



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



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)** **Rated at < -40° C in special enclosures**		
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)		

Key Benefits of the EFOY Pro Fuel Cell

- Reliability and Operating Safety
- Long Periods of Autonomy, Maintenance-free
- Remote Monitoring
- Lightweight and Compact
- Easier logistics, reduced operating costs
- Quiet & Economically-friendly
- Plug & Play solution

ADT

encana natural gas

ConocoPhillips

bp

devon

Canadian Natural

EFOY Pro was specially developed for professional daily use

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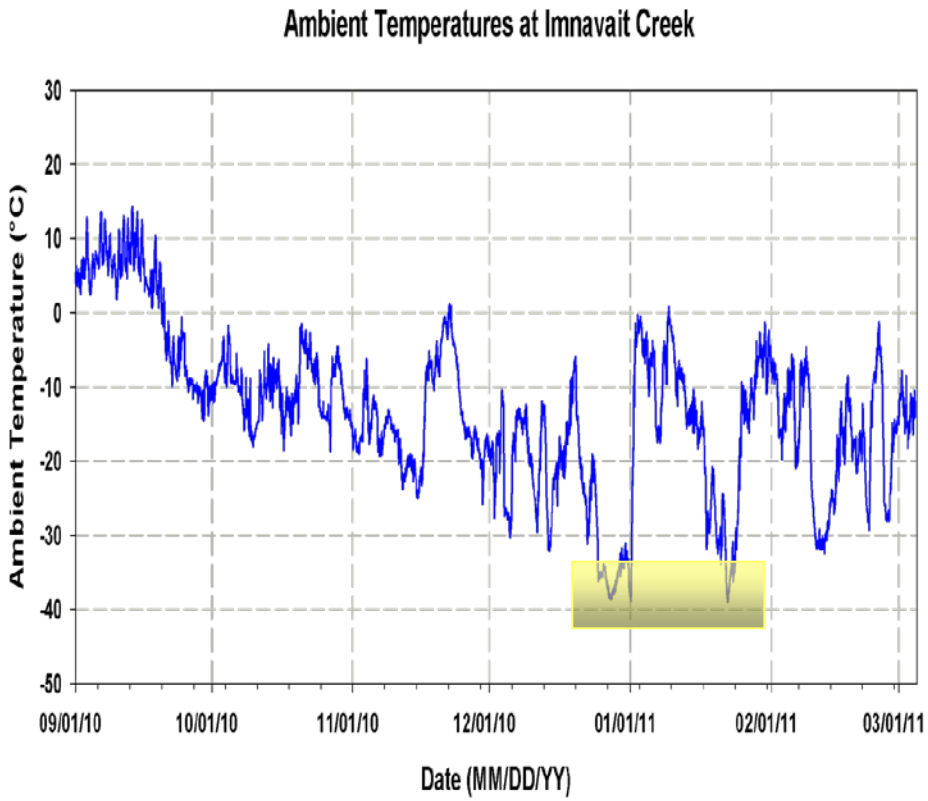
SRI International - Proof of Concept of DMFC

Imnavait Creek Communications Node

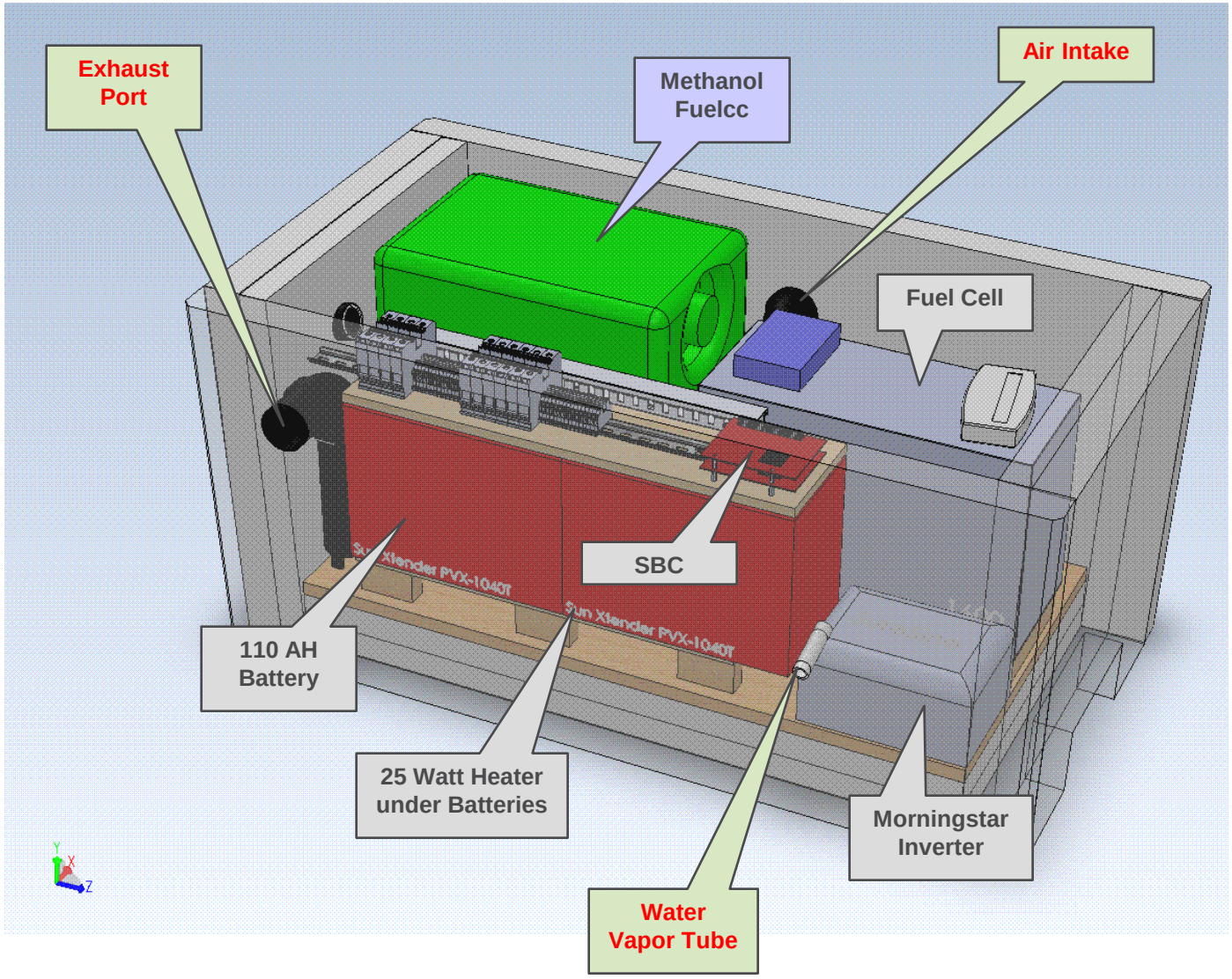
- 65-Watt EFOY Pro 1600 Fuel Cell for winter power
- Wind power not reliable in Interior Alaska in winter
- 40-Watt PV panel for Spring – Fall primary power

Ambient Temperatures at Ridge Site

- System running well at -39 ° C



SRI International - IRP “Grizzly” Enclosure Interior



Water Vapor Port Icicle Formation

- Fuel turns mostly into water
- Fuel cell errors indicate when tube is blocked with ice
- Installed Vapor Port Tube w/ Heater does not avoid icicle formation

45 days

Blocked water exhaust
→ Fuel Cell failure

Overheating Event Causes Fault

- Restricted air intakes to keep warm air inside
- Interior temperature exceeded EFOY spec
- Service fluid reservoir dried out, shutting down fuel cell before SRI could limit run time

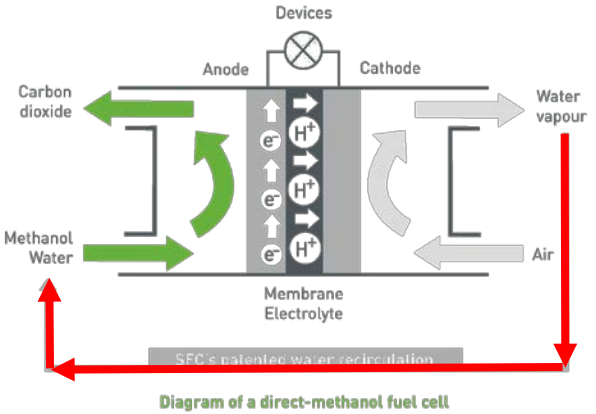
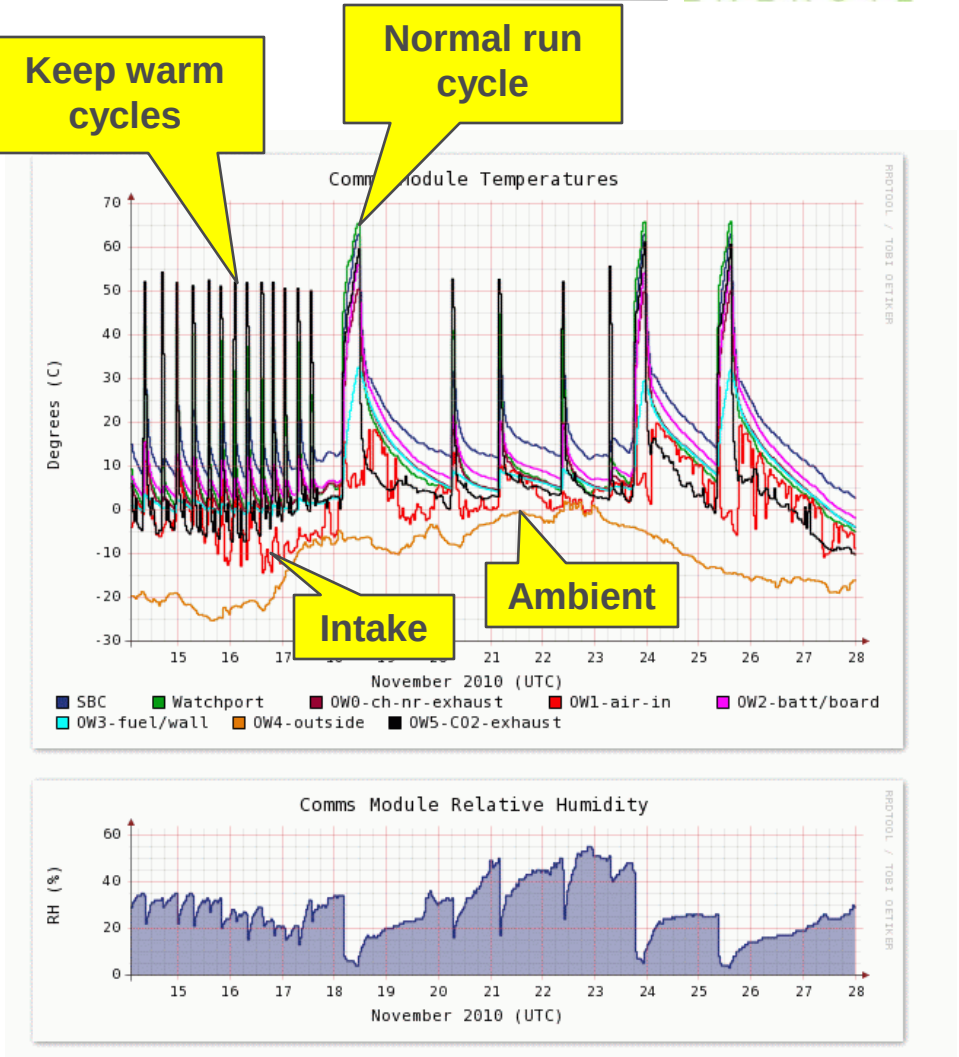


Diagram of a direct-methanol fuel cell

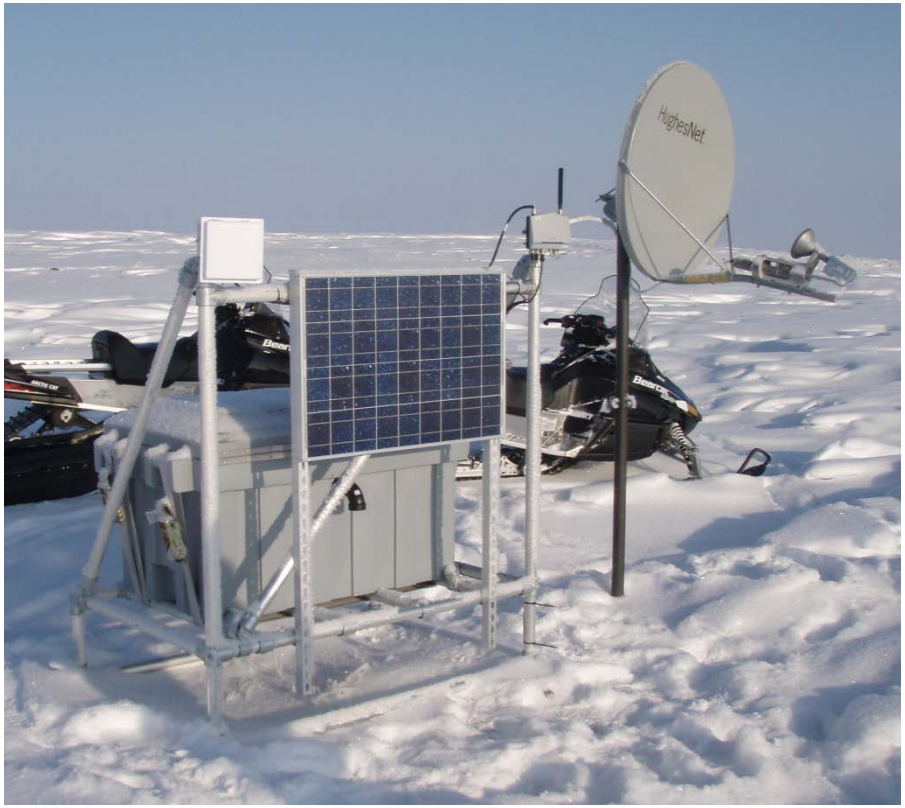
- Interior drops to ambient temperature → stack freezes



Elevated Support

- Eliminates drifting snow that could clog air ports

Communications Node



RE Power Station

Conclusions by SRI International

- Proper **thermal** and **water management** permits winter operation of a fuel cell
- Open ports caused extra fuel to be used
- Need to monitor Service Fluid level to prevent unrecoverable stack failure/freezing
- Elevated enclosure prevents drifts from forming and blocking air ports
- Remote Control could get very complex if there is no self regulating heat management

SFC and its Partners have addressed that

in order to succeed in the industry

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Key market for SFC Energy fuel cell products

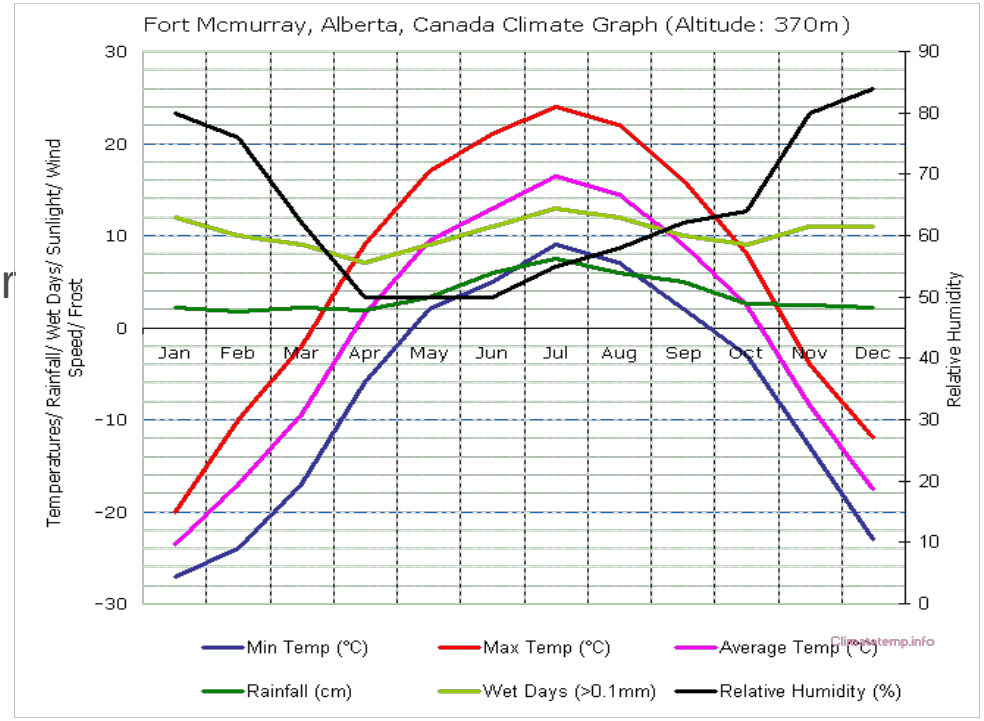
Oil & Gas production North Canada

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 work

Opportunity for SFC:

The environmental challanges in the field mean largest opportunity in North Canada



Very demanding Oil & Gas Industry

- Demand by the industry:
  - 0% downtime (saves $$$$)
  - Easy to deploy (time is $$$$)
  - Hybrid for all-year operation
  - Proven concept
  - Easy logistics
- Task: development of a reliable -40°C solution
- Design of a standard heat and waste water management

…“You have only one shot to prove your technology within the oil & gas industry“…

Success Story: Surveillance at < -40° C

Mobile Video Detection System for Gas well site surveillance & bird monitoring

~ 80% of all deployed surveillance systems are donwn in winter time up north in Canada

(Jason Lefort, Netvision)

- Power demand**:** 60-90 watts nominal
- Solar Power: Four (4) 225W photovaltaic modules only covers ~70% of the year

Surveillance at < -40°C

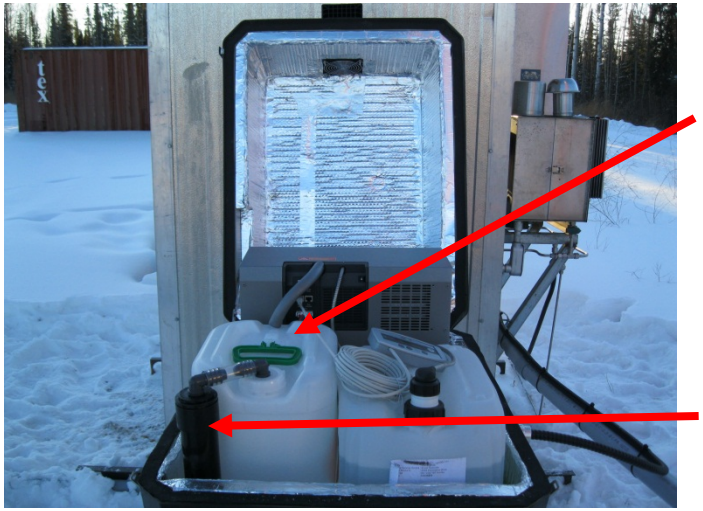
- EFOY Pro fuel cell being deployed and set up in temperatures down to -44 °C
- Hybrid systems: Solar + EFOY Pro fuel cell → full year operation
- Deployment of dozen units in 2011 - in temperatures as low as -48 in Ft. Mac Murray, Canada

→ Proven -40°C concept resulted into futher deployment of a significant amount of EFOYs in 2012 by verious customers in West Canada

EFOY Pro hybrid solution

Proven -40°C Enclosure concept customized for highest latitudes (vertical solar panels) & an elevated support (drifting snow)

EFOY fuel cell in the oil & gas environment



Communication Tower power package

- excellent results putting an insulated exhaust line into a secondary collection chamber sized for roughly ~70-90% of the fuel cell cartridge volume.
- Secondary chamber is then exhausted through the bottom of the enclosure (most is CO2)
- Minimal exhaust moisture amount
- Open basement as elevation against drifting snow possible

EFOY fuel cell in the oil & gas environment

- Thermostat controlled air intake and outlet

EFOY fuel cell in the oil & gas environment

- Drilling rig where the fuel cell is being used to power fuel gas metering skid that keeps the entire rig operational
- Without this unit the drilling rig would be out of commission
- It was -35C with high winds and blowing snow when this unit was installed
- installation was done on an emergency basis to get the rig back up and running
- fact that once the unit was installed fall 2011 the rig has not gone down since

EFOY fuel cell in the oil & gas environment

Air Compressor to power pneumatic instrumentation

- Sustained -35°C during the winter with lows of -40 to – 50°C
- now downtime since deployment in Nov. 2011

PALAOA observatory, Antarctica

PALAOA, worldwide unique underwater acoustic observatory, celebrated 2011 its 5th anniversary – live sounds of seals and whales from Antarctica

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

Application Scenarios: Telecommunication

Base Transceiver Station (Austria) since 2008

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 very much for your attention

Any Questions???

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