Photovoltaic Power for Remote Site Remediation

Komex Renewable Energy Solutions

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KOMEX

Introduction

- **Availability of power can be limiting factor for remote remediation projects.**
- **These site are not tied to the grid.**
- **Have limited manpower for operations and maintenance.**
- **Traditional options are Propane / Diesel generators**
  - **High capital cost / high rental cost**
  - **Require an operator for maintenance and fueling**

- **Opportunity for a reliable, maintenance free, cost effective solution.**
- **Opportunity = Renewable Energy**

Remote Site design basis

- **Design Considerations:**

  1. Environmental Considerations:
  - **Burning propane or diesel as a fuel to recover pentane does not benefit the environment.**

  2. Financial Considerations:
  - **Costs of bringing power to remote sites are high.**
  - **Costs associated with operation and maintenance are high.**
    - **Hauling costs – e.g. Vacuum truck disposal**

  3. Social responsibility and corporate philosophy

Remote Site design basis

Design Basis: Need to address practicality vs. cost

- **Reliable power for long term projects.**
- **Simple robust systems.**
- **Maintenance free.**
- **Operator friendly.**
- **Cost effective vs. traditional power generation.**

THE KEY TO DESIGNING WITH SOLAR IS TO KEEP THE SYSTEM SIMPLE

Characteristics of Remediation systems

- **Remediation projects are typically long-term.**
  - **Seasonal operation (May to October).**
  - **Do not necessarily require 24hrs of operation.**
- **Simple robust systems.**
- **Power requirement 150 w to 5 kW / system.**

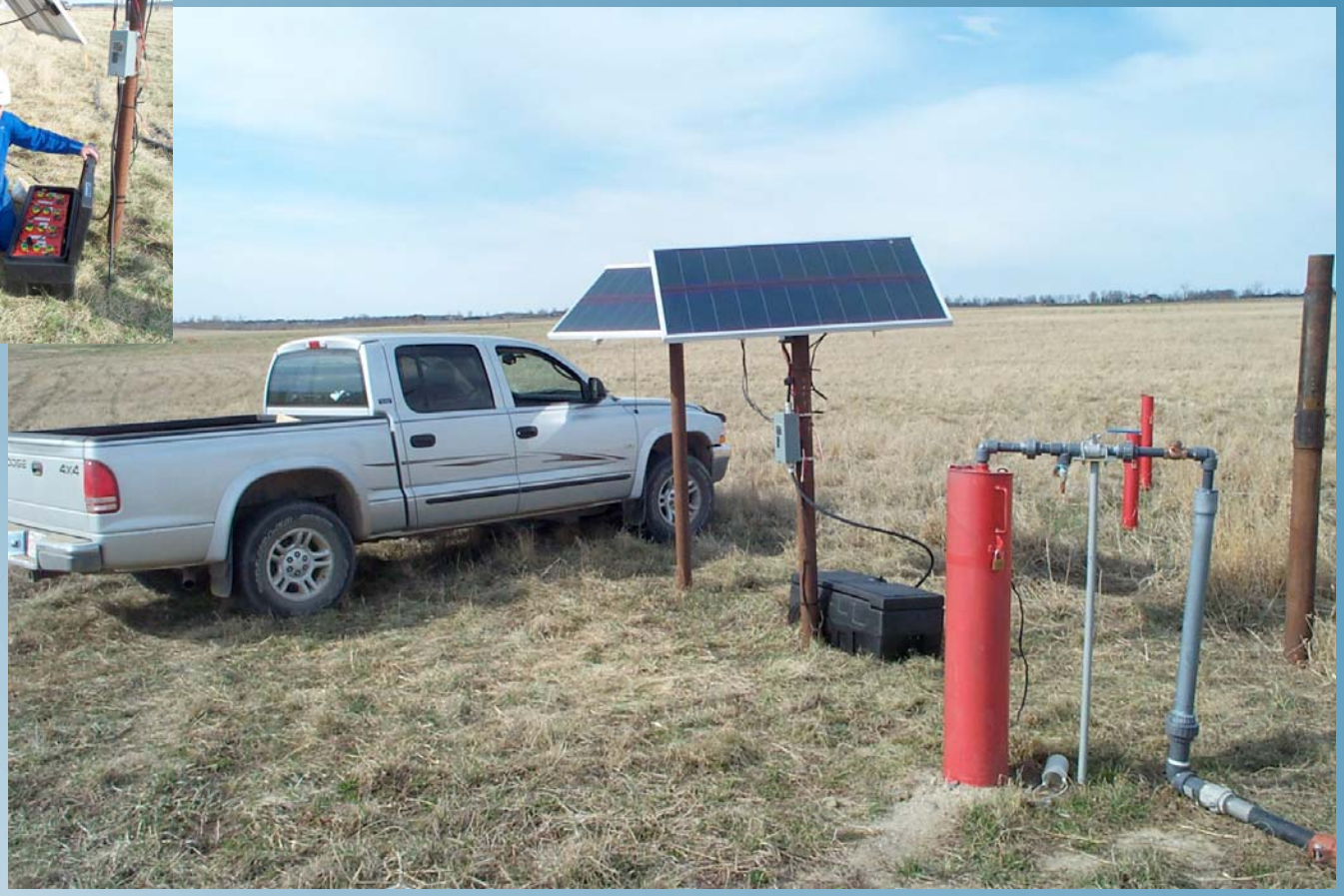
Photovoltaic Cells

- **Economics**
  - **Production cost has reduced by 50% in last 10yrs.**
  - **Approximate cost of PV modules $10 / watt.**
- **Efficiency**
  - **Convert 15–20% of sun's energy into usable power.**
  - **In Alberta we have 6-8 hrs/day of available sunlight in summer and 4-6 hrs/day in winter.**
- **Opportunity**
  - **25 year Guarantee**
  - **Can be used to operate DC, AC or pneumatic systems.**

Solar Applications.
Examples from Alberta

- **Groundwater Extraction / Plume containment**
- **Soil Vapour Extraction**
- **Reverse Osmosis**
- **Brine Evaporation/Reduction**
- **Well Product Skimming**

Groundwater extraction Okotoks Alberta.



Groundwater Extraction

- **The Challenge:**
  - **Containment of chloride contaminated groundwater.**
  - **Reduction of disposal costs.**
  - **Cost to bring power to site prohibitive.**
- **Remediation goal:**
  - **To prevent further migration of the chloride plume offsite.**
- **Solution:**
  - **Solar Powered DC submersible pumps.**

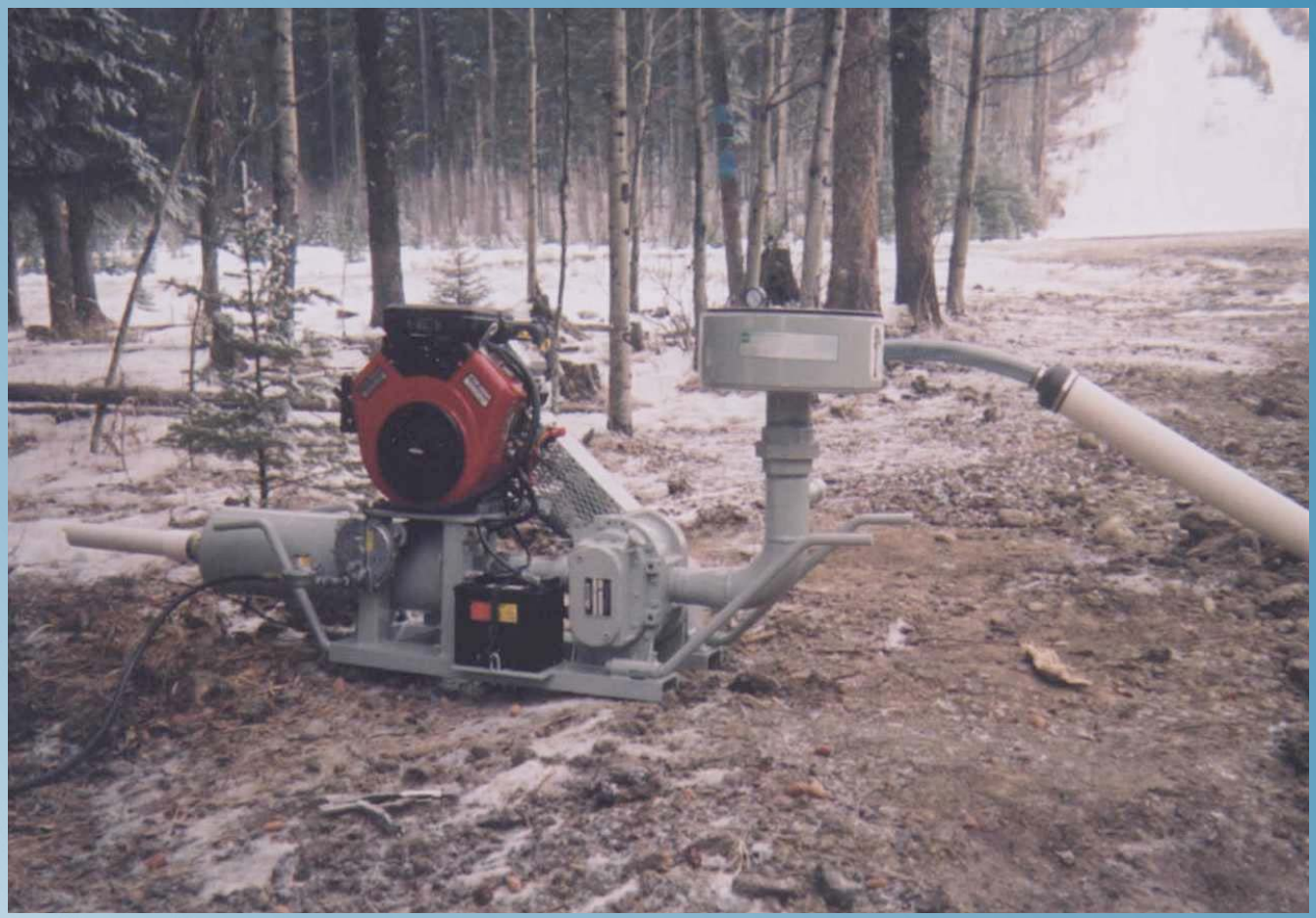
Soil Vapour Extraction
Ricinus Alberta

Soil Vapour Extraction

- **The Challenge:**
  - **Removal of residual hydrocarbon from soil**
  - **Power supply 1 km from site.**
  - **Cost to bring electricity $26,000**
- **The solution:**
  - **Solar Powered Soil Vapour extraction system**
  - **Introduce bioventing**
- **Key facts:**
  - **12 x 85 Watt modules**
  - **1 hp DC Baldor Motor coupled to blower**
  - **Vacuum 30”H_2O, Flowrate 250 cfm**
  - **Removal of 1000 kg Hydrocarbons from soil.**

Soil Vapour Extraction – Pipe Break

Soil Vapour Extraction – Propane powered pilot test



Soil Vapour Extraction – Installation of Horizontal wells

Soil Vapour Extraction – Installation of solar modules

Soil Vapour Extraction – 1 year later

Solar Powered Reverse Osmosis

Solar powered Reverse Osmosis

- **The Challenge:**
  - **Containment of Chloride contaminated groundwater.**
  - **Reduction of extracted brine for deep well injection.**
  - **No source of power at site.**

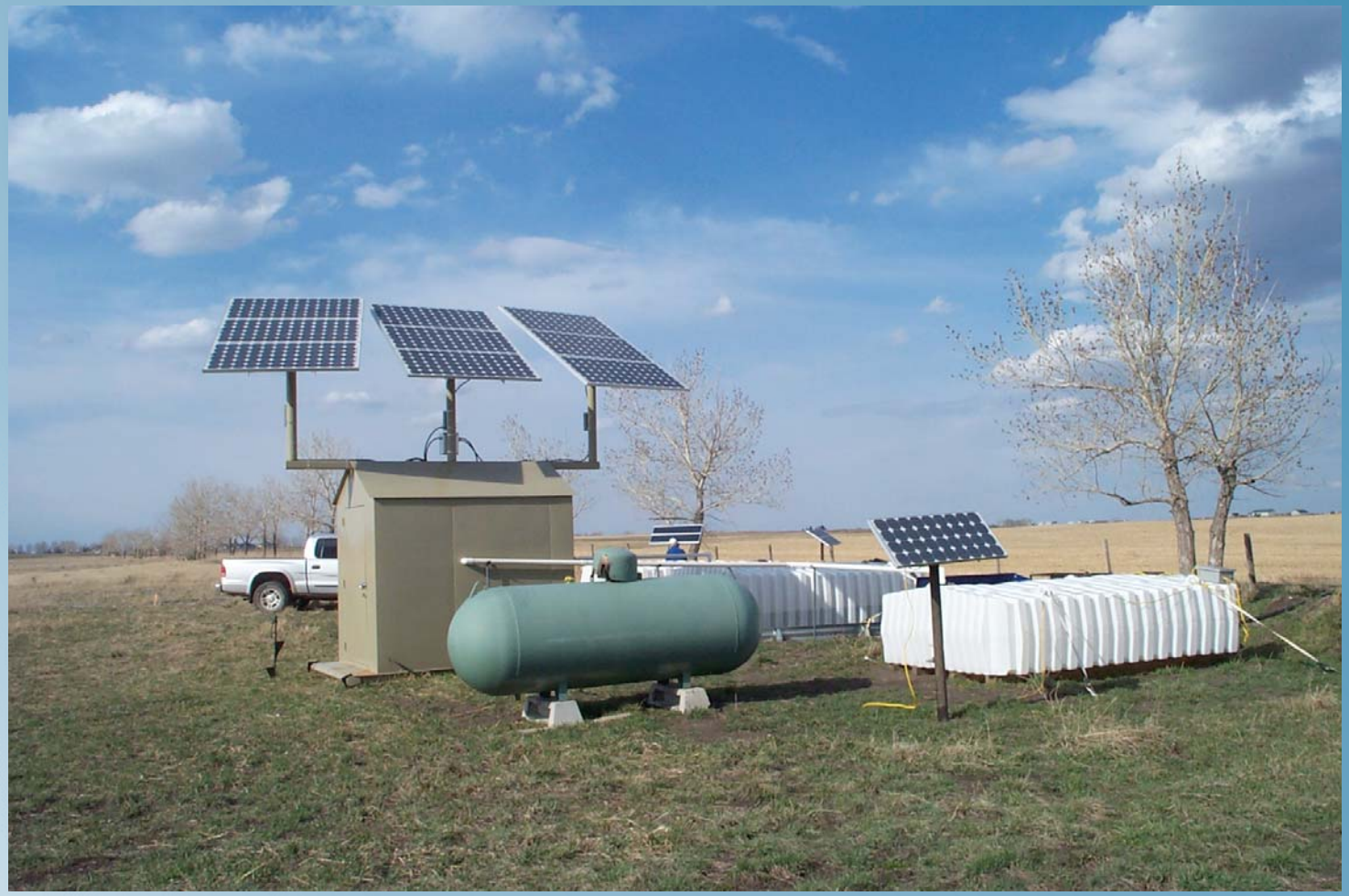
Solar powered Reverse Osmosis

- **The Solution:**
  - **24 hr Groundwater pumping for containment.**
  - **Solar powered reverse osmosis system.**

- **Key facts:**
  - **Volume required for disposal reduced by 50%.**
  - **Quality below drinking water standards.**
  - **9 x 130 Watt Modules.**

Reverse Osmosis - Pilot system

Reverse Osmosis - Final system 1 year later



Solar Powered Brine Reducing Evaporator

Solar Powered Brine Reducing Evaporator

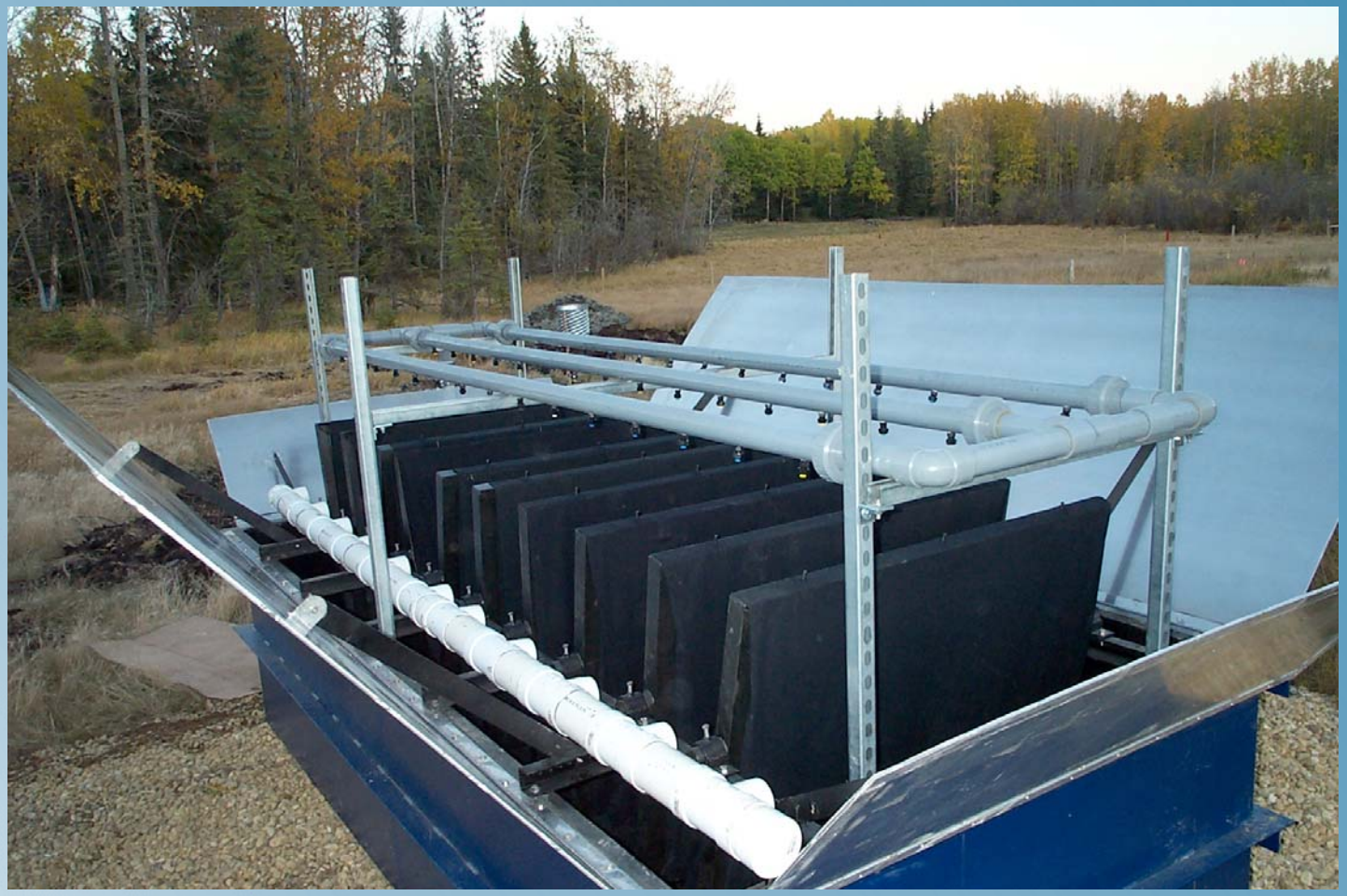
- **The Challenge:**
  - **Evaporation of Brine at sites where concentration of chloride >10,000mg/l.**
  - **Solar powered Reverse Osmosis costly at this concentration due to high pressure required.**
  - **No source of power at site.**

Solar Powered Brine Reducing Evaporator

- **The Solution:**
  - **Brine Reducing evaporator to engineer evaporation.**

- **Key Facts:**
  - **Footprint of tank 6.5 m^2**
  - **Evaporation enhanced by:**
    - **Increasing surface area**
    - **Atomizing brine into a mist**
    - **Increasing temperature of water**
  - **In 25^0C tests show max of 32% evaporation / 24 hr**

Brine reducing Evaporator – Installed system



Brine reducing Evaporator – Atomization of brine

Brine reducing Evaporator – Complete System

Product Skimming
SolarREM

Calculation Example

Belt Skimmer:

- **8 amps continuous output at 12 volts**
- **Central Alberta location**

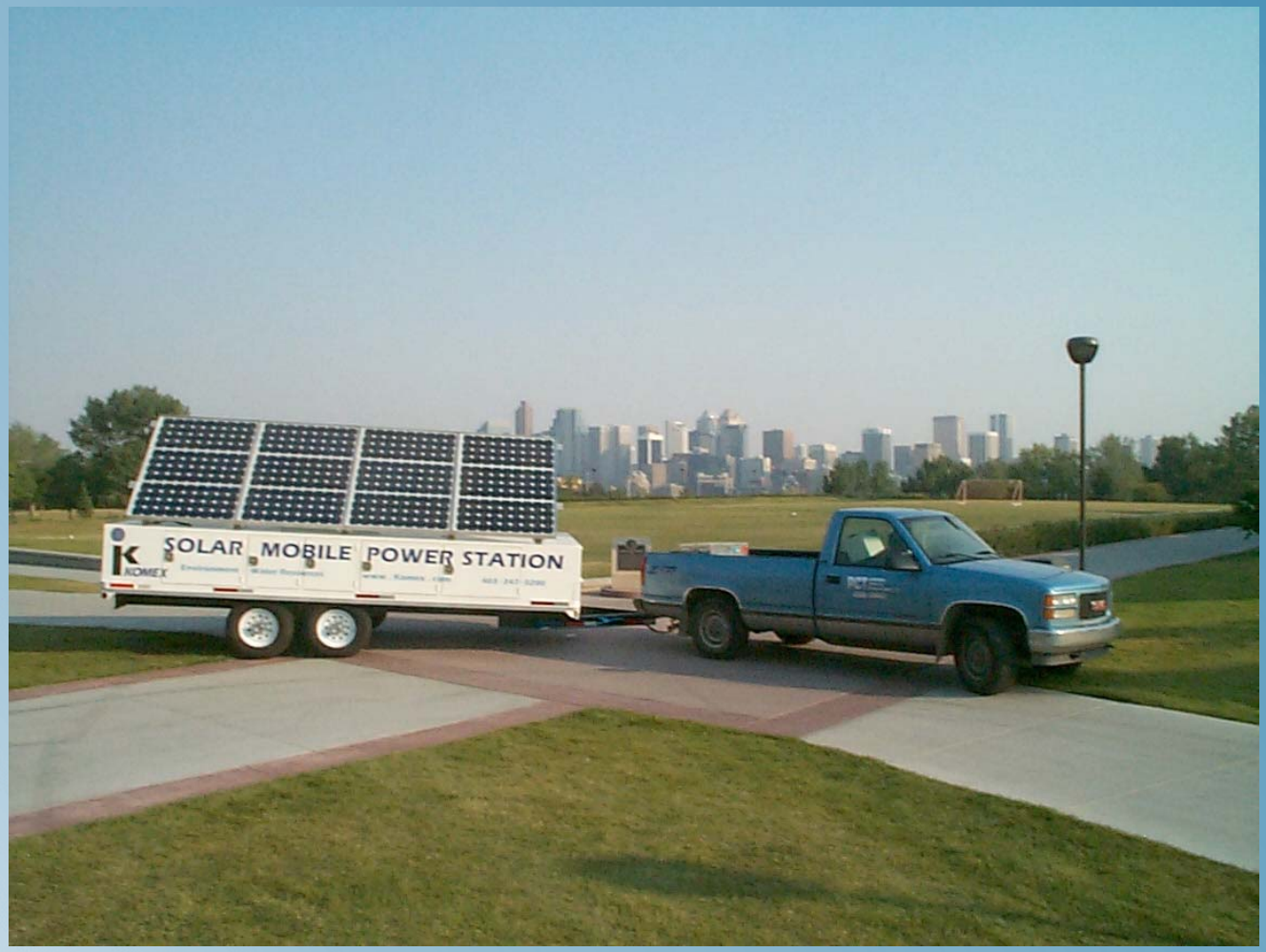
Calculation:

- **Power output = 8 amps x 12 volts = 96 watts**
- **Energy used per day = 96w x 24h = 2304 w-hrs/day**
- **Summer sun conditions: assume 5 hours/day average of good sunlight**
- **Array size required = 2304w-h/5h = 460w**
- **Add 15% for losses: array recommended = 530w minimum**
- **5 days autonomy = 2304 x 5 = 12,500 w-hrs = 1,040 amp-hrs/day**

Benefits of Solar Power

- **System is stand alone and robust.**
- **No fuel requirement (fuelling cost).**
- **No emissions- no pollution, improved air quality.**
- **Little or no Operations and Maintenance required.**
- **Long life - Panels guaranteed for 25 years.**
- **Portable onsite power.**
- **Low cost for remote application.**

Solar Mobile Power Station



Solar Mobile Power Station

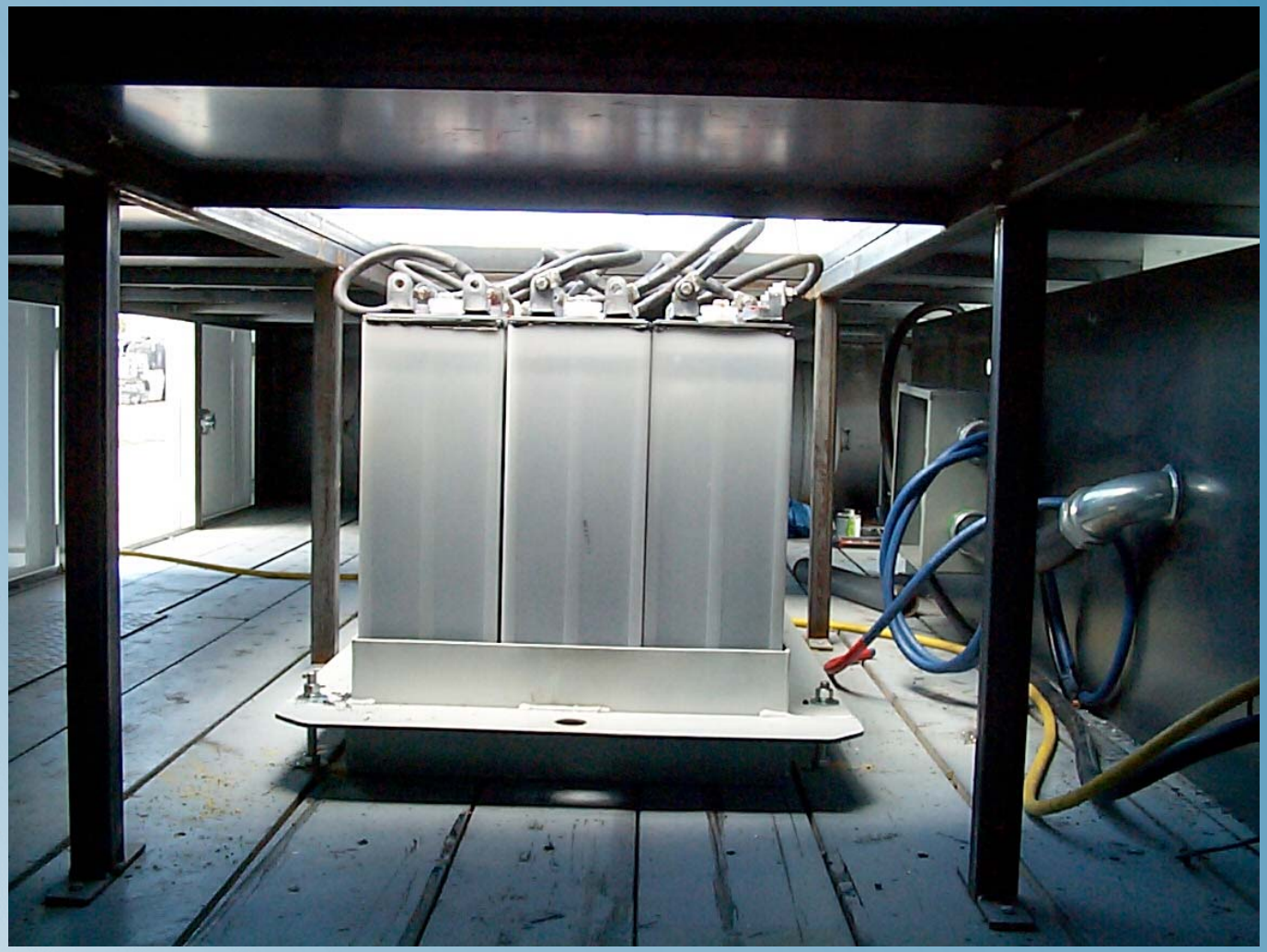
- **The Challenge:**
  - **To provide a maintenance free, operator free, yet reliable source of power for remote sites.**
  - **To provide a complete power solution with a source of AC, DC and pneumatic air supply.**

Solar Mobile Power Station

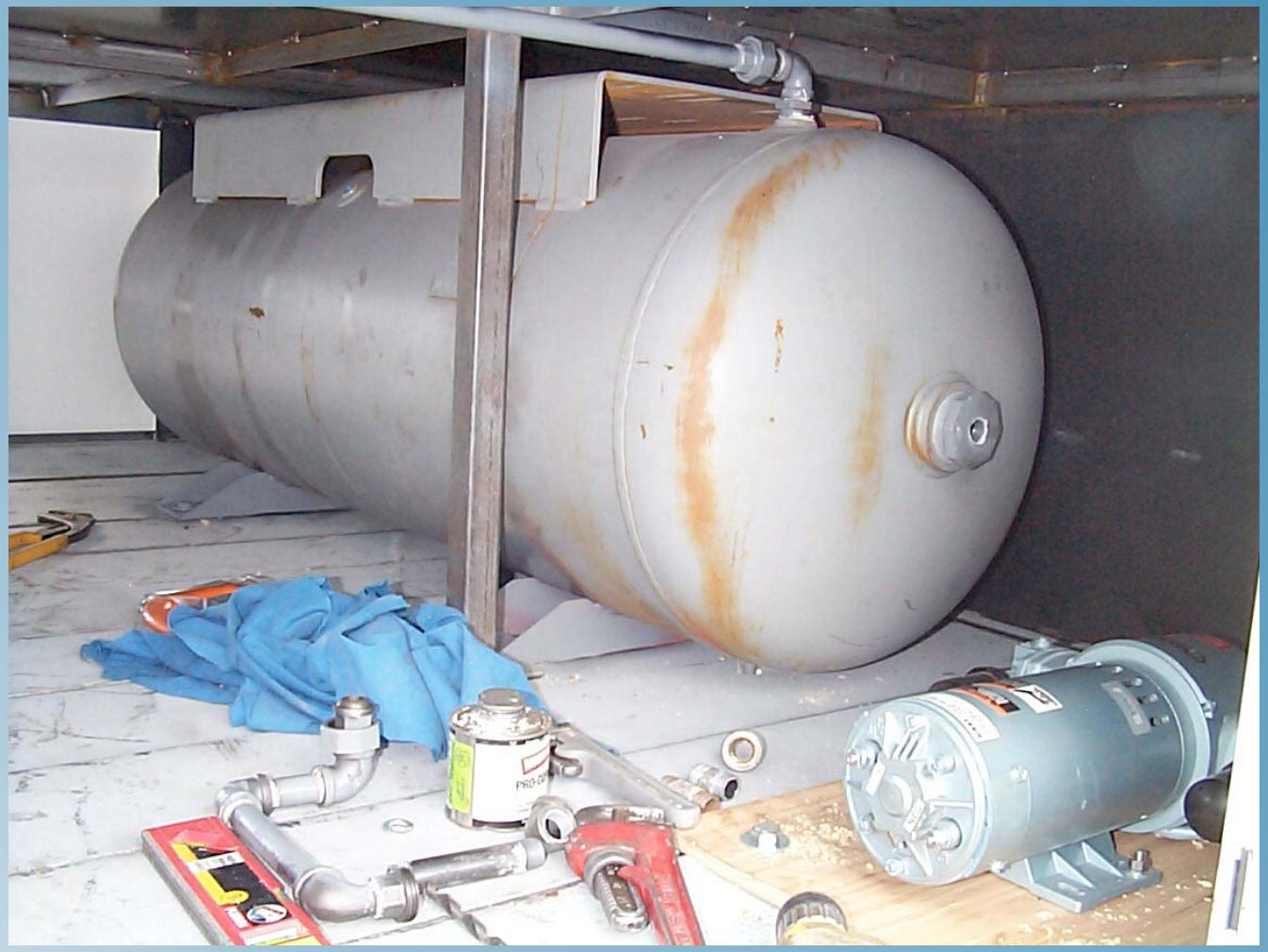
- **The Solution:**
  - **The Komex Solar powered mobile power station**

- **Key facts:**
  - **12 Solar panels - 1kW of Solar Power**
  - **12 x 2 Volt Batteries - 1700 amp-hrs available**
  - **Charge Controller**
  - **DC to AC power Inverter with auxiliary charging option**
  - **Air Supply at 100 psi, regulated at 5 ports**
  - **5 kW emergency back-up diesel generator**

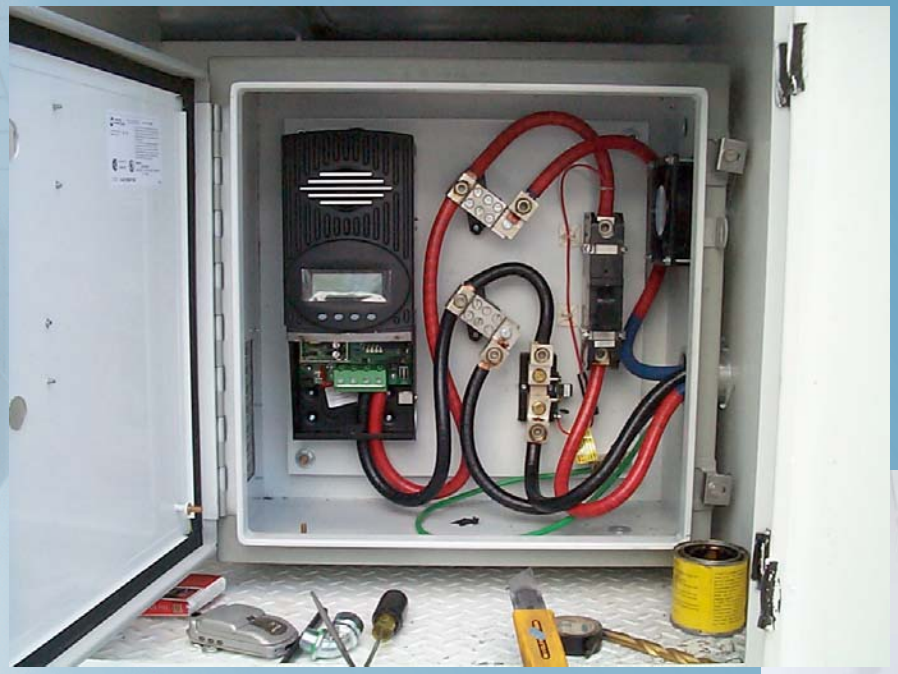
Solar Mobile power Station – 24 Volt battery supply



Solar Mobile Power Station – Air compressor and tank

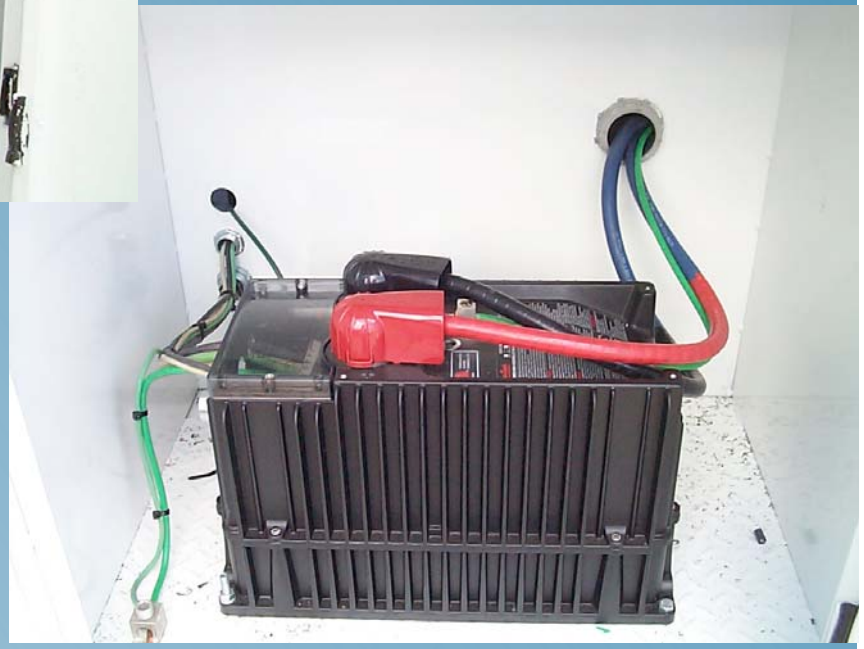


Solar Mobile Power Station – Inverter and controller

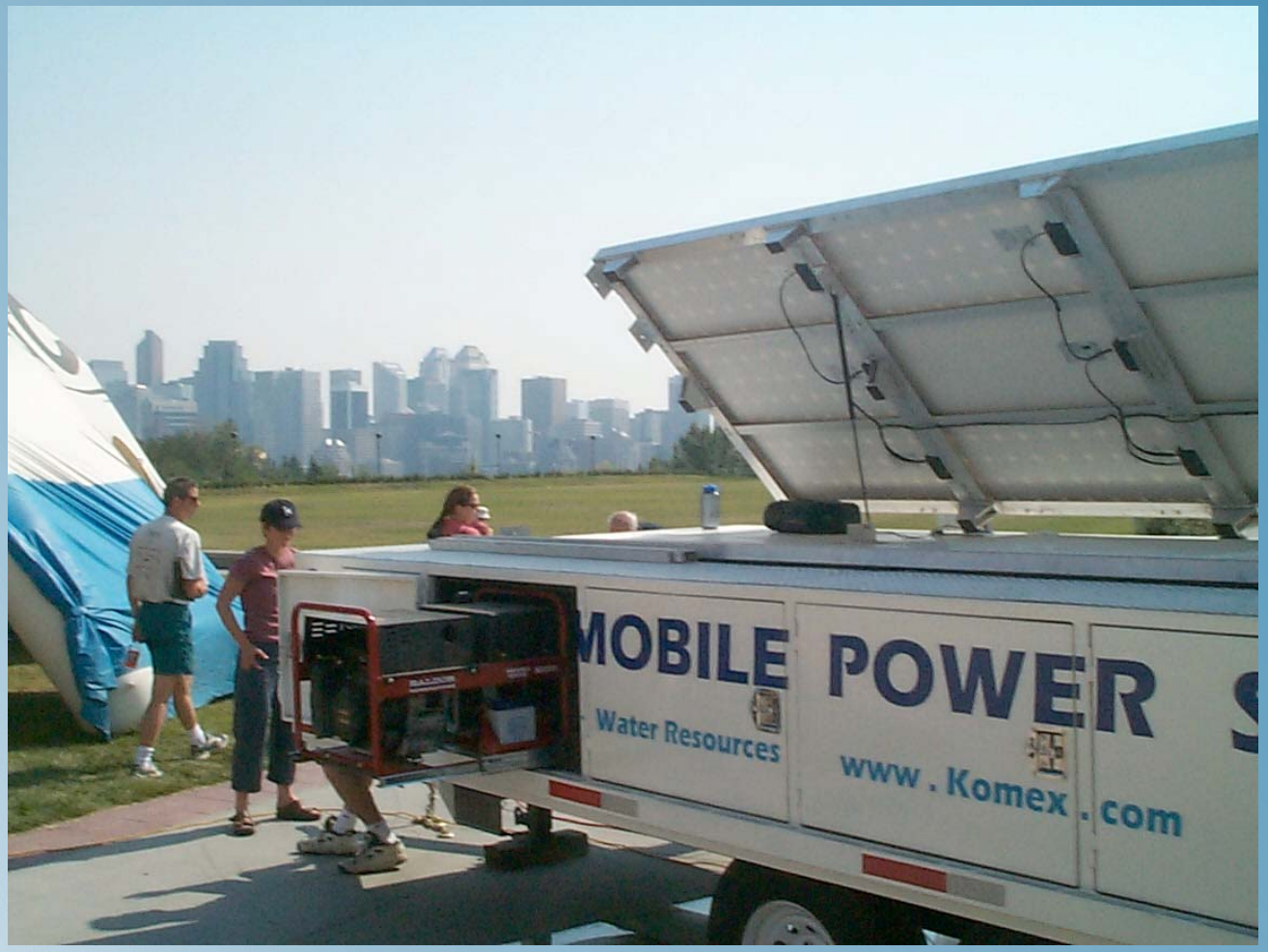


Charge Controller

Inverter



Solar Mobile Power Station – Emergency Generator



Power capacity of Mobile Power Station

Summer Applications:

- **1 kW for 5.5 hrs = 5500 watt-hrs**
  = 230 watts of continuous power

DC Pump Example:

- **At 24 volts the SUB300 delivers 15 lpm (head of 15m)**
- **SUB300 Pump uses 6.8 amps.**
- **The operating watts = 24 x 6.8 = 163w.**
  In a 24 hour day it delivers:
  24 x 60 x 15L = 21,600 Litres (5,700 usgal.)
  using 163w x 24 = 3,912 w_hrs.

Winter applications:

- Necessary to look at number of available days of operation without sunlight (Autonomy).

Watts	Days of Autonomy
50	12.5
100	6.25
150	4.20
280	2.00
380	1.60
480	1.25

Example based on 600 amp-hrs battery capacity.

Economic Payback

- **Costs of Traditional Power generation**
  - **High cost of generator rental**
  - **Fuel cost and delivery cost**
  - **Labour**
  - **Maintenance Cost**

Environmental Payback

- **Most remediation systems require 1kW power.**
- **1 kW PV array would produce about 1600 kWh each year, and 48,000 kWh in 30 years.**
- **1kWh = 160g carbon equivalent of CO2.**
- **This would avoid 7 metric tons (MT) of carbon equivalent over 30 years. (230kg/year).**
- **Typical Energy Payback on Crystal-silicon modules is 4yrs.**
- **Economic modeling allows us to predict payback and GHG production.**

Renewable Solutions for Remote Site Remediation