

A New Technology (eRET: Electrical Radiant Energy Transfer) for the Simultaneous Production of Power and Hydrogen Using Only Solar Energy

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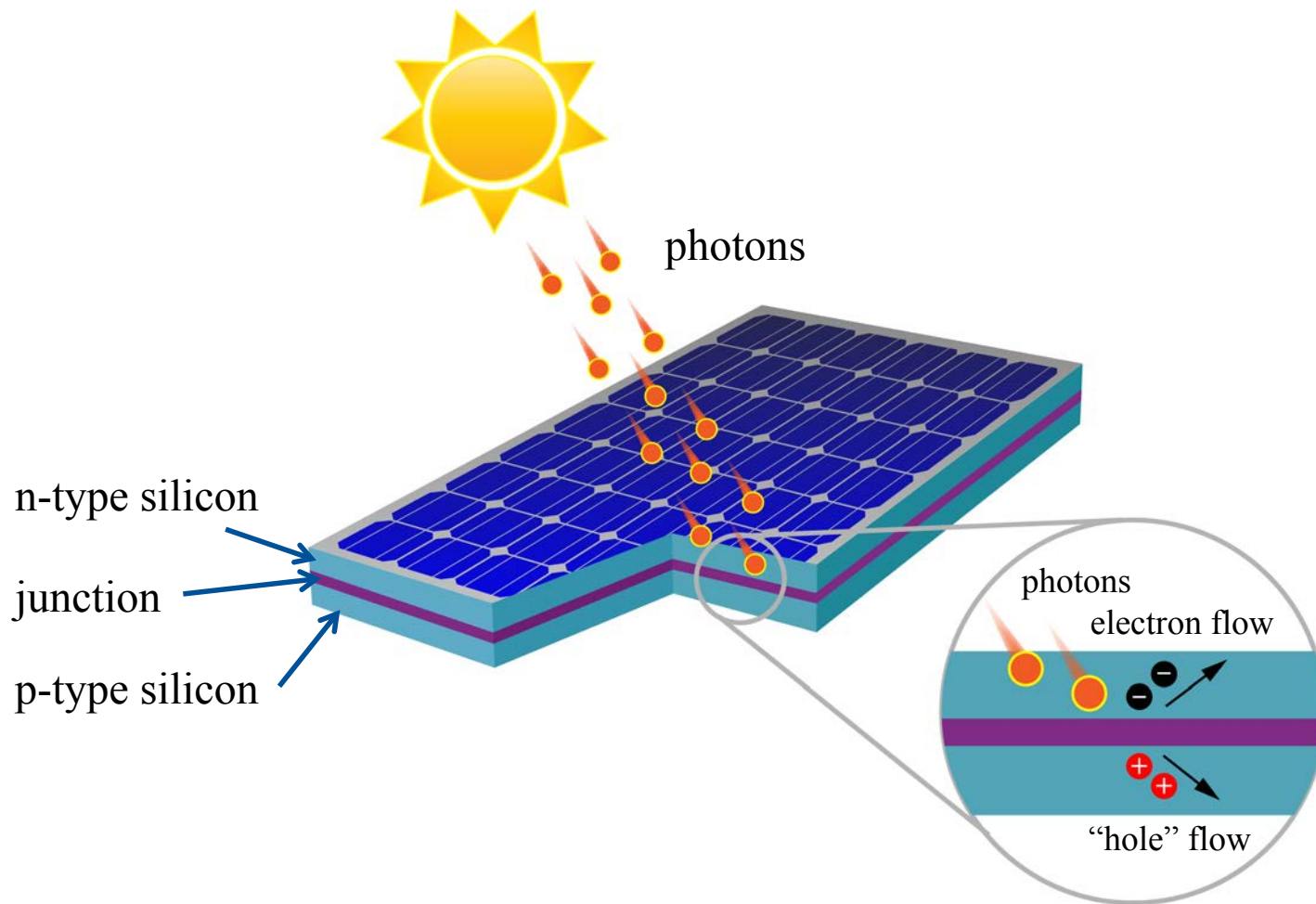
Genesys
Energy at the speed of light

*This presentation
is dedicated to*

MY BELOVED WIFE,
TERI

A GOOD FRIEND,
A GREAT HEART
AND MOST IMPORTANTLY
A VERY BEAUTIFUL HUMAN BEING
IN ALL WAYS

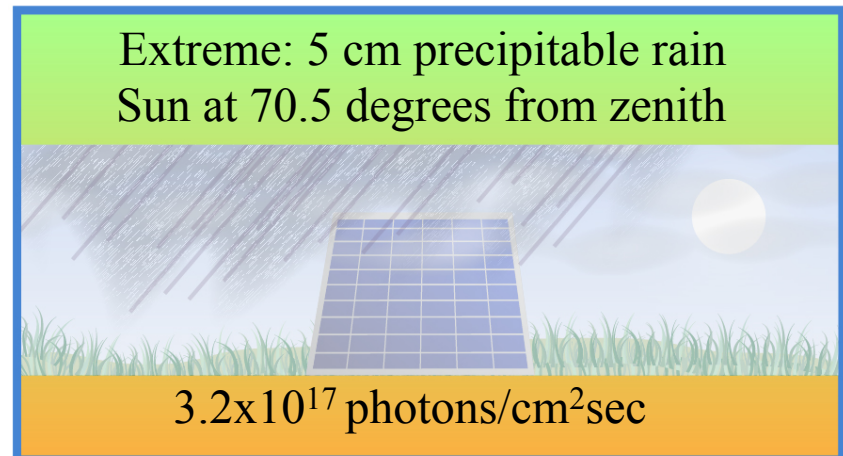
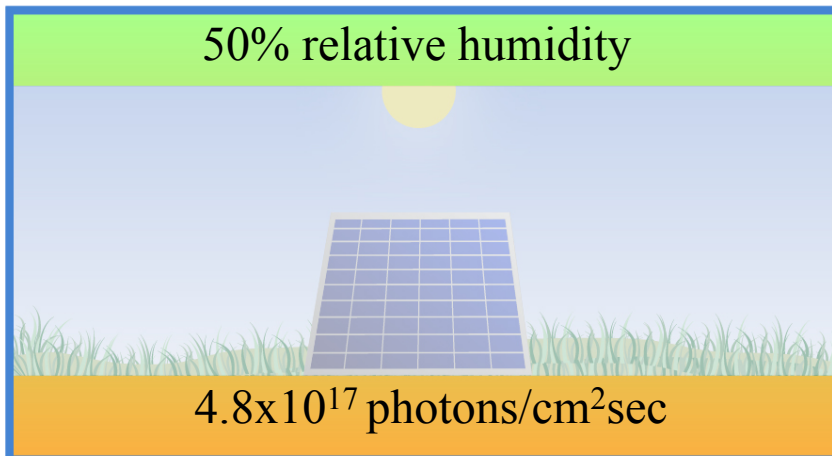
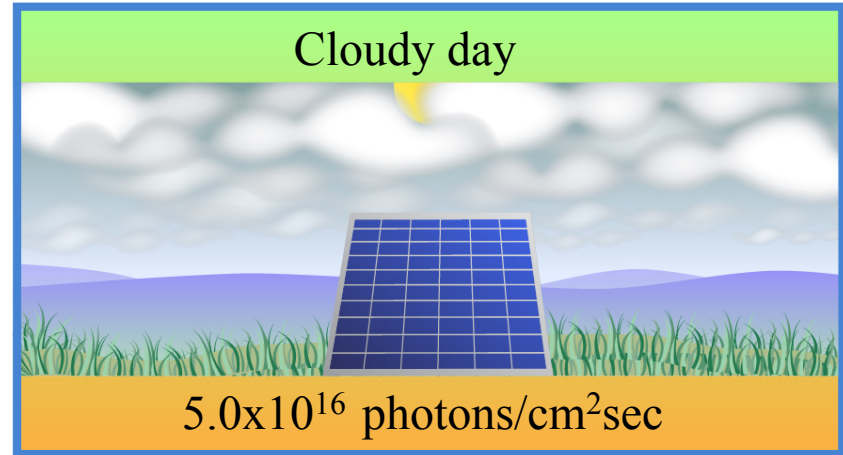
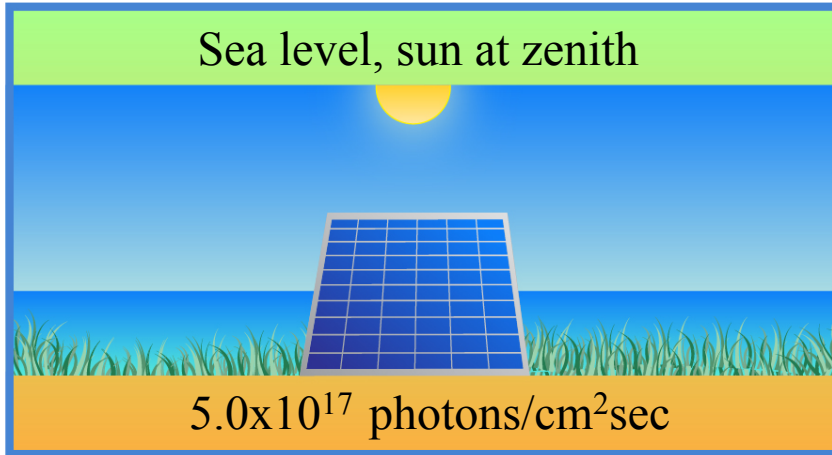
A Typical Solar Cell Assembly



The Sun Has a Great Deal of Potential!

- For every photon interacting with a solar cell one electron-hole pair is generated.
- For the case of a silicon solar cell, the potential of the generated electron-hole pair is roughly 0.6 volts.
- Every second the Sun emits at least a billion, billion volts of potential for every centimeter of area reaching the surface of the Earth!
- If we could save this amount of charge in one second we would have the largest battery in the world.

The Sun Has a Great Deal of Potential!

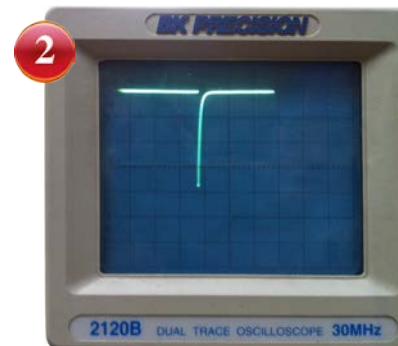


Direct Energy Conversion, S.W. Angrist, p.169, Allyn & Bacon, Inc., 1965

A Field Experiment to Test the High Voltage Capability of the eRET was Performed on February 5, 2013

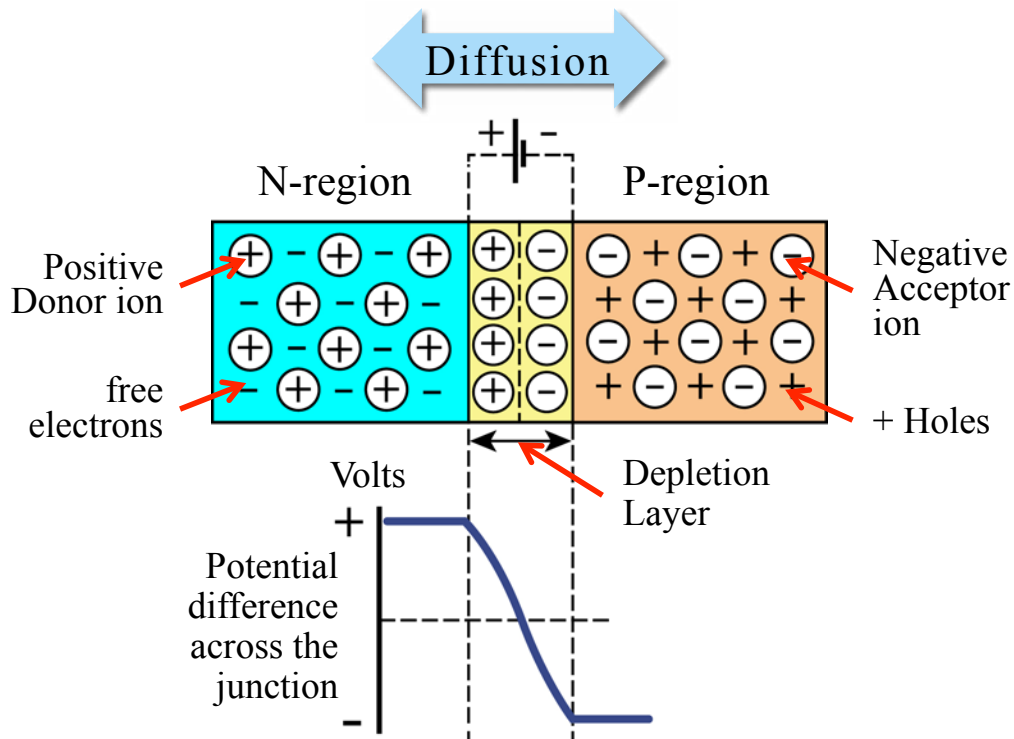
The experiment was conducted on an overcast day (12:15 p.m.) to test the eRET's capability of generating extremely high voltages (20,000 V) from two 100 watt solar panels

1. Shows the actual solar panels next to a car displaying its size and position on a very overcast day
2. Shows an oscilloscope trace exhibiting a 20,000 volt pulse of a 2 millisecond duration, directly resulting from the conversion of photons to voltage using the eRET
3. Visualization of the high voltage produced as a plasma discharge of a gas

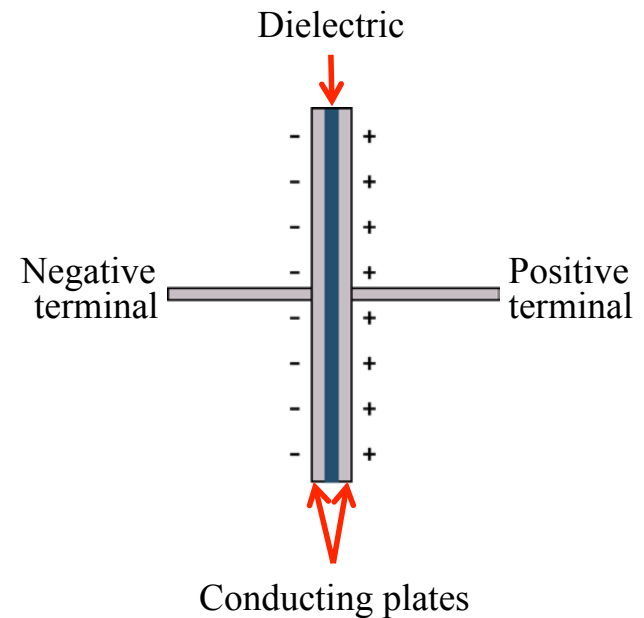


A Solar Cell is Simply a P-N junction or a Diode

It Also Has Other Interesting Properties.....



A typical p-n junction



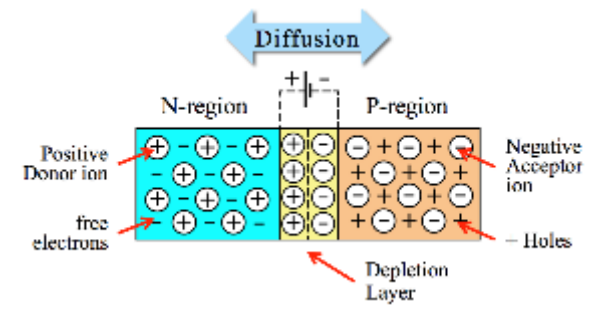
A typical capacitor

A solar cell is also a capacitor that can store charge and energy.

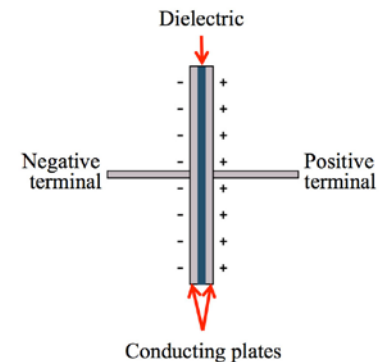
Solar p-n Junctions Have Similar Properties to a Capacitor But Retain Unique Features

- Solar p-n junctions retain a fixed charge when initially fabricated whereas a capacitor must continuously receive charge from an external source.
- Solar p-n junctions are activated by an excited electron in the junction crossing from the valence to conduction band in order for stored energy to be accessed in the junction.
- Charging the p-n junction occurs $\sim 10^{20}$ times per second.
- Stored energy of 70 to 100 μ J are common for a solar p-n junction
- The p-n junction behaves like a capacitor with a fixed charge whose energy storage capacity is fairly constant under most weather conditions.

• The source of energy of a solar cell is the separation of charge in a p-n junction. The Sun's energy is just the activator or catalyst to access stored energy.



A typical p-n junction



A typical capacitor

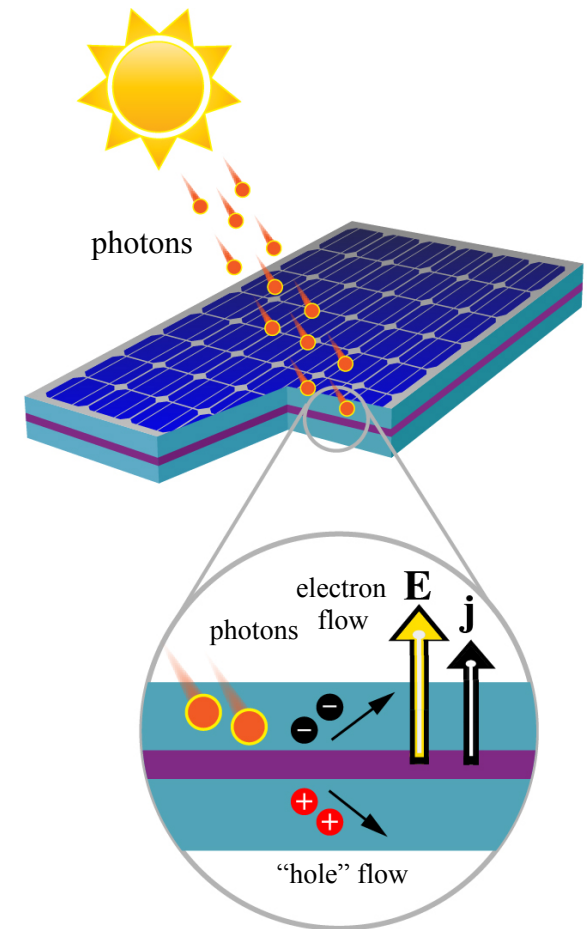
Solar Cells Possess Enormous Power Densities

How do we get the Genie out of the Bottle?

- The power density is defined as: $\mathbf{E} \cdot \mathbf{j}$, where \mathbf{E} is the electric field intensity, (volts/m) and \mathbf{j} is the current density (amps/m²)
- Typical values for a solar p-n junction are:
 - ❖ $\mathbf{E} \sim 2.0 \times 10^6$ volts/m
 - ❖ $\mathbf{j} \sim 350$ amps/m²

Power ~ 750 MW/m³

- ❖ The structure of the solar cell does not lend itself to the recovery of the power generated in the p-n junction



There Are Many Reasons Why High Powers Are Not Attained by Conventional Solar Cells

- Power is not captured in the p-n junction since the electric field intensity(E) does not survive outside of the p-n junction; potential of exiting electrons are limited to the contact potential difference of the n- and p- junction. Current is limited to the leakage current of the p-n junction.
- Phonon scattering leads to high I^2R losses in the form of heat
- Space-charge repulsion leads to a reduction in the flow of charge

HOWEVER.....

- P-N junctions possess high power densities
- Silicon has a high dielectric constant (~ 11.9), so access to high energy densities in the junction are realizable ($1/2\epsilon E^2$)
- P-N junction is a continuous source of potential energy so long as the Sun is shining
- Access times for the p-n junction are very fast (picoseconds)

We Need to Define Power in a Different Way

The p-n junction of a solar cell (~ 100 μ J of stored energy) cannot supply the energy needs for high power applications (20,000 J per second, for example) unless the frequency of energy transfer is very high.

Conventional definition of power:

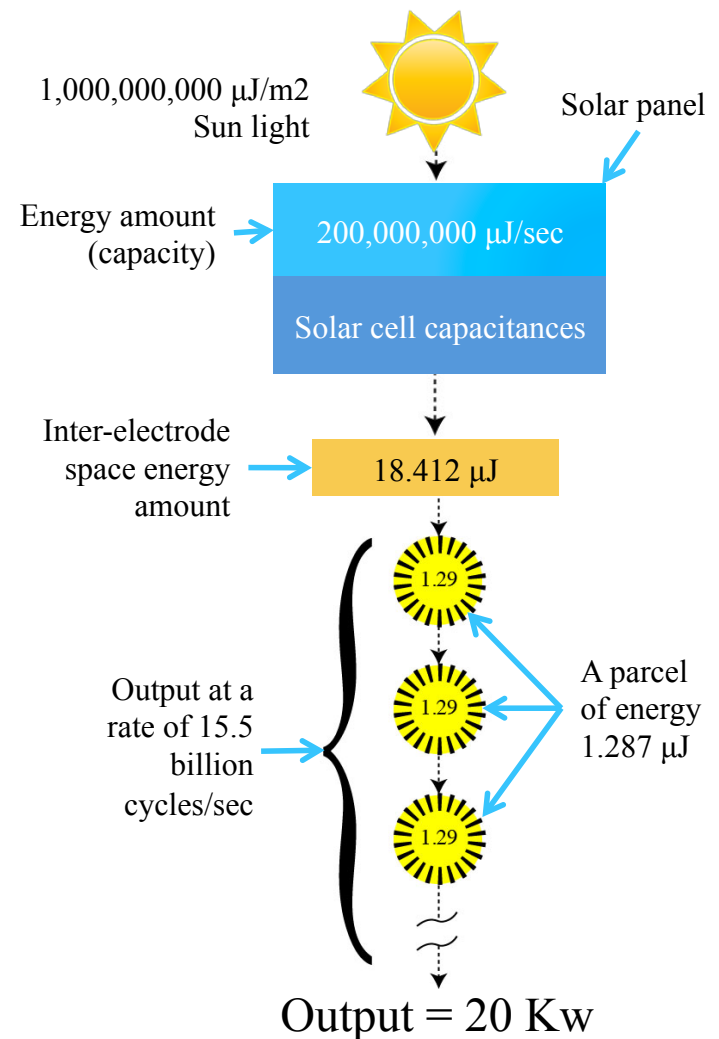
$$\mathbf{POWER} = \mathbf{energy/time(second)}$$

New definition of power:

$$\mathbf{POWER} = \mathbf{Frequency(cycle/second)*Energy(energy/cycle)}$$

Energy Flow of the eRET

- The energy density of the eRET is smaller (lower dielectric constant) than the energy density of the P-N junction (higher dielectric constant): **Energy flows from the P-N junction to the eRET.**
- Higher transfer rates lead to lower capacitance reactance and higher efficiencies: $X_C = 1/2\pi fC$
 $f = \text{frequency in cycles per sec}; C = \text{capacitance}$
- Unlike the P-N junction, the eRET has no space charge issue, I^2R losses are minimized or non-existent and its emitter is at least two orders of magnitude higher than a P-N junction solar emitter.
 $\sim 350 \text{ Amps/m}^2 \text{ VERSUS } >20,000 \text{ Amps/m}^2$
- The electric field intensity, E , of a P-N junction is about the same as the eRET, but the eRET has a better collector!



The Sun Charges the P-N Junction with Every Photon to Electron Conversion Event

The total current crossing the junction is composed of the sum of the diffusion and drift components:

$$j = j_s [\exp(qV/kT) - 1]$$

j_s = saturation current density is simply the absolute value of the reverse current density

Excess electrons on the p-side

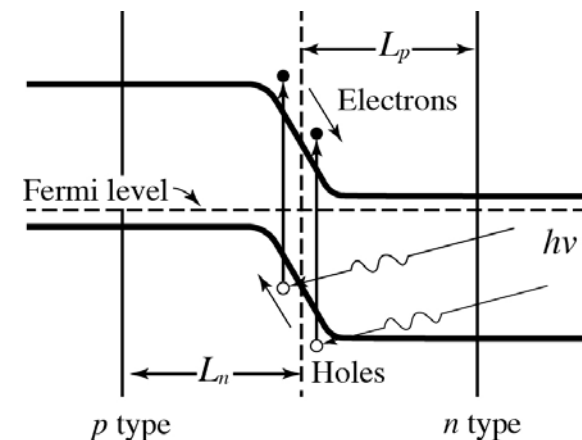
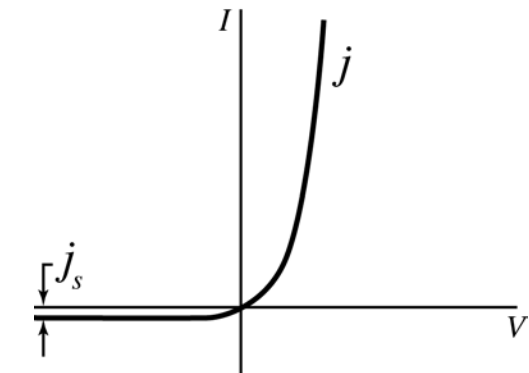
$$\Delta n_p = n_p [\exp(qV/kT) - 1]$$

Excess holes on the n-side

$$\Delta p_n = p_n [\exp(qV/kT) - 1]$$

If $V=0.6$ volts increase of ~10 billion times the saturation current

If $V=1.1$ volts increase of ~24 billion, billion times the saturation current



Capabilities of eRET Today

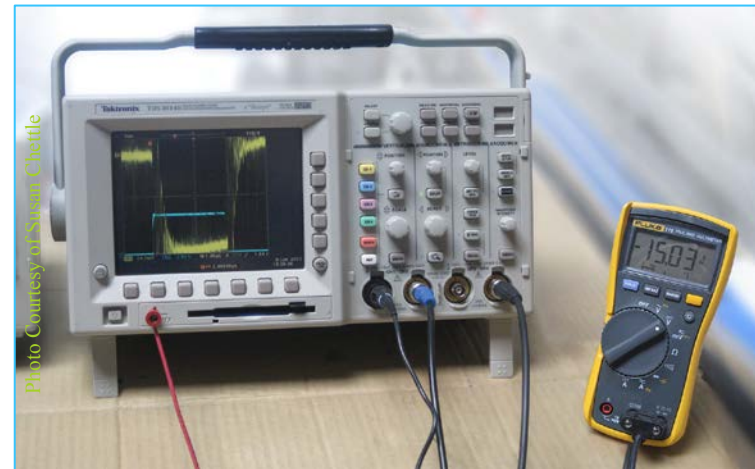
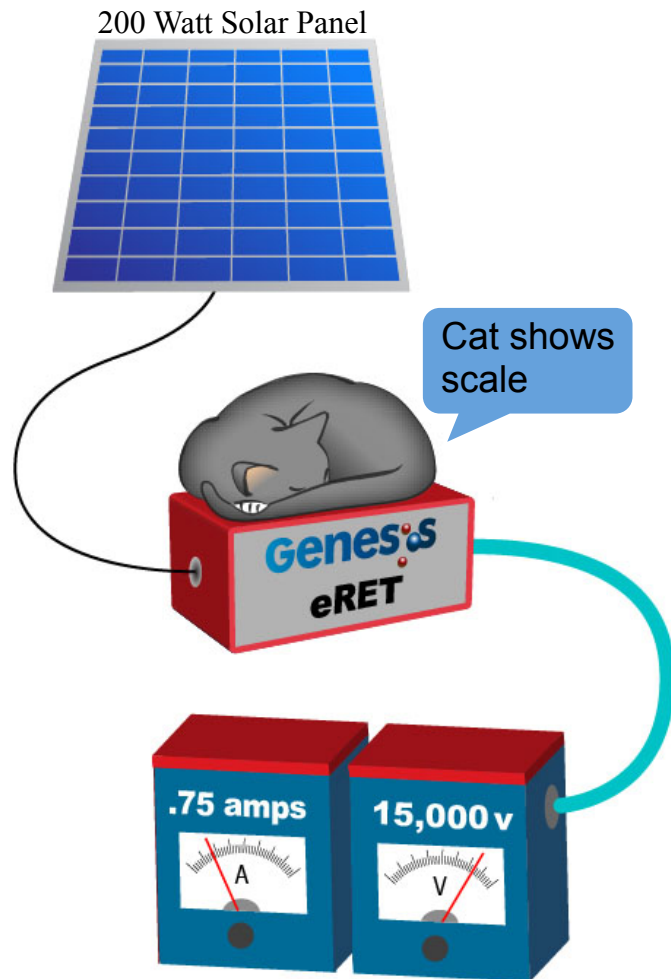


Photo Courtesy: Alan Chettie

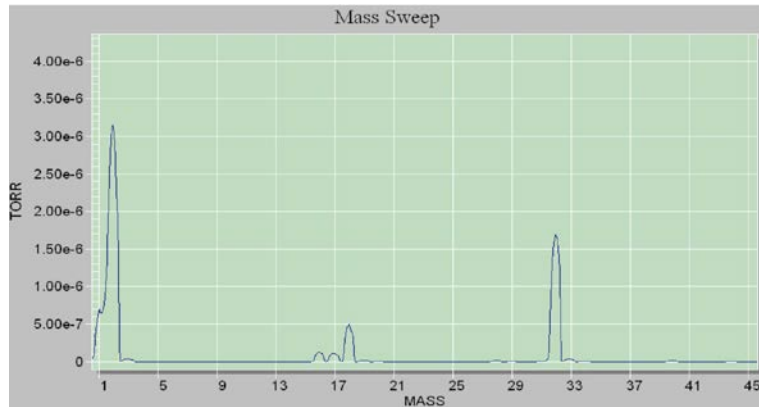
OPERATING PROPERTIES Present Capabilities

- Output Voltage: 15,000 volts
- Output Current: 0.75 amps
- Output power: 10,000 watts
- Source: one 200 watt solar panel
- Input power: 66 watts
- Efficiency: 98.5%

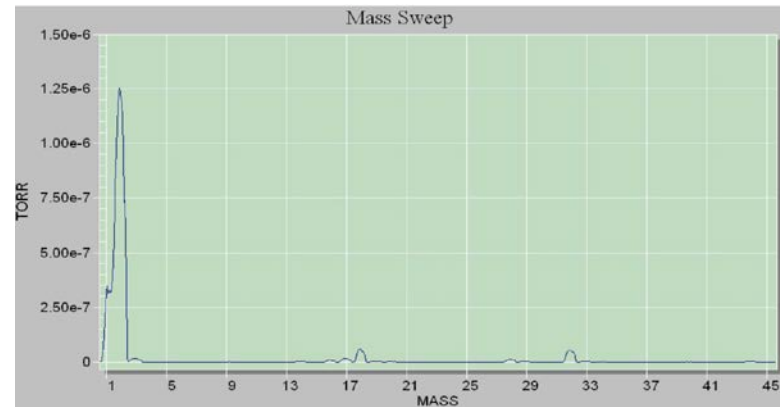
eRET Can Produce Hydrogen Simultaneously With Power

- Coherent radiation is a by-product of the power generation process
- There are many resonant absorption frequencies for the water molecule; they are used to efficiently split the OH bond resulting in hydrogen and oxygen
- The hydrogen produced can also be used to manufacture chemicals
- **This is the only technology today that stores its own energy (hydrogen) when producing power**

eRET Can Produce pure Hydrogen and Oxygen Using its Proprietary Membrane Technology



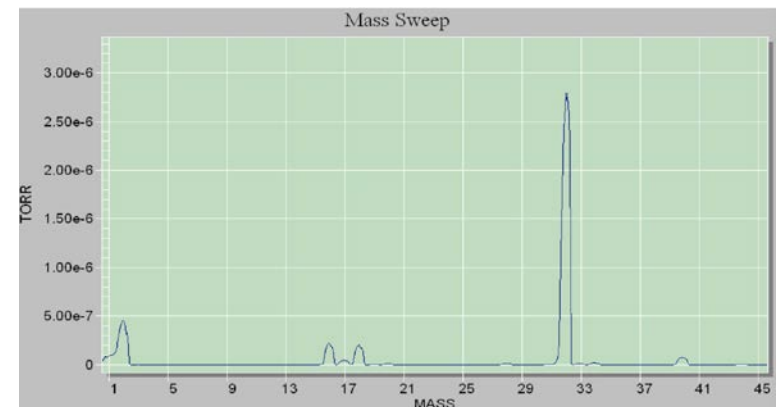
Entrance of the water vapor to the membrane reactor



Pure hydrogen is produced as part of the eRET technology in the generation of power

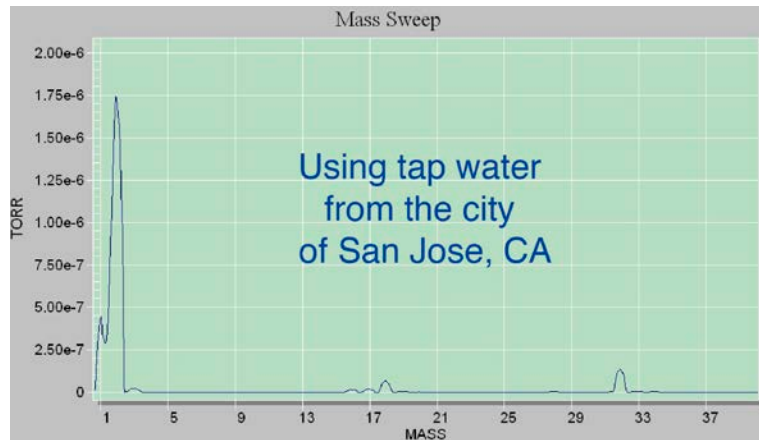


Quadrupole Mass Spectrometer Assembly

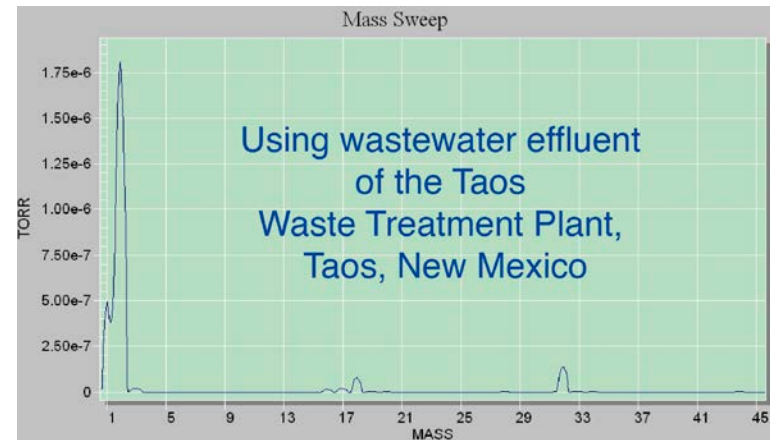


Pure oxygen is produced along with the hydrogen

eRET Can Produce pure Hydrogen and Oxygen from any Water Source Along with Power



Pure hydrogen produced from water vapor using tap water



Pure hydrogen produced from water vapor from a wastewater effluent stream



Raw Wastewater



Water Inlet



Pure Hydrogen

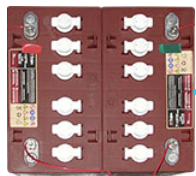
eRET Lab System

Diagnostic Measurements

(2) 100 W Solar Panels



Junction Box with Voltage Regulator



Batteries



Power Supply

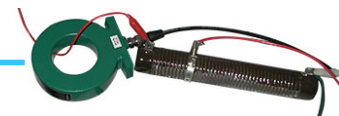
eRET (Electron Generator)



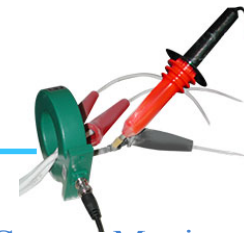
Volt Meter



Digital High Speed Oscilloscope

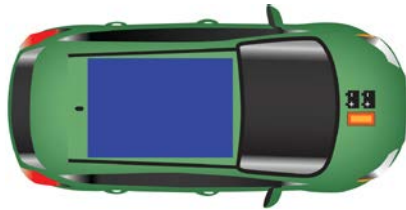


Current Monitor (in)

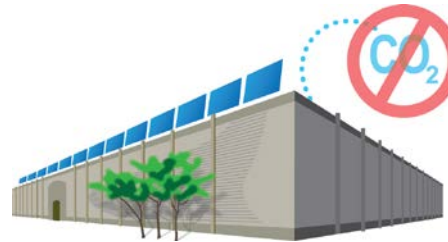


Current Monitor (out)

There are Multiple Applications of the eRET



A self-charging car doesn't need a recharging station or lithium-ion batteries thereby reducing the cost of an electric car



Zero emission data centers (cloud) at a fraction of the operating cost of power compared to fossil fuels



The realization of micro-grids as a practical method of power distribution



Elimination of fossil derived chemicals at competitive prices



Generation of pure water with superior economics compared to other water treatment technologies



A practical solution to global warming concerns

Summary of Findings

- We found a solution to the “bottleneck” problem of power generation in a solar cell
- The Sun is a great source of potential which can charge a p-n junction or capacitor at faster rates than energy extraction: $\tau_{\text{ENERGY}} \gg \tau_{\text{CHARGE}}$
- Conventional solar cells are limited to the leakage current at the contact potential of the junction: WE COULD DO BETTER!
- Conventional solar cells are limited to at most 1 kw/m²
- A p-n junction was successfully used as a rechargeable energy source for the eRET; the Sun is used to maintain potential

Summary of Findings

- The Schroteffekt Effect, “Shot Effect”, of electron emission permits coherent excited charge generation and injection at very low energy quantities resulting from the inherent sequential nature and granularity of electricity
- Hydrogen is generated simultaneously with electricity allowing for 24/7 operation
- Water, nitrogen and noble gases are potential by-products of the hydrogen process for producing power
- Economics are very favorable compared to fossil fuels:
 - ❖ <2 CENTS/KWH FOR POWER
 - ❖ <80 CENTS PER KILOGRAM OF HYDROGEN
- We have over 1.5 years of operational experience with the eRET

Conclusions

- A new technology has been developed to provide economic, renewable power for electrical applications that competes with conventional fossil fuel energy sources
- Storage of electrical energy has been solved using the eRET technology
 - ❖ The use of lithium-ion batteries for cars and trucks is not necessary:
BATTERIES NOT NEEDED
- eRET does not produce carbon so it can provide a cheaper alternative to carbon sequestration technologies in order to mitigate the effects of climate change
- eRET consumes carbon to produce useful commercial chemicals (economic sequestration)

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