Romance of Innovation-Promise of Solar Energy

(Gemini Ganesan Memorial Lecture at Madras Christian College (MCC)
3rd March 2015)

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Good morning Ladies and Gentleman,

I must thank Narayani Ganesh for suggesting my name and Dr. Joshua of MCC for inviting me for this prestigious lecture. I am delighted and honored to give a talk at this well known college. A college is known not only for its scholarship but also by its illustrious alumni.

I did some research on the illustrious alumni of this college and found out that I know one directly and two indirectly.

Mr. A. P. Venkateshwaran an alumnus of MCC and former foreign Secretary to Government of India came to University of Florida (UF) Gainesville in 1977 with the Indian Ambassador. Mr. Venkateshwaran was at that time the Minister in Indian Embassy in Washington D.C. Since I was the President of India Association in UF at that time hence I had an occasion to interact with him for almost 2 days. His wit and understanding of geopolitics was remarkable.

Another illustrious alumnus whom I know indirectly is Dr. S. Radhakrishnan the Second President of India. He was a friend of my grandmother-in-law Dr. Iravati Karve and gave her his autographed books. Those books have come to me as a part of dowry! I have read them and quoted from them in my spiritual writings.

And the third person whom I know indirectly is Gemini Ganesan (GG) in whose honor this lecture has been arranged. I have come to know GG through the lovely book written by his daughter Narayani Ganesh.

Reading Narayani's book on her father showed me that he was a romantic hero both on and off screen and so I thought that the topic of today should also be about romance but for the innovation and ideas.

Without romance life is boring and aimless. Romance is a result of passion. You have to have passion for whatever you do. Then only you can overcome obstacles and do things differently. My journey in life can be described by one word - Junoon or passion and today I am going to talk about Innovation and solar energy.

It was my passion for solar energy that took me in 1974 from IIT Kanpur to US and it was again the passion to do something useful with my knowledge that brought me back to rural India in 1981 in a place called Phaltan. Phaltan was a small rural town where to make a long distance phone call I would hop on the bus and go to Pune – a journey of 4 hours just to make the call. If I had an iota of intelligence I would not have come to Phaltan. But Junoon makes you do strange things!

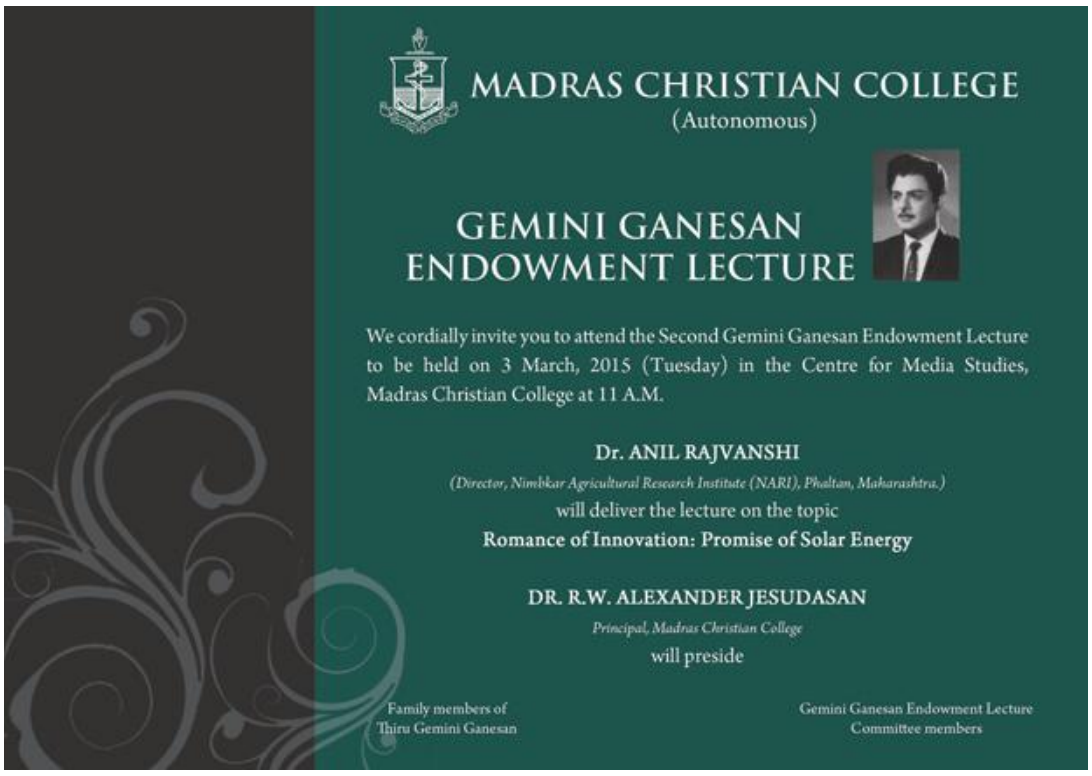
Thus the passion and junoon to do something interesting made us survive and thrive. My journey to US and back has been written in two books – "1970's America – An Indian student's journey", and a recently released "Romance of Innovation – A human interest story of doing R&D in rural setting". This book has been made available free on the internet.

Though I was trained in solar energy but we have done lot of work on renewable energy, mostly in biomass, in our Institute. So when Dr. Joshua suggested that I should talk on solar energy I thought this will give me an opportunity to come back to my original love. So my lecture is on promise of Solar Energy.

L-R; AKR, Nandini Nimbkar; and Gemini Ganesan's daughters Jaya Shreedhar and Narayani Ganesh

Narayani Ganesh giving a short speech about the lecture

Dr. Anil Rajvanshi delivering the Gemini Ganesan endowment lecture.



Romance of Innovation – Promise of Solar Energy

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Gemini Ganesan Memorial Lecture
Madras Christian College, Chennai, 3 March 2015

Our Journey

- 1970s America – An Indian Student's journey. www.nariphaltan.org/usexp.pdf
- Romance of Innovation – A human interest story of doing R&D in rural setting. www.nariphaltan.org/roibook.pdf

Solar Energy

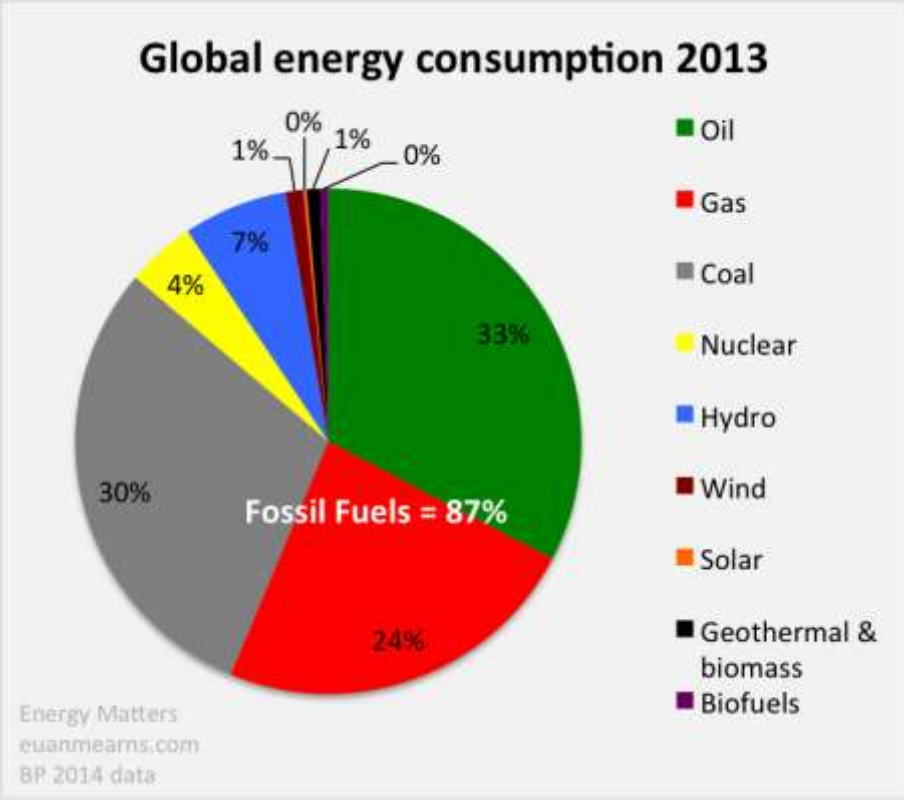
- Basis of life on earth is solar energy. Light from sun fuelled life. Worshipped as God in all civilizations.
- Light is life and darkness is death.
- Huge amount of solar energy on earth. On an average we get 5 kWhr/m^2 per day.
- On India's land mass we get 570 times more energy than India consumes! With 10% solar cell efficiency, still 57 times more energy.
- Democratic. It is available to all and every where.
- Available only for 6-8 hrs/day. Need reliable and environmentally friendly storage.

Solar energy …. Contd.

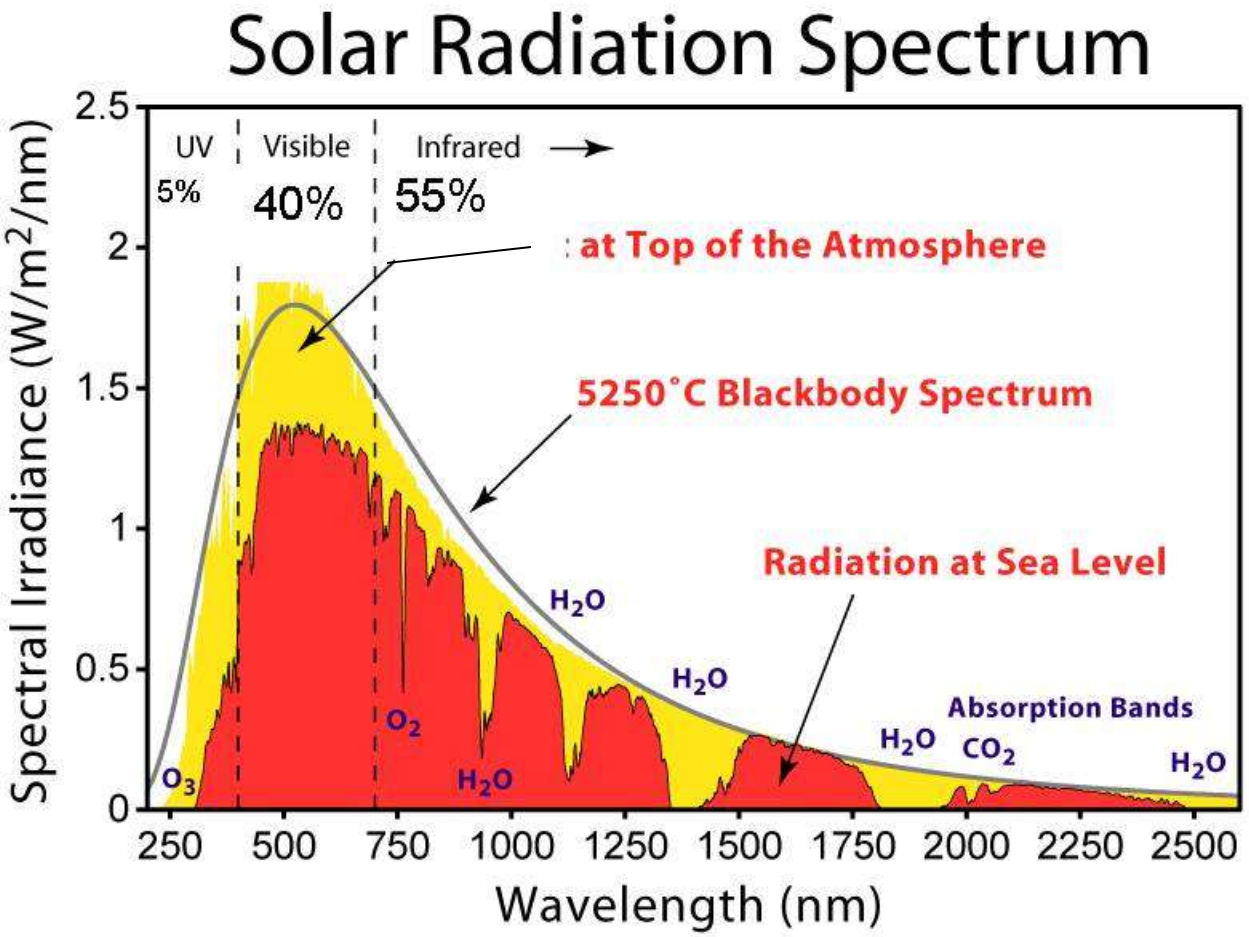
- World land mass gets 1900 times more solar energy than consumed by the world!
- Renewable energy by countries
  - Germany 27% of all energy. Solar, wind and biomass.
  - US 13-15% from renewables.
  - India less than 2%! World's first RE ministry.
- Need to increase device efficiencies, reduce cost and develop cost effective storage.
- Need for engagement of corporate world and R&D workers. Great challenge for youngsters.

Solar energy ….contd

- Except for nuclear and geothermal all energy is solar energy (SE).
- Fossil fuels are millions of years stored SE.
- We need to use SE in form which is recycled in our lifetime. Sustainable?



Solar spectra



How nature uses solar energy

System	UV region	Visible	Infrared
Wavelength (μm)	0.3-0.4	0.4-0.75	0.75-3.0
Use by Natural systems	Life in early evolution. Vitamin D	Photosynthesis (PS) IR and blue used by leaves	Wind, clouds, transpiration, etc. Brain?
Conversion systems	Photochem.	PS, PV and thermal	thermal
End products	Chemicals	Chemicals Thermal	Thermal

Nature stores solar energy in chemicals (food)

What can solar energy (SE) do?

- It fuelled life and can fuel industrial society.
- SE can provide all our end use energies; electricity, heat, and fuel for mobility.
- Electricity through PV or solar thermal plants.
- Heat via solar water and air heaters.
- Air-conditioning or refrigeration via absorption systems.

Mobility

- Nature (chemicals)

Hybrid!

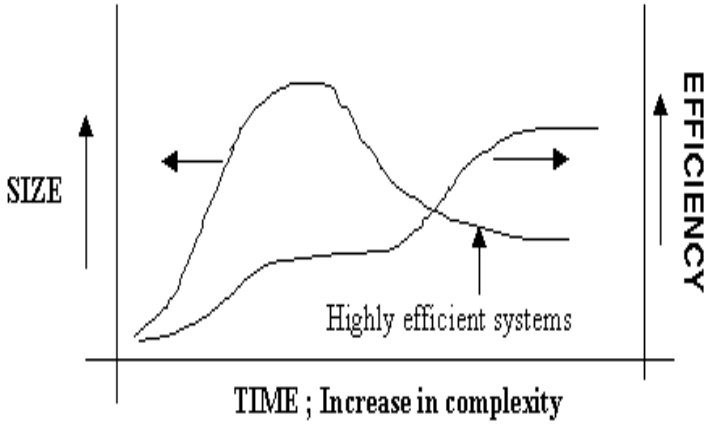
Fuel for mobility through electricity

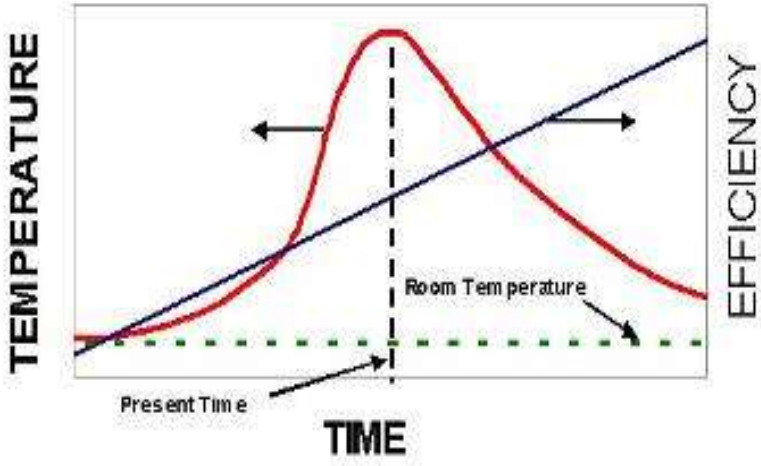
What can SE do?

- Nature converts SE into chemicals. We convert it into electricity.
- Nature stores energy in food. Our storage strategies are below par and unsustainable.
- Challenge. A + solar energy ⇨ B + C.
- B + C ⇨ either light, heat or mechanical power via artificial muscles. Chemical storage strategy. Bionic leaf ; solar to liquid fuel.
- Need to follow nature's solar strategy for sustainable energy production and storage.

Philosophy of natural systems

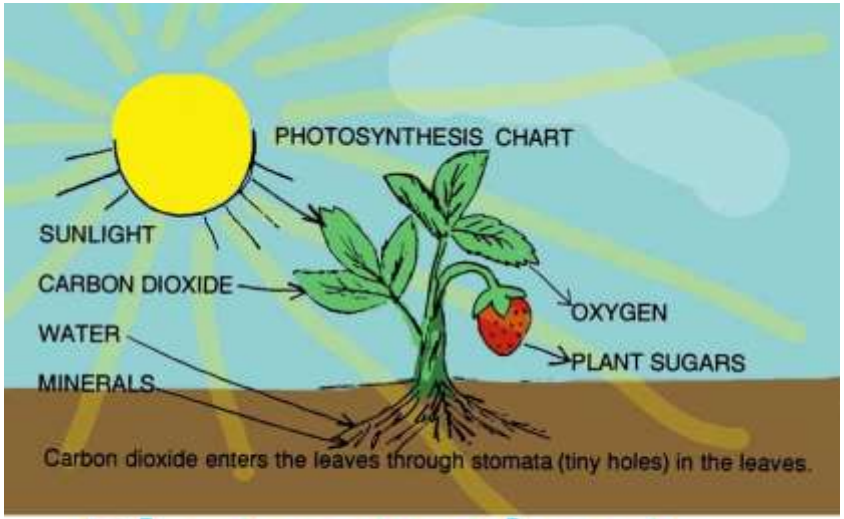
- Hallmark of evolution:
  - Size reduction
  - Increased efficiency; uses all forces
  - Room temperature processes
  - Min. energy conversion steps
  - Robustness
- Biomimicry as mantra for design.
- Our designs are following this route. Cell phones, power plants, etc.
- Societies as Prigogine's dissipative structures.





Nature uses all forces for its process

- Wind brings CO_2 to trees and plants.
- Makes root system strong, helps in evapotranspiration and sap flow.
- Pollen distribution.
- Breeze rushing through trees is music to ears!
- Millions of years to perfect design strategy.



Photosynthesis

Fossil fuel mentality?

- Even using solar energy we use fossil fuel mentality.
- Need small but large numbers of decentralized systems even with lower efficiency.
- Photosynthetic efficiency ~ 1-2%. Large numbers.
- Source to end product. Minimum steps.
- Challenge for young chemists for max P vs. T fuel.

10 kW organic Rankine cycle solar thermal power plant

Future strategy for SE

- All household energy by solar and other renewables.
  - Electricity and heat
  - Gas for cooking; biogas or liquid fuel from biomass
- All farm energies from solar or biomass.
  - Heating and electricity
  - Fuel for machinery from solar or biomass
- Industrial energy
  - Google, Tesla motors and others use most of the energy in their factories/offices from solar and wind

Our work in solar energy

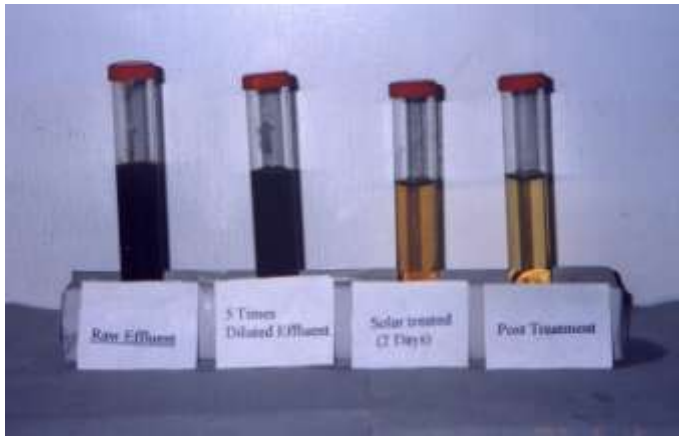
- Solar distillation of ethanol
  - 80% of total energy used in ethanol prod. is in distillation
  - 50 lpd of 95% ethanol
  - 75% energy from solar; rest from biomass
- Plant set up in 1987 at NARI.
- Used for stoves and lanterns

Globe award in Stockholm

Solar detoxification of dist. waste

- 15 liters of effluent generated per liter of ethanol produced
- High in BOD and COD
- Black in color and foul smelling

- 200 lpd plant. Uses photocatalyst
- T from 0 to 90% in 2 days
- COD reduction 98%
- Treated effluent used on plants as fertilizer



Greening of deserts

- Average water production 300 ml/day.
- 100% seedlings survival.
- Pits as rain water collectors.
- Gave technology to NDDB in 1992.

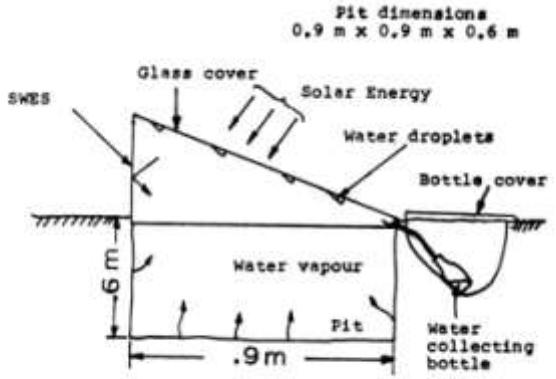


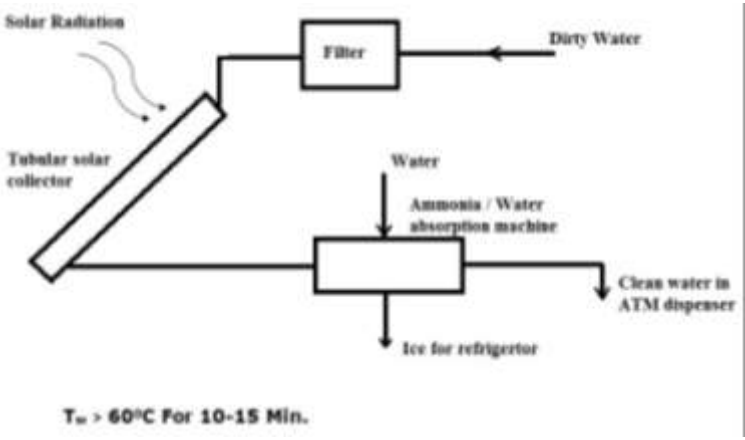
Fig. 1 Schematic of Soil Water Evaporation Still (SWES)

Solar powered petal collector

- For spiny varieties.
- Petals as herbal tea.
- Sells at Rs. 1000/kg.
- Exported to Iran and Nepal.

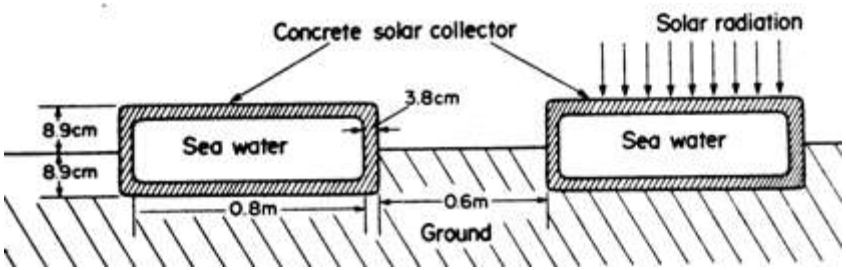
Potable water and refrigeration

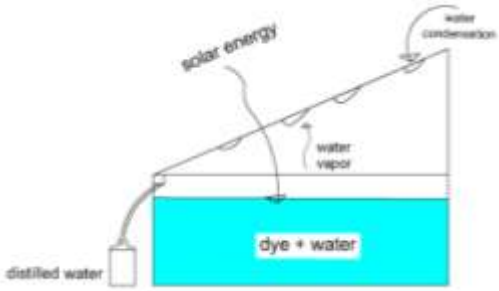
- Filtering dirty water through 4 layers of cotton sari and heating it to 60^0 C for 10-15 minutes or 45^0 C for 3 hours inactivates all coliforms.
- Use of solar tubular water heaters. 99.5% times water temp > 50^0 C.
- Hot water can also be used to produce ice for refrigerators via NH3/H2O absorption system.
- Challenge
  - Efficient and non toxic absorption refrigeration pairs.
  - Low cost ATM for water and ice.
  - Efficient ice box as refrigerator.



Solar energy for water production

- Rain is liquid sunshine. Is not available when and where needed.
- Need for desalination.
- Solar energy in Thar desert to desalinate sea water.
- Dew water condensation.
- Use of dyes to increase sea water evaporation.





Happiness through innovation

- All of us work to maximize our happiness.
- Fame and money gives it to some.
- Creating something wonderful, inventing and innovating also gives happiness.
- Innovation is like yoga. To reach the goal all the roadblocks and pinpricks become inconsequential.
- To do something meaningful in one's life and give back to society brings great joy and happiness.
- Help in making this a hospitable and lovable place to live. We will all be born again and again on this planet earth.
- It is the romance of innovation!

Thank you

- Useful sites:
  - www.nariphaltan.org (Institute site)
  - www.nariphaltan.org/roibook.pdf (Romance book)
  - www.nariphaltan.org/writings.htm (My writings)
- Email: nariphaltan@gmail.com