

ELECTRIC TRANSPORTATION GLOBAL OUTLOOK

**A National Conference on “Electrifying Experience
in Electrical Transportation in India”**

February 6 and 7, 2018

Pune, India



**Tesla Solar Supercharger site
in Rocklin, California**

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EV TECHNOLOGIES

Vehicle Technologies

(ZERO EMISSION VEHICLES OR ZEV)

- PV – Plug-In Vehicles
- PHEV – Plug-In Hybrid Electric Vehicles
- FCEV – Fuel Cell Electric Vehicles

5 Emerging Battery Technologies

- Lithium-ion batteries
- Solid state batteries
- Aluminum-ion batteries
- Lithium-Sulphur batteries
- Metal-air batteries

WHY ELECTRIC TRANSPORTATION?

- **No Fossil Fuel Needed (RE source is cheaper than oil)**
- **Fewer vehicle parts to maintain**
- **Cheaper and cost-effective as compared to gasoline**
- **Reduce air pollution or zero emission, improving public health and reducing ecological damage**
- **End-to-end efficiency increase (21% vs 62%) gasoline vs grid power to wheel power**
- **Electric motors has better torque**
- **Charging EV on Renewable Energy like Solar or Wind (charging stations all over India like PCOs in 1970s)**
- **EV as Distributed Energy Sources can be used to Power your house, back up Grid and reduce PEAK power**

EV CHARGER

Tesla's Public Charging System



Not Just Cars

- **Transit** – Electric buses are in service in over 60 + cities
- **Airports**
- **Seaports** – electrified
- **Fleet** – Utility companies investing more than billions
- **Support Electric Grid** (excess power)
- **EV as Distributed Resources** Reduce Utility Peak Demand
- **EV to power your house**

THE BYD ELECTRIC BUS

BYD CHINA'S BEST ELECTRIC BUS



BENEFITS OF GOING ELECTRIC

- **Reduce the emissions (CO₂)** that contribute to Climate Change and Global Warming
- Provide greater **diversity of fuel choices** available for transportation
- **Cheaper and cost-effective** as compared to gasoline
- **EV charging on Renewable Energy** (solar or wind)
- Advantage of **charge EV at night**
- **Distributed PV, Micro-grids** will reduce the money spend on grid expansion

BENEFITS OF GOING ELECTRIC

- **Improved air quality** because EV Produce virtually no exhaust (Zero Emission)
- EVs have **potential to benefit the electrical grid**
- Response and storage strategies to help integrate Renewables and EVs (**can help balance load**)
- **EVs have superior technology** to ICEVs
- **Reduced operational and maintenance costs**
- EVs **electric motors are safer, quieter, and don't smell**

EV CHARGER

Shopping Mall Public Charging System



HOW TO EXPAND THE EV MARKET

- EVs' range will expand to 200 to 400 miles per charge (**500 miles is coming soon**)
- Battery prices have come down 73%/kWh since 2010
- EV can recharge 15 to 30 minutes or less
- More models will become available
- EVs are nearing price parity to ICE vehicles
- **EV Instant charging** in the pipe line
- Solar Roadways – **Charging car while driving** (EV Charging Lane on the road)

EV CHARGING ROADWAYS



HOW TO BRING EVs IN INDIA FASTER

- **EV Incentives/Rebate** (Central+ State Government schemes)
- Develop **favorable policies**, standards and infrastructure support
- **Infrastructure:** Develop EV Charging Network in shopping centers, Malls, Highways, etc.,
- **State and local financial support** of new infrastructure
- Private sector action on **Fast DC chargers**

USA FEDERAL INCENTIVES

- Each automaker's eligible plug-in vehicles can receive a credit of up to **\$7,500 until the 200,000th** eligible vehicle is registered inside the U.S.
- At the time of the 200,000th sale, full credits continue for the remainder of that quarter and continue until the end of the next quarter
- Credit is then reduced to **\$3,750 for the next 6 months**, then reduced again to \$1,875 for the next 6 months before expiring completely

OPPORTUNITIES FOR UTILITY COMPANIES

- Additional Revenue from PV charging for electric transportation
- Night EV charging will bring Energy and capacity cost down
- Improved system utilization will bring down pressure on rate increases

EV CHARGER

Work Place Public Charging System



SUMMARY

EVs OFFER MANY BENEFITS TO SOCIETY:

- “**GREEN**” Renewable Energy based Integration and Energy Storage
- Price-Stable Domestic fuel source (India has abundant FREE Sunshine)
- More efficient (**kWh/km travel cost**)
- **Excess power can feed grid network**
- **Air Quality & Human Health:** Clean Pollution and reduce Global Warming and Climate Change

SOLAR ROADWAYS ARE COMING



Conclusions

- Electric transportation is real
- The question isn't if, but how quickly can we scale?
- Electric companies can help accelerate the transition - Improved system utilization puts downward pressure on rates
- **Now is the time to build on momentum**

INDIA NEEDS A MASSIVE "SOLAR ROOFTOP WITH STORAGE" AND "ELECTRIC CARS" TO BRING "GREEN ENERGY" REVOLUTION

– By Darshan Goswami

[http://solaretribe.org/pdocss/1473024631INDIA%20NEEDS%20A%20MASSIVE%20SOLAR%20ROOFTOP%20WITH%20STORAGE%20AND%20ELECTRIC%20VEHICLES%20TO%20BRING%20GREEN%20ENERGY%20REVOLUTION%20\(2\).pdf](http://solaretribe.org/pdocss/1473024631INDIA%20NEEDS%20A%20MASSIVE%20SOLAR%20ROOFTOP%20WITH%20STORAGE%20AND%20ELECTRIC%20VEHICLES%20TO%20BRING%20GREEN%20ENERGY%20REVOLUTION%20(2).pdf)

SOLAR PARKING LOT



2018 - The 10 Most Anticipated Electric Cars

1. 2018 Nissan LEAF



2018 - The 10 Most Anticipated Electric Cars

2. 2018 Faraday Future FF91



2018 - The 10 Most Anticipated Electric Cars

3. Tesla – Model 3



2018 - The 10 Most Anticipated Electric Cars

4. 2018 Audi-etron



2018 - The 10 Most Anticipated Electric Cars

5. 2018 Mercedes Benz C-Class



2018 - The 10 Most Anticipated Electric Cars

6. 2018 Jaguar-I-Pace



2018 - The 10 Most Anticipated Electric Cars

7. 2018 Porsche- Panamera 4 E-hybrid



2018 - The 10 Most Anticipated Electric Cars

8. 2018 Aston-martin rapid-e



2018 - The 10 Most Anticipated Electric Cars

9. 2018 Mitsubishi - i



2018 - The 10 Most Anticipated Electric Cars

10. 2018 Hyundai – Ioniq-7



Solar Energy will Make India's Future Very Bright

THANK YOU!

ENVISION INDIA POWERED ENTIRLY BY RENEWABLES

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ADDITIONAL INFORMATION

- **“How Concentrated Solar Power Can Meet India’s Future Power Needs”** by Darshan Goswami, M.S., P.E.
http://www.energypulse.net/centers/article/article_display.cfm?a_id=2264
- **“Solar Farming Potential in India”** by Darshan Goswami, M.S., P.E. ; EnergyPulse.net -
http://www.energypulse.net/centers/article/article_display.cfm?a_id=2457
- **“How To empower India With Big Solar Energy Plans”** - By Darshan Goswami, M.S., P.E.
http://www.energypulse.net/centers/article/article_display.cfm?a_id=2525
- **“India’s solar sunrise - By Darshan Goswami**
<http://www.renewableenergyfocus.com/view/25555/full-version-india-s-solar-sunrise/>
- **“Renewable Energy Solutions For India - Action Plan”** - By Darshan Goswami, M.S., P.E.
http://www.solaretribe.com/sites/default/files/RENEWABLE_ENERGY_SOLUTIONS_FOR_INDIA_AN_ACTION_PLAN_FOR_THE_PRIME_MINISTER_OF_INDIA.pdf
- **“CAN INDIA GO 100% RENEWABLE BY 2050?”**
By Darshan Goswami, M.S., P.E.; U.S. Department of Energy; Pittsburgh, PA; USA
<http://www.solarpowerworldonline.com/2014/05/can-india-go-100-renewable-2050/>
- **“HOW INDIA CAN BECOME A SOLAR SUPER POWER”** - By Darshan Goswami, M.S., P.E., Pittsburgh, PA, USA
<http://cleantechnica.com/2015/11/02/how-india-can-become-a-solar-super-power/>

How Concentrated Solar Power (CSP) Can Meet India's Future Power Needs

How Concentrated Solar Power (CSP) Can Meet India's Future Power Needs - By Darshan Goswami

<http://www.triplepundit.com/2010/02/rajasthan-desert-solar/>

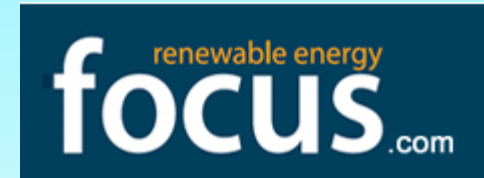
The Sun: Goldmine of Green Energy



Solar energy is an enormous resource that is readily available in all countries throughout the world, and all the space above the earth. Long ago scientists calculated that an hour's worth of sunlight bathing the planet held far more energy than humans worldwide could consume in a year.

India's solar sunrise

- **India's solar sunrise** By Darshan Goswami
- 02 May 2012



- **Full version: India's solar sunrise**
<http://www.renewableenergyfocus.com/view/25555/full-version-india-s-solar-sunrise/>

Solar Energy has the potential to re-energize India's economy by creating millions of new jobs, achieve energy independence, reduce the trade deficit and propel India forward as a 'green nation'. In short, solar offers too many benefits for India to ignore or delay its development.

CAN INDIA GO 100% RENEWABLE BY 2050?

*By Darshan Goswami, M.S., P.E.; U.S. Department of Energy;
Pittsburgh, PA; USA*

SOLAR POWER WORLD



<http://www.solarpowerworldonline.com/2014/05/can-india-go-100-renewable-2050/>

Renewable energy is the only technology that offers India the theoretical potential to service all its long-term power requirements. The Indian subcontinent is blessed with abundant renewable energy resources. For instance, taking advantage of 300 to 330 sunny days a year, India could easily generate 5000 trillion kWh of solar energy, which is higher than India's total yearly energy consumption.

ENDING INDIA'S MASSIVE POWER GRID OUTAGES – *By Darshan Goswami, M.S., P.E.; U.S. Department of Energy; Pittsburgh, PA; USA*

TriplePundit.com



<https://www.triplepundit.com/2012/09/ending-indias-massive-power-grid-outages/>

Solar energy is a game-changer for India: It has the potential to re-energize India’s economy by creating millions of new jobs, achieve energy independence, reduce the trade deficit and propel India forward as a “Green Nation.” Solar energy offers too many benefits for India to ignore or delay its development.

SOLAR FARMING POTENTIAL IN INDIA

- By Darshan Goswami, M.S., P.E.; Project Manager; U.S. Department of Energy



<http://www.triplepundit.com/2011/08/solar-farming-potential-india/>

Imagine a crop that can be harvested daily on the most barren desert and arid land, with no fertilizer or tillage, and that produces no harmful emissions. Imagine an energy source so bountiful that it can provide many times more energy than we could ever expect to need or use. Imagine that an hour's worth of sunlight bathing the planet holds far more energy than humans worldwide could consume in a year. You don't have to imagine it -- it's real and it's here. Solar energy is an abundant enormous resource that is readily available to all countries throughout the world, and all the space above the earth. It is clean, no waste comes from it, and once a system is in place, it's "free."

SOLAR ENERGY FROM THE RAJASTHAN DESERT CAN MEET INDIA'S FUTURE POWER

- By Darshan Goswami, M.S., P.E.; Project Manager; U.S. Department of Energy



<http://www.eartheasy.com/blog/2010/04/solar-energy-from-the-rajasthan-desert-can-meet-india%E2%80%99s-future-power-needs/>

The Government of India must take advantage of the vast amounts of energy available from the Rajasthan Desert sun (instead of oil from the Arab nations) to power its future energy needs. In addition, solar energy would not only create millions of jobs, but also sustain India's positive economic growth, help lift its massive population out of poverty and combat climate change.

HOW TO EMPOWER INDIA WITH BIG SOLAR ENERGY PLANS - *By Darshan Goswami, M.S., P.E.; Project Manager; U.S. Department of Energy*



http://www.energypulse.net/centers/article/article_display.cfm?a_id=2525

Solar energy can be the source of many benefits for India and the environment. Solar energy has the potential to re-energize India's economy by creating millions of new jobs, achieve energy independence, reduce the trade deficit and propel India forward as a "Green Nation." Solar Energy offers too many benefits for India to ignore or delay its development..

Go solar - *By Darshan Goswami*

LifePositive

Go solar

- By Darshan Goswami

<http://lifepositive.com/go-solar/>

June 2014

Darshan Goswami makes a strong argument for India to harness concentrated solar power, a renewable, safe and clean resource, for its future energy needs.³⁹



“HOW INDIA CAN BECOME A SOLAR SUPER POWER” - *By Darshan Goswami, M.S., P.E., Pittsburgh, PA, USA*



<http://cleantechnica.com/2015/11/02/how-india-can-become-a-solar-super-power/>

Clean air and a livable climate are inalienable human rights. And solving this crisis is not a question of politics. It is a question of our own survival.

CLIMATE CHANGE AND GLOBAL WARMING ACTION PLAN FOR INDIA

- By Darshan Goswami, Pittsburgh, PA., USA

Renewable Energy World



[http://www.renewableenergyworld.com/ugc/articles/2017/07/20/
climate-change-and-global-warming-action-plan-for-
india.html](http://www.renewableenergyworld.com/ugc/articles/2017/07/20/climate-change-and-global-warming-action-plan-for-india.html)

Clean air and a livable climate are inalienable human rights. And solving this crisis is not a question of politics. It is a question of our own survival.

How India Can Export Sunshine Around the World

*- By Darshan Goswami, M.S., P.E.; U.S. Department of Energy;
Pittsburgh, PA; USA*

Renewable Energy World



<http://www.renewableenergyworld.com/articles/2017/09/how-india-can-export-sunshine-around-the-world.html>

India's next big export could be its sunshine, as game-changing technology makes it easier to generate, store, transport and deliver “Solar Fuels.”

The Hydrogen Economy – The Future of Energy



**Indian Institute of Technology
(Banaras Hindu University),
Varanasi, India
November 6, 2012**

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Renewable Energy Solutions For India - Action Plan

**PREPARED FOR
THE PRIME MINISTER OF
INDIA
NEW DELHI, INDIA**



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The Sun: Goldmine of green energy