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# Solar Energy for Airports

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## Solar Energy for Airports

### Presentation Overview

- Solar Energy Today
  - Global Trends & the Status of Solar
  - How Solar Works
  - Markets and Applications
- SunEdison's Approach to Solar
  - Simplify Solar & Transform Lives
- Airport Solar
  - Case Study – Kuala Lumpur International Airport

Happy to take questions



SunEdison: Kuala Lumpur Airport - 2014



## Solar Energy Today

### Global Trends & the Status of Solar

“Understanding that climate change is a challenge in managing risk opens a wide range of opportunities for integrating adaptation with economic and social development and with initiatives to limit future warming.

...understanding those challenges and tackling them creatively can make climate-change adaptation an important way to help build a more vibrant world in the near-term and beyond.”

Chris Field, Co-Chair Working Group II – IPCC Press Release, 03-31-2014

**IPCC**  
INTERGOVERNMENTAL  
PANEL ON  
CLIMATE CHANGE





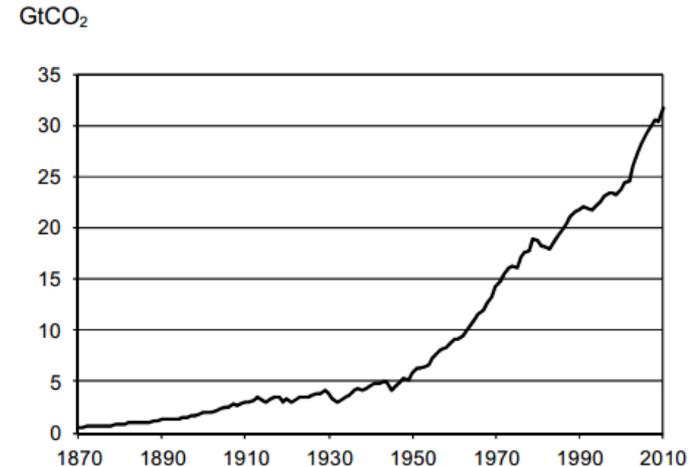
## Solar Energy Today

### Global Trends & the Status of Solar

**“Current trends in energy supply and use are patently unsustainable – economically, environmentally and socially. Without decisive action, energy-related emissions of CO<sub>2</sub> will more than double by 2050 and increased oil demand will heighten concerns over the security of supplies. We can and must change our current path, but this will take an energy revolution and low-carbon energy technologies will have a crucial role to play.”**

Nobuo Tanaka, Executive Director, International Energy Agency

**Figure 3. Trend in CO<sub>2</sub> emissions from fossil fuel combustion**



Source: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, US Department of Energy, Oak Ridge, Tenn., United States.

*Key point: Since 1870, CO<sub>2</sub> emissions from fuel combustion have risen exponentially.*



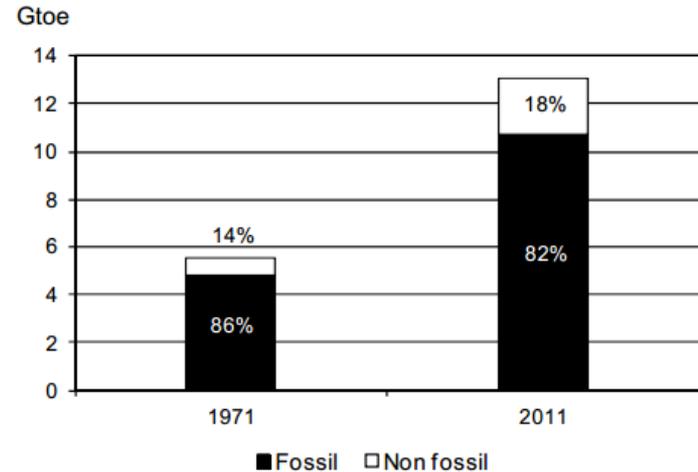
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Figure 2. World primary energy supply\*



\* World primary energy supply includes international bunkers.

*Key point: Fossil fuels still account for most – over 80% – of the world energy supply.*



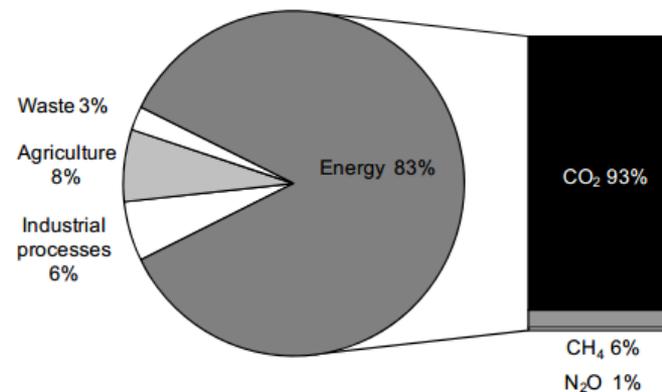
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**Figure 1. Shares of anthropogenic GHG emissions in Annex I countries, 2011\***



\* Based on Annex I data for 2011; without Land Use, Land-Use Change and Forestry, and with Solvent Use included in Industrial Processes and “other” included with waste.

Source: UNFCCC.

*Key point: Energy emissions, mostly CO<sub>2</sub>, account for the largest share of global GHG emissions.*



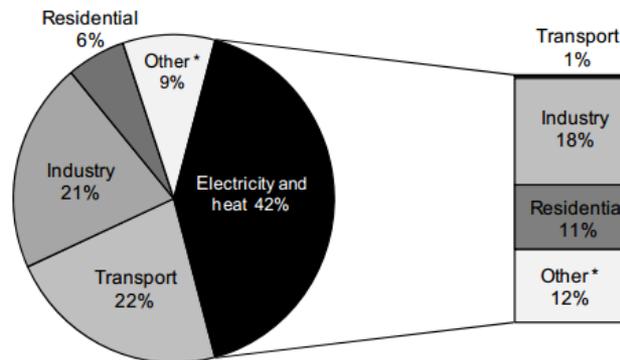
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Figure 9. World CO<sub>2</sub> emissions by sector in 2011



Note: Also shows allocation of electricity and heat to end-use sectors.

\* Other includes commercial/public services, agriculture/forestry, fishing, energy industries other than electricity and heat generation, and other emissions not specified elsewhere.

*Key point: Two sectors combined, generation of electricity and heat and transport, represented nearly two-thirds of global emissions in 2011.*



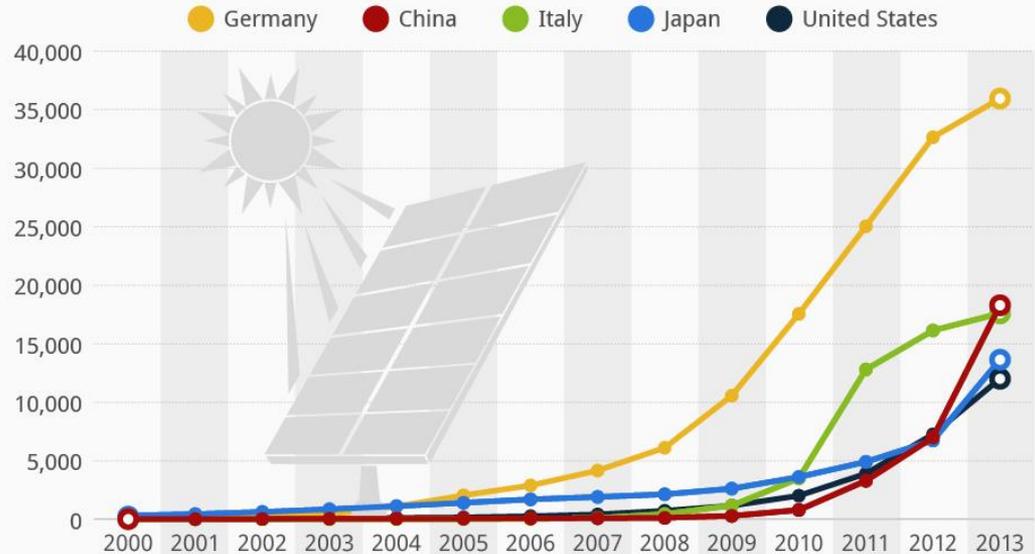
## Solar Energy Today

### Global Trends & the Status of Solar

- Low Carbon Pivot Emerging
  - Energy demand is growing but efficiency is increasing
  - Resource depletion, environmental impact and climate change are key drivers
  - Electricity market share to increase (transportation a key driver)
  
- IPCC & IEA:
  - Key focus now on adaptation and mitigation: Renewables

### Solar Power Made Massive Strides in 2013

Cumulative installed solar photovoltaics capacity in leading countries (in megawatts)



@StatistaCharts Sources: BP, Earth Policy Institute



## Solar Energy Today

### Global Trends & the Status of Solar

- Solar is a proven solution
  - Rapid growth in nearly every region of the world
  - Global energy costs are rising, while solar energy costs are declining.

“Investments in new clean-energy capacity will total \$1.61 trillion through 2020 even as the expansion of renewables is expected to slow”  
Stefan Nicola, Bloomberg (reporting on IEA)

“...by 2050, PV will provide around 11% of global electricity production and avoid 2.3 gigatonnes (Gt) of CO2 emissions per year.”

IEA, 2010

Figure 2.1 U.S. PV Installations and Average System Price, 2000-2013



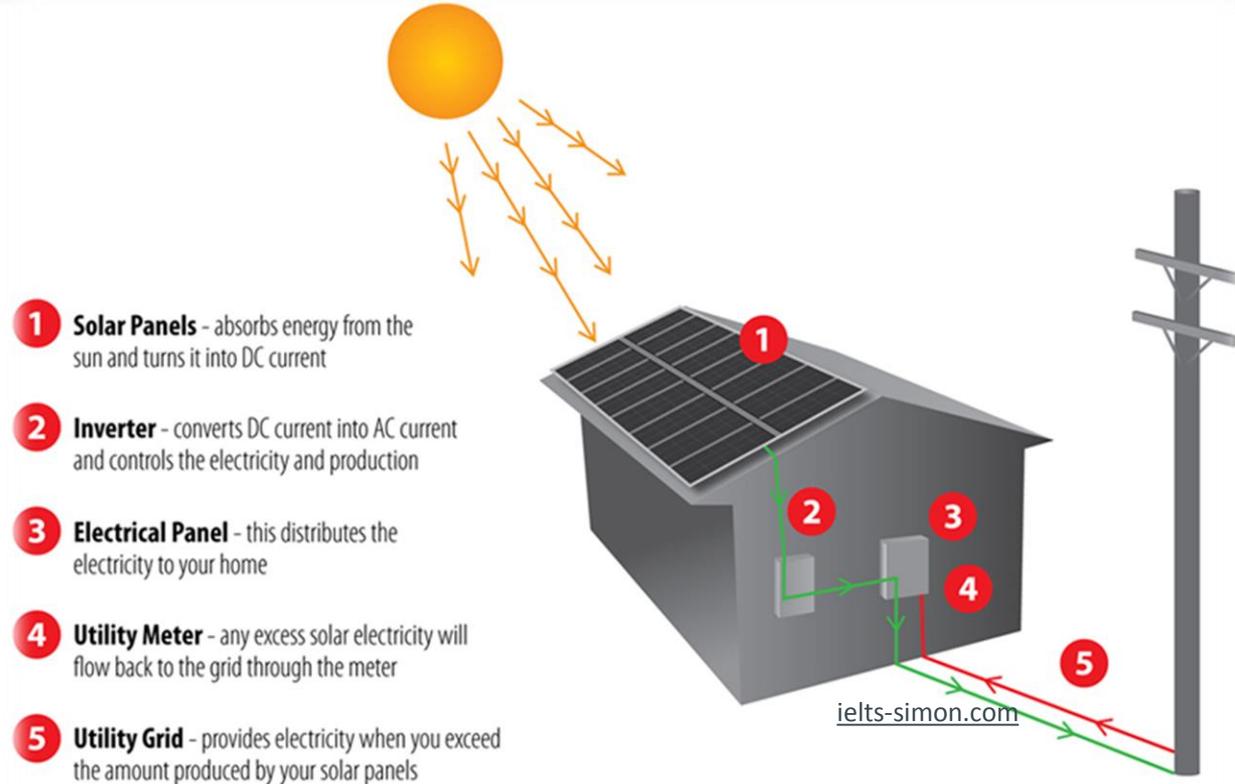
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## Solar Energy Today

### How it works

- Solar Photovoltaics:
  - Sunlight to electricity
- Other types of solar energy
  - Solar Thermal:
    - air heating and water heating
  - Concentrating Solar:
    - geographic limitations
  - Thin Film and BIPV:
    - available today but expensive

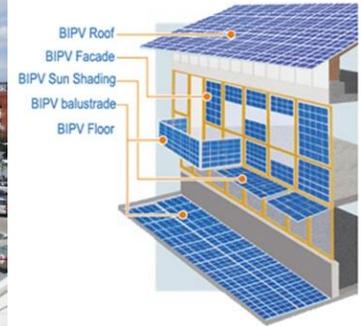




## Solar Energy Today

### Market Segments and Applications

- Primary market segments
  - Utility
  - Commercial and Industrial Rooftops
  - Residential
  - Off-grid & Emerging Markets (more on this later)
  
- Applications:
  - Rooftop
  - Ground Mount
  - Carport/Canopy
  - BIPV





## SunEdison

### Simplify Solar and Transform Lives

- We simplify solar with a vertically integrated turnkey approach
  - We develop, finance, and operate solar energy solutions worldwide from some of the world's largest solar deployments to our residential customers' rooftops.
  - Our solar energy solutions reduce the world's dependence on fossil fuels.
- Global market leadership
  - One of top three developers in the world
- Long-term vision and culture of innovation
  - MEMC + SunEdison
  - Innovation happens everyday



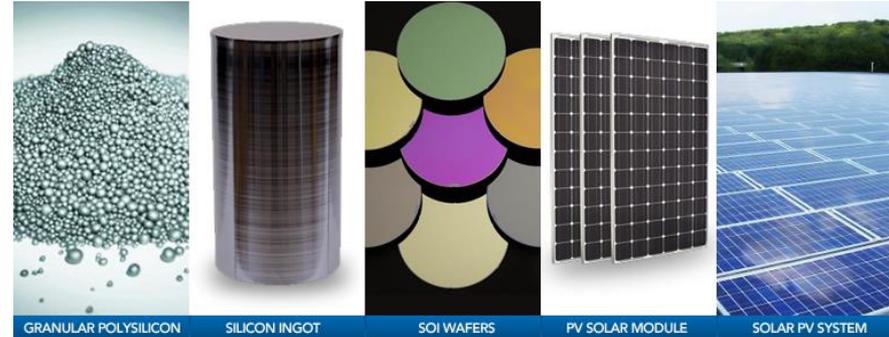
INTELLIGENT  
ENERGY  
SOLUTIONS  
FROM A GLOBAL  
LEADER

POWER COMPANIES | BUSINESSES  
PUBLIC SECTOR | RURAL ELECTRIFICATION



## SunEdison Simplify Solar and Transform Lives

- **Company Strength:**
  - NYSE: SUNE (~\$6 billion market capitalization)
  - Fortune 1000
  - 5000+ Employees
  - 39 Locations around the world
- SunEdison builds on a vertical process that seamlessly integrates our services.
  - This benefits our customers because we have control over quality at every step of the process and we are able to offer predictable forward cost curve visibility to our customers
- **Renewable Operations Centers (ROC)**
  - Real-time performance monitoring and maintenance.
  - System analytics, including GHG emission reductions.



GRANULAR POLYSILICON    SILICON INGOT    SOI WAFERS    PV SOLAR MODULE    SOLAR PV SYSTEM





## SunEdison

### Simplify Solar and Transform Lives

- Eradication of Darkness Initiative
  - 159 kilowatts (kW) of solar PV micro-grids with battery storage in six remote Indian villages, which will bring electricity to, and thereby improve health and education for, 4,875 off-grid people.
  - A brighter education
  - Better, safer quality of life
  - New economic opportunities
  - Improved communication
  - A healthier community
- Innovative solutions:
  - SunEdison's 1 MW Solar Power Plant suspended above the Narmada Canal is expected to save 2 million gallons of drinking water per year by reducing water evaporation and minimizing algae growth.

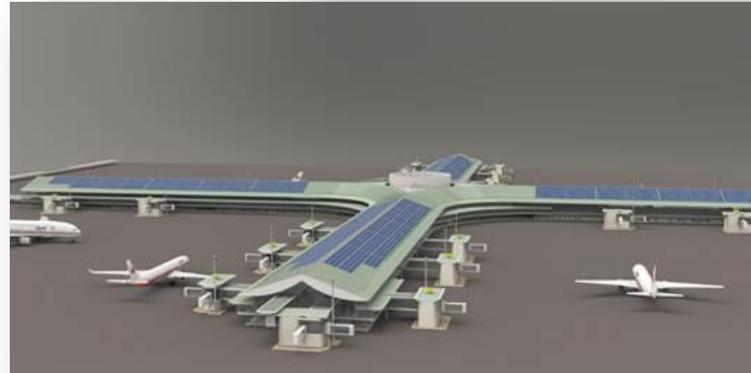




## Solar Airports

### A Viable Option Today

- Solar is a viable option for airports to:
  - Reduce GHG emissions
  - Offset grid electricity
  - Protect from grid power failures
  - Engage passengers
  - Attract positive media attention
- Application options:
  - Rooftop
  - Ground Mount
  - Canopy
  - BIPV
  - Other? Case by case opportunities





## Solar Airports

### Case Study

- Kuala Lumpur International Airport
  - 19 MW (4MW rooftop, 10 MW parking canopy, and 5MW ground mount)
  - Owned by SunEdison.
  - Power sold to local utility through Feed-in Tariff (FIT) program.
  - Airport incurred zero project costs and receives lease payment revenue.
  - SunEdison handled all project development, permits and approvals, financing, engineering, construction and commission and now operates and maintains
- Airport expected to save ~2.1 million RM (~US\$627,000) per year based on current energy costs.





## Solar Airports

### Case Study

“Rooftops, parking lots and 'buffer' areas at airports are traditionally not multi-purpose facilities, but we've turned them into a clean energy generation facility... This initiative also demonstrates our support towards the Government's initiative in introducing renewable energy and also to further reduce carbon footprint.”

Tan Sri Bashir Ahmad, Managing Director  
Malaysia Airports





## Solar Airports

### Case Study Continued

- Kuala Lumpur International Airport
  - Rooftop Installation
  - **Location:** Sepang, Selangor, Malaysia
  - **Size:** 4 MWp (DC)
  - **Energy Generation projection:** 5000 MWh per year
  - Largest Roof top Project in Asia at and largest capacity project in the world for a single-airport-roof PV project.





## Solar Airports

### Case Study Continued

- Kuala Lumpur International Airport
  - Ground Mount Installation
  - **Location:** Sepang, Selangor, Malaysia
  - **Size:** 5 MWp (DC)
  - **Energy Generation projection:** 7615 MWh/year
  - **Type:** Single Axis Tracker
  - 36 acres of Oil Palm land
  - First of its kind in Malaysia
  - The regulatory body SEDA has chosen this as a reference project in the field of Solar RE which was visited by delegates from ASEAN Centre for Energy (ACE) which is an intergovernmental organization established by ASEAN nations.





## Solar Airports

### Case Study Continued

- Kuala Lumpur International Airport
  - Canopy/Carport
  - **Location:** Sepang, Selangor, Malaysia
  - **Size:** 10 MWp (DC)
  - **Energy Generation projection:** 13556 MWh/year
  - **Type:** Parking Canopy Solar PV Project
  - 60 acres in the Long Term Car
  - This is one of the largest Solar Parking Canopy project in the world. The project provides Solar PV based roof-shelter to about 4570 parking bays.
  - This parking space will be also catering to the increased passenger traffic of the new terminal of Kuala Lumpur International Airport scheduled to be operational later part of 2014.





## Solar Airports

### Case Study Continued

- Kuala Lumpur International Airport
- Engineering Studies:
  - Full engineering studies (similar to any solar project or construction project).
  - Roof capacity engineering study, including clamp test (pull and slide test) on roof.
  - Drainage and water flow study for both roof, canopy and ground mount projects.
  - Glint & Glare study for Department of Civil Aviation to get the no objection certificate (NOC) for all the projects in the vicinity of the airport.
  - During execution attained a Permit To Work for inside airport areas (vehicle passes and security passes for all workers and staff, approvals from the internal airport authorities for cable routing, location of the various equipment).



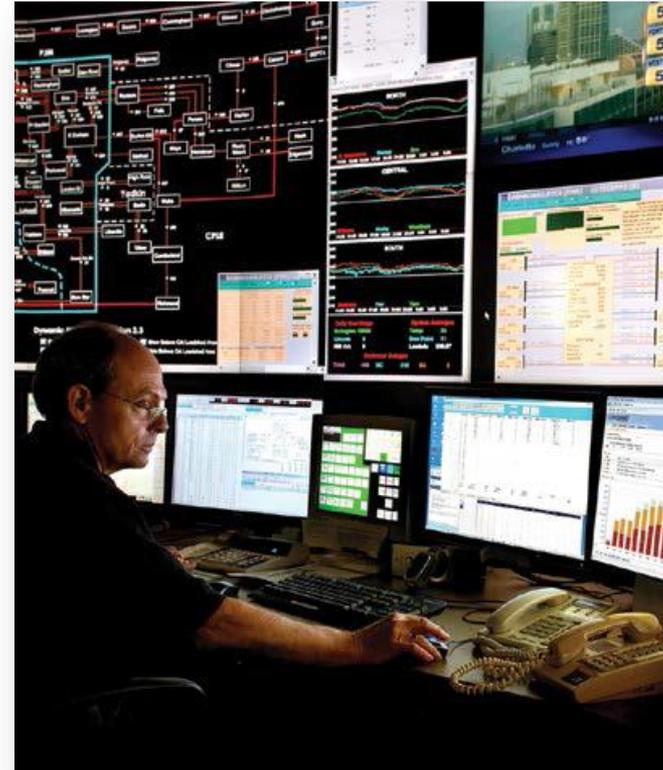
The FIT rates for the 3 projects are:

1. Ground Mount 5MW – 0.90 RM/kWh
2. Parking Canopy 10 MW – 1.37 RM/kWh
3. Rooftop 4MW – 1.14 RM/kWh



## Solar Energy Tomorrow Intelligent Energy Solutions

- Integrated, intelligent energy solutions.
- Key trends to watch:
  - Electric Vehicles (and electrification of transportation generally)
  - Battery storage
  - Smart Buildings
  - Smart Meters/Grids
- Operational projects already exist in many jurisdictions and trend will only grow.
  - Many argue it is simply a matter of time before widespread adoption.
  - Utility role still in question.





## Thank You

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