Type them into questions box!

“Why am I muted?”
Don’t worry. Everyone is muted except the presenter and host.
Thank you and enjoy the show.

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- ACS Leadership Development System
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- College to Career
- ACS Webinars
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Talk Industry + Career Development with Top Chemists

VIRTUAL
ACS Virtual Career Day
SATURDAY, NOVEMBER 21
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**ASSESSING TRANSPORTER LIABILITIES AND IDENTIFICATION TRANSPORTOMICS**

**LA QUÍMICA COMPUTACIONAL DE LOS RADICAL-MOLÉCULA**

**STARTING A COMPANY: WHERE DO YOU GET FUNDS?**

**Monday, December 1, 2020 at 2:30pm ET**
Speakers: Bryn E. Bode, BCI at ICN Biomed and Mark C. Schleiffer, Merck & Co.

**What You Will Learn**
- The role of drug-induced liver injury
- The importance of drug discovery
- Development of in vivo and in vitro models
- The role of transporters in drug metabolism
- The role of transporters in drug disposition
- The role of transporters in drug-target interactions
- The role of transporters in drug toxicity
- The role of transporters in drug development

**Tuesday, December 2, 2020 at 2:30pm ET**
Speakers: John R. Knoepfler, PhD, and Thomas J. Forster, PhD

**What You Will Learn**
- The role of drug-discovery and drug-development
- The importance of drug-discovery and drug-development
- The role of drug-discovery and drug-development
- The role of drug-discovery and drug-development
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- The role of drug-discovery and drug-development
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**Wednesday, December 3, 2020 at 2:30pm ET**
Speakers: Michael J. McNamee, PhD, and Brian J. M. O’Connell, PhD

**What You Will Learn**
- The role of drug-discovery and drug-development
- The importance of drug-discovery and drug-development
- The role of drug-discovery and drug-development
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**Thursday, December 4, 2020 at 2:30pm ET**
Speakers: John R. Knoepfler, PhD, and Thomas J. Forster, PhD

**What You Will Learn**
- The role of drug-discovery and drug-development
- The importance of drug-discovery and drug-development
- The role of drug-discovery and drug-development
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**Friday, December 5, 2020 at 2:30pm ET**
Speakers: John R. Knoepfler, PhD, and Thomas J. Forster, PhD

**What You Will Learn**
- The role of drug-discovery and drug-development
- The importance of drug-discovery and drug-development
- The role of drug-discovery and drug-development
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**Saturday, December 6, 2020 at 2:30pm ET**
Speakers: John R. Knoepfler, PhD, and Thomas J. Forster, PhD

**What You Will Learn**
- The role of drug-discovery and drug-development
- The importance of drug-discovery and drug-development
- The role of drug-discovery and drug-development
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**Sunday, December 7, 2020 at 2:30pm ET**
Speakers: John R. Knoepfler, PhD, and Thomas J. Forster, PhD

**What You Will Learn**
- The role of drug-discovery and drug-development
- The importance of drug-discovery and drug-development
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Here Comes the Sun: Advances In Solar Power

November 17, 2020

Vijay Kapur
CEO (retired), International Solar Electric Technology
Here Comes the Sun: Advances in Solar Power

Presentation slides are available now! Edited recordings are an exclusive ACS member benefit.

www.acs.org/acswebinars

This ACS Webinar is co-produced with the Science History Institute and Chemical and Engineering News.

Vijay Kapur
CEO (retired), International Solar Electric Technology

Bill Tuszyński
Partner, The Unami Group LLC
Sustainability Challenges  
(similar to UN SDGs)

- Climate Change
- Access to Clean Water
- Eco-friendly Agriculture
- Zero Emission Transportation
- Access to Digital Information
- Education
- Economic Opportunities
- Health Care
- Affordable and Comfortable Habitats
  - Heating and Cooling
  - Cooking Facilities
- Poverty Eradication

Abundant and low-cost solar energy provides possible solutions to all of these challenges.

Historic and Current Level of CO2 in the Atmosphere and the Impact of Climate Change

Major Climate Change Impacts

- More Frequent Extreme Weather Events
- Curtailed Fresh Water Resources (Melting of Glaciers)
- Rising Sea Levels
- Mass Migration of Climate Refugees

Oct.2020 CO2 Level 411 ppm
Cumulative CO2 in Atmosphere about 3200 Billion MT
Annual Increase in CO2 about 40 Billion MT
Urgent Actions Needed to Correct Climate Change

- Curtail Local Emissions of Greenhouse Gases and Establish Systems for CO2 Sequestration
- Minimize use of Fossil Fuels
- Promote Clean Public Transportation
- Replenish Lost Greenery by Planting Trees
- Sustainable Agriculture and Promote Vertical Farming

Maximize the Use Solar Energy

Solar Abundance

- Ubiquitous sunshine has sustained life on earth for billions of years
- The challenge we face now, is to use it wisely without polluting the Environment
Solar Energy Spectrum

$\rightarrow AM0 = 1.37 \text{ KW/M}^2$

$\rightarrow AM1.5: = 1.0 \text{ KW/M}^2$

Available Solar Resource: Worldwide
Available Solar Resource: USA

Harnessing Solar Energy
Photovoltaics (Direct Conversion of Sunlight to DC Electric Power)

Cross-Section & Semiconductor Band-gap vs. Solar Cell Conversion Efficiency

Types of PV Cells—Classified by Absorber Material

**First Generation:**
- Monocrystalline Si
- Polycrystalline Si
- III-V Compound semiconductors (GaAs)

**Second Generation:**
- Amorphous Si
- CIGS (CuInGaSe₂)
- CdTe
- Multi-junction

**Third Generation:**
- Perovskite
- Organic PV
- Dye-sensitized cells
- Quantum Dot
Processing Silicon into PV Cells & Modules

Multi-Junction “Rainbow Cell”
Best Efficiencies

Historical Cost Lowering Milestones: 1977-2018

Cell Manufacturing Cost($/Watt)
Installed Cost of PV Systems at Various Scales

Price of Electricity

The average cost of energy in North America

SunShot Progress and Goals
Projections of World Power Generation & Cumulative Installed PV (2010 – 2030)

Advantages of Solar PV Systems

- It converts solar energy directly into electrical energy without going through thermal-mechanical link. It has no moving parts.
- Solar PV systems are reliable, modular, durable and generally maintenance free.
- These Systems are quiet, compatible with almost all environments, expected life span of 20 years or more.
- It can be located at the place of use and hence no distribution network is required.
Energy Storage

- **Batteries** — a range of electrochemical storage solutions, including advanced chemistry batteries, flow batteries, and capacitors

- **Thermal** — capturing heat and cold to create energy on demand or offset energy needs

- **Mechanical Storage** — other innovative technologies to harness kinetic or gravitational energy to store electricity

- **Hydrogen** — excess electricity generation can be converted into hydrogen via electrolysis and stored

- **Pumped Hydropower** — creating large-scale reservoirs of energy with water

Grid-connected & Battery-Backed PV Systems
Vertically mounted PV Systems

South and west facing vertically mounted PV systems, at locations of latitudes 40 N or higher, yield 60% of the max. output.

At 20 N the output is about 50%.

With very low PV system prices competing with the high price of land in big cities, the ROI of vertically mounted PV systems is quite attractive.

Flotovoltaics

- Water provides natural cooling of arrays and enhances their output
- Large PV systems placed on an ocean surface provide a convenient means of producing clean water via desalination
Agrivoltaics

Agrivoltaics is co-developing the same area of land for both solar photovoltaic power as well as for agriculture.

Benefits:
- Dual use of land
- Reduced electricity cost
- Diversification of revenue stream
- Control of wind and soil erosion
- Water saving
- Improved crop production

Remote Applications

- Village Water Pumping
- Power for Cellular Towers
- LED Street Lights
- Parking Meters
- Trash Compactors
Global Energy Consumption

- World's Daily Power Consumption: 15.8 TW
- US Daily power consumption: 3.35 TW
- Daily Incident Power on Planet Earth: 174,000 TW

1 Terawatt (TW) = 1 Trillion Watts

Energy Access

- **940 million** (13% of the world) do not have access to electricity. [Link](https://ourworldindata.org/energy-access#access-to-electricity)

- **3 billion** (40% of the world) do not have access to clean fuels for cooking. This comes at a high health cost for indoor air pollution. [Link](https://ourworldindata.org/energy-access#access-to-clean-fuels-for-cooking)

- Per capita electricity consumption varies more than 100-fold across the world. [Link](https://ourworldindata.org/energy-access#how-does-per-capita-electricity-consumption-vary-across-the-world)

- Per capita energy consumption varies more than 10-fold across the world. [Link](https://ourworldindata.org/energy-access#how-does-per-capita-energy-consumption-vary-across-the-world)

- Energy access is strongly related to income: poorer households are more likely to lack access. [Link](https://ourworldindata.org/energy-access#low-income-households-lack-access-to-electricity-and-clean-fuels)
HDI vs. Annual Electricity Consumption per Capita (KWh)

Providing an affordable 0.5 to 1.0 KW PV system to people living in sunny countries, can improve the quality of their life significantly.

Solar Powered Extraction of Potable Water from Air

Very active field. A variety of different approaches have been developed. Some require electric power while others work on a temperature gradient and choice of a number of efficient absorbers.
Solar Water and Space Heating

- Space heating can be done with fan coil heat exchanger or by radiant heat from the embedded hot water pipes in the floor

---

Solar Cooking - Sun Oven and Go-Sun

- Cook, Bake, Dehydrate or Boil with the World’s Most Universal Power Source… Free Sunshine!
- Reaches Temperatures of 360 to 400 Degrees Fahrenheit!
- Bake, Boil or Steam Foods — Boil or Pasteurize Water!
- The most energy-efficient way to re-hydrate freeze-dried emergency preparedness foods.
- Dehydrate Fruits, Vegetables or Jerky!
- Slow cook or cook in comparable time to conventional stove tops or ovens!
- Totally Safe — No Danger of Fire!
- As Portable as a Small Suitcase — Only 23 lbs!
- Ruggedly Built for Years of Trouble-Free Use!
- Everything you need to cook, dehydrate, bake and pasteurize water with the power of the sun.
Community Cooking with Solar Generated Steam

Solar Steam Cooking Facility at Mt Abu India

Cooks **20,000 Meals Daily** with little carbon foot print.

A number of other religious centers in India have established similar facilities and are preparing **> 30,000 meals a day**.
People can be trained in a short time to work on projects in solar energy
Advanced college degree is not required for this training
Focused and accelerated training programs can help reduce the poverty level

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Thank you for your interest and attention.

Materials and data used in this presentation has been drawn from the reports & websites of the following: DOE, NREL, EIA, IRENA, REN21, WIKI-SOLAR ORG, SEIA, FRAUNHOFER ISE AND OTHERS.
See you January 21, 2021

Fluid Movements: Interpreting the History, Present, and Future of Water

Jahnavi Phalkey
Founding Director, Science Gallery
BengaluruResearch

Jesse Smith
Research Curator, Science History Institute

Here Comes the Sun: Advances in Solar Power

Vijay Kapur
CEO (retired), International Solar Electric Technology

Bill Tuszyński
Partner, The Unami Group LLC

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