

***Cornell University:  
Clean Energy Analysis***

Ithaca, 29th March 2013

# CLEAN ENERGY (CE) AT CORNELL OUTLINE

- Current Situation
- Why Clean Energy (CE)?
- Awareness of CE at Cornell.
- What about knowledge?
- Cornell CE: Some ideas.

# PACO'S BACKGROUND

- Bachelor's degree in Economics, University of Cantabria, and a Master of Business Administration, IESE, University of Navarra.
- Managing Director of the Regional Development Agency in Cantabria. Experience in the creation of startups and clusters, and a member of more than 20 Boards of Trustees at private and public companies.
- Responsible for Corporate Strategy in the area of Ocean Energy. 1<sup>st</sup> Ocean Energy cluster in Spain.

# CORNELL: CURRENT SITUATION

- Cornell Clean Companies
- Cornell Clean Products / Patents .
- Awarded CE Projects in energy R&D.
  - Cornell Program: Academic Venture Fund (AVC)
  - NYS: Proof-of-Concept Centers
  - Federal Program (DOE): Arpa –E, EFRC, IEH
- Key points

# Clean activities: Areas of interest

## Sources

- Ocean energy: wind, waves, tidal
- Onshore Wind
- Solar
- Biomass
- Geothermal
- Hydraulic

## Infrastructure, transportation:

- Electric vehicle
- Storage
- Efficiency
- Environmental
- Smart grids
- Carbon capture

**CLEAN ENERGY: A WIDE RANGE OF ALTERNATIVES**

# CE COMPANIES WITH CORNELL TECH

- Eight companies in four clean or green areas:
  - **Polymers:** e2e materials, Novomer, Nano Surfaces.
  - **Storage Energy – Batteries:** NOHMS, Widetronix.
  - **Semiconductors:** Rosestreets Labs, Kionix.
  - **Environmental:** Terrenew.
- Three of them appear in the 50 more promising CE companies of New York State (*Green Capital Empire ranking. Sept 2012*).

# CCTEC: CE PRODUCTS / PATENTS

- **CCTEC CE Products:** Brochure about the market based on licensed Cornell Technology. *No specific CE products.*
- **CCTEC CE Patents:** “approximately” 30 patents in 9 different specializations.
  - Energy storage - Batteries (15), Ocean – Polymer for biofouling (4), Semiconductors (2), Biofuels (2), Solar (2), Algae (1), Biomass (1), Wind (1), Environmental (1).

NO PRODUCTS, AND AGAIN, MATERIAL SPECIALIZATIONS

# Cornell Program - Academic Venture Fund (AVF)

- Atkinson Center for a Sustainable Future : To foster **interdisciplinary collaboration** for Cornell faculty, students, and research staff.
- Seed funds: An average of \$100k/project.
- Results: 9 Clean Energy of 38 awarded projects in 5 years, 3 projects in the last 3 years:
  - Algae (3), Wind (2), Electric Vehicle (1), Biomass(1), Solar(1), Efficiency(1).

**GOOD SEED FUND, NOT INDUSTRY INVOLVED**



# CE: NYS FUNDS

The New York State Energy Research and Development Authority (**NYSERDA**):

- Proof-of-Concept Centers: dedicated to helping **grow clean energy businesses**, entrepreneurs' high-tech. \$5 million each Center in seed money over five years.
  - High Technology Rochester Inc. (HTR): partnering with Cornell University.
  - Columbia University: partnering with Cornell University's NYC Tech
  - The Polytechnic Institute of New York University

# DOE: PROGRAMS IN ENERGY R&D

Department Of Energy (DOE): Three different federal aids and categories.

- Advanced Research Projects Agency – Energy (ARPA-E): ~ \$1M
  - Basic Research: To accelerate an immature energy technology with exceptional potential.
  - Too risky for industrial investments, funding scientists and technologists.
  - **Mainly, Professor or University Groups.**
- ENERGY FRONTIER RESEARCH CENTERS (EFRC):~\$20M
  - Basic research: needed to overcome roadblocks to revolutionary energy technologies.
  - Mostly multi-institutional centers composed of a self-assembled group of investigators.
  - **Mainly University Groups or Public Labs.**
- ENERGY INNOVATION HUB (EIH):~\$100M
  - **Robust links to industry**
  - The Hubs bridge the gap between basic scientific breakthroughs and industrial commercialization.
  - Initial awards are for a maximum of \$122 million over the five year term.

# DOE: ARPA-E AWARDS AT CORNELL

- **Biofuels 2012 Program** - \$910K grant for a new type of bioreactor that efficiently delivers light and collects fuel produced by **algae**. Cornell Professors.
- **Smart grid 2012 Program** - \$1,300K. New software platform for grid operators called GridControl that will utilize **cloud computing** to more efficiently control the grid. Cornell Professor.
- **Energy storage 2011 Program** - \$1,000K NAVITASMAX company, a novel heat **storage method for solar** and nuclear applications. The project team includes Harvard University, Cornell University, Nano Terra and Barber-Nichols.

# DOE: EFRC (ENERGY FRONTIER RESEARCH CENTERS) AT CORNELL

Projects: 46 EFRC in US.

- **Energy Storage:** Lead institution Emc2 “Energy Materials Center” at Cornell, to help nanoscientists enhance the **performance of fuel cells, batteries, photovoltaics and photo-electrochemical cells.** \$18.25 million over five years (Federal + NY State Funds). Includes 14 faculty members from five departments and two colleges.
- **Superconductors:** Center for Emergent Superconductivity involving Cornell Professor J.C Seamus Davis. Some materials can improve superconductors’ performance, - **conduct electricity without heating or energy loss** – and could lead to more efficient motors and generators.

**MORE ACTIVE GROUPS, ALSO IN STARTUPS AND PATENTS**

# DOE: ENERGY INNOVATION HUB (EIH)

- Full spectrum of R&D performers: universities, private industry, non-profits, and government laboratories.
- To become a world-leading R&D center.
- Topical areas:
  - Integrating *smart materials* into buildings to designing
  - New materials needed to convert *solar energy* into electricity
  - Challenges of devising advanced methods of *energy storage*
  - *Fuels directly from sunlight* without the use of plants or microbes.
  - Focus on the supply of *rare earth elements* which is controlled by China.

NO CORNELL REPRESENTATION

# CE AT CORNELL: KEY POINTS

- Ranking of the top 10 clean-tech universities in USA, Cornell occupies 8<sup>th</sup> position. *(Cleantech Group, 2010)*
- Few CE researchers collaborating with industry *(New York state's task force Report, Dec. 2009)*
- A clear basic research specialization, in storage energy – batteries.
- Clean Energy is a research focus, but not one of the most prominent focuses.

# Why clean energy?

- **Energy security:**
  - USA has 2% of current oil production and uses 21%, highest world consumer.
  - World population could rise from 7 billion to 10 billion by 2030. In terms of electricity, world will require double the amount of power by 2050.
- **Environment:**
  - Fossil fuel is driving climate change: impacts on water, air and water pollution. Loss of biodiversity.
- **Economic well-being.**

**AND, WHAT ABOUT BUSINESS OPPORTUNITY?**

# Clean Energy: Potential market

- The worldwide **Private** sector investment in 2012 was \$282 billion.
- **Federal** support for Clean Energy **R&D**: received \$90 billion from the stimulus package four years ago. March 2013: "Obama proposes \$2 billion plan for clean energy technology research".
- "Every dollar invested [in Atkinson] programs results in another 10 dollars" of support from **other investors**.

HUGE POTENTIAL, A LOT OF POSSIBILITIES...



# NYS: ENERGY SOURCES FRAMEWORK

- **New York State potential:** (Stanford & Cornell Report. 2013)
  - Onshore and offshore **wind** turbines.
  - Rooftop and standalone utility scale **solar** arrays.
  - **Geothermal** power plants.
  - **Ocean** wave, tidal turbines, and **hydroelectric**.
- The bulk of the energy would come from local wind power (40%) and local solar power (38%)

SOLAR POWER IN NEW YORK STATE? IN ITHACA???

# Solar example: Germany

Germany beats the US in solar power capacity:

- German Solar Power Energy, is 32.5 GW and the U.S. has over 7.7 GW (3.3 GW in 2012)
- Germany has over 21 times more solar power per capita than the US.

WHAT AMERICAN STATE HAS A SIMILAR SOLAR RESOURCE?



# CE Cornell Options

- **Hydroelectric:** current hydro plant upgraded and operational
- **Solar:** optimal?
- **Wind:** good resource, siting faces issues
- **Biomass:** 14,000 acres of ag forest land
- **Geothermal:** good resource

# Awareness of CE at Cornell (1)

- Organizations/Centers: *The Atkinson Center for a Sustainable Future (ACSF)*, Johnson's Center for Sustainable Global Enterprise, Cornell roundtable on environmental studies topics (C R E S T), The Cornell University Energy Club, **Center for Future Energy Systems** (a partnership between Rensselaer Polytechnic Institute in Troy, NY and Cornell University), Water Innovations Alliance, New York State Water Resources Institute (WRI), The Cornell Greens, Sustainable Enterprise Association SEA, Sustainability Hub, Society for Natural Resource Conservation, Renewable Energy Society CURES, Office of Environmental Compliance & Sustainability (ECOS), Cornell Cooperative Extension(CCE) New World Agriculture & Energy Group, Kyoto NOW!, Engineers for a Sustainable World, Cornell Sustainable Campus, Cornell Solar Decathlon, Cornell Center for the Environment, Center for Global Sustainable Enterprise, AXP-Auto X Prize Project Team 100 mpg car, AAPG Student Chapter. **Almost 25 Cornell Organizations in Sustainability!!**
- PIRE Program: was a Cornell proposal of \$4.5M in 2012 to the National Science Foundation (NSF). Through an International Collaboration (Spain, Denmark and Ireland), PIRE proposed an integrated **research and education program in wind energy** led by Cornell.

# Awareness of CE at Cornell (2)

- UNIVERSITY COLLABORATION ON WIND ENERGY: A Cornell report. The goal was the development of long term university based program of basic and applied research. **Most important wind companies involved: General Electric, Vestas..**
- Campus Sustainability in the Cornell University 2010-2015 Strategic Plan: the Climate Action Plan (CAP) sets the goal of reducing carbon-based emissions from the Ithaca campus to net zero by the year 2050. **(Plan to focus on Biogas and Geothermal).**
- **Funds** (Public and Private): Atkinson Foundation, \$80 million, the largest individual gift to the Ithaca campus in Cornell's history.
- **Investors:** The Kevin M. McGovern Center, BR Venture Fund (BRV), Cayuga Venture Fund, Cornell Angel Network, Excell Partners, Seed Capital Fund of CNY, LLC
- **Entrepreneurs:** Johnson School Program, The Entrepreneurship and Innovation Institute (EII)

**NO DOUBT ABOUT IT, BUT INTEREST IS NOT ENOUGH...**

# What about knowledge?

- **Emc2 The Energy Materials Center:** energy conversion (especially fuel cells) and storage (including batteries)
- **Center for Emergent Superconductivity** involving Cornell (No lead inst.)
- **KAUST-Cornell Center for Energy and Sustainability (Kaust-CU)** Termed nanoparticle ionic materials (NIMs), for carbon-dioxide capture and sequestration, photovoltaics and energy storage systems
- **Ober Group:** a multidisciplinary group focuses on creating new polymeric materials (anti-biofouling).
- **Institute for Computational Sustainability (ICS), Northeast Regional Climate Center (NRCC) the Biofuels Research Laboratory, the Cornell NanoScale Facility (CNF)...and many more!**

Investigating: plant materials (or biomass), hydrogen and other types of fuel cells, improved efficiency of internal combustion engines, pollution abatement... **UNTIL 55 GROUPS OR DEPARTMENTS IN CLEAN ENERGY!!**

Cornell is plenty of knowledge, a lot of outstanding researchers

# Some Ideas: Specialized Program (1)

## **Specialized Program to promote CE projects, Atkinson's leadership ?:**

no more than two types of energy. Choice procedure:

- **State of the art:** value chain analysis and main technological challenges (Industry needs).
- **Inventory** of Cornell Knowledge : faculties, labs, research groups and professors. (research and practical experience)
- **To match** Cornell knowledge with industry necessities.
- Potential **market**, local energy **resources**, national and international **technical partners** (contacts).
- Public (Federal and State) and Private **support:** Political, legal and financial.



# Other Ideas: future actions

- **Industry Collaboration - Cluster:** To promote **aids** for research projects.
- **Pilot project** for each selected technology: to gain practical experience and to involve the highest number of Cornell participants.
- **Educational program** to complement research projects.
- **Harmonization** with the Cornell Sustainable Plan.
- **To raise funds** to attract the interest of researchers and CU professors and attract companies and researchers, talent.

*And, what about?*



*Thank you everyone for your  
help!*

Ithaca, 29<sup>th</sup> March 2013