INTERNATIONAL CENTER FOR RENEWABLE ENERGY, AEROSPACE, TURBULENCE & EDUCATION (I-CREATE)

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 To develop a self-sustained Economy in Puerto Rico by fostering the integrating:

Education, Partnerships, Research & Innovation.



GOALS OF I-CREATE

EDUCATION I

- Provide support to the STEM Schools of Excellence (K-12) in PR (Caguas) by developing advanced curriculum in Math & Science.
 - Pipeline of workforce in PR including teachers.
- Collaborate with the interactive museum of STEM (Caguas).
 - Attract and Mentor K-12/Teacher into STEM
 - Showcase of projects by Hispanics (I.e.,NASA)
 - Success stories.
 - IMAX
- The First National Academy of Science & Engineering.

EDUCATION II

- Build a Center for Mentoring and Development: NSF-AGEP
 - Cornell, Rensselaer, Johns Hopkins, Syracuse, UPRM, & U. Turabo.
 - International partners: Sweden, Italy, Spain, France, Australia.
- Initiatives at Universities as initial setting for

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\begin{array}{l} \text{Design Projects} \rightarrow \text{Prototypes} \rightarrow \text{Innovations (Patents)} \rightarrow \\ \text{Incubator} \rightarrow \text{Business Plan} \rightarrow \\ \text{Test Bed of Market in PR} \rightarrow \text{Economic Development} \end{array}
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OUTREACH: K-12 INITIATIVE

- Science Summer Camp: 3 sessions
- Courses on Math & Science: Saturday Program for University Credit.
- Hand on Projects:
 - Aerospace, Environmental & Energy.
- Summer Research Jobs in PR & USA.
- Mentoring & Coaching Program.
- Teaching Development Program.

THE CNY-PR AGEP PROGRAM

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- Main Objective
 - To increase the number of minority PhDs and to promote their success in academia.
- The CNY-PR alliance is based on mutual commitment to promote:
 - Research experiences for undergraduate and graduate students.
 - Faculty development programs in an environment where recruitment, retention and mentoring are essential.

PARTNERSHIPS

- Integrate all Research efforts and Centers of PR with the objective of creating strong synergy of *International Reputation & Visibility*:
 - Energy/Sustainability, Environmental, Aerodynamic, Engineering testing & Innovation, Mini-Incubators
- Use the NSF-AGEP Project to bring partners from Europe, Asia, Africa and Latin America.
 - Trained & mentor the next generation of scientists/leaders of PR.
- Build Partnerships in *Research, Education and Industry* between Puerto Rico and the international community.
 - (i) World class research facility, (ii) World class scientists, (iii) Bring local talent back to Puerto Rico, (iv) Unique synergy in areas of national need.

RESEARCH

- Establish the research infrastructure and train a knowledge-based workforce to support industries in **fundamental & applied research**.
 - Multi-Scale Fluid Dynamics: Turbulence/Aerospace/Homeland security/Urban Aerodynamics/Environmental/Regional Climate
 - **Renewable Energy:** wind power, solar energy, hydrogen, desalination.
- Research Facility @ I-CREATE: well control conditions for validation and fundamental knowledge.
- Use Puerto Rico as a natural laboratory:
 - full-scale implementation (scientific & commercial).

INNOVATIONS

- Research facility will promote new jobs by the creation of the I-CREATE, mini-incubators and new local companies within the facility.
 - Bring investors, companies (Tech Park).
- Establish an office for integration of research between industry/academia/government.
 - Commercialization of knowledge through patents.
 - Energy policies.
 - Pilot projects.
- Use the knowledge in center for sustainability in Caguas as a world class example.

OUTCOME OF I-CREATE

OUTCOME

- Role model country on sustainability.
- Development of local economy/jobs based on Education, Partnerships, Research & Innovation.
 - A new work force based on knowledge (STEM) located in Puerto Rico.
 - Attract best native/international talent ("brain drain") on key areas.
 - Attract companies to PR
 - clearance, US citizens, close proximity to America, unique facilities & expertise.
- Increase ranking & reputation of Universities in PR.
- First Climate/Energy Simulator of International need.
 - Multi-Scale Wind-tunnel Research Facility

MULTI-SCALE WIND TUNNEL FACILITY

- Large enough to remove the effect of side walls on the energetic turbulence scales.
- Fast enough and large enough to get the necessary high Reynolds numbers, yet still resolve the dissipative scales.
- Long enough and with low enough background disturbances to obtain the necessary downstream development times.
- An experimental facility capable of resolving some of the oldest questions in turbulence while also testing conclusively new ideas.

MULTI-SCALE WIND TUNNEL FACILITY

I-CREATE will be an international research facility:

- Overall dimensions: 80m long, 22m wide, 7 m height
- Test section:
 - Length of test section: 40 m.
 - Cross section: 3m x 3m.
- Max speed at test section: 40m/s
- Turbulence intensity level: < 0.025%



APPLICATIONS of WIND-TUNNEL FACILITY

APPLICATIONS I

- Multi-scale turbulence to answer fundamental & applied questions
 - Wind turbine energy:
 - Produce electricity & desalination & hydrogen for fuel cells
 - Development of technologies
 - Provide industries with water supply & electricity
 - Reduce operational costs.
 - Hybrid systems: solar/wind energy/geothermal
 - Regional climate simulator (e.g. Caribbean)
 - Urban aerodynamics (buildings), environmental, car & aerospace industry.
- Use test bed on scaled system in research facility and then test a full scale study in Vieques or Ceiba.



APPLICATIONS II



Conceptual/Theoretical

APPLICATIONS III



Indoor/Air Pollution

Glauser, Syracuse University

UAV: Dynamic Sensor & Homeland Security



Amitay, RPI

TRAINING of PhDs



NSF IGERT: RPI, JHU & U. of Turabo

WIND TURBINE RESEARCH

MOTIVATION





- Models representing the WT effects physics are overly simplified.
 - Impact on environment globally (temperature) and locally (interactions with ground).
- Influence of atmospheric boundary layer with helical tip vortices not presently known.
- Lack of high-resolution measurements.

PROPOSED STUDY (Meneveau, Cal, Castillo)

Wind turbine – Atmospheric boundary layer interaction: • Model experiments _ Upstream/external conditions effects Wind Tunnel Tip-speed ratio facility @ JHU • WT array spacing/geometry studies - Implications on numerical simulations Deterministic Stresses • LES formalisms Scaled with BL WT model Painted Surface for Near-wall **Measurements**

ACTION PLAN

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- Summary of Symposium & Strategy (May 31- June 2, 2007)
- Proposal for Aerospace Program due to PRIDCO (July 15, 2007)
- Strategic Plan for I-CREATE (September 1, 2007)
 - Sabbatical PR (Fall 2007- Spring 2008)
 - Design of facility & contractors.

VIEQUES & CEIBA: The Full Scale Implementation?



RENEWABLE ENERGY/ WIND POWER FACTS

FACTS I



- In 2005, Denmark produced 25% of its electric energy
- Implify the Magaziniad (issuer Neing 12 in 2006) in personal wind turbines are mentioned as one of the best inventions of 2006; in some cases, managing to provide up to 80% of
- Enevertexative introduction and installation.

FACTS II



- In 2006, about \$30 billions were invested in new
- Renewable energies generations much electric power worldwide in 2004 as 1/5 of the world nuclear power
- plantsastingkowingchyteroppowegy in the world is gridconnected solar photovoltaic (grew 60% per year).

FACTS III



- Second fastest is wind power with 28% per year.
- In 2004, 1.7 Million jobs direct result of renewable energy.
- At least 48 countries worldwide have energy promotion policy.

TOP 10 WIND POWER MARKETS



Total capacity	MW	Market share
Germany	20,622	27.8%
Spain	11,615	15.6%
US	11,603	15.6%
India	6,270	8.4%
Denmark	3,136	4.2%
China	2,604	3.5%
Italy	2,123	2.9%
UK	1,963	2.6%
Portugal	1,716	2.3%
France	1,567	2.1%
Top 10 - Total	63,217	85.2%
Rest of the World	11,004	14.8%
World total	74,221	