Puerto Rico Energy Center: Current and Future Projects

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Frontiers in Science and Engineering: Fueling the Future

Introduction

- Puerto Rico is in the unique position of needing to develop ecologically sustainable and economically viable alternative sources of energy while advancing its economy. The Puerto Rico Energy Center is an instrument to satisfy this energy need. It also contributes to the creation and attraction of new business to the region.
- The Center forms innovative partnerships with academia, government and industry to develop sustainable and viable strategies and goals for addressing energy issues and concerns.
- PREC provides a forum for examining the scientific data and technological advances which promote environmentally conscious solutions to energy problems.

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Background

For this project Universidad del Turabo (UT), is joining efforts with INTECO, a local nonprofit corporation that unites the central-eastern region municipalities, academia, government, and private industry to spur economic development.

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Vision

The PREC will be internationally recognized as a center of excellence in research, development and demonstration of alternative energy and energy efficiency products and services.

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Mission

To foment the knowledge, use and the production of alternative energy and energy efficiency contributing to the preservation of the environment and the sustainable economic development of Puerto Rico by pursuing R&D, education, commercialization support, and technical assistance activities.

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Actividades Principales

- **Empresarial** - Fomentar y brindar apoyo a estudiantes y otros empresarios en el desarrollo de proyectos relacionados con los productos y servicios de la energía renovable, y eficiencia energética.
- **Investigación y Desarrollo**: Contribuir al desarrollo e implementación de productos y servicios en energía renovable a través de unidades de investigación, asistencia técnica, y demostración de alta calidad en conjunto con las instituciones, la industria y las organizaciones afines para promover la energía renovable.
- **Educación**: Proporcionar el entrenamiento y la educación en aspectos teóricos y prácticos de la tecnología de los sistemas de energía. Proporcionar actividades para estudiantes y maestros K-12 y el público en general con información actual sobre uso y la producción de la energía alternativa.

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On going projects

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Ecologic House

This structure occupies an area of 1,250 sq. ft. It is ecologically and environmentally friendly with an innovative design. Some of the features are natural ventilation, compost toilets, solar panels for electricity, and rainwater for domestic use.

- Demonstration of an ecologic, sustainable, and efficient house
- Demonstration of interconnection to the electric grid using net metering
- Development of new construction and retrofitting building codes

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Ecologic House - Solaria

North Perspective

South Perspective

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Villas Miantojo
Tu Hogar a tu Gusto
www.miantojo.com

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Photovoltaic

An area of 23,000 sq. ft. is covered by an array of solar panels with an installed capacity of 81 kW will provide electricity to the office areas of the center.

- Demonstration of one of the largest photovoltaic array system in PR.
- Data collection: Evaluation of PV panels, Inverters, and Storage Means performance

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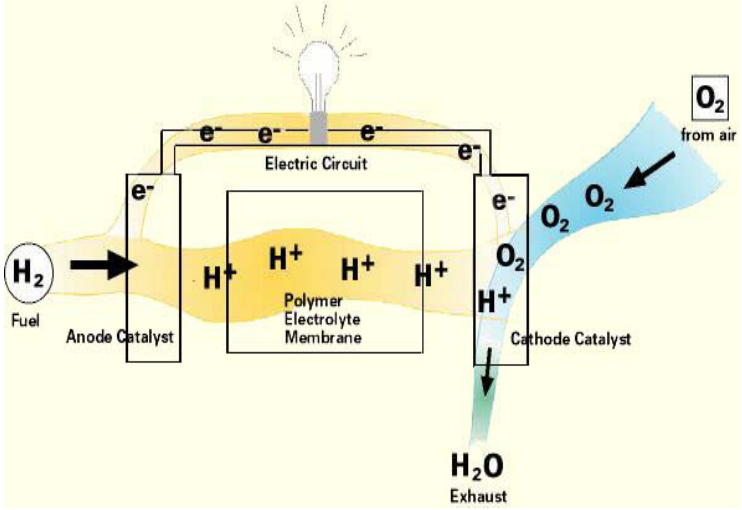
Fuel Cells

- Demonstration of fuel cell technology
- Modeling, design, construction, and testing of polymer electrolyte membrane and solid oxide fuel cells - CREST



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Hydrogen

The Institute of Physical-Chemical Applied Research (IPCAR).

- Research on new materials for Hydrogen purification and storage
- Hydrogen production by water splitting
- Production of sustainable hydrogen by bioethanol steaming and partial oxidation - CREST

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IPCAR
Institute of Physical-Chemical Applied Research

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Energy Efficiency

- Development of student company consultants on energy efficiency and conservation of energy
- Perform energy audits in small and medium size companies of the region
- Energy Management Training for technicians and Engineers
- Energy Management Basic Training for small and mid size business owners

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EMCO
THE ENERGY MANAGEMENT COMPANY

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Future projects

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Biofuels

- Research, development and demonstration of petroleum alternatives renewable fuels such as biodiesel and ethanol

- Colaboration with Interdiciplinary Research Institute

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Biomass to Energy

Plasma gasification technology allows the conversion of low value fuels/feed stocks, such as bio-mass, and different waste forms into a low heating value synthesis or syngas containing carbon monoxide and hydrogen gases. This gas can be employed as a primary fuel for a gas turbine.

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Wind Energy

Wind turbine research and investigation in Colaboration with Rensselaer Polytechnic Institute (RPI)

- Study of interactions between the atmospheric turbulent boundary layer and the vortices created by arrays of wind turbines - CREST

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Other Future Projects

- Solar Refrigeration
- Ocean Thermal Energy
- Green Roof
- Technical Certifications – Net metering
- Electrical Distribution Mesh Grid

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Energy Audits

Main reason to reduce energy consumption

- Economical – reduce operating cost
- Environmental – CO2 emission, depletion of fossil fuels

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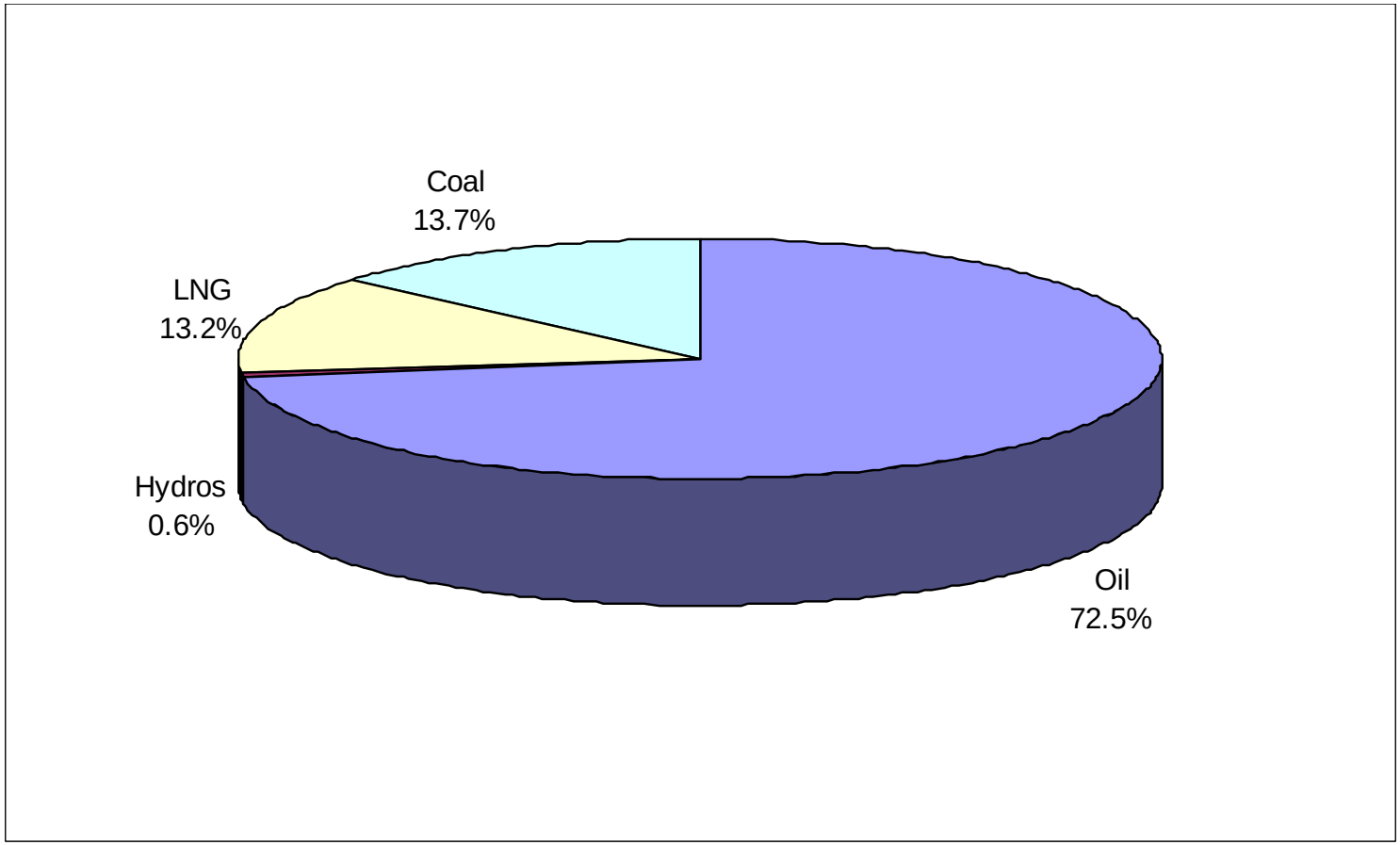
PR Energy Generation by Source



PREPA Annual Report 2006

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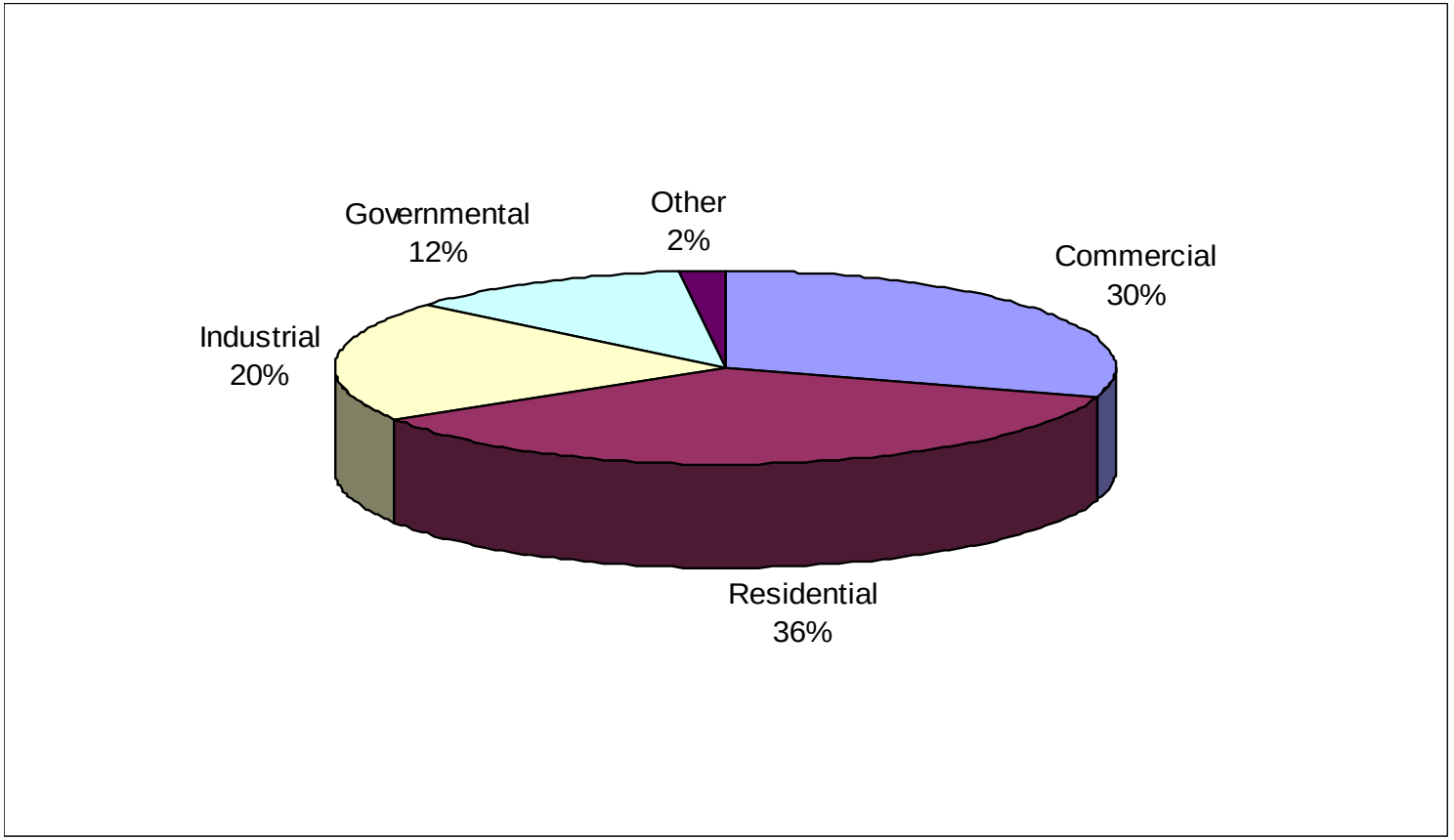
PR Energy Usage by Sector



PREPA Annual Report 2006

Energy Efficiency

- Energy efficiency is the amount of useful energy you get from a system. A perfect, energy-efficient machine would change all the energy put in it into useful work—an impossible dream. Converting one form of energy into another form always involves a loss of usable energy.
- Energy efficiency is the use of technology that requires less energy to perform the same function. A compact fluorescent light bulb that uses less energy than an incandescent bulb to produce the same amount of light is an example of energy efficiency.

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Energy Audit

- An Energy Audit or Energy Survey is a study of how energy is used in a facility and an analysis of what alternatives could be used to reduce energy cost.
- The process starts by collecting information of the facility's operation and about its past record of utility bills. This data is analyzed to get a picture of how the facility uses energy, and identify ECO's.

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Types of Energy Audit

- **Level I: Walk through Assessment**
  Identifies preliminary energy savings. A visual inspection of the facility is made to determine maintenance and operation energy savings opportunities plus collection of information to determine the need for a more detailed analysis.

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Types of Energy Audit (cont.)

- **Level II: Energy Survey and Analysis**
  Identifies and provides the savings and cost analysis of all practical measures. Requires test and spot measurements to quantify energy uses and losses and determine the economics for changes.

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Types of Energy Audit (cont.)

- **Level III: Detailed Energy Audit**
  Focus on potential optimization and capital intensive projects identified in Level II audit. Involve more detailed field data gathering and engineering analysis. It also requires model analysis, such as computer simulation, to determine energy use patterns and predictions on a year-round basis, taking into account variables such as weather data.

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Information needed from facility

- One year of utility bills with rate structure
- Site plan and building plans
- Building floor area and uses
- Operating hours per areas
- Equipment used with technical specifications

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Benchmarking Parameters

Parameter	Description	Meaning
kWh/sq.ft.	Annual or monthly per building area	Efficiency of building
W/sq.ft.	Lighting per area	Efficiency of lighting
Tons/sq.ft.	Chillers per area	Effectiveness of building envelope
kW/ton	Chiller kW per cooling load	Efficiency of chillers

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Load Factor Analysis

- Electrical Load Factor is a measure of how well the facility's electrical capacity is used on a monthly basis

$$ELF = \frac{\text{Monthly energy consumption (kWh)}}{\text{Monthly actual demand (kW) x Hours per billing period (hrs)}}$$

- 0.20 to 0.25 for single-shift operation 5 day/wk
- 0.45 to 0.60 for two-shift operation 5 day/wk
- 0.70 to 0.85 for three-shift operation 5 day/wk
- 1 indicates full load operation 24 hrs/day all year long

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Load Factor Analysis

- Production Load Factor an average fraction of the plant capacity

$$PLF = \frac{\text{Monthly energy consumption (kWh)}}{\text{Monthly actual demand (kW) x Operating Hours per billing period (hrs)}}$$

- PLF > 0.85 is considered good
- PLF = 1 when the facility uses monthly peak demand at all production hours
- PLF >1 indicates that some equipment is on when plant is not in operation

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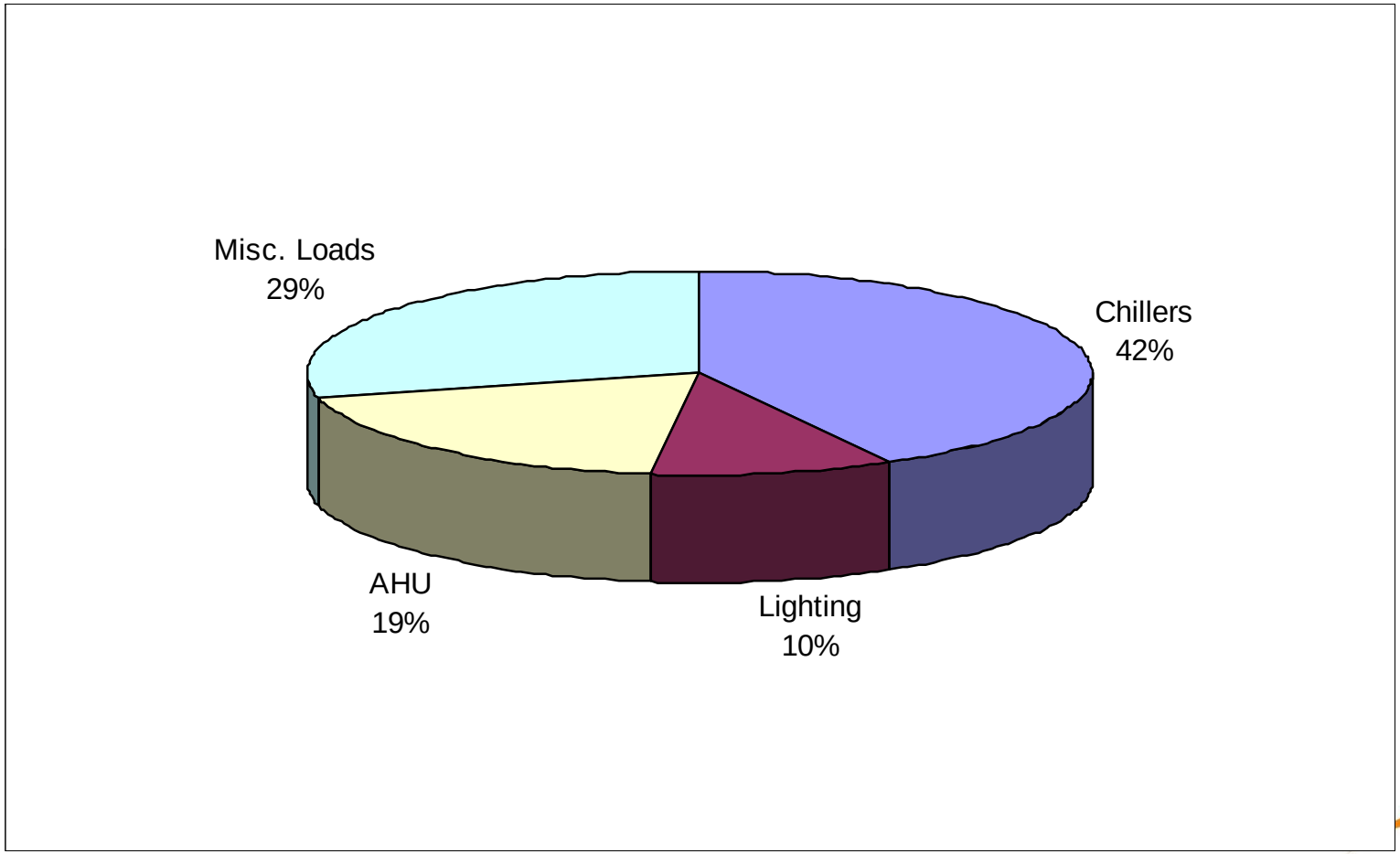
Typical Energy End Use Profile



Common Energy Conservation Recommendations

- Chillers
- Air Handling Units
- Compressed Air
- Motors
- Lights
- Building Envelope
- Heated Systems

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Write-up format

- Recommended action
  - One or two sentences
  - Answer: What should the plant do?

- Summary of savings & implementation costs
  - Savings in fundamental units – kWh/yr, lb/yr, etc.
  - Savings, costs, & revenue in $/yr
  - Implementation costs
  - Economic measures – simple payback common
  - Environmental impact – CO2 & NOx

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Write-up format (cont.)

- Current operation & observations
  - What was witnessed & measured
  - What the change will do
- Calculations
  - Data table – sources specified
  - Equations in sentence-like manner, then data interposed, then final answer
  - Results tables OK, but show one complete example calculation

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Write-up format (cont.)

- Implementation costs
  - Capitol costs for large equipment
  - Minor costs for supplies or part replacement
  - Labor costs for installation
  - Some recommendations cost nothing
- Financial analysis
  - Simple payback = implementation cost / savings

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Thank you

Questions?

http://prec.ut.pr

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