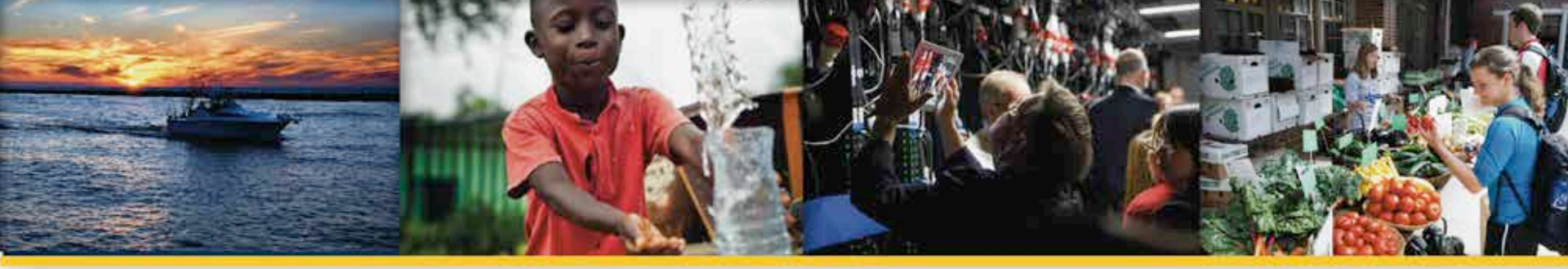

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How to start a Green Lab Certification Program?

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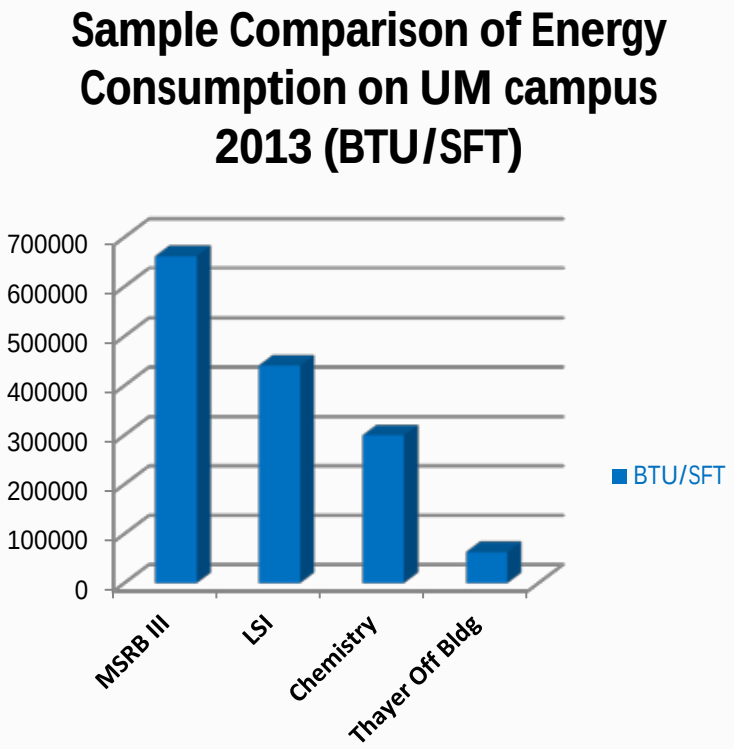
Background

- According to EPA estimates laboratories consume 4-10 more energy when compared with a class room environment
- It is true in case of our campus
- *Reasons*: HVAC, Fume hoods, Utilities, Equipment, research and teaching activities
- ***What does this mean us?***
- Providing rich opportunities to save on energy, utilities and achieve waste reduction through green initiatives
- A Sustainable Laboratory not only establishes best lab practices but also improves safety in the lab



What is a Sustainable Lab?

An ideal Sustainable Lab would actively engage in the following:

- Ø P2 & WM
- Ø Green Purchasing
- Ø Green Chemistry
- Ø Green Computing
- Ø Energy and utilities
- Ø Reduce, Recycle & Reuse
- Ø Disposal and Treatment
- Ø Safety

How it can be achieved?

It has three elements:

- **Engineering Controls:**
  - Upper Management
  - E.g. CAV to VAVs/HVAC
- **Administrative Controls:**
  - PI, Manager/Safety Liaison
  - Introduce best practices
- **Behavioral Controls:**
  - To be practiced by every lab occupant

Goals & Objectives of the Program

Through Sustainable Lab Certification program we intended to achieve:

- Standardized operations to establish best lab practices
- Reduction in use and generation of hazardous materials including mercury
- Increase in Reuse and Recycling
- Green initiatives/Substitution
- Behavioral change to save $$s
- Improved heath & safety

How it started?

- **2008-09** – Green Chemistry Task Force (GCTF) was formed:
  - Sudhakar & Anya from OCS
  - Ingrid and Greg from Hazmat
- Researched on happenings at:
  - Peer Institutions
  - Government (EPA)/GCI
  - Conferences on Green Chemistry/Sustainability
- **2010/11** – OCS and Planet Blue Operations sponsored a project for ENV 391 class on "Sustainable Labs"

Program launched Summer of 2011

- Two Labs Piloted by ENV 391 Student group:
  - Lurie Nanofabrication Lab (*Research lab*)
  - USB Teaching Lab *(Teaching lab)*
- The work was presented at the 2011 Michigan Green Chemistry & Engineering conference on Oct. 27, 2011
- To date, 100 labs ***(reached out to 8000)*** have been evaluated through this program and the number is growing

Team Behind this Program

UM Campus

- GCTF Team
  - Sudhakar & Anya: OCS
  - Mark & Greg: Hazmat
- Mark Sedmak: Med School
- Dan Rife: L S & A
- John Keedy: CoE
- Cathy Andrews, LSI
- Planet Blue Operations Team

UM Health System

- Chris Victory: Engineer

We also Thank…

- Terrance Alexander, Director
- Deans and Facility Directors
- OSEH Managers
- Mike Shriberg and his students, Graham Institute
- Planet Blue Operations Team
- Tracy Artley and her team, Ground/Waste Management
- All PIs and Managers supporting this program

How does it work?

- Program is run in phased manner
- Steps involved:
  - Initial contact with OCS by Lab manager/Safety Liaison or PI
  - Receive and respond to a comprehensive questionnaire
  - Lab visit and assessment of questionnaire by OCS
  - Recommendations provided by OCS
  - Recommendations implemented by Lab
  - Evaluation report by OCS
- The certificate of recognition is awarded to the lab typically at their group meeting following final report

Questionnaire

It is very comprehensive and covers:

- Lab activity and waste streams generated
- Pollution prevention activities
- Green purchasing
- Green Chemistry & Engineering
- Chemical Substitution
- Reuse/reduce/recycle
- Energy and utilities
- Lab safety
- Treatment and disposal

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the sustainable difference

GREEN LABORATORY OPERATIONS FOR SUSTAINABILITY

Lab:		PI:
Building:	Room #:	Number of Employees:
Lab Coordinator:	Phone:	Email:
Evaluation by:		Date:

LAB COMMITMENT:

We, the members of above mentioned lab are applying for Green Lab Operations for Sustainability (GLOS) certification and affirm that, to the best of our knowledge, provide the following information for your consideration. We are aware of the significant environmental impact of research on our campus, recognize the benefits of this program from sustainability point of view and willing to commit to reduce carbon footprint.

LAB ACTIVITY:

Description of research, operations, equipment, techniques, etc.: _____

_____

_____

_____

_____

_____

_____

_____

Waste Streams Generated (type, amount, frequency, costs):

_____

Lab visit/Recommendations

- **Lab Visit**
  - Nature of work done
  - Waste streams generated
  - Equipment
  - Techniques
  - Recycling efforts
  - Lab Safety
- **Recommendations**
  - Implementations
  - Corrective actions

Each lab is evaluated on point system:

96% and above:	**Platinum**
90-95%:	**Gold**
80-89%:	**Silver**
70-79%:	**Bronze**

Labs scoring less than 70% need to work with OCS closely to improve their operations to get recognized under this program

Awarding certification of recognition

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Awarding certification of recognition

Lab User Guide

Clock with 12 Green Chemistry Principles

A Lab receiving certification

Bartlett Laboratory		
Rooms:2616,2622,2624	Bartlett Laboratory, Chemistry Department	
# of Personnel: 10	PI: Prof. Bart Bartlett	Lab ID#: 519
The Bartlett group focuses on inorganic synthesis to prepare compositionally complex materials that address three chemical challenges in sustainable energy. First, we are preparing semiconducting oxides to harvest solar energy to convert it to hydrogen fuel efficiently. Second, we are synthesizing Li-ion battery nanostructures to store chemical energy, and afford its rapid conversion to electrical energy for high power applications such as automobiles. Third, we are creating small molecule catalysts that store and transfer charge rapidly for making and breaking chemical bonds in overall water splitting. These areas of research are of paramount importance to realize a future with an alternative form of clean, affordable energy.		
Sustainable Lab Rating: **GOLD**	Date Received: 09-05-2012	

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Results – Green Chemistry

- **Safer Alternatives:**
  - Toxic ethidium bromide is being substituted with safer alternative, Gel-Red in Life Sciences labs. Nearly 30 labs have switched to Gel-Red in their DNA research
  - Cyclopentyl methyl ether and methyl tetrahydrofuran are being used in place of toxic solvents such as dichloromethane and THF
  - Micro scale chemistry adapted where applicable
- **Energy Efficient Reactions:**
  - Sonication and microwave energy sources are employed as alternative reaction conditions

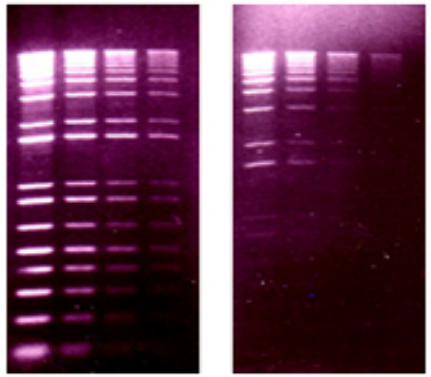
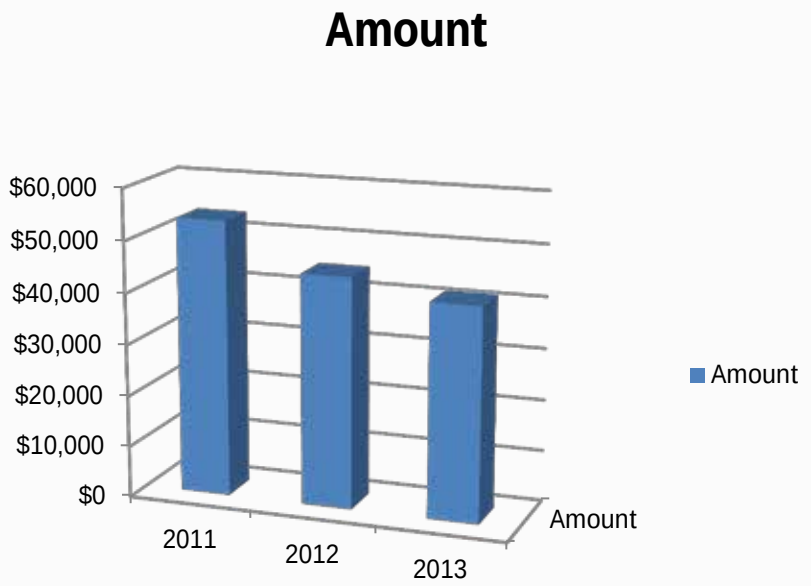


Figure 1. Comparison of GelRed™ and ethidium bromide (EtBr) in precast gel staining using 1% agaose gel in TBE buffer. Two-fold serial dilutions of 1 kb Plus DNA Ladder from Invitrogen were loaded onto each gel in 4 lanes in the amounts of 200 ng, 100 ng, 50 ng and 25 ng, respectively, from left to right. Gels were imaged using a 300-nm transilluminator and photographed with an EtBr filter and Polaroid 667 black-and-white print films.

Ethidium Bromide Waste Expenses

Liquid waste: $2.75/lb

Solid waste: $0.53/lb



Results – Reuse and Recycling

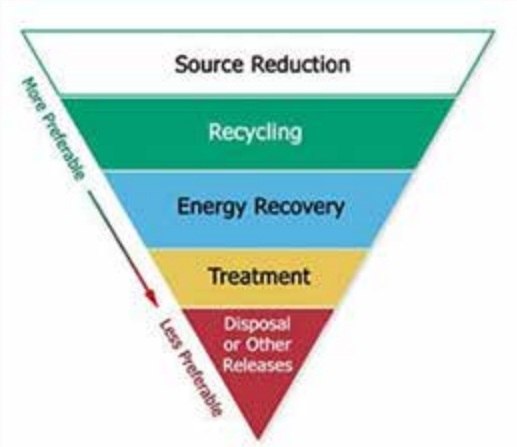
- **Recycling**
  - Solvents recycled: Acetone, alcohol, xylene and formalin
  - Pipette tip boxes, plastic bottles and other uncontaminated plastic
  - Ice packs and Styrofoam boxes
  - Electronics, universal waste, paper, glass, pens, pencils, packaging materials etc.

- **ChEM (Chemicals, Equipment and Materials Reuse Program:**
  - In excess of 400 lbs/year of Surplus chemicals, equipment and materials are being redistributed to those in need, saving $25,000

Results - Treatment

- **Treatment:**
  - HPLC eluent containing mild buffer can be neutralized and disposed down the drain. >300 gallons/year reduced.
  - Ion chromatograph waste is slightly basic with no toxic metals. It is being neutralized to pH 8 and discarded down the drain in a lab in EWRE. 200 gal/yr. haz waste reduced.
  - Dialysate waste generated in Life Sciences labs is slightly basic and contain salts that can be neutralized to pH 8 to release into the sewer. >250 gallons/year reduced.
- **Elemental Neutralization:**
  - Acid (HCl only) or basic waste is neutralized in many labs for drain disposal

EPA P2 Hierarchy



Results – Energy conservation

- Turn of lights when leaving lab
- Shut the sash on chemical fume hoods when not in use
- Raise ULT temperature to -70C
- Power down small equipment when no in use to save on vampire power or standby power
- Shut down computers before leaving
- If printing is a must, print on both sides

Results – Utilities conservation

- Avoid water aspirators; they consume 3 gallons/minute water. Install PIAB local vacuum system that run on lab compressed air. *(e.g. Richard Laine Lab in GG Brown)*
- Avoid single pass water usage. Install recirculating chillers
- Check for leaks and drips. Get them fixed. Water/sewer costs doubled in the last 5 years
- Run dishwashers/autoclaves full

Results – Spills and Safety

- **Mercury Spills**
  - As a part of mercury removal program we have collected several hundreds of pounds of elemental mercury and 7000 mercury thermometers for proper disposal
  - Spills due the breakage of mercury devices were **62** in 2002
  - These spills greatly reduced to **6** in this fiscal year of 2014
- **Safety**
  - Best lab practices ensure safety in the laboratory
  - Improved safety in our labs may be seen through less number of accidents/spills in the long run
  - ***No spills from the labs participated in this program***

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Program details

For details on the program visit:

http://www.ocs.umich.edu/labs.shtml

What next?

- Revisit the certified labs to for reevaluation to retain their certification
- Pay closer attention to their operations
- Capture metrics
- Long term goal of this program is to improve up on the operational changes through green chemistry, pollution prevention, waste reduction and behavioral change

Acknowledgements

- Green Chemistry Task Force Members
  - Anya Dale
  - Gregory Marquis
  - Ingrid Walstad
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- Terrance Alexander, Director, OSEH and OCS
- Henry Baier, Executive Vice President, Facilities and Operations

Thank you!