EEcoMark® v2

An overview of BAPCo EEcoMark® v2

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This document outlines the development of BAPCo EEcoMark® v2, a tool for measuring PC energy consumption

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About BAPCo

Business Applications Performance Corporation (BAPCo) is a non-profit consortium with a charter to develop and distribute a set of objective benchmarks for personal computers based on popular computer applications and industry standard operating systems.

For more information about BAPCo or a complete list of the current membership, see our website at http://www.bapco.com/.

Contents

1.0 Introduction

BAPCo EEcoMark v2 is a tool that uses real world applications for the purpose of measuring the performance-qualified energy consumption of personal computers. EEcoMark v2 may also be used to evaluate systems for compliance with energy regulation specifications such as Energy Star v4 and v5.

Supporting both high-accuracy and low-cost power meter options, EEcoMark v2 increases lab productivity by improving the consistency of data collection through reducing occurrences of human error.

2.0 Bapco Development Process

BAPCo creates software in accordance with the BAPCo Development Process, a set of milestones and checkpoints collaboratively developed and agreed upon by the BAPCo membership.

Early in the process, prevailing business personal computer usage models are identified and grouped into scenarios according to their fit within a workflow. Applications are selected for each usage model on the basis of market research and technical feasibility.

BAPCo members then join together with expert application users in development sessions to collaboratively develop a workload specification for each scenario, defining each user/PC interaction which is to be simulated by the tool.

The goal of the development sessions is to produce representative business application workloads for the tool. Each application workload consists of three elements: the input data set, the tasks performed on the input data set, and the generated output. An example of generated output would be an image generated through an iterative process of steps to create a desired appearance. These three elements of the workload are chosen to represent the workflow of a user skilled in each given application.

After the workload specifications are created at the development sessions, BAPCo developers implement the workloads according to those specifications while satisfying workload automation constraints to ensure the stability of the software, the consistency of results, and the feasibility of the implementation and distribution of the product.

2.1 Milestone Overview

The BAPCo development process is divided into six major phases (Initialization, Design and Planning, Implementation, Validation, Characterization and Launch). Each phase consists of a series of milestones, some of which may be worked on concurrently.

The membership must vote to close each milestone. Once all the milestones within a phase are complete, the membership must vote to exit the phase and enter the next phase. BAPCo members work in a collaborative process where decisions regarding products are sometimes made by majority vote rather than unanimously.

The following is the list of the development phases and the corresponding milestones. Some of these milestones are explained in greater detail in the following sections.

1. **Initialization Phase**
   a. Milestone 0 – Committee kickoff
   b. Milestone 1 – Benchmark market and customer analysis
   c. Milestone 2 – Product positioning and customer value proposition
   d. Milestone 3 – Preliminary marketing requirements document
   e. Milestone 4 – Final marketing requirements document
2. **Design and Planning Phase**
   a. Milestone 5 – Preliminary engineering requirements document
   b. Milestone 6 – Usage model selection
   c. Milestone 7 – Application selection
   d. Milestone 8 – Define member resource commitments
   e. Milestone 9 – Define development infrastructure
   f. Milestone 10 – Define scoring methodology
   g. Milestone 11 – Define application licensing requirements
   h. Milestone 12 – Plan and execute workload development sessions
   i. Milestone 13 – Define product release criteria
   j. Milestone 14 – Select product name
3. **Implementation Phase**
   a. Milestone 15 – Create implementation schedule
   b. Milestone 16 – Determine calibration system
   c. Milestone 17 – Software development
4. **Validation Phase**
   a. Milestone 18 – Validation testing
   b. Milestone 19 – Define risk management plan
5. **Characterization Phase**
   a. Milestone 20 – Characterization testing
   b. Milestone 21 – Beta testing
6. **Launch Phase**
   a. Milestone 22 – Product pricing
   b. Milestone 23 – Pre-launch materials
   c. Milestone 24 – Release to manufacture vote and sign-off
   d. Milestone 25 – Duplicate and distribute media
   e. Milestone 26 – Post-launch material

2.2 Usage Model/Scenario Selection

Milestone 6 of the BAPCo Development process marks the point at which usage models are chosen for inclusion in a product. The active workloads included in EEcoMark v2 were grouped by the consortium into the following scenarios.

Productivity Basic

The Productivity Basic scenario models creating and replying to emails, viewing and modifying a presentation, working with text documents, and spreadsheets. Web browsing and archiving/unarchiving digital photos are also included.

Productivity Advanced

The Productivity Advanced scenario models working with text documents to save as PDF, mail merge, and word count operations. Actions performed in Microsoft Excel include financial calculations and inventory management.

Media Creation

The Media Creation scenario models the usage of media tools in content creation. Actions include converting music files to MP3 format, working with digital photos, and encoding a movie project at low and medium quality resolutions.

Media Consumption

Windows Media Player is used to play back media files: an audio track, a short movie titled 'Obey the Squirrel', and a clip from the movie 'Elephant's Dream'.

Graphics

The Graphics scenario models playback of HD video in a media player, viewing of video content in a web browser, and the creation of video content.

2.3 Application Selection

Application selection is completed in Milestone 7 of the BAPCo development process. Applications are chosen by consortium members based on upon market research and technical feasibility.

Sufficient lead time is needed after the applications are selected for BAPCo to develop workloads, integrate the applications into the product and perform validation of the software. Therefore, some of the application versions may not be the latest available at EEcoMark v2 release time.

BAPCo has identified the following applications for the five usage scenarios in EEcoMark v2.

Application	Version	Document Type
Microsoft Internet Explorer®	9	Web pages
Microsoft® Excel®	2007	Spreadsheets
Microsoft® Outlook®	2007	Emails
Microsoft® PowerPoint®	2007	Presentation files, image files,
Microsoft® Word	2007	Text documents
WinZip®	11.0	Zip files, various file types

Table 1: Productivity Basic Applications

Application	Version	Document Type
Microsoft® Excel®	2007	Spreadsheets
Microsoft® Word	2007	Text documents

Table 2: Productivity Advanced Applications

Application	Version	Document Type
Adobe® Photoshop® Elements	9	Image files
Apple® iTunes®/QuickTime®	7.6/7.4	Audio files
Windows Live Movie Maker	14	Video files
Windows Media Player	11	Video files

Table 3: Media Creation Applications

Application	Version	Document Type
Windows Media Player	11	Video Files

Table 4: Media Consumption Applications

Application	Version	Document Type
Adobe® Flash Player	9	Flash content
Adobe® Premiere Elements	9	Video files
Adobe® Photoshop Elements	6	Image files
Microsoft® Internet Explorer®	9	Web pages
Windows Live Movie Maker	14	Video files
Windows Media Player	11	Video files

Table 5: Graphics Applications

2.4 Workload Development Sessions

Once the usage models, scenarios, applications, and scoring methodology are decided, BAPCo members and application experts meet to create the application workloads that will be used in the product.

For EEcoMark v2, the workload development sessions consisted of three face-to-face meetings that included representatives from BAPCo member companies as well as application experts. The application experts included professionals in the fields of financial forecasting, graphic design, video editing, and office productivity.

In the workload development sessions, the experts take the lead, weaving the usage models supplied by BAPCo into a storyboard of user interactions within a series of applications. Each user/PC interaction is written down in a workload specification, and the specification used to automate the workloads.

EEcoMark v2 workload development focused on differentiating computer systems on the basis of energy efficiency. Some examples of this methodology include the Productivity Advanced and Basic scenarios, as well as the Media Rich Creation and Consumption scenarios. BAPCo voted to segment the workloads in these two respective scenarios in order to better measure the energy consumed across a wide variety of tasks and usage models.

In the Productivity Advanced scenario, the financial forecasting simulation affords the opportunity for systems to show differentiation on the basis of performance qualified energy consumption during a heavier workload. By contrast, the Productivity Basic scenario models tasks of the more typical office worker. These tasks are often not performance intensive, but the amount of energy consumed during their execution takes greater importance, and this differentiation is exposed by EEcoMark v2.

The Media Rich scenarios follow the same model as mentioned above. The Media Rich Creation workloads have a performance qualified energy consumption component and allow potential customers to see how system performance relates to energy consumed. The Media Rich Consumption workload consists of constant time video playback; yet, energy consumption can be measured and compared across computer systems for purchasing evaluations.

At the end of the workload development sessions, BAPCo comes away with a detailed workload specification for each of the product scenarios and all of the input data sets needed to reproduce the workloads created at the sessions.

2.5 Scenario Workload Description

EEcoMark v2 active scenario workflows are summarized below.

Productivity Basic

Launch MS PowerPoint. Open presentation file, apply presentation theme. Modify slides. Apply new themes. Save the presentation to new file name. Launch MS Excel and open spreadsheet file. Switch to PowerPoint and open presentation. Insert table. Insert WMV file into presentation. Save presentation in various file formats (pdf, jpg, htm). Launch MS Word. Open text document. Peform find and replace. Open second text document, enable track changes. Modify document. Save final version. Launch MS Outlook. Reply to email and include file attachment. Switch to Excel and open file. Switch to Outlook and perform email search. Launch IE and browse simulated website. Switch to Excel, open file and work with US geographical data. Create chart based on weather forecast data contain in spreadsheet.

Productivity Advanced

Launch MS Word. Open large text document and perform word count. Perform mail merge. Save document to PDF. Launch Excel. Open open spreadsheet containing financial data. Perform recalculation based on $40 stock price. Filter data based on profits. Perform recalculation based on $60 stock price. Open spreadsheet containing inventory data. Auto filter the data based on various criteria.

Media Creation

Launch iTunes. Import music folder and convert files to mp3 format. Launch MovieMaker. Open video editing project. Encode video project. Playback output of encode. Launch Photoshop Elements. Open collection of photos and preform AutoSmartFix. Open second collection of photos. Create slideshow and save as PDF. Open photos for panorama creation. Stitch collection into panoramic photo. Save panoramic photo file.

Media Consumption

Launch Windows Media Player. Play back mp3 files. Open and play back clip from "Elephant's Dream". Open and play back short movie "Obey the Squirrel".

Graphics

Launch Premiere Elements. Open project file. Import media files. Perform preview render of project. Encode project to file. Launch web browser. Play video files in browser window.

2.6 Workload Implementation

After the workload specifications have been created, BAPCo begins the work of translating those specifications into an automated tool.

EEcoMark v2 is built upon scripts that do things much the way a user would, using controls like buttons, text input boxes, and menus to navigate applications. See Appendix B for screenshots taken of the active scenarios running on a test system.

To ensure that EEcoMark v2 has deterministic behavior, BAPCo uses a framework to install applications, collect system information, run the scenario scripts, record performance, power and energy measurements, calculate performance ratings, and display test results. The framework is kept lightweight, consuming a minimal amount of memory and compute resources, in order to ensure that power and energy measurements reflect the workload energy consumption and do not include overhead from the framework.

The fundamental unit in the active workloads of EEcoMark v2 is Energy (*watt/hour)*. The EEcoMark v2 framework computes the energy consumed in watt/hours for each measured task in the active workloads. Examples of tasks include launching an application, finding text in a document, copying a file, encoding a video, and performing an image manipulation.

The framework has several methods of detecting task completion, depending upon the method the application uses to signal task completion to the user. For example, the framework may wait for the application to show a completion message in the form of a pop-up window, or may wait for a progress dialog to disappear and for control of the application to be returned to the user.

3.0 EEcoMark v2 Results

The active workloads in EEcoMark v2 are scored based on performance qualified energy consumption. To determine energy consumed during a given active scenario, the Controller polls and records the UUT (Unit Under Test) power draw at a sampling rate of once per second. The samples are averaged together at the conclusion of the workload to produce the UUT's average power draw for the scenario. The Controller also records the elapsed time (in seconds) of the workload on the UUT. The energy consumed is calculated from this recorded data and displayed in the FDR (Full Disclosure Report) as Watt/hours.

A full EEcoMark v2 run will output the following information

Avg Power in Watts

Short term idle - EEcoMark measures the average idle power of the system for two minutes

Long term idle - EEcoMark measures the average idle power of the system for 15 minutes

Sleep - EEcoMark measures the power of the system in S3 sleep for 5 minutes

Off - EEcoMark measures the power of the system in off state for 5 minutes

Time in seconds

This number indicates the elapsed time of each active workload scenario

Energy in Watt/hours

The energy consumption for each active workload scenario is displayed in Watt/hours

Scenario Performance Rating

EEcoMark is a tool for measuring energy consumed during a set of active workloads. However, EEcoMark results also include a performance rating for each active scenario. The performance rating helps users evaluate the level of system performance they can expect from a corresponding energy consumption rating.

EEcoMark scenarios Productivity Basic, Productivity Advanced, Media Rich Creation, and Graphics each receive a rating calculated by taking the sum of the response times of tasks in that scenario as performed on the test system and then comparing it with the sum of those same task response times as performed on the calibration system (see section 2.7). The calibration sum is

divided by the measured sum on the test system and multiplied by 100. The result is then rounded to the nearest integer.

Note: Media Rich Consumption scenario does not receive a performance rating. Video playback is constant time on all platforms and therefore it will not show performance differentiation in platform comparisons.

4.0 Calibration System

The calibration system is a system chosen in milestone 16 as a reference point for EEcoMark v2 performance rating results. BAPCo chose the configuration below for its wide availability and its representation of a typical mainstream PC at the time of release of EEcoMark v2.

EEcoMark v2 has been calibrated such that a PC with performance equivalent to this calibration system for a given workload will have a performance rating of 100. A system twice as fast as the calibration system on a given workload (or, equivalently, that responds in half the time on average) will have a performance rating of 200.

The specifications of the EEcoMark v2 calibration system are listed below:

Lenovo M90 Series Tower

- Processor: Intel Core i3-540 Processor (3.06GHz,4M Cache)
- Operating System: Windows 7 Professional 64bit
- RAM: 4GB PC3-1333MHz SDRAM (2 DIMMs)
- Graphics: Integrated Video
- Audio: Integrated High Definition Audio
- HDD: 250GB capacity, 8M Cache, 7200RPM SATA II
- Optical Drive: DVD Recordable
- Networking: Integrated Gigabit Ethernet

A clean operating system installation is performed on the system and necessary drivers are added.

For more details about the configuration of the calibration system, please contact support@bapco.com.

Please note that the minimum requirements to run EEcoMark v2 are listed in Appendix A and are not equivalent to the calibration system

# Appendix A: Minimum System Requirements

Controller

- CPU: Intel Celeron 420 or greater (or equivalent)
- RAM: 512MB or higher
- HDD: 5GB free space
- OS: Windows® 7 x86/x64

Unit Under Test (UUT)

- CPU: Intel Celeron 420 or greater (or equivalent)
- RAM: 1GB or higher
- HDD: 5GB free space
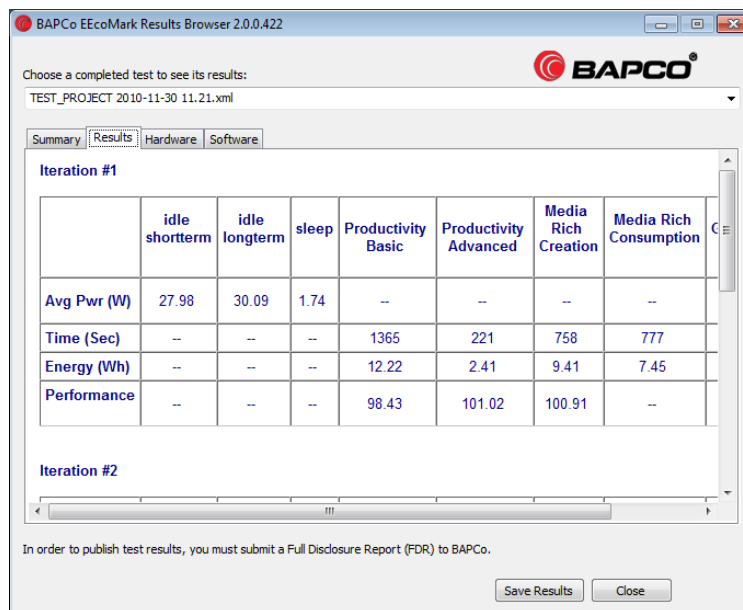- OS: Windows® 7 x86/x64

Appendix B: Screenshots

The first illustration below is an example of an EEcoMark v2 equipment configuration. The remaining screenshots have been taken on a system running the EEcoMark v2 active workloads.
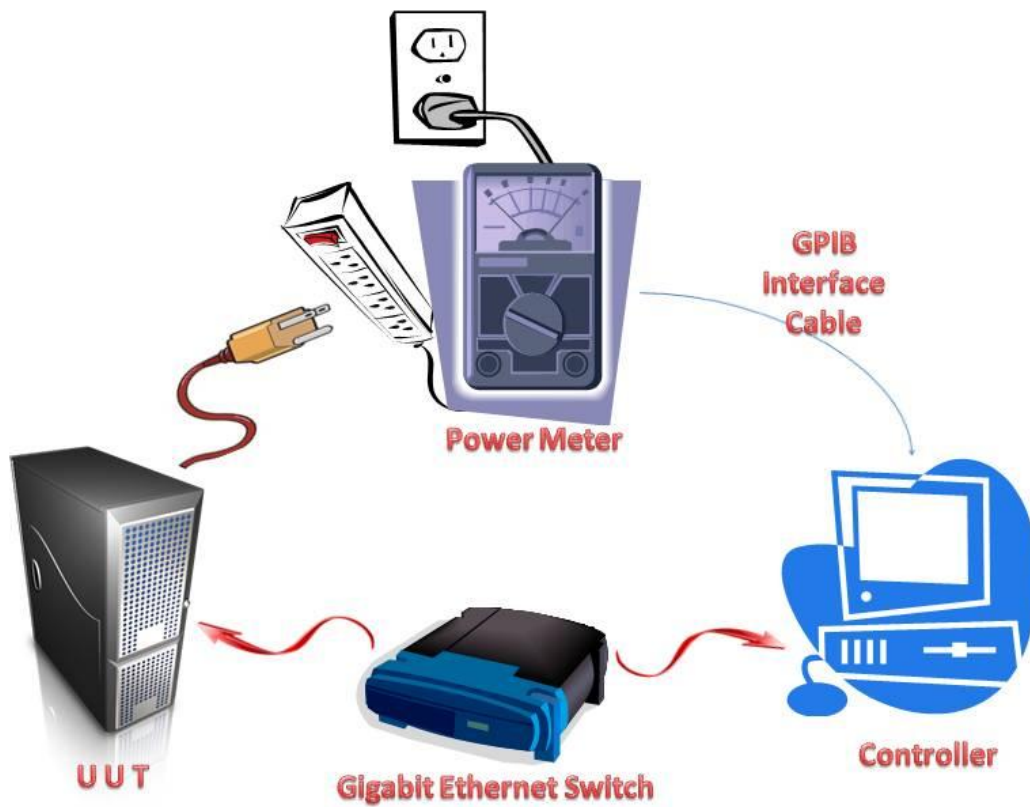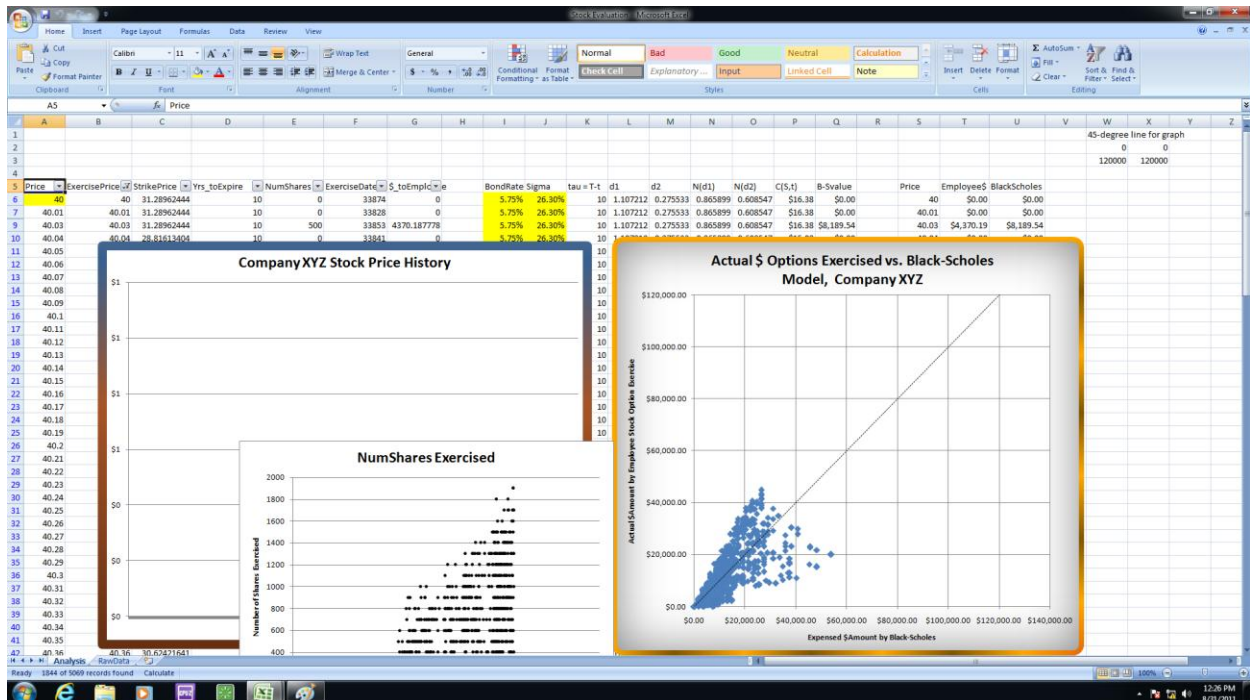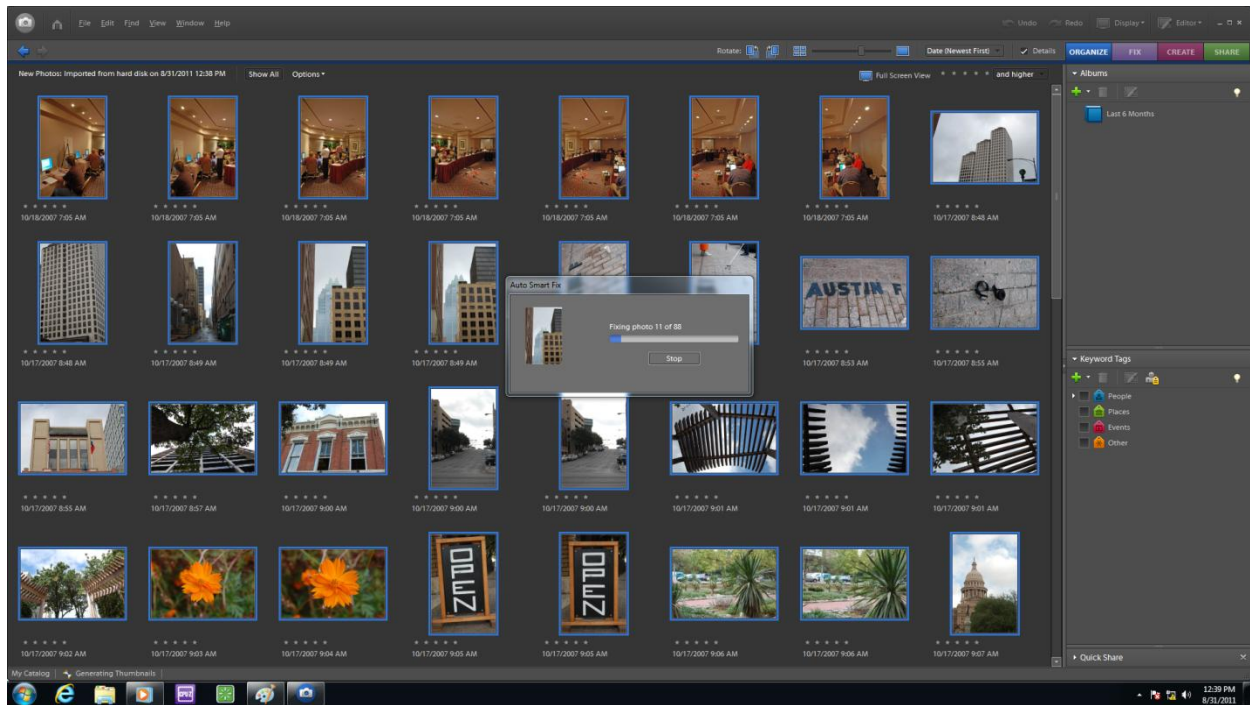

Equipment Configuration
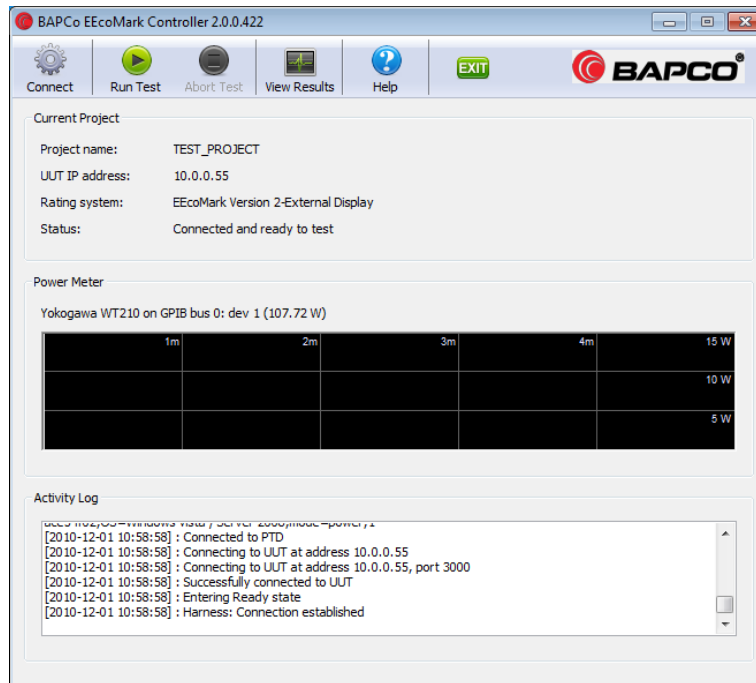
Controller interface

EEcoMark v2 Results
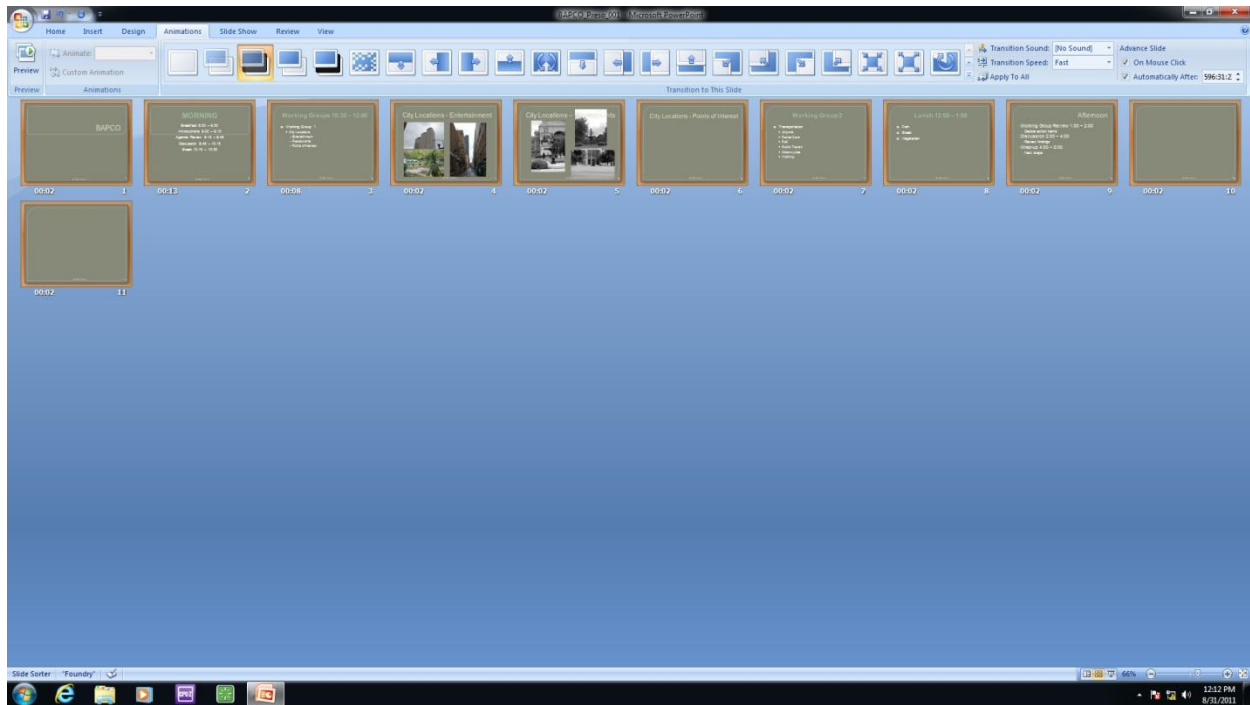
Productivity Basic Scenario

Productivity Advanced Scenario

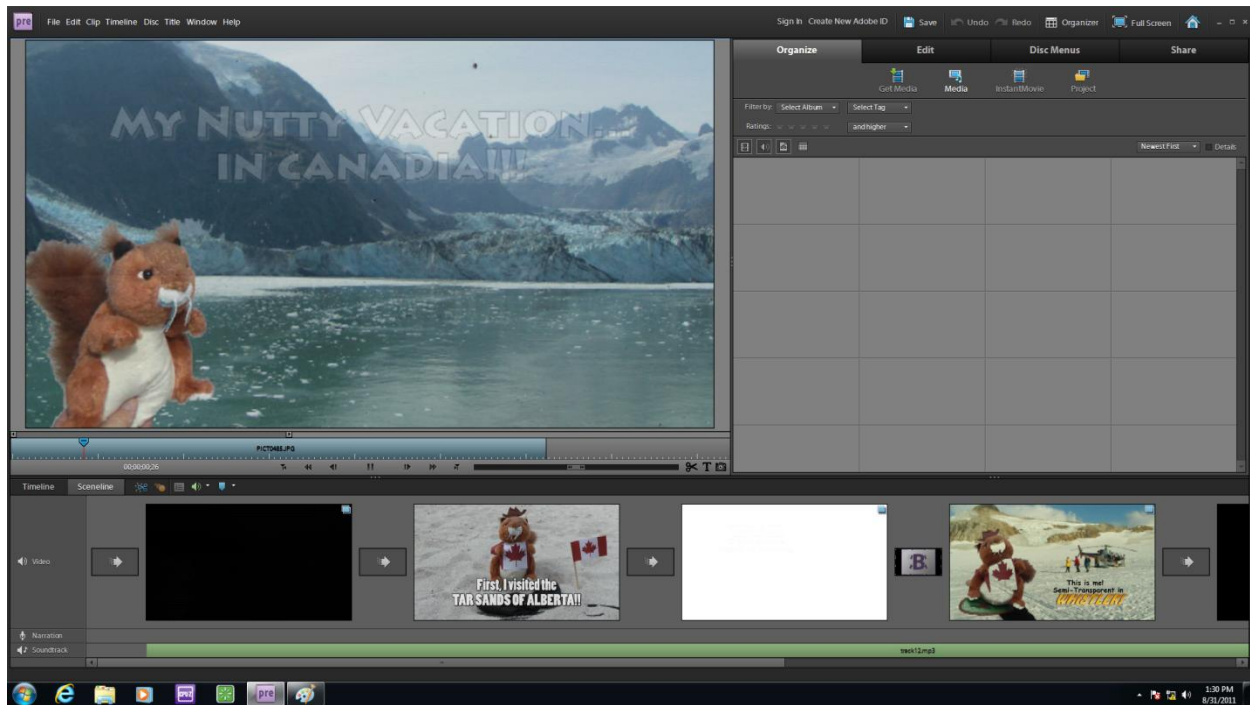**Media Rich Creation Scenario**

Media Rich Consumption Scenario

Graphics Scenario