MEASURING REAL-WORLD ENERGY USE OF COMPUTERS

EXECUTIVE SUMMARY

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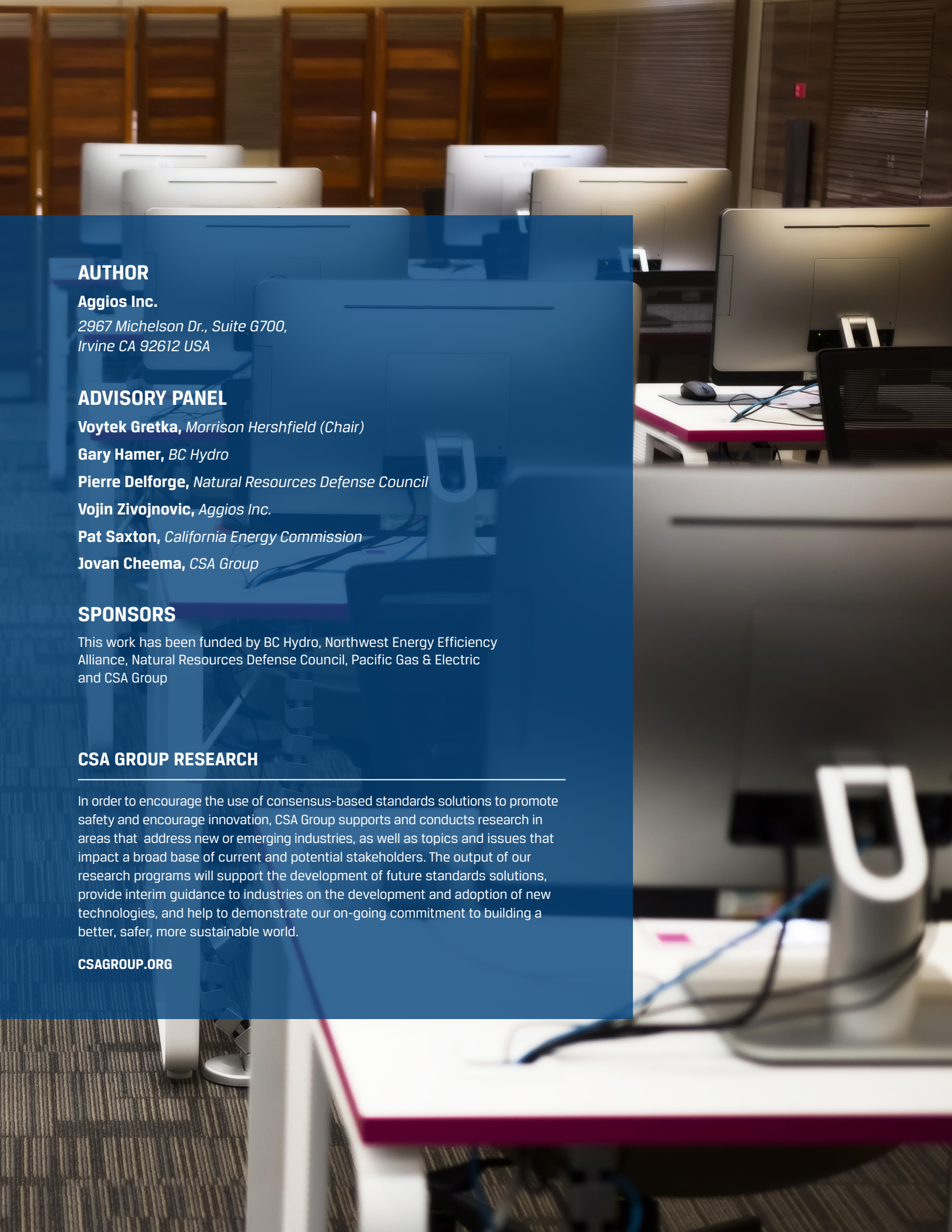

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SPONSORS

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EXECUTIVE **SUMMARY**

SUMMARY

The objective of this project is to develop a new test procedure and measurement infrastructure to assess the real-world energy consumption of computing appliances (defined as appliances that support web browsing and audio/video streaming), with an initial focus on computers. The improved testing is essential for the industry, energy efficiency advocates, and regulators to accurately assess and cost-effectively leverage the energy savings potential of computing appliances in residential and commercial buildings.

BACKGROUND

Standardized energy testing procedures, like those defined by the ENERGY STAR® program for computers, are key tools for industry, energy efficiency advocates, and regulators to assess the energy use of computing appliances and plan improvements. The current ENERGY STAR® v6 test procedure is largely based on the ENERGY STAR® v5 framework, which was developed in 2009. At that time, the power demand of computing devices in idle state was sufficiently similar to the power demand during active operation that, for simplicity, the idle state consumption was used as a proxy for assessing active mode energy use.

PROBLEM

With the emergence of mobile phones and tablets, computing appliance manufacturers have started to leverage power savings techniques from mobile devices to reduce idle power demand. This technology evolution resulted in significantly reduced typical idle power demand of key computer components, and created a situation where the key assumptions of the ENERGY STAR® tests for computers are no longer representative of real-world use.

The real-world power demand of a typical desktop computer can be an order of magnitude higher than the ENERGY STAR® idle mode power demand when performing compute-intensive operations like gaming and video editing. Even in low-intensity active mode such as web browsing and media playback, or in "real-world idle" mode with no user activity but applications loaded, windows open, and background processes running, computer power draw can be significantly higher, by 50% or more, than the ENERGY STAR® short idle mode.

In short, the current ENERGY STAR® test method for computers is like measuring the gas mileage of a car while coasting downhill. As such, it may mislead policymakers and consumers, and encourage manufacturers to invest in energy efficiency improvements that may not result in expected reductions in real-world energy use.

This situation will be exacerbated by the upcoming adoption of "modern standby" by the computer industry, a new mode that allows computers to reduce power to very low levels when idle. The broad deployment of this capability is driven in part by the upcoming California computer regulations scheduled to take effect in January 2019 and July 2021. By then, the ENERGY STAR® v6 test procedure will become largely obsolete. To continue with the car analogy, the ENERGY STAR® v6 idle mode will be measuring gasoline consumption of a car that is stopped at a traffic light and has the auto-stop feature engaged, i.e. the gasoline engine turned off. While this is an important energy-saving capability, this mode of operation does not represent overall energy use in a typical driving scenario.

PROPOSED SOLUTION

This project aims to develop a new test setup and methodology for the execution of a standard set of "light active" benchmark tasks (browser and audio/video rendering) to measure the active mode power demand of computing devices while performing these common activities.

It also includes a real-world idle sequence that measures power draw when the computer is not actively used but browser tabs are open. This real-world idle state differs from the ENERGY STAR® v6 idle states in that it will have browser windows open and background processes running as is typical for computers in the real world.

The project does not cover high-intensity active mode (e.g. gaming and video editing), at least not in this initial phase, because gaming would add significant complexity and development risk for limited additional representativeness benefits. Gaming represents a significant but minority share of computer active energy use overall.

While the initial phase will focus on computers, this new infrastructure and content can be leveraged in future phases to measure the power demand under real-world conditions of other computing appliances capable of web browsing and video streaming, including game consoles, media players, set-top boxes, and smart TVs.

BENEFITS

Once validated, this infrastructure and content can be used within a CSA standard or an express document as the basis of an enhanced test procedure for computing appliances that is more representative of real-world consumption and remains meaningful in a world where modern standby is broadly adopted in the market. Additionally, this light active mode benchmark will provide a draft test method for inclusion in ENERGY STAR® for computers and other computing appliance efficiency policies. The new testing standard will enable more effective efficiency standards and labels, and support better customer purchasing choices.

Additional benefits include:

- Unified testing of active modes for a wider class of computing appliances that provide web browsing and audio/video streaming functionality, such as game consoles and smart TVs, thereby potentially increasing the total savings potential;
- Simplified and accelerated voluntary and regulatory efforts based on unified horizontal standards for all computing appliances.

PHASES

This project, focused on computers, is intended to be implemented in two phases:

1. **Phase 1: Local execution**
   a. Phase 1a: Proof of concept *(Completed)*
      i. Deliverable 1: active benchmark specification
      ii. Deliverable 2: active benchmark execution prototype environment
      iii. Deliverable 3: proof of concept content delivery and testing
   b. Phase 1b: Production benchmark
2. **Phase 2: Remote execution**

Phase 1a: Proof of Concept
Status: *Completed*

Phase 1a is designed to demonstrate the feasibility of a testing infrastructure that allows for the execution of benchmarks that does not rely on compiled code for execution. These content-driven benchmarks differ from traditional benchmarks in that they do not need to be compiled for each operating system or CPU architecture used by the computing devices under test. Content-driven benchmarks leverage the browser and media player that come by default on the device under test rather than compiled code snippets or compiled applications. This benchmarking technique has been used successfully in the mobile phone industry to compare performance across mobile operating systems without requiring a software application to be compiled for each operating system.

Specifically, Phase 1a includes the development of a detailed specification of the environment and procedure, the infrastructure used to measure the energy consumed and sample content to be used during the execution of the benchmark. The developed specification will feature the following contents:

- Benchmark description
- Execution environment
- Content description
- Power measurement
- Environmental considerations

Phase 1a also covers the specification of an execution environment that enables the execution of the benchmark using the sample content. The execution environment includes a server that hosts the benchmark content (webpages and media content) to the device under test via a dedicated local network. The dedicated local network is used to eliminate network delays from influencing the results of the test. The infrastructure envisions a plug load energy-measuring device so that the total energy consumed by the device under test during the rendering of the content will be captured.

Phase 1a testing is being done using the execution environment and sample content to demonstrate that the system can be used to capture energy measurements in a repeatable manner. This sample content is not designed to be representative at this stage. Representative content will be developed in phase 1b.

Phase 1b: Production Benchmark
Status: *Planned* (2018)

Phase 1b is intended to create the content needed for the various computing devices that can be measured using the execution environment. Content will be acquired or created that has appropriate copyright rights. Content will also be tailored for the specific device categories to be covered. For example, a mobile device may be capable of playback of 1080p content whereas a TV computing device may be capable of 4K content playback. This content creation/acquisition/encoding will be followed by repeatability, reproducibility, and representativeness testing and validation.

Phase 2: Remote Execution
Status: *Planned* (2019)

The final phase of the project proposes to develop an online platform that delivers testing content, to be more representative of online usage, and to simplify testing for third parties by removing the need for them to install a benchmarking execution infrastructure on their local network.

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