ANALYZING ENERGY CONSUMPTION OF ELASTIC HPC APPLICATIONS IN THE CLOUD

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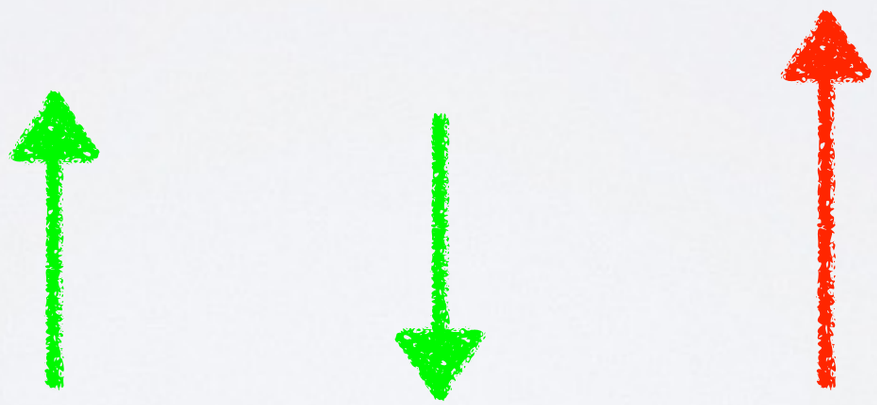
CAPES

SUMMARY

- Introduction
- Energy Consumption
- Elastic Energy Consumption Model
- Methodology
- Results Analysis
- Conclusion

INTRODUCTION

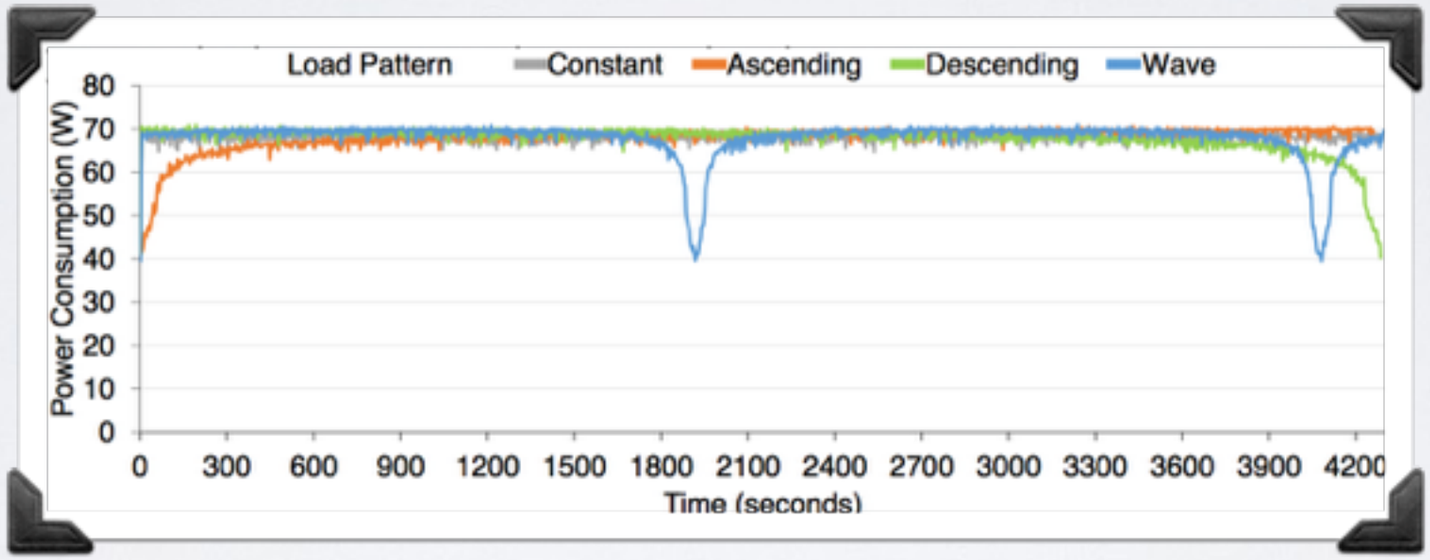
- **Elasticity** can be a double-edged sword involving performance and energy consumption;



A user can achieve a good performance considering the time to execute its application, but using a large amount of resources, resulting in a waste of energy.

INTRODUCTION

- Measuring performance and energy consumption accurately are not easy tasks;



Administrators can suffer with resource sharing among the users, besides a waste on energy consumption.

Can be measured by the server. But how much power each user is consuming in a moment?

MODEL

- Deploying energy sensors or wattmeters can be **costly** if not done at the time the whole infrastructure is set up (besides being **time consuming** as the infrastructure scales up);

- We present an elastic energy consumption model which gives data about energy when executing HPC applications in elastic-based cloud environments.

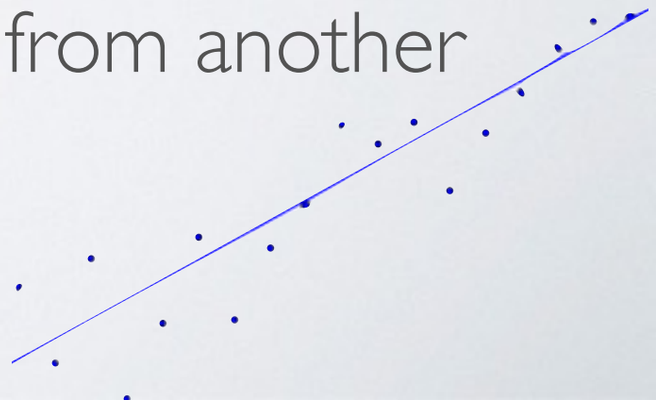
MODEL

The proposed model extracts energy consumption data from a **malleable infrastructure of resources**, enabling relationships among energy consumption, resource consumption and performance.

1. Collect samples of resource usage, and the machine energy consumption using a smart power meter;

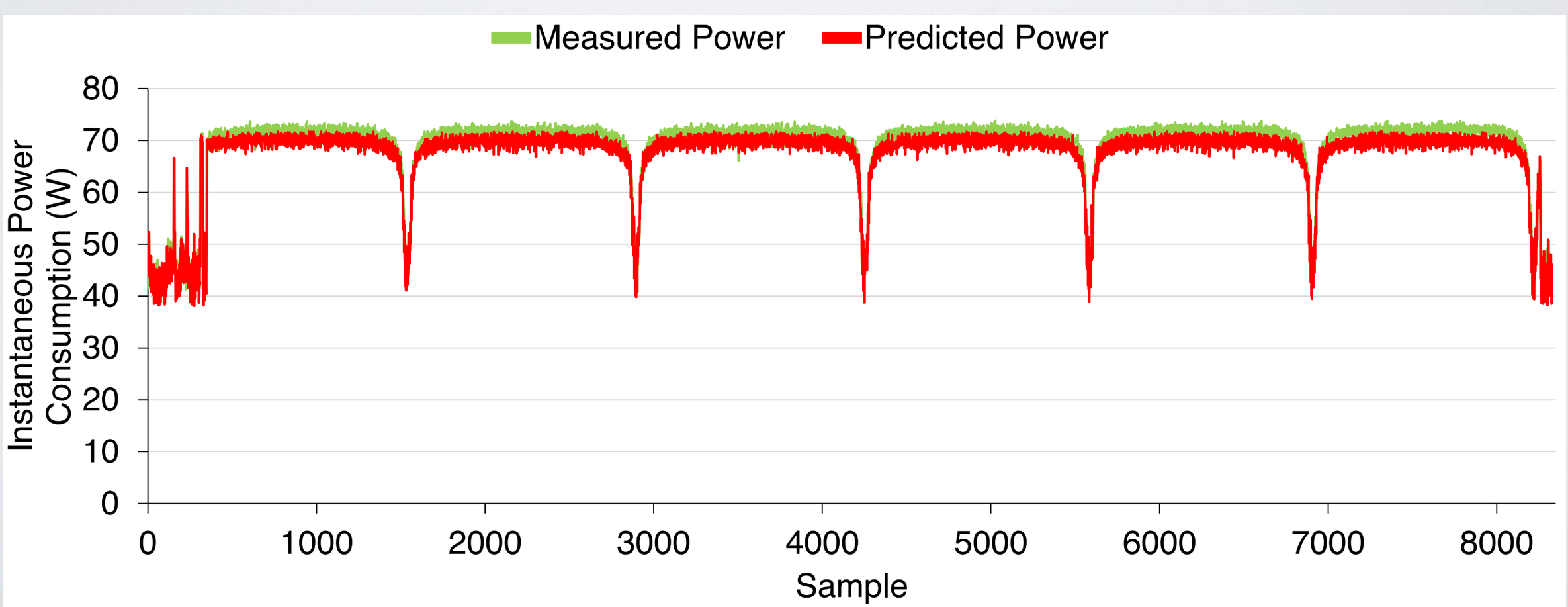
2. Perform regression methods to generate the energy model;

3. Test the model in a different set of data collected from another homogeneous machine.



MODEL

- We obtained a mean and median accuracy of 97.15% and 97.72%, respectively.



MODEL

- Considers the cloud elasticity;
- Can measure shared resources power consumption;
- Scales as the infrastructure grows up (homogeneous).

MODEL

$$f(CPU, Memory) = \alpha + \beta \times CPU + \delta \times Memory$$

α represents an IDLE power consumption. **β** and **δ** represent the variable power consumption determined by the amount of resources that is used in the moment

$$MC(m, i) = f(CPU(m, i), Memory(m, i))$$

Energy consumption of machine **m** according to the logged **CPU** and **memory** in a instant **i**

MODEL

$$ETC(t) = \sum_{i=0}^{Machines} MC(i,t) \times x \begin{cases} x = 0 & \text{if machine } i \text{ is not active in the instant } t; \\ x = 1 & \text{if machine } i \text{ is active in the instant } t. \end{cases}$$

ETC calculates the total power consumption of all machines allocated in an instant **t**, taking into account elasticity using the previous equation MC

$$TC(t) = \sum_{i=0}^{t} ETC(i) \{ \ 0 \leq \ t \ \leq TotalApplicationTime$$

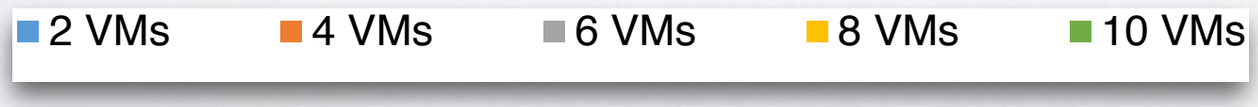
TC calculates the total energy consumption using the previous equation ETC in a determine time interval.

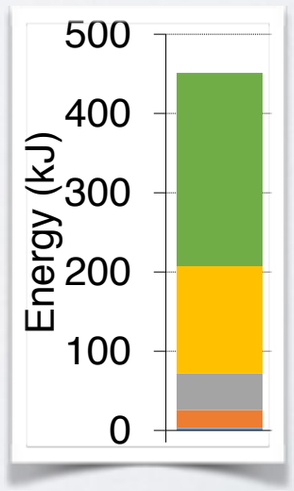
MODEL

$$NEC(z) = \sum_{i=0}^{AppTime} ETC(i) \times y \begin{cases} y = 0 & \text{if in instant } i \text{ the total of active machines} \neq z; \\ y = 1 & \text{if in instant } i \text{ the total of active machines} = z. \end{cases}$$

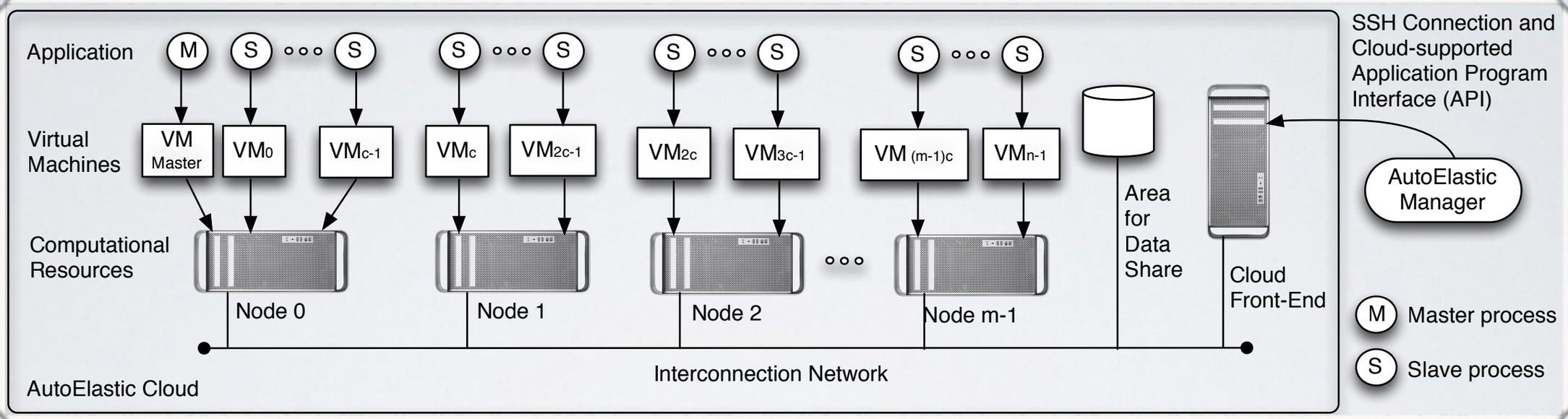
Presents the application power consumption when employing an specific amount of nodes represented by **z**.

It allows the analysis of how much energy has been spent using a specific amount of nodes during the application execution



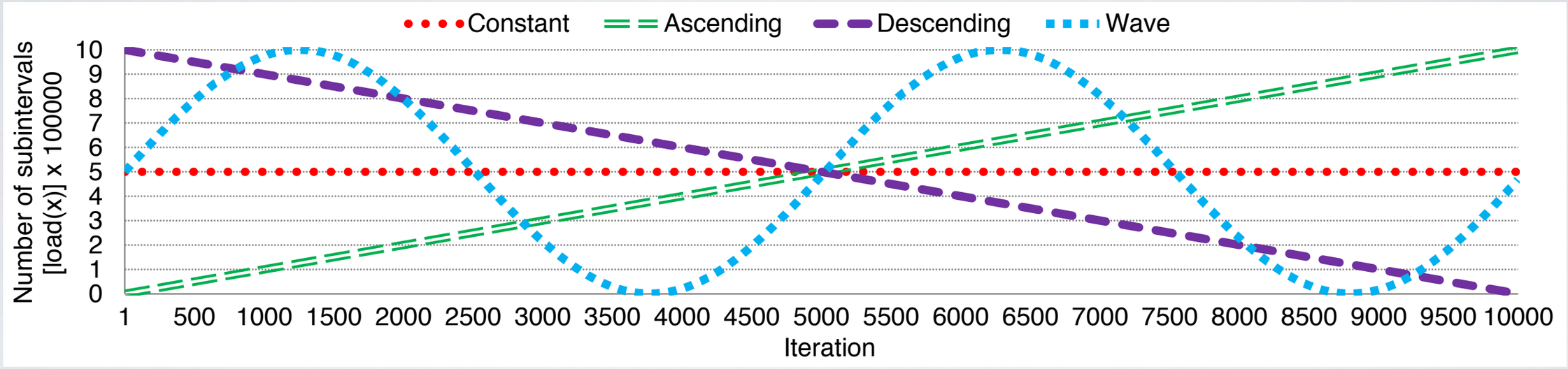


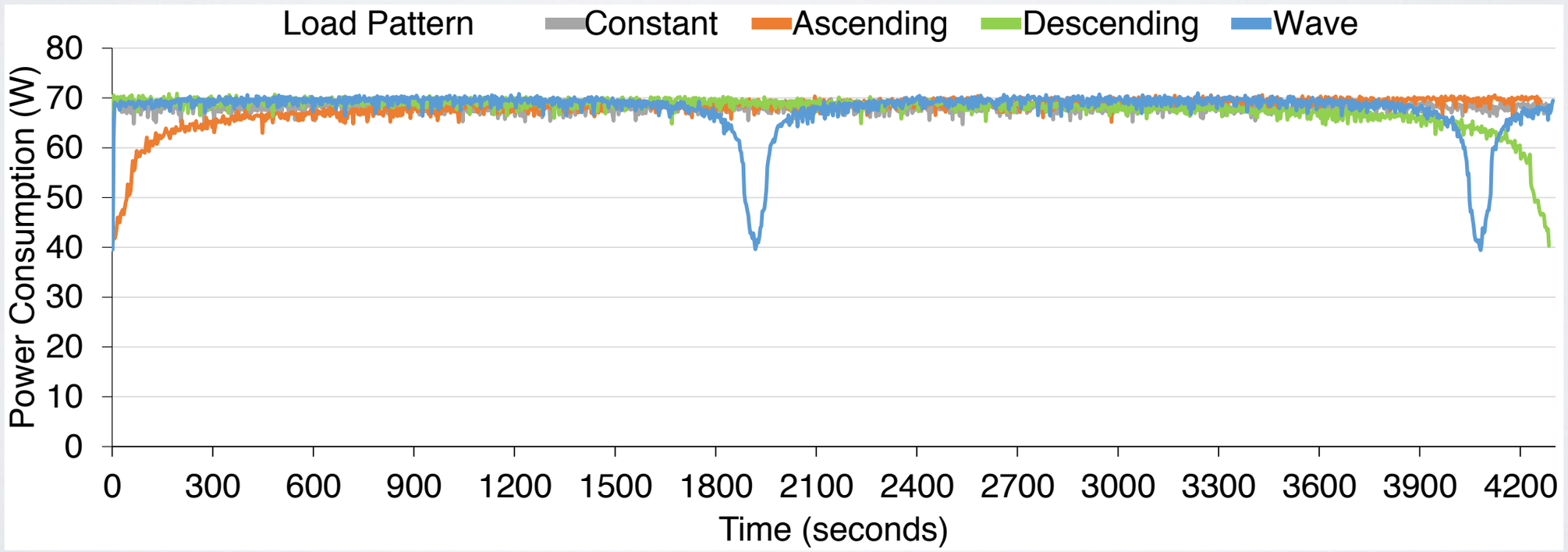
METHODOLOGY



- 6 Nodes - 1 FrontEnd 5 Computing
- 2.9 GHz Dual Core
- 4 GB RAM
- 100 Mbps

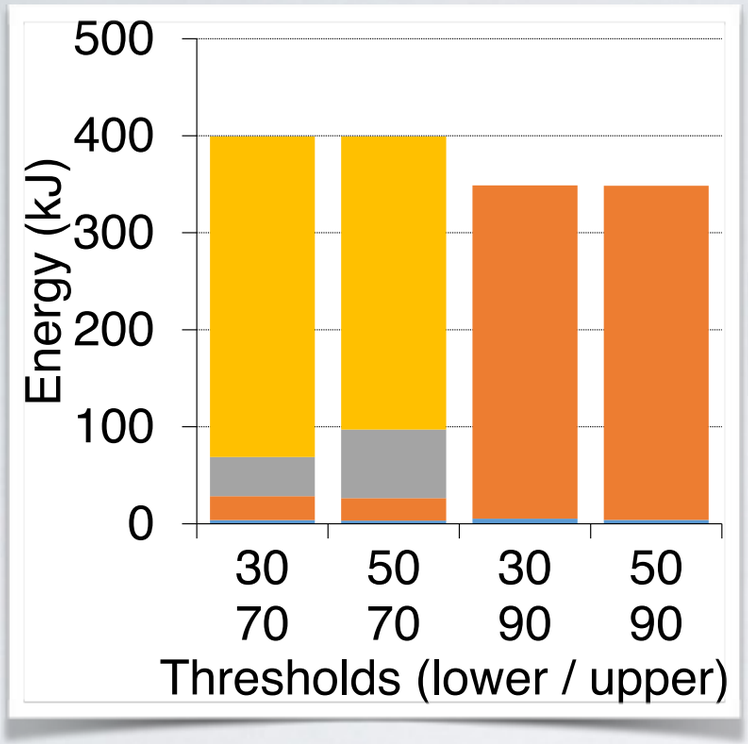
METHODOLOGY





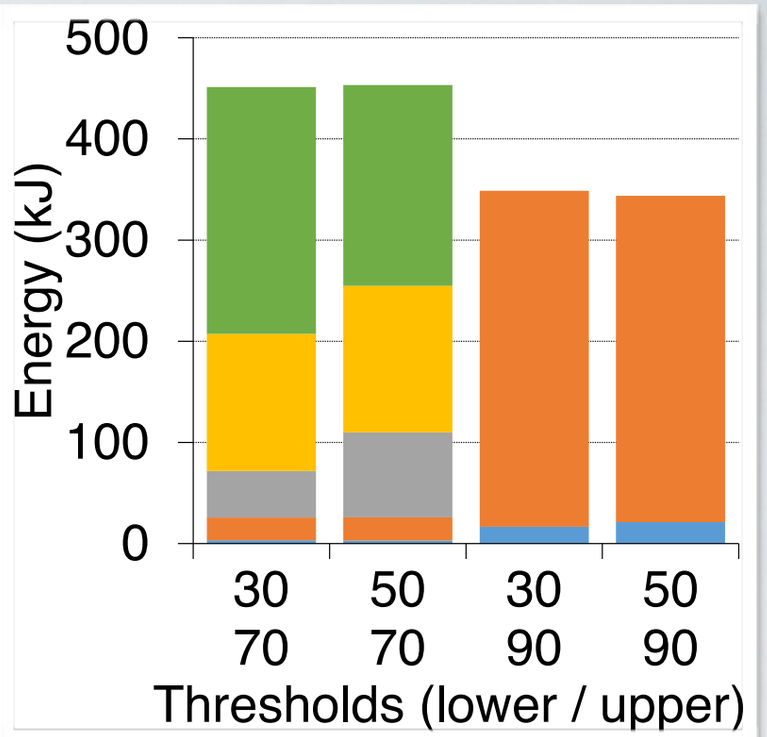
Power Consumption of a Single Node Varying the Load Pattern

RESULTS ANALYSIS

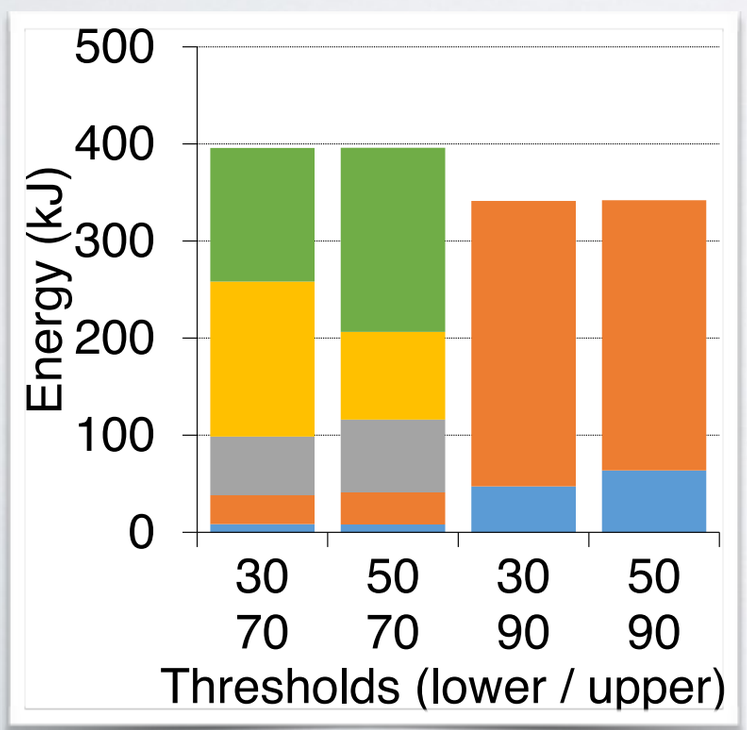


Constant

Wave

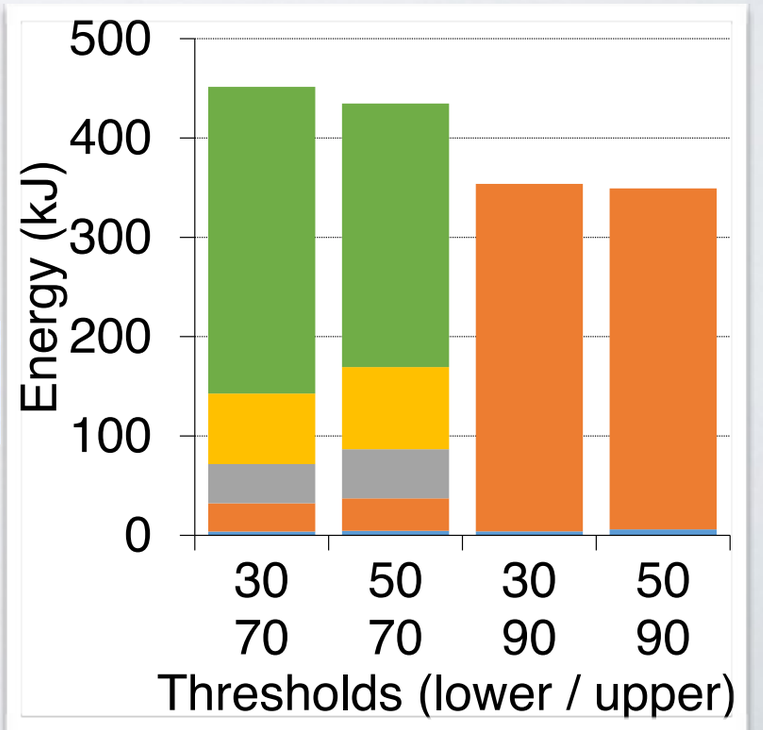


2 VMs 4 VMs 6 VMs 8 VMs 10 VMs

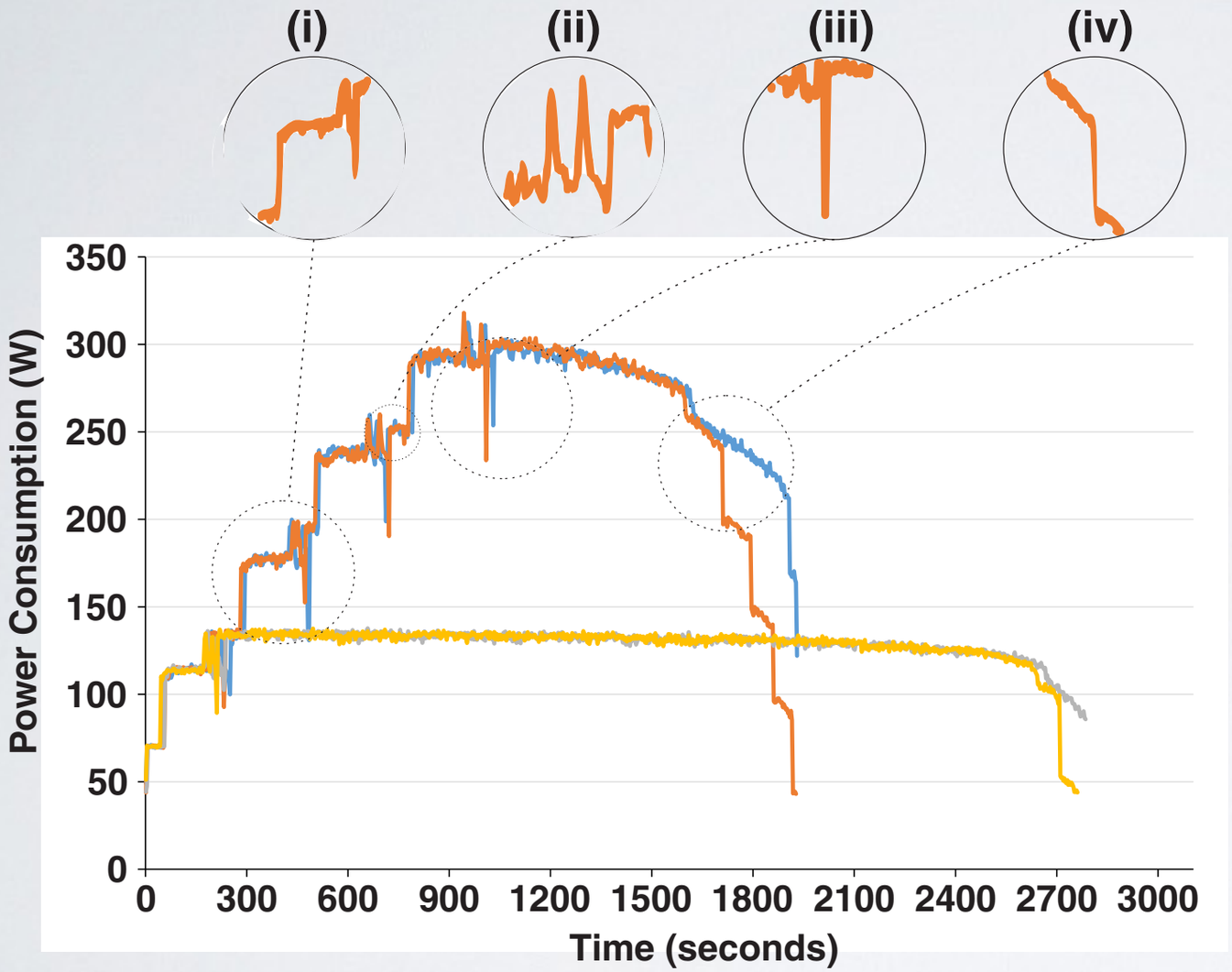


Ascending

Descending



RESULTS ANALYSIS



(i) Host allocation;

(ii) Virtual machines booting;

(iii) Processing stop to incorporate new resources;

(iv) Host Deallocation.

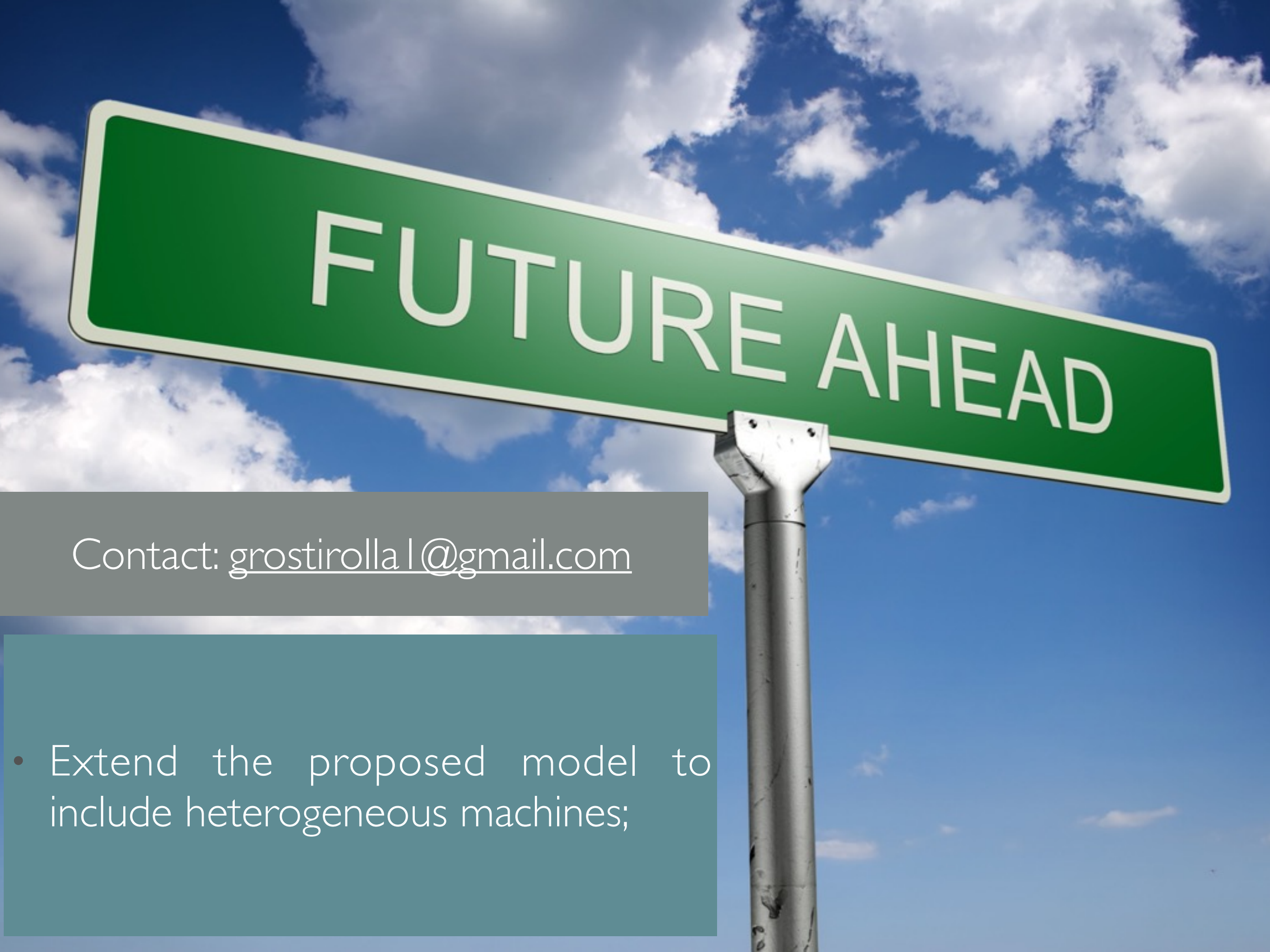
CONCLUSION

- A model estimates energy consumption based on CPU and Memory traces with mean and median accuracy of **97.15%** and **97.72%**;

- Equations to analyze HPC application power consumption on elastic cloud environment;

- Best energy saving with a threshold close to **90%**;

- Worst energy saving with an upper threshold equal to **70%**, but it reaches the best performance rates.



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- Extend the proposed model to include heterogeneous machines;