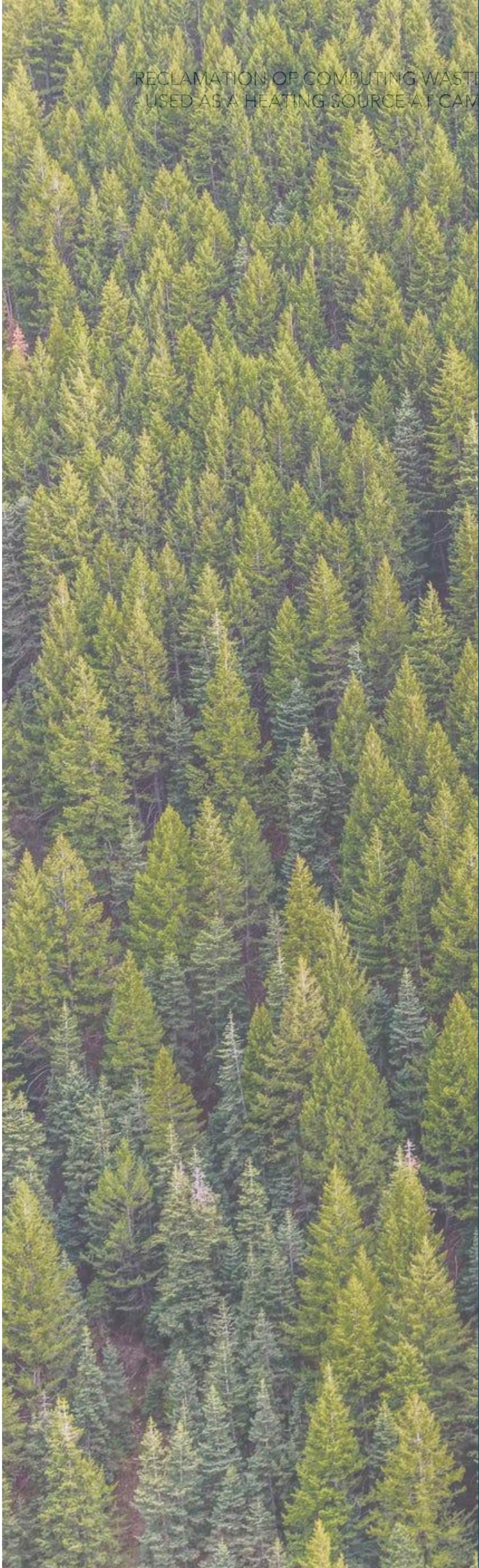

Reclamation of computing waste heat - used as a heating source at campuses

A CONCEPT DEVELOPED BY
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INTRODUCTION

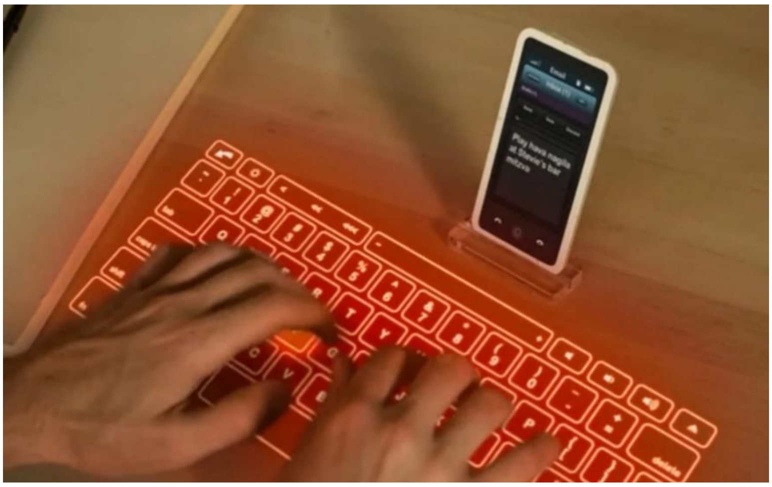
In the last general trend of reducing the environmental impact, university campuses have in their local areas and globally is increasingly becoming a topic of discussion. This results in an apparent need for finding innovative solutions that can tackle some of the issues currently found at these campuses across the world.

In the last decade the reliance on computers at the university level have increased exponentially. Laptops have become an essential part of a typical university students' life. Recent studies have shown an increasing need for fast computing and access to servers that can run software which requires a lot of processing power. To serve this purpose universities have high power servers which can be used by researchers and students to compute these tasks.

VISION

Tackling some of the environmental issues currently found at campuses, one solution is to rethink current waste streams and transform them into an asset that is possible to utilise in another area rather than viewing it as a waste product. Doing this would lower the amount of resources introduced to the system and generate value in another part of the system that otherwise would have required virgin resources.

The idea presented here would create one of multiple systems that should be used to solve campus waste problems. This specific concept focuses on transforming heat waste into a useful asset, whereas others would be focusing on utilising other types of waste found at campuses creating multiple systems that would result in a zero-waste campus.



Source: https://venturebeat.com/

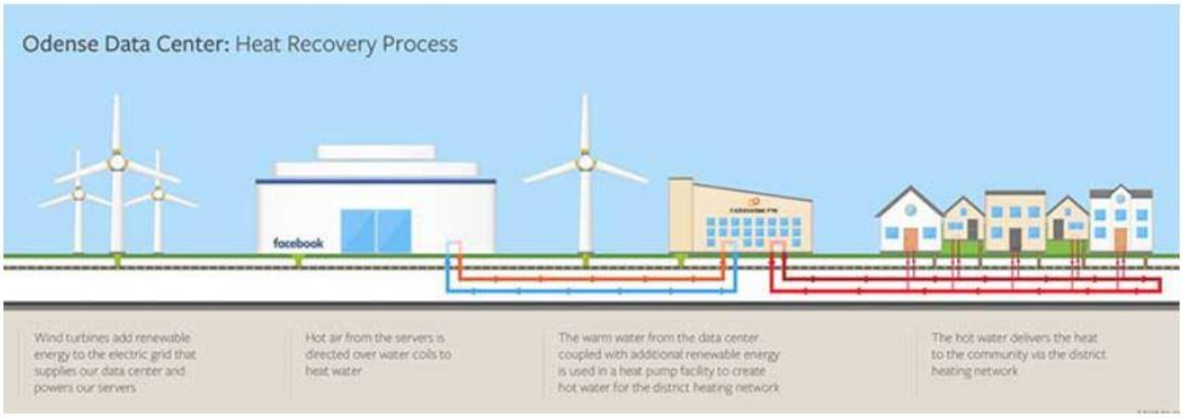
IDEA

The idea consists of two parts, **a virtual computer for the users and a reclamation of the heat generated by the servers** running this platform, **allowing it to be used in the campus heating system.**

The platform that would enable students and staff to compute tasks requiring a lot of processing power already exists. The idea is to expand this concept of having a virtual computer, which would allow users (students, researchers, and staff) to compute all their work-related tasks on the platform rather than on their personal computers. The platform will offer access to pre-installed programs already offered by the institution (Autodesk, Adobe, Microsoft Office, etc.)

Moving the computing power to one central area rather than having it on the personal computers, would allow the university to tap into the heat waste generated from these servers could then be converted into, and convert it into heat used in the campus internal to heat the buildings. The concept of this is already implemented in newer data centres to save money on cooling, as illustrated in the picture below.

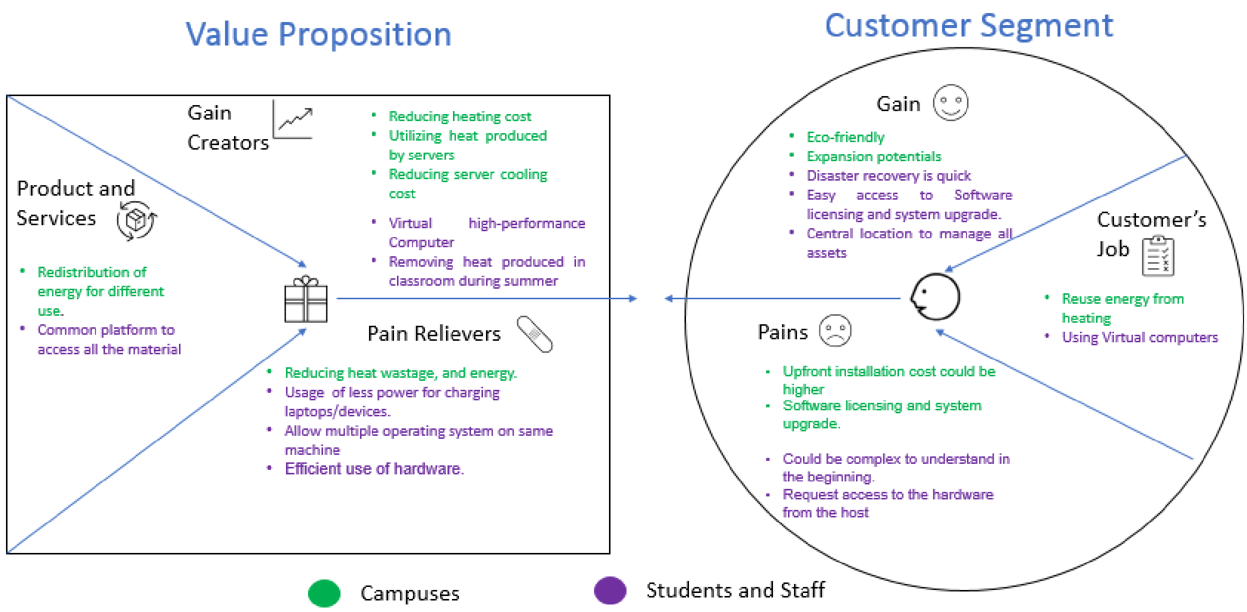
The campus's heat regulation system should be monitored closely, generating data that can later be used to predict the energy demand for each room at campus at all times. The monitoring of the indoor climate is already done to some extend at all three campuses represented in this team



Picture 1 - Illustrating how the waste heat generated in Facebook' data center, is used for district heating (datacenterfrontier.com)

VALUE PROPOSITION

The following framework is designed to illustrate and understand the current needs and also to identify what value it will create for the users. With the help of the Value proposition canvas, the gains and pains of the users is identified when it comes to implement the idea. The canvas showcase the two different users differentiated by colour.



CALCULATIONS AND ASSUMPTIONS

To evaluate the potential impact and feasibility of our solution, we primarily focused on MIT's campus. We estimated the average maximum and idle power consumption of student laptops from the Microsoft and Apple websites to be 35 and 6 Watts, respectively. On MIT's campus, we predicted the average equivalent hours of maximum computing to be 3 and of idle hours to be 8 for each student due to the fact that nearly all students live on campus and have technical focused majors. Assuming students spend 270 days a year on campus, student laptops' annual energy consumption is then 470 MWh. The annual cost of charging laptops equates to about 70.070 USD, using the Boston electricity cost of 0.15 USD/kWh.

By connecting student PCs to a virtual server, energy and money will be saved due to reduced laptop energy usage and charging needs. Connected to a virtual machine, we assume the student laptops would then operate on low power or idle mode for 11 hours a day. Consequently, 203 MWh will be used annually for student laptops. This translates to annual energy savings of 267 MWh and cost savings of 39.840 USD from charging PCs.

Centralized computing allows for waste heat from student computing to be utilized to heat buildings. We calculated the amount of energy for computing that will be used by the virtual machine to be 56.9% of the energy input to each laptop. If 80% of the energy going into the server is then extracted as useful heat, 45.5% of the energy put into laptops can be utilized for campus heating. The amount of heat that will be recovered annually is therefore 214 MWh. The recovered heat is 0.08% of the energy required to heat one of the smaller buildings on campus, building 31. To reduce heat loss in transmission and storage, the heat will be used continuously as it is extracted for the space heating of buildings.

Because the recovered heat represents just a small fraction of the energy needed to heat a building, we did not consider energy storage. Additionally, we assume that the servers have already been built. A typical supercomputer uses about 21.900 MWh annually, assuming it operates 24/7 year-round. The additional inputted energy of 267 MWh from student computers is therefore considered to be negligible in our analysis. We thus did not consider operation and maintenance costs. As a result, our predictions likely overestimate energy savings. DThe next step in the development of our proposal is to incorporate the capital costs of implementation. Data center details can be inputted into the Cloud Energy and Emissions Research Model, developed by Lawrence Berkely National Lab and Northwestern University, to gather more accurate energy saving estimates.

Calculations for other universities can easily be executed by determining the number of equivalent PC use hours, the cost of electricity, and the heat used in campus buildings. Our solution will have a larger impact at technical universities where students are more likely to perform high-level computation. Similar systems can also be implemented at companies.

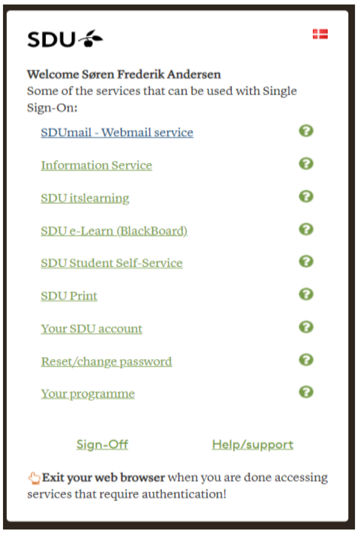
MAIN BENEFITS AND OUTCOMES

- Annual savings of 267 MWh of electricity (MIT campus)
    - 39.840 USD for electricity (MIT campus)
- Reduce annual heating needs by 214 MWh (MIT campus)
- Faster computing and access to servers for students

Ref : See attachments for calculations.

OVERCOMING OBSTACLES

Getting users on the virtual platform



The universities represented in this team already use a common access point to access the institutions' services. The picture on the right display is the login used for SDU

One idea is that users would be required to be logged into the virtual computer to reach this page. Another benefit would be having access to the pre-installed software removing the need for users to install and update required software for courses on their personal computers.

This would create a daily interaction with the user making them more familiar with the platform.

Generating enough heat to make a difference

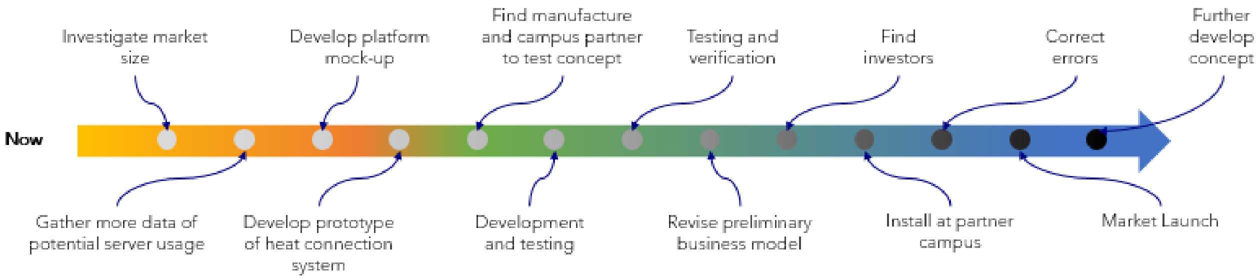
Moving this vast number of both students and faculty on to the platform would also move the energy otherwise used to charge the personal computers, allowing the personal computers run on the lowest possible power usage. If the system is fully implemented, it could remove the students' needs even to get a PC, making it possible to use more energy-saving devices. This would decrease their materiel footprint and expand the time between regular PC updates due to ageing hardware.

SDGs

This idea targets the SDGs 4, 7, 9, 11, 10, 12 and 13. The idea of increasing the usage of a particular server and using the waste heat produced by it is quite innovative, and it also improves the infrastructure of the buildings by minimizing the need of access space heating required. Hence it also makes the buildings more sustainable by making the usual high-power consuming data centres more circular. Using a common high-power server for all the complex computation would considerably improve the education quality as everyone will have access to high-speed computers and the newest software.

Picture of the 17 Sustainable Development Goals (sdgs.un.org)

MOVING FORWARD



Our timeline offers an overview of different activities needed to be executed before market launch

The process is divided into different stages, from research requirements to developing mock-ups and prototypes, to testing the solutions, and improve the concept based on feedback from users and customers.

The timeline illustrates how future planning for developing the project could look like. This presentation of the concept is not nearly complete as there are still many areas requiring further investigation and development to ensure that both the platform and heat exchange system will satisfy the customer and user.

CONCLUSION

We aim to develop a sustainable solution that saves energy on campuses. Technical universities and large campuses contain larger servers and many students. Those servers dissipate a larger amount of heat that goes to waste. Whereas the student on the campus sometimes complete tasks inefficiently due to multiple platforms and having lower performance computers. With the implementation of virtual computers would reclamation of computing waste heat can be used as a heating source at campuses and the energy saved by this can be redirected for several uses such as lights in the classrooms, projectors, and Wi-fi routers etc.