

Génie logiciel pour la conception d'un Système d'Information

CSC4521

**Voie d'Approfondissement
Intégration et Déploiement de Systèmes d'Information
(VAP DSI)**

Sand Battery - Simulation and Dashboard

<http://jpaulgibson.synology.me/~jpaulgibson/TSP/Teaching/CSC4521/>

<.../CSC4521/CSC4521-SandBattery.pdf>

Sand Battery - Simulation and Dashboard

How 2,000 Tons Of Sand Stores 100 Megawatt-Hours And Slashes Carbon Emissions 70%

By [John Koetsier](#), Senior Contributor. © Journalist, analyst, author, podcas... [Follow Author](#)

Published Apr 14, 2026, 06:43pm EDT



Inside the world's largest sand battery.
JOHN KOETSIER

The world's largest sand battery doesn't have a copper top. It doesn't really look like a battery. But it stores 100 megawatt-hours of energy, delivers 1 megawatt consistently, and has slashed a rural Finnish town's carbon emissions by 70%, cutting 160 tons of carbon dioxide emissions annually. And it's about to lose its title as the world's largest sand battery, because the company that made it is building another one, twice its size.

FORBES' FEATURED VII

<https://www.forbes.com/sites/johnkoetsier/2026/04/14/how-2000-tons-of-sand-stores-100-megawatt-hours-and-slashes-carbon-emissions-70/>

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Szewerda, Kamil, et al. "Concept of Adapting the Liquidated Underground Mine Workings into High-Temperature Sand Thermal Energy Storage." *Applied Sciences* 15.7 (2025): 3868.

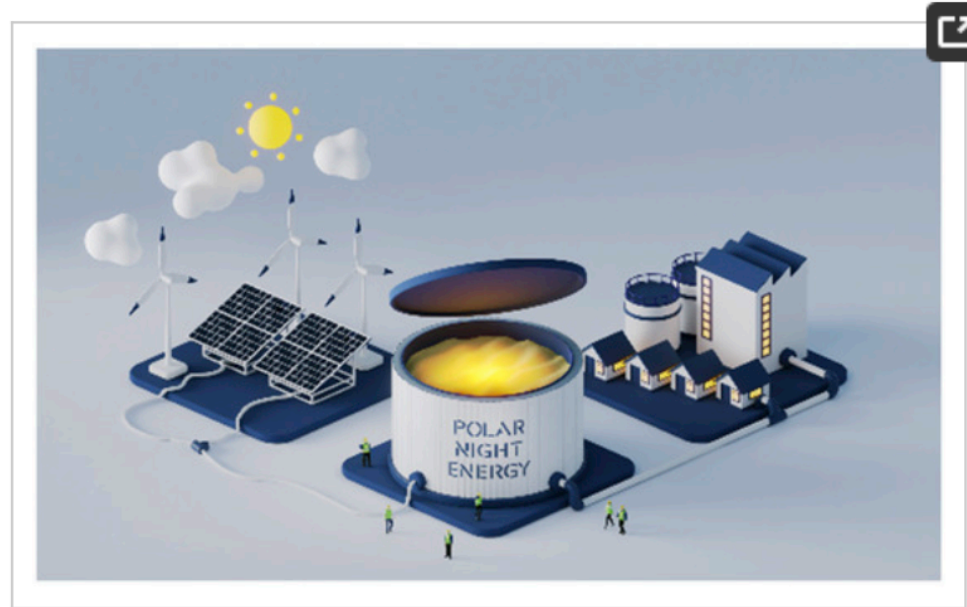


Figure 2. Polar Night Energy's sand battery is a large-scale high-temperature thermal energy storage that uses sand or sand-like materials as its storage medium. It stores energy in sand as heat. It has three main purposes: to store excess wind and solar energy; to balance the electrical grid, and to produce heat and power without burning. [Illustration by Simo Heikkinen/Polar Night Energy].

<https://www.mdpi.com/2076-3417/15/7/3868>

Sand Battery - Simulation and Dashboard

When developing systems such as this we often do 3 things:

- 1) Lab based validation of physical system
- 2) Simulation model (often a digital twin)
- 3) Dashboard Prototype (View and Controller) connected to simulation model

We do not have time to do this for the sand battery, but we will do 2 and 3 for a toy version of the battery (simplified - 2D, not true thermodynamics, etc.)

You can download the initial project code from:

https://jpaulgibson.synology.me/~jpaulgibson/TSP/Teaching/CSC4521/Code/SandBattery_Simulation_Dashboard.zip

Sand Battery - Simulation and Dashboard



Sand Battery - Simulation and Dashboard

Problem 1 - Understand the code and the architecture (run the validation tests?)

Note - most comments have been removed and there are no unit tests (this corresponds to a more ‘real’ situation/challenge)

You can/should add comments and unit tests (where necessary)

A key comment for the gateway is included:

```
public interface SandBatteryGatewaySpec {  
  
    /**  
     * A limited communication protocol using only Strings of characters.  
     * All communication with the gateway must use this String-based protocol  
     * @param words the input strings  
     * @return the output strings  
     */  
    public String[] gatewayMessage( String[] words);  
  
}
```

Sand Battery - Simulation and Dashboard

Problem 1 - Understand the code and the architecture (run the validation tests?)

*****PHASE 1 - input only*****

Sand Battery Size 4 input :on output :off SAFE

9000
0000
0000
0000

Sand Battery Size 4 input :on output :off SAFE

9400
0000
0000
0000

Sand Battery Size 4 input :on output :off SAFE

9330
2100
0000
0000

Sand Battery - Simulation and Dashboard

Problem 1 - Understand the code and the architecture (run the validation tests?)

```
Sand Battery Size 4 input :on output :off SAFE
```

```
9878  
9878  
8887  
8877
```

*****PHASE 2 - input and output*****

```
Sand Battery Size 4 input :on output :7 **UNSAFE**
```

```
9987  
8887  
8887  
8780
```

```
Sand Battery Size 4 input :on output :4 **UNSAFE**
```

```
9897  
8887  
8887  
8740
```

Sand Battery - Simulation and Dashboard

Problem 1 - Understand the code and the architecture (run the validation tests?)

```
Sand Battery Size 4 input :on output :1 SAFE
```

```
9555  
6543  
5442  
4500
```

*****PHASE 3 – output only*****

```
Sand Battery Size 4 input :off output :1 SAFE
```

```
7655  
6552  
5422  
5420
```

```
Sand Battery Size 4 input :off output :0 SAFE
```

```
7655  
5543  
6522  
4420
```

Sand Battery - Simulation and Dashboard

Problem 1 - Understand the code and the architecture (run the validation tests?)

```
Sand Battery Size 4 input :off output :0 SAFE
```

```
1121  
1112  
1100  
1110
```

```
Sand Battery Size 4 input :off output :0 SAFE
```

```
1112  
1101  
1111  
1110
```

```
Sand Battery Size 4 input :off output :1 SAFE
```

```
1111  
1111  
1111  
1100
```

Sand Battery - Simulation and Dashboard

Currently, the input and output rods are in fixed positions - top left and bottom right.

Problem 2 - Integrate a terminal/console controller (in the dashboard) so that you can move the input and output controllers using keyboard input

Sand Battery - Simulation and Dashboard

Currently we only print out the current state of the battery.
We would also like a dashboard view that shows the input/output history

Problem 3 - Implement the function that displays information about the battery output history.

```
public void displayOutputHistory() {  
  
    System.out.println("\n\ndisplayOutputHistory");  
    // TODO  
  
}
```

Sand Battery - Simulation and Dashboard

Problem 4 (Optional - not required for bonus)

- Make a GUI version of the dashboard.

Use Java AWT or JavaFX libraries (if you know them)

You can work on this problem in teams (not necessarily your Wavestone teams) or individually.

Work that is submitted (by the final session) will result in a (0-10%) bonus to your final marks. So, eg, if your overall mark is 15/20 and you get the full bonus of 10%, then your final mark will be 16.5.