

**NPRE 477  
NPRE 498ESU  
NPRE 498ESG  
Energy Storage Engineering  
Fall 2025**

1. Please read the assigned-reading lecture-notes chapters.
2. Then answer the corresponding written assignment,
3. For questions about the assignments, please access the teaching assistants by email:  
<https://www.mragheb.com/NPRE%20402%20ME%20405%20Nuclear%20Power%20Engineering/talist.htm>
4. Submit the corresponding written assignment through email to <https://canvas.illinois.edu>
5. Please use either the Word or pdf formats
6. In case of internet “rationing” (e. g. to health and government authorities), instability, or collapse through overload, please read the lecture notes and submit the corresponding assignments. Already-taken tests and submitted assignments would be used in assessing the final grade.

**Threat of Nuclear War:**

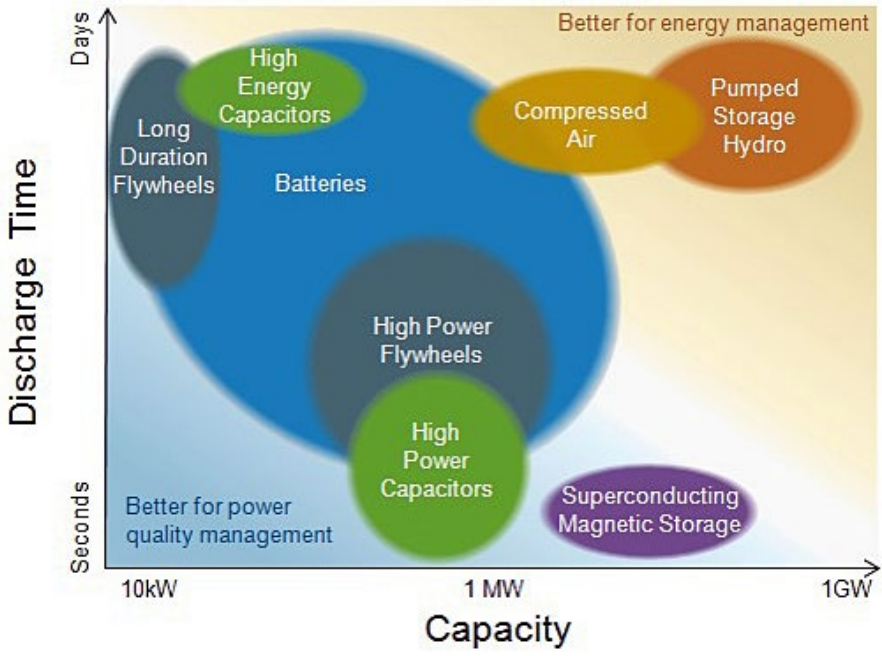
<https://www.youtube.com/watch?v=HSC7Lp1nvx8>

<https://www.youtube.com/watch?v=M7hOpT0IPGI>

Regrettably, some 3,278 colleges and universities across the USA have been impacted by the Covid-19 pandemic, with many temporarily closing their campuses and switching to online classes, affecting more than 22 million students.

To all and everyone we wish good health and well-being.

Number	Date Assigned	Due Date	Description													
1	8/25	9/1	<b>Reading Assignment</b>													
			<a href="#">Preface</a>													
			<b>Written Assignment</b>													
			Using the table, estimate the needed <i>rated power</i> for a solar or wind energy installation to provide the power needs for a family of four in different countries, assuming the presence of a capability to store the energy in battery banks, an overall conversion efficiency of 30 percent, and an intermittence (capacity) factor of 40 percent for both wind and solar.													
			Country	Energy consumption [kWe.hr / (capita.year)]	USA	12,878	Japan	7,432	Switzerland	7,206	Germany	6,027	Hong Kong	4,847	China	1,899
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capita: person																
Using a Ragone plot version, compare the following energy storage options:																
1. Chemical storage using Li-ion batteries,																
2. Fuel cells using hydrogen as an energy carrier.																
2	8/27	9/3	<b>Reading Assignment</b>													

			<p><b><u>Title-Preface</u></b></p> <p><b>Written Assignment</b></p> <p>Using the Ragone plot, compare the following energy storage options:</p> <ol style="list-style-type: none"> <li>1. Pumped storage hydro,</li> <li>2. Chemical Batteries.</li> </ol>  <p>Draw a diagram for the Internet of Things (IoT) envisioned for energy systems showing its components and the interconnections between them.</p> <p>Construct a table showing the allocation of electrical energy production, storage (pumped), export and use on a given day at two different times of the day.</p> <p>Use the links:</p> <p>Energy mix in electrical production, France  <a href="https://www.rte-france.com/en/eco2mix/eco2mix-mix-energetique-en">https://www.rte-france.com/en/eco2mix/eco2mix-mix-energetique-en</a>  or:  <a href="https://www.rte-france.com/en/eco2mix/power-generation-energy-source">https://www.rte-france.com/en/eco2mix/power-generation-energy-source</a></p>
3	8/29	9/5	<p><b>Reading Assignment</b></p> <p><b><u>Introduction</u></b></p> <p><b>Written Assignment</b></p> <p>List the characteristics of a viable energy Storage System.</p> <p>List the perceived advantages of energy storage in conjunction with renewable and conventional Energy systems.</p> <p>An electrical storage battery is charged from a power supply at 1 kW for an hour. If its efficiency is 60 percent, how long would it take to totally discharge it if it used to supply a load at 100 Watts?</p>
4	9/3	9/10	<p><b>Reading Assignment</b></p> <p><b><u>Energy Storage Options</u></b></p> <p><b>Written Assignment</b></p>

		<p>List the main options under consideration to store energy.</p> <p>To produce Hydrogen as an energy carrier, balance the thermo-chemical reactions used in the high temperature Iodine Sulfur (IS) hydrogen production process:</p> $2H_2SO_4 \rightarrow 2H_2O + ? + O_2$ $2I_2 + ? + 4H_2O \rightarrow 4HI + ?$ $4HI \rightarrow 2H_2 + ?$ <hr/> $2H_2O \rightarrow 2H_2 + ?$																										
5	9/5	<p><b>Reading Assignment</b> <a href="#">2. Solar Thermal Power and Energy Storage Historical Perspective</a></p> <p><b>Written Assignment</b> Henry E. Willsie identified the major weakness of all the previously built solar engines in their inability to overcome the intermittency problem of solar radiation. As an energy storage medium, he used large flat-plate collectors that heated water, which he kept warm all night in a large, insulated basin. Identify the working medium that he used to extract the stored solar energy. What was earlier pioneer Charles Tellier’ s choice as a heat storage medium?</p> <hr/> <p><b>Reading Assignment</b> <a href="#">2. Solar Thermal Power and Energy Storage Historical Perspective</a></p> <p><b>Written Assignment</b> Henry E. Willsie identified the major weakness of all the previously built solar engines in their inability to overcome the intermittency problem of solar radiation. As an energy storage medium, he used large flat-plate collectors that heated water, which he kept warm all night in a large, insulated basin. Identify the working medium that he used to extract the stored solar energy. What was earlier pioneer Charles Tellier’ s choice?</p> <p>In the Concentrated Solar Power (CSP) projects shown in the following table, calculate the corresponding idealized Carnot Cycle efficiencies. Rank the thermal energy storage media according to the achievable thermal cycle efficiency.</p> <table><tr><th rowspan="2">Project</th><th rowspan="2">Type</th><th rowspan="2">Storage medium</th><th rowspan="2">Cooling loop</th><th colspan="2">Nominal temperature [°C]</th></tr><tr><th>Cold</th><th>Hot</th></tr><tr><td>Irrigation Pump Coolidge, Arizona, USA</td><td>Parabolic Trough</td><td>Oil</td><td>Oil</td><td>200</td><td>228</td></tr><tr><td>IEA-SSPS Almeria, Spain</td><td>Parabolic Trough</td><td>Oil</td><td>Oil</td><td>225</td><td>295</td></tr><tr><td>SEGS I</td><td>Parabolic Trough</td><td>Oil</td><td>Oil</td><td>240</td><td>307</td></tr></table>	Project	Type	Storage medium	Cooling loop	Nominal temperature [°C]		Cold	Hot	Irrigation Pump Coolidge, Arizona, USA	Parabolic Trough	Oil	Oil	200	228	IEA-SSPS Almeria, Spain	Parabolic Trough	Oil	Oil	225	295	SEGS I	Parabolic Trough	Oil	Oil	240	307
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6	9/8	9/15	<p><b>Reading Assignment</b> <a href="#">2. Solar Thermal Power and Energy Storage Historical Perspective</a></p> <p><b>Written Assignment</b> Calculate the theoretically achievable Carnot cycle efficiencies for the following liquid thermal energy storage media used in solar thermal applications</p> <table><tr><th rowspan="2">Storage medium</th><th colspan="2">Operational Temperature</th></tr><tr><th>Cold [°C]</th><th>Hot [°C]</th></tr><tr><td>Mineral oil, liquid petroleum (alkanes, cyclic paraffins, petroleum jelly)</td><td>200</td><td>300</td></tr><tr><td>Synthetic oil, polyalphaolefin, synthetic esters, hydrocracked/hydroisomerized base oils.</td><td>250</td><td>350</td></tr><tr><td>Silicone oil, polymerized siloxanes, ...Si-O-Si-O-Si...</td><td>300</td><td>400</td></tr><tr><td>Nitrite salts, KNO<sub>2</sub>, NaNO<sub>2</sub></td><td>250</td><td>450</td></tr><tr><td>Nitrate salts, NaNO<sub>3</sub>, KNO<sub>3</sub></td><td>265</td><td>585</td></tr><tr><td>Carbonate salts, Na<sub>2</sub>CO<sub>3</sub></td><td>450</td><td>850</td></tr><tr><td>Liquid Na</td><td>270</td><td>530</td></tr></table>	Storage medium	Operational Temperature		Cold [°C]	Hot [°C]	Mineral oil, liquid petroleum (alkanes, cyclic paraffins, petroleum jelly)	200	300	Synthetic oil, polyalphaolefin, synthetic esters, hydrocracked/hydroisomerized base oils.	250	350	Silicone oil, polymerized siloxanes, ...Si-O-Si-O-Si...	300	400	Nitrite salts, KNO <sub>2</sub> , NaNO <sub>2</sub>	250	450	Nitrate salts, NaNO <sub>3</sub> , KNO <sub>3</sub>	265	585	Carbonate salts, Na <sub>2</sub> CO <sub>3</sub>	450	850	Liquid Na	270	530				
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7	9/10	9/17	<p><b>Reading Assignment</b> <a href="#">3. Thermal Energy Storage</a> <a href="#">4. Thermal Energy Storage with Solar Power Generation</a></p> <p><b>Written Assignment</b> Classify CSP plants according to their operational conditions.</p> <p>List the eutectic mixtures considered for thermal energy storage.</p>																														

			Compare the heat capacities and heat of fusion of energy storage materials used in flat-plate solar collectors.
8	9/12	9/19	<b>Reading Assignment</b> <b><u><a href="#">4. Thermal Energy Storage with Solar Power Generation</a></u></b> <b>Written Assignment</b> List then compare the options considered for Concentrated Solar Power Generation, CSP.  List the reflecting materials used in CSP applications.  Define the Concentration Ratio CR in solar CSP applications.  List the types of tracking in CSP applications.  List the choices of collector glazing materials in CSP applications.  Draw a diagram showing the favored energy storage strategy in CSP applications.
9	9/15	9/22	
10	9/17	9/24	
11	9/19	9/26	
12	9/22	9/29	
13	9/24	9/29	
14	9/26	9/29	
	9/29		<b>First Midterm Exam</b>
15	10/1	10/8	
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### **Assignments Policy**

Assignments will be turned in at the beginning of the class period, one week from the day they are assigned.

The first five minutes of the class period will be devoted for turning in, and returning graded assignments.

Late assignments will be assigned only a partial grade. Please try to submit them on time since once the assignments are graded and returned to the class, late assignments cannot be accepted any more.

If you are having difficulties with an assignment, you are encouraged to seek help from the teaching assistants (TAs) during their office hours. Questions may be emailed to TA's, but face-to-face interaction is more beneficial.

Although you are encouraged to consult with each other if you are having difficulties, you are kindly expected to submit work that shows your individual effort. Please do not submit a copy of another person's work as your own. Copies of other people's assignments are not conducive to learning, and are unacceptable.

For further information, please read the detailed assignments guidelines.