

Today's Agenda (27-March-2025)

- New Requirements from 19-March-25 Judging Call
- Changes in Solution to Respond to New Requirements
- Overview of Solution
- Key Features of the Solution
- Why does this Solution Stand Out?
- Potential Challenges and Risks of the Solution
- Unproven Aspects of the Solution

New Requirements from 19-March-25 Judging Call

1. Wheat cultivation happens from December – June (see “Insolation” line to right)
2. The time of highest irrigation is March and April
3. There are typically 84 days per season where irrigation is done (out of ~180 days of the season)
4. There is a need to irrigate when cloudy.
5. There is a need to irrigate at dawn.
6. The current farmer expense for diesel fuel and lubricating oil for the diesel engine is US\$1,500 per year.
7. A farmer will not consider an alternative to the current technology if it requires more than a 5 year payback (this limits our cost to US\$7,500).

<https://www.gaisma.com/en/location/al-hasakah.html>

al-Hasakah, [Syria](#) - Solar energy and surface meteorology

Variable	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Insolation, kWh/m ² /day	2.20	3.10	4.33	5.39	6.50	7.67	7.63	6.75	5.62	3.78	2.52	1.96
Clearness, 0 - 1	0.46	0.50	0.54	0.55	0.59	0.67	0.68	0.66	0.64	0.55	0.48	0.44
Temperature, °C	5.01	6.13	10.72	17.19	23.11	28.53	32.43	31.73	27.14	20.94	12.92	6.89
Wind speed, m/s	4.43	4.87	5.30	5.46	5.29	5.89	6.62	6.46	5.46	4.73	4.14	4.29
Precipitation, mm	59	49	50	53	21	1	0	0	2	19	28	50
Wet days, d	10.9	10.0	10.6	9.9	6.0	4.7	7.2	7.7	5.3	5.1	7.3	10.2

These data were obtained from the NASA Langley Research Center Atmospheric Science Data Center; New et al. 2002

Notes: [Help](#). Change [preferences](#).

[Gaisma Planet](#) - Interactive Climate and Environment Imagery Viewer

Changes in Solution to Respond to New Requirements

Strategy Change: The system is now composed of 4 identical and separate batteries to respond to the long charging times required in December/January while providing the ability to flexibly and effectively use the stored thermal energy up to 6 hours per day. The farmer will connect charged modules as necessary and disconnect used sand batteries to allow their recharge. The 4 batteries provide a large reserve of thermal energy.

Other Changes:

1. Sloping cover on the south side at the top of the block

- Allows you to set the most optimal position relative to the sun in December and January. In other months, it helps to avoid overheating due to indirect rays, thereby maintaining a constant average power of the installation during the operating period.

2. Larger block (5.4 tons of sand in each of the 4 sections, 21.6 tons of sand in total, versus 2.5 tons of sand initially)

- Allows you to create a large reserve of thermal energy, quickly change the heat accumulators in case of discharge, thereby maintaining long-term operation of the irrigation system in conditions of low insolation in the winter and spring.

3. Larger surface area for capturing sunlight (8 sq. m versus 1.77 sq. m)

- Instead of the original system with a small lens area of 1.77 sq. m and one module, a system of four modules is proposed, each of which has a lens area of 2 sq. m, and the total lens area is 8 sq. m. This allows to increase efficiency several times by increasing the amount of concentrated solar energy, to create a system that can quickly restore the initial heat supply and provide energy backup.

4. Other Fresnel lenses (more efficient, larger surface area)

- It was decided to switch to more advanced Fresnel lenses, which are specially adapted for solar heating and allow more efficient use of the surface, since they are an array of lenses, which allows collecting and accumulating solar energy with minimal losses.

5. More thermal insulation (600 mm versus 400 mm)

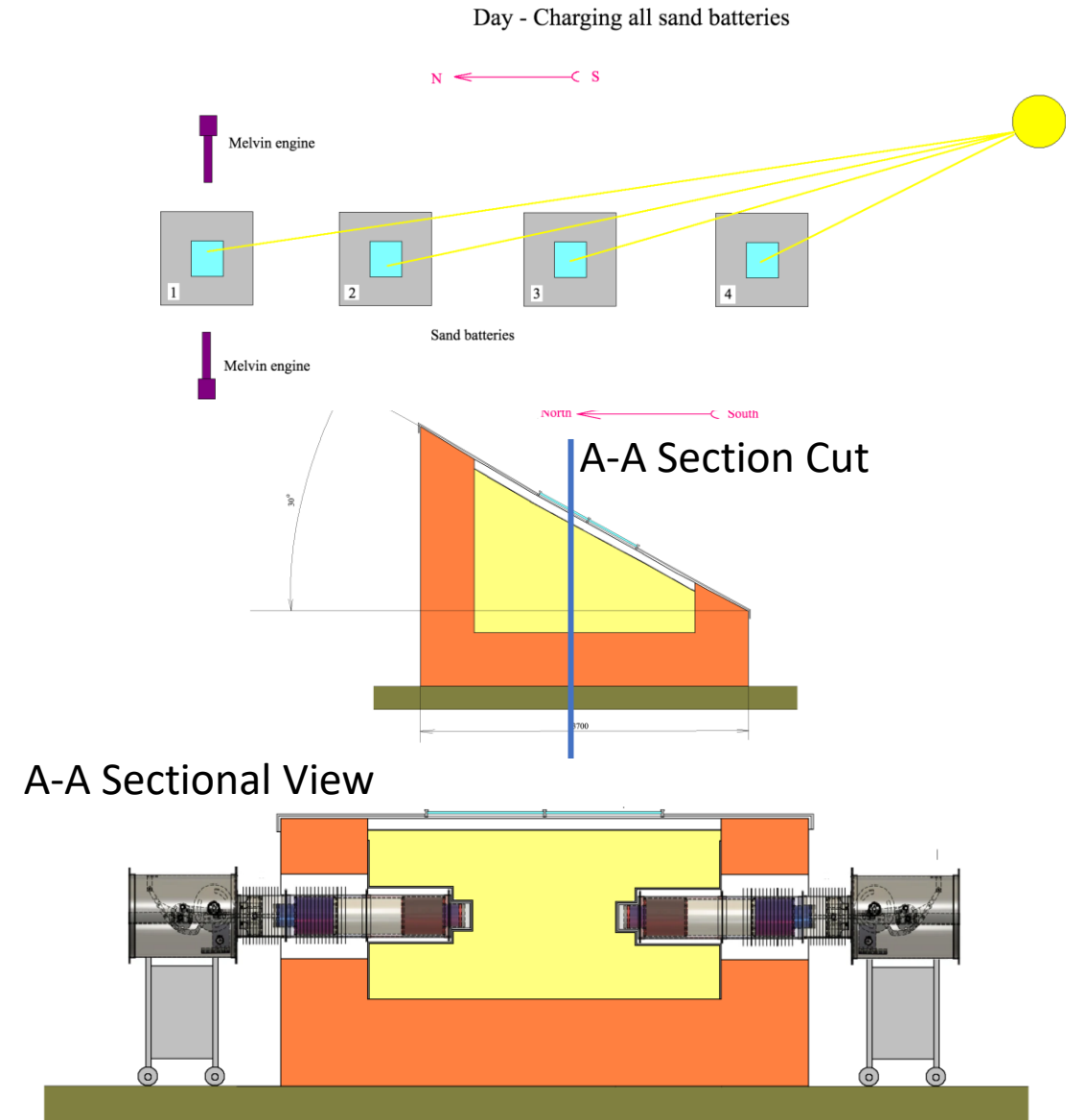
- The greater thickness of the thermal insulation allows it to reduce losses in the cold winter time, provide longer storage of stored thermal energy, create a reliable energy reserve, and provide the maximum temperature regime for Melvin engines.

6. Lower 'Hot End' Operating Temperature (350°C vs 400°C)

- Cool the 'Cool End' with irrigation water at ~10 °C so that the temperature difference between hot and cold end is still 340°C (676 °F).

Overview of the Solution (new)

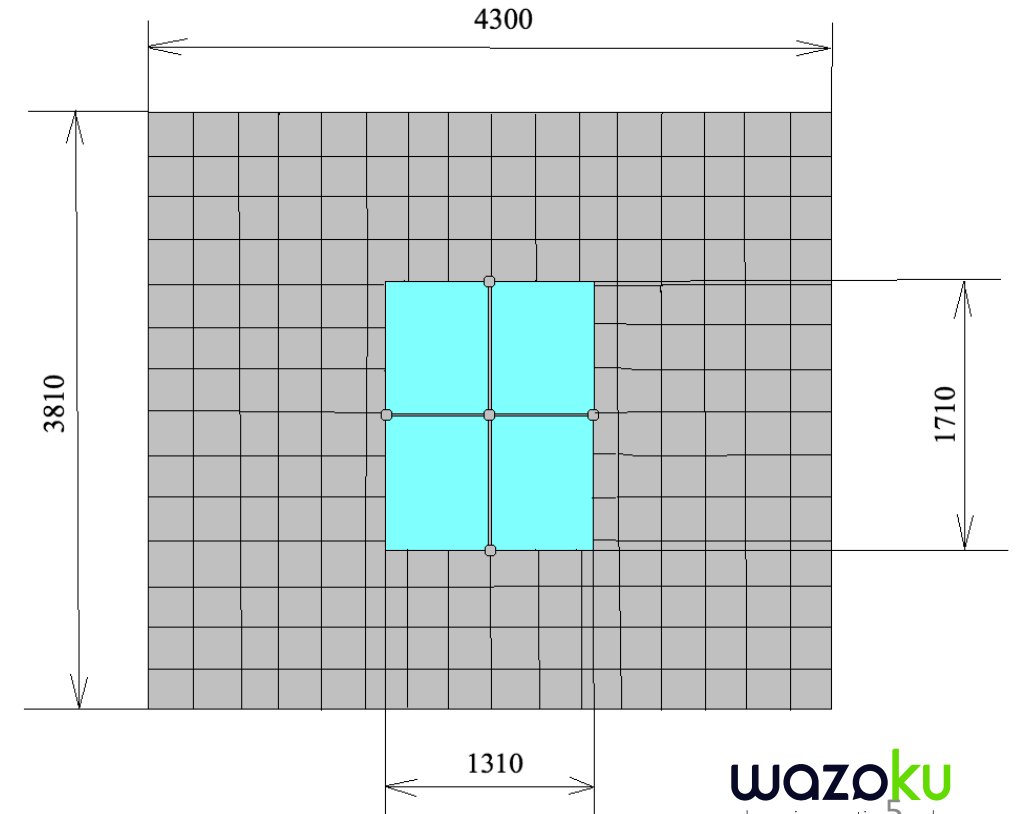
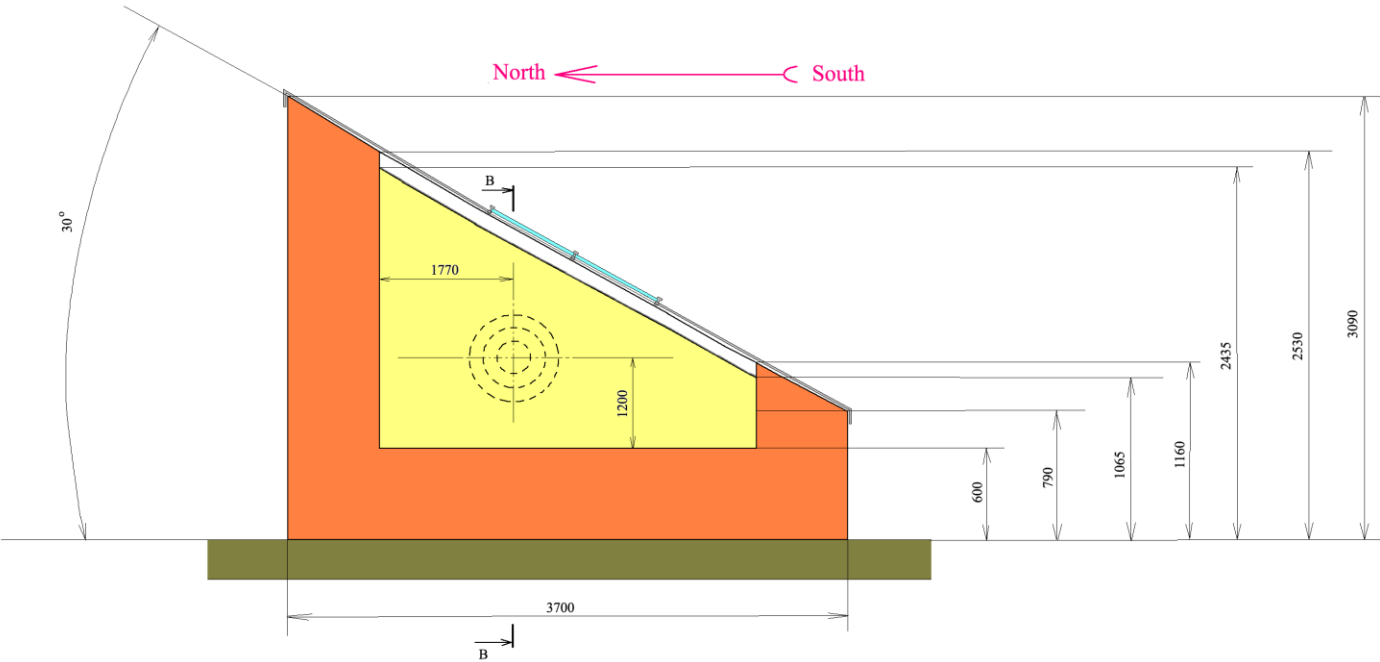
- Development of 2 key ideas of 130834:
 - **All-Season** sand battery
 - Stirling engine
- Intended to work with electric submersible pump of 6kW/8HP.
- No fossil fuel needed
- Capital costs:
 - BOM – US\$4,292
 - Labor – US\$2,700
 - **TOTAL - US\$6,992**
 - Plus freight allowance of US\$500
 - **GRAND TOTAL – US\$7,492**



Details of the Solution – Single Sand Battery (new)

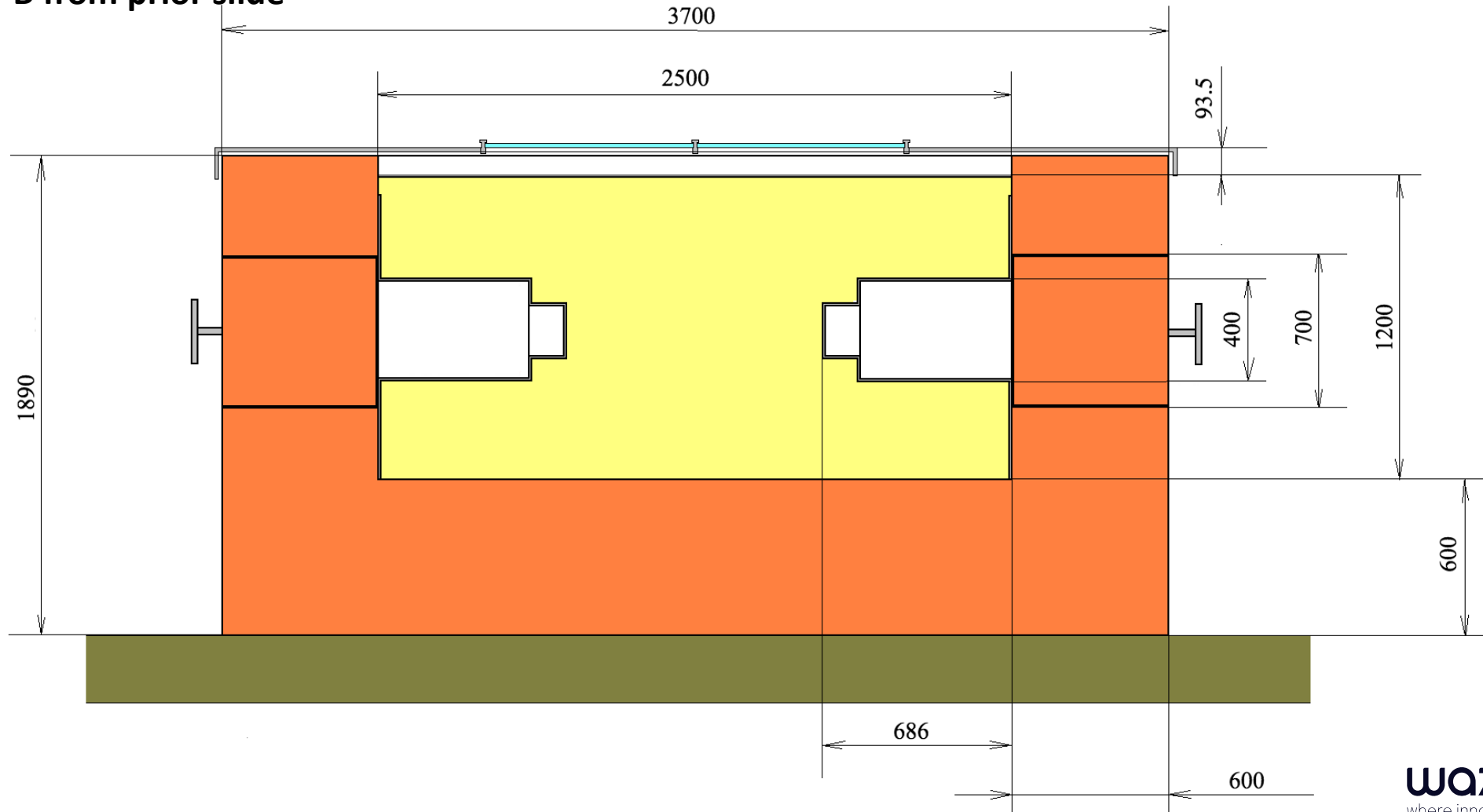
- 4 Separate Sand Heat Sinks – Accumulates heat to drive Stirling Engine

- Cover – 4 special Fresnel lenses concentrate solar radiation to produce 350°C sand



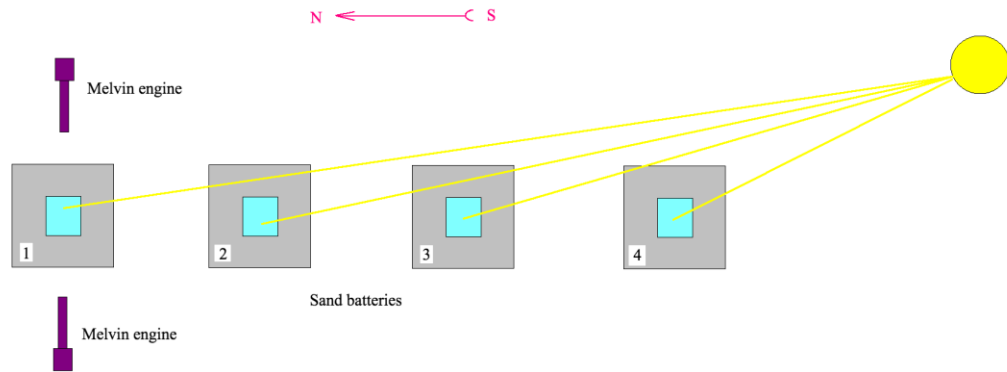
Details of the Solution – Single Sand Battery (new)

Cross-section at B-B from prior slide

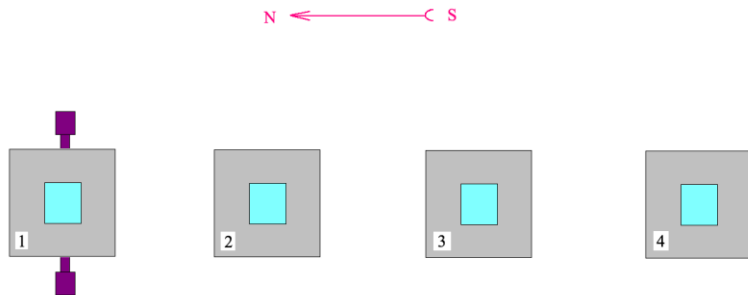


January Irrigation Strategy-4 Batteries (new)

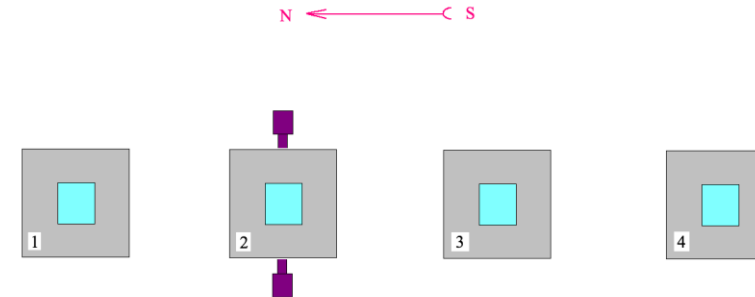
Day - Charging all sand batteries



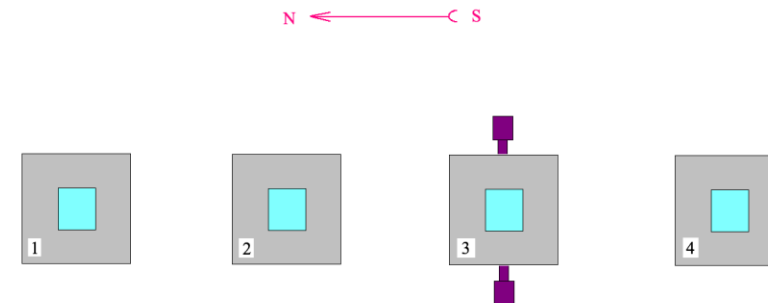
Night # 1 - Using sand battery # 1



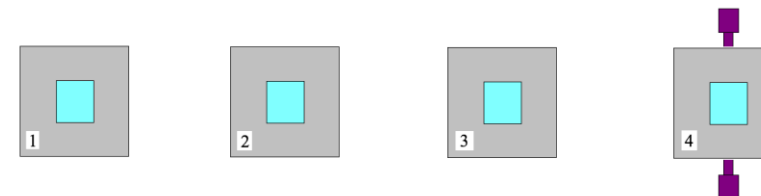
Night # 2 - Using sand battery # 2



Night # 3 - Using sand battery # 3



Night # 4 - Using sand battery # 4



Details of the Solution – Stirling Engine

- Small company (www.seftonmotors.com) in Michigan, USA.
- Still doing R&D to improve electric output and maintenance. Currently requires 2 units to generate 6kW.
- Willing to license design to IRC for Syria manufacture.
- Youtube channel for the company at <https://www.youtube.com/@seftonmotors>.
 - a. Details of how the engine works and company update (15:30) - <https://youtu.be/dTiHu7VfFfA>.
 - b. Details of the electric output process for the engine (10:35) <https://www.youtube.com/watch?v=oTMZGBXJmMM>



The Melvin-Base Engine

\$ 1,800.00

Quantity

1

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Description

Introducing the Melvin. The heart of becoming energy self-reliant. The Melvin Engine runs off of heat. The Melvin is a "Universal Generator" (tm), you can use any form of heat to generate electricity.

Details of the Solution – Costs

Subsystem	Components	BOM Cost	Labor Cost	Total Cost	Sub-system Cost
Sand Battery					
	4 Boxes of Rock Wool Wood (3 layers of 200mm thick)	\$ 484	\$ 300	\$ 784	
	Fresnel Lenses (16 panels of 16*12/830*630mm Fresnel Lens Arrays)	\$ 800		\$ 800	
	Cover (4 of 4.3m x 3.5m)	\$ 152	\$ 100	\$ 252	
	Sand or Clay (21.6 tons), Graphite Powder (30 kg)	\$ 52		\$ 52	
	8 Engine Sleeves and Cover; 4 Thermometers	\$ 329	\$ 100	\$ 429	
	SUBTOTAL				\$ 2,317
Stirling Engine					
	Melvin Base Engine (1.5kW - 2)	\$ 1,800	\$ 1,800	\$ 3,600	
	2nd Hub Generator (Add 1.5kW - 2)	\$ 200	\$ 200	\$ 400	
	Cart & Support System (2)	\$ 200		\$ 200	
	SUBTOTAL				\$ 4,200
Electrical					
	Charge Controller (12-48V)	\$ 96		\$ 96	
	Inverter (12V)	\$ 135		\$ 135	
	Battery (12V)	\$ 29		\$ 29	
	Wires/Cabling	\$ 15		\$ 15	
	On-site labor		\$ 200	\$ 200	
	SUBTOTAL				\$ 475
TOTALS		\$ 4,292	\$ 2,700	\$ 6,992	
	Allowance for Freight, Tax, etc.			\$ 500	
	GRAND TOTAL ESTIMATE			\$ 7,492	

Why Does Solution Stand Out?

Changes from 17 March 2025 version are in RED.

- Concept
 - No fossil fuel required
 - No operating costs expected
 - Not quite as easy as turning on diesel generator, but could be close, **except in Dec-February when will require engine movement between batteries**
- Sand Battery
 - Holds heat even on cloudy day or at night
 - No moving parts
 - Only maintenance is covering at night to reduce heat loss
 - Temperature expected to be at least **350 °C**
- Stirling Engine
 - This model needs hot-cold delta **>340°C** to generate power.
 - Few moving parts. Easy to maintain.
 - Option to manufacture in Syria or elsewhere. Drawings available for purchase.

Potential Challenges & Risks

- Concept
 - Need to work out an 'easy' way to engage & dis-engage engine from battery
- Sand Battery
 - Need to verify with IRC that physical land and sand requirement is acceptable to target farmers
 - Need to prove that the Fresnel cover can generate temps of ~600 °C on the surface of the sand
 - Need to prove that temperature inside sand will be consistently above 350°C
 - Need to prove that heat loss during night and/or clouds is not too great
 - Need to prove that the unit can be made 'safe' enough for farm use
- Melvin Stirling Engine
 - Need to prove that engine can run on 'sand heat'
 - Need to prove that engine can produce 3kW per engine

Unproven Aspects of Solution

- Sand battery **is unproven but we have external validation**
 - Commercial sand battery heating sand to 600 °C: <https://polarnightenergy.com/sand-battery/>
 - Fresnel lens (5m x 5m) can produce temperatures of 800-1,000 °C: <https://thekidshouldseethis.com/post/solar-metal-smelter-jelle-seegers-video>
- Melvin Engine **Unknowns**
 - Company needs to 'complete new kinematics' – expected by mid April 2025.
 - Company needs to operate unit in a pressurized mode to enhance electricity output.
 - Produces 400W at ambient pressure now. Expectation is 1.5kW with one hub motor and internal pressure of ~20psi.
 - Expected later in 2025.
 - Theoretical potential to get to 40psi internal pressure, which would generate 3kW with one hub motor.
 - 2nd hub motor would allow up to 6kW from one Melvin engine
 - Can independent machine shop actually build a working unit?
- Electrical
 - Will a system based on 12V be appropriate for this application?

Chat-GPT5 Prompt for Validation

Optimize a solar heating system with the following parameters: The solar heating system will be operated in Syria in December, the daylight hours are 9 hours, the solar radiation power is 2 kW/m²; The heating material is local dry powdered compacted loam without organic residues; The density of the loam is 1800 kg/m³; The loam is heated in rectangular sections, thermally insulated with mineral wool on 5 sides. The thickness of the thermal insulation on all sides is 600 mm; The upper surface is partially thermally insulated except for the places where the lenses are located; For better absorption of sunlight, the surface of the compacted loam under the lenses is covered with a 5 mm thick layer of graphite powder; Heating is achieved by multiple arrays of rectangular Fresnel lenses, each 830mm by 630mm in size, comprising 192 square Fresnel lenses, each 50mm by 50mm in size, with a focal length of 93.5mm. The lens arrays are framed above a horizontal graphite-coated loam surface at a distance equal to the focal length of the lenses, 93.5mm. The thermal energy from the heated material is used to drive two Stirling engines. The optimum operating temperature of the Stirling engines is at least 330 degrees Celsius. The temperature must not drop below 330 degrees Celsius during engine operation. The cold side of the Stirling engine is cooled with 10 degree Celsius cold water. The temperature difference between the hot and cold sides of the Stirling engine is 315 degrees Celsius. The engines receive thermal energy for operation by connecting to the sections through side ports, in which steel sleeves are installed, repeating the shape of the hot end of the Stirling engine; When connecting the engine, a piece of thermal insulation with a diameter of 400 mm is removed; The size of the hot end of the Stirling engine: length 686 mm, diameter 400 mm; Each Stirling engine is connected to an electric generator with a power of 3 kW; Stirling engines must operate simultaneously, producing a total of 6 kW of electrical power. Less power is not allowed; The simultaneous operation time of two Stirling engines in the absence of solar heating for 6 hours every day; Operating time less than 6 hours per day is not allowed; Thermal insulation material - mineral wool, 600 mm thick, in several layers; No other devices and accessories, heat exchangers, protective coatings, protective glass, automation, protective systems and positioning systems and other systems are provided; Optimize the system and describe the optimized system and its operating principle taking into account all losses and the efficiency of Fresnel lenses; Determine the required number of Fresnel lens arrays; Provide the following additional data: Geometric dimensions of the rectangular section; Number of sections; Total mass of loam and mass of loam in each section; Number of lenses per section; Optimum angle of inclination of lenses to the horizontal surface of the section; Thickness of thermal insulation; Area of thermal insulation; Calculate the required amount of source material for thermal insulation, mineral wool, 200 mm thick, in several layers, in square meters. Perform a test calculation, is there enough energy and time for the system to operate?

Chat-GPT5 Validation Response

System Optimization:

1. Optimized Configuration:

- Sections measuring 2.5m x 2.5m x 1.2m
- 4 Fresnel lens arrays per section
- Lens tilt angle to the horizon 30°

2. Operating Principle:

- Solar radiation is focused by lenses onto a graphite coating
- Heat is accumulated in a loam array
- Stirling engines are connected via side ports
- The system operates as a heat accumulator

Main Parameters:

1. Section Geometric Dimensions:

- Length: 2.5m
- Width: 2.5m
- Height: 1.2m

2. Number of Components:

- Sections: 4 pcs
- Lens arrays per section: 4 pcs
- Total lens arrays: 16 pcs
- Total Fresnel lenses: 3072 pcs

3. Mass characteristics:

- Loam mass in section: 5.4t
- Total loam mass: 21.6t

4. Thermal insulation:

- Thickness: 600mm
- Thermal insulation area: 50m²
- Required amount of mineral wool (200mm layer): 150m²

Verification calculation:

1. Energy balance:

- Solar energy input:
- Lens area: $16 * 0.83 * 0.63 = 8.3\text{m}^2$
- Intensity: 2kW/m^2
- Time: 9 hours
- Input energy: $8.3 * 2 * 9 = 149.4 \text{ kW}\cdot\text{h/day}$

2. Losses:

- Thermal conductivity of thermal insulation: ~20%
- Radiation: ~15%
- Thermal capacity of the material: ~25%
- Conversion efficiency: ~20%

3. Output power:

- Required power: $6 \text{ kW} * 6 \text{ h} = 36 \text{ kW} * \text{h}$
- Available energy: $149.4 * 0.4 = 59.8 \text{ kW} * \text{h}$

Conclusion:

The system is operational with an energy reserve of ~ 60% of the theoretically required. Required: The efficiency of the system is about 40%, which is an acceptable indicator for such installations. The system is capable of providing the required power of 6 kW for 6 hours daily.

Further Information from Solver

- See FAQ document for further details from Solver

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