Conceptual Design for Converting a Vintage Tractor to a Safe, Functional Electric Tractor

By Anya Guzman, Radhika Marwaha, Varsha Senthil
Tractors are too loud to teach students!

**Where:** UC Davis Student Experimental Farm

**POC:** Jim Muck, Field Operations Coordinator

For converting 1950’s Allis Chalmers model G gasoline tractor on the Student Experimental Farm to **electric** (15-20 hp, 4 hours per charge) we did:

- Conceptual Design
- Grant Writing

*D-lab team goes tractor training!*
Methodology

- Research Individual components
- Product LCA
- Stakeholder Analysis
- SWOT
- Tractor Driving Trained!
- Policy ID
Conceptual Design

❖ Tractor Conversion Kit

❖ Battery

❖ Occupational Health
Stakeholder Analysis

Power / Influence

High
- Tractor Companies (experts + patents)
- UC Davis Agricultural Sustainability Institute
- Environmental Policy Makers and Government
- Niekamp Tool Company, NY and their staff

Low
- UC Davis Blum Center
- Small-holder farmer communities in Davis, Central Valley, Midwest, etc.

Jim Muck
- UC Davis Full Time Farm Employees
- ESDC
- D-Lab

Student Farmworkers (trainees + interns)
- College of Engineering
- College of Agriculture

Interest / Impact
Low
High
Niekkamp Tool Company in Kingston, New York, is excited to share with you the unique and innovative Electric G Tractor.

The belts seem to last nearly forever...I've heard of one replaced. There are kits as old as 14. Most I've seen that remarked of any problem related to battery life and usage. Running batteries. The farmers I heard most from even charged a bit at lunch time.

Hope this is useful.

HN
<table>
<thead>
<tr>
<th></th>
<th>Lithium Ion</th>
<th>Lead Acid Battery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>$5,000 - $15,000</td>
<td>$500 - $3,000</td>
</tr>
<tr>
<td>Capacity</td>
<td>High energy density (discharge more energy)</td>
<td>Low energy density</td>
</tr>
<tr>
<td>Depth of Discharge</td>
<td>80%</td>
<td>50%</td>
</tr>
<tr>
<td>Efficiency</td>
<td>~95% efficient (charge faster/more solar power can be stored)</td>
<td>~80-85%</td>
</tr>
<tr>
<td>Lifespan</td>
<td>Several lifespans</td>
<td>One lifespan</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Little to no maintenance</td>
<td>Requires maintenance</td>
</tr>
<tr>
<td>weight</td>
<td>~400 lbs.</td>
<td>~1,000 lbs.</td>
</tr>
<tr>
<td>Charge Rate</td>
<td>Fast</td>
<td>Not so fast</td>
</tr>
<tr>
<td>LCA</td>
<td>75-80% of material recyclable</td>
<td>80% material is recycled for other batteries</td>
</tr>
<tr>
<td></td>
<td>Incineration of waste generates electricity and produces a lot of emissions</td>
<td>Easy to recycle</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very toxic</td>
</tr>
<tr>
<td>Considerations/ Options</td>
<td>Noise (Wt - 3)</td>
<td>Emissions (Wt - 3)</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>----------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Solar and Rechargeability</td>
<td>3+</td>
<td>3+</td>
</tr>
<tr>
<td>Gasoline Tractor</td>
<td>3-</td>
<td>3-</td>
</tr>
<tr>
<td>Hybrid Tractor: Gasoline and Electric</td>
<td>3+</td>
<td>0</td>
</tr>
<tr>
<td>Biofuel</td>
<td>3-</td>
<td>3-</td>
</tr>
</tbody>
</table>

Q: Solar Rechargeability vs. Hybrid Electric Tractor?
Occupational/ Environmental Health & Safety

➔ Student Training Experience
➔ Occupational Health
➔ Policy ID

Rollover Protection System (ROPS)
Source: [https://blogs.cdc.gov/niosh-science-blog/2013/04/30/crops/](https://blogs.cdc.gov/niosh-science-blog/2013/04/30/crops/)

Sciatica (compression of spinal nerves in lower back)
Source: [https://www.medindia.net/patients/patientinfo/sciatica.htm](https://www.medindia.net/patients/patientinfo/sciatica.htm)

(Seifi et al., 2016)
Components
Tractor Model
## SWOT Analysis

<table>
<thead>
<tr>
<th></th>
<th>Electric Tractor</th>
<th>Gasoline Tractor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strengths</strong></td>
<td>❖ Has already been converted!</td>
<td>Students have worked/train on it</td>
</tr>
<tr>
<td></td>
<td>❖ Access to D-lab</td>
<td></td>
</tr>
<tr>
<td><strong>Weakness</strong></td>
<td>Students limited to our electric tractor once trained; need to be well versed in</td>
<td>❖ Can impair hearing - long term + during training</td>
</tr>
<tr>
<td></td>
<td>shifting gears</td>
<td>❖ Inhaling particulate matter</td>
</tr>
</tbody>
</table>
D-Lab I Deliverables
Recommendations for D-lab 2

- **Refurbish Tractor**
  - Strip components we don’t need and build **blueprint**

- **Wiring solar panels + Selection of batteries**
  - Location and installation of **charging** station

- **Component Check**
  - Engine in the front while retaining hydraulics
  - ROPS, seatbelts, **safety** mechanisms

- **Get the design!**
  - Icon of **sustainability** on campus
  - Design **competition**

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Winters’ Tractor Parade 2020!

“Solectrac Electric Tractors: eUtility.” | Solectrac

https://www.solectrac.com/eutility

*Sulfation build-up, and Using the Battery Repair Mode on Genius Chargers.* (2020). No.Co.

https://no.co/support/sulfation-and-battery-repair-mode


https://www.wholesalesolar.com/blog/lead-acid-vs-lithium-batteries/

SketchUp Components:-------------------------
QUESTIONS?