Assignment Brief and Front Sheet PGT

This front sheet for assignments is designed to contain the brief, the submission instructions, and the actual student submission for any WMG assignment. As a result the sheet is completed by several people over time, and is therefore split up into sections explaining who completes what information and when. Yellow highlighted text indicates examples or further explanation of what is requested, and the highlight and instructions should be removed as you populate 'your' section.

This sheet is only to be used for components of assessment worth more than 3 CATS (e.g. for a 15 credit module, weighted more than 20%; or for a 10 credit module, weighted more than 30%).

To be completed by the student(s) prior to final submission:
Your actual submission should be written at the end of this cover sheet file, or attached with the cover sheet at the front if drafted in a separate file, program or application.

Student ID or IDs for group work	**5569029**

To be completed (highlighted parts only) by the programme administration after approval and prior to issuing of the assessment; to be consulted by the student(s) so that you know how and when to submit:

Date set	3/3/25
Submission date (excluding extensions)	**28/3/25 by 12 pm UK time**
Submission guidance	Tabula link
Marks return date (excluding extensions)	29/4/2025
Late submission policy	If work is submitted late, penalties will be applied at the rate of **5 marks per University working day** after the due date, up to a **maximum of 10 working days** late. After this period the mark for the work will be reduced to 0 (which is the maximum penalty). "Late" means **after the submission deadline time as well as the date** – work submitted after the given time even on the same day is counted as 1 day late. For **Postgraduate** students only, who started their **current course before 1 August 2019**, the daily penalty is **3 marks** rather than 5.
Resit policy	If you fail this module and/or component, the University allows students to remedy failure (within certain limits). Decisions to authorise resits are made by Exam Boards. These will be issued at specific times of the year, depending on your programme of study. More information can be found from your programme office if you are concerned. If this is **already a resit** attempt, this means you will not be eligible for an additional attempt. The University allows as standard a maximum of two attempts on any assessment (i.e. only one resit). Students can only have a third attempt under exceptional circumstances via a Mitigating Circumstances Panel decision.

To be <u>completed</u> by the <u>module leader/tutor</u> prior to approval and issuing of the assessment; to be <u>consulted</u> by the <u>student(s)</u> so that you understand the assignment brief, its context within the module, and any specific criteria and advice from the tutor:

Module title & code	WM9F7-15 Managing Design and Manufacturing Technology
Module leader	Helen Ascroft
Module tutor	See above
Assessment type	**Module Assignment 4 (IMA4) – Life Cycle Analysis**
Weighting of mark	20 %

Assignment brief
"A business report critically evaluating the primary material and manufacturing process proposed in the case study in the context of a circular /sustainable economy" Write an **800-word business report** critically discussing sustainability and design for the circular economy within the context of your case study. You are permitted to use the outputs/findings from the group LCA in-class exercise to complete this assignment.

Criteria for Assessment PMA (20% of final mark)

This table details the weightings of the criteria by which your work will be assessed.

Weighted criteria	Allocated Marks
1. **A business report critically evaluating the primary material and manufacturing process proposed in the case study in the context of a circular /sustainable economy**	**70%**
2. **The conclusions and recommendations must follow clearly from the Case study tasks outputs and analysis:** • Look operationally practicable • Include alternative recommendations and reasons given for the chosen path	**20%**
3. **Overall structure of the report:** • Logical structure / sequence • Clarity / written style/grammar/ spelling/referencing • Proper business report style (page numbers, table of contents; sub-headings etc.) • Appropriately presented charts / diagrams/figures and other illustrations	**10%**
Total	**100%**

Word count	The word count is 800 (+/- 10%). **Deductions for excess length:** More than 10% and less than 30% - 10 percentage points from original total mark. More than 30% - Mark is capped at the pass mark. Note: marks less than the pass mark are returned as normal. The word limit includes quotations and citations but excludes figures, tables, references list and appendices.
Module learning outcomes (numbered)	1. Demonstrate an advanced understanding of the fundamentals of product design and development processes, including: methods; technologies; latest trends; tools and techniques; outcome and functional/resource interdependence, interpreting their relationships from concept to customer. 2. Critically evaluate and make recommendations on approaches to the management of product design and development processes. 3. Critically evaluate and contrast: materials; manufacturing processes; manufacturing tools and technologies that are most used in the manufacturing industry. 4. Critically evaluate manufacture-design, demonstrating detailed knowledge of fundamental aspects of manufacturing and materials processes and technologies in the context of a circular /sustainable economy.
Learning outcomes assessed in this assessment (numbered)	4

Marking guidelines	See next page

Learning Outcome Assessed	Comments	80 Outstanding	70-79 Distinction	60-69 Merit	50-59 Pass	40-49 Marginal Fail	<40 Fail
4. Critically evaluate manufacture-design, demonstrating detailed knowledge of fundamental aspects of manufacturing and materials processes and technologies in the context of a circular /sustainable economy.	**University standard PGT marking descriptors for reference.**	An exemplary answer, showing complete mastery of the learning outcome, with an exceptionally developed and mature ability to analyse, synthesise and apply concepts, models, and techniques. All requirements of the learning outcome are exceeded, and the answer is free from errors. The answer demonstrates originality of thought, with strong critical reflection and the ability to tackle issues not previously encountered. Ideas are explained with great lucidity and in an extremely structured manner.	An excellent answer, showing mastery of the learning outcome, with a highly developed and mature ability to analyse, synthesise and apply concepts, models, and techniques. All requirements of the learning outcome are covered, and work is free from all but very minor errors. There is good critical reflection and the ability to tackle issues not previously encountered. Ideas are explained very clearly and in a highly structured manner.	A strong answer, showing a sound grasp of the learning outcome and a skillful attempt at analysis, synthesis and application of concepts, models, and techniques. All requirements of the learning outcome are covered, but there may be some minor errors. There is some critical reflection, and a reasonable attempt is made to tackle issues not previously encountered. Ideas are explained clearly and in a well organised manner, with some minor exceptions.	A satisfactory answer, showing a grasp of the learning outcome but analysis, synthesis and application of concepts, models and techniques is mechanical, with a heavy reliance on course materials. The requirements of the learning outcome are covered but with little or no critical reflection and limited ability to tackle issues not previously encountered. Ideas are explained adequately but with some confusion and lack of organisation.	An unsatisfactory answer. The learning outcome is not met, but it would not take too much to meet it. There is a weak attempt at analysis, synthesis and application of concepts, models, and techniques. Only some of the requirements of the learning outcome are covered. Inability to reflect critically and difficulty in beginning to address issues not previously encountered. Ideas are poorly explained and organised.	An inadequate answer and there are extremely serious gaps in knowledge and many areas of confusion. Few or none of the requirements of the learning outcome are covered. There is a lack of serious engagement with the learning outcome and there is no evidence that issues not previously encountered can be addressed. The levels of expression and organisation in the work are very inadequate.

Evaluation Criteria	90-100	80-89	70-79	60-69	50-59	40-49	30-39	0-29
	Outstanding		Distinction	Merit	Pass	Marginal fail	Fail	
1. Up to 70% for A business report critically evaluating the primary material and manufacturing process proposed in the case study in the context of a circular /sustainable economy	Authoritative analysis which argues convincingly recommendations from the LCA and case study strategy for design for the circular economy addressing all aspects. Strikingly insightful, displaying for example: publishable quality, high originality and independent thought, outstanding ability to make informed judgements.	Authoritative analysis which argues convincingly recommendations from the LCA and case study strategy for design for the circular economy addressing all aspects. Original and independent thought. Well informed judgements.	Authoritative analysis which argues convincingly recommendations from the LCA and case study strategy for design for the circular economy addressing all aspects.	Challenging and relevant analysis which addresses most aspects of the proposal LCA and case study strategy for design for the circular economy and demonstrates good attainment of the learning outcome. Understanding of may not be obvious but implied.	Good analysis of which covers key aspects of the proposal LCA and case study strategy for design for the circular economy but may be incomplete unbalanced. Interdependence not addressed. May be descriptive in places however demonstrates acceptable attainment of the learning outcome.	Patchy and weak description. A write up of design for circular economy/LCA task. Insufficient evidence of meeting learning outcome.	Descriptive and incomplete write up of design for circular economy/LCA. No evidence of meeting learning outcome.	Output poor or trivial. No engagement in assignment. Not linked to case study.
2. Up to 20 % for The conclusions and recommendations must follow clearly from the IMA tasks outputs and analysis.	All recommendations are unequivocally suitable for case study product and scenario and unarguably linked to the IMA task outputs.	Sophisticated presentation of ideas. Linked to the case study.	Challenging and relevant recommendations. Linked to the case study. Mostly executed well.	Completed routinely. Linked to the case study. May be imbalance in execution.	Imbalance in critique. May or may not be obviously relevant to the case study. Some parts be incomplete.	Some conclusions may be more of a summary. Generic or obvious.	Summary of task but some aspects ignored or incomplete.	No summary of the task conclusions/recommendations.
3. Up to 10 % for Overall structure of the report	Full range of sources used selectively to support argument. The ability to analyse primary sources critically. Coherent and compelling argument well presented. Professional standards of writing and presentation. Error free.	Full range of sources used selectively to support argument. The ability to analyse primary sources critically. Coherent and compelling argument well presented. Error free.	Good range of sources used selectively to support argument. Coherent and compelling argument well presented.	Complex work and concepts presented. Key texts used effectively. Argument concise and explicit.	Sound knowledge base of primary and secondary sources. The argument is developed but lacks fluency.	Limited sources used. Argument not fully developed and lacks structure	Overreliance on course notes. Missing references. Limited argument. No logical structure.	Missing or no references. Not in the style of a business report. Incomplete. Trivial.

Academic guidance resources	Lecture slides and recommended reading list

Where to get help:

1. Talk to your module tutor if you don't understand the question or are unsure as to exactly what is required.
2. There are also numerous online courses provided by the University library to help in academic referencing, writing, avoiding plagiarism and a number of other useful resources. https://warwick.ac.uk/services/library/students/your-library-online/
3. If you have a problem with your wellbeing, it is important that you contact your personal tutor or wellbeing support services https://warwick.ac.uk/services/wss

Contents

List of Figures and tables

Introduction

This report talks about the circular economy and sustainability of material and manufacturing processes used to build the LeviStool. The aim is to use minimum resources, minimize waste and reduce environmental impact. We had decided 2 different manufacturing locations one being Tacoma and other one is Missouri with the raw material sourced from North Carolina USA. With the help of Life Cycle Assessment performed on GaBi software, this report evaluates the manufacturing location and talks about the recommendations for the environment friendly approach.

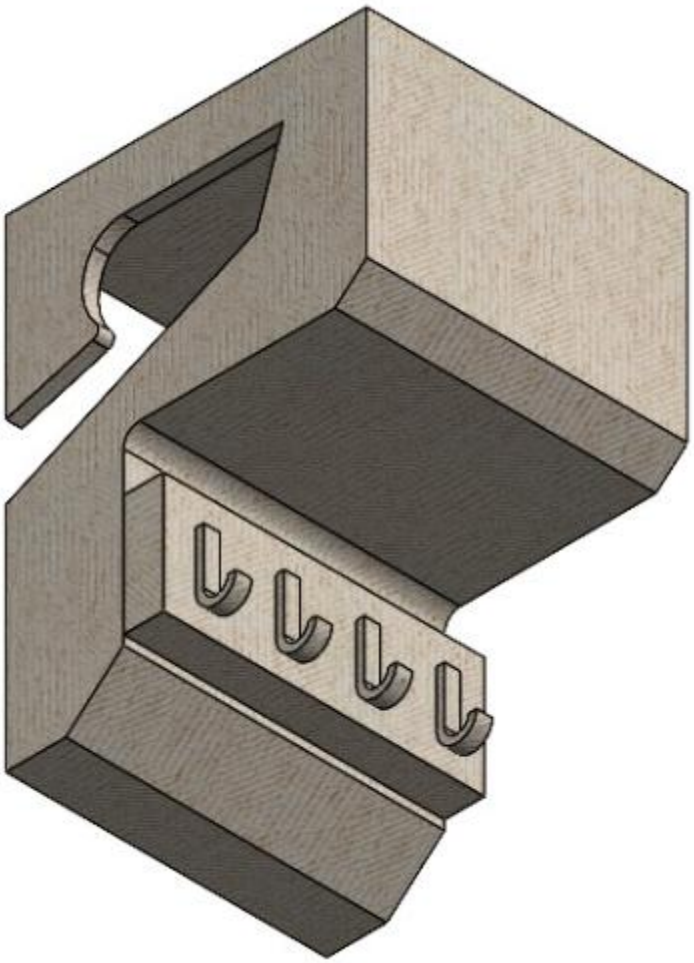

Fig. 1 LeviStool

Material

We decided to go with the Hickory (Carya Glabra) wood because of its strong, durable features. North Carolina is considered as one of the best ideal sources for Hickory in USA due its availability, legal ease and price. The US Hickory growing stock is 742.3 million cubic meters, about 4.7% of US's total hardwood growing (Ninja 2025). American hickory grows by 14.6 million cubic meters per year, while only 5.9 million cubic meters are cut. This leaves a net gain of 8.6 million cubic meters each year (Council 2025). This would help us the continuous supply of the wood.

Critical Evaluation of Material

However, the growth of the Hickory is slow with the rate of 1-2 foot per year (Knapp, Snell et al. 2021). Also, since it is heavy, it increases the transportation cost as well. At the end of the life, mostly the wood is used to fire the meat as it adds to the flavor, but simultaneously increase the smoke emitted due to burning (Ninja 2025).

Fig 2. Hickory (Carya Glabra) (Botany 2024)

Manufacturing Processes

For the manufacturing of LeviStool, we decided to go with traditional stool manufacturing processes to get the lower manufacturing cost. The benefit we will get is, there will not be expensive machinery to invest in. Manufacturing the stool from Hickory wood has a low carbon footprint. The most energy consuming process kiln-drying emits only 42.7 kg of CO2 per cubic meter of hickory wood (Ninja 2025). The main manufacturing process include are as follows,

Manufacturing Process	**Function**
Wood Cutting	A panel saw cuts 8×8 hardwood sheets into precise frame pieces, for uniform size for stable assembly
Thickness Planing	A planer thicknesser evens out the thickness of stool parts.
Shaping and Profiling	A scroll saw cuts curved shapes for legs and side arms, improves ergonomics for user comfort.
Slot Cutting	A CNC milling machine cuts slots into the side arms, for secure fit and safe functionality.
Sanding	A sanding machine smooths surface.
Coating	A protective sealant is manually applied to improve durability and moisture resistance, extending the stool's lifespan.

Table 1 Manufacturing Processes.

Critical Evaluation of Manufacturing Processes

The manufacturing processes helps quality but come with sustainability challenges. Wood cutting and planing generate waste (Yao and Boh 2019), but recycling it into biomass can help reduce environmental impact. CNC milling is more efficient than manual shaping, which minimizes material loss (Demarco, Bertacchini et al. 2023). Sanding produces fine dust, requiring proper filtration to maintain air quality. Coating improves durability but can release harmful emissions, making water-based sealants a more sustainable choice (Zhong, Sha et al. 2017). Using energy-efficient tools scan further improve the overall sustainability of the process.

Life Cycle Assessment

Life Cycle Assessment (LCA) is a method used to evaluate the environmental impact of a product throughout its entire life (Rebitzer, Ekvall et al. 2004). We compared two different manufacturing locations Missouri and Tacoma. Table given below compares the important parameters which helped us the finalise our manufacturing location.

Parameters and Location	Missouri	Tacoma
Distance from North Carolina	912 mi (Maps 2025)	2863.9 mi (Maps 2025)
Labor Cost	$18.62/hr (Statistics 2023)	$23.41/hr (Statistics 2023)
Electricity	$0.082(Administration January 2025)	$0.094(Administration January 2025)

Table 2. Manufacturing Locations Comparison

For our LeviStool, we compared Missouri and Tacoma based on sustainability factors like distance, labor and electricity. Missouri is much closer to North Carolina (912 miles vs. 2,863.9 miles from Tacoma), which significantly reduces shipping emission and shipping cost, making it a greener choice. Also, the labor cost in Missouri are lower at $18.62/hr as compared Tacoma's $23.41/hr rates (Statistics 2023). In addition to that, Missouri even has cheaper electricity rates as well. This certainly gives financial benefit over Tacoma. On the basis of above findings, Missouri came out to be the better option.

Use of GaBi Software

We used GaBi software to find out the best possible outcomes for our stool's LCA (Silva, Nunes et al. 2017). We considered 3 factors, material, electricity and diesel for transportation. Unfortunately, we couldn't find the Hickory (Carya Glabra) so we used plywood. As mentioned earlier, we compared 2 different locations and the results for both the locations are as follows

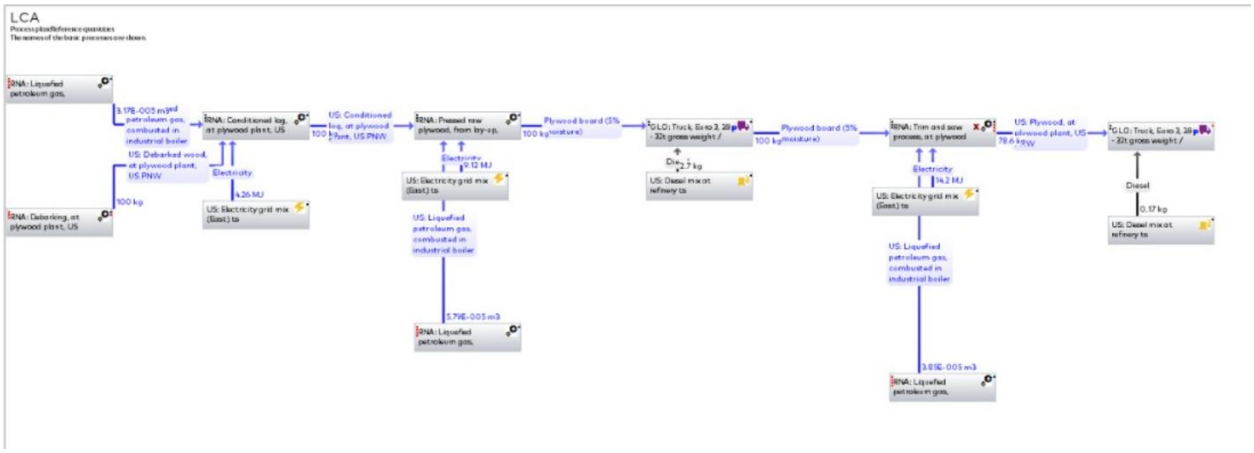

Fig 3. Case 1 (North Carolina-Missouri) Simulation

We put all the important and required parameters for Missouri location, afterwards we ran the simulation and we got the following results.

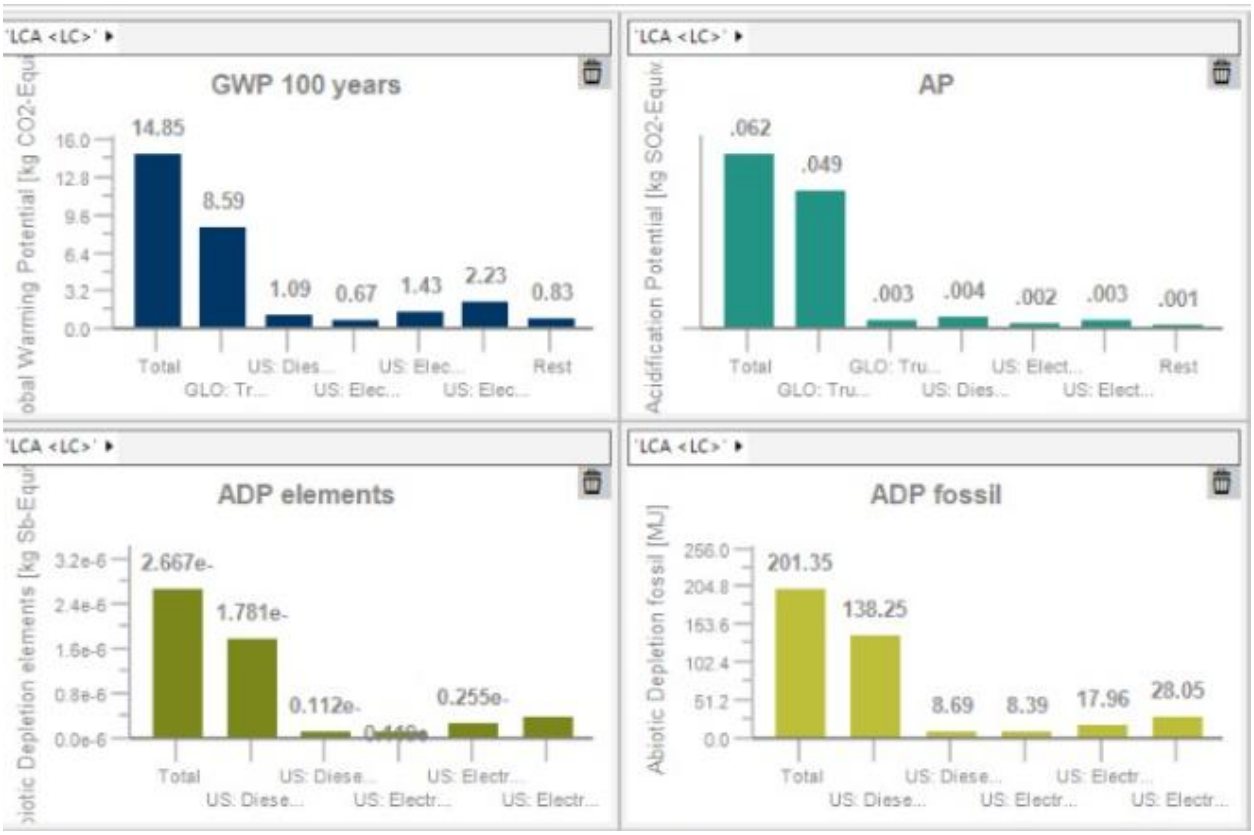

Fig 4. Case 1 Output on GaBi Software

As can be noticed in the above graphical image, the GWP (Global Warming Potential) value is really high indicating the emission caused due to burning of diesel from truck. Since diesel is a fossil fuel, it contributes further to depletion of the fossil resources.

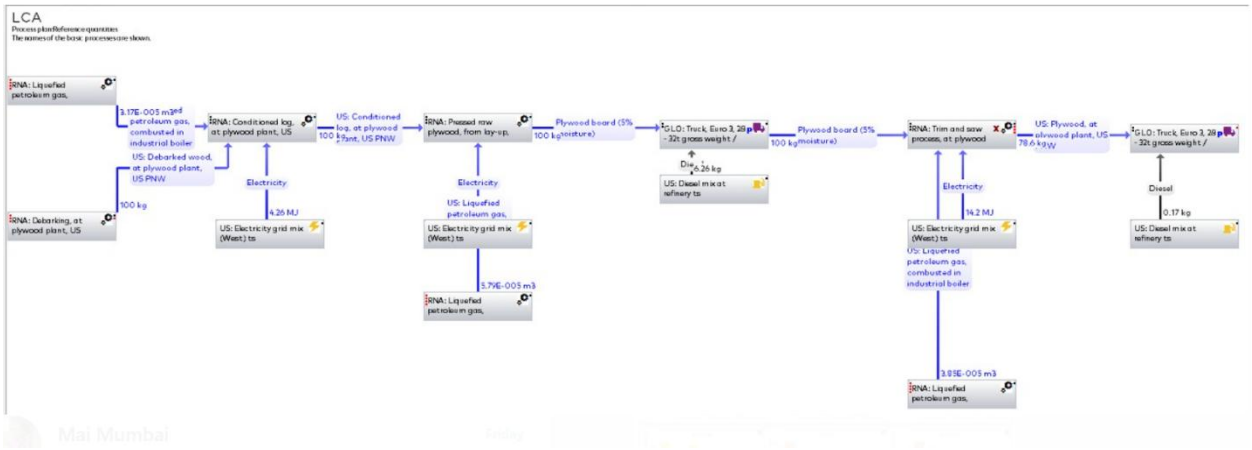

Fig. 5 Case 2 (North Carolina-Tacoma) GaBi Simulation

Now, we considered the same parameters for case two, and after running the simulation we got following results.

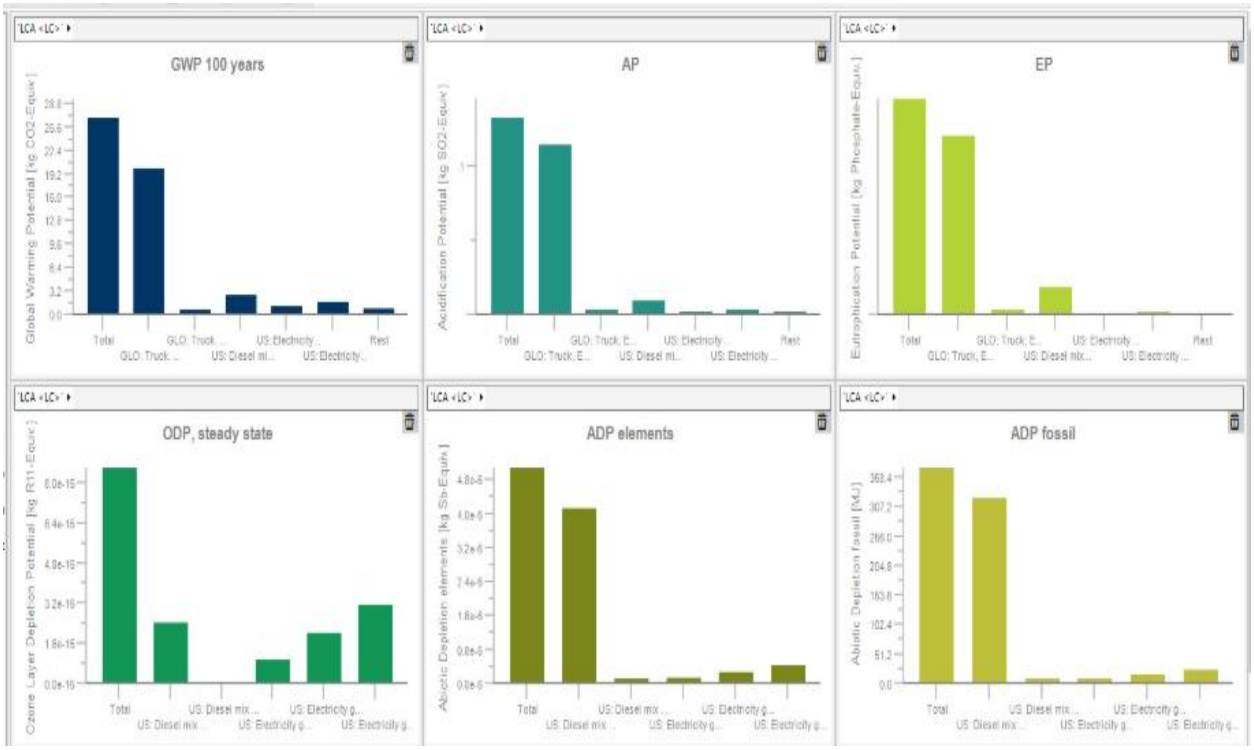

Fig. 6 Case 2 output on GaBi Software

As can be seen, the GWP has drastically increased from 14.85 to 26.6. This is because of the increased distance from case 1. Since the distance increased it led to more consumption of diesel which means more fossil will be depleted.

Circular Economy for LeviStool

A circular economy uses resources efficiently through reuse, reduce and recycling which helps to minimize material loss in order to maintain environmental balance (Korhonen, Honkasalo et al. 2018). We can promote circular economy by reusing the leftover Hickory scrap from sawing process. Also, we can reduce the use of artificial adhesives since they possess Volatile Organic Compounds (VOCs) and can switch to natural adhesives (Kim 2009). Furthermore, we can collect the sawdust occurred from milling and sanding process and can recycle them to use it as wood fillers.

Fig. 7 Circular Economy. (Association 2023)

Recommendation

1. Switch to renewable energy to power the manufacturing processes and install latest instruments which consume lesser power.

2. For the logistics part, we can adopt Electric transportation option to support the green logistics.

Conclusion

In conclusion, we decided to set up the manufacturing plant in Missouri and source Hickory wood from North Carolina. Using GaBi software, we analysed two location options, considering factors like logistics emissions, labor costs, and electricity expenses. The distance between North Carolina and Missouri was shorter, it offered a balanced approach in terms of sustainability and cost. We also identified ways to implement circular economy principles through reuse, reduce, and recycle strategies. Finally, we provided recommendations to further improve sustainability in our manufacturing process.

List of References

Administration, U. S. E. I. (January 2025). "Electricity." from https://www.eia.gov/electricity/.

Association, S. P. D. (2023). "Embracing a Circular Economy: Protecting Our Planet, Saving Money, and Creating Jobs." Retrieved 30/03/2025, 2025, from https://www.linkedin.com/pulse/embracing-circular-economy-protecting-b7tyf/.

Botany, G. (2024). "Carya glabra — pignut hickory." Carya glabra — pignut hickory. Retrieved 30/03/2025, 2025, from https://gobotany.nativeplanttrust.org/species/carya/glabra/.

Carolina, T. H. S. o. N. (2025). "Domestic Lumber." Retrieved 30/03/2025, 2025, from https://hardwoodstore.com/domestic-lumber/.

Council, A. H. E. (2025). "American hickory." American hickory. Retrieved 30/03/2025, 2025, from https://www.americanhardwood.org/en/american-hardwood/american-hickory.

Council, A. W. (2025). "How can I tell if wood is sustainably sourced?" How can I tell if wood is sustainably sourced? Retrieved 30/03/2025, 2025, from https://woodsourcing.awc.org/.

Demarco, F., et al. (2023). Algorithms for design with CNC machines: the case study of wood furniture. International Conference on Numerical Computations: Theory and Algorithms, Springer.

Kim, S. (2009). "Environment-friendly adhesives for surface bonding of wood-based flooring using natural tannin to reduce formaldehyde and TVOC emission." Bioresource technology **100**(2): 744-748.

Knapp, L. S. P., et al. (2021). "The 'other'hardwood: Growth, physiology, and dynamics of hickories in the Central Hardwood Region, USA." Forest Ecology and Management **497**: 119513.

Korhonen, J., et al. (2018). "Circular economy: the concept and its limitations." Ecological economics

Maps, G. (2025). Retrieved 30/03/2025, 2025, from https://www.google.com/maps/dir/North+Carolina,+United+States/Missouri,+United+States/@36.9780697,-90.7093677,6z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1s0x88541fc4fc381a81:0xad3f30f5e922ae19!2m2!1d-79.0192997!2d35.7595731!1m5!1m1!1s0x87c0e6d54822e37d:0xb55bc4590466bd72!2m2!1d-91.8318334!2d37.9642529!3e0?entry=ttu&g_ep=EgoyMDI1MDMyNS4xIKXMDSoASAFQAw%3D%3D**143**: 37-46.

Ninja, I. (2025). "How Sustainable Is Hickory Wood? Here Are the Facts." How Sustainable Is Hickory Wood? Here Are the Facts. Retrieved 30/03/2025, 2025, from https://impactful.ninja/how-sustainable-is-hickory-wood/.

Rebitzer, G., et al. (2004). "Life cycle assessment: Part 1: Framework, goal and scope definition, inventory analysis, and applications." Environment international **30**(5): 701-720.

Silva, D., et al. (2017). How important is the LCA software tool you choose Comparative results from GaBi, openLCA, SimaPro and Umberto. Proceedings of the VII Conferencia Internacional de Análisis de Ciclo de Vida en Latinoamérica, Medellin, Colombia.

Statistics, U. B. o. L. (2023). "Occupational Employment and Wage Statistics." Occupational Employment and Wage Statistics. Retrieved 30/03.2025, 2025, from https://www.bls.gov/oes/2023/may/oes517099.htm.

Yao, T. X. and T. K. Boh (2019). "Energy reduction by optimizing sharpness angle and feed per knife in wood planing operation." International Journal of Agriculture **8**: 40-47.

Zhong, Z., et al. (2017). "Sector-based VOCs emission factors and source profiles for the surface coating industry in the Pearl River Delta region of China." Science of the Total Environment **583**: 19-28.