Перспективи меблевого виробництва через призму ресурсоефективності, сталого розвитку та інноваційності

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Head of the Department of Furniture Production Techniques and Wood Product Technology

Content

Вступ

?

Green transformation of Ukraine

In order to rebuild Ukraine we need to elaborate some strategy. I hope this strategy will be green

Вступ

Green transformation of Ukraine

GREEN BUILDING CONCEPT

MAIN PRINCIPLES	MAIN TRENDS IN UKRAINE
Efficient use of energy, water and other **resources**	Development of the **recycling facilities**
Increase in use of **renewable energy**	**Renovation** and increasing of **energy efficiency of buildings**
Pollution and waste reduction, and **enabling re-use and recycling**	**Prolonging life cycle** of the building materials
Consideration of the **environment and final users impact**	Increasing **use of renewable energy**
Use of materials that are **non-toxic, ethical and sustainable**	Increasing use of **recycled products & raw materials in production**

TOP TRENDS

- Buildings energy efficiency
- Eco-friendly materials
- Circular business model

Джерело: Ukraine Invest

Вступ

Green transformation of Ukraine

Green transformation of Ukraine

Despite a lot of problems that this bloody war evokes whole world is moving in the green direction since future of our planet can be very bright and promising only in the decarbonized society. It is necessary right now to think about **green Ukrainian future** since this war will end sooner or later. There is an idea according which we will create in the peaceful future very favorable situation for the **“Ukrainian jump” towards sustainable development**

Sustainable green industry

Forest sector (forest sector consists of all industries and subindustries that have deal with forest: forestry, woodworking industry, furniture making, wooden buildings, making energy with wood, green tourism and others) of Ukraine can become **the sustainable centre of the Ukrainian industry since** it can provide favourable conditions for **climate change mitigation through three effects simultaneously: absorption, storage and substitution ones**

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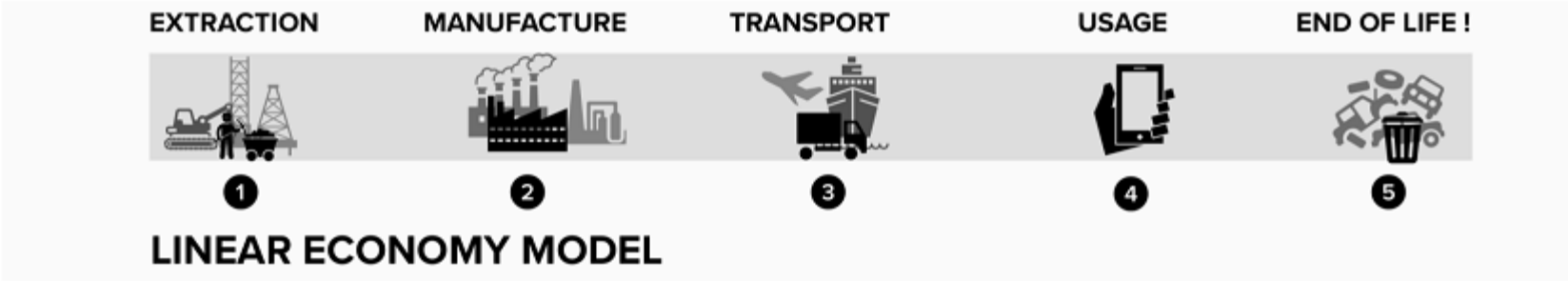
Circular economy - definition



Linear
VS
Circular

ELLEN MACARTHUR FOUNDATION
Rethink the future

Rethinking the future:
It is a profound challenge, at the end of an era of cheap oil and materials to rethink and redesign how we produce and consume; to reshape how we live and work, or even to imagine the jobs that will be needed for transition.

Circular economy - definition

Linear VS Circular

A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems and business models.

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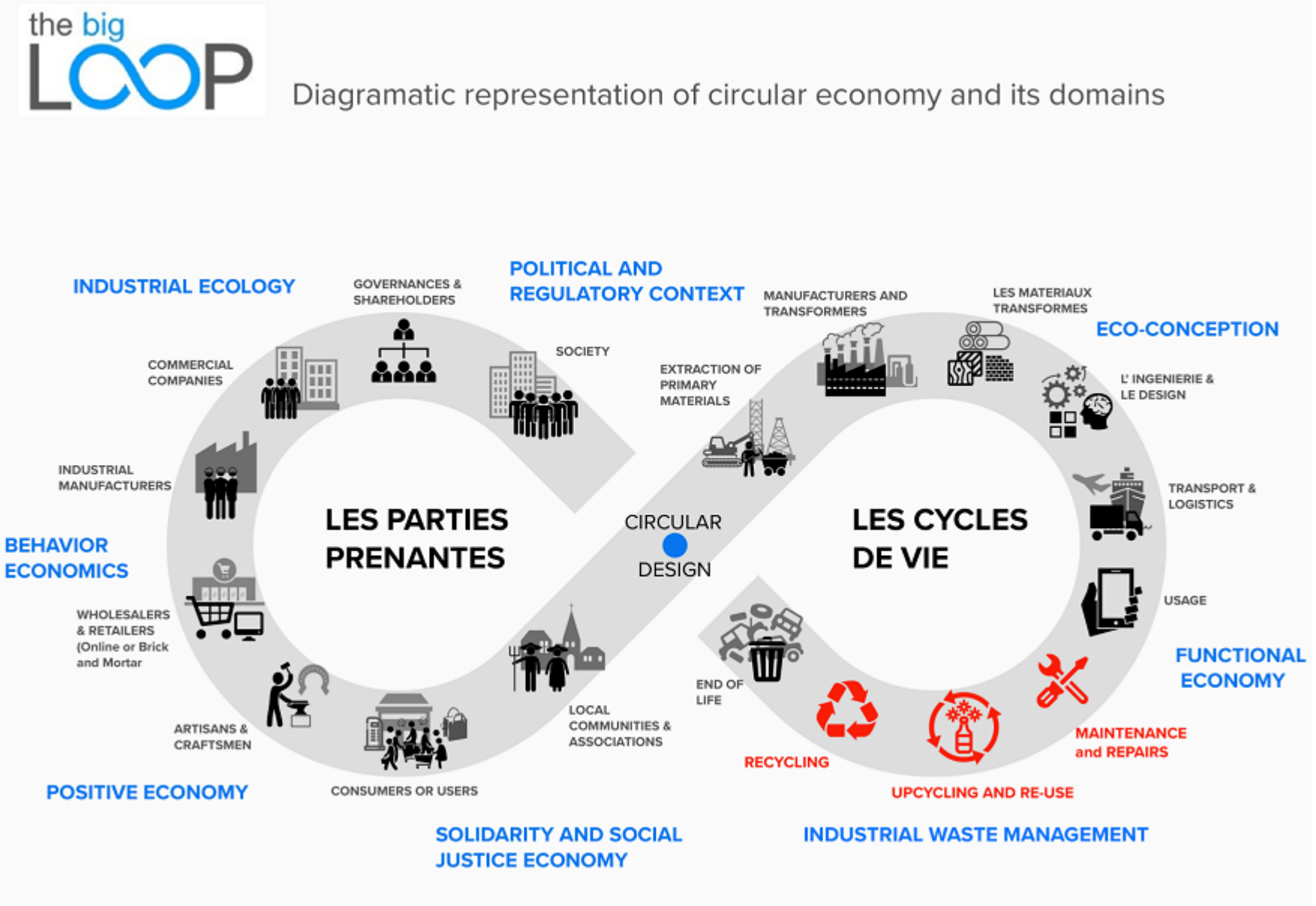
Принципи економіки замкнутого циклу у меблевому виробництві

Linear VS Circular



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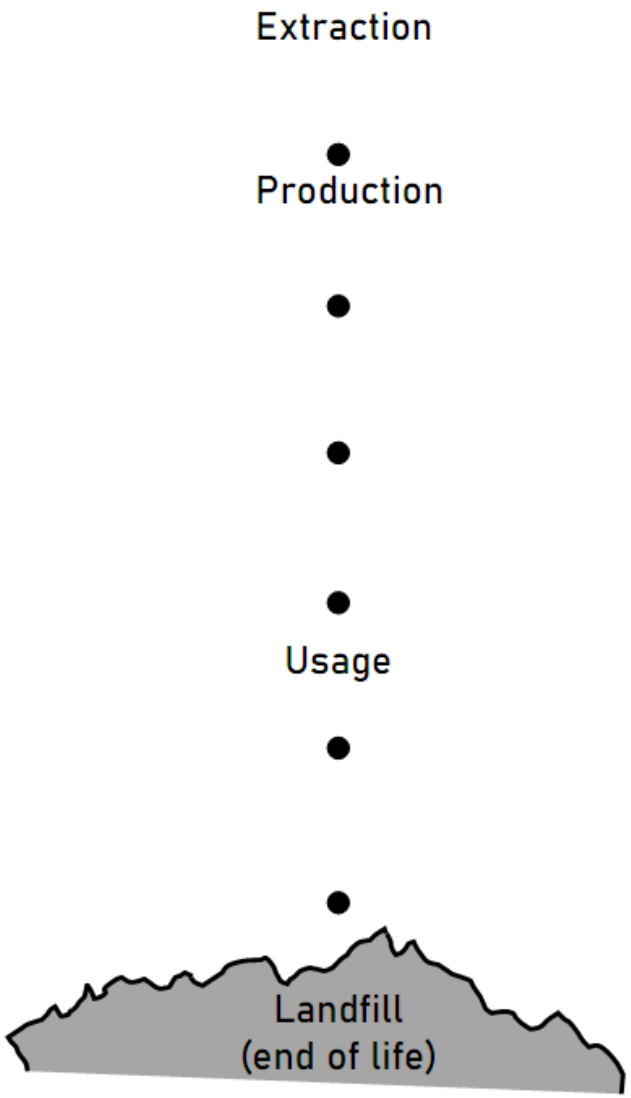
Butterfly diagram

ELLEN MACARTHUR FOUNDATION
Rethink the future

Circular economy - definition



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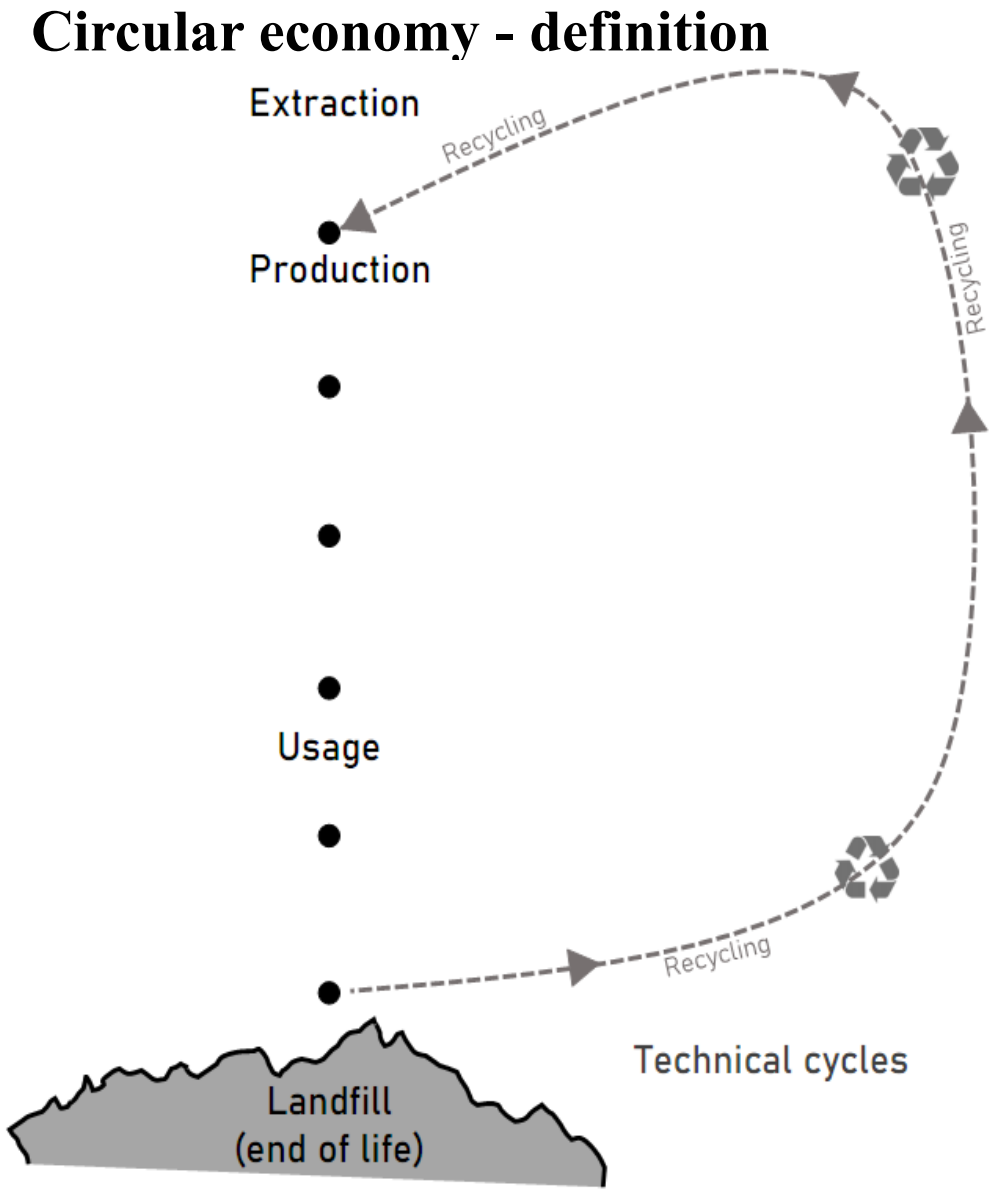

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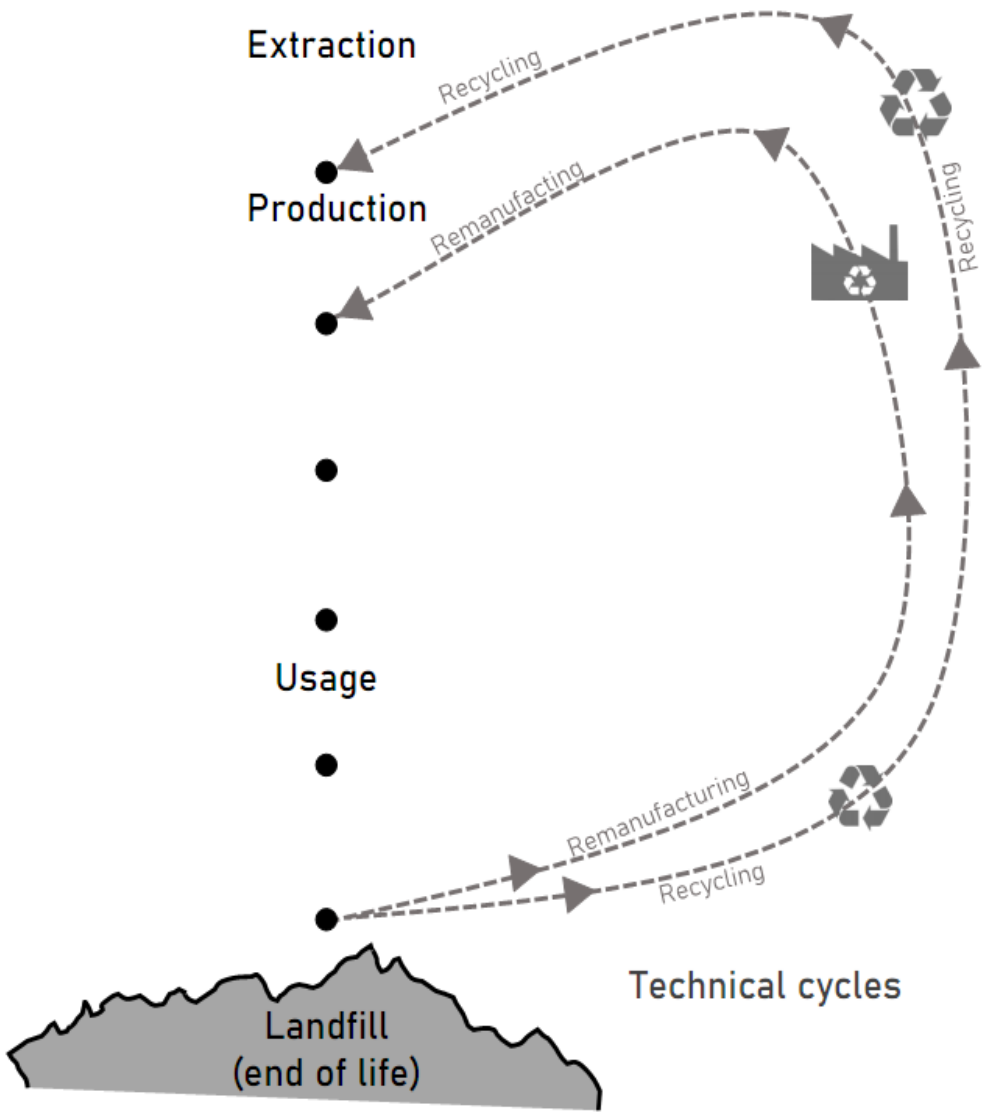

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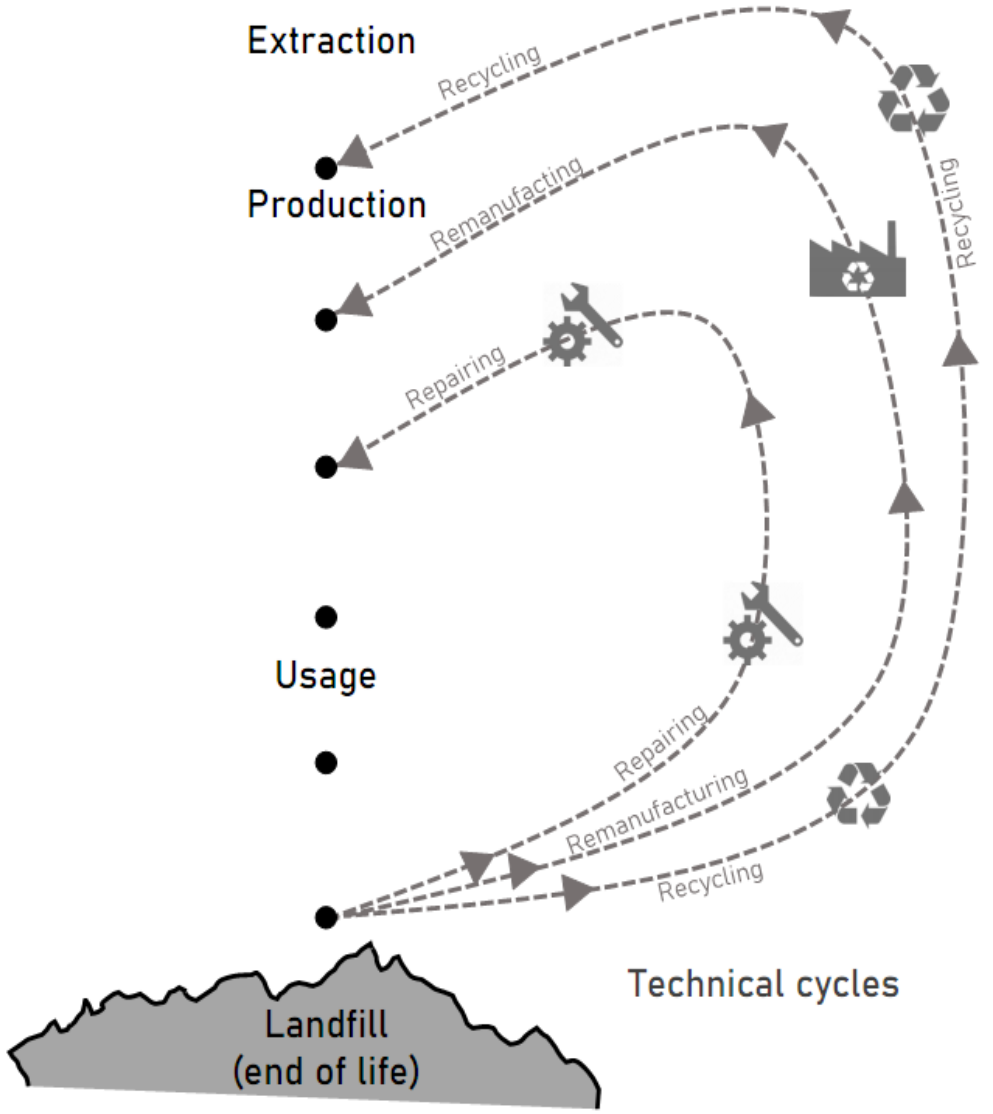

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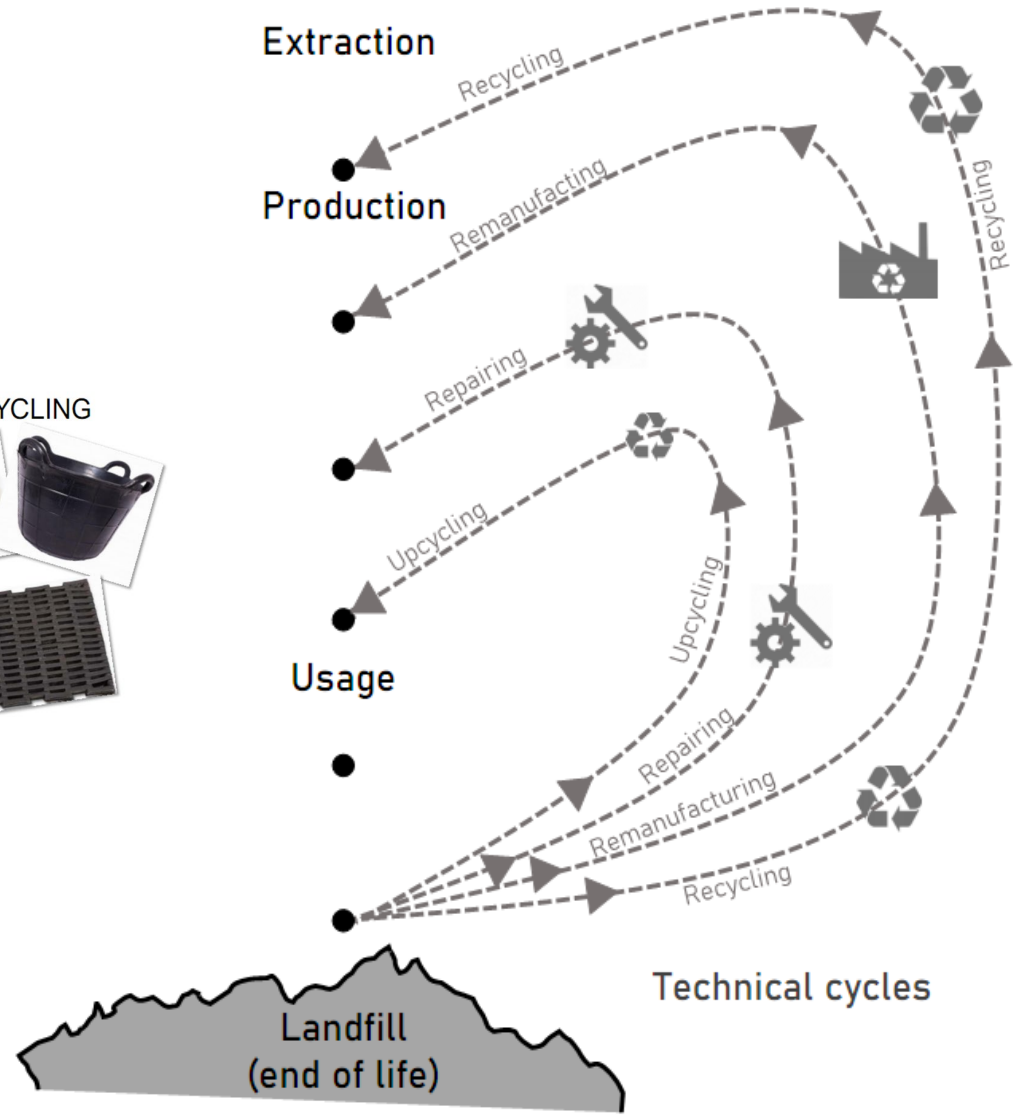
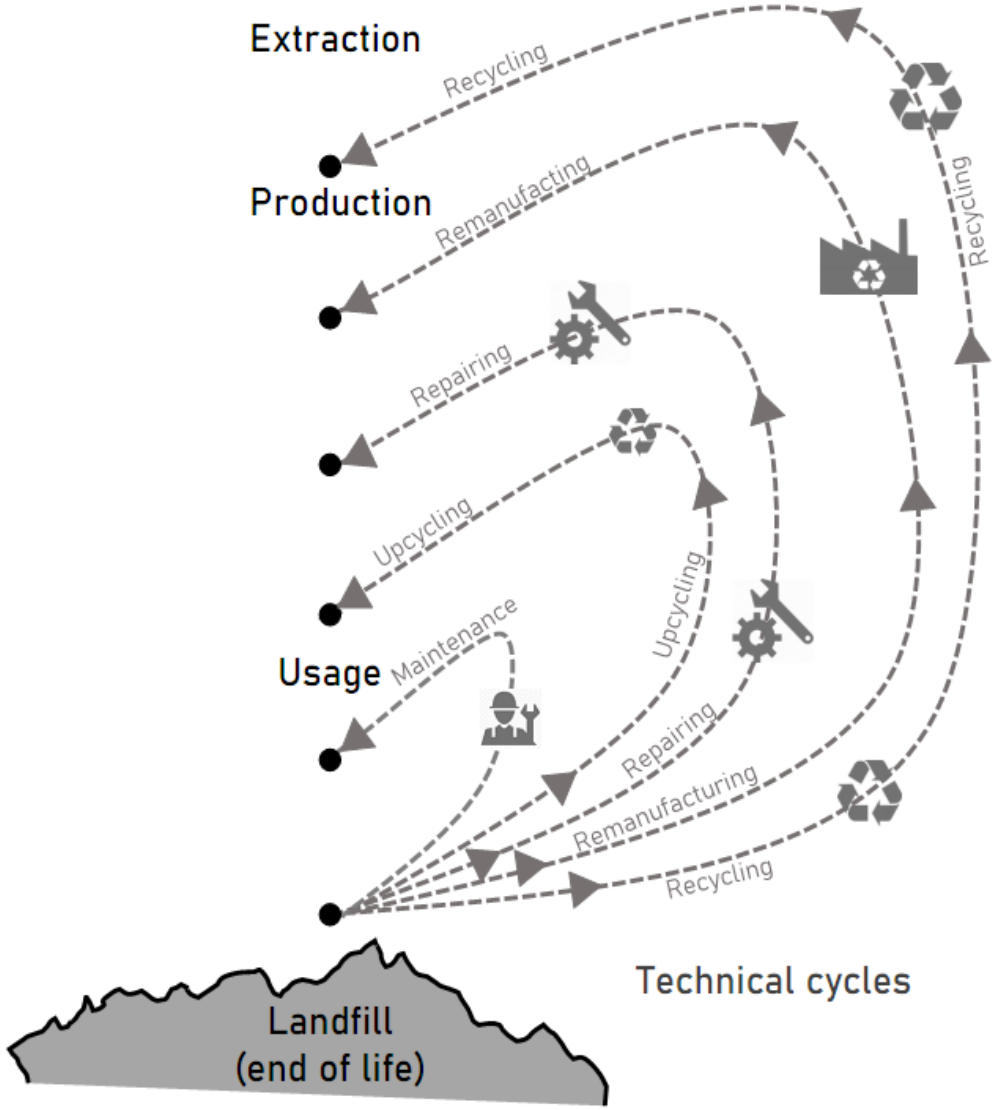


Принципи економіки замкнутого циклу у меблевому виробництві

Butterfly diagram



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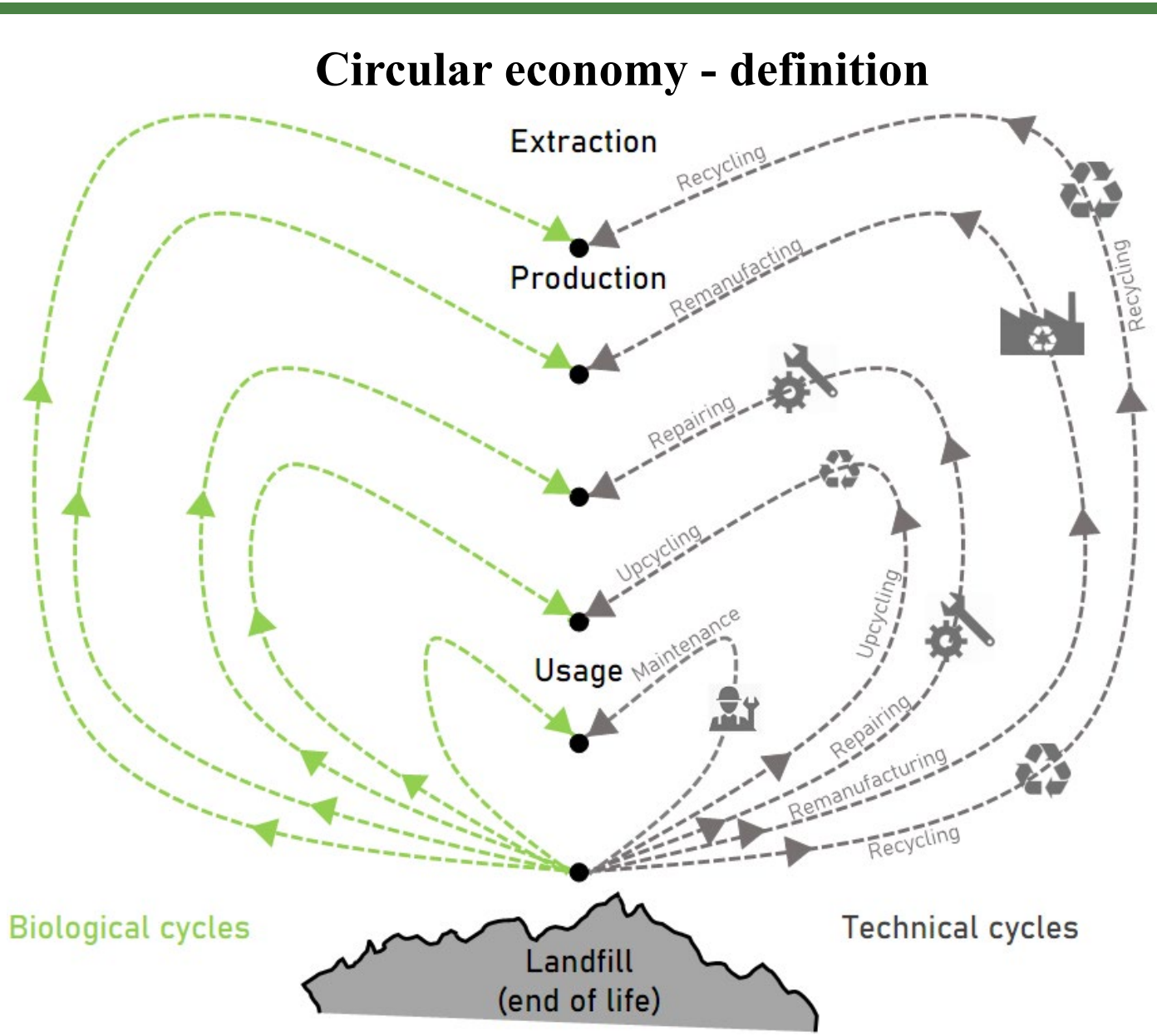

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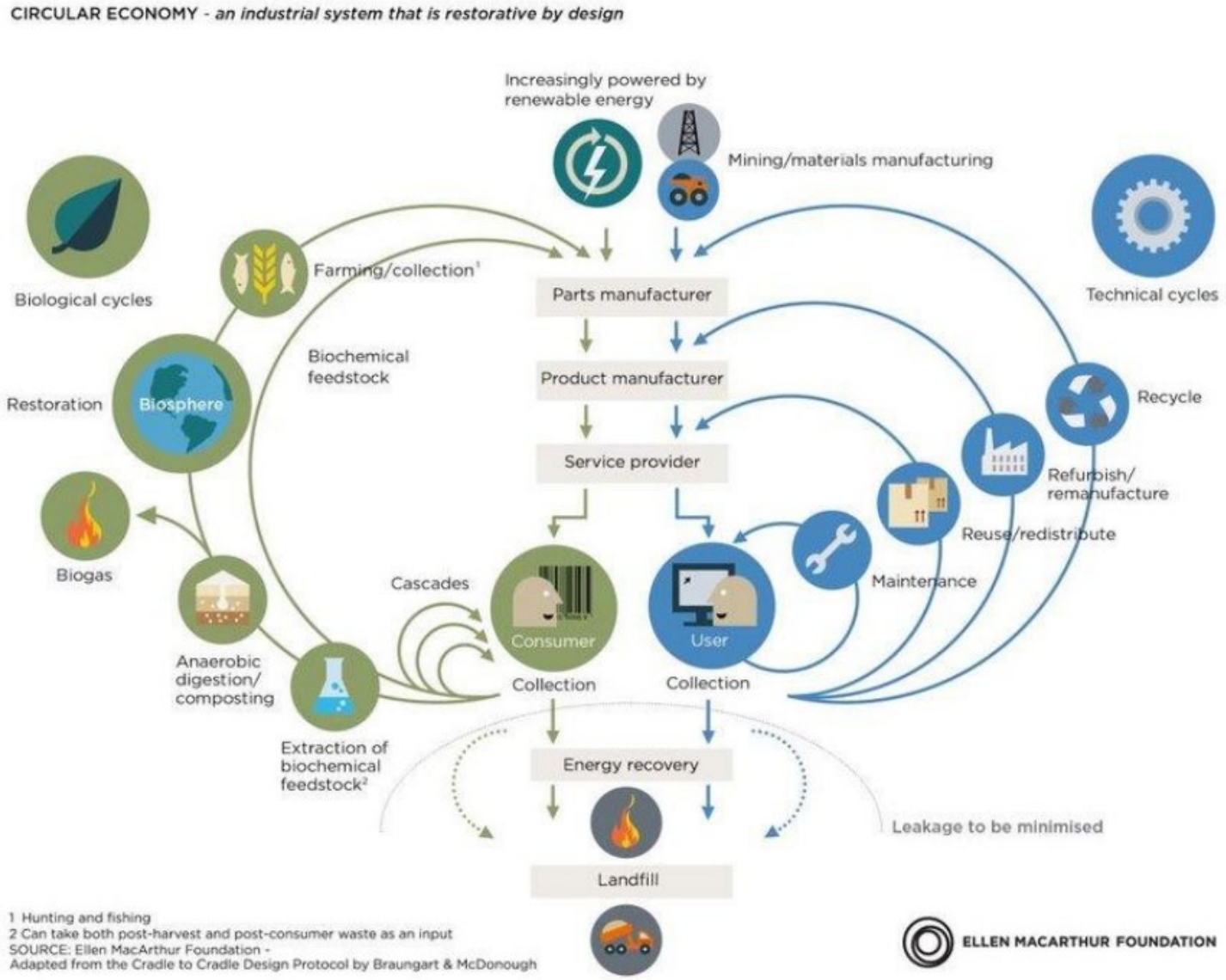

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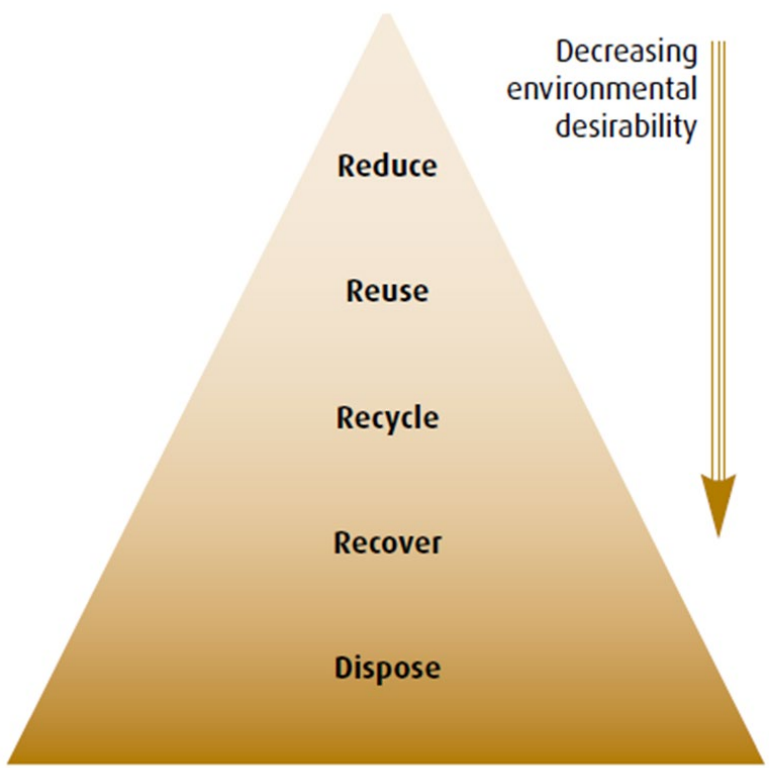

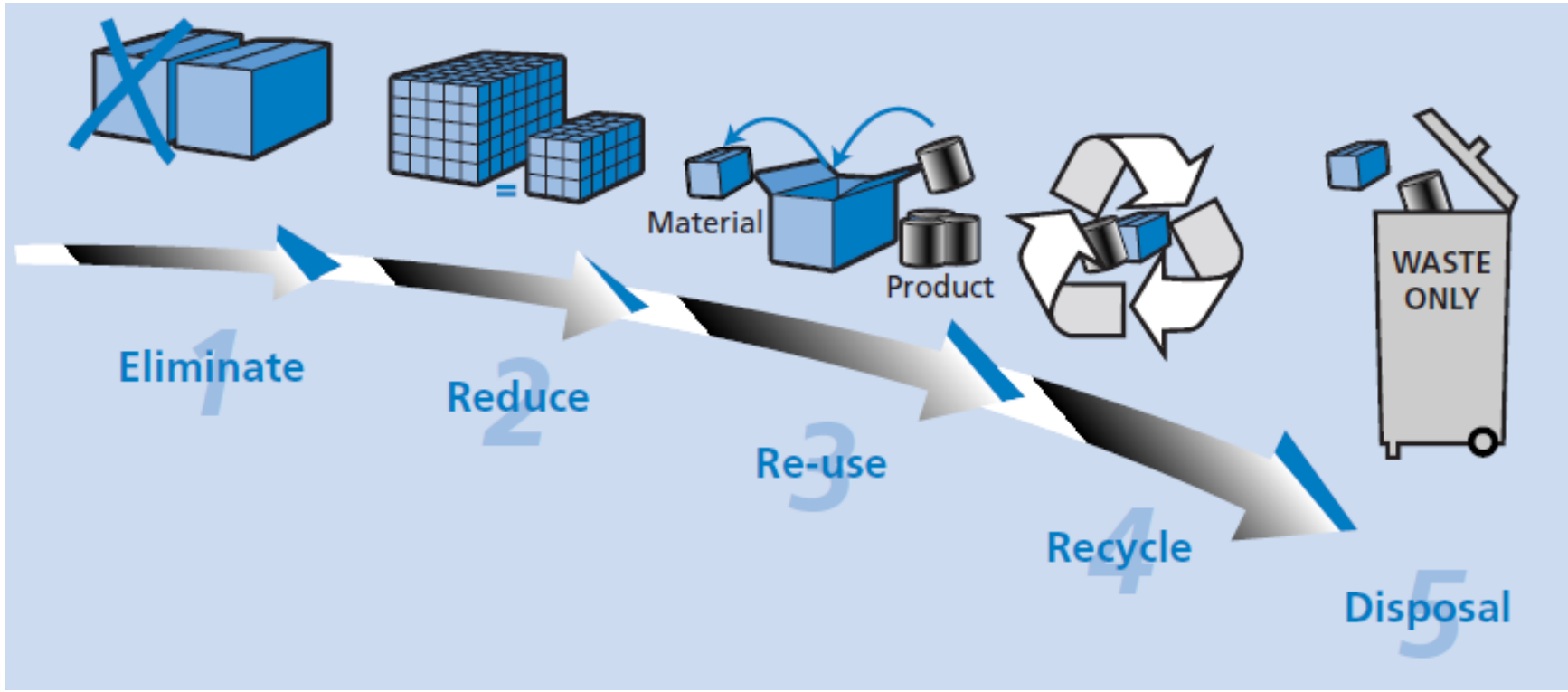

GG 290. Savings from waste minimization in furniture manufacturing. This Good Practice Guide was produced by Envirowise. United Kingdom. Harwell International Business Centre. 2001.

Принципи економіки замкнутого циклу у меблевому виробництві

In UK businesses, the cost of waste is typically **4%** of turnover - in some companies it can be as high as **10%**. Implementing waste reduction measures as part of a waste minimization program can reduce these costs by a quarter whatever the size of the company.

The furniture manufacturing sector has significant scope for reducing waste. Savings of **1%** of turnover can be readily achieved with little or no investment cost. Across the industry as a whole, this could result in savings of some **£60 million/year**.

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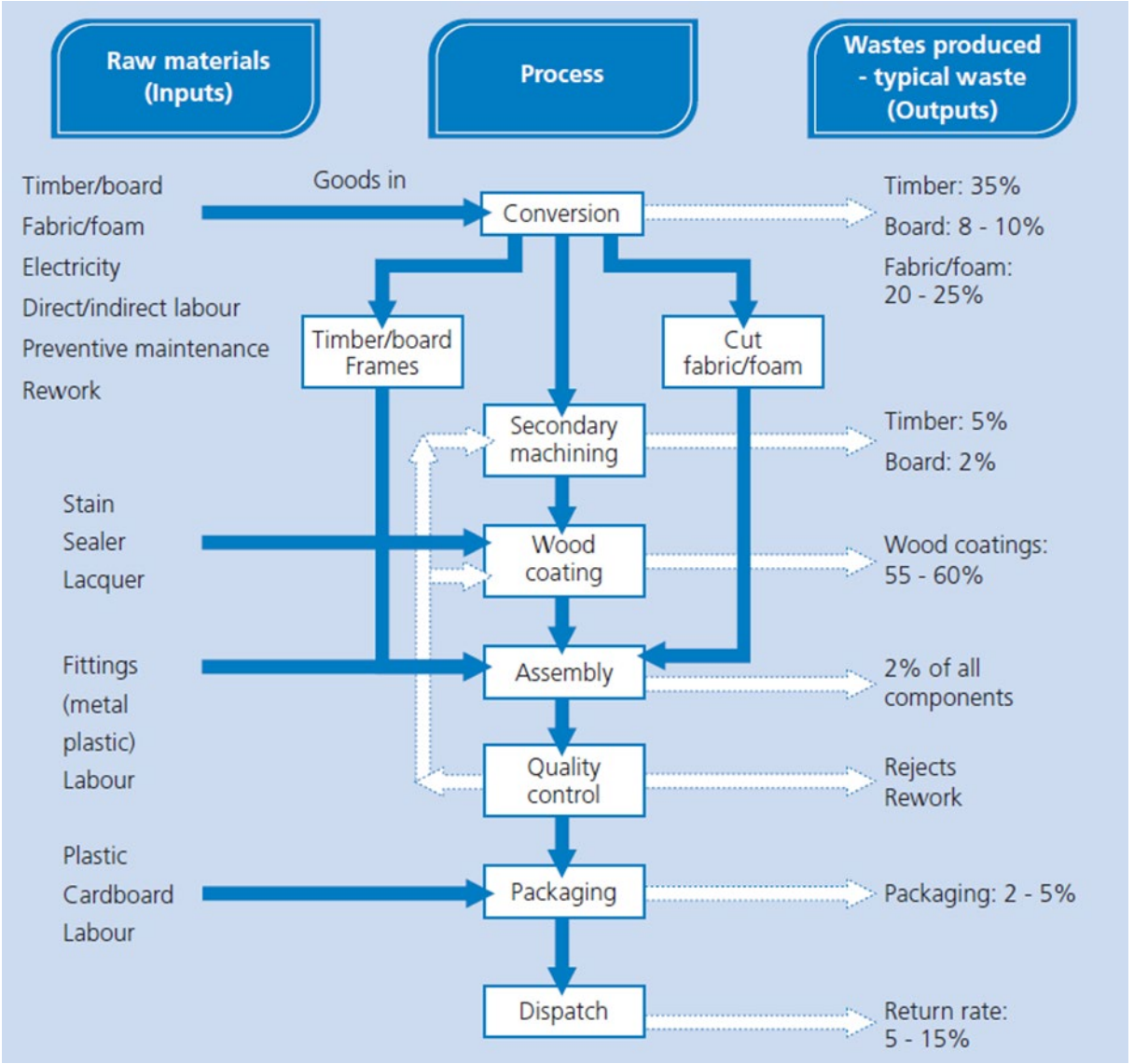
Identify waste



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Identify waste

Timberwise Furniture Ltd is a manufacturer of domestic furniture. Turnover is £8 million with a profit margin of 7%, equivalent to £560 000/year.

The company's managing director recently met an old colleague who was singing the praises of waste minimisation. The MD was not convinced, as the annual cost of waste disposal was only £32 000. However, he asked the production manager to provide an estimate of the total cost of waste. He found the result surprising. The production manager began by calculating the cost of raw material wasted.

Item	Total cost of raw material (£)	Waste (%)	Cost of waste (£)
Solid timber	600 000	44	264 000
Board material	300 000	18	54 000
Fabric and foam	120 000	30	36 000
Wood coatings	160 000	70	112 000
Packaging	75 000	5	3 750
Total	1 255 000		469 750

Additional costs included:

- £23 490 labour costs and processing costs of raw material prior to when it is wasted (estimated at 5% of cost of waste);
- £32 000 disposal charges.

The total cost of waste was £525 240, some 6.6% of turnover.

The MD realised that a 1% reduction in waste, from 6.6% of turnover to 5.6%, would reduce the cost of waste from £525 240 to £448 000. This amounts to a saving of £77 240 - equivalent to almost a 14% increase in profit!

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Принципи економіки замкнутого циклу у меблевому виробництві

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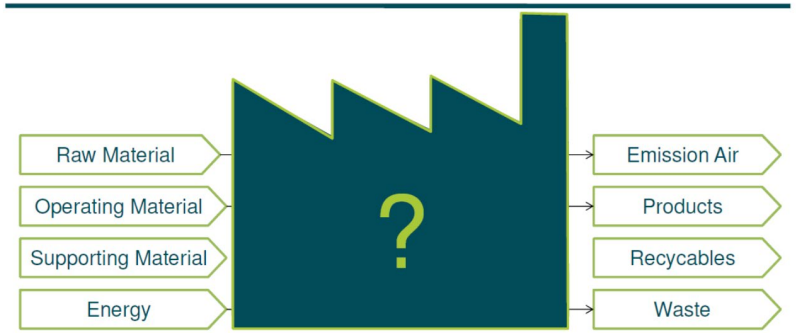
RESOURCE FLOW ANALYSIS / PIUS-CHECK

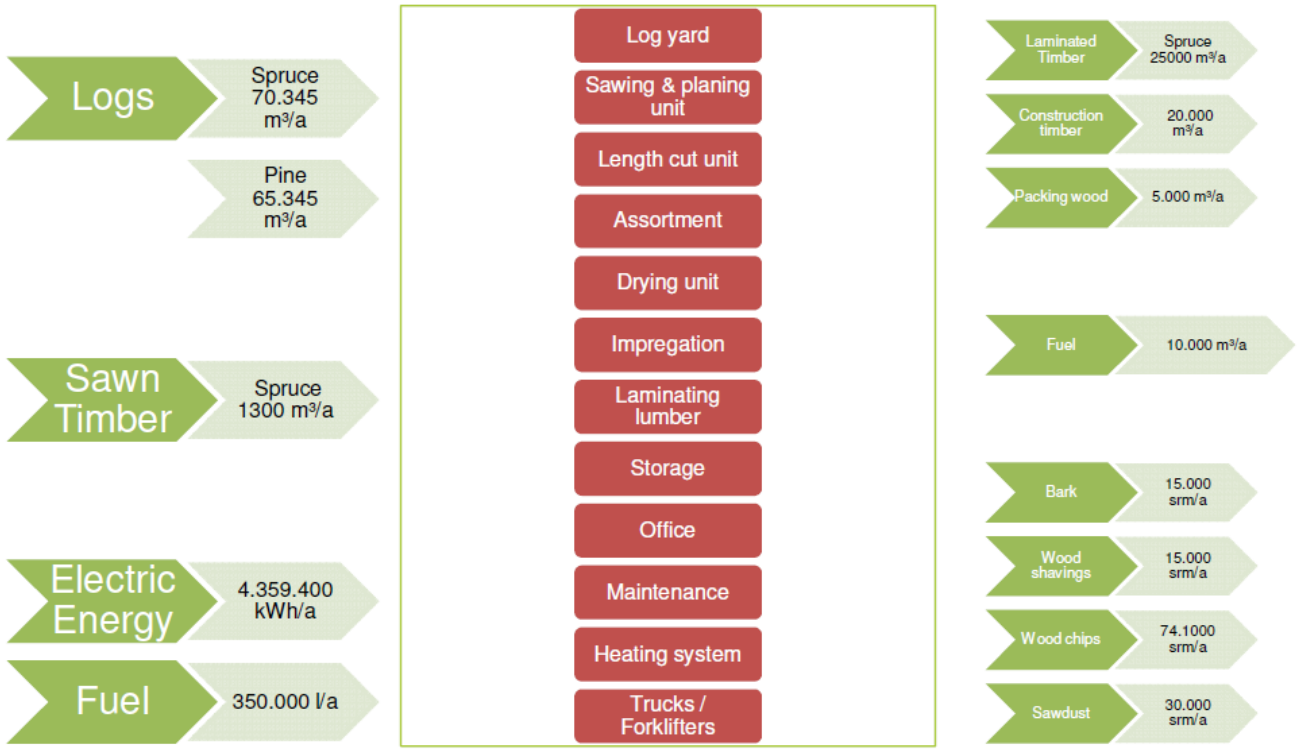
HOW DOES IT WORK ?



1. Allocation of consumption
2. Action plan to improve efficiency

RESSOURCE FLOW

INPUT - OUTPUT



Принципи економіки замкнутого циклу у меблевому виробництві

RESOURCE FLOW ANALYSIS / PIUS-CHECK

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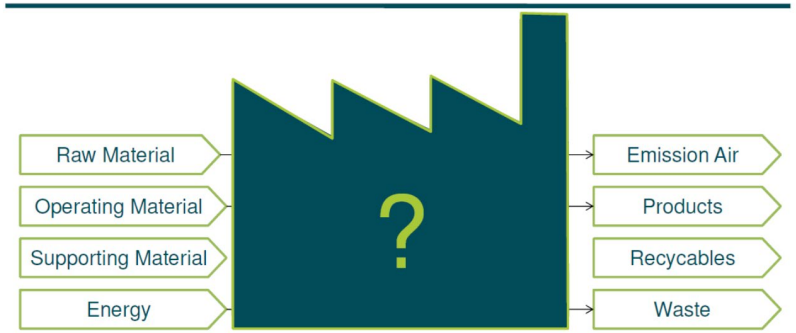

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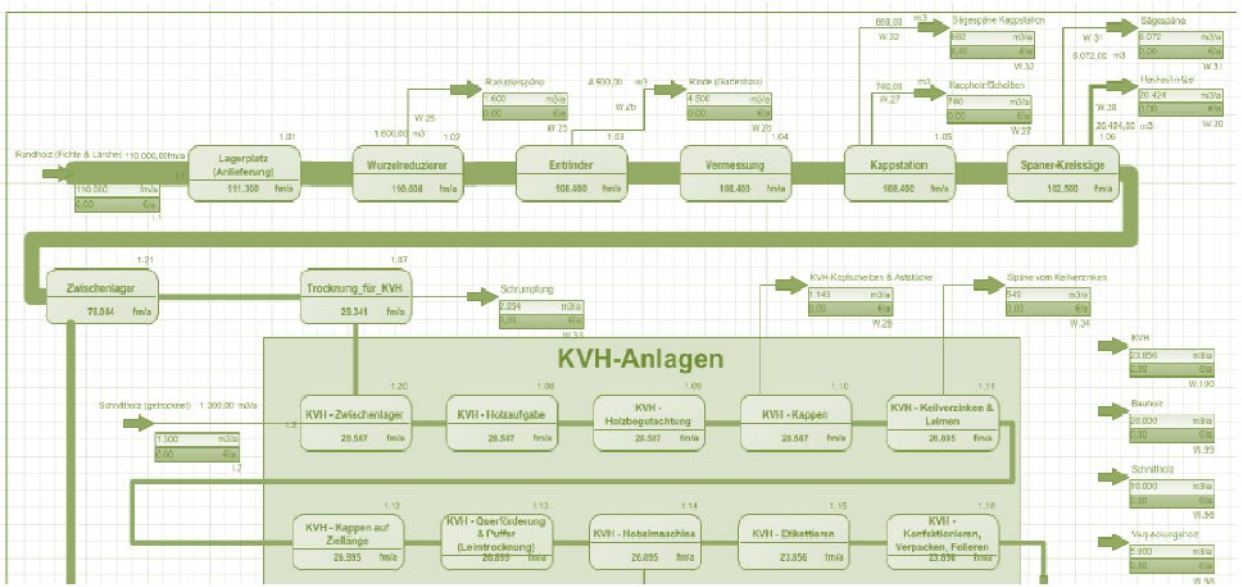
RESSOURCE FLOW

ALLOCATION OF CONSUMPTION



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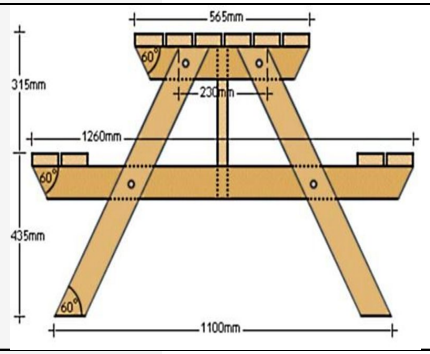	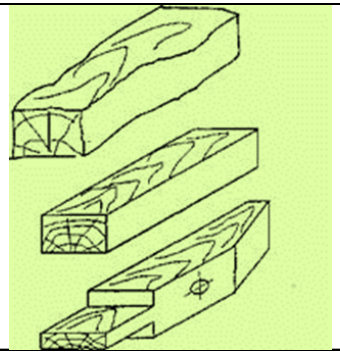		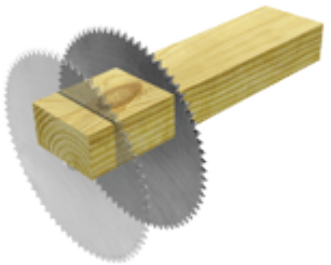
$V_1 <$	$V_2 <$	$V_3 <$	V_4
Volume calculated on the base of wooden products' sizes taken from ***drawing***	Volume calculated taking into account the value of the ***allowance*** for processing	Volume calculated taking into account the value of the ***technological losses***	Volume calculated on the base of ***cutting useful output percentage***

Wastes	$V_2 - V_1$	$V_3 - V_2$	$V_4 - V_3$	**Additional ways of wastes minimization**
Methods of the wastes minimization	**Allowance decreasing**	**Technological losses decreasing**	**Cutting useful output percentage increasing**	

Принципи економіки замкнутого циклу у меблевому виробництві

Process stage	Inputs	(Value added)	Product value	Increase in value (%)*
Goods in	Base board		£5/base piece	-
Conversion	Labour, overheads	(£15)	£20/piece	400
Secondary machining	Labour, overheads	(£12)	£32/tabletop	640
Sanding and coating	Stain, sealer, lacquer, labour, overheads	(£54)	£86/tabletop	1 720
Packaging and delivery	Polythene, cardboard, labour, overheads, vehicle maintenance	(£14)	£100/tabletop	2 000

* Increase in value compared to base piece.

Process step	Goods into process (tonnes)	Waste arisings (% of goods into initial process)	Waste produced (tonnes)	Value of waste (£/tonne)*	Total value of waste produced (£) [a]	Disposal cost (£) (at £30/ tonne) [b]	Total cost (£) [a + b]	Rank in order of priority
Timber conversion	1 000	35	350	1 000	350 000	10 500	360 500	1
Secondary machining		5	50	1 600	80 000	1 500	81 500	4
Sanding and coating		2	20	4 300	86 000	600	86 600	3
Packaging and delivery		2	20	5 000	100 000	600	100 600	2
Total		44	440		616 000	13 200	629 200	

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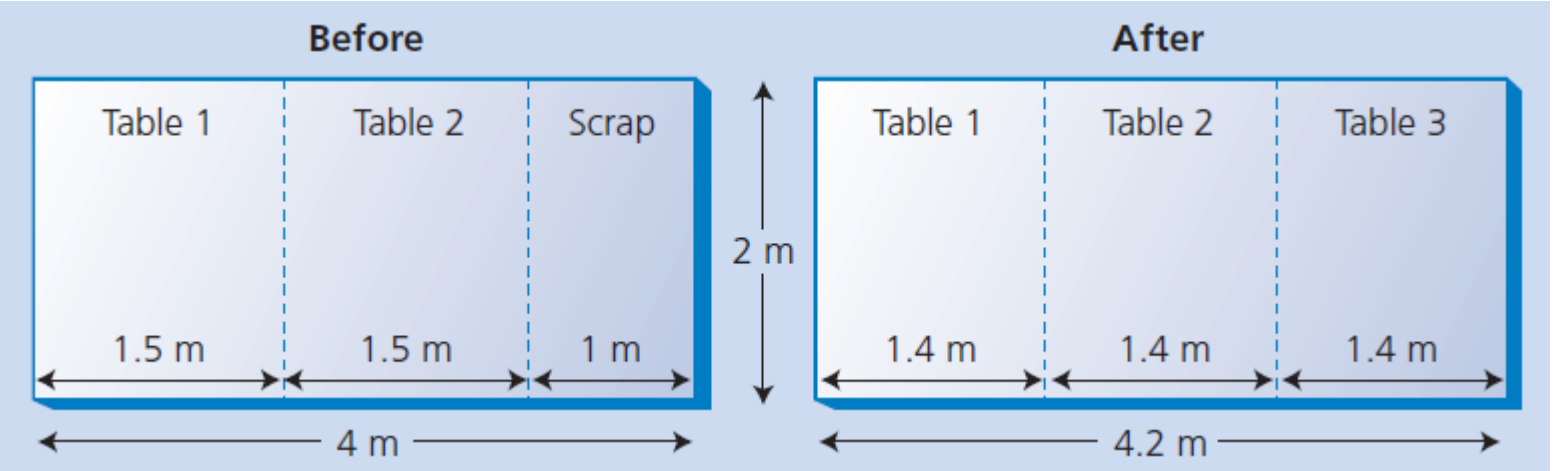
Принципи економіки замкнутого циклу у меблевому виробництві



Cornwell Parker Furniture Ltd investigated waste rates of solid timber components and rationalized its ordering and specification policy accordingly at its Chipping Norton site. Previously, it was kilning its own timber - purchasing 1.6 m^3 of timber in plank form to achieve 1 m^3 of usable timber billets. By standardizing billet sizes, the company now purchases 1.2 m^3 of timber to achieve 1 m^3 of usable billets. Removal of the kilning operation, with associated heating and labour costs, paid for the premium associated with billet material, while the savings in the volume of timber purchased, machining requirements and waste disposal costs amount to around £250 000/year.

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Принципи економіки замкнутого циклу у меблевому виробництві

Layezee Beds found that a large number of divan drawers were being damaged in transit around the shop floor. Through the use of improved handling mechanisms in trolleys and racks, the number of drawers damaged in the factory was reduced from 6% to 1%, with an annual saving of £16 500/year.

In common with all furniture manufacturers, Senator International Ltd has a problem with goods damaged in transit and products being returned. To counter this, it has decided to use an increased amount of transparent plastic packaging so that carriers can see the product they are handling. Senator believes that this has resulted in fewer damaged returns.

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Принципи економіки замкнутого циклу у меблевому виробництві

Waste type	Options
Wood off-cuts	Particleboard manufacture Charcoal manufacture Crafts (local schools and groups) Local residents (fuel) Pellet manufacturer
Sawdust and shavings	Briquetting (fuel) Equestrian uses Animal bedding Composting
Metal off-cuts (eg springs, furniture legs)	Re-use in local industry
Fabric and leather	Crafts (local schools and groups)
Foam	Re-use as mattress/cushion filling
Cardboard	Recovery contractors
Plastic	Recovery contractors
Packaging	Re-use with product

Layezee Beds has identified all of its waste products that can be re-used or recycled more economically than disposal to landfill:

- wood shavings and dust are collected and sold for use as animal bedding at £60 - £70/tonne;
- larger wood off-cuts are given to a local company for use in manufacturing woodchip wallpaper;
- cardboard is sold to a local recycling firm at £15 - £16/tonne.

Olympia Furniture Ltd sends out its final products on wooden pallets. The pallets are sold with the furniture and bought back from the customer as and when required, maintaining a market for pallet re-use. Through giving the pallets a monetary value, a financial benefit is gained from continued re-use, as it reduces the amount of packaging waste included in any obligation under the packaging waste regulations.

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Принципи економіки замкнутого циклу у меблевому виробництві

1. Which processes are producing the most waste?
2. Which is the most expensive waste produced or to dispose of?
3. Which waste could be most easily reduced?

To find out the actual cost of your waste you need to look first not at the waste itself, but at your bills and purchase orders.

In addition to process wastes, there are many other areas within a manufacturing base where waste could be reduced. For example, there are many no-cost and low-cost ways of reducing water use in washrooms, where the true cost of water is higher than the supply and sewerage charges alone. The true cost should include the energy taken to heat and deliver the water in any building.

Once you have identified all of your waste materials, look at different ways of incorporating or using them in your products. This may require a change in approach to product design and time to investigate the possibility of using waste in new products. In certain cases, it may actually be possible to create complete products from waste materials.

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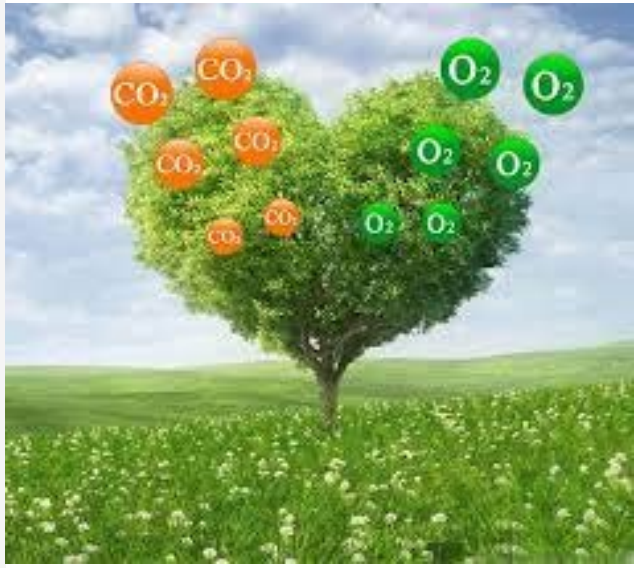
Concept of the "forest sector" for plans and actions

Екологічні цінності у меблевому виробництві

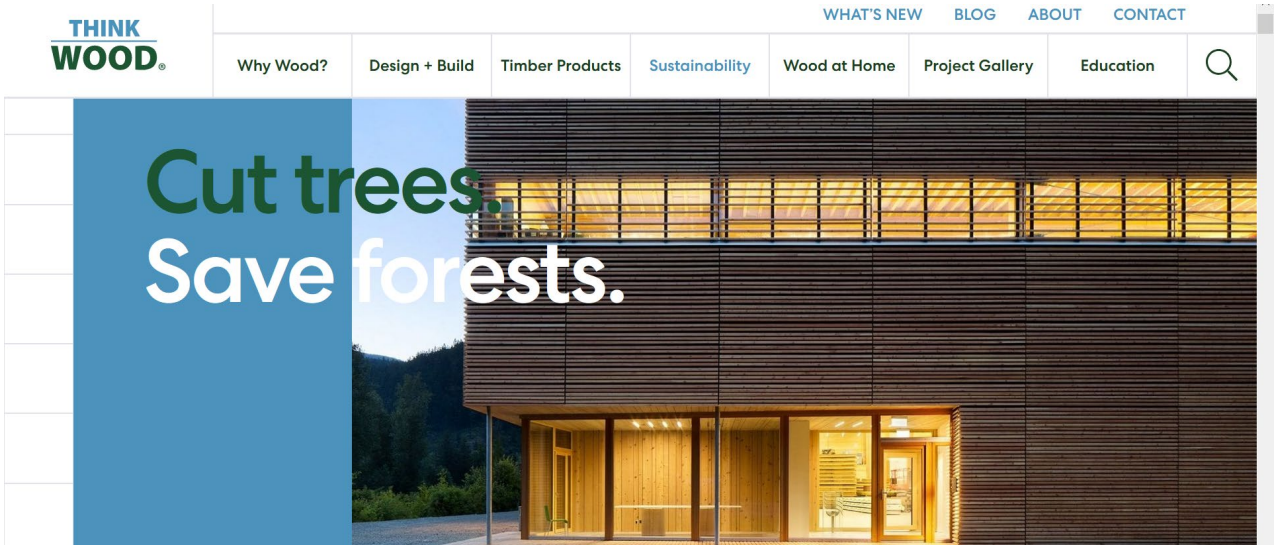
Concept of the "forest sector" for plans and actions



1. Absorption effect.

2. Storage effect.

3. Substitution effect.



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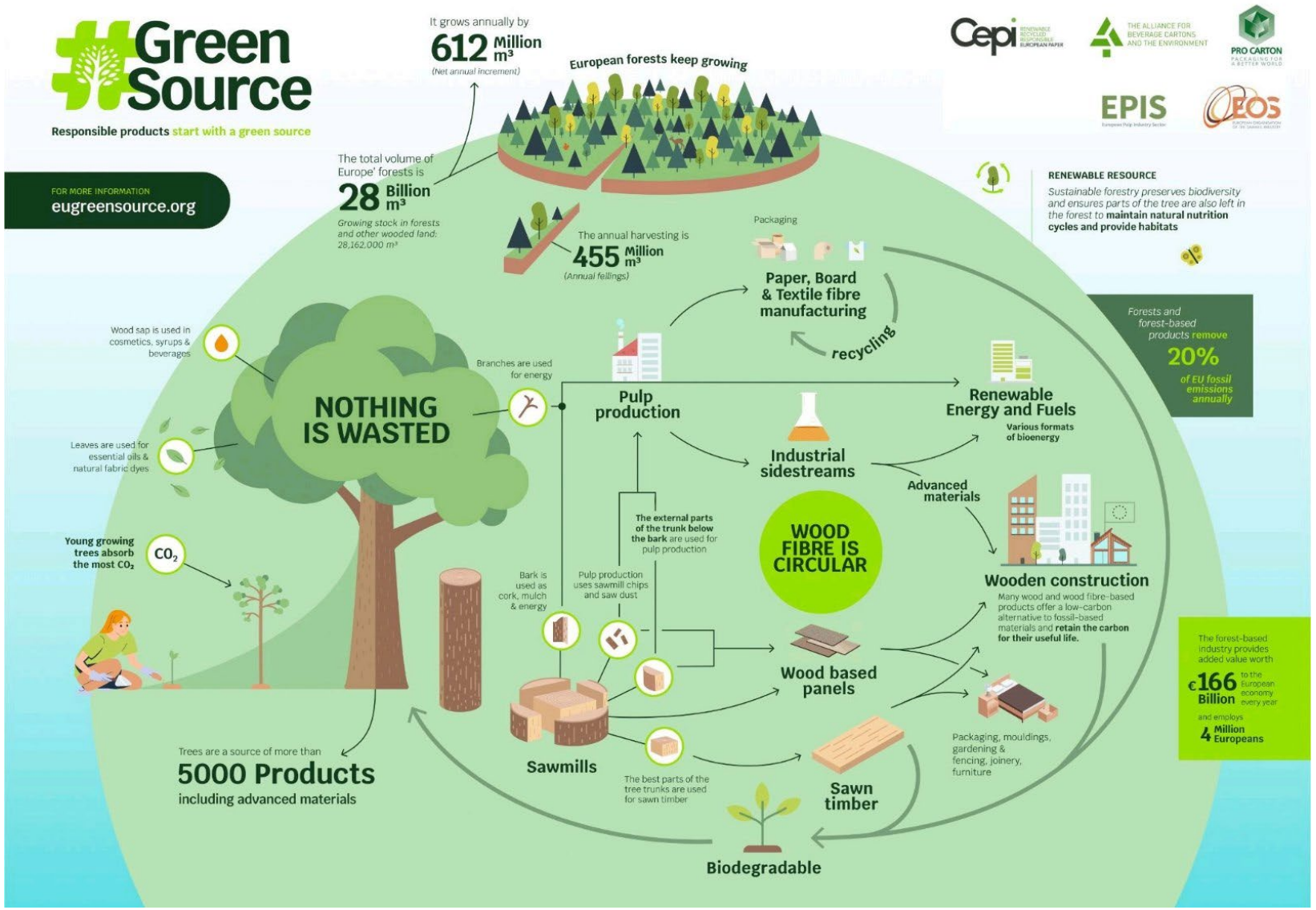

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Екологічні цінності у меблевому виробництві

CircHive

Ukrainian case within the frameworks of the CircHive project. Piloting: status quo

Orest Kiyko,
DSc, Professor , Ukrainian National Forestry University (UNFU)

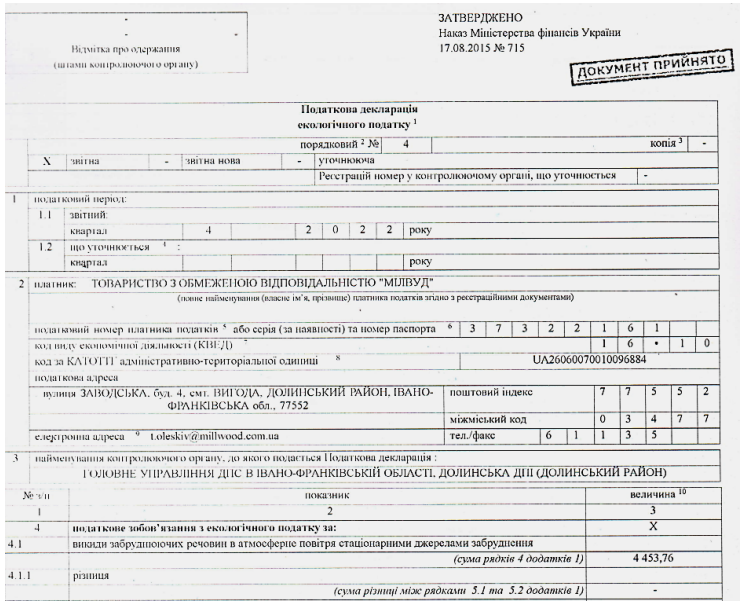
@CircHive

circhive.eu

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101082081

The first steps towards biodiversity (ecological reporting)

Environmental tax declaration



ЗАТВЕРДЖЕНО
Наказ Міністерства фінансів України
17.08.2015 № 715

ДОКУМЕНТ ПРИЙНЯТО

Відмітка про одержання
(штамп контролюючого органу)

Податкова декларація екологічного податку [1]

порядковий [2] № 4 | копія [3] -

X звітна - звітна нова - уточнююча

Реєстраційний номер у контролюючому органі, що уточнюється -

1 податковий період:

1.1 звітний:
квартал 4 | 2022 року

1.2 що уточнюється [4]:
квартал | року

2 платник: ТОВАРИСТВО З ОБМЕЖЕНОЮ ВІДПОВІДАЛЬНІСТЮ "МІЛВУД"
(повне найменування (власне ім'я, прізвище) платника податків згідно з реєстраційними документами)

податковий номер платника податків [5] або серія (за наявності) та номер паспорта [6]: 3732216161

код виду економічної діяльності (КВЕД) [7]: 16.10

код за КАТОТТГ адміністративно-територіальної одиниці [8]: UA26060070010096884

податкова адреса
вулиця ЗАВОДСЬКА, буд. 4, смт. ВИГОДА, ДОЛИНСЬКИЙ РАЙОН, ІВАНО-ФРАНКІВСЬКА обл., 77552 | поштовий індекс: 77552
міжміський код: 03475
електронна адреса [9]: t.oleskiv@millwood.com.ua | тел./факс: 61135

3 найменування контролюючого органу, до якого подається Податкова декларація:
ГОЛОВНЕ УПРАВЛІННЯ ДПС В ІВАНО-ФРАНКІВСЬКІЙ ОБЛАСТІ. ДОЛИНСЬКА ДПІ (ДОЛИНСЬКИЙ РАЙОН)

№ з/п	показник	величина [10]
1	2	3
4	**податкове зобов'язання з екологічного податку за:**	X
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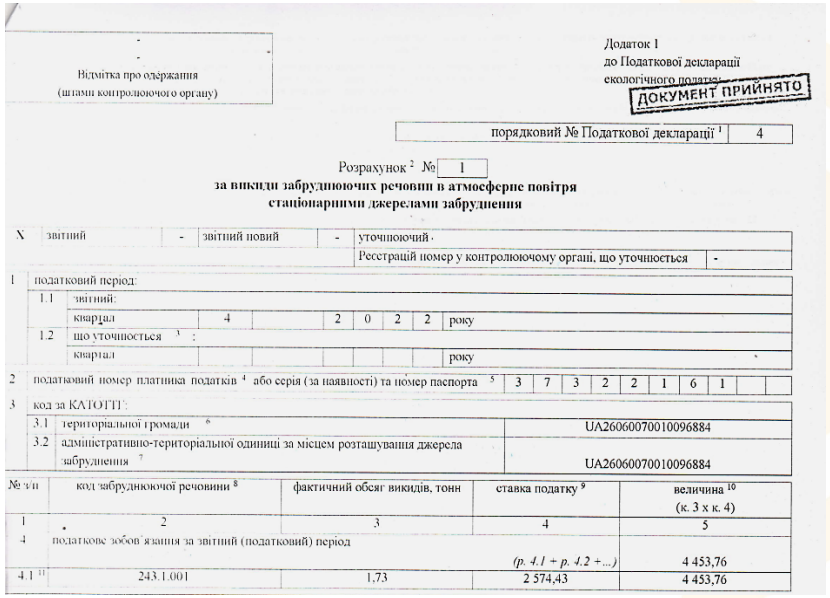
	(сума рядків 4 додатків 1)	
4.1.1	різниця	-
	(сума різниці між рядками 5.1 та 5.2 додатків 1)	

Calculation of the pollutants emissions



Додаток 1
до Податкової декларації
екологічного податку

ДОКУМЕНТ ПРИЙНЯТО

Відмітка про одержання
(штамп контролюючого органу)

порядковий № Податкової декларації [1]: 4

Розрахунок [2] № 1

за викиди забруднюючих речовин в атмосферне повітря стаціонарними джерелами забруднення

X звітний - звітний новий - уточнюючий

Реєстраційний номер у контролюючому органі, що уточнюється -

1 податковий період:

1.1 звітний:
квартал 4 | 2022 року

1.2 що уточнюється [3]:
квартал | року

2 податковий номер платника податків [4] або серія (за наявності) та номер паспорта [5]: 3732216161

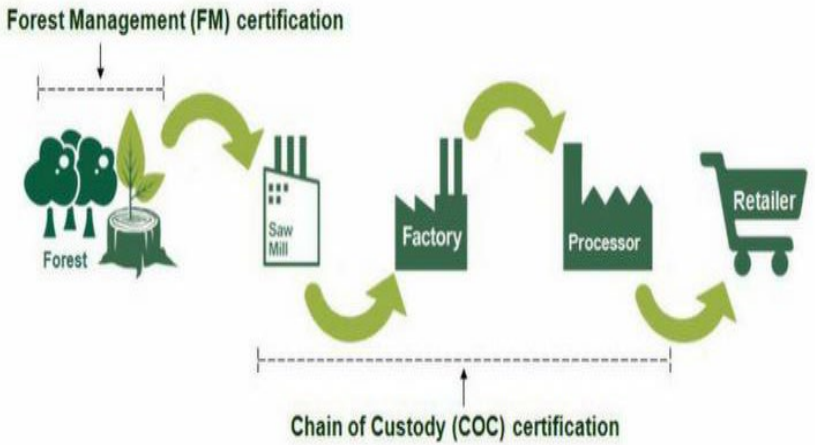
3 код за КАТОТТГ:

3.1 територіальної громади [6]: UA26060070010096884

3.2 адміністративно-територіальної одиниці за місцем розташування джерела забруднення [7]: UA26060070010096884

№ з/п	код забруднюючої речовини [8]	фактичний обсяг викидів, тонн	ставка податку [9]	величина [10] (к. 3 х к. 4)
1	2	3	4	5
4	податкове зобов'язання за звітний (податковий) період		*(р. 4.1 + р. 4.2 +...)*	4 453,76
4.1 [11]	243.1.001	1,73	2 574,43	4 453,76

"Supply Chain Certification Standard" (FSC-STD-40-004 V 3-0); (FSC-STD-40-004 V 3-1)



The environmental tax is calculated as the multiplication of the polluting substance mass by the corresponding tax rate

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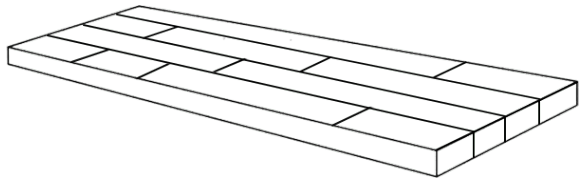
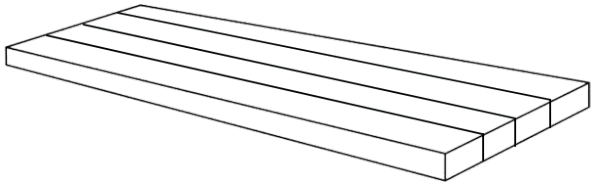
The first steps towards biodiversity





Construction of the furniture boards made from solid slats and furniture boards made from slats that are joined lengthwise

Technological map of furniture board production from hardwood species lumber at Agroderew LLC

Stage No	Raw materials	Expected product	Type of works	Waste		Useful output (average) in %	Useful output (average) in m3 (input volume - 100 m3 of logs)
				Sawdust	Fuel wood		
1	Logs	Raw uncut lumber 53 mm	Sawing of logs	12%	16%	72%	72
2	Raw uncut lumber 53 mm	Raw bar	Rip-sawing	14%	14%	72%	51.84
	56%	53x53 мм					29.030
	44%	43x53 мм					22.810
3	Raw bar	Dry bar	Drying	Shrinkage, 10 %		90%	46.656
	53x53 мм	50x50					26.127
	43x53 мм	40x50					20.529
4	Dry bar	Rough-sawn stock (not planed)	Optimization cross-cutting				
	50x50	50x50		2%	8%	90%	23.514
	40x50	40x50		2%	10%	88%	18.066
Total							41.58
5	Rough-sawn stock (not planed)	Planed bar	Processing to the specified width and thickness				
	50x50	46x49		18%	0%	82%	19.281
	40x50	36x48		14%	0%	86%	15.536
Total							34.817
When planning a part of the rough-sawn stock will be transformed into shavings. The standard ratio is considered to be 80% dimension blank and 20% shavings. This information will be used in the subsequent calculation of the useful output of production							

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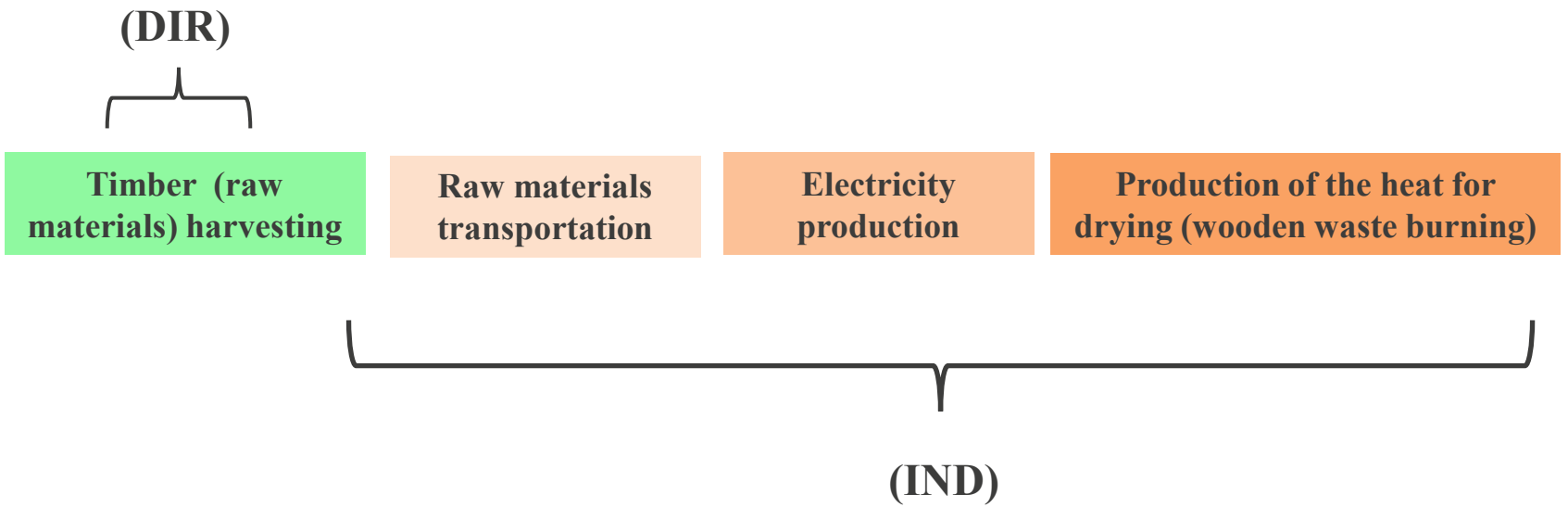
Calculating the ecological footprint for the product

In general, the overall ecological footprint of a product can be divided into two components, referred to as direct **(DIR)** and indirect **(IND)**, according to the equation:

$$EPF = EPF_{DIR} + EPF_{IND}$$



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Calculating the ecological footprint for the product

Table 1. Formulas for calculating the ecological footprint of a furniture boards production, which is related to direct land use

N	Indicator	Formula	Explanation	Result
1	**The rate of consumption of round timber for the production 1 m³ of a furniture boards**	$H = \frac{V_{rt}}{V_{fb}}, {}^{m^3}/_{m^3}$	V_{rt} - estimated volume of round timber ($V_{rt} = 100\ m^3$); V_{fb} - the volume of manufactured furniture boards ($V_{fb} = 26.21\ \text{m}^3$).	3.81
2	**The area of land of direct use, which is necessary for production 1 m³ of a furniture boards**	$EPF_{DIR} = \frac{H}{A}, ha$	H - the rate of consumption of round timber for production 1 m³ of a furniture boards ($H = 3.81\ {}^{m^3}/_{m^3}$); A - the average timber stocks in the forests of Ukraine ($A = 251\ {}^{m^3}/_{ha}$).	0.015

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Calculating the ecological footprint for the product

Table 2. Formulas for calculating the ecological footprint of a furniture boards production, associated with the burning of diesel fuel by internal combustion engines of automotive transport during the supply of raw materials

N	Indicator	Calculation formula	Explanation	Result
1	**Permissible volume of round timber for simultaneous transportation by three-axle automotive transport**	$V = \frac{M_{max}}{\rho}, \text{m}^3$	M_{max} - the maximum weight which simultaneous transportation by three-axle automotive transport ($M_{max} = 22{,}000\ kg$); ρ - the density of freshly harvested of oak wood ($\rho = 990\ {}^{kg}/_{m^3}$).	22.22
2	**The volume of consumption of diesel fuel for the transportation of round timber**	$V_{fuel_l} = \frac{L}{100} \times C + \frac{L}{100} \times (C + k_C \times M_{max}), l$	L - the average transportation distance of round timber ($L = 200\ km$); C - consumption of diesel fuel by an empty truck per 100 km ($C = 23\ l$); M_{max} - the maximum weight which simultaneous transportation by three-axle automotive transport ($M_{max} = 22\ tons$); k_C - the coefficient accounting for additional fuel consumption per ton of cargo ($k_C = 1.3$)	149.2
3	**Amount of fuel actually used in tons**	$V_{fuel_t} = V_{fuel_l} \times 0.001 \times \text{K}, t$	V_{fuel_l} - the volume of consumption of diesel fuel for the transportation of round timber ($V_{fuel_l} = 149.2\ l$); K - average fuel conversion factor from liters to kilograms (density), for diesel fuel K = 0,85.	0.127
4	**The emissions of CO_2 when burning the diesel fuel**	$M_{CO_2} = 0.001 \times V_{fuel_t} \times Q, \text{t}$	V_{fuel_t} - amount of fuel actually used in tons ($V_{fuel_t} = 0.127\ t$); Q - average specific emissions of carbon dioxide (${}^{kg}/_{t}$), for diesel fuel Q = 3138.	0.398
5	**The emissions of N_2O when burning the diesel fuel**	$M_{N_2O} = 0.001 \times V_{fuel_t} \times Q, \text{t}$	V_{fuel_t} - amount of fuel actually used in tons ($V_{fuel_t} = 0.127\ t$); Q - average specific emissions of nitrogen oxide (${}^{kg}/_{t}$), for diesel fuel Q = 0.12.	0.000015

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Calculating the ecological footprint for the product

Table 3. Formulas for calculating the ecological footprint of a furniture boards production, associated with the electricity production consumed for the operation of the main technological equipment and lighting in the production premises

N	Indicator	Calculation formula	Explanation	Result
1	**The electricity consumption for production 1 m³ of a furniture boards**	$P_{m^3} = \frac{P_{month}}{V_{fb_{month}}}, kW \times h$	P_{month} - the average monthly electricity consumption to support the operation of the production equipment and lighting in the premises ($P_{month} = 180{,}000\ kW \times h$); $V_{fb_{month}}$ - the average monthly of a furniture boards production ($V_{fb_{month}} = 200\ m^3$).	900
2	**The average weighted emissions of CO_2 during generation 1 kW×h in the unified energy system of Ukraine**	$M_{CO_2/kW \times h} = \sum_{i=1}^{n} M_{CO_{2_i}} \times S_i, g$	$M_{CO_{2_i}}$ - CO_2 emissions during the production of 1 kW×h of electricity depending on the i-th generation method (look in the table); S_i - the share of electricity generation on the i-th method in the unified energy system of Ukraine (look in the table).	239.311
3	**CO_2 emissions during electricity generation for production 1 m³ of a furniture boards**	$M_{CO_2/m^3} = 10^{-6} \times M_{CO_2/kW \times h} \times P_{m^3}, t$	P_{m^3} - the electricity consumption for prodution 1 m³ of furniture boards ($P_{m^3} = 900 kW \times h$); $M_{CO_2/kW \times h}$ - the average weighted emissions of CO_2 during generation 1 kW×h in the unified energy system of Ukraine ($M_{CO_2/kW \times h} = 235.311 g$).	0.21538
4	**The "virtual land area" required to absorb the CO_2 generated during the electricity production consumed for the operation of the main technological equipment and lighting in the production premises for production 1 m³ of a furniture boards**	$A_{2\ Forest} = \frac{M_{CO_2/m^3}}{AFCS}, ha$	M_{CO_2/m^3} - specific emissions of CO_2 during the electricity production consumed for the operation of the main technological equipment and lighting in the production premises for production 1 m³ of a furniture boards ($M_{CO_2/m^3} = 0.21538$); $AFCS$ – (Average Forest Carbon Sequestration) is the long-term capacity of one hectare of world-average forest ecosystem to sequester atmospheric carbon dioxide through the photosynthesis mechanism ($AFCS = 2.67\ \frac{tons\ CO_2}{ha \times year}$).	0.081

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Calculating the ecological footprint for the product

Table 4. Formulas for calculating the ecological footprint of a furniture boards production, associated with the heat generation for drying sawn timber by burning production waste

N	Indicator	Calculation formula	Explanation	Result
1	**Consumption of wood waste for drying sawn timber for production 1 m³ of a furniture boards**	$W_{waste} = V_w \times \rho_w \times N_{st}$, kg	V_w - the necessary amount of wood waste for thermal energy generation for drying 1 m³ of sawn timber ($V_w = 0.27 m^3$); ρ_w - density of oak wood ($\rho_w = 930\ ^{kg}/_{m^3}$); N_{st} - the norm of consumption of sawn timber for production 1 m³ of a furniture boards ($N_{st} = 2.74\ ^{m^3}/_{m^3}$).	688
2	**Specific emissions of CO_2 during the burning of wood for drying sawn timber for production 1 m³ of a furniture boards**	$M_{CO_2/m^3} = W_{waste} \times M_{CO_2/kg} \times 10^{-3}$, t	W_{waste} - consumption of wood waste for drying sawn timber for production 1 m³ of a furniture boards ($W_{waste} = 688\ kg$); $M_{CO_2/kg}$ - the amount of CO_2 remissions when burning 1 kg of wood ($M_{CO_2/kg}$=1.304 kg).	0.897
3	**Specific emissions of N_2O during the burning of wood for drying sawn timber for production 1 m³ of a furniture boards**	$M_{N_2O/m^3} = W_{waste} \times M_{N_2O/kg} \times 10^{-3}, t$	W_{waste} - consumption of wood waste for drying sawn timber for production 1 m³ of a furniture boards ($W_{waste} = 688\ kg$); $M_{N_2O/kg}$ - the amount of N_2O remissions when burning 1 kg of wood ($M_{N_2O/kg}$= 0.023×10^{-3} kg).	0.000016
4	**Specific emissions of CH_4 during the burning of wood for drying sawn timber for production 1 m³ of a furniture boards**	$M_{CH_4/m^3} = W_{waste} \times M_{CH_4/kg} \times 10^{-3}, t$	W_{waste} - consumption of wood waste for drying sawn timber for production 1 m³ of a furniture boards ($W_{waste} = 688\ kg$); $M_{CH_2/kg}$ - the amount of CH_4 remissions when burning 1 kg of wood ($M_{CH_4/kg}$= 2.38×10^{-3} kg).	0.001637
5	**The specific emissions of N_2O in terms of CO_2 equivalents during the burning of wood for drying sawn timber for production 1 m³ of a furniture boards**	$CDE_{N_2O}/_{m^3} = M_{N_2O}/_{m^3} \times E_{CO_2}$, t	M_{N_2O/m^3} - specific emissions of N_2O during the burning of wood for drying sawn timber for production 1 m³ of a furniture boards ($M_{N_2O/m^3} = 0.000016$); E_{CO_2} – the global warming potential of greenhouse gas (E_{CO_2} for N_2O is 298).	0.00477

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Calculating the ecological footprint for the product

Table 4. Formulas for calculating the ecological footprint of a furniture boards production, associated with the heat generation for drying sawn timber by burning production waste

6	**The specific emissions of CH_4 in terms of CO_2 equivalents during the burning of wood for drying sawn timber for production 1 m³ of a furniture boards**	$\mathrm{CDE}_{CH_4/m^3} = M_{CH_4/m^3} \times \mathrm{E}_{CO_2}, t$	M_{CH_4/m^3} - specific emissions of CH_4 during the burning of wood for drying sawn timber for production 1 m³ of a furniture boards ($M_{CH_4/m^3} = 0.001637$); E_{CO_2} – the global warming potential of greenhouse gas (E_{CO_2} for CH is 25).	0.041
7	**The "virtual land area" required to absorb the CO_2 generated during the burning of wood waste for drying sawn timber for production 1 m³ of a furniture boards**	$A_{3\ Forest} = \frac{M_{CO_2/m^3} + \mathrm{CDE}_{N_2O/m^3} + \mathrm{CDE}_{CH_4/m^3}}{AFCS}, \mathrm{ha}$	M_{CO_2/m^3} - specific emissions of CO_2 during the burning of wood for drying sawn timber for production 1 m³ of a furniture boards ($M_{CO_2/m^3} = 0.897$); CDE_{N_2O/m^3} - the specific emissions of N_2O in terms of CO_2 equivalents during the burning of wood for drying sawn timber for production 1 m³ of a furniture boards ($\mathrm{CDE}_{N_2O/m^3} = 0.00477$); CDE_{CH_4/m^3} - the specific emissions of CH_4 in terms of CO_2 equivalents during the burning of wood for drying sawn timber for production 1 m³ of a furniture boards ($\mathrm{CDE}_{CH_4/m^3} = 0.041$); $AFCS$ – (Average Forest Carbon Sequestration) is the long-term capacity of one hectare of world-average forest ecosystem to sequester atmospheric carbon dioxide through the photosynthesis mechanism ($AFCS = 2.67\ \frac{\mathrm{tons\ CO_2}}{\mathrm{ha \times year}}$).	0.353

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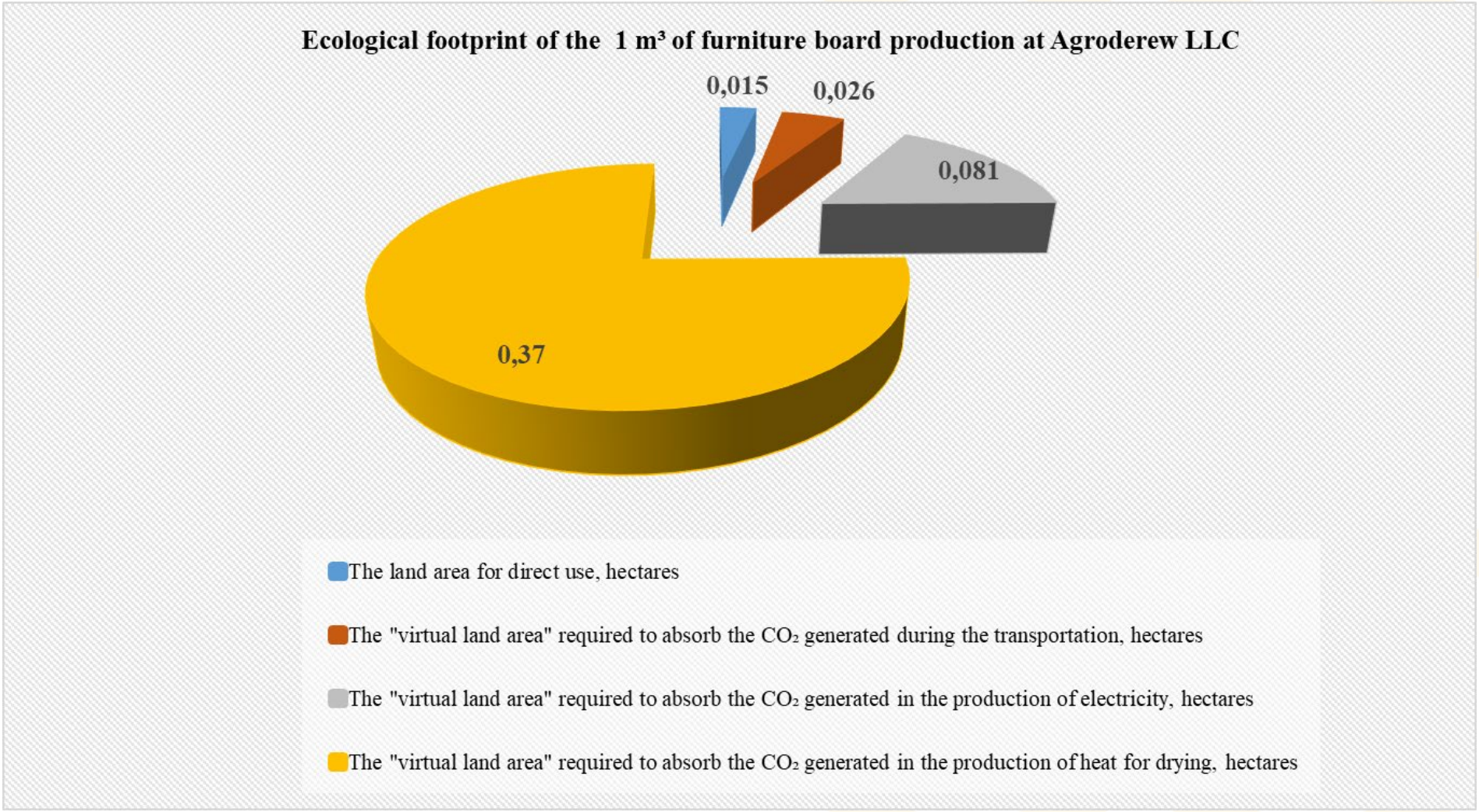
Calculating the ecological footprint for the product



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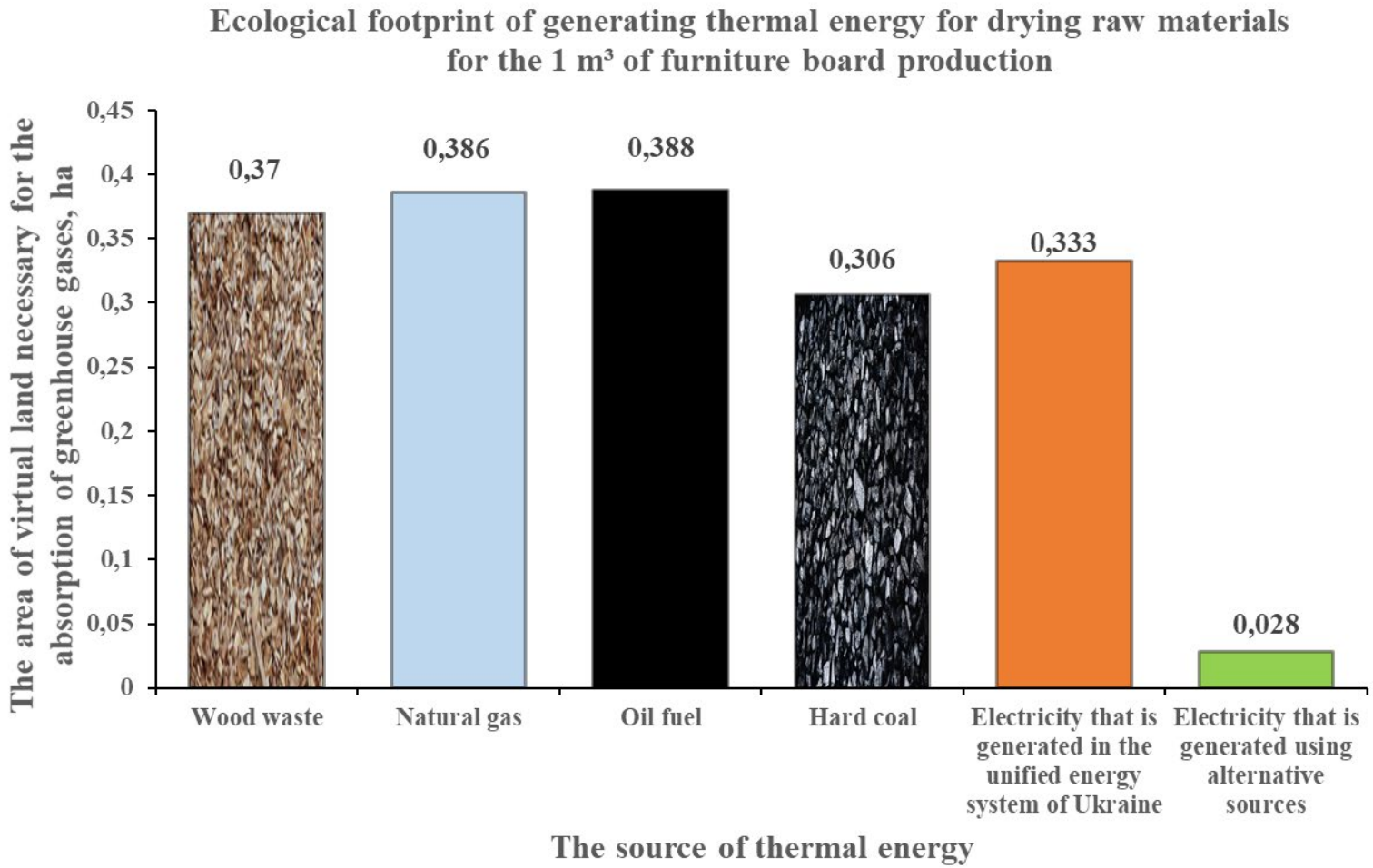
3. The first steps towards biodiversity



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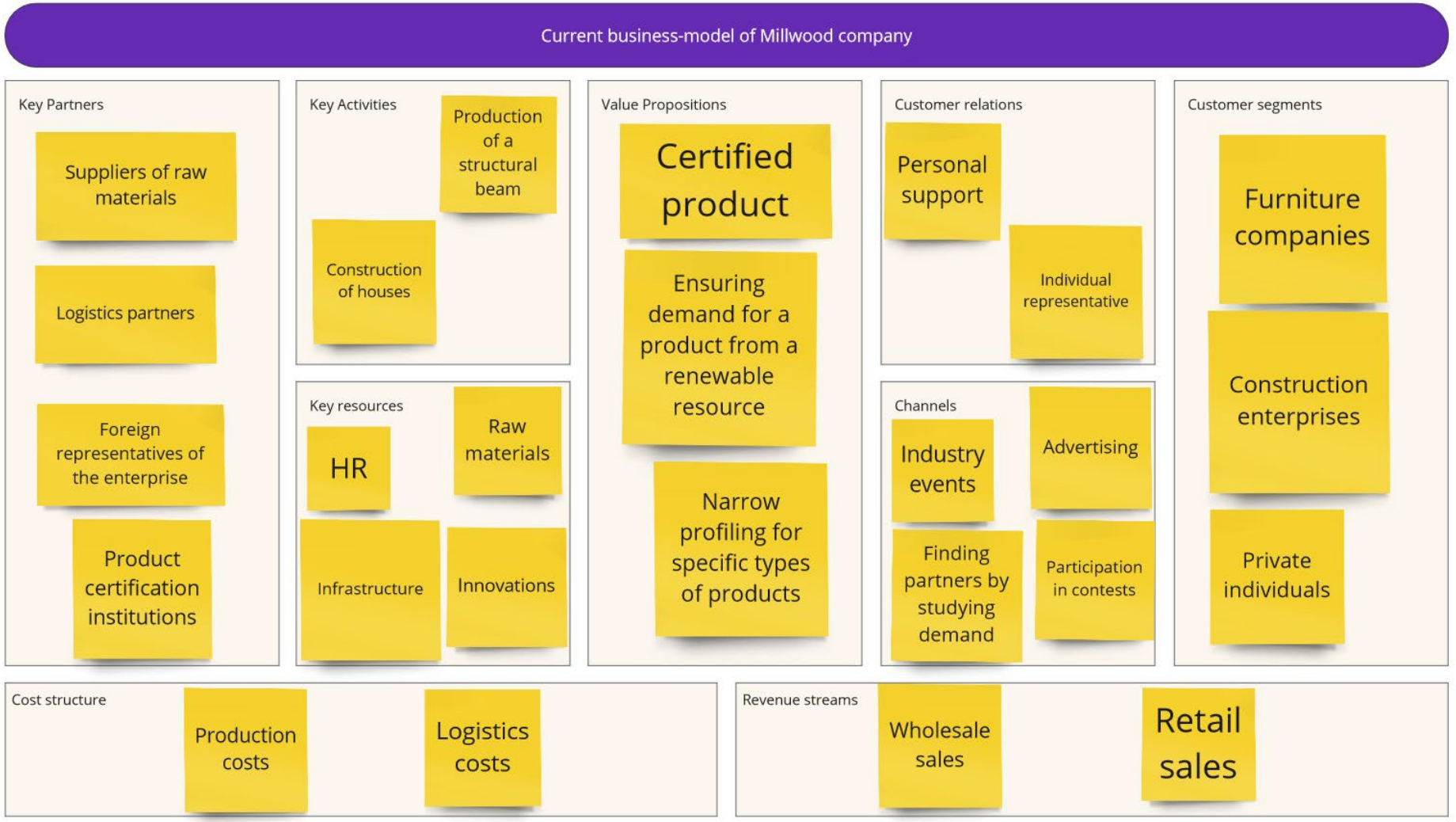
Sustainable Business model



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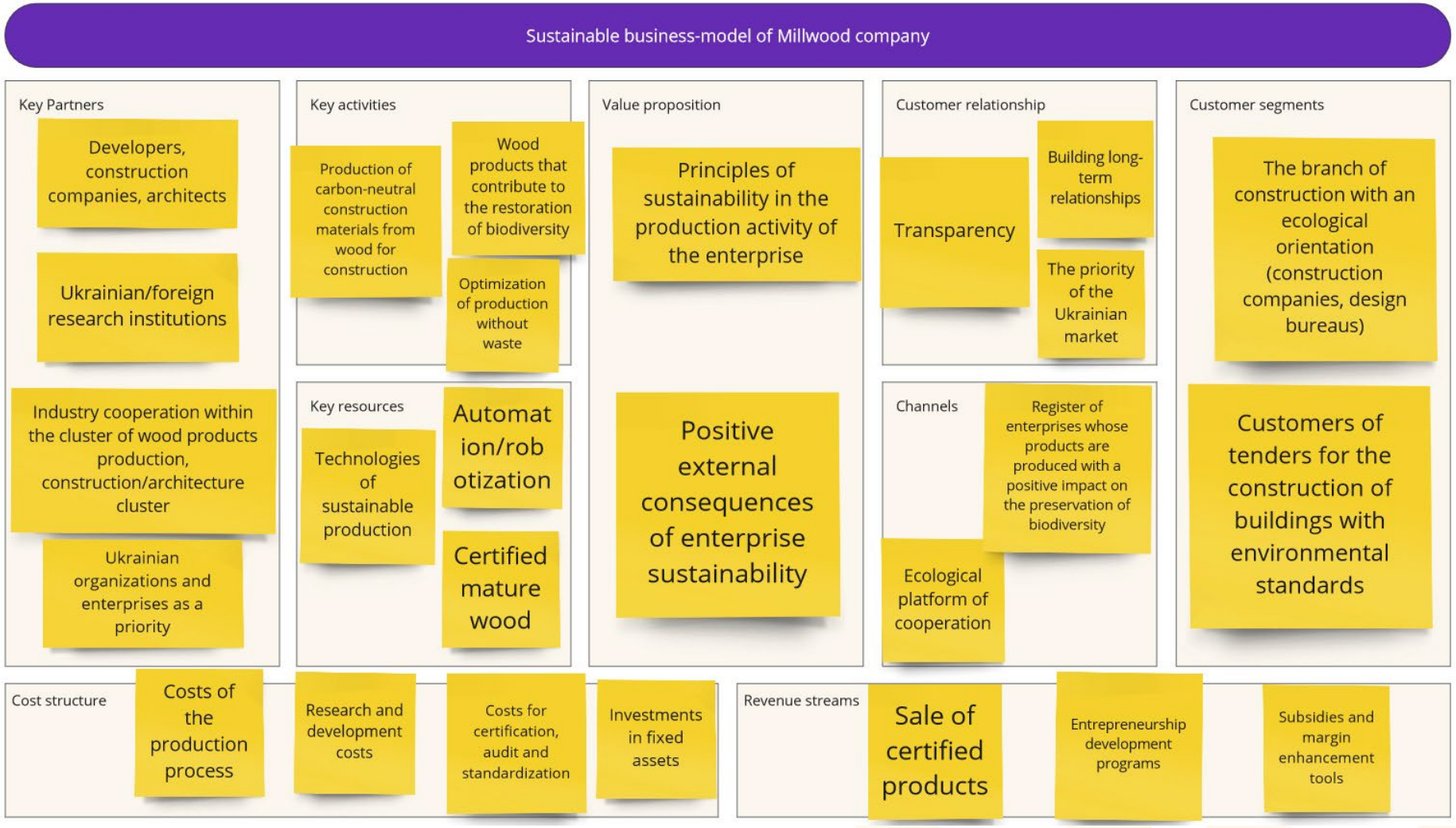
Sustainable Business model



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Industry 4.0

The term “Industry 4.0” was initially put in focus at the Hanover trade fair 2015 by an industry-comprehensive alliance of the Federal Government for digitalization in economy. The “fourth revolution”, after the steam engine, the conveyor belt and automation by IT, is targeted at the creation of smart factories.

In a smart factory, people, machines and resources communicate directly with state-of-the-art information and communications technology. Smart components know their production processes and future uses, to actively support production and documentation. Production also changes - cycled conveyor belt production is replaced by disconnected, entirely flexible and highly integrated production systems.

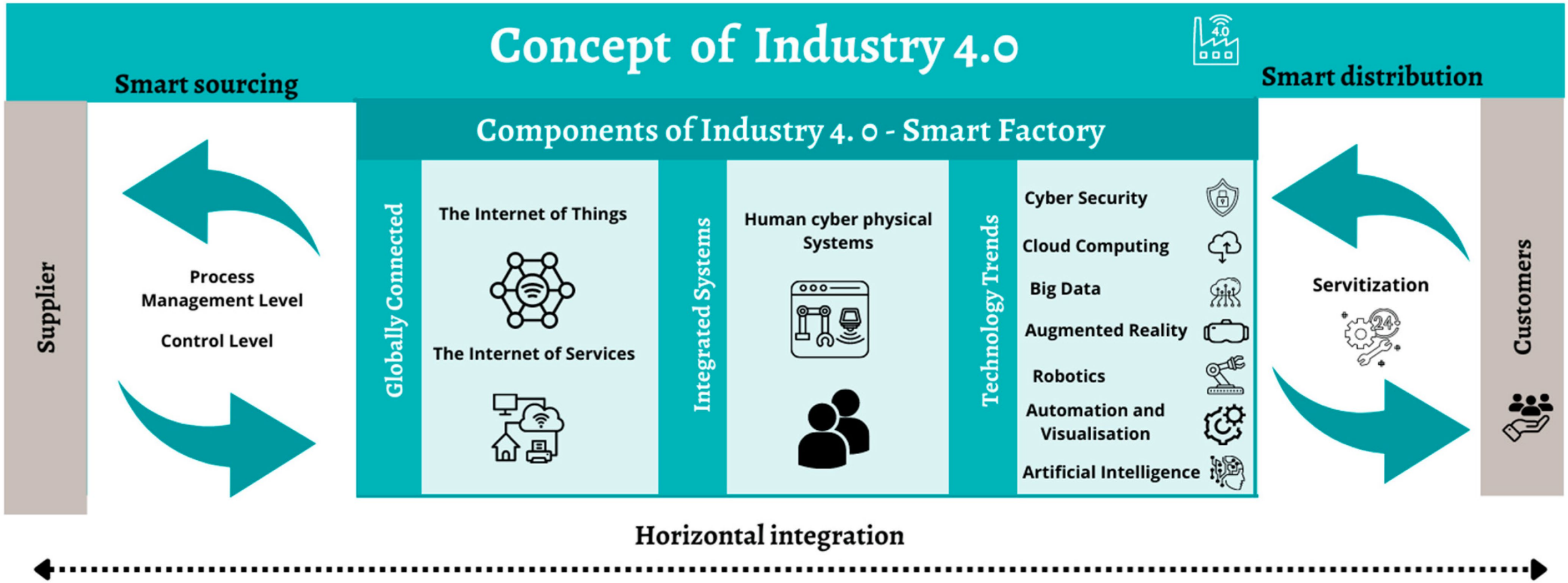
IT forms the technical basis of the smart factory. It supports communication between the machines and workpieces and forms the basis for smart and digitally linked systems and production processes. For example, material flow can be controlled by the system (quantity-dependently) based on variation or order data, status messages, etc., and can be called in real time.

www.2020spaces.com/solutions/manufacturing/*

Принципи промисловості 4.0 у меблевому виробництві

Ukrainian National Forestry University

Принципи промисловості 4.0 у меблевому виробництві

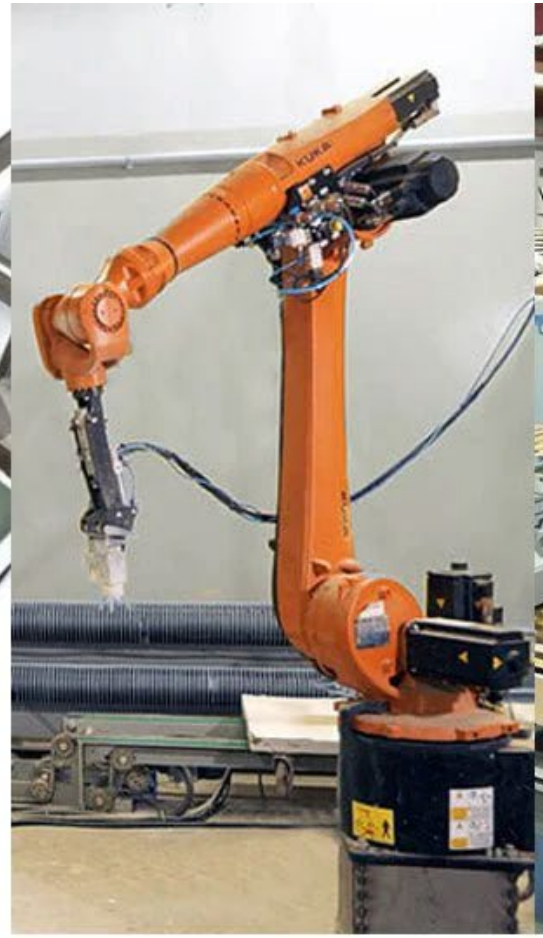


Принципи промисловості 4.0 у меблевому виробництві

Принципи промисловості 4.0 у меблевому виробництві

Flexible

Intuitive



Automated

Intelligent

Принципи промисловості 4.0 у меблевому виробництві

To maintain economic efficiency, today's furniture manufactures must be able to do the following:

- **Optimization** of the customer-specific product design
- **Tracking** the product status and order history
- **Execution** of real-time analyses of costs and resources
- **Evaluation** of factory performance and setup of early indicators
- **Provision** of valid planning data and operating indices
- **Improvement** of production and product as well as information quality
- **Reduction** of power and material costs

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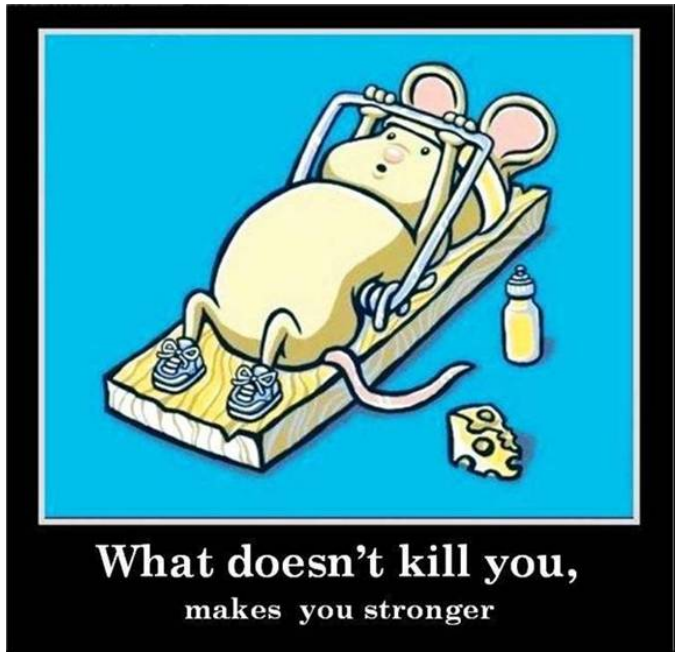
Висновки



crisis =

危机

wēi = danger

jī = opportunity

Thank you for your attention!

Orest Kiyko, Doctor of science, Professor
Ukrainian National Forestry University (UNFU)
Head of the Department of Furniture Production Techniques and Wood Product Technology

orest.kiyko@nltu.edu.ua

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