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Green Tech Made in Ukraine:

Assessing the potential of green value chain manufacturing localisation in Ukraine

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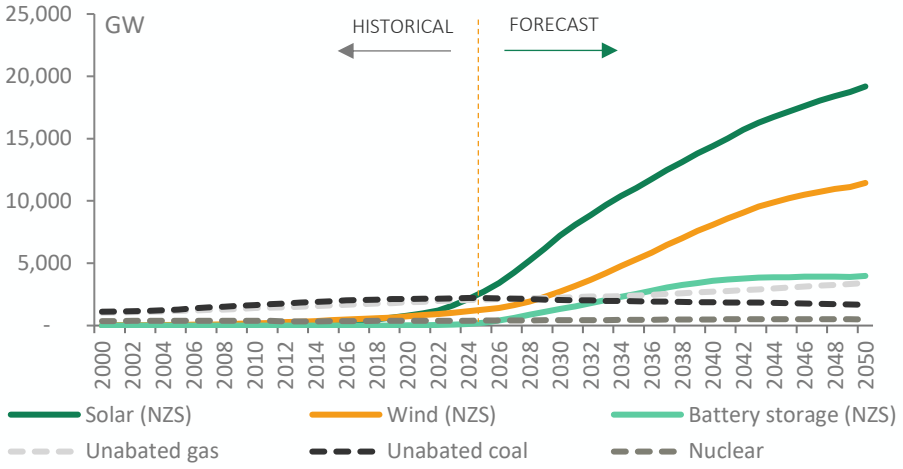
Webinar for German businesses, organised by the AHK Ukraine, DIHK, Ost-Ausschuss

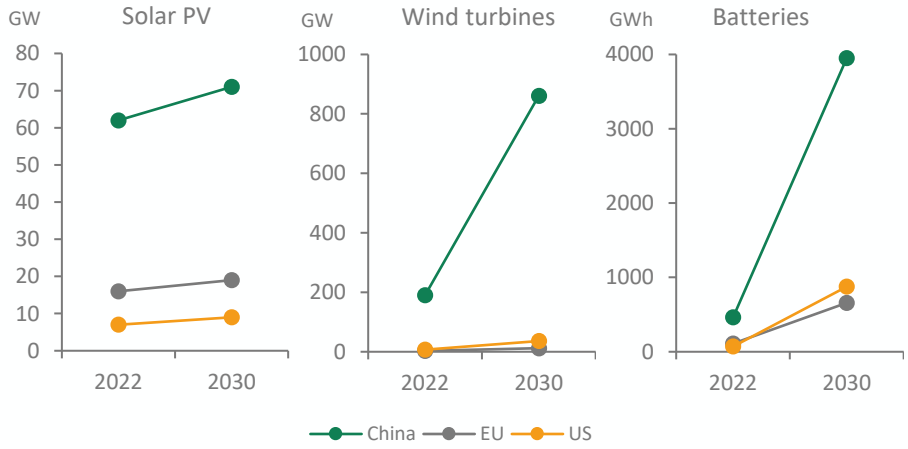
1. Global green technology manufacturing landscape

Historical and forecasted global installed capacity by source



Source: BNEF Net Zero Outlook (2024). Note: Net Zero Scenario 2050.

Current and projected manufacturing output for key clean technologies, 2022 - 2030 project pipeline



Source: IEA (2023). Link

Demand for green tech is surging…

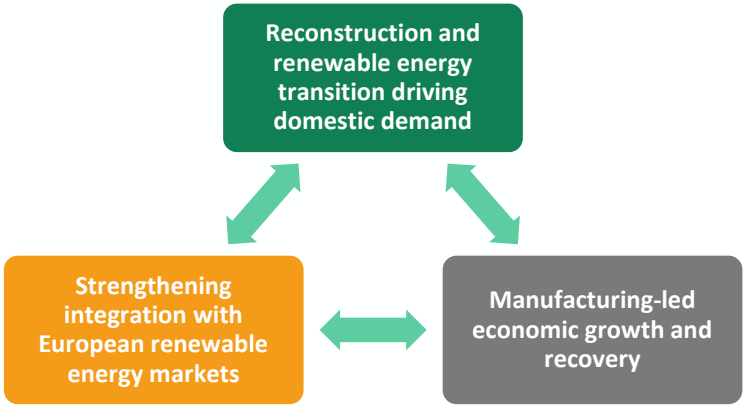
- Global decarbonization goals, decentralization and decreasing costs are driving green technology deployment
- Solar PV, wind turbines and lithium-ion batteries hold potential both in terms of decarbonization and economic value

… and the manufacturing landscape is shifting

- A handful of countries (esp. China), now dominate green tech value chains
- But seismic shifts are leading to global reconfiguration of value chains, driven by energy security consideration and localization of manufacturing industries
- Green windows of opportunity may exist and enable emerging economies to leapfrog legacy industries and enter green tech value chains

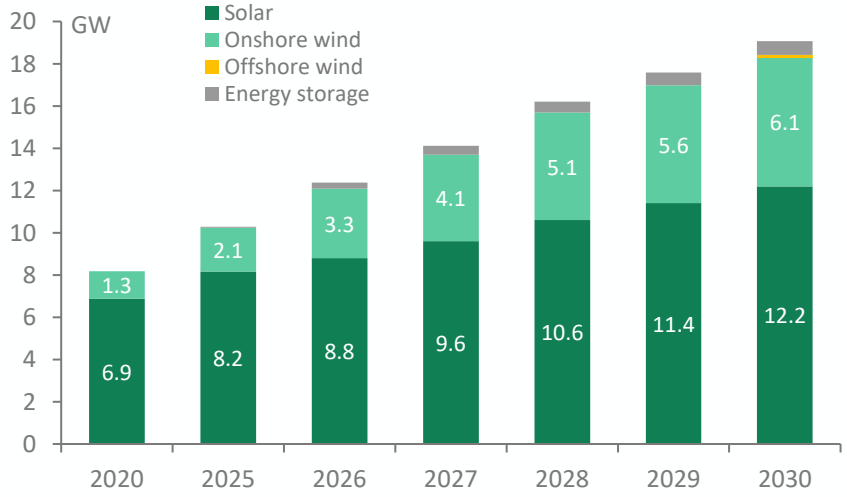
2. Rationale for green technology manufacturing in Ukraine

Strategic rationale underpinning the potential for manufacturing localisation in Ukraine



Source: Own illustration

Installed capacities in Ukraine: solar PV, wind power, energy storage



Source: Ukraine National Plan for 2025-2030.

Domestic demand for reconstruction needs

- Creates strong demand for renewable energy equipment
- Plans to increase share of renewables from 11% in 2024 to 27% in 2030
- Mitigating exposure to global supply chain disruptions and geopolitical risks increases energy security

Manufacturing sector drives economic growth

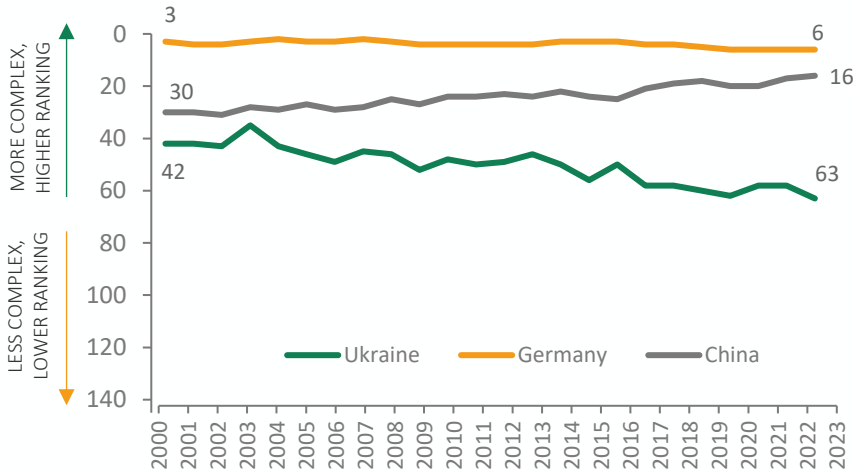
- Manufacturing supports GDP growth, job creation, and investment inflows
- Economy needs deeper diversification, and renewable manufacturing could help
- Aligns short-term recovery with long-term strategic transformation

Integration with EU market

- By 2030, 66% of EU electricity from renewables, but unlikely to meet targets through domestic manufacturing
- Local manufacturing could integrate Ukraine into EU supply chains and provide export market

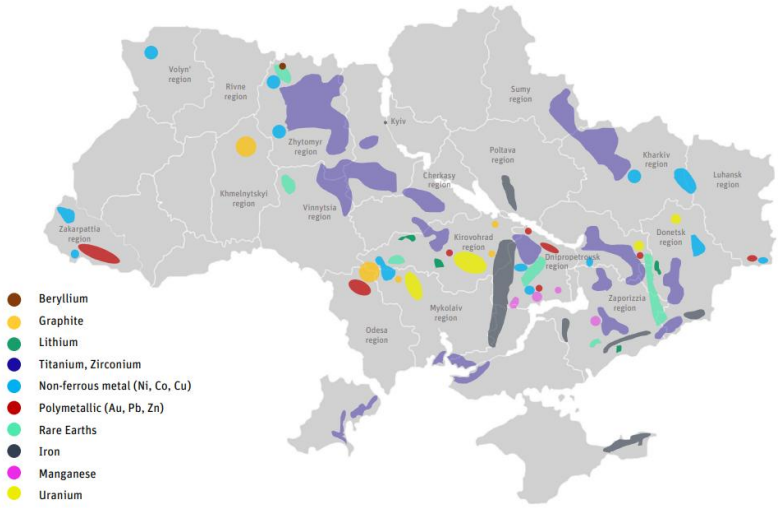
3. Ukraine's industrial base (1/2)

Ukraine's global economic complexity ranking, 2000-2023



Source: The Growth Lab at Harvard University (2025), own illustration

Map of critical raw minerals in Ukraine



Source: Ukraine Geological Survey

Industrial capabilities

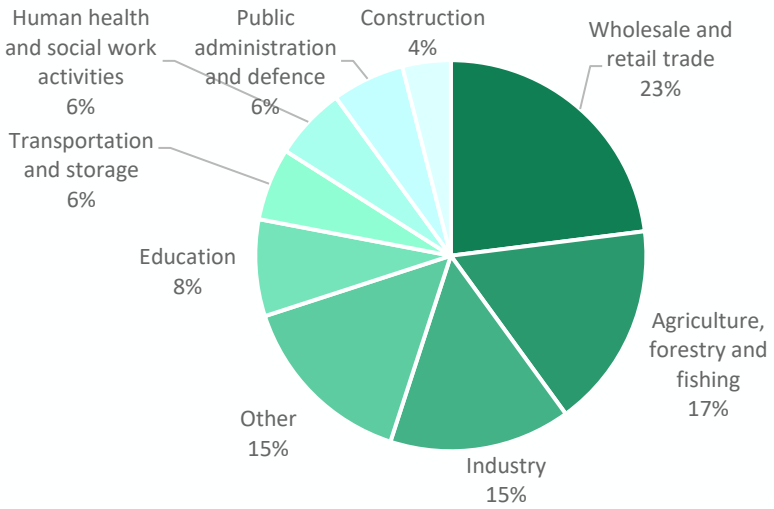
- Ukraine's industrial base is strong in key sectors including mining and metallurgy, engineering, and energy
- The manufacturing sector accounts for 56% of all industrial value
- But economic complexity has steadily declined, limiting growth potential
- War has caused damage to energy, transport, and manufacturing assets, severely impacting industry and logistics

Critical raw minerals

- Ukraine has reserves of several critical raw materials for green value chains (lithium, graphite, titanium, manganese, iron)
- High potential and positive developments, but significant challenges remain
- Russian occupation of key resource areas, long lead times for new mines and processing plants, old infrastructure, logistics, high capital costs and risks

3. Ukraine's industrial base (2/2)

Employment in Ukraine by type of economic activity, 2021



Source: State Statistics Service of Ukraine

Financial environment in Ukraine

	Ukraine	Germany	Poland
Weighted Average cost of Capital (WACC)	10-20%*	8.3%	~ 9%
Corporate Income Tax (CIT)	18%	30%	19%
Value Added Tax (VAT)	20%	19%	23%
Average gross salary (EUR/mo.)	489	3,719	1,901

Source: KPMG Cost of Capital Study (2024), KPMG Industrial manufacturing opportunities in Ukraine (2025)

Human capital

- Workforce is down 25% since pre-war due to emigration and conscription
- Strong skills base (engineering and technical training) with lower cost labour

Access to finance

- Financing remains costly due to war
- But government programmes and international grants, concessional loans, insurance support etc. play a key role

Innovation ecosystem

- Consistent innovation and development, very strong IT sector, growing startup ecosystem
- Limited public R&D funding

Policy and regulatory framework

- Improvements in business environment
- Increasing the speed of starting a business permitting, and land use reclassification

4.1 Solar PV: Value chain overview (1/3)

Solar PV manufacturing value chain

	 POLYSILICON	 INGOT	 WAFER	 SOLAR CELL	 SOLAR MODULE
Description	Quartz is purified into high-grade polysilicon	Polysilicon is melted and formed into silicon ingots	Ingots are sliced into thin, clean wafers	Wafers are processed into electricity-generating cells	Cells are assembled into framed, laminated modules
Major producers (% global market share)	China-79% Europe-8% APAC-6%	China- >80%	China-97% APAC-2.5% Europe-0.5%	China -85% APAC-12% Europe-0.6%	China-75% APAC- 15% Europe-3%
Ukraine existing production	No production	Future plans	Future plans	Future plans	Existing limited production

Source: IEA(2022), expert interviews. Own illustration

Global landscape

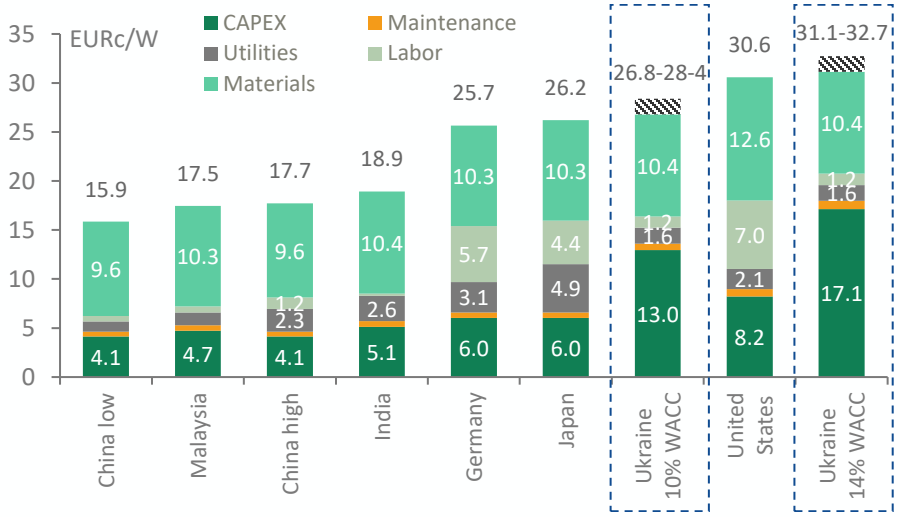
- Massive concentration, with over 80% of global solar PV value chain dominated by China, especially in upstream stages (polysilicon, wafers, cells)
- Module assembly is more dispersed, with capacities in 38 countries by 2021

Ukraine's capabilities

- **Polysilicon:** Historical production but not anymore, highly energy-intensive
- **Ingot, Wafer, Cell:** Minimal activity, but future plans do exist to scale up
- **Modules:** Some experience in assembly exists, but current capacity is limited
- **Intermediate materials & BOS:** Production of tempered glass, steel and aluminium frames, copper wires, inverters

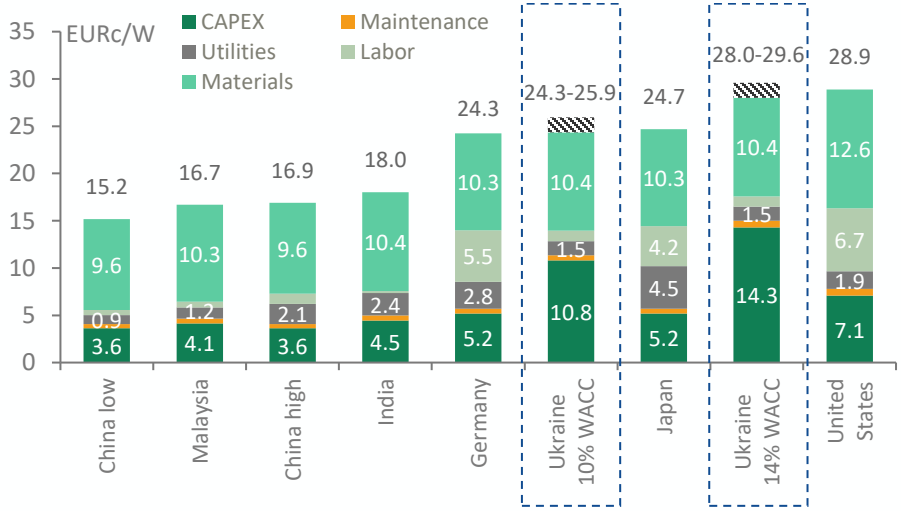
4.1 Solar PV: Analysis and results (2/3)

Solar PV manufacturing costs – 500 MW annual capacity



Source: NREL (2024), expert consultations, authors' calculations.

Solar PV manufacturing costs – 1 GW annual capacity



Source: NREL (2024), expert consultations, authors' calculations.

Analysis

- High CAPEX due to high WACC is the main cost driver, hurting competitiveness
- Material costs are comparable worldwide and in Ukraine due to global value chains
  - But logistics and transportation disruptions could increase costs
- Lower energy and labour costs vis-à-vis other countries
  - Market reform and re-building energy system as green and least-cost is key to long-term competitiveness

Potential economic benefits*

- **Direct jobs:** 13,400 job-years in manufacturing
- **GVA contribution:** EUR 233-381 million/year added to Ukraine's GVA
- **Fiscal revenues:** EUR 54.7–79.1 million/year in fiscal revenues
- **Export revenues:** EUR 217-306 million/year
- **Domestic demand for materials:** Tempered glass (78,900 t), steel (115,400 t), aluminium profiles (12,800 t), copper cables (7,800 t)

** Assumed annual demand: 850 MW domestic + 850 MW export to EU. (2 GW production capacity with 85% utilisation). Direct economic contributions of manufacturing only.*

4.1 Solar PV: Assessment (3/3)

Conclusions

- **Ukraine unlikely to compete with China and South-east Asia** on a pure cost basis, but neither is the EU or US
- Ukraine's production would only make sense in wider EU ecosystem, but could then help improve EU **value chain supply security**
- **Assembly operations and other equipment manufacturing** (inverters, steel & aluminium frames, tempered glass, cables) made in Ukraine can be scaled up for exports
- Repurposing existing assets could reduce CAPEX, but **greenfield projects needed for scale** to meet domestic and EU demand
- Support is needed **to reduce cost of financing**, which currently poses a major obstacle to sectoral expansion
- **Training and skills needed** on both manufacturing and deployment side
- **Demand-side support measures** for solar PV deployment are key to creating stable market, alongside additional mechanisms

Sector specific development policies

non-exhaustive

Short-term

- Align with broader EU strategy on sector revival
- Assess and stimulate the production of ancillary equipment (e.g. inverters, glass)
- Reconsider import exemptions on final assembled modules

Medium-term

- Scale-up ancillary equipment markets and assess need for domestic assembly
- Re-assess value chain economics based on EU sectoral policy developments

Long-term

- Pursue avenues that can position Ukraine as a strategic contributor to the EU solar PV value chain by focusing on strategic components

4.2 Wind turbines: Value chain overview (1/3)

Wind turbine manufacturing value chain

	 TOWER	 BLADE	 GEARBOX	 GENERATOR & POWER CONVERTER	 NACELLE
Description	Steel or concrete towers that support the turbine structure	Composite materials molded into aerodynamic blade shapes	Precision-machined components assembled into gear systems	Copper coils and magnets form generators; electronics convert power for grid use	Final assembly of gearbox, generator, and converter into nacelle housing
Major producers (% global market share)		61% China	66% China	Generator: 66% China Power converter: 77% China	60% China, 19% Europe
Ukraine existing production	Yes	Future plans	Yes	Yes	Yes

Source: Global Wind Energy Council (2024), Boston Consulting Group (2023). Own illustration

Global landscape

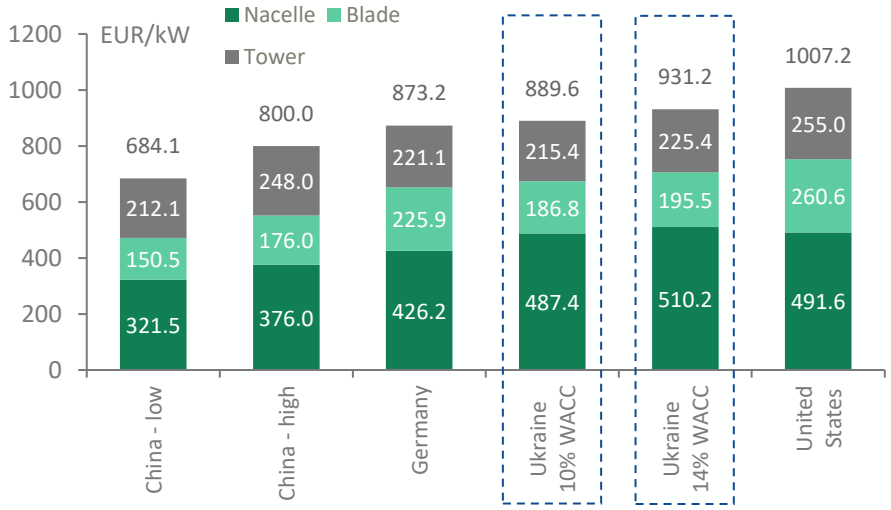
- Highly complex value chain, more than 8,000 individual components, size massive in scale
- Concentrated manufacturing, China leading in global manufacturing, but European countries also present

Ukraine's capabilities

- **Generators:** Assembled from imported and domestic materials
- **Nacelles:** Local assembly from imported and domestic components
- **Blades:** Local production after 2025 from imported materials
- **Towers and foundation:** Local production from Ukrainian steel
- **Minerals**: Some key elements (iron, manganese, gallium, graphite) produced in Ukraine

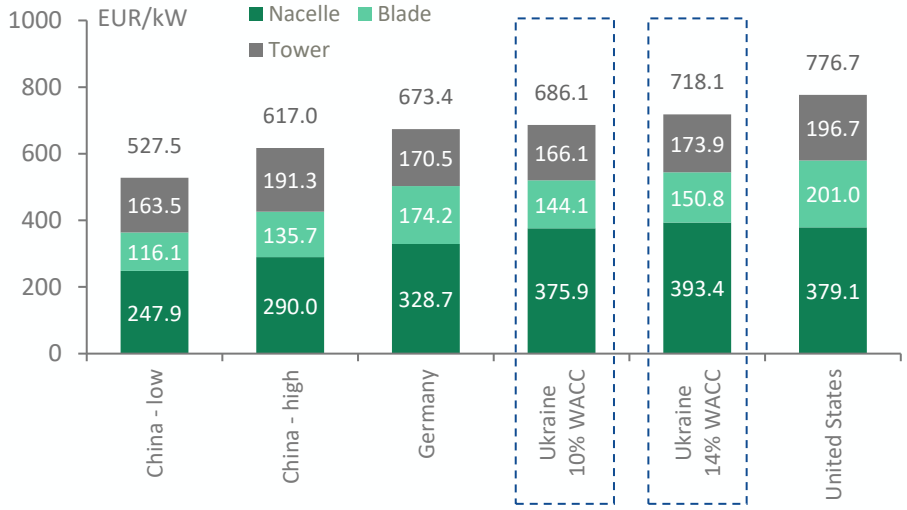
4.2 Wind turbines: Analysis and results (2/3)

Estimated cost of manufacturing, 3-4 MW turbine power



Source: NREL (2024), Deutsche WindGuard (2024), expert consultations. Authors' calculations.

Estimated cost of manufacturing, 4-5 MW turbine power



Source: NREL (2024), Deutsche WindGuard (2024), expert consultations. Authors' calculations.

Analysis

- Blade and tower production could be competitive due to labour-intensity, strong domestic inputs (steel), and distance to end-market as key factors
- Nacelle costs higher due to high number of components and complex supplier ecosystem
  - But feasible with some components and assembly taking place domestically
- Integrated production with some imported sub-components can be a strong pathway

Potential economic benefits*

- **Direct jobs:** 6,513 job-years in manufacturing
- **GVA contribution:** EUR 247-468 million/year added to Ukraine's GVA
- **Fiscal revenues:** EUR 140-210 million/year in fiscal revenues, mostly from VAT
- **Export revenues:** EUR 612-754 million/year
- **Domestic demand for materials:** Concrete (702,100 t), steel (202,300 t), cast-iron (15,300 t)

** Assumed annual demand: 850 MW domestic + 850 MW export to EU. (2 GW production capacity with 85% utilisation). Direct economic contributions of manufacturing only.*

4.2 Wind turbines: Assessment (3/3)

Conclusions

- Ukraine's wind manufacturing sector **could possibly be cost-competitive vis-à-vis EU**
- **Blades could be an area of opportunity** due to high-skilled and low-cost labour, and **towers** also due to material inputs
- Nacelle production is costlier due to imports and the supplier ecosystem. But components are also produced in Ukraine, and **assembly makes economic sense**
- **Ancillary equipment and turbine/nacelle sub-components** can be evaluated for export competitiveness
- **Strong and reliable domestic deployment targets** and **support for demand-side** are fundamental for growth and for FDI/MNCs
- **Regional synergies with neighbours** could be key for Ukraine's export potential, especially for blades and towers
- Ukraine could produce to **meet domestic goals** and become a supplier of wind power equipment **to the EU**

Sector specific development policies

non-exhaustive

Short-term

- Assess potential to revitalise existing manufacturing
- Stimulate the manufacturing of tower and blades, and expand assembly operations
- Organise production of special steel at machine-building plants with electric furnaces

Medium-term

- Scale-up tower and blade production
- Attract investments into turbine and nacelle production
- Strengthen component supply chains ecosystem
- Provide trade financing support via export credit agency

Long-term

- Expand domestic R&D for existing technologies and entry into new segments (e.g. offshore)
- Explore export market potential beyond EU

4.3 Lithium-ion batteries: Value chain overview (1/3)

Lithium-ion battery manufacturing value chain

	 MATERIAL PROCESSING	 ANODE, CATHODE, ELECTROLYTES	 BATTERY CELL	 BATTERY ASSEMBLY
Description	Refining raw minerals into high-purity battery materials (e.g., lithium hydroxide)	Manufacturingkey components: cathodes, anodes, electrolytes, and separators	Producing cells by integrating electrodes and electrolytes	Final assembly of battery cells into packs or stations
Major producers (% global market share)	Lithium: China - 57% Nickel, Manganese: China - 70%	NMCO: China - 57% LFP: China - 88%	China - 68% Europe - 9% USA - 9%	
Ukraine existing production	Partial capabilities	No production	No production	Past capabilities Recoverable

Global landscape

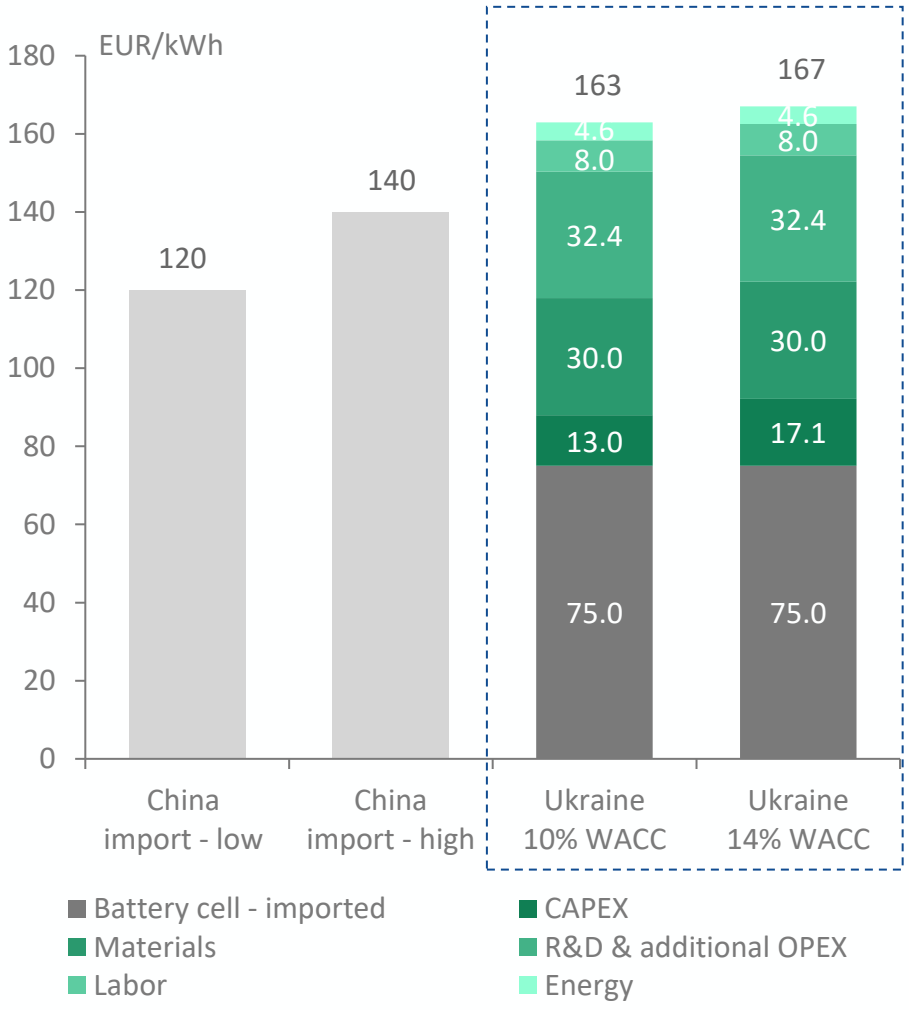
- Technologically complex, heavily dependent on a small number of critical minerals, mined and processed in a few countries globally
- Geographically concentrated, China holds around 70% share in processed materials, component manufacturing, and assembly

Ukraine's capabilities

- **Material dimension:** existing deposits and production of manganese (for cathodes), graphite (for anodes), promising lithium deposits but no production. Some battery-grade processing
- **Components and cells:** No manufacturing of cathodes, anodes, electrolytes, or cells
- **Assembly:** Past assembly of imported cells into battery stations

4.3 Lithium-ion batteries: Analysis (2/3)

Estimated cost of manufacturing battery stations



Source: Expert consultations. Authors' calculations.

Analysis

- Imported battery cells are 45% of the total cost of the battery stations
- CAPEX share within production cost relatively low compared to other value chains (8%-10% of cost of production)
- Low labour cost share despite the labour-intensive production (5% of total cost)
- R&D and additional OPEX significant share of total cost
  - Includes maintenance and upgrades
  - Needed to adapt final battery stations to end-user specifications

Potential economic benefits*

- **Direct jobs:** 250 to 375 full-time employment in manufacturing
- **GVA contribution:** EUR 74-107 million/year added to Ukraine's GVA
- **Fiscal revenues:** EUR 93.3 - 99.8 million/year in fiscal revenues, mostly from VAT
- **Export revenues:** EUR 612-754 million/year

** Assumed annual demand: 3 GWh assembly capacity facility with 85% utilisation rate. Direct economic contributions of manufacturing only.*

4.3 Lithium-ion batteries: Assessment (3/3)

Conclusions

- Ukraine produces **some** key minerals including manganese (cathodes), graphite (anodes), future potential for lithium) **but outlook uncertain:**
  - Unclear production and processing costs, long lead times, high CAPEX
- **Minerals development** for li-ion battery via EU financing, US-Ukraine Minerals Deal, and other off-take agreements is essential
- No experience in battery cell manufacturing
- **Assembly from imported battery cells could be ramped up** to satisfy domestic demand (but unclear case for exports)
- **Strategic co-op opportunities** in minerals and ancillary equipment supply to EU neighbours with battery manufacturing (e.g. Poland, Slovakia, Hungary, Romania)
- Assembling **batteries for domestic defense sector and potentially electromobility** could make strategic sense

Sector specific development policies

non-exhaustive

Short-term

- Map domestic li-ion battery demand including existing and emerging sectors
- Support scaling-up of assembly capacity
- Explore RD&I in assembly for end-products
- Re-assess critical mineral reserves and economics of extraction and processing

Medium-term

- Scale-up assembly in line with domestic demand
- Regional supply chain co-operation with neighbours to reduce cost
- Re-assess economics of mineral processing in line with extraction and global developments

Long-term

- Continue developing domestic critical raw minerals sector via off-takes and product sharing agreements
- Explore potential for entering other parts of the value chain (pre-cursor or cell production)

5. Policy recommendations

Industrial base

- Develop **sectoral linkages**, identify complementarities and spillovers
- Investigate potential to **restart/repurpose existing production sites or assets**
- Upgrade intra-country and cross-border **renewable supply chain logistics**
- Continue developing **industrial parks** across Ukraine, with stable access to renewable energy in mind

Critical minerals

- Develop **national mineral strategies** with a long-term view of the sector in light of development, agreements and obligations
- Create **realistic pathways** to add value to Ukraine's minerals, assessing potential domestic and EU demand

Finance

- Extend **government-backed loan guarantees**
- Launch a **greenfield equity insurance fund**
- Extend **war insurance** to large manufacturing plants

Labor and skills

- Launch **re-skilling programmes** for existing workforce for roles on green value chains
- Provide **targeted green skills training** for women, veterans and returnees
- Introduce **dual study programmes** in key renewable energy occupations
- Create a **national green skills certification framework** for green energy jobs

Research and development

- Create a **public research institute** on clean energy manufacturing and deployment
- **Scale-up Innovation Fund** and expand scope to renewable technologies
- Facilitate **public-private and private-academia partnerships**
- Establish national or regional **innovation hubs or "green tech clusters"**

Policy and regulatory frameworks

- Create broader **industrial policy vision** and targeted **FDI attraction programme**
- **Expand CAPEX refund programmes** to large manufacturing investment projects
- Provide **working capital support** and testing/certification subsidies for Ukrainian manufacturers

Demand-side measures

- Further develop **renewable roll-out**
- Continue **energy market liberalisation**
- **Re-design support mechanisms**, moving away from Green Tariff, open up ancillary service markets to private BESS operators
- Publish **multi-year auction calendars**
- Introduce **corporate and cross-border PPAs**

6. Conclusion

- Ukraine displays **varying levels of competitiveness** across the solar PV, wind power and lithium-ion battery value chains, with significant upside in light of **domestic targets and export ambitions**
- Green value chains could be a **pathway to increased energy security**
  - **Decentralised, renewable energy** is a key pillar of Ukraine's energy strategy
  - Ukraine could become a **key partner for the EU**, helping bridge gap in manufacturing and decreasing reliance on non-EU production
  - Origin and nature of finance and MNCs looking to localise in Ukraine is therefore also key
- Localising any value chain segment **would improve technological capabilities and add value**
  - Research and development occurs at all stages, with process and incremental innovation fundamental to further technological development
  - **Linkages between existing sectors and green technology manufacturing** may create positive spillovers and complementarities with emerging technological sectors
  - Further integration with **Ukraine's dynamic IT sector** could create win-win situations
- **Government and international donor support** will continue to be fundamental for the development of green technology value chains in Ukraine, including through **creating an enabling environment and providing direct supply- and demand-side support**

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