Evaluation of Location Factors for Photovoltaic Module Factories

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Motivation and Problem Statement

- PV installations in Europe are dominated by Chinese modules with a market share of >94% [1].
- Resilience and strategic de-risking require PV module manufacturing in Europe: new factories are required.
- Choice of manufacturing location is crucial for the economic success.
- Location specific advantages and disadvantages influence module manufacturing costs and the costs of module transport to the final consumer.

→ Module manufacturing and transport costs are calculated considering location specific input data
→ **Analysis and ranking of manufacturing locations by costs**

Approach and Model

- Application and parametrization of cost model „SCost.Module“ by Fraunhofer ISE (Fig. 1) [2]

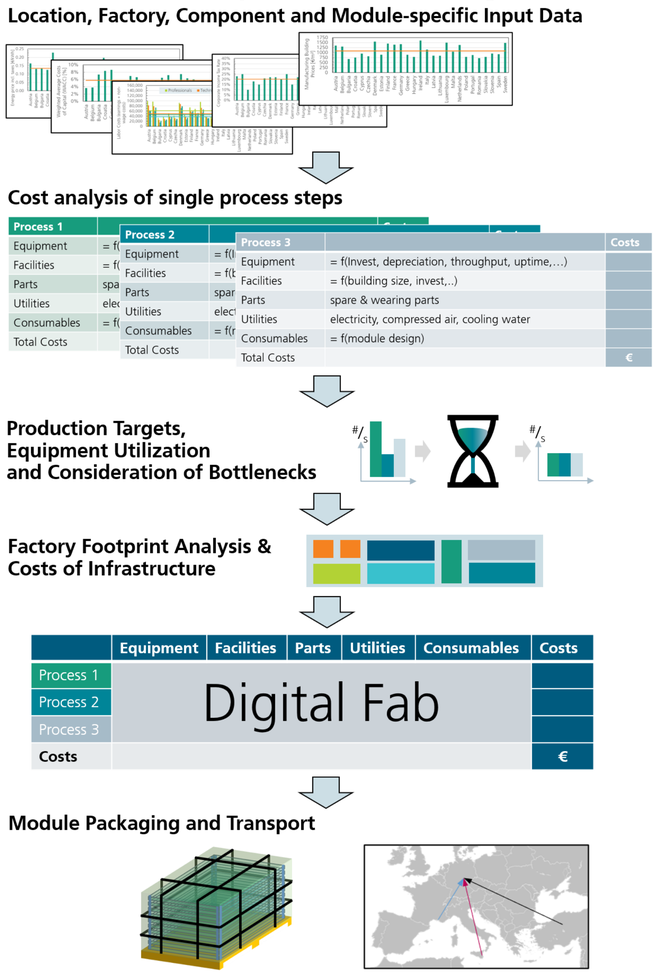

Fig 1: Structure of the SCost.Module Cost of Ownership model

- Analysis for a 5 GWp/a manufacturing (7200 h/a)
- Module material and equipment prices based on Asian prices
- 132x G12R half cell glass-glass module with 585 Wp
- Factory output is transported to the Top10 installer countries by their respective share in the total EU market [3]. Other countries are considered as destinations in equal proportions.

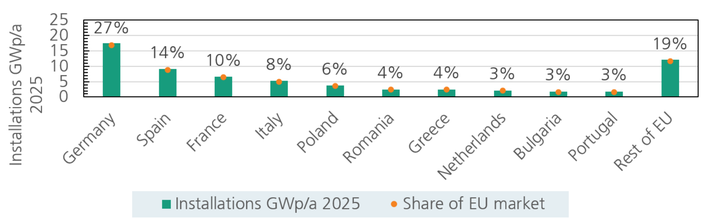

Fig 2: Destinations and their respective share

Input Data Manufacturing Cost Calculation

- Energy Prices

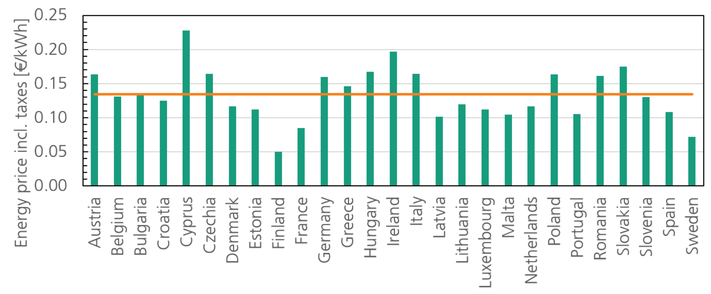

Fig 3: Energy Prices, 20-70 GWh/a, excluding value added tax, recoverable taxes and levies [4]

- Labor Costs

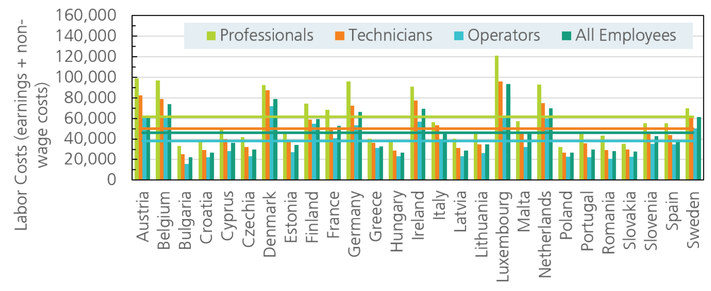

Fig 4: Annual earnings by occupation and non-wage costs [5]

- Leave and sick days

Fig 5: Total paid leave days and sick days [6]

- Costs of Capital

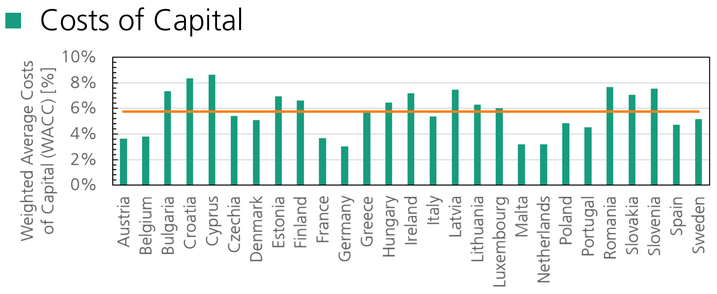

Fig 6: Weighted Average Costs of Capital (WACC) for renewable energy projects [7]

- Corporate Income Tax

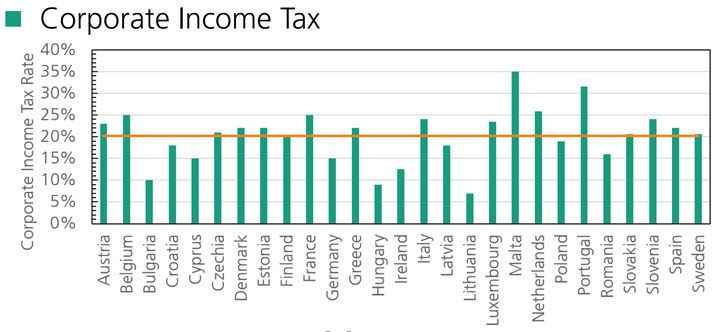

Fig 7: Corporate income tax [8]

- Costs of Buildings and Infrastructure

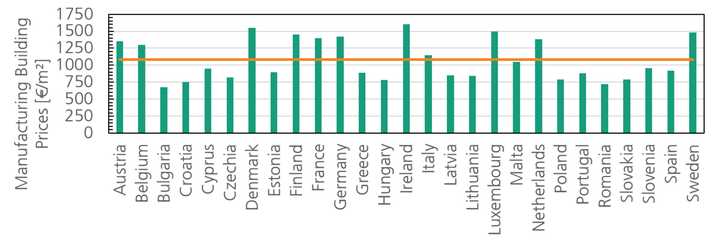

Fig 8: Construction costs for industrial buildings [9]

Transport Costs

- Transport costs calculated for transport of modules between geographical centers of each country [9].
- Packaging, insurance, capital costs and direct trucking costs are considered.
- Palette size optimized for 40t trucks: 738 modules on 20 palettes: payload limited by weight
- Individual trucking rates between each location are considered: direction of transport impacts results

Results

- Material costs dominate module costs with approx. 84% of total manufacturing (incl. SG&A)
- Smaller differences between locations in terms of location-specific cost factors (energy prices, leave days etc.): ±2.4% between sites
- Strong variation between locations in transport costs: between 5.2% and 18.7% of total costs

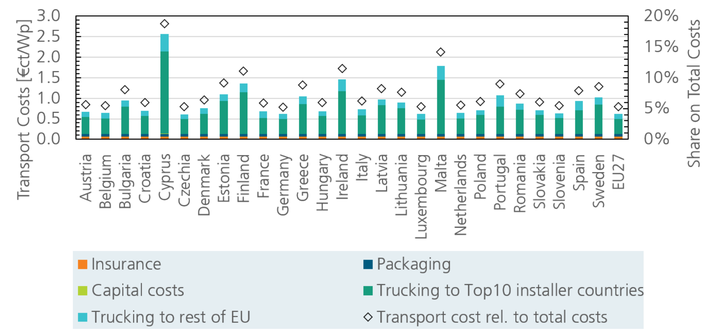

Fig 10: Total transport costs by manufacturing location

- **Material costs dominate site-specific parameters**

Location Ranking	Total Manufacturing						Total Costs		
Austria	21	22	5	4	20	20	**25**	15	**18**
Belgium	15	26	8	6	24	19	**22**	7	**10**
Bulgaria	16	1	26	23	3	1	**2**	19	**13**
Croatia	13	3	12	27	8	3	**8**	11	**2**
Cyprus	28	13	27	28	5	14	**24**	28	**28**
Czechia	23	8	10	13	15	7	**11**	4	**1**
Denmark	10	27	13	10	16	27	**26**	14	**20**
Estonia	8	11	9	20	16	12	**7**	21	**21**
Finland	1	20	2	19	11	24	**17**	27	**25**
France	3	19	4	5	24	22	**10**	8	**3**
Germany	19	23	11	1	5	23	**28**	2	**24**
Greece	18	10	28	15	16	11	**13**	24	**22**
Hungary	25	4	24	18	2	4	**14**	9	**7**
Ireland	27	24	22	22	4	28	**27**	25	**27**
Italy	24	18	25	12	22	18	**21**	13	**14**
Latvia	4	7	15	24	8	9	**3**	20	**16**
Lithuania	12	12	18	17	1	8	**5**	17	**11**
Luxembourg	9	28	16	16	21	26	**23**	3	**12**
Malta	5	16	20	3	28	16	**4**	26	**26**
Netherlands	11	25	18	2	26	21	**20**	6	**9**
Poland	22	2	17	9	10	5	**9**	12	**5**
Portugal	6	9	6	7	27	10	**1**	23	**19**
Romania	20	6	23	26	7	2	**12**	16	**15**
Slovakia	26	5	21	21	13	5	**16**	10	**8**
Slovenia	14	15	3	25	22	15	**19**	5	**6**
Spain	7	14	1	8	16	13	**6**	18	**17**
Sweden	2	21	7	11	13	25	**15**	22	**23**
EU27 avrg.	17	17	14	14	12	17	**18**	1	**4**

module location specific
transport parameters
not location specific (material costs + overheads)
EU27 avrg.

Fig 11: Ranking of EU27 PV manufacturing locations by site-specific manufacturing cost factors and transport costs (lower numbers = cheaper); Note: Majority of costs is not site-specific.

Summary

– Access to cheap components most essential for low module manufacturing costs.
– Consideration of transport costs is vital in choosing the manufacturing location.

References

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10 Mittag et al, “Analysis of transport costs structures of solar modules”, EPJ Photovoltaics, 2024

Link to Fraunhofer ISE contributions of the 43rd EU PVSEC 2026
https://ise.link/eupvsec2026

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