A Policy Framework for Promoting Local PV Manufacturing in Australia

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Decarbonizing energy systems by transitioning to more renewable energy to fulfil the world's energy demand will critically impact the climate change crisis. Continuing price reduction for solar energy use, which has resulted in a drastic increase in the PV installed capacity, will play a key role in leading to much cleaner energy systems, including moving away from fossil fuels to counter climate change. Therefore, most of the future carbon mitigation scenarios include ambitious PV installation for decarbonizing the grid and electrifying the energy sectors[1]. For instance, the International Energy Agency (IEA) estimates that 34% of the global electricity demand will need to be provided by PV if the world is to reach net zero emissions by 2050. This will require a 14-terawatt peak (TWp) of installed PV capacity by then. In other words, 630GWp annual installation is required to reach the IEA net-zero emissions scenario[2]. The concentration of PV manufacturing capacity in China and Southeast Asia on the supplier side creates a significant imbalance and insecurity in the global supply chain. To avoid another energy crisis and to boost healthy economic growth, nations are looking for options to develop their own PV supply chain with different business models and policy frameworks. In this study, we analyse different policy frameworks for promoting local module assembly in Germany and the USA. Then, we propose a policy framework for Australia based on economic optimization.

Review of Current Policy frameworks

To build up our policy framework, we have reviewed China, Germany and the USA policies for promoting local PV manufacturing. Figure 1 shows policy implications on PV manufacturing in candidate countries.

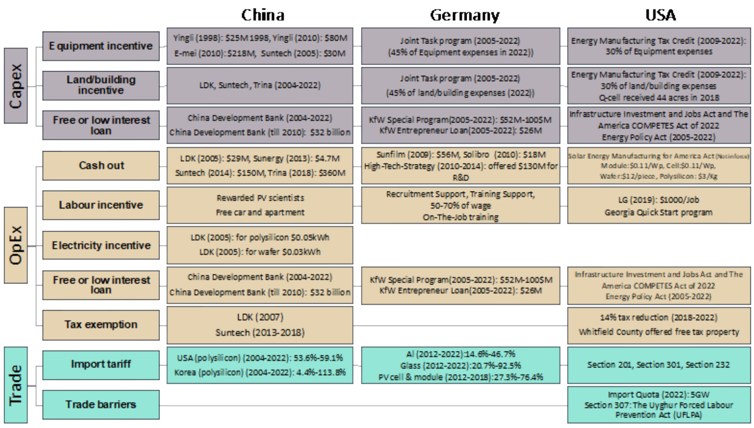

Figure 1 Policy implications in China, Germany and USA on PV manufacturing

Considering the relevant policies enacted by China, Germany and the USA has led us to notice that in China, the national government[1] develops broad strategic policies with few details and broad goals, whilst local governments reinterpret the policies in a more practical way with the aim of attracting manufacturers and building up tax revenues and jobs. The advantage of the Chinese approach lies in the flexibility of local governments to localize national programs to their particular contexts. However, any conflicts and misalignment between national and local governments can

[1] National level can be taken to mean federal level, while local level can mean state, province or county levels.

lead to challenges [3]. In contrast, the national government in Germany or USA has its strategic policies in detail. Moreover, in some cases, local governments in Germany and the USA provided extra incentives for local manufacturers. Nonetheless, the current signed-in-to-law policy in the USA, the inflation reduction act of 2022, is based on the direct cash per unit model.

Methodology

In our study, we use mixed-integer linear programming (MILP) to model the entire supply chain of local PV module assembly by importing input materials and making modules locally. By adding uncertainty to parameters, we apply Monte Carlo analysis to the model. After 1000 iterations, the results were segmented into the 10^{th} percentile as the lower bound, the 90^{th} percentile as the upper bound, and the median. We first run the model for Germany and the USA module assembly with their current policies. A 600MWp production capacity is considered. Then various policy mechanisms (Table 1) are applied to the Australian market.

Table 1 Policy mechanisms employed in this research

Policy Group	Policy	Impacts
Supportive	Incentive on CapEx	Equipment expenses
	Free land	Facility expenses
	Incentive on OpEx	Minimum Sustainable Price (MSP*)
	Incentive on labour	Labour cost
	Incentive on electricity	Electricity cost
	Tax exemption	IRR
	Interest -free loan	WACC
Protective	Selective import tariff	Input materials expenses or imported PV module price
	Non-selective import tariff	Input materials expenses and imported PV module price
	Import quota	Import capacity of input materials or imported PV module
	Trade embargo	Import capacity of input materials or imported PV module

* It is defined as the minimum cost per module that results in an IRR equal to the manufacturer's cost of capital[4].

Finally, the best policy mix for Australia by examining the financial measurements such as internal rate return (IRR) and sustainable growth rate (SGR) is proposed. For local PV module assembly, we assumed all of the required input materials and PV modules were imported from China. The required input materials are cells, glass, aluminium (Al), EVA[2], backsheet, junction box and others.

Results

- **Germany**

A 600MWp/year production capacity is about 12% of the total PV installed capacity in Germany in 2021. Current policies for local PV manufacturing in Germany are as follows:

- KfW special program: an interest-free loan
- Labour incentive: 50-70% of the wage
- Joint Task program: 45% of equipment
- Joint Task program: 45% of land/building

Since there is no data on supporting land/building, we assume the same incentives on equipment apply to land/building expenses. After 2018, the only enforce import duties are on glass and Al. Import tariffs on glass range from 21% to 92%, whilst Al import tariffs are from 15% to 47%. Without any incentives, for a 600MWp PV module production in Germnay, where we import all of

[2] Ethylene Vinyl Acetate

the required input materials, our results show the minimum sustainable price (MSP[3]) would be USD 0.39 Wp, on average, for 2022. Importing PV modules direct from China cost around USD 0.32 Wp and consists of the PV module average selling price (ASP)[4] and related logistic costs for shipping the completed module. Figure 2A shows the price gap between the local PV module assembly and the imported PV module. The required capacity to make local PV manufacturing, without incentives, competitive in Germany is 2GWp on average (Figure 2B).

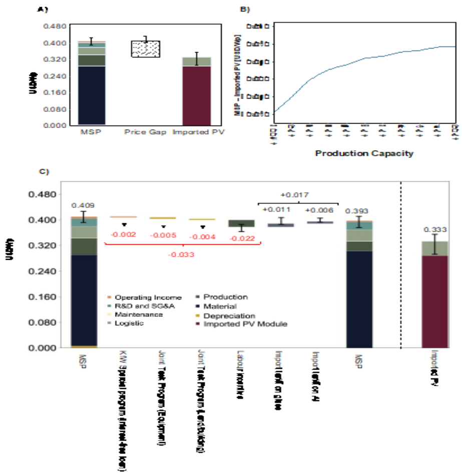

Figure 2 Local PV manufacturing in Germany A) price difference between imported PV modules and locally assembled B) required capacity for making local manufacturing competitive C) impact of current policy in Germany on local manufacturing

Our results on enforced policies in Germany show for 600MWp module assembly these policies fall short to bridge the price gap (Figure 2C).

- **USA**

While the USA PV market is much larger than Australia and Germany, a 600MWp production capacity is used to make a fair comparison. This hypothetical PV module assembly centre would account for approximately 2.5% of the PV market in the USA[5]. Figure 3A shows the price gap in the US market is USD 0.066 Wp. To make local PV manufacturing competitive in the US market, the production capacity should reach at least 1.6GWp per annum.

[3] MSP is a minimum sustainable price so that the return on capital expenses (equity and debt sources), or IRR = Weighted Average Cost of Capital (WACC).

[4] PV Average Selling Price is USD 0.289 Wp

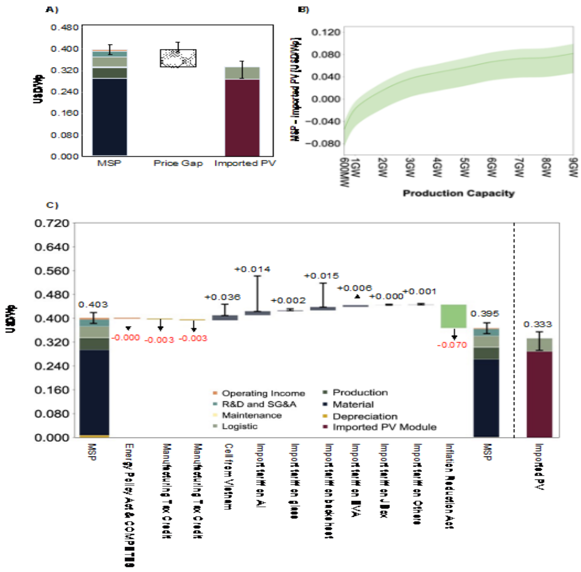

Figure 3 Local PV manufacturing in the USA A) price difference between imported PV modules and locally assembled B) required capacity for making local manufacturing competitive C) impact of current policy in the USA on local manufacturing

The main supportive policies in the US market are interest-free loans, Manufacturing Tax credits and the Inflation Reduction Act. The manufacturing tax credits provide a 30% incentive on equipment and land/building facilities. As can be seen in Figure 3C, although the Inflation Reduction Act drops the cost significantly by USD 0.07 Wp, the import tariffs on input materials make this policy inefficient. The import tariffs increase the MSP at least by USD 0.04 Wp.

- **Australia**

The Australian PV installed capacity in 2021 was about 5GWp. A 600MWp module production per year can translate to around 12% of the market. Since there is no specific promoting policy for local PV manufacturing in Australia, we analyse the impact of different incentives. Figure 4 shows 600MWp local PV manufacturing conditions in the Australian market. The required capacity for Australian local manufacturers to be competitive is 1.6GWp (Figure 4B), which is about 38% of the market.

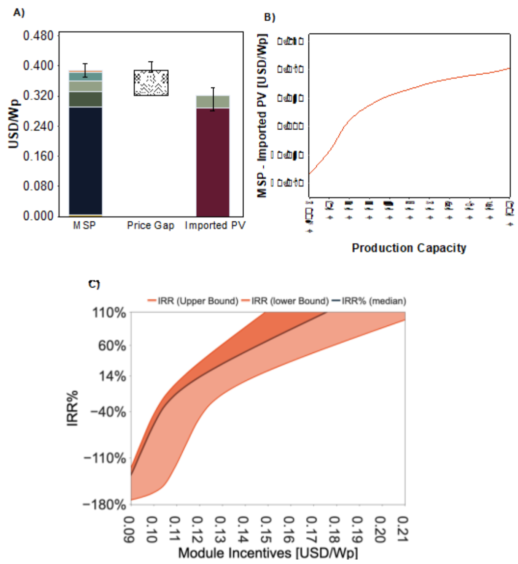

Figure 4 Local PV manufacturing in Australia A) the price difference between imported PV modules and locally assembled B) the required capacity for making local manufacturing competitive C) the impact of module incentive on local manufacturing

Figure 4C shows the impact of module incentives on IRR%. As can be seen, around USD 0.12 Wp is needed to result in enough return on investment for competitive local manufacturing. Figure 5 shows different scenarios for combinations of incentives. Scenario 0% presents incentives only on modules. As can be seen, Scenario 0% requires the highest cash support over 7 years and results in 24% SGR%

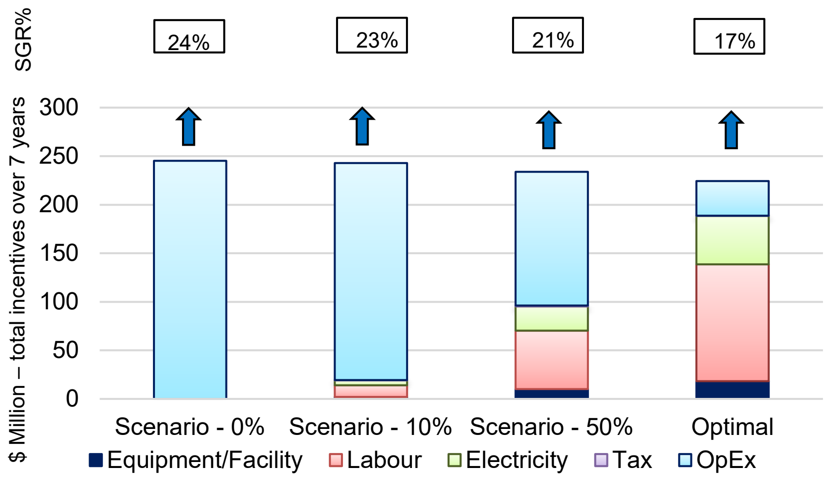

Figure 5 different incentives impact on promoting local PV manufacturing in Australia for 600MWp module assembly

Scenario 10% shows, to bridge the price gap, if we incentivize 10% of labour, electricity, tax and CapEx and support the rest of the price gap by module incentives, less cash support over 7 years is required. The optimal results happen when we inject less direct cash into the modules as can be seen in the Optimal scenario in Figure 5.

Reference:

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[5] Wood Mackenzie, Solar Energy Industries Association. Solar Market Insight Report 2021 Year in Review. 2022.