

Spatial re-localisation in global production networks: a path creation perspective of Solar Panel Industry in Malaysia

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Introduction

- There is a renewed interest in what is called “Green Industrial Policy”
- Indeed, specific regional economic corridor development is placed to develop this specific industry e.g. Sarawak Corridor of Renewable Energy (SCORE).
- It requires undergoing structural change moving into new green industries that could address environmental externalities and promote green technologies
- Nevertheless, what is less clear is how countries build this new path
- We, therefore, take Malaysia as the case to understand how the changes in industrial structure occurred and what it takes to do that.
- We situated this within the context of Solar Panel Industry

The Country Context

- Malaysia is a small open economy (GDP per capita: 11,095; Population: 31.6 million; average growth 4.5-6%)
- Its past success is mainly attributed to its success in transforming its economy activities – making the needed structural change – via the industrialization process - export oriented industrialization strategies
- In the process, FDI and MNCs activities played a critical role
- Specifically, the largest being semiconductors and electronics components industry (2018: E&E contributes 38% of the total exports; trade surplus of 120bil)
- Malaysia is the third largest solar panel exporter after China and Korea

The Aim

- The aim here is to understand how the solar panel industry has evolved in Malaysia
- In doing so, we were interested in investigating and understanding how institutions have had played a role in shaping and building the solar panel industry - we take more of an institutional-centered focus, and organizational learning .
- Why? Existing literatures solely focus on lead firm – but yet little is know on how the environment and institutions within which they operate shapes them.
- We call this the “invisible hand” that cannot be captured by formal modeling approach but rather by building narratives for policy lessons. Its also a dynamic process that evolves over time and space.

Methods and Framework

- We observed the firms for the past 9 years (from 2010-2019); including institutional and policy changes.
- Interviews, Focus Groups & Surveys (Policy makers, Firms, Institutional Agents)
- It helped us build the “narrative” in understanding the complexity of institutions and industrial development
- Specifically, we were interested to see how the so called “path creation” (which includes “path dependence”) helped shaped the spatial re-localization and the learning process.
- Framework – GPN and GVC, combining institutional perspective and organizational learning

Some Concepts

GPN – the relational framework was attractive in many forms in that it encompasses various actors, the so called network, in understanding the relational dynamics – the interconnected operational functions and transactions.

GVC – focuses on the value chain within the industry and the governance structure that shapes the value chain. Its dominant emphasis is on lead firm that poses adequate capabilities to fully organize, coordinate and manage the value chain governance in various geographical spaces.

Path Creation - consist three moments of time path (past), the present and the creation (future).

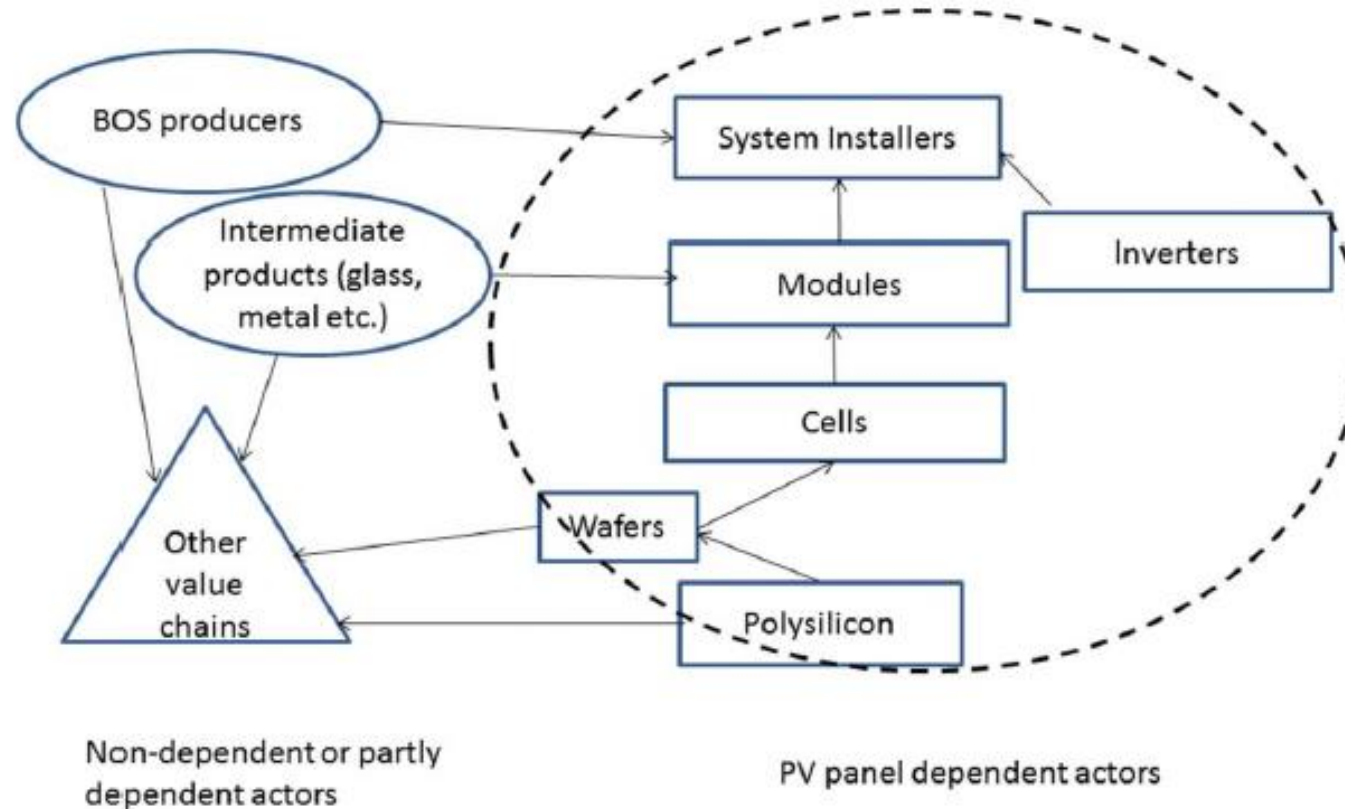
Institutions –consist of (1) Formal rules (constitutions, laws, property rights), and 'Organisational forms of institutions (groups bound by some common purpose to achieve objectives)

MNC, Industrial Development Path, and the Solar Panel Industry

- In studying MNCs activities – we moved from motives of internationalization (Dunning; 1993, 2000) to that of Global Production Network and Global Value Chain.
- Recently, GPN framework brought together the complexity in analysing the relation - it requires one not only to look into the linear relations but also in many other directions.
- Likewise, the GVC perspective is more restricted in a sense that it sees the network or more profoundly the so-called “governance structure” to understand the inter-firm relationship.
- With more data made available – scholars are exploring the nature of GPN and GVC
- Nevertheless, what is missing is the in-depth account of how institutions shape the GPN (including GVC governance) and vice versa– from the path creation perspectives

The Context – GPN of Solar Panel Industry

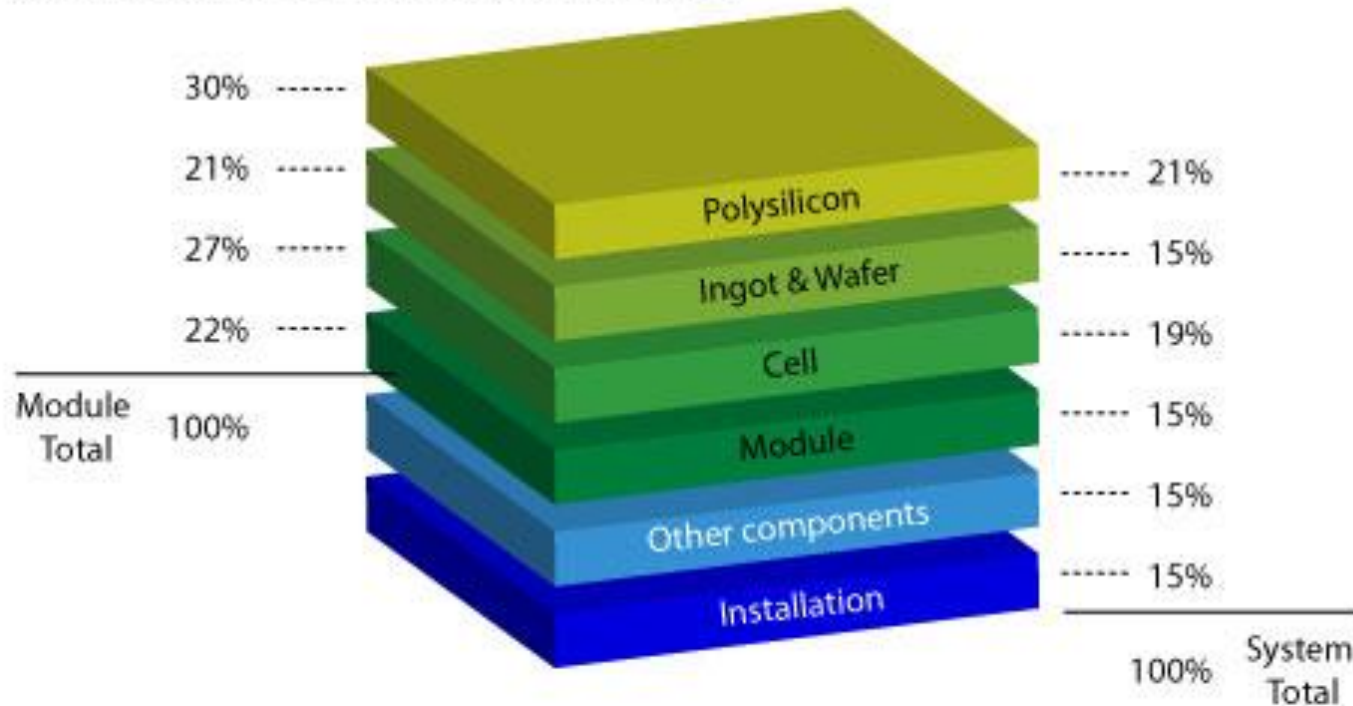
First, it is important to understand the GPN of Solar Panel Industry



Source: Louise Curran (2015)

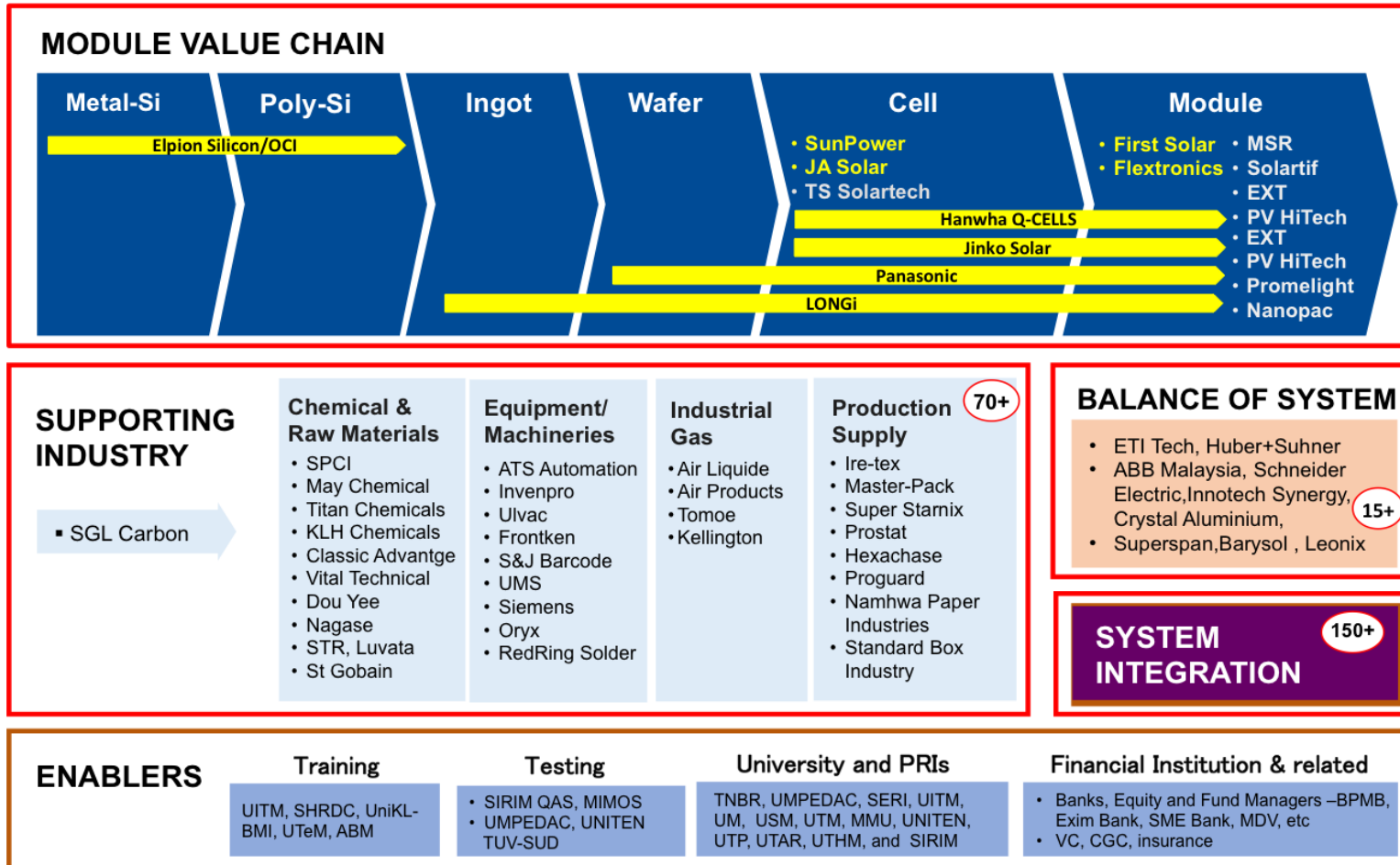
Who captures the value within the GPN?

The Photovoltaics Value Stack (Crystalline Silicon)



It is important to understand that, even if all of the inputs and the panel itself comes from one firm/country, half the added value can still be for others.

Solar Panel Value Chain and its players in Malaysia



Most companies are partially vertically integrated in order to capture more stable value. As the whole industry develops, vertical integration becomes more feasible.

However, no group covers the whole value chain, whilst there are many highly specialised companies upstream and in the more service-oriented downstream segment.

Source: Compiled by author based on MIGHT (2015) and Interviews

Production Capacity

Table 1. Products and production capacities of key players

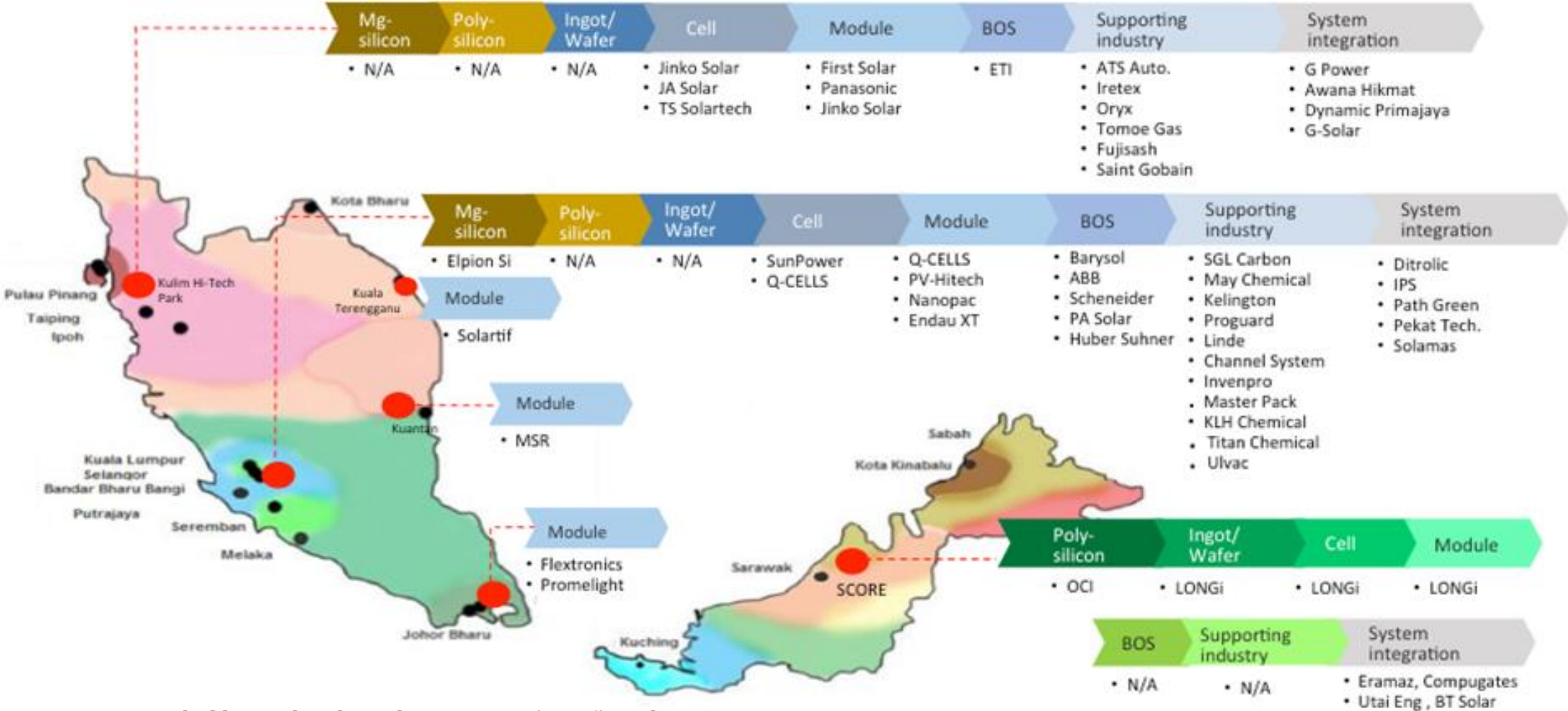
Company	Product	Product type	Annual production capacity 2017	
			Malaysia	Other AMS
Elpion Si	Metallurgical silicon		33,400 metric tonnes	
OCI	Poly silicon		16,000 MT by end of 2018	
LONGi	Ingots	Mono-crystalline PERC	1GW by end of 2018	
	Wafers		1GW by end of 2018	
	Cells		700MW by end of 2018	
	Modules		900MW by end of 2018	
Panasonic	Wafers/cells/modules	HIT N-Type Mono-crystalline	430MW	
Hanwha Q-Cells	Cells	Mono and multi-crystalline	1.9GW	
	Modules		1.8GW	
Jinko Solar	Cells	Multi-crystalline	1.3GW	
	Modules		450MW	
Trina Solar	Cells	Multi-crystalline PERC		Thailand: 700MW
	Modules			Thailand: 500MW

Company	Product	Product type	Annual production capacity 2017	Other AMS	
JA Solar	Cells	Multi-crystalline	500MW		
SunPower		N-type Mono-crystalline	745MW		
TS Solartech		Mono and multi-crystalline	550MW		
Yingli Solar	Modules	Multi-crystalline			Thailand: 500MW
First Solar		CdTe thin film	3.6GW by end of 2018 (Including 1.2GW from one new S6 factory)		Vietnam: 2.4GW from two S6 factories by end of 2019
Nanopac	Modules	Nano-material thin film	12MW		
Flextronics		Crystalline	900MW		
Solartif		Multi-crystalline	80MW		
			5MW		
Malaysian Solar Resources		Mono and multi-crystalline	100MW		
			200MW		
Promelight					

Notes: Almost all of Malaysia's production is for export purposes, as Malaysia's domestic market is small; Trina Solar's and Yingli Solar's products in Thailand are targeted at export markets in Europe, US and Japan; First Solar's products in Vietnam are targeted at the US market.

Source: Compiled by author based on MIGHT (2015); PV-Tech, 2018; IEA-PVPS (2018); and PV-Magazine (2018).

Key players and geographical locations



Source: Compiled by author based on MIGHT (2015) and Interviews

Why MNCs relocate?

- Technology relatedness - E&E
- Resources
- Markets (not domestic markets)

Ownership and spatial re-localisation

Chinese Firms – purely markets; anti-dumping; Asia Pacific (Entry Mode – M&A and new investments)

Japanese firms – Technology relatedness; history (New Investment)

US Firms – Technology relatedness; history (New Investment)

Korean Firms – technology relatedness (M&A)

Development of the Industry Value Chain – Institutional Path Creation Perspective

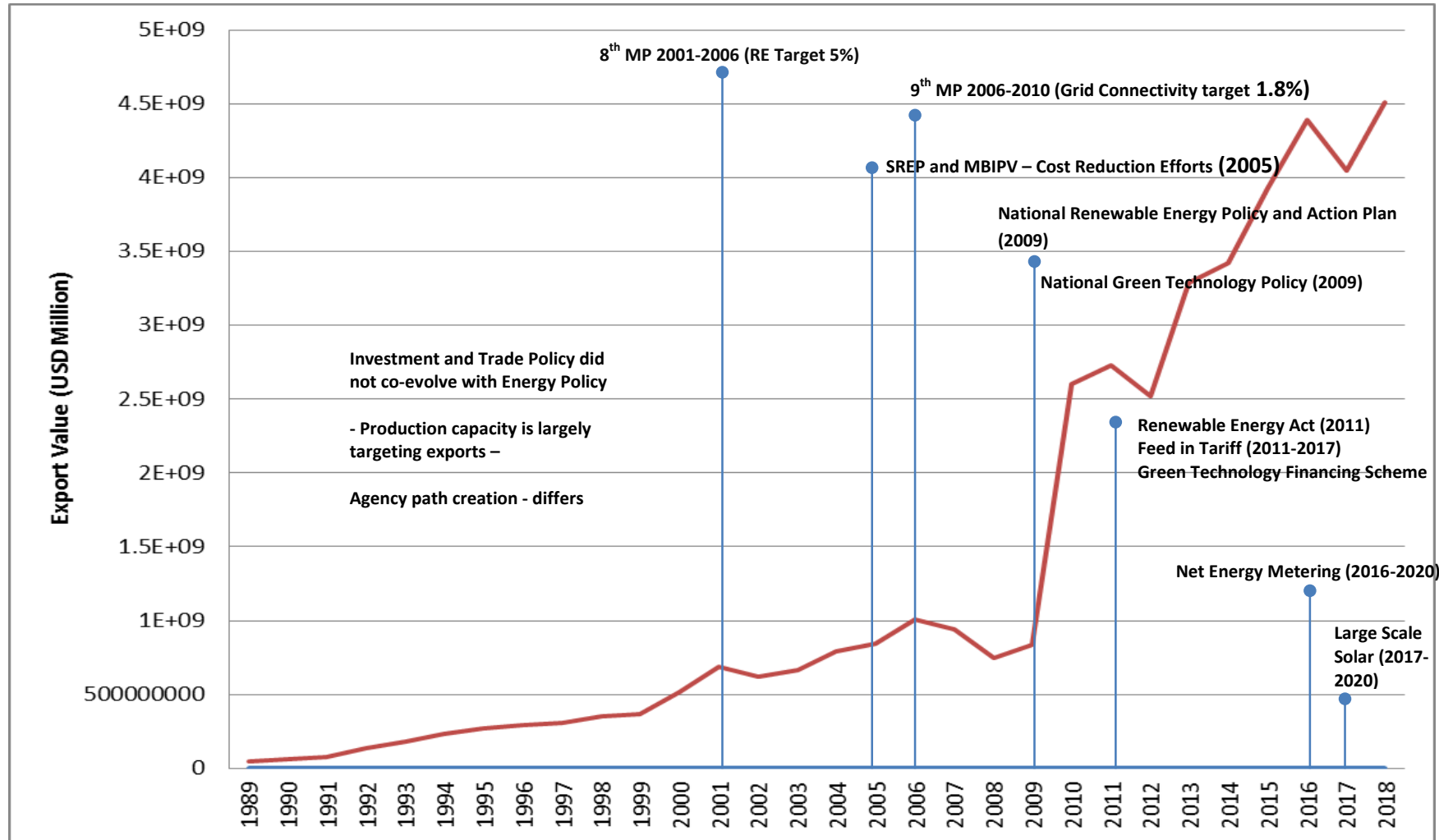
Institutional co-evolution enabled path development and creation of the solar industry

- Experimentation of Energy Policies and Instruments (started from 2004)
- Investment promotion board – experience of E&E industry provided them the niche to make strategic decision in shaping the institutional settings:
 - Selective mission driven targets – ensuring ecosystem completeness
 - Coordination of related key policies and regulatory instruments (well coordinated efforts on R&D, Human Capital with that of Investment Policy)
 - And, establishment of targeted incentives and framework.

Aimed is to achieve eco-system completeness:

- They also avoided government national interest projects moving into upstream activities – due to bitter experience of Siltera – a wafer plant experience for the E&E industry
- Understood the implications of scale; policy complementary (Investment, Trade, Human Capital and R&D)
- However, what remained weak in this path creation is the:
 1. Weak link between energy policy and trade policy (in some aspects) limiting the industrial path creation.

Malaysia, Exports of Solar PV, 1989-2018



The schemes help build local capacity and capability specifically the BOS and System Integrators segments
 The link between upstream and downstream is distorted by the export oriented industrialization strategies which requires firm to solely export.
 The exporting capability expended to services and goods by BOS and System Integrators.

Source: Comtrade; HS 854140 (Export data); Author

Balance of System and System Integrators Path Creation

How these industry emerged: The role of Institutions

- Technological relatedness – many were suppliers within the E&E sectors
- Malaysian Building Integrated Photovoltaic Project (2007-2011) – Government started the first solar – capital subsidies for PV industry; then after 2009 various institutional path creation
- FiT policy – provides avenues to venture into new forms of industry – this was particularly easy – because of self-discovery was relatively easy with their existing capabilities – e.g. using one set of skills and capability and moving into different product space.
- When the subsector become profitable – extractive institutions emerged and we observed rent seeking behaviour limiting the productive firms to move further – limiting their path creation
- Energy policy – they are subjected to energy generation, distribution and supply licensing conditions - which is a complicated process
- One clear obstacles are the National Energy Company – Tenaga Nasional – grid connectivity; interest of National firm; independent power producers.

Trade Policy and Path Creation

- Trade policy (an institutional environment) has not been adequately analyzed in the literature of GPN and GVC.

Liberalization brought in substantial gains for the country but our study shows some of its limitations, having different implications within the GPN and GVC.

(1) Export Processing Zones – traditional approach for export oriented industrialization strategy – Limits of EPZs – it affects downstream activities differently

- It limits the interaction between module, cell and BOS and system integrators interactions
- BOS and System Integrators – limits experimental and incremental innovation

(3) Tariffs – Reduction of tariffs had various implications – neglected tariff rates at component levels that interact with the final product (While the tariffs for panels are 0%, the rates for key solar PV components like batteries, cables, fuses and breakers, and surge protection devices are all above 15%).

(4) Anti-dumping – and the relocation efforts of the Chinese Manufacturers – Emerging market MNEs implications? - GPN restructured

MFN Tariff Rates (Solar Panels)

HS Code	Product	BRN	CAM	IND	LAO	MY	MYA	PHL	SGP	THA	VNM
840410	Auxiliary plant for use with boilers of headings 84.02 or 84.03	0	0	6.7	10	2.5	1	3	0	5	0
840290	Boilers; parts of steam or other vapor-generating boilers	0	15	5	10	5	1	4	0	5	0
841919	Other non-electric water heaters	0	0	7.5	10	2.5	1	1	0	10	10
854140	Photosensitive semiconductor devices, including photovoltaic cells, whether or not assembled in modules or made up into panels; light-emitting diodes	0	7	1	5	0	7.5	0	0	0	0
730820	Towers and lattice masts	0	7	12.5	5	15	1.5	6.5	0	10	4
850231	Wind-powered electricity generating sets	5	0	10	5	0	1	1	0	10	0
841011	Hydro-turbines of a power exceeding 1000 kW but not exceeding 10,000 kW	0	0	0	5	5	0	1	1	0	0
841012	Hydro-turbines of a power not exceeding 1,000 kW	0	0	5	5	0	1	1	0	0	0

MFN Tariff Rates (Components)

HS Code	Product	BRN	CAM	IND	LAO	MY	MYA	PHL	SGP	THA	VNM
850440400	PV Inverters	5	7	10	5	0	1	7	0	10	0
854140000	Solar power panels	NA	NA	NA	NA	0	NA	NA	NA	NA	NA
850780900	Photovoltaic cells	NA	NA	NA	NA	20	NA	NA	NA	NA	NA
853540000	Surge protection devices	5	15	5	5	0	1	1	0	10	0
853630910		NA	NA	NA	NA	15	NA	NA	NA	NA	NA
853620990	Fuses and breakers	5	15	5	5	0	1	5	0	10	15
853521900		5	15	5	5	15	1	5	0	10	3
903289100	Charge controllers	5	15	5	5	0	1	1	0	10	0
854420100	Insulated wire, cable and other insulated electric conductors	NA	NA	NA	NA	30	NA	NA	NA	NA	NA

Institution and Lead Firms – Path Creation

- We find the causal relations to be bidirectional – and not unidirectional
- Equally important is to recognize that lead firms can also shape institutional path creation,
- Lead firms, in the upstream segments, have tremendous power relations to shape institutional path creation – via various channels – therefore, institutional construct may not be exogenous in nature by itself.
- They have direct ties to relevant agencies (mostly investment related) and they form industry associations (or specific groups). However, what we observe is that they have less inclination to relate to other actors that shapes technology and product space (e.g. institutions that relates to shaping technology policy, R&D and others – mostly engage with domestic firms).

What shapes the intensity of interaction between actors and institutions?

- Ownership – next slide

Ownership and institutional path creation

- US and Japanese firms, due to its long history, developed more power relation to influence the institutional path creation.
- The Chinese, who is relatively a new comer, are continuously searching to understand the institutional path creation and ways to influence them
- Given that businesses are largely owned by the ethnic Chinese in Malaysia, the mainland Chinese were able to connect easily with other firms but not with institutions.
- They are in the process of understanding the institutional environment and how it operates in Malaysia – Indeed, they have to deal with the socio-culture dimensions given the negativity portrayed on them.

The power struggle – shaping the institutional path creation (Future)

- Independent system integrators – focuses on roof tops in generating energy – thus FiT and NEM becomes the policy choice – with grid connectivity
- They also try to shape the institutional environment via creative policy choices – e.g. peak demand management.
- Independent energy producers – solar farms – given their existing power relations, they seems to be in a better position to shape the future institutional factors – third wave of large solar farm scheme is launched.
- Indeed, National Energy Company – interest may distort the whole market. The arrangements seem to be that the independent solar farms generate energy and have it sell to the National Energy Company – given that it owns the grid and infrastructure – this decision is more political than economics

Institution and Industry Path Creation

We always assume that policy is exogenous – as a shock to industry path creation

Nevertheless, its nature is more dynamic than what we previously thought –

- Initial stage – policy acted as exogenous factors as: in correcting market failures e.g risk, uncertainty, promoting investments in new industry
- However, when the industry matures – it moves to alter the institutional path creation – altering the position of future policies. Here institutions becomes endogenous – and its important that institutions evolve
- Policy makers realize the potentials – creating new institutional path
- The institutional path creation is a cycle rather than linear process

GVC configuration – shaped by path dependence

A detail mapping of sourcing activities indicates that GVC is shaped by its path dependence – mainly the capacity and capabilities of the firms supporting the E&E.

The lead firms sourcing activities shows the following pattern –

- Sourcing largely – depends on imports – but equally local sourcing emerges in certain areas.
- Local sourcing occurred in areas in which Malaysia has already build its capacity and capability in the past due to strong presence of supporting industry for the E&E sectors.
- They, typically, support the wafer, cell and module segments.
- Top Management Composition of the lead firms alters this relationship – e.g. Local MD vs. Foreign MD; ownership structure.
- Continuous searching occurs – due to competition (Lobbying government by establishing the notion of local content effect

GVC – Is shaped by path dependence

Module value chain	Category	Products of support industry	Source	
			Local	Imported
Mg-Si	Raw materials	Quartz		○
		Petroleum core		○
		Charcoal		○
		Woodchips	○	
	Consumables	Electrodes	○	○
		Parts and components	○	○
Equipment	Furnaces		○	
Poly- Si	Raw materials	Mg-Si		○
		Chemicals	○	○
		Industrial gases	○	○
	Consumables	Parts and components	○	○
	Equipment	Poly-Si processing system		○
Ingot	Raw materials	Poly-Si		○
		Chemicals	○	○
		Industrial gases		○
	Consumables	Parts and components		○
	Equipment	Ingot pullers		○
Wafer	Raw materials	Ingots	○	○
		Chemicals	○	○
		Industrial gases	○	○
	Consumables	Parts and components	○	○
	Equipment	Wafer-slicing machines		○
	Production support	Packaging	○	
		Electrical projects and services	○	
		Assembly, logistics, servicing and maintenance	○	○

Module value chain	Category	Products of support industry	Source	
			Local	Imported
Cell	Raw materials	Wafers	○	○
		Gas	○	
		Metals	○	
		Soldering wire	○	
		Chemicals	○	
		Inks		○
	Consumables	Targets	○	
		Screens		○
		Parts and components	○	○
	Equipment	Semiconductor processing		○
	Production support	Injection-moulded plastics	○	
		Rubber gloves	○	
		Office supplies	○	
		Safety equipment	○	
		Plastic packaging	○	
		Rack forms	○	
		Polyester tape	○	
		Packaging	○	
	Facility service	Waste water treatment	○	
Electrical projects and services		○		

GVC – Is shaped by path dependence

Module value chain	Category	Products of support industry	Source	
			Local	Imported
Module	Raw materials	Cells	<input type="radio"/>	<input type="radio"/>
		Al frames	<input type="radio"/>	<input type="radio"/>
		Glass	<input type="radio"/>	<input type="radio"/>
		Encapsulants	<input type="radio"/>	
		Silicon	<input type="radio"/>	
		Back sheets		<input type="radio"/>
		Wiring		<input type="radio"/>
		Junction boxes		<input type="radio"/>
		Cord plates	<input type="radio"/>	
		Adhesives	<input type="radio"/>	
		Gas	<input type="radio"/>	
		Chemicals	<input type="radio"/>	<input type="radio"/>
	Equipment	Injection-moulded plastics	<input type="radio"/>	<input type="radio"/>
		Fabrication/jigs/fixtures	<input type="radio"/>	<input type="radio"/>
		Equipment and parts	<input type="radio"/>	<input type="radio"/>
		Module-processing machines		<input type="radio"/>
	Production support	Packaging	<input type="radio"/>	
		Pellets	<input type="radio"/>	
	Facility support	HVAC/water treatment	<input type="radio"/>	
		Assembly, logistics, servicing and maintenance	<input type="radio"/>	<input type="radio"/>

Financial and Industrial Path Creation

- Malaysia has little experience with Financial Policy to tackle the path creation of green industry
- Weak green technology risk assessment system among the financial institutions – limits the financial access that is critical for the Solar Panel Industry Development
- Positioning the financial system to function for renewable energy sector is crucial
 - Green Technology Financing Scheme
 - Green Sukuk – Green Islamic Bonds

The nature of path creation

1. GPN and GVC is restructured by strong presence of institutional path creation – often embedded from their past experiences
2. Firms take multiple strategies to upgrade and spatially re-locate and the decision also depends on institutional setting – it has implications for catch-up/upgrading theory.
3. Institution and firm path creation are dynamic. They also strongly related to each other at various degree.
4. Success of the institutional path creation is subjected to dynamic coordination between agencies - wider array of actors and multiscalar institutional contexts.

THANK YOU