Chapter 7 – Conclusion

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Research work is concluded with summary of following findings, as learnt by researcher during the research work. To put forward more effectively, conclusions are divided into six broad headings, more relevant in context of Bangalore and largely may be applicable to Indian solar equipment suppliers industry. Since solar industry is national industry, it is difficult to only restrict to Bangalore region based on players considered and their national wide approach.

7.1 Global Demand & Supply with reference to Indian solar industry

Research concludes that solar supply chain, in any part of the world, is tightly linked to demand and supply situation, across the globe. Following points detail out the findings.

a) Local solar equipment industry need a wider scanning, across global sources and demand, for solar equipments, to create plan cost effectively and efficiently, to have better supply chain surplus, irrespective of intended consumer location in any part of the world.

b) There is large mismatch between capacity and demand of solar equipments in some countries, especially solar cells and modules, which decides flow from large capacities and inventory pools to country in which there is high demand.
Difference in capacity and consumption of solar equipments, leads to price fall across the globe, where prices are lowered to an extent that local manufacturers are hardly viable. China proved to be a major solar capacity hub for world offering solar cells and modules at lowest price and easiest availability.

c) There is a co-relation between Chinese module price and their share of solar market acquisition in an aggregated global market demand. This share has continuously increased in favor of Chinese solar players, as prices have fallen for solar modules produced in the country.

d) Price, ease of availability, competitive quality and technology available globally, are driving forces for supply chain planning and procurement decisions in favor of these low priced and high capacity countries. Among all such forces, primary force is price, pulling global procurement from these countries.

e) Solar equipment suppliers are facing high capacity and inventory challenges for their domestic products from imported sources. The reasons for such alternates are price, availability and competitive quality and technology. These players have a high confidence to have reliable supplies from imported source with the help of excess stocks and availability, as compare to their local suppliers. Time of transportation of 4 to 10 weeks, from such a low priced country, to a destination country of consumption, is hardly able to influence on-time-availability, from high capacity and high inventory stocking players abroad.

f) Major import of solar equipments or raw material is being procured from China, thus dependency of prices from China and risk of foreign exchanges is increasing, for domestic importers, exposing them to substantial financial risk.

g) Global solar inventories are increasing from year 2010 till now. There is expected to be a discouraging pressure on domestic solar cells and module manufacturers, being small in installed capacity base. The reason for such pressure is easy accessibility of global inventory to procurement and planners, at the place of requirement.

h) Domestic and some global solar manufacturers have recently shut down or underutilizing their capacities. These players are trying to make these capacities available to solar companies across the globe to utilize cost effectively.
Equivalent months of inventories from running manufacturing sources are continuously increasing despite such manufacturing capacity shut down.

7.2 State support, creating primary solar energy demand in country

State (National or state level) are a major force boosting solar power growth in India through their multiple support programs sponsored by governments. Following points detail out the findings.

a) In solar industry, demand driver are prominently state support in the form of feed-in-tariff, capital financing, REC or tax holiday or a combination of more than one, depending on schemes. JNNSM has put forward a comprehensive support structure for development and deployment of solar power in the country, along with multiple state level policies.

b) State policy support is a critical parameter to decide promotion of solar energy in a country. Better state supported countries have more demand of solar energy deployment. Source and destination of solar energy equipments is decided by level of support offered by state from a comparative perspective. A higher support to solar manufacturing in one country makes it a strong source of solar equipment supplies to other countries where support from local state is meager on a comparative basis.

c) Domestic state support on a particular type of solar technology indirectly promotes non-supported solar products, available at a lower cost without subsidy. As in India, deployment of solar thin film based solar PV deployment took place in much larger volumes, in Phase-I (Batch-I) of JNNSM even though it was not supported by state. During this phase support was not being offered to thin film technology based solar projects. In Phase-1 (Batch-II) onwards both the solar technologies were included under support program as a corrective action to make state support technology neutral.

d) Even though solar industry is growing at fast pace, say 35% of CAGR, growth rate of domestic solar manufacturing is sluggish. State (through MNRE) has
launched program to promote domestic solar manufacturers, by providing level playing field, at par with internationally low price manufacturers. Solar project developers have to buy domestically manufactured solar equipments under DCR requirements, to give boost to domestic solar manufacturers.

e) Significance of natural demand factors, arising out of inherent customer need, is weaker than state supported demand. Growth of solar sector in India is attributed to support program run by central and state governments.

f) Solar products have a large natural demand in rural market. Demand for solar products is growing at a faster pace, replacing kerosene usage, which in unclean fuel, used in country. Therefore solar products have comparatively large natural demand as compare to solar projects. Unfortunately high initial cost and less affordability by needy rural customers is still causing distortion in natural demand of solar products. Rural consumers wait for subsidy or micro financing by various state schemes to convert their need into a demand for a solar products.

7.2 Solar Industry planning complexity factors (Planning Width)

Planners keep a watch on the solar state support policies and regulations, as announced from time to time. Watch on solar state policies and their enforcement process are intended to consider in their planning and procurement source. Planners begin visualizing decision for a source of solar material procurement, depending on visibility of the state support policies horizon. Source decides lead time to procure material against an order on suppliers. In turn, back end time calculation is done for an order placement, to receive the material at the time of requirement. A material arriving before, causes inventory and liquidity concerns, whereas a material reaching late causes project delays. Both are sub-optimal outcomes for a solar firm. Chief causes of planning iterations are change in visibility horizon of state support policy and anticipating of exact order placement time, to receive material on time. Some fine point conclusions are as follows.

a) Planners have to be cautious in deciding whether to increase module/cell production capacity or not. Other alternates are use of domestic contract
manufacturing or source from Chinese suppliers. Manufacturing capacity additions can lead to capital at risk, in the event of procurement from domestic manufacturing is not supported by state or an unviable cost of production. Reason for non-viable cost of manufacturing is lowest price availability from China. Visibility of demand through state supported are not beyond two years of horizon in one go.

b) Delay and withdrawal of subsidy from solar roof top projects is causing multiple planning concerns in the event of delay or withdrawal of subsidy, after customer has agreed to put up solar plant. There is a trend of gradually reduction in state subsidy. Two contradictory forces are working at the same time, one side investors are waiting for subsidy to get approved and others side there is a fear that subsidy may go off.

c) State level local subsidy and net-metering, as announced by some states in the countries, has potential to cause very large solar business upside, depending on success of deployment. In case of any slowdown of roof top solar project deployment, it may affect forecasted capacity planning, to build large capacity of such solar installations. This is similar to obligation posed on state to deploy solar energy through SRPO mechanism, which has failed to create any demand for solar energy.

d) Tax holiday and accelerated depreciation create a pull for solar energy deployment from investors. This is watch out for planners for any expected increase in demand for effective planning. This width factor is more consistent than a direct cash subsidy program. This creates a constant demand from investor throughout the year since government is not forced to transfer any cash outflow directly.

e) Planning material from idle lying manufacturing capacity is a prevalent trend in case of shortage of domestically manufactured solar modules, instead of creating additional manufacturing capacity.

f) Strict review of customer contract and “bill of material (BOM)” by finance controlling function is to assure profitability, causes extra number of planning iterations in a solar firm.
g) Planners are getting extended to plan full solar projects including smaller level details like dispatch and completion of documentation required for projects like QAPs, engineering drawings, invoices and road permits. They reprioritize dispatch to a project site based on all statutory and customer clearances.

h) Supply chain planning for solar equipments in India, is conservative by nature. The reason for this conservatism is large fluctuation is prices and demand due to unpredictable state support structure. These fluctuations cause risk of increasing manufacturing or inventory stocking capacities across the supply chain. In long run demand is expected to be growing rapidly but in short term unstable prices and state support do not allow supply chain planners to be optimistic in planning. Market and state support to solar projects will continue to show high demand signals but planners remain realistic in planning. Nature of realistic or a bit pessimistic planning in solar industry is attributed to business survival, in high volatile market. A planner doubly or triply ensures that they procure material against a firm demand or customer commitment.

i) Sales team in solar companies act as a “solar demand speculator” and forecast given to planners are far beyond the actual demand. In some companies the errors between demands forecast and actual off-take varies up to +/- 500%. Solar companies in India have a very low reliance on forecast. This pushes solar companies to runs on extremely thin stocks and plan material back to back against an order.

j) Since solar industry planning goes back to back, a base stocking model is not evolved, which is suppose to take care of a base minimum demand. The reason is liquidity shortage, falling prices and probable value loss of inventories due to obsolescence.

k) Fragmented solar market in India is not allowing aggregation of demand for supply chain planning coming from a few large solar players, to reap benefit of economies of scale. Thus players are neither able to gain surplus them nor able to pass benefit to customers.

l) Solar products stock is still being managed, even if it is fast moving project stocks. In principle solar projects follow only “MTO” plans and Project wise
material planning and procurement is encouraged. Stocking for solar products is
most liberal across solar industry, followed by small rooftop based projects and
no stocks for large mega watt scale projects. Planners expedite material by
diverting to other projects, in case of similar requirement is in projects getting
executed earlier than the project for which material was ordered, to keep
inventory stock to a minimum.

7.3 Factors driving planning iterations in Indian solar industry

Indian solar firm follows an extraordinary iterative supply chain planning process, given
an uncertainty in demand, supplies, state support and other given internal and external
firm’s environment. There is about 35% year on year growth in demand of solar industry,
and high confidence in future upside trend, planning material for solar energy is
extremely iterative and discrete in nature. Following points detail out the findings.

a) Planner’s first dilemma is to judge the time to start planning of material, for a
solar project under discussion. This dilemma prevails from a stage of engagement
of customer for order discussion till a firm contract order is signed or cash
advance is received from customer. Different solar projects have different degree
of order winning probability. On one hand an early material planning helps in
meeting project deadlines, on other hand it can lead to risk of blockage of
liquidity, in event of delay or non-materialization of order. This fact drives
planner into iterations, carried out at various stages.

b) A few planners also believe that planning process should not start after getting
purchase order, but only after getting contracted advance amount from customers.
Postponing material planning at the later part of the order receipt stage, reduces
number of iterations and also satisfies developers even though some delay takes
place in commissioning and handover of a solar project.

c) Solar project design changes causes material planning iterations. A solar project
design keeps on evolving, due to reasons internal or external to firms. Some of
design changes are requested from customer; other reasons of design changes are due to project site change, material non-availability and cost optimization.

d) Very small or no buffer inventory stocking leads to supply chain planning iterations, to match demand and requirements with multiple combinations. Inventory turns increases with more number of iteration performed by planners in a dynamic solar firm.

e) Stricter norms of inventory obsolescence and excess, causes constrained situation for planners. It has been observed that more numbers of iterations are performed by planners to meet these internal norms of a firm.

f) In solar projects, sequence of an ideal material supply, is being followed loosely. Solar modules supporting structures, required in the beginning of project, faces major supply bottle neck, and thus get delayed in getting dispatch. Modules structure bulkiness, fabrication capacities, galvanization process and quality problem causes multiple iterations in planning. Under the state support program material used in project are required to be procured from MNRE approved suppliers. Once order is placed on such a supplier, it is time consuming to seek approval from MNRE for a different supplier, in case contracted supplier is not meeting delivery performance. Modules supplies to a solar project are faster than rest of the material supplies. This causes dispatch and invoicing of solar modules much ahead than required by a project. It adds to planning iteration when cash collection from customers causes delay in further delivery of material.

g) Fund availability of company procuring solar material delays payment to suppliers which further leads to more number of planning iterations on account of schedule of downstream procurement. Cash collection from state nodal agency is for various solar installations is very slow. Thus it becomes difficult to rotate cash for the same project for which procurement was undertaken. For every such supplies companies goes for extending their line of credit to ensure availability of working capital.

h) Longer supplier credit period reduces number of planning iterations. It leaves no room for changing the supplier, in case of any issue faced by buyer or supplier at later stage.
i) A large proportion of outsourced value of material causes more dependence on suppliers and causes more planning iteration. A larger portion of in-house manufacturing of solar module or cells lowers numbers of iterations in planning.

j) Solar raw material planning for manufacturing cells and modules for in-house manufacturing causes extra planning iterations, than what is required for finished goods.

k) Numbers of planning iterations are dependent on solar business segment – large project has more number of iterations, followed by small project and solar products.

l) State supported solar product tenders are filed within a very limited period of time from the date of announcement of proposal for bidding. Solar companies are not able to come up with a complete design and estimation of cost in such a limited period, causing extra planning iterations at later stage to manage supplies.

m) Solar planners are using spread sheets as a planning tool, rather than an automatic material planning like standard MRP. Each project is being considered as unique planning situation by planners, which causes project wise planning and manual iterations.

n) Planning iteration increases non-linearly (more rapidly) with addition of block of about 5 MW. Within a block of 5 MW supplies are more predictable. Therefore planning is more iterative with every increase in 5 MW of solar project installations.

o) Multiple solar project execution at the same time during second half of the Indian financial year leads to more number of iterations. Multiple on-going projects at the same time, causes chaotic planning and causes delay in projects commissioning. Planners are undertaking a large number of iterations to meet requirements of all ongoing projects from a limited sources of material.

p) An approximation is used in project land site survey during customer order acceptance stage, causing multiple iterations before firming up of project design. The reason for rough project site survey is under multiple assumptions, to minimize effort and cost at initial assessment of an order of solar project, which may or may not get materialize.
q) Evolution of QAP during the project execution also causes planning iterations thus experienced designer tries to keep provision in the beginning for such changes on account of specific quality requirement from customer.

r) Many developers’ related issues like project site availability and statutory clearances are monitored by planners to iterate and ensure timely availability of material.

Broadly more number of iteration take place to manage cost in a project after winning tender/orders.

7.5 Solar business segment specific Supply Chain Planning

Supply chain planning attributes, specific to a solar business segments are summarized below

a) Solar Projects Planning

I) As a part of conservative material planning in Indian solar industry, buying for solar projects is extremely conservative, to avoid incurring additional cost of stocking and holding liquidity.

II) Entire planning and procurement for solar projects is dependent on lead time from suppliers. Lead time of supply either from China or from local manufacturing varies between 10 to 16 weeks including transportation. Thus lead time to deliver material has hardly any difference from the two sources. There is high confidence to ensure availability from global module inventory stocks to support delivery of solar projects in India. Planners do not mind even if it cost some premium to expedite supplies on priority from China. Planner trade off and pay premium shipment charges, if required, rather than stocking in house. Lead time from China is only equivalent to transportation time of 4-8 weeks, since they carry high volume inventories to cater to solar customers worldwide.

III) Economies of scale are not being explored due to high fragmented EPC contractors and developers in the country.
IV) It is difficult and unmanageable to plan material project by project in small solar installations. A project solar planner has an opportunity to identify two groups of material, one general material stock which can be used in any project, second is project specific stock, required in a particular solar project.

V) Planned materials for a solar project is not being procured in one go. Firming up purchase order on suppliers keeps on releasing, even during the execution of projects, as not all requirements have been captured in the beginning. Some specific material is procured during project execution stage as per need expressed by customer or to meet actual design or project site conditions. This causes unavailability of material exactly when it is required.

VI) Module mounting structures fall in critical path for a large mega watt scale solar projects. High volume supplies from limited vendors causes constraints on production capacity and quality. Planning of mounting structures has largest potential to delay a solar project from material related reasons.

VII) Solar project contractors wish to enhance a wide supplier base, spread across country. A wide spread suppliers base, especially for structures helps reducing extra logistic cost. A wide spread supplier base reduces cost of project, but limitation in having such large supplier base, on account of demand fragmentation among multiple solar contractors, is being faced by a solar firm.

VIII) Direct dispatch from suppliers to solar project site is preferred in the planning process by project installers, as it minimizes cost of procurement of material by saving on multiple transportation and logistics.

IX) To minimize number of SKUs in small solar projects, a material kitting is being recommended by planners to have an ease of planning and logistics management. Kitting can minimize number of wrong and short supplies at project site causing project delays.

X) Solar EPC contractors are pushing suppliers of solar modules to stock for them without a firm order. Module suppliers are seen as generic suppliers, carrying pooled solar module inventory, for any contractor who wins order for solar projects. A module supplier seems not in agreement with this view of contractors.
XI) A supplier, who offers longest credit period, is being given more preference to source material. This is causing sustainability of smaller suppliers, constrained on liquidity.

XII) Solar project demand visibility horizon is generally up to two years, whereas solar product demand visibility is up to two months during study between years 2010-2015.

Numbers of average estimated iterations in planning a solar project are between 5 to 8 as against 2 iterations, in a fast moving product.

b) Solar Product Planning

I) Solar product planning aggregation is more efficient at local level of demand than national level. At the point of consumption, demand of a solar product depends on customer and local state government support.

II) Retail demand fluctuation for solar products, being sold through retail dealer channel is minimal, except small seasonal variation. Large order for solar installations against state nodal agency supported tenders causes demand spikes, creating large suction of capacity. Such large demand is causing bottle neck in supply, project installations and quality. These issues are handled by solar players at later stage. Time of arrival of such large solar product order varies significantly, depending on time of program announcement by state nodal agencies.

III) Solar product range is so wide that it is difficult to keep safety stock of all variety due to risk of inventory obsolescence. Procurement of material takes place depending on specific order. Solar players are focusing their distribution in a few selected product categories, e.g. solar lights, pumps, power packs or thermal heaters. A regular stock replenishment practices in solar product business is not well established. Supply chain player evaluate requirement of items every time before ordering.

IV) An only solar product retailer keeps a marginal safety stock to avoid sales loss at their counters. Confidence of retailers, to stock for a base demand is increasing continuously over a period of time. A safer option is to keep stocks
of one month, without any major risk of inventory obsolescence. In recent year last mile dealers and retailers are getting better comfort to keep stock of solar material. Solar product business segment is very similar to FMCG, for retail customers. Except the fact that there is large forecast error to the tune of +/-500%, as observed by of solar product supply chain planners.

V) Solar product demand, seasonality plays an important role in planning. Demand for solar product is always higher in summer and dry winter when sun light is adequate for generation of solar power. During rest of the year, especially in rainy season, sales trend goes down substantially.

VI) Solar product demand visibility horizon is generally less than two months, whereas solar project demand visibility is up to two years during study between years 2010-2015.

VII) Solar product demand is geographical region specific localized, varying from region of state to state, depending on their state promotion policy to a particular solar product. Whereas solar project planning is more efficient at national level, by aggregating demand, spread out in the country. Global or local sourcing, to meet requirement of such a local level or national level planning does not influence optimum planning outcomes.

VIII) National level solar product players have limited distribution network. Only a few national level product suppliers has multi state distribution channel. Solar products available in the market are mostly from local state level companies, as their cost of service and meeting local customer requirement is more effective. Solar product players keep stock in regional warehouses to cater to these retailers near customer. National level players find it difficult to reach to retailers in a given cost.

IX) Full truck load transportation is preferred from mother warehouse. Local transportation is managed by dealer, integrators or retailers. Big opportunity exists to follow milk run from regional warehouses to retailers after solar supply volume goes up, with growth in solar market size.

c) Solar manufacturing planning for cells & modules

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Capacity of solar cells and modules manufacturing by Indian solar manufacturers is very small, as compare to worldwide manufacturing capacity. Availability of low price and speedy delivery from large sized manufacturing capacity of global sources, to Indian solar project contractors is very convenient, unless project is mandated under DCR requirement by state. Domestic manufacturers stock raw material, more optimistically than a finished solar modules. Manufacturers feel safe to manufacture solar modules against a firm demand. Raw material stocking to manufacture cell and modules provide flexibility to manufacturers to produce modules of any specification as per customer requirement. 

In solar module manufacturing, most of the raw material is imported. Except a few low value or bulky items incurring high transportation cost in import, is being procured locally like module frame and glass etc.

7.6 Sales & Operation Planning

In solar industry sales and operation planning, is used extensively to collaborate views of multiple stakeholders regarding demand and supply. Firms have created either dedicated or part time “operation planning” functions to carry out sales and operation planning (S&OP). This function balances both the views of optimistic sales and pessimistic inventory planning, to reach an optimum between the two. This is a cross function team formed by a set of people who represent from sales, project execution and supply chain planning. This department also tries to minimize cost by advising to explore source and guide regarding appropriate material destination, to optimize taxation and transportation.

There is large mismatch and reprioritization of material dispatch taking place, based on cash advance receipt from customers and availability of road permit to release material from warehouse to customer sites. S&OP process generally runs weekly to set a latest priority. Solar firms are prioritizing dispatches based on short term liquidity inflow management, but are not sure whether it will lead to adverse long term expected customer relationship.
During S&OP planning process, government liaison and advocacy plays a role to create accurate demand visibility. Participants of S&OP help in creating visibility more than one month and help in demand and supply planning. Solar project S&OP is part of their project execution. In practice it has been seen that solar firms focus more on current material shortages issues at project sites to complete an ongoing project, than spending time on creating demand visibility for future. In a regular S&OP, long term a very limited demand visibilities have been observed.

Manufacturing S&OP, to plan for raw material is much smoother and flexible than for solar project planning. In case of any large order, special S&OP is planned with sales, manufacturing and quality team, to create visibility of required raw material, certification and desired quality.

7.7 Role of planners in complex decision making

a) Operational planner in solar industry has a limited view to independently plan and procure material. Uncertainty of demand, large liquidity requirement and extremely thin profit margins, pull senior management staff of solar industry in supply chain planning. To safeguard the interest of solar industry, supply chain as a whole, government (state) also acts as a planner to protect long term interest of country from solar power deployment perspective. Objective of state planning is to provide clean power to masses and ensure sustainability of solar industry in the country. Complexities of solar supply chain, shifting planning role to higher hierarchical in an organization is to ensure most optimal decision. Solar planner role is much wider than a material planner; they are extended to project and cash flow planning in a solar firm till project is handed over to customer. An enlarged role of planner required special skills and competencies than a routine material supply chain planner.

b) Planning role in solar industry is shifting from a solar firm to state, but the objective of industry and state planning is uniquely different. Industry planners make most appropriate decision to safeguard interest of solar firm in short term.
But state planners save interest of solar ecosystem in country at large. Industry
planners are dependent on state planning, to make their decisions as a leading one.
c) In solar industry, role of planner have been extended to manage end to end
delivery of material. This end to end planning by a planner ensures accurate and
correct supplies at intended place. With a number of complex scenarios, senior
management involvement in solar planning is evident. Planner establishes a
seamless communication with senior management to collaborate with regards to,
demand visibility, source of material, cost and solar project design engineering
requirements.
d) Role of planner in solar developer firm is critical to connect and manage seamless
coordination with EPC contractor’s planners and manufacturing planners
simultaneously.
e) Project design, quality and documents expectations; keep evolving by customer as
project proceeds. Such evolution of requirement and design changes causes
multiple planning conflicts, disagreement and delays. Planners are supposed to
coordinate with the function supporting such requirement along with material and
project planning, to timely meet customer’s requirement.
f) Planner should have special skills of knowing quality of solar project,
documentation requirement, state and central government policies, tendering
process, state and central taxation on solar products, judgment of probability of
winning order and financing schemes on solar products,
g) In a solar firm, decision of cells and module planning is influenced by state
planners. BOS procurement decision is influenced by senior management
planners, followed by state. In case of solar products planning, operational
planner decisions is most influential.
h) One of the competencies required by a planner is to be able to utilize material for
alternate use, to minimize blockage of liquidity in inventory.

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