



## HUMANS OF SOLAR

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# Mr.Chandrasekhara- FOUR-C-TRON- Share Solar Journey with EQ

It is an interesting topic to write about how I got involved in Solar since last 34 years.

Behind the Sun:

Started my career in Defence Establishment in 1967 and worked for 13 years in Army, Navy and Air force organizations as Scientific Officer and resigned in 1980. During this period actively involved in Documentation, Inspection and QC, preparing standards and specification for Radars, communication equipment and components manufactured at Bharat Electronics, headed import substitution and indigenization team, vendor evaluation, Defect analysis and rectification modalities. Had a stint of 2 years in a British origin company manufacturing solders and fluxes (now Cooksun group).

Under the Sun:

In 1982 I joined as Sales Manager at Siltronics, sister Organisation of Grindwell Norton to manufacture silicon wafer for semiconductor industry. The facility had one CZ puller, one FZ puller, ID saw, lapping and polishing machine. As Karnataka government was not industry friendly, Siltronics was started in Hosur. Being a new facility, I had the opportunity to associate in all activities from facility set up till production trials as number 2 in the Organisation next to GM. Here is the real story of my deep involvement in solar in early 80's and I would like to narrate under Chapters.

Chapter 1: The factory had strength of 30 and the production was focused on 2 FZ and 3 CZ wafers exclusively for semiconductor devices. Then the customers in India were Keltron, Meltron,

Hind Rectifiers, Usha Rectifiers, BEL, BHEL, SCL, NGEF, ITI and other Diode manufacturers. Wacker and Topsisil were our competitors who had established their business with all the above customers. I proposed GM that we invite all the CEOs of semiconductor industry to visit our facility at Siltronics cost and have a small inaugural ceremony. GM being an Ex BARC scientist and R&D oriented, refused my proposal on the ground that we should not show the ingot growing facility to visitors! I visited all the semiconductor industry and was surprised to learn that Wacker had pre-booked annual order on the pretext that they will stop 2 and 3 wafer production for Indian customers as 4 is international market. This motive of Wacker is to kill Siltronics entry and to deliberately delay delivery of poly. Moreover, Siltronics has to get qualified being new vendor and could secure some trial orders only.

Chapter 2: Siltronics had strength of 30 and production was not picking up because of thin orders. Metkem in Salem were focusing on polysilicon manufacturing but they were unable to deliver even the quality poly to Siltronics and giving some excuses to avoid delivery.

At this time there were only 3 companies in solar business – CEL and BHEL both manufacturing cells and module and REIL only modules. Spire, USA was the first company to introduce their laminator and sun simulator to these three companies in 1983 and then cell efficiency was below 11% and module output was 35 Watt with 36 nos. 4 dia cells. Spire also gave a 3 MW turnkey solar cell line to BEL in 1996 which was in operation for more than 10 years. The wafers were imported by CEL and BHEL and it was 4 dia P Type Mono priced around Rs.75 per wafer and output of 4 cell was 1 Watt. I made a survey on quantity and spec of wafer required by BHEL and CEL and it was big opportunity for Siltronics to enter solar sector than solely depend on semiconductor industry demand. Again the management was pessimistic about solar industry and proposal was deferred. But I pursued my argument and convinced top management to add up only one additional ID saw (No multiwafer or wire saw at that time) to slice 4" dia ingot so that solar wafer can be supplied to BHEL and CEL. It took 6 months to realize my effort to become first Indian company to supply wafers to solar cell companies. Metkem followed and started manufacturing wafers.

Chapter 3: When Siltronics can deliver wafers, the first problem was "payment against delivery" terms by CEL and BHEL. The second problem is how you pack the wafers and transport. I prepared the wafer spec, selected the packing materials, designed the package, wafer separators, labelling keeping in mind not a single wafer should get broken till it reaches customer. This was a great experience for me.

As Siltronics needed funds for day to day operation, I found a solution to get paid for wafer within 30 minutes of delivery to CEL. The modus operandi were – I will pack 4000 wafers, 100 wafers in a plastic circular box using wafer separators, sponge – keep 40 such boxes in a cardboard box and hand carry to my home in the evening. Next day, I will go to HAL airport by 6.30 am to book the cargo to fly by first Indian Airline flight to Delhi (No other airlines at that time). I will carry the AWB and reach factory in Hosur by 8 a.m. Fax/Telex information to CEL to keep the cheque ready and ask Grindwell Norton person at Delhi to collect the cargo from airport and drive direct to CEL to deliver and collect cheque. The delivery was 3 times a week and it worked smoothly and not a single wafer was damaged!

I should place on record here that in those years Dr.Venkateswarlu was heading CEL and Dr. Kaul was in charge of production. Dr.Venkateswarlu was so happy to hold the 4 wafer in hand and I still remember his face with joyful expression.

Chapter 4: At BHEL we were about to secure order for 1 million wafer with all efforts put behind to get their approval, but one of the Director on Siltronics Board, who was an Harvard MBA in Finance, did not agree to the price of BHEL though they offered little higher price than imported wafer price to encourage Siltronics. I feel the Director erred here not accepting BHEL offer and this affected growth of Siltronics. I resigned with 3-month notice period, but regularly visited Bharat Electronics to convince them on converting their unused 100 kg poly in inventory to semiconductor wafers. I was successful in securing Rs.25 Lakh single order as conversion charges. But the problem was to lift the poly against Bank Guarantee. Siltronics was fund strapped but here again I found a solution to give Bank guarantee for 5 kg poly (as single charge needed 5 kg only) and on delivering the wafers lift again 5 kg with same BG. Till the time I secured the order and completed first delivery of wafers I did not inform BEL about my leaving Siltronics. I left Siltronics with a kind of satisfaction that I made

Siltronics to deliver 4 dia wafer against odds and secured order from BEL for Siltronics to continue their existence for some more years.

Chapter 5: Founded my own company Four-C-Tron in 1989 after working for few years for electronic equipment and material trading Organisation representing overseas companies. As semiconductor industry did not grow beyond SCL, BEL and ITI who are still in 4 and 6 wafer domain even now, Four-C-Tron focused on sales and service of production equipment and materials for solar industry. In association with Spire Corp, we set up moderate capacity of 20MW and 40 MW turnkey module production lines starting with Emmvee Solar in 2005 and then with HHV Solar, Vikram Solar, Alpex, Sova, Sonali Solar, Green Brilliance, Evergreen, Rahima Frooz and REIL. Besides nearly 40 Spire sun simulators were installed at other module manufacturers. I also visited NREL to get Udaya Semiconductor solar cells evaluated.

During factory visits, I observed that there were no standards/specification in module materials like EVA and Backsheet and customers followed just part nos. of one or two suppliers of these materials. We introduced EVA in 1989 from then BP Solar/Etimex, Germany with Specification sheet and test methods as second supplier in India. We also made customers to realise that 0.5 thick EVA as used by Siemens is not absolute and 0.45 mm is good enough and later 0.45 mm became preferred spec by many module manufacturers, which reduced the price of EVA by 20%. In 1991, during Productronica exhibition, Four-C-Tron gave the product idea of backsheet manufacturing to Krempel, Germany who were just dealers for Tedlar and Polyester then for different application. They were not aware that the same material is being used for Solar application if laminated with adhesive. With a sample sent by Four-C-Tron, Krempel formulated their own adhesive and brought out their AKASOL brand for trial at BHEL and first order for backsheet for Krempel was from an Indian company BHEL, Bangalore. I thank here BHEL team who had confidence in Four-C-Tron and Krempel. Krempel then started entering European market and later Chinese market. A new factory was opened exclusively to manufacture backsheet for solar industry and today Krempel has nearly 6 types of backsheet and have in house R&D. With completion of 25 years as backsheet supplier I am now their Technical Consultant for their Solar Material.

Chapter 6. In 34 years of my association with solar industry I have visited many wafer, cell and module manufacturing companies in Europe, USA, Russia, Taiwan, China and regularly visit Intersolar and PVSec shows. Between these years, I could see the changes in this industry globally. In India from mere 3 MW production capacity by 4 companies in 1982 it is 6 GW capacity now from 150 plus manufacturers now. But the completion of solar mission with balance target of 90 GW within next 6 years is a Herculean task. This leads to continuous import of modules, wafers, cells and other module materials.

It is unfortunate that Government on one hand advocate "Make in India" but it is actually encouraging "Make-up in India" by opening the door to overseas companies to sell their modules. Even the existing module manufacturers are resorting to OEM contract with these companies to brand their modules to survive due to competition.

Before setting the 100 GW target, Government should have established National Silicon Facility to manufacture poly and/or wafer of at least 50 GW capacity. Under this scheme, Government itself should have been JV partner with overseas companies for poly and wafer manufacturing facility to ensure continuous supply of wafer at market price for local cell and module manufacturers. This would have been then real fit for "Make in India" slogan. For the good cause of public and as a social measure, to light millions of homes by solar – Government can deploy the huge money collected during recent voluntary black money disclosure scheme, confiscated currency and gold after demonetization for investment in Silicon manufacture. In the same magazine I had shared earlier my thoughts on the subject and also wrote to Prime Minister but he has not lent his ears yet except mere acknowledgement which I received after one year!

If I look back those initial years and my involvement in solar industry – there are many more chapters untold here but I continue to enjoy working with SILICON and SUN untired.

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