Megatrends: Workforce; Technology; Public Policy

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I'd like to address the Megatrends topic by examining the rise - and subsequent decline - of Arizona's semiconductor economy. We'll also see how solar energy represents an attractive economic development opportunity for Arizona.

The foundation for Arizona's semiconductor economy was laid 60 years ago by a Chicago-based electronics company called Motorola. In 1949 Motorola decided to create a research and development center in Phoenix.

Historically, Arizona's growth had been limited compared to other states because of the allegedly hot climate.

Well look, it was 115 here last week . . . but you know . . . it's a dry heat!

Anyway . . . when air conditioning was broadly adopted following World War II, Arizona experienced a rapid growth in population and finally became attractive to potential employers and employees, especially those who appreciated a nice round of golf.

Back in 1949 Motorola produced radios and televisions. There was no semiconductor industry. There were no cell phones. No computers. No video games. No iPods.

But thanks in part to the work accomplished here in Arizona, Motorola broke new ground in advanced electronic technology, and in 1955 the company introduced the world's first electronic transistor.

This proved to be a key moment in the formation of the semiconductor industry, and it presaged a series of technological developments that would transform modern society.

As semiconductor technology evolved in the 1950's and 60's, Motorola expanded its operations and ultimately established a sizable presence in metro Phoenix.

In 1980 Arizona took another major step toward creating a semiconductor economy when a small company named Intel established a manufacturing operation in Chandler.

During the 1980's and 1990's the semiconductor industry enjoyed considerable growth, and this led to significant job creation – for Motorola, for Intel, and ultimately for others.

Over time, several other semiconductor companies either located to Arizona or were established here in the shadows of Motorola and Intel.

As the manufacturing base grew, there developed an Arizona-based semiconductor food chain that included support services, engineering & design houses, suppliers of chemicals and other materials, equipment companies and testing operations.

This direct food chain was further supported by a growing base of research and development resources in the universities and community colleges, and by independent industry organizations and other support groups that either started in Arizona or located here.

By the late 1990's, Motorola was Arizona's largest private employer, with over 25,000 associates. At its peak, Intel employed nearly 10,000 in Arizona.

Eventually, Arizona became home to a semiconductor ecosystem with close to 50,000 direct employees plus thousands more in supporting roles.

Eventually, semiconductors developed into a $200 billion global industry, and within the U.S. Arizona became our third largest semiconductor state, trailing only California and Texas.

However, over the past ten years, the health of Arizona's semiconductor economy has suffered a dramatic decline. There are several reasons for this.

- Semiconductor industry expansion has slowed considerably from the double-digit growth rates of the previous two decades.
- Companies have adopted new business models involving a significant amount of off-shoring and outsourcing.
- Market pressures, including the rise of Asian-based competitors, have led to large-scale reorganizations, impacting Motorola and its derivative operations, and many smaller companies.

By 2009, semiconductor industry employment in Arizona had fallen to around 20,000, and this number continues to decline in the face of a global economic recession.

So where's the solar connection?

During the past half-dozen years, the solar energy industry has enjoyed outstanding growth. We don't have time to discuss all the why's and wherefore's behind this growth, but several factors are worth mentioning.

- Like semiconductors, the technology behind mainstream solar energy – called photovoltaics (or PV) – is based on silicon wafers
- And like semiconductors, PV technology is driving toward greater efficiency and more productive manufacturing processes
- As a result, PV manufacturing is able to leverage much of the knowledge base and learning curves associated with semiconductor manufacturing
- Unlike semiconductors, the adoption of solar energy has largely been stimulated by public policy and cultural considerations – rather than business economics
- Broad consumer adoption of solar started in Japan during the mid-90's with the "Sunshine Program" which was based less on regulatory impositions and more on a strong appeal to cultural sensitivities

- Then governments in Europe, notably Germany and Spain, adopted extensive public policy frameworks that incentivized both consumers and businesses to adopt solar and other sources renewable energy
- These public policies represented a double-edged sword, in that they came with renewable energy tariffs that effectively increased the price of electricity for all users, not just those who went green
- The use of these so-called "feed-in-tariffs" has been a controversial, but highly effective example of using public policy to modify consumer behavior and stimulate the growth of new industries.

Because of the similarities between solar and semiconductors, and because of solar's rapid growth, there has been a substantial migration of resources from the semiconductor industry to the solar energy industry. This migration extends across the entire food chain and to the financial markets.

While the semiconductor industry remains significantly larger than the solar industry, the momentum has clearly shifted, and discretionary resources are increasingly being applied to solar. This is especially true in developmental efforts and in the financial markets.

As a result, we are seeing much more emphasis on the emergence of enterprises focused on solar and other forms of renewable energy.

In addition, as the world grows increasingly flat and digital, industry participants, bankers, investors, educational institutions, human resource organizations and individuals have unprecedented freedom to travel the path of least resistance towards business and employment opportunities, wherever they may be.

In many places, particularly in Europe, solar energy is rapidly supplanting a declining semiconductor industry. Europe is the world's leading producer of solar energy. European companies, notably those in Germany and Spain, are world leaders in the design, development, engineering and manufacturing of solar energy components and systems.

Most of the groundbreaking solar and renewable energy projects under consideration in the U.S. are being developed by European companies.

The transition to solar has been slower in the U.S. but is poised for much more rapid change. Industry analysts predict that the U.S. will become the world's largest consumer of solar energy. Two key factors are driving this change:

- On both local and national levels we're adopting progressive, and in some cases aggressive, policies dealing with renewable energy
- And we're getting closer to "grid parity" which means the cost of generating solar electricity is approaching the utility's current cost of generating electricity

The coming explosion of solar energy adoption in the U.S. brings many challenges . . . and in the context of today's conference, it raises some key questions.

Creating a solar industry that can effectively compete with more established energy sources, such and coal and natural gas, requires innovative solutions based on advanced technologies.

- **How do we intelligently and prudently allocate research and development resources & how do we determine the proper direction of these efforts?**

We also need to change the way businesses and consumers approach their thinking about energy generation and consumption. In Arizona, electricity is relatively inexpensive, so the conversion to solar comes at a cost.

- **To what extent can classic, bottom-line economics be offset by positive environmental considerations?**

And a third set of challenges involves workforce creation and transition. As the old economy clashes with the new,

- H**ow do we ensure that our emerging workforce is properly educated and trained to compete on a global basis?**

There are many lessons to be learned from the successful development of Arizona's semiconductor economy – and also from observing its decline.

Solar energy presents a compelling opportunity for Arizona.

I believe we are obligated to understand the challenges and to enter into productive collaborations with those who wish to be part of the solution.