## *Industry Outlook Report*

# Different Oil Industries for Different Futures

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### Scenario Thinking: Back from the Future

Many oil and gas companies are highly focused on the next five years. They see challenges in another period of relatively low commodity prices and opportunities in the opening of previously closed countries and in the worldwide restructuring of the regulated natural gas and electricity businesses. However, some companies recognize that they are now making investments in businesses that will still be operating 30 years from now. After all, the initial discoveries of the North Sea and Alaska North Slope were made in the late 1960s and early 1970s, when Middle East oil prices were around $1.25 per barrel. At that time, several companies invested in residual fuel oil desulfurization to meet growing power generation needs, and Shell and Gulf Oil had an emerging business in nuclear energy. Soon thereafter, many oil companies diversified into the coal and metals industries. Few people at that time envisaged the imminence of nationalization, the massive reduction of residual fuel oil markets, the difficulty in managing a diversified portfolio, or the travails of the nuclear business. Nor did they fully anticipate the huge potential of the North Sea and the North Slope.

For many years, we at Arthur D. Little have recognized the inherent uncertainty of the future and have tried to portray this uncertainty through the use of scenarios. The scenarios – pictures of the future based on educated guesses – have generally foreseen: the behavior of OPEC countries, particularly those in the Middle East; the fundamental variability of economic growth and its energy intensity; the effect of technological advances on supply and demand of oil; and the impact of the environmental movement. When we first considered the use of scenarios in 1984, we were most concerned with the timing and the manner in which oil prices would decline from their then-giddy heights. We predicted that this decline would remove a tax on the consuming countries and would lead to accelerated economic growth. We did not foresee, however, that it would become one of the factors leading to the fall of communism and the opening of previously closed economies to international investment. This opportunity, along with an explosion of new technologies, is enabling potentially extraordinary economic growth around the world.

Some of our clients are now embarking on investments with huge potential – similar in magnitude to the North Sea and the North Slope developments. At a time when the political, technological, environmental, and commercial context for the full life of these investments is extremely uncertain, the risks are huge. hi effect, the industry, and perhaps the planet, is going through a period of change of even greater importance than „the rapids“ that Pierre Wack, the father of scenario planning at Shell, described in the early 1970s. We can’t yet see clearly what the world will look like when we come out of the rapids, but we can be sure that it will be quite different from the past.

One key reason the future will be different from the past is illustrated by the following syllogism: Together China and India have today nearly 10 times the population of the United States and Canada, which consume nearly 20 million barrels per day (AIMED) of oil. China and India have aspirations to North American living standards; therefore, their populations will consume 200 MMBD of oil. Wrong! It can’t happen! Total world oil supplies are currently just under 75 MMBD. It is technically improbable that world oil supplies will ever much exceed 100 MMBD and politically likely that the Middle East will again find high oil revenues to be a destabilizing force. Moreover, concern over the impact of excessive oil consumption on climate change may well demand a different future. The problem is, we don’t yet know what form that future will take, and even less what path will get us there.

Nonetheless, we can begin to identify some of the dimensions of the change and imagine the world that might emerge in about a generation’s time. For example, looking back from the year 2025, we may have observed the following developments:

• China and India have become major economic powers; Japan and northern Europe are struggling to cope with aging populations.

• The sustainable development debate has seriously influenced the energy scene.

• The geopolitics of oil have dramatically changed, with China and India forced into close relations with the Middle East.

• Financial markets, not cartels, now determine the supply, demand, and price of energy commodities.

• The agreed roles of supra-national organizations, national governments, corporations, and nongovernment organizations (NGOs) have changed.

• Technology has revolutionized energy consumption and production, and renewable fuels have become commercial.

• The concept of a high standard of living has changed considerably.

These observations may call to mind the comment of die Scottish lady as she finished reading the *Oxford English Dictionary:* „Very interesting, but a wee bit disconnected." What else do we need to know about the future state of the world to connect the story? If we are trying to plan for an oil company, it would be most useful to understand how we got to that future. The questions are numerous and intriguing:

• Was the concept of sustainable development elevated to the level of a globally shared vision, or did this movement evaporate? How were its principles applied on a global basis?

• How high did oil demand get before starting to slow down or decline?

• Did fundamentalist Islamic forces inhibit access to resources in the Middle East and Central Asia?

• How did China and India manage their relations with Western oil companies and Middle East/Central Asian governments?

• What mechanisms balanced oil supply and demand in the short term and the long term?

• Did NGOs continue to increase their influence relative to national governments?

• Did supra-national organizations, such as the European Union, continue to erode national sovereignty? Was this a peaceful process? Were the United Nations, the World Bank, the OECD, and NATO effective in aligning national interests?

• Did technology continue to reduce the cost of finding and developing hydrocarbons and to increase recovery rates? Did technology lower the cost of transforming natural gas and heavy oil into fungible energy commodities?

• Which of the renewable energy sources became commercial: wind, biomass, solar? Did they penetrate the market on the basis of technological advances, through global emissions trading systems, or by government mandate?

• Did the on-board fuel processor/fuel-cell power train take off as a viable replacement for the internal combustion engine? Did gas stations feature hydrogen generators for fuel-cell-powered vehicles?

• Did the shift from large, centralized energy-producing facilities toward smaller, distributed facilities continue? How far did it go? Was electricity generated at every household?

• How was natural gas mostly brought from remote locations to demand centers?

• Was there an outcry against factory farming and a move back toward „free range" animal foods? Were fertilizers and pesticides made obsolete by plant genetics? Were „designer" plants and enzymes developed that made cheap renewable bio-energy available?

• Was travel still an important component of a high standard of living? Did people still like to get together for business meetings and personal gatherings, or did technology advance so that electronic meetings became commonplace?

• What happened to mass transit? Did it become flexible enough to appeal to Americans?

• Were oil prices high, low, or volatile? What was the amplitude and periodicity of the volatility?

• How many oil companies were left after 50 years? What determined who survived and who disappeared?

By creating a set of stories or scenarios that credibly connect the answers to these questions, we uncover some interesting possible futures. As the previous syllogism illustrates, current trends are unlikely to continue forever, just as the rapid growth trends of the 1960s have proven unsustainable. The resolution of the earlier tension between supply and demand was achieved through price increases and controls over supply that were supported by the trend of heightened nationalism. It seems that the current trend toward globalization and sustainable development may allow a different resolution.

### The Pitfalls of „More of the Same"

Pierre Wack was careful to distinguish things that could be projected from things that could not. (As an example of the former, he cited the predictability of the extent of flooding of the Ganges River from the snowfall in the Himalayas.) So let's illustrate the consequences of predicting the future on the basis of simply extrapolating recent trends.

If China and India continue to grow their GDPs as they have since 1990 – China at double-digit rates and India at around 5-7 percent per year – by 2025 their combined economies will be around 5 times their current size. (These growth rates are within the range European countries achieved in the 1950s and 1960s, so they are feasible.) If the United States manages to grow at 3 percent annually, the size of its economy will double. In Europe and Japan it may turn out that their significantly aging populations will indeed blunt economic growth; if so, their economies will increase at slightly under 2 percent per year, growing only 50 percent by the year 2025. (This exercise graphically illustrates the power of compounding!) This pattern of growth would lead to a dramatically different world in which China is the second-largest economic power behind the United States (Exhibit 1).

*We* know that energy consumption per capita increases with economic development, while energy intensity (i.e., energy used per unit of economic output) declines. This is because the more developed economies use more advanced technologies and have a larger proportion of high-value-added and service industries. If we assume that the developing countries follow similar paths to the industrialized countries, then the global energy demand pie will also change dramatically. The share of the „big three“ (Europe, Japan, and the United States) in total energy usage would drop from nearly half to less than 30 percent.

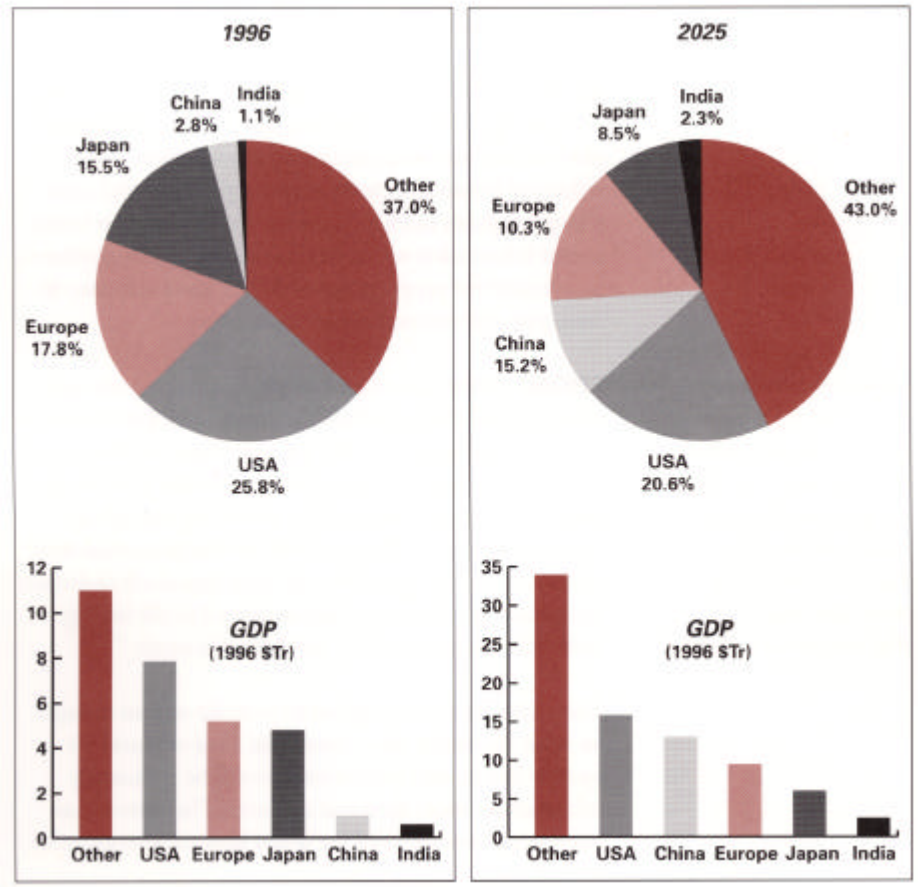
Now we come to the difficult part. What do we assume about the energy supply side, and what will be the reaction of the global community to the emissions associated with such a high consumption level? As soon as we start running the numbers, we must realize that current trends cannot be sustained. Most likely, the fossil fuels will not be available in the quantities required, and the emissions implications will not be acceptable. So we need to develop some new scenarios.

### Exploring Futures Through Long-Term Scenarios

This kind of thinking was behind the scenario initiative sponsored by the World Business Council on Sustainable Development (WBCSD). Its thought-provoking study was inspired by the recognition by many companies that the concepts of sustainable development had substantial worldwide resonance. The definition adopted by the Brundland Commission – “meeting the needs of the present without compromising the ability of future generations to meet their own needs“ – has enormous practical and moral significance that makes sustainable development a durable concept likely to persist well into the future.

### Exhibit 1

### Global GDP (Based on Extrapolation of Current Growth Trends)



The WBCSD team devised three global-governance scenarios to depict possible futures, with somewhat whimsical names: GEOpolity, Jazz, and FROG!

**GEOpolity.** Recognition emerges that „the market has no inherent incentives to protect the commons, social welfare, or any other non-economic values." New forms of global governance emerge to „design and enforce global standards and measures to protect the environment and preserve society."

**Jazz.** As in the music form, orchestration and improvisation coexist. „This is a world of social and technological innovations, experimentation, rapid adaptation, much voluntary interconnectedness, and a powerful and ever-changing global market." Quick learning based on transparent information within free markets, sound legal systems, and respect for property rights deliver rapid solutions to emerging environmental and social issues.

**FROG!** („First Raise Our Growth!") depicts a strongly nationalistic future in which the underdeveloped countries move forward rapidly so that the total impact on the planet's eco-structure becomes unsustainable. Neither technological advances nor global institutions are strong enough to respond effectively. „People react like the proverbial frog: when placed in boiling water, the frog leaped out of danger; but placed in cold water that was heated to the boiling point, the complacent frog was boiled to death."

These scenarios are designed to provoke serious thought on what we might do to create the kind of world we want to live in, and what strategies will be sufficiently robust under more than one scenario. They provide an interesting basis for thinking about how the energy industry may evolve.

Let's now imagine three energy scenarios that are consistent with the three WBCSD global-governance scenarios, respectively. We will call them Orchestrated Supply (GEOpolity), in which renewables become extensively integrated into the world fuel balance; Technology Solutions (Jazz), in which end-use technologies are revolutionized and a high standard of living is redefined worldwide to favor a less energy-intensive lifestyle; and Malthusian Future (FROG!), in which expectations have to be lowered.

## Orchestrated Supply

This scenario (Exhibit 2) will require major advances in renewable fuel technologies. Specifically, breakthroughs will be needed in plant genetics to accelerate growth of the cellulose product and its susceptibility to transformation into a liquid hydrocarbon or alcohol fuel. More breakthroughs will be required to increase the efficiency and selectivity of the enzymes (or other mechanisms) to realize such a transformation. In addition, breakthroughs will be necessary in the manufacturing cost of silicon photovoltaic panels, in their distribution, and in the mechanisms for integrating them into power generation and building designs. Some of the risk in developing international natural gas projects will need to be assumed by governments.

## Exhibit 2

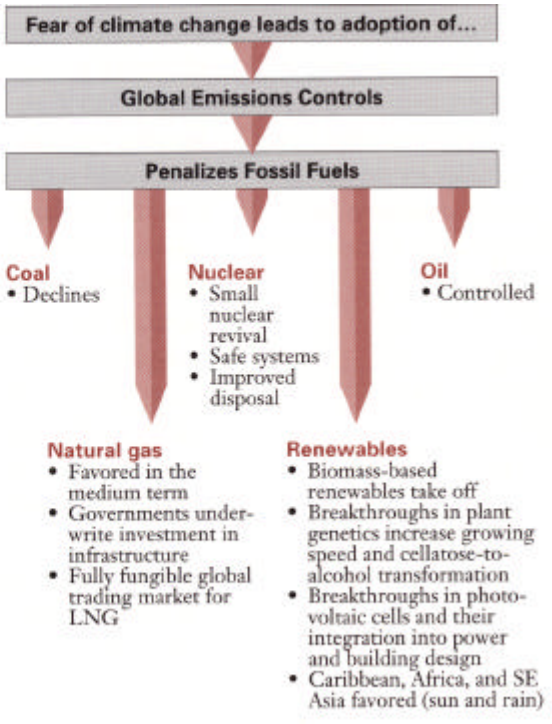
## The Orchestrated Supply Scenario

**2025 Orchestrated Supply**

| | *MMBDOE* | *Change vs. 1996* |
|---|---|---|
| Coal | 30 | (35%) |
| Oil | 70 | 0% |
| Gas | 100 | 150% |
| Nuclear | 40 | 208% |
| Hydro | 7 | 75% |
| Renewables | 53 | N/A |
| Total | 300 | 73% |

**1996–2025 Average Annual Growth**

| | |
|---|---|
| Energy | 1.9% |
| Economy | 3.5% |
| Average Oil Price | $15/B |



What will induce these breakthroughs? Technologies are moving in the right direction, but it seems that an external boost will be needed to increase deployment of capital and technological resources for making these advances. In the 1970s, it was a major rise in oil prices that accelerated the development of nuclear energy and natural gas and rejuvenated the coal industry. It was the conventional economic response to a mismatch between supply and demand. This response was also consistent with the strong nationalistic forces of the time, which supported the move of the OPEC countries to increase their rent from oil resources.

However, in the recent environment of globalization and efficiency gains, transformation driven by a commodity price is less likely. An alternative driver that seems more in keeping with our times would be global emissions limits that would set a value on emissions, thereby penalizing fossil fuels relative to renewables. Such a system might be difficult and contentious to set up because it's not easy to calculate for each fuel a net energy balance that fully accounts for production (including consumption of fertilizers, but crediting for carbon absorption from the atmosphere in the case of biomass), distribution, installation, and operation. However, taking the GEOpolity model as a guide, we can imagine a new global environmental governance body that would set up and administer the system.

This emissions-trading driver would favor natural gas in the medium term and encourage investments in the international transportation infrastructure – leading to continental gas pipeline grids and a fully fungible global LNG trading market. We should expect a modest revival in safe nuclear systems coupled with improved disposal technologies for nuclear waste. Coal, by contrast, would be disfavored and in decline.

If biomass-based renewables take off as described in this scenario, it is interesting to speculate on the regional implications. Essentially, biomass uses solar power to fix carbon through photosynthesis. Consequently, the best places to build these industries will be in tropical areas, which have the most sun, as well as rain. This requirement will benefit Africa, the Caribbean, South America, and Southeast Asia.

### Technology Solutions

A revolutionary change in the traditional link between energy demand and economic growth would require advances in end-use technologies, as well as some potentially significant changes in lifestyle. In this scenario (Exhibit 3), economic growth will be similar in aggregate but distributed differently among sectors of the economy compared to the Orchestrated Supply case. Service sectors, especially telecommunications, would be preferred, while the traditional energy-intensive sectors of heavy industry would be disfavored. Telecommunications technologies would continue to astound, and a growing proportion of business transactions, including meetings, would take place electronically.

### Exhibit 3

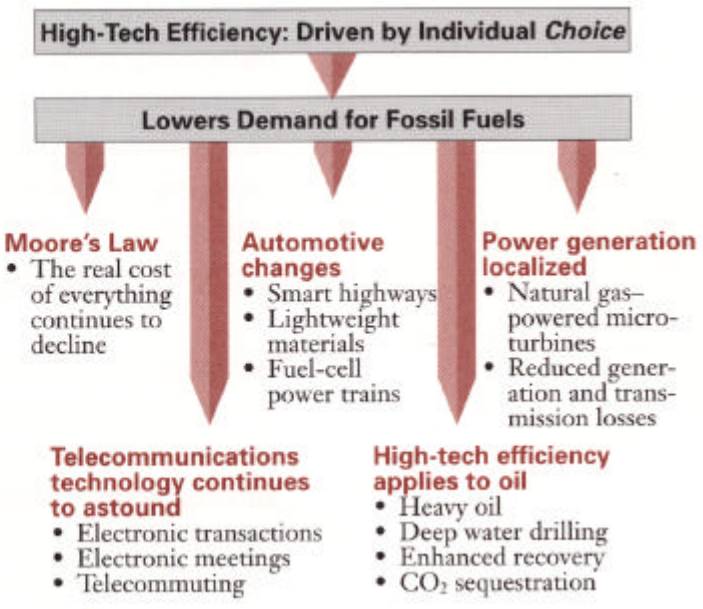
### The Technology Solutions Scenario

**2025 Technology Solutions**

| | *MMBDOE* | *Change vs. 1996* |
|---|---|---|
| Coal | 40 | -13% |
| Oil | 100 | 43% |
| Gas | 90 | 125% |
| Nuclear | 20 | 54% |
| Hydro | 7 | 75% |
| Renewables | 53 | N/A |
| Total | 270 | 56% |

**1996–2025 Average Annual Growth**

| | |
|---|---|
| Energy | 1.5% |
| Economy | 4.0% |
| Average Oil Price | $20/B |



In this scenario, we should anticipate radically different vehicles, possibly using lightweight materials and fuel-cell power trains; people will further save fuel by using smart highways. Power generation is distributed to the end-users, who have installed low-cost natural-gas-powered micro-turbines or fuel cells. These units reduce generation losses and eliminate electric transmission losses. Genetic engineering minimizes the need for fertilizers and pesticides.

In the previous scenario, the supply revolution is driven by a new global constraint on emissions, which propels a series of major investments in supply. In contrast, the demand revolution of the Technology Solutions scenario will require a driver that will influence a large number of smaller decisions by individuals on subtle lifestyle changes involving less energy-intensive products and services. Consistent with the Jazz global governance context, this shift will be driven by the sheer attractiveness of the new technologies, rather than by government fiat or by a strong price signal. It could be that Moore's law,[1] which seems to govern the rate of change in price and performance of computer chips, becomes so ubiquitous that electronic applications and novel materials are irresistible regardless of the price of energy. Furthermore, bio-technological advances could follow the same path, making traditional forms of agriculture look as obsolete as the steam engine.

Nevertheless, we would expect in this scenario a period of somewhat higher prices for energy commodities that would provide an incentive to technological and behavioral changes aimed at reduced energy consumption. The price driver will also allow slightly greater oil production than in the previous scenario, and a modest introduction of renewable fuels.

### Malthusian Future

In the Malthusian Future scenario (Exhibit 4), global economies would strive for growth but be constrained by the lack of natural resources. It turns out that the exciting promise of the technologies of the late twentieth century was overrated. Advances in automobile efficiency are quite limited, consumers are inflexible to changes in lifestyle, and telecommuting and reduced travel are rejected.

Renewable fuel sources will remain uneconomical, and no consensus can be built around emissions reductions on a national – let alone global – level. Producers of raw material would claim rent for their resources, transferring wealth from consumers to producers. Ultimately, this scenario returns us to the 1970s environment marked by confrontation between the owners of natural resources and their consumers in the context of the FROG! global governance scenario.

### Exhibit 4

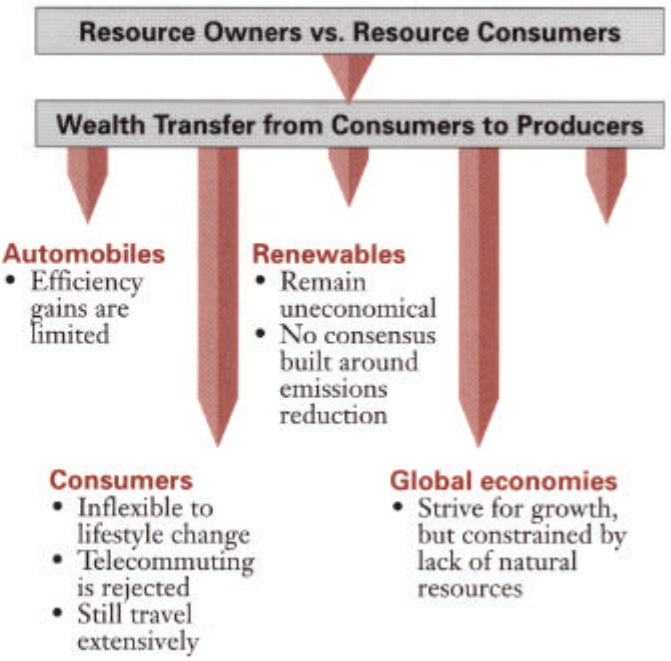
### The Malthusian Future Scenario

**2025 Malthusian Future**

| | MMBDOE | Change vs. 1996 |
|---|---|---|
| Coal | 50 | 9% |
| Oil | 90 | 29% |
| Gas | 80 | 100% |
| Nuclear | 20 | 54% |
| Hydro | 7 | 75% |
| Renewables | 3 | N/A |
| Total | 250 | 45% |

**1996–2025 Average Annual Growth**

| | |
|---|---|
| Energy | 1.3% |
| Economy | 2.2% |
| Average Oil Price | $25/B |



## Prospering in Any Future

We are often asked what is the probability of a single scenario. The answer we give is „zero." Something different from any of the contemplated scenarios will invariably happen. For example, we may end up with a hybrid – with some renewables, some demand efficiencies, and some lowering of expectations. Or we may jump from one scenario to another in response to unexpected events. Or technological and social changes may be so remarkable that one of the scenarios occurs in a much more radical form than we have imagined.

The point of scenarios is not to predict the future, but to explore different possible futures. As evidenced in the 1970s, it seems to us that the future cannot be just an extension of the past. We believe that the concepts of sustainable development are as influential today as the forces of nationalism were then, and that the integration of economic growth with environmental quality and social equity will in one way or another mold the future.

### Exhibit 5

### Characteristics of Leading Companies Under Three Scenarios

| | Leading Company Strengths |
|---|---|
| Orchestrated Supply | • Ability to deal with global rule-setting bodies • Participation in the renewables businesses • Acquisition of weak by strong |
| Technology Solutions | • Rapid deployment of new technologies • Partnering and alliancing skills • Continuous productive conversations with multiple stakeholders • Flexible organizational architecture |
| Malthusian Future | • Global portfolio of opportunities • Ability to withstand loss of a major asset • Strong identity with host country • Ability, to use home country leverage |

Energy companies need to face up to the probability that the world will change substantially during the economic life of many of the projects that they are now planning. They need to be sure that these projects are adaptable to the possible changes, and they need to seek out the exciting opportunities that will emerge during the years of change. The leading company may well be different in each scenario, but there are some common themes that seem likely to be important in all scenarios: rapid learning, technology deployment, innovation, and global reach (Exhibit 5). Companies will need new or different mental models, forms of governance, and perhaps people to prosper in the generation ahead.

[1] *Moore's Law is the observation made in 196) by Gordon Moore, co-founder of Intel, that the number of transistors per square inch in integrated circuits had doubled every year since the integrated circuit was invented. Moore predicted that this trend would continue for the foreseeable future. In subsequent years, the pace slowed down a bit, but data density has doubled approximately every 18 months, and this is the current definition of Moore's Law, which Moore himself has blessed.*

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