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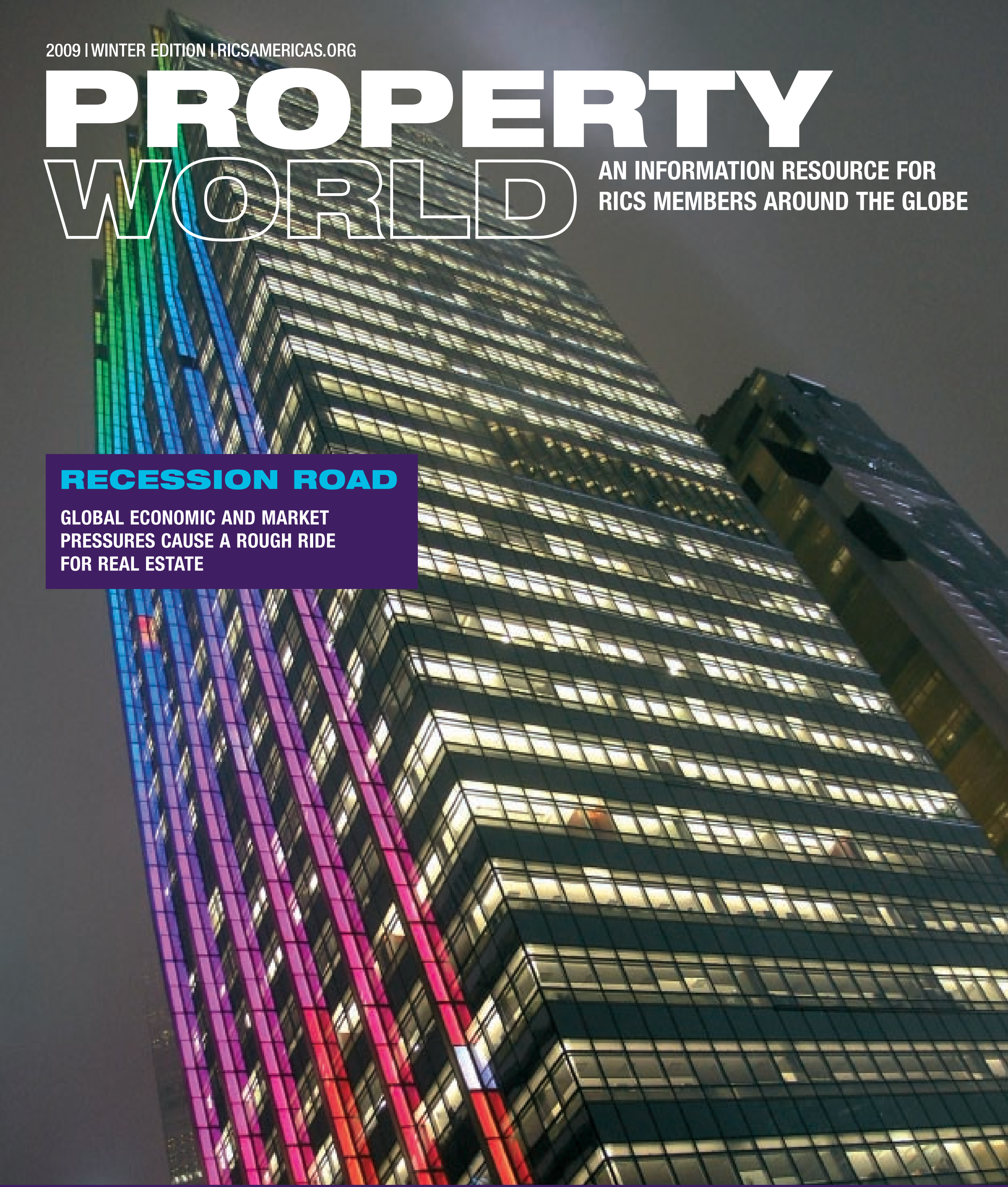

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Building an alternative energy future: the value and cost of energy alternatives

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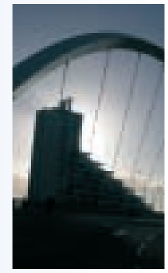
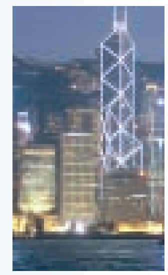
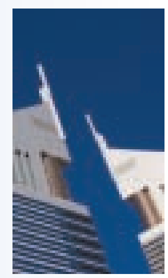
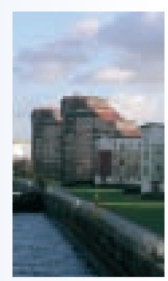
Contents









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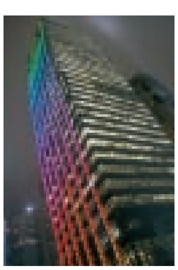

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Energy for Change: Building our Alternative Energy Future

Mark Pomykacz FRICS analyzes the value and cost of alternative energy.

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In the coming decades, two different but equally powerful forces will converge and confront humankind. One is global warming, which will require a massive shift away from CO2 releasing technologies. The other is the increase in energy consumption as the developing world demands more energy. Do we have a response and can we afford it? Yes, to both questions. In fact the response could be profitable. In particular, green electricity will be a green business pasture in the next two decades. Here's how the major electricity generation technologies currently line up.

The Scope of the Issue

Americans use 13.75 megawatts hours (MWh) of electricity per person. In contrast, the Chinese only use 2.5 MWh. Furthermore, there are 1.6 billion people in the developing world that do not yet have any access to electricity. As these countries develop, world electricity production and demand will nearly double by 2030. Currently developing nations use three quarters of the electricity developed nations use, but by 2030 they will use nearly 50 percent more than developed nations (see Figure 1).

Traditional Electricity

Currently, the majority of the world's electricity is generated using non-renewable fuels: coal (41 percent), natural gas (20 percent), nuclear (15 percent), petroleum (6 percent). By 2030 coal and natural gas-fired electricity will increase to 46 percent and 25 percent, respectively. These rates vary from country to country and region to region.

Coal: While coal-fired power is fairly expensive to construct, coal as a fuel is inexpensive. On an internalized cost basis coal is the least expensive power. However, coal has significant external costs. Old coal technology causes acid rain, smog, mercury pollution, and mining collateral damage. Though new technology coal largely solves most of these problems, it still continues to be a green-house gas emitter. Technologies that sequester CO2 are in the laboratory phase, and are not likely to result in commercially viable processes for many years. The CO2 sequester technologies will be a future growth sector. Governments are continuing to ratchet up regulation on coal in order to motivate greener electricity from coal, and its alternatives. Coal is a base-load provider, meaning it runs non-stop for months at a time, which is very important to a well managed electricity supply system. While coal enjoys no direct subsidies, and suffers increasing regulations, it benefits indirectly from a well developed low-cost mining and rail transportation systems. As practical matter, modern life will continue to depend on coal power in one form or another.

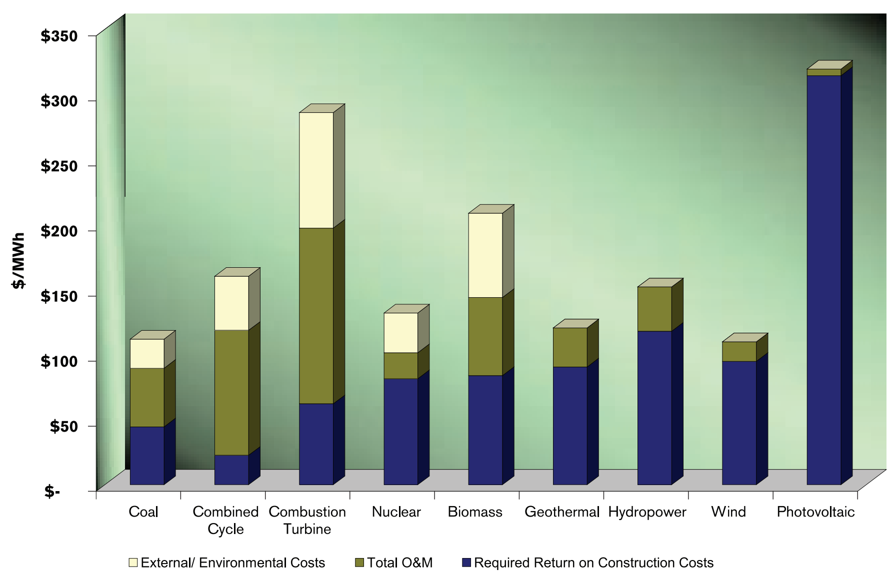

Figure 1: Electricity Consumption

Natural Gas: Natural gas-fired power is the least expensive to build. However natural gas prices make this power among the more expensive on an internalized cost basis. Except for the green-house gas emission problem, this power source has few external cost issues. Natural gas is a peak-load provider (it fills in for base-load plants and at peak demand periods). As a practical matter, a well managed power system must have peaking power, which will continue to be, mainly, gas. Natural gas supporting infrastructure is developed, and is growing with Liquefied Natural Gas.

Nuclear: Nuclear power is among the most expensive to build, but least expensive to operate, if externalized costs are excluded. In the U.S. the externalized costs are large. The United States government assumes all costs to dispose of spent fuel and radioactive waste, and local consumers pay indirectly and separately for plant decommissioning. Since it produces no CO2, nuclear electricity generation is considered green, but this does not account for the potential damage from radiation accidents or incidents. Nuclear is a base-load provider. As a practical matter, modern life in several of the developed countries will continue to depend on the existing nuclear power fleet. In spite of the recent positive press, future nuclear development will be limited by high construction costs and the supply of fuel which is as exhaustible as oil, gas, and coal.

Oil: Oil is a peak-load provider and is fairly inexpensive to build but expensive to operate, as fuel oil is expensive. Also oil facilities are often older, and do not utilize modern clean technologies. Even though a well managed power system must have peaking power, oil will play a decreasing role in the future.

Hydro: Hydroelectric power is renewable energy. Unfortunately nearly all the good sites for hydro power have already been developed. The remaining sites are small, having inadequate economic efficiencies marginally feasible and/or the sites are ecologically undevelopable. New hydros will continue to be developed, but will contribute less to satisfying new demand, unless anti-hydro attitudes soften on the ecology issues. Practically speaking, hydroelectric power does not usually provide base-load power due to seasonal and daily dry periods.

The Green Need

Currently the U.S. Energy Information Agency (EIA) estimates that 18 percent of worldwide electricity is supplied by renewable sources. The EIA expects the contribution for renewable technologies to decline to 15 percent by 2030. However, EIA forecasts global demand will increase by nearly 100 percent, (3.5 percent annually) by 2030. This increase in demand will require the utilization of traditional non-renewable energy sources, because they are known technologies, and are more quickly and predictably deployed. The challenge to governments and investors in active green energy development will be to become knowledgeable and supportive of the new, renewable technologies, because the old traditional technologies enjoy direct and indirect support in the form of subsidies and externalized costs.

The Green Electricity Solutions

Wind: Wind will be a part of our future supply portfolio, because while it is a little expensive to build, it is inexpensive to operate and renewable. Problematically, wind power is not base load power or peaking power, which requires our continued use of gas and oil, and the development of new power storage and transmission technologies and infrastructure. On average, wind generates electricity only 30 percent of the time, and we cannot choose which times (peak or off-peak) it runs. Wind mills generate when there is wind, which may be at night (off-peak) or in winter (off-season). While similar to hydroelectric power in this respect, wind suffers a greater disadvantage. To help visualize the base-load/peak-load problem for wind, recognize that it would take roughly 2,000 1.5-megawatt wind mills to replace one 1,000 MW coal or nuclear plant, which generate about 90 percent of the time (1,000MW * .90%/30%/1.5MW = 2,000), and still we have not solved the energy on demand issue.

Presently, wind is only feasible with the aid of government supports, but within the next decade, as the price of fossil fuels continues to increase, driving electricity prices higher, wind power will pass into self-sufficiency. In addition to the construction cost support, governments will need to support the development of new wind technologies, and power storage and transmission technologies and infrastructure, in order to truly level the playing field and promote green energy societal goals.

Photovoltaic: Even though photovoltaic is the least expensive to operate, the cost to build is so expensive, that this is the least competitive supply of electricity. More work in the laboratory is needed, although some new technologies appear practical in the intermediate future. Increases in production would help reduce installation costs through improved economies of scale. Photovoltaic is not base-load, as it can not run half the time (at night) and on cloudy days. This drawback requires the continued use of gas and oil, and the development of new power storage and transmission technologies and infrastructure. Current power storage technology is not practical for community wide applications. This is the greenest of all power technologies, and has no external costs. It requires and deserves government supports to level the playing field.

Others: There are perhaps a dozen other green technologies under development, such as solar concentrators, rising hot air vortexes, tidal systems, wave systems, thermal differentials, bio-mass, bio-gas, bio-fuels, compressed air power storage, and efficient long distance transmission. To varying degrees, all of these suffer substantially from the difficulties of new technology. They are laboratory-proven, but not commercially/economically feasible. There is a lack of widespread know-how and experience. They suffer from limitations on scale (small sized plant which negatively impact economies), and very high construction costs. However, since nearly all are inexpensive to operate and have little to no external costs, they deserve government support to complete their development and to level the playing field.

The Real Cost and Value

Readers should note that while the prices of commodities like the fuels used for electricity generation are notoriously volatile, historically the costs of both plant construction and operation have been moderately predictable. However, in recent years, all fuels, beginning with gas, then oil, and now coal and uranium, have become increasingly volatile and inflationary. This appears to be the new permanent characteristic of the market. Additionally, the price of steel and concrete for plant construction has hit an all time highs. This will surely lead to new winners and displacements among the competing energy technologies.

The following tables and graphs compute the cost/value of power from different sources, first on cost to build, then on a cost to generate power, for basic comparison. We then compute the external costs of the generated power to find the true cost of our alternatives and choices. While the cost to build and to generate reflects the realities of the developer and operator, this view does not encompass the total cost to humankind, as some costs are external to the developer and operator. The external costs include CO2 management and nuclear decommissioning (see Figure 2).

As expected those long lived assets with the longest construction periods and the newer technologies cost the most. Our analysis includes the cost of financing and other soft costs. This analysis appears to indicate that combined cycle and combustion turbines are the superior choice. However our analysis does not account for economies of scale, fuel costs and other operating costs.

The last graph (see Figure 3) converts the construction costs to an annual required return, which accounts for the capacity factor of the technology. This graph adds in the operating costs, including fuel costs. On a combined capital and operating cost basis (and before accounting for external costs), coal and nuclear are the best buys. Surprisingly, wind is getting to be competitive. In future years, as fuel expenses rise, wind may carry the day. After accounting for the external costs of CO2 management and nuclear decommissioning, wind is already the winner. Governments must provide modest supports for wind development (and the other green technologies) to internalize value and costs against the traditional technologies, and level the playing field.

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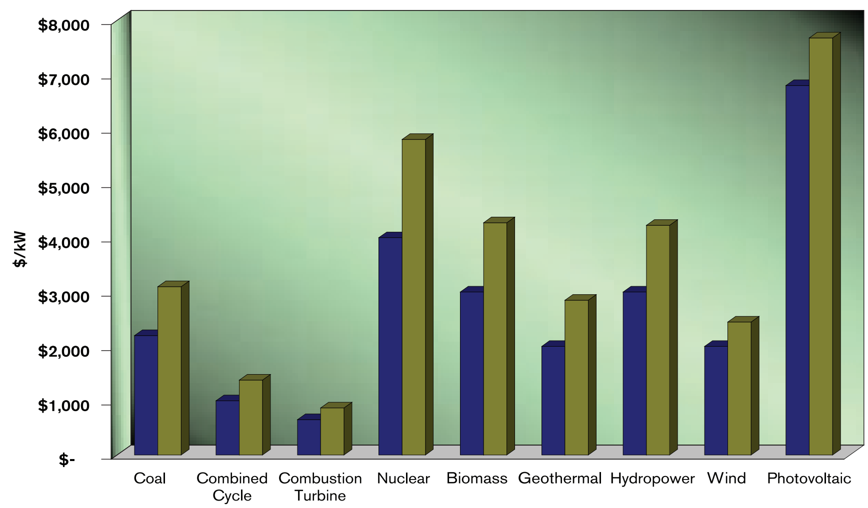

	Coal	Combined Cycle	Combustion Turbine	Nuclear	Biomass	Geothermal	Hydropower	Wind	Photovoltaic
Overnight Construction Costs	$2,200	$1,000	$650	$4,000	$3,000	$2,000	$3,000	$2,000	$6,800
Overnight, Other & Financing Costs	$3,099	$1,380	$868	$5,808	$4,275	$2,850	$4,226	$2,448	$7,676

Figure 2: Overnight vs Total Construction Costs to Build

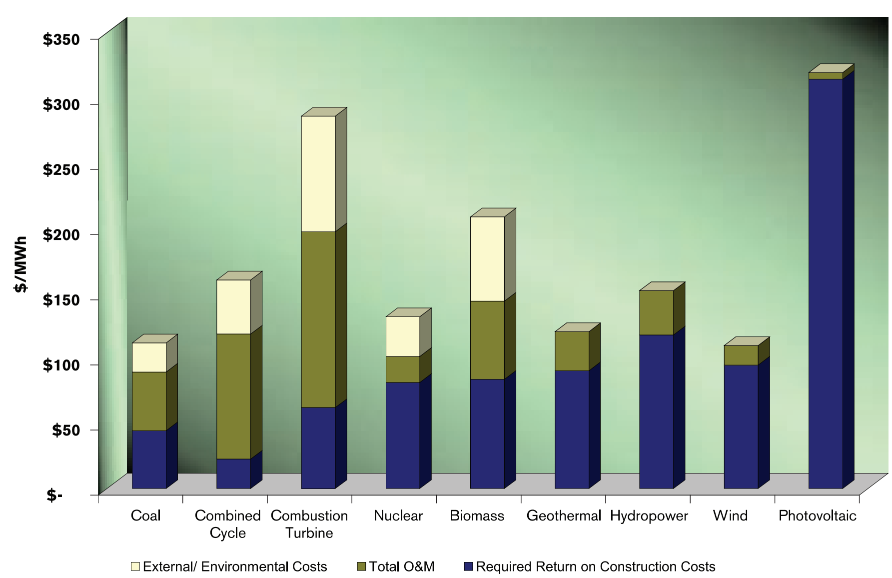

Figure 3: Total Internal and External Costs