TUTORIAL - 4

Importance and Role of Energy Management, Computer Controlled Management and Energy Management Program

1. What is energy management? How it helps in solving problems of energy crisis?

The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect. The term energy management means many things to many people. One definition of energy management is:

"The judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions" **or** "The strategy of adjusting and optimizing energy, using systems and procedures so as to reduce energy requirements per unit of output while holding constant or reducing total costs of producing the output from these systems"

→ The world is facing an energy crisis. In short, we use more energy resources than we can sustain. Fortunately, scientists and researchers around the globe are developing new methods and technologies to generate, store and transmit energy in secure, sustainable and environmentally friendly ways.

This transition to more sustainable energy use involves developing clean energy sources that are cost competitive with coal, transmitting energy over large distances with little loss, and increasing energy storage capacity to make batteries lighter, more efficient and cheaper to use. In the long run, all of this will be achieved by creating new paradigms and technologies for **energy management.**

One of desirable sub objective of energy management program is **"reducing the impacts of curtailments, brownouts, or any interruption in energy supplies".**

Here curtailment is in terms of energy management and Energy Crisis is **"To cut short or reduce and the action or fact of reducing or restricting use of energy" *or* in technical terms "A technique used by a company to help it become more stable by reducing company operations".**

Curtailments occur when a major supplier of an energy source is forced to reduce shipments or allocations (sometimes drastically) because of severe weather conditions and/or distribution problems. For example, natural gas is often sold to industry relatively inexpensively, but on an interruptible basis. That is, residential customers and others on non-interruptible schedules have priority, and those on interruptible schedules receive what is left. This residual supply is normally sufficient to meet industry needs, but periodically gas deliveries must be curtailed.

Even though curtailments do not occur frequently, the cost associated with them is so high sometimes a complete shutdown is necessary—that management needs to be alert in order to minimize the negative effects. There are several ways of doing this, but the method most often employed is the storage and use of a secondary or standby fuel. Number 2 fuel oil is often stored on site and used in boilers capable of burning either natural gas (primary fuel) or fuel oil (secondary fuel). Then when curtailments are imposed, fuel oil can be used. Naturally, the cost of equipping boilers with dual fire capability is high, as is the cost of storing the fuel oil. However, these costs are minuscule compared to the cost of forced shutdown. Other methods of planning for curtailments include production scheduling to build up inventories, planned plant shutdowns, or vacations during curtailment-likely periods, and contingency plans whereby certain equipment, departments, etc., can be shut down so critical areas can keep operating. All these activities must be included in an energy management program.

Although energy conservation is certainly an important part of energy management, it is not the only consideration. Curtailment-contingency planning is certainly not conservation, and neither are load

shedding or power factor improvement. To concentrate solely on conservation would preclude some of the most important activities—often those with the largest savings opportunity.

2. What are various energy management techniques?

1. Efficiency upgrades

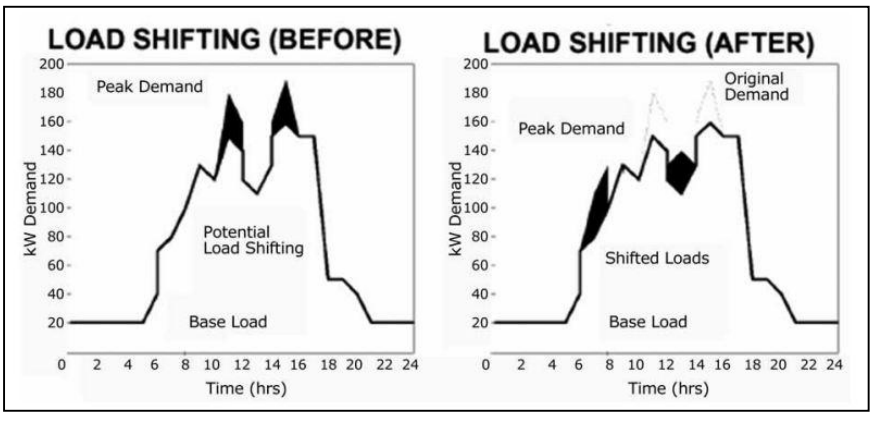
The fastest way to reduce energy consumption is to locate equipment within the building that is consuming more power than is reasonable. Technology that was designed before energy efficiency became such an important value in business is fundamentally wasteful. The most reasonable way to begin an electrical energy management program is to replace various systems with new technology. While the cost of these upgrades can be considerable, the savings that result begin to accrue almost instantaneously.

2. Building automation

Building automation allows facility managers to control every device in the building. Most building management systems already have sufficient capability for advanced energy management. All that needs to be added to the system is an online interface like VirtuWatt™. This interface streams pricing information into the BMS. The facility manager can now see how much money each device on the network is costing per minute, per hour, and per day.

3. Load shifting

Linking information technology to building automation allows facility managers to make choices about what building systems need to run during peak hours. Many operations can be scheduled for off-peak times when energy prices are considerably lower. This process, known as load shifting, opens the door for aggressive electrical energy management. The ability to move an entire segment of power away from the most expensive times of the day paves the way for two additional energy saving measures: load shedding and distributed generation.



4. Load shedding

The percentage of power that is typically used will naturally decrease when load is shifted away from peak times. The percentage of decrease represents the amount of power utilization that has actually been curtailed. Companies can actually do something with this decrease that adds value beyond basic electrical energy management. They can shed this load during demand response events, earning money from the ISO (independent service provider) as a reward for helping alleviate stress from the grid.

5. Distributed generation

Curtailment of power consumption does not necessarily mean that you have to use less power per se. You have to use less power from the grid. Power that you generate in-house does not accrue a monthly service charge. If you are using natural gas for space heating, you can upgrade to combined heating and power technology. This uses excess heat to generate electricity, which you can then use to power other parts of your operation.

3. Discuss electricity saving techniques by category of end use.

1. **Interior Lighting**: [lamp/luminaries, bulb, fluorescent (standard/compact)]

   - ✓ Use fluorescent tubes in preference incandescent bulbs. Fluorescent lamps are three (3) times more efficient and last ten (10) times longer.
   - ✓ Consider the purchase of compact fluorescent lamps/luminaries (CFL). These lamps produce less heat and last longer.
   - ✓ Rooms can be light-zoned. In non-reading and non-working areas reduced lighting (25 watts – 40) watts can be used.
   - ✓ Avoid "long-life" bulbs. They are 20% less efficient than the standard bulbs.
   - ✓ Dimmer switches can save energy when used with incandescent lighting fixtures.
   - ✓ Use high-pressure sodium or metal halide lamps for outdoor/external lighting (left on all night).
   - ✓ Turn off all lights, when someone is not occupying the washroom, closets and in-frequently used area.

2. **Office Equipment:** [printer, scanner, photocopier, facsimile/fax, calculator, cash machine, paper shredder, detacher, transformer (power)]

   - ✓ All office equipment is to be in accordance with the suppliers/manufacture operational procedure manual; failure to comply can and would result in poor equipment operation and failure.
   - ✓ Use as necessary or as the need arise. All nuisance use or non- work related task and assignments are to be avoided.
   - ✓ Do not leave transformers plugged into the wall outlet receptacle; disconnect (turn-off the outlet switch) and isolate (remove) all transformers at the end of the working day.
   - ✓ Shut off unnecessary computers, printers, and copiers that are not in use and close-down/disconnect at the end of the working day.

3. **Air Conditioning:** [air conditioner unit (window, split, central)]

   - ✓ All office windows are to be covered by light coloured blinds/curtains or screens. E.g. white, beige, light cream, to reduce heat conduction, radiation and convection. Awnings to shade windows also help.
   - ✓ Unit setting should be at 70 – 74 deg. F or 22 – 24 deg. C. Each increase will reduce air conditioning consumption by approximately 8 %.
   - ✓ All doors, windows and openings are to be thermally sealed and kept closed on entry/exit to reduce unit over-work.
   - ✓ Set thermostat/temperature control to "auto". The "fan-on" setting will increase energy use.
   - ✓ Seal all leaks around coils.
   - ✓ Provide shade for the condenser unit, without obstructing airflow currents.
   - ✓ Fans should not run in rooms that are unoccupied.

- ✓ Ceiling fans can augment natural breezes to increase comfort. They can improve ventilation and lessen the need for air conditioning.
- ✓ Open windows as wide as possible to admit cool circulating breeze and fresh breeze.

4. **Domestic Refrigeration, Heating & Ventilation:** [refrigerator, freezer, chillers, water fountains, water heater, fans, ventilator]

- ✓ Be conscientious and mindful of the time spent with the refrigerator door open, during the entry and/or retrieval of items.
- ✓ Use as the need arise; however before opening (the door) think and decide on what item, one wish to remove from the appliance.
- ✓ Allow warm food to cool before storing in the refrigerator.
- ✓ Make sure that air spaces under/beneath and behind the refrigerator allows for the free escape of hot air currents
- ✓ Motor and condenser coils should be kept free of dust.
- ✓ Proper (i.e. at appropriate times) defrosting as directed [by the manufacturer] increases efficiency.

5. **Cooking, Domestic Equipment, Laundry & Clothes Drying:** [oven, range/cooker, hot plate, microwave, toaster, blender/mixer, kettle, floor polisher, vacuum cleaner, dryer/blower, iron, television, video, radio/stereo, washing machine]

- ✓ All appliances must be turned off, when not in use.
- ✓ Stove/oven/ ranges are to be set on the medium range at 2 – 3temperature level. - Laundry: Good practices saves on energy use for water heating, washing and drying.
- ✓ Use cold water (70° to 80° F) for most cloths and for rinsing. This does not affect the quality of the wash.
- ✓ Use hot water (130° F) only for colour fast cotton and stains.
- ✓ Use short wash cycle for lightly soiled garments
- ✓ Wash full loads ALWAYS if and when possible.

- **Clothes Drying:**

  - Use a clothes-line or "solar clothes dryer". This saves 100 % use in electric energy.
  - If a power dryer is used, wash and dry several loads in succession, since a warm dryer uses less energy.
  - Dry ONLY full loads as often as possible.

6. **Miscellaneous Equipment:** [motors, pumps, compressors, irrigation schemes]

- ✓ Stagger start-up times for equipment with large starting currents to minimize load peaking.
- ✓ If possible, shut off a piece of equipment before starting the alternate piece.
- ✓ Disconnect primary power to transformers that do not serve any active loads (e.g. periodic/seasonal loads or surpluses transformers).

4. What are the factors influencing energy management program?

- **Identify energy influencing factors:**

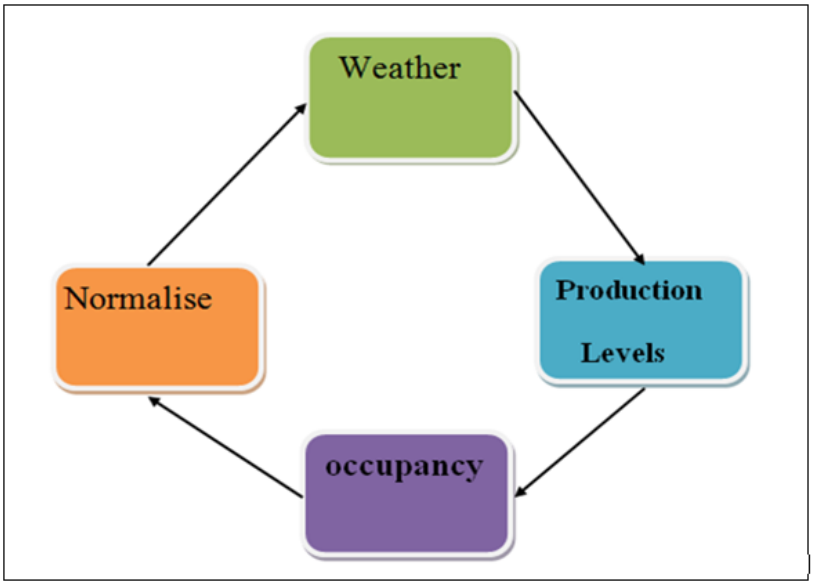


Figure: Identify energy influencing factors

First you need to identify the factors that influence energy consumption. These may include the following:

1. Weather

Where energy is used mainly for heating and cooling of buildings, daily or seasonal variations in the weather will influence energy use. There should be a direct relationship between weather conditions and energy use. To quantify the influence of the "weather" and normalize your energy data, use Degree days, which gives you a measure of the severity and duration of cold weather.

2. Production levels

Compare energy use against production levels. Increased production will usually cause increased energy use. However, this may mask the true relationship, as the lighting or heating energy use may not change much against production levels. Therefore try to separate out non-production related energy use in normalizing data.

3. Occupancy

Is your energy use consistent with occupancy? Compare usage during the week with usage at night, weekends or holidays and see if you are using energy unnecessarily outside of working hours.

4. Normalize

In order to compare energy use over time, you need to normalise your energy consumption figures. After doing this you can identify trends in consumption and apply performance indicators to compare performance.

Having identified the factors that influence consumption and normalised your data, it is important to compare your performance against other internal or external reference standards to determine how well you are actually performing.

- **The factors influencing energy management :**

Five key factors, what are they? Focus, planning, resources, processes and people greatly affect the performance of energy management. These factors are applicable not only to the energy management team members but also, in a narrower domain, to the front line managers in the plant.

(1) Focus:

The energy management manager team needs to ensure that the overall manufacturing operation has a clear sense of direction and strategic focus. Frontline managers also need to ensure correct interpretation of the goals by the workforce. Once the workforce in the plant is clear about goals and focus, the energy manager and the frontline managers need to delegate responsibility and decision-making authority to the required people, making them accountable for results.

(2) Planning:

It is the energy manager's responsibility to chalk out a strategy to achieve goals with maximum input from the people who will implement the plan. Effective strategic and operational planning on the management team is a must for optimal performance of the manufacturing operation.

(3) Resource:

The energy manager should be able to garner enough financial support for his/her operation, deploy appropriate technologies and take steps to put together an effective team. It is then extremely important that the energy management team work directly with frontline management to ensure that financial resources and technologies are properly used for operations and maintenance.

(4) Processes:

Without appropriate processes, focus, planning, and resources are of no use. I can't stress how vital it is for the energy management team to have an efficient operating system in place, which closely monitors the operations and triggers a corrective action if the performance of the operation falls below expected efficiency and/or production levels.

(5) People*:*

An effective and motivated workforce can be a blessing to any energy management effort. The energy management team should share a good working relationship with the frontline management group.

5. How energy and power management is done in industry?

Energy and power management in industries is becoming a competitive necessity. Manufacturers must capture opportunities to reduce energy use and emissions, and at the same time increase bottom line profitability. An integrated approach for reducing energy operating costs and emissions considers both the steam and power utility system (the utility supply side) and the production processes (the utilities demand side).

- **Benchmarking Energy Consumption**

Understanding the patterns of all forms of energy use and other utilities is the first step in assessing the potential for efficiency savings. With the data available through system, Energy Management system can guide the plant manager to organize and display (visualize) key energy and other parameters in real time thus providing a tremendous diagnostic tool for identifying and solving energy problems and appreciating opportunities for cost savings.

- **Reduction in Specific Energy consumption**

The majority energy consumption in the plant is for production activity. Each product manufactured will be measured by energy consumed to make one unit of product. With Energy Management system, the plant manager can measure as well as reduce energy by close monitoring of machinery run hours and prevent idle running of machine and thereby reducing the specific energy consumption of manufactured product.

- **Reduction in Distribution Loss**

The power received from Electricity board and captive power is being fed through various transformers to various load centers like MCC, PCC Pumps, Blowers, Compressors, Fan, Chillers, Lighting loads and so on. With the Energy Management system it is easy for plant manager to identify energy consumed by each machinery. It is very important to know whether power received from source is being utilized effectively by all machines and level of the losses incurred due to distribution.

- **Reducing Peak Demand**

This can assist in reducing peak demand and associated demand charges. Regular verification of daily load profile will help plant manager to identify and eliminate demand spikes, such as those associated with simultaneous motor, pump, compressor startups or schedule operation in such a way as to reduce overall demand.

- **Energy Resources Planning**

Our system computers the energy balance at various nodes and system losses to formulate and implement loss elimination schemes as any electrical distribution network has inherent losses. Conducts overall energy accounting. Since energy use pattern of every feeder is monitored, any variation in power consumption pattern at any process or sub section is exposed immediately for immediate control.

- **Predictive Maintenance**

Energy management system helps in planned shutdown based on run hours and efficiency of the equipment. This reduces down time and helps plan predictive maintenance. In a palm oil company.

- **Root Cause Analysis**

The system can analyze incidents like Excess energy consumption, overloading, excess T&D loss, Machine breakdown, breaker tripping, damages to capacitors etc. for which Root Cause Analysis is

necessary. Energy management system helps to correct problems in production rate and product quality by analyzing the trends of energy consumption in relation to production.

- **Measurement and Verification**

Energy Management system covers the measurement and records energy consumption trends. Verifies results of energy savings measures taken. Enables achievement of the objectives with the precision, which assist in decision making.

- **Improving Energy Equipment Performance**

Malfunctioning or degraded equipment often has an associated "energy fingerprint". For example a broken economizer damper may be signaled by an increase in the frequency of compressor cycling.

- **Remote Energy Efficiency Consultancy Services**

This is a remote monitoring of EMS system through Internet which does complete data analysis and also understanding process of the plant and single line diagram. Based on consultancy, the saving opportunity in the plant is being found and recommendation of Energy Efficiency measures report is being submitted.

6. Explain demand management.

Energy demand management, also known as demand side management (DSM), is the modification of consumer demand for energy through various methods such as financial incentives and education. Usually, the goal of demand side management is to encourage the consumer to use less energy during peak hours, or to move the time of energy use to off-peak times such as night-time and weekends.

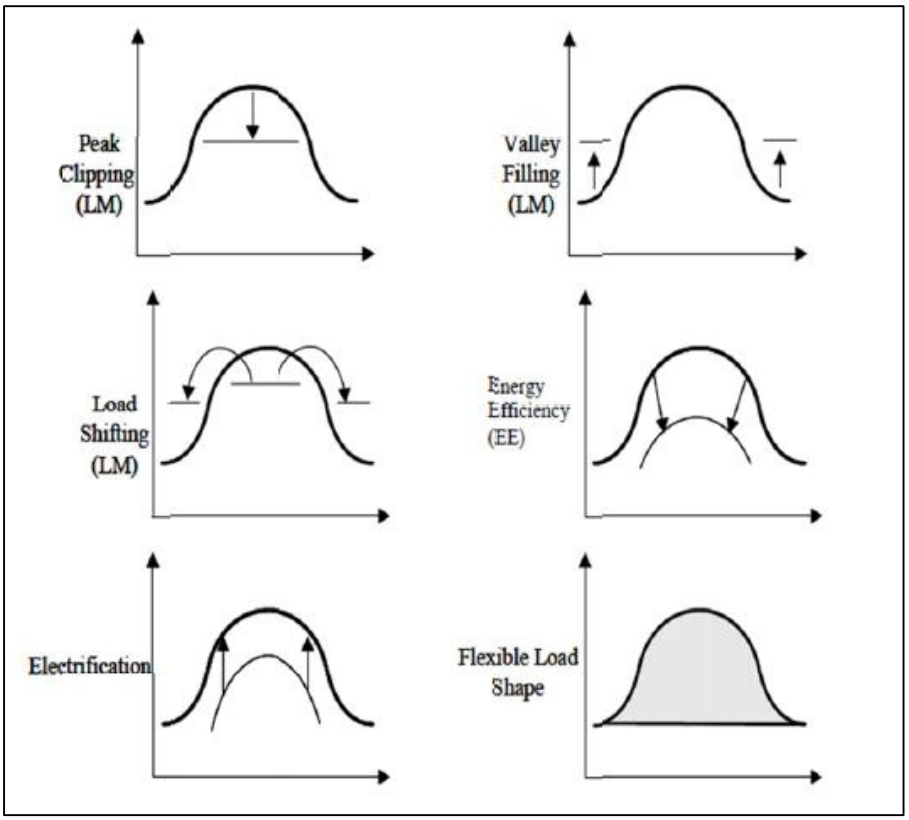
Peak demand management does not necessarily decrease total energy consumption, but could be expected to reduce the need for investments in networks and power plants .To ensure stability on the electricity grid, electricity supply and demand must remain in balance in real time. Traditionally utilities have called upon peaking power plants to increase power generation to meet rising demand. Demand-side management (DSM), which includes energy efficiency and demand response (DR), works from the other side of the equation – instead of adding more generation to the system, it pays energy users to reduce consumption. Utilities pay for demand-side management capacity because it is typically cheaper and easier to procure than traditional generation.

Some important objectives are:

- "Peak lopping" to reduce energy consumption during daily system peak. This is done by using technologically more advanced and efficient consumer end equipment on services like heating cooling etc.
- "Valley filling" to build up off peak loads to flatten load curves improve system load factor and consequently more revenue.
- "Load Shifting" which can be alone by Thermal Storage
- Energy conservation at the consumer end by use of energy efficient equipment. Energy efficiency programs are to be considered along with the cost of achieving the energy conserved in comparison with the cost of procuring the quantum of energy that may have to be purchased i.e. cost in Rs. per KWh of conserved/ saved with that of energy procured/purchased.

There are 3 main categories of utility DSM programs viz (i) Energy Conservation (ii) Load Management and (iii) Strategic Load Growth.

1. Energy Conservation Program: - This is intended to be achieved by using equipment with improved efficiency, building and industrial processes.
2. Load management Programs:- This is achieved by redistributing energy demand to spread it more evenly i.e. load shifting program offering time of use tariff and interruptible power tariff rates etc.
3. Strategic Load growth program: - Programs that uncover cost effective electrical technologies that operate primarily during periods of low electricity demand.



7. Explain Energy Management Strategies for Industries with suitable examples.

The energy strategy for the future could be classified into immediate, medium-term and long term strategy. The various components of these strategies are listed below:

- **Immediate-term strategy:**

  - Rationalizing the tariff structure of various energy products.
  - Optimum utilization of existing assets
  - Efficiency in production systems and reduction in distribution losses, including those in traditional energy sources.
  - Promoting R&D, transfer and use of technologies and practices for environmentally sound energy systems, including new and renewable energy sources.

- **Medium-term strategy:**

  - Demand management through greater conservation of energy, optimum fuel mix, structural changes in the economy, an appropriate model mix in the transport sector, i.e. greater dependence on rail than on road for the movement of goods and passengers and a shift away from private modes to public modes for passenger transport; changes in design of different products to reduce the material intensity of those products, recycling, etc.
  - There is need to shift to less energy-intensive modes of transport. This would include measures to improve the transport infrastructure viz. roads, better design of vehicles, use of compressed natural gas (CNG) and synthetic fuel, etc. Similarly, better urban planning would also reduce the demand for energy use in the transport sector.
  - There is need to move away from non-renewable to renewable energy sources viz. solar, wind, biomass energy, etc.

- **Long-term strategy:**

  - Efficient generation of energy resources

    - Efficient production of coal, oil and natural gas
    - Reduction of natural gas flaring

  - Improving energy infrastructure

    - Building new refineries
    - Creation of urban gas transmission and distribution network
    - Maximizing efficiency of rail transport of coal production.
    - Building new coal and gas fired power stations.

  - Enhancing energy efficiency

    - Improving energy efficiency in accordance with national, socio-economic, and environmental priorities
    - Promoting of energy efficiency and emission standards
    - Labeling programmes for products and adoption of energy efficient technologies in large Industries

  - Deregulation and privatization of energy sector

    - Reducing cross subsidies on oil products and electricity tariffs
    - Decontrolling coal prices and making natural gas prices competitive
    - Privatization of oil, coal and power sectors for improved efficiency.

  - Investment legislation to attract foreign investments.

    - Streamlining approval process for attracting private sector participation in power generation, transmission and distribution.

A long-term energy strategy should be part of the overall strategy of a company. This strategy may include the objective of increasing the use of renewable energies. Furthermore, criteria for

decisions on energy investments, such as yield expectations, are determined. By formulating an energy strategy companies have the opportunity to avoid risks and to assure a competitive advance against their business rivals.

- **Potential energy strategies**

There are the following energy strategies.

- Passive Strategy: There is no systematic planning. The issue of energy and environmental management is not perceived as an independent field of action. The organization only deals with the most essential subjects.
- Strategy of short-term profit maximization: The management is concentrating exclusively on measures that have a relatively short payback period and a high return. Measures with low profitability are not considered.
- Strategy of long-term profit maximization: This strategy includes that you have a high knowledge of the energy price and technology development. The relevant measures (for example, heat exchangers or power stations) can have durations of several decades. Moreover, these measures can help to improve the image and increase the motivation of the employees.
- Realization of all financially attractive energy measures: This strategy has the goal to implement all measures that have a positive return on investment.
- Maximum strategy: For the climate protection one is willing to change even the object of the company.

In reality, you usually find hybrid forms of different strategies.

- **Energy strategies of companies**

Many companies are trying to promote its image and time protects the climate through a proactive and public energy strategy. General Motors (GM) strategy is based on continuous improvement. Furthermore they have six principles: e.g. restoring and preserving the environment, reducing waste and pollutants, educating the public about environmental conservation, collaboration for the development of environmental laws and regulations.]

Nokia created its first climate strategy in 2006. The strategy tries to evaluate the energy consumption and greenhouse gas emissions of products and operations and sets reduction targets accordingly. Furthermore, their environmental effort is based on four key issues: substance management, energy efficiency, recycling, promoting environmental sustainability. The energy strategy of Volkswagen (VW) is based on environmentally friendly products and a resource-efficient production according to the "Group Strategy 2018". Almost all locations of the Group are certified to the international standard ISO 14001 for environmental management systems.