Integrated Resource Planning
Glossary of Terms

Acknowledgments

Glossary of IRP terms

This glossary provides an overview of the key concepts, definitions, and acronyms which are used in Integrated Resource Planning and key topics associated with it. It is also included as an Annex to the IRP Development Manual.

Accounting cost: total money expenditure or outlay necessary to achieve a particular objective

Annuity: a fixed sum payable at specified intervals over a period. In practice, there is often an initial transaction, followed by equal annual payments over a predetermined life of the annuity. See also 'Recovery factor'.

Capacity and energy: these are two different aspects of electricity supply and demand:

- ***Capacity*** is the ability to deliver ***power***, which is the rate of doing work. The power demand, which needs to be met by supply capacity, is also often referred to as the ***load***. In an IRP, a common unit for power is megawatts (MW).

- ***Energy*** is the quantitative property that must be transferred to an object in order to perform work. Electrical energy delivered to households is usually measured in kilowatt hours (kWh), but in an IRP gigawatt hours (GWh) is a more common unit.

Capacity factor: The ratio of the expected output of a generation plant over a specific time period compared to the output if the plant operated at full-rated capacity in the same time period. For example, if a power plant is only expected to produce 100 MWh in a year could provide a capacity of 1,000 MWh in a year it would have a capacity factor of 10%. Capacity factor is closely related to 'load factor':

- **Capacity factor** says how much of the capacity is being used over time.

- **Load factor** tells you how much you load your power plant relative to the capacity.

These are much the same and the terms are often used interchangeably.

Captive power: Refers to plants set up by a person or company, primarily for their own consumption (eg a large factory or hospital which has a generator). See also 'distributed power'.

Coincidence factor – see 'Diversity'

Commercialisation: requiring publicly owned supply entities to act like private companies.

Counterfactual scenarios: show what would have happened if a certain intervention were not to take place. This is important as it allows us to determine the actual impact of the intervention. Setting the counterfactual is a difficult task and requires assumptions about what would happen. In the energy efficiency space, there are two main counterfactual scenarios against which improvements can be measured:

- A **baseline** or **business-as-usua**l scenario, which includes efficiency improvements which would happen anyway in the absence of intervention.

- A **frozen** or **static** scenario, which assumes no efficiency improvements. This is easier to define but is less than realistic than the baseline/business-as-usual scenario.

Debt financing: loans which may have different conditions attached in terms of grace periods, interest rates and periods over which the loans have to be repaid

Demand: the quantity of electricity that consumers are willing to buy at a given price

- ***Supressed demand*** refers to hypothetical demand for electricity, which does not translate to actual demand because it is not available or not accessible. This is an issue for some demand forecasting methods outlined below, as supressed demand is not captured in historic demand.

Demand forecast: a component of the planning process which aims to predict demand. There are two components to the demand forecast:

- ***Energy demand forecast*** predicts the total amount of energy that needs to be supplied. It is usually expressed in GWh

- ***Peak demand forecast*** predicts the maximum demand faced by the system, measured in MW. It informs the total amount of generation, transmission and distribution capacity that need to be developed

Different methods can be used to develop the demand forecast, including:

- ***Trend***: Past demand growth patterns are extrapolated to estimate future demand. This is a fairly simple approach and is easy to apply but is dependent on the assumption that future growth will continue to follow the same trajectory.

- ***Bottom-up:*** A detailed assessment of the electricity usage of different types of consumers and how their consumption habits will change in the future. This is more accurate but requires large amounts of data and significant time resources.

- ***Econometric (or top-down):*** Demand is forecast using **regression analysis.** This involves developing a mathematical relationship which shows the relationship between electricity consumption and the primary driver (eg GDP or GDP per capita)

- ***Hybrid approaches:*** Combine two or more of the above approaches to develop the demand forecast

Demand side management (DSM): DSM is the process of managing energy consumption to optimise available and planned resources for power generation. DSM incorporates all activities that influence customer use of electricity, result in the reduction of the electricity demand and are mutually beneficial to the customers and the utility.

Depreciation: the decrease in the value of an asset over time. Even if they are properly maintained, assets which are used for production lose value (in real if not nominal terms) as they wear out. Depreciation allowances provide for the periodic replacement of physical assets.

Dispatch / despatch of power systems: the process managed by national or regional control centres of bringing power plants onto the power system to meet power and energy requirements. The power requirements vary over the day and by season – see 'load shape'. The following terminology applies:

- ***Firm power*** refers to the electricity which is intended to be available at all times.

- ***Intermittent power*** is not always available due to external factors. For example, power generated through ***variable renewable energy*** sources such as wind and solar may be intermittent as it depends on wind and sun.

- ***Dispatchable and non-dispatchable plants:*** dispatchable plants are those which can be dispatched at request to meet the current demand in the market. Non-dispatchable plants such as wind and solar cannot be controlled by operators and can therefore not be used to respond to fluctuations in system demand.

- ***Base load plants*** are capable of continuous operation which tend to operate at maximum output, such as coal, natural gas and nuclear plants. They typically have high capital costs but lower operating costs. They have less operating flexibility, meaning they are not suited to respond to short-term fluctuations in demand.

- ***Mid-merit plants,*** also referred to as load following plants, have an output which can be adjusted throughout the day to meet fluctuations in demand.

- ***Peaking plants*** are only required for a few hours in a year, meaning they are flexible and able to be turned on and off quickly. Examples include open cycle gas turbines, battery storage and hydropower. They typically have lower capital costs but higher operational costs.

Discounting: a technique for systematically including time preference in the assessment of decisions which have consequences over a long time period.

- ***Discount factor***: The formula for the discounting process involves a discount factor being applied to each flow, the formula being **$1/(1+i)^n$**, where **i** is the discount rate and **n** is the number of periods (normally years) from the reference point ('the present').

- ***Discount rate***: The conventional discounting structure makes the simplifying assumption that the discount weights decline over time at a constant rate. This results in time preference being modelled by a single discount rate i. Those with a strong preference for resources now discount the future heavily (in the formula, future flows are heavily 'penalised'). See also 'Social rate of discount'.

- ***Net present value [NPV]:*** The single summary number which results from discounting a series of future flows (in the case of financial values these may be a mixture of outflows and inflows). 'Net' emphasises that both the outflows and inflows are taken into account: all flows, irrespective of their sign and when they occur must be discounted (they are all subject to time preference).

- ***Internal rate of return [IRR]***: the discount rate at which the NPV is zero (for complex projects with investments at different intervals, IRR may not be unique)

Distribution: *The network which carries electricity from the transmission network to end users. They are usually managed by **Distribution System Operators (DSOs).***

Distributed power / distributed generation: Small-scale generation which produces electricity close to the end users of power. This would strictly speaking include stand-alone systems and mini-grids which are not connected to the national grid, but the term is generally used for small generation systems which are connected to the grid and often installed by existing customers of the main utility.

Despatch of distributed power generators is not controlled by national control centres, but operates on a must take basis. The different distributed generation models include:

- **Self-supply:** A household or a commercial or industrial enterprise with a small generation system (eg rooftop solar panels) which is used as a supplement to the utility's electricity supply for the customer's own consumption. It may displace the requirement for utility supply, reduce the peak demand or provide a back-up to utility supply. The next item defines the associated commercial arrangement.

- **Net metering / net billing:** A commercial arrangement that allows self-generated electricity to displace some of the electricity which would be purchased from the utility at certain time, with surplus generation available at other times being sold to the utility.

  Net metering was first introduced in industrialised countries that treated each unit of electricity (kWh) as having the same value and this meant that a single, bi-directional, meter could be used. In Africa, net metering typically involves two separate meters (one for sale and another one for consumption) or a smart meter with this capability. This makes possible the price at which the electricity is sold to the grid being less than the price of electricity purchased, the difference reflecting the costs the utility bears in ensuring security of supply for the net metering customer and the fact (for solar PV systems for example) that the electricity that is purchased from the utility may be in peak hours while the energy that is sold may be in off-peak times.

- **Stand-alone system operating as buy all / sell all:** A distributed generation facility in which all electricity is sold to the utility under a **feed-in tariff**. The generator is usually bigger than those involved in net metering arrangements but small enough to be treated as **embedded.**

- **Feed-in tariff:** A feed-in tariff (FiT) is a policy mechanism designed to accelerate investment in renewable energy technologies by offering long-term contracts to renewable energy producers. In the face of rapidly declining renewable energy prices, FiTs have fallen out of favour and renewable energy is now typically procured through auctions.

- **Embedded generation:** distributed generators which are not under the control of the National Control Centre. The generators are therefore not despatched and are instead permanently connected to grid (unless faulty or removed for maintenance) and are contracted on the basis of 'must run, must take'.

- **Wheeling:** Wheeling is the use of transmission or distribution facilities of a system to transmit power of and for another entity. Where a power purchase agreement (PPA) exists between a distributed generator and a customer in another part of the network, a payment is made to the transmission operator for the use of the network.

Diversification: Ensuring electricity is obtained from a range of different generation resources thereby minimising the risk of relying on a single type of supply. For example, an IRP might include a diversification scenario which places emphasis on developing alternative generation capacities to hydropower to limit the impact of rainfall on security of supply.

Diversity and coincidence: these are related terms which are often carelessly used leading to unnecessary confusion. Preferred definitions are given below. Their importance in IRP planning is that power can be supplied with a lower installed generation capacity (and hence at a lower cost) to customers on an interconnected grid than would be the case if each customer's peak demand had to be separately met in an individual off-grid mode of supply.

- **Diversity** arises from the fact that the peak demand of individual electricity consumers in a group of similar consumers will not occur at the same time, so the peak demand of the group will be less than the sum of the individual peak demands.

- **Diversity factor**: A consumer group's peak demand as a ratio of the sum of the individual peaks of each consumer in the group. Ratio of individual customer peak demand to group peak demand.

- **Coincidence** arises from the fact that the peak demand of a group of electricity consumers will not necessarily occur at the same time the peak demand for the system as a whole.

- **Coincidence factor**: A consumer group's demand at the time of the system peak demand as a ratio of the consumer group's peak demand. Ratio of customer group peak demand to system peak demand

Economic analysis: is synonymous with 'social cost-benefit analysis'. Economic analysis is normally used in preference to SCBA when it is necessary to distinguish the additional steps which SCBA involves from 'financial analysis'. The latter is the first step in a viability analysis and involves using unadjusted market prices and other basic financial data to calculate viability measures. See 'financial analysis'.

Economies of scale: a situation in which long-run average total costs decline as the output of a firm increases. This is also referred to as 'increasing returns to scale'. The profits of a firm which produces a good to which economies of scale apply would certainly increase its financial returns if it kept the price constant while increasing production and sales. One of the objectives of infrastructure regulation is to ensure that the benefits of economies of scale are largely passed on to consumers and not simply appropriated by producers.

Economies of scale are characteristic of the electricity sector. Large, shared generation plants with economies of scale are what underpin the economics of the national transmission grid. When grid electricity is so unreliable that a large proportion of a utility's customer base invests in standby generators not only are there much higher capacity costs per kW and energy costs per kWh but the benefits of diversity on a shared grid are also lost. In recent times, the alternative supplies may be PV and batteries, in which case the recurrent cost becomes negligible but initial capital costs are very high.

Efficiency is used in various different senses in economics, including:

- ***Usage efficiency***: the avoidance of waste so that the minimum amount of a commodity is used to meet a particular need.

- ***Allocative efficiency***: the allocation of resources between competing uses so as to maximise the attainment of some social goal or goals.

See *Energy Efficiency* for its application to electricity use.

Elasticity: see 'price elasticity of demand'. The concept of elasticity applies in a corresponding fashion to any factor affecting demand, such as income (the income elasticity of demand is the degree to which demand for a particular good increases – or decreases - as income rises). Elasticity also applies to any binary relationship, for example the price elasticity of supply is a measure of the responsiveness of producers of a good to changes in its price.

Energy efficiency (EE): Refers to when a fixed level of service can be provided with reduced energy input, or if the level of service provided improves with fixed energy input. For example, LED lightbulbs provide the same level of lighting while requiring less energy input. Important terms relating to EE are:

- ***Energy intensity:*** The quantity of energy required per unit of output. This often acts as a proxy for energy efficiency. Energy intensity typically falls as countries move from low to high-income, although this is dependent on the structure of the country's economy.

- ***Energy efficiency potential***: Different definitions exists relating to potential for EE measures in a given environment, including:

  - ***Technical potential:*** The improvements in end-use EE which could result if the most efficient technologies known today were to attain 100% market saturation during one lifetime of the technology (10-20 years).

  - ***Economic potential:*** The EE improvements that result from the maximum use of *cost-effective* technologies.

  - ***Market potential:*** The improvements which result from EE measures which can be *effectively implemented*.

- ***Energy efficiency cost curves*** show the marginal cost of energy savings delivered by EE measures (see graph below). They are developed by ranking EE measures from the lowest to highest cost – considering both the initial investment costs and ongoing operational costs – per kWh saved.

Figure 1 Illustrative energy efficiency cost curve
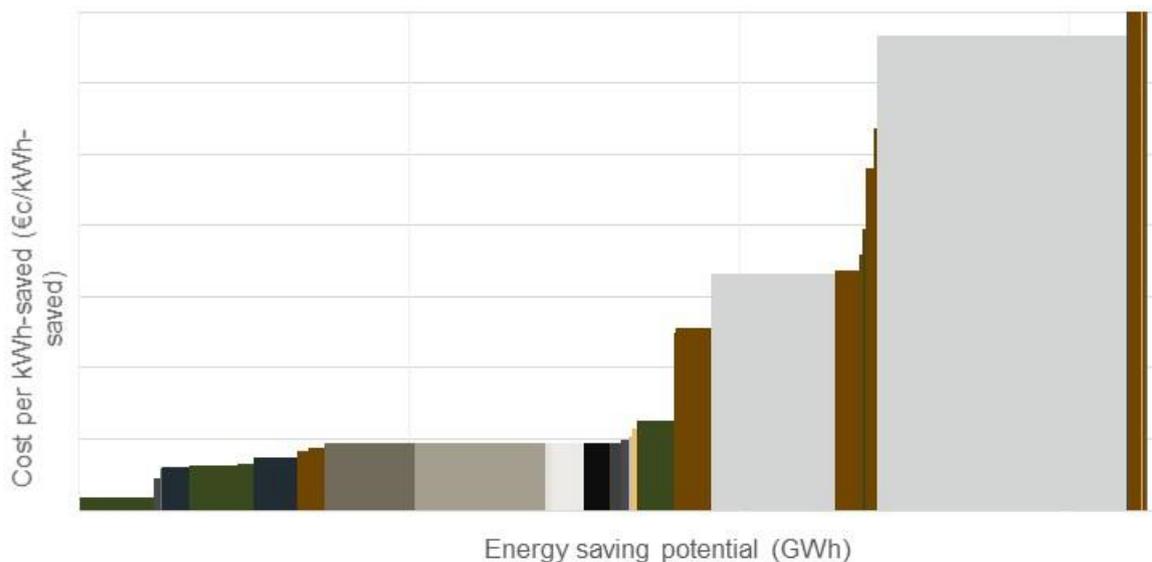
Source: ECA

- **Minimum Energy Performance Standards** are regulations which specify the maximum amount of energy which can be consumed by a specific product or building.

Environmental valuation: the assignment of a value (usually in monetary terms) to environmental resources and outcomes. Some of the terminology that is involved includes **active use values, passive use values, option values** and **existence values.** The chief methods are: **hedonic property value, travel cost, defensive expenditures, production function approach** and **contingent valuation.**

Equity: projects are typically financed by a mix of equity and debt, with equity being funds provided by project owners or shareholders in the expectation of earning a share of the profits in the form of dividends, while debt financing consists of various forms of loans. Interest and loan repayments associated with debt financing have to be met before profits are declared out of which dividends can be paid. Not to be confused with the concept of *social equity.*

Externalities: costs or benefits (of production or consumption) which are not fully reflected in market prices. Externalities apply to both production and consumption:

- *Production Externality*: when production activities of one firm directly affect the production activities of another firm.

- *Consumption Externality*: when level of consumption of some good or service by one consumer has a direct effect on the welfare of another consumer (as opposed to an indirect effect through the price mechanism).

Feed-in tariff: see Distributed generation.

Financial analysis: when used with reference to national project viability studies, financial analysis typically refers to the first step in the social cost-benefit process – calculation of project viability without giving any weight to national objectives, without adjusting market prices and using some rate of interest as the discount rate in NPV calculations. See 'economic analysis'

Generation planning: the following terminology is used in least cost generation planning:

- ***Committed power plants***: Power plants which have been commissioned or have been procured and will be coming online within the period covered in the planning process.

- ***Candidate power plants/resources***: Potential power plants (or EE measures) which could be developed in the time period covered by the planning process.

- ***Investment sequence:*** the output of the least cost generation model is a sequence of investment projects.

Green accounting: the integration of environmental resources into national accounts. Under the UN System of Integrated Environmental and Economic Accounting, the main components are (1) natural resource asset accounts (2) flow accounts for pollution, energy and materials (3) environmental protection and resource management expenditure accounts and (4) valuation of non-market flow and environmentally adjusted aggregates.

Health impact evaluation: the assignment of a value (usually in monetary terms) to health outcomes, arising for example from environmental changes. Some of the terminology that is involved includes **statistical value of life [VOSL], value of a healthy life year [VOLY]** and **disability adjusted life year [DALY]**.

Independent power producer (IPP): A non-utility generator who own plants to generate electricity which is sold to utilities and end users

Inflation: the rate of change of prices in an economy. The first step in measuring inflation is to establish a price index. This is done by tracking the prices of a particular basket of commodities, putting each of these onto an index basis and calculating a weighted average index for the entire basket. Inflation is then the change in the index relative to say the previous month, corresponding month of the previous year or some average over a specified period. Related definitions:

- ***Inflation rate:*** is some measure of inflation, usually the change in an index of the prices of a defined basket of goods. This may be measured over different time periods – monthly, quarterly, annual etc.

- ***Price indices:*** a commonly used inflation index is the consumer price index [CPI] reflecting the weighted average of changes in the prices of a basket of consumer goods. There are similar indices for other types of baskets eg the producer price index measures the weighted average increase in the price received by producers of goods and services.

- ***Nominal values:*** monetary values which are subject to the effects of inflation. Nominal values, which reflect ongoing price increases, are said to be in terms of 'money of the day'.

- ***Real values:*** monetary values which have been put onto a basis whereby they can be directly compared. This is achieved by removing the effects of inflation so as to produce values which reflect the same ***purchasing power*** or ability to acquire real goods and services.

Interest rate: proportion payable on an amount of money that is saved (savings rate of interest) or is borrowed (loan rate of interest). Banks generate income from the spread between loan and deposit rates of interest.

Integrated Resource Planning [IRP]: is an approach to national power system development planning that incorporates a holistic assessment of available energy resources and opportunities for demand management into deriving a least cost combination of supply and energy efficiency measures to meet long-term requirements for electricity services during a specified period, while furthering broad national objectives such as social equity and environmental sustainability.

Internal rate of return [IRR]: the discount rate at which the net present value is equal to zero. See 'discounting'.

Iterative approach/iteration: process of repeated analysis or calculation intended to involve to successive improvements.

Levelised cost of energy [LCOE] provides an indication of the average cost of a technology. It is calculated as the discounted total cost of a technology option over its economic life divided by the discounted output from that technology over the same period.

Figure 2 Illustrative LCOE for different technologies
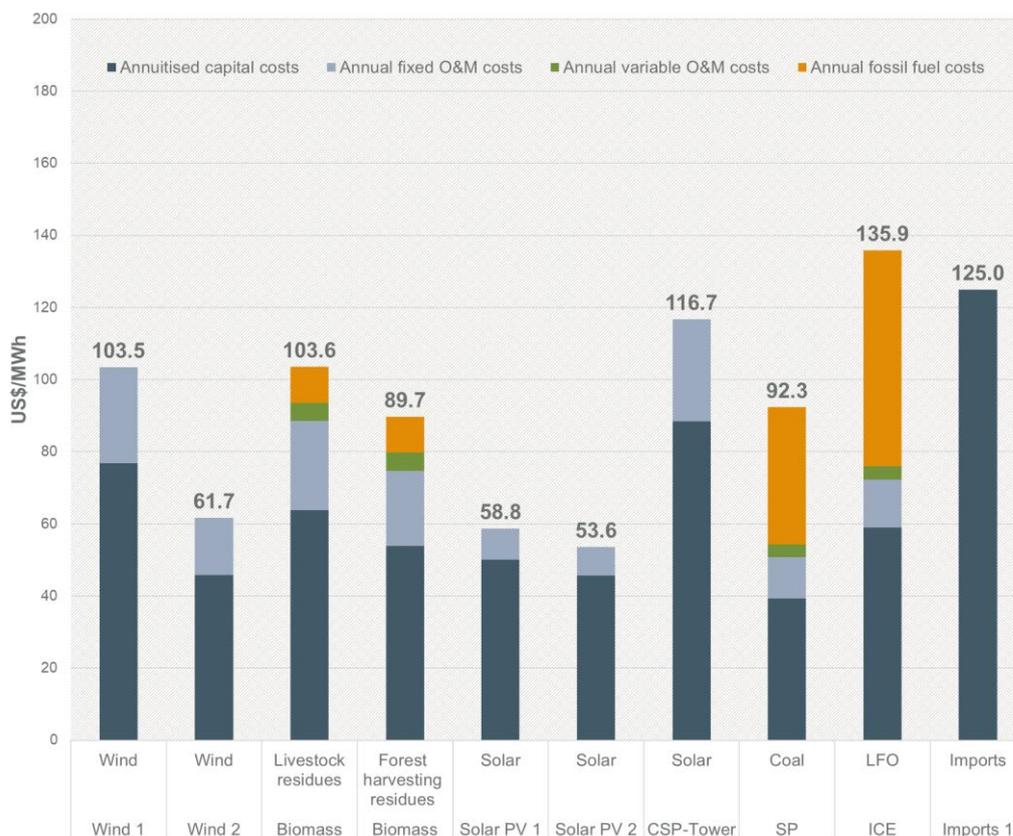
Source: ECA analysis, 2018

The graph above provides LCOEs for different technologies in a southern African country. Although it provides a simple and common basis to compare different generation technologies, it does not provide sufficient detail for power planning. This is because LCOE does not reflect

the reality that electricity is worth more at peak periods and that the capacity of non-dispatchable plant, such as wind or solar PV, does not constitute 'firm' power that can be used to meet peak demand. Power planning with a mix of generation technologies has to consider how the different types of plant will be despatched to meet the load profile.

Light emitting diode [LED]: type of lighting which has progressively replaced incandescent lighting, with significant reduction in capacity and energy requirements while providing comparable levels of lighting.

The savings are substantial. According to the World Bank "Under India's UJALA ("Bright Light") scheme, 105 million energy efficient LED bulbs have been distributed across 24 states, targeting 33 million customers. The programme is helping improve the quality of lighting and at the same time lowering electricity bills. It has also helped the country reduce peak demands for electricity by 2,700 MW. If the entire India used energy efficient LED bulbs, total electricity demand would decrease by 10%".

Load factor [LF] is a ratio of the average load divided by the peak load in a specified time period (typically a year, but can be other periods or a load factor for a particular season). The load factor as defined would have MW in both numerator and denominators, but the load factor can also be calculated in energy terms, for example the MWH generated over a year divided by the plant capacity multiplied by 8,760 (the number of hours in a year).

'Load factor' is often treated as synonymous with 'capacity factor' – see the entry for capacity factor for a (marginal) distinction between the two terms.

Load flow study is a quantitative analysis of the flow of electric power in an interconnected system. A load flow study usually uses simplified notations such as a one-line diagram and per unit system, and focuses on various aspects of AC power parameters, such as voltages, voltage angles, real power and reactive power. It analyses the power systems in normal steady-state operation.

In addition to load flow, comprehensive transmission studies also include short-circuit fault analysis, stability studies (transient as well as steady-state), unit commitment and economic dispatch.

Load forecasting – see ***Demand forecasting***

Load shape and load management: Shows the capacity which needs be satisfied at any given hour. It can be based on the demand over a day (see illustrative example below) or a year. Although producing an hour-by-hour analysis of demand over an entire year adds complexity, it can be useful if there are large seasonal fluctuations (for example if there is an afternoon peak in summer months when air-conditioning units are used).

Figure 3 Illustrative daily load curve
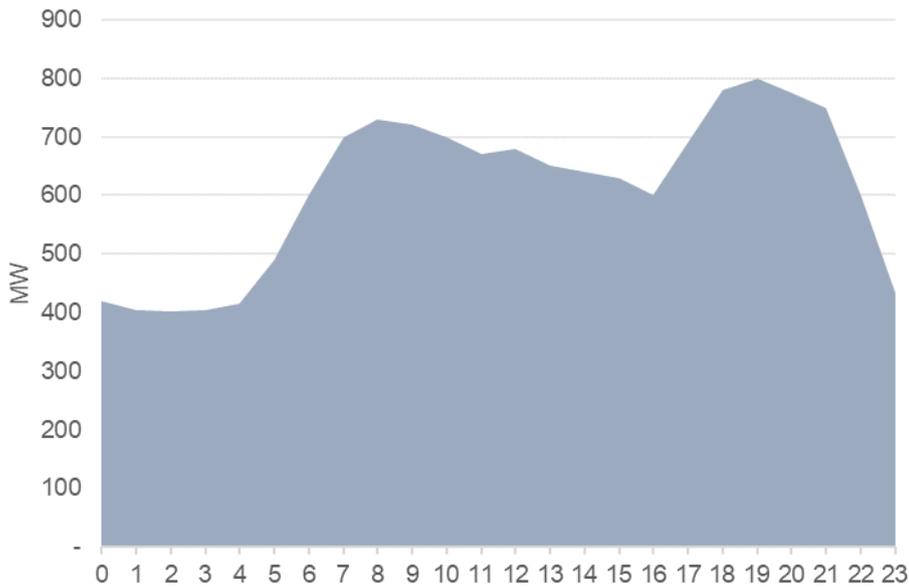
The load shape is related to *peak demand* and can be used for *load management,* in which measures are taken to shift load. Examples of this include:

- **Peak shaving / clipping** in which measures are taken to try and reduce peak load. For example, if peak demand is driven by electric cooking appliances and heating, it may be worthwhile to invest in energy efficiency measures in these areas to lower the peak demand. This will reduce the overall level of investment needed to meet peak demand.

Figure 4 Impact of peak shaving on load curve
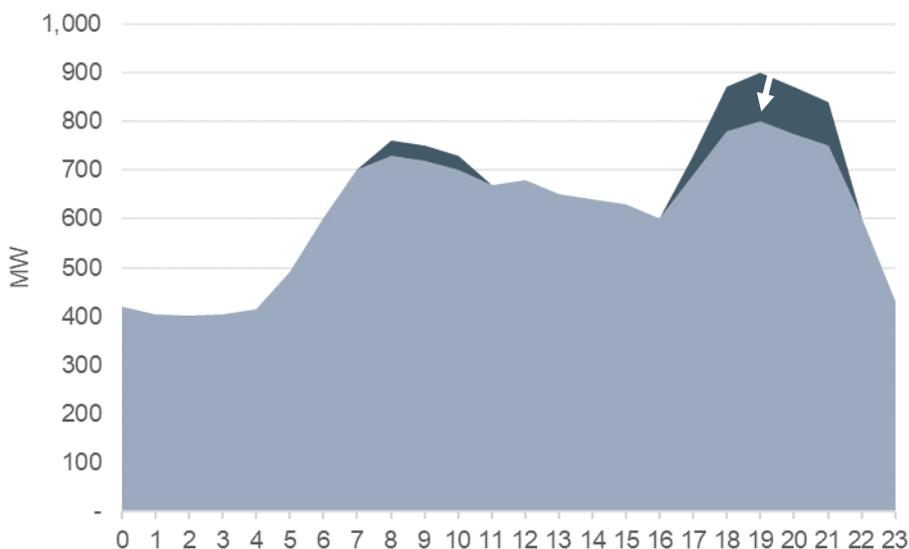
Load shifting, in which measures are taken to shift demand from high load periods to low demand periods. For example, smart meters and time of use pricing (see *Tariffs*) may incentivise certain consumers to shift their demand from peak hours to off-peak hours.

Figure 5 Impact of load shifting on load curve
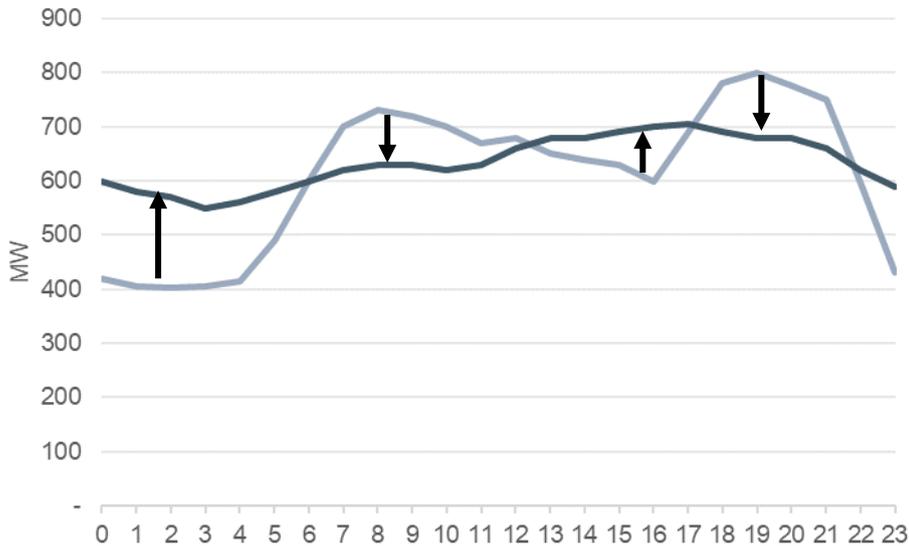
Marginal cost: the cost incurred in supplying the last unit demanded. This will typically be higher than the average cost incurred to supply the entire number of units demanded. One of the theorems of neo-classical economics is that allocative efficiency is achieved when the price of a commodity is set equal to the marginal cost of its supply. Further definitions:

- *Short-run marginal cost [SRMC]*: the marginal cost incurred in the short-run, where adequate capacity is assumed to be available (the costs therefore are largely operation and maintenance costs).

- *Long-run marginal cost [LRMC]:* the marginal cost of supply taking into account future investment costs as well as operation and maintenance costs.

- *Long-run average incremental cost [LRAIC]:* the strict 'marginal' or 'last unit' cost is often difficult to calculate and instead the average cost which would be incurred to meet a specified increment in demand is calculated. This is the average incremental cost and becomes the long-run average incremental cost when successive investments to meet demand increments are considered over an extended time horizon.

Multi-criteria analysis (MCA): an evaluation technique which uses a weighting schema to take different criteria into account in systematic way.

National income: there are various different measures of national income including the following:

- *Gross domestic product [GDP]:* a measure of the total value of economic activity in an economy over a particular time period, normally a year. 'Gross' refers to the fact that no account is taken of the capital that is used up in producing goods and services during the year in question.

- *Gross national product [GNP]* is a measure of the total value of economic activity by nationals of the country in question. GNP is GDP plus income from capital invested

abroad or nationals working outside the country, less income from foreign investments and foreign workers in the domestic economy. GNP<GDP in countries which have significant numbers of foreign investors and expatriate workers (eg Zambia), while GNP>GDP in countries which have large remittances from migrant workers (eg Lesotho).

- **GDP or GNP in purchasing power parity [PPP] terms:** a means of adjusting for distortions in exchange rates to produce comparable figures for aggregates such as GDP or GNP per capita. The technique involves taking account of different prices for similar baskets of goods in different countries.

Nationally determined contributions (NDCs): Targets set by each on country for emissions reduction as part of the Paris Climate Agreement. An IRP may have targets on the level of renewable energy in the system or emissions produced, which may be informed by a country's NDCs.

Net metering: see **Distributed generation**.

Net present value [NPV]: see 'Discounting'.

Opportunity cost: value of the next best alternative or opportunity which has to be foregone in order to achieve a particular objective.

Peak demand: the maximum demand faced by the system. This can be a specific time (eg evenings), day/week/month, or combination of these. For example, in warm countries peak demand is experienced in summer afternoons when air-conditioning units are turned on. **Load curves** can be used to illustrate peak demand.

Power factor and power factor correction – see 'Reactive power'

Power sector reform – see Vertically integrated utility

Price elasticity of demand is a measure of the degree to which consumers react to prices changes. In more formal terms, the price elasticity of demand is defined as the percentage change in demand resulting from a percentage increase in price. The elasticity is a negative number since demand normally decreases as price increases, and typically the value ranges between -1 and 0.

Quality of service: These indicators are used to measure the reliability of supply to customers. Common indices include:

- **SAIDI – System Average Interruption Duration Index.** Measures the average outage duration for each customer served and is calculated as the ratio of duration of all customer interruptions and the total number of customers served.

- **SAIFI – System Average Interruption Frequency Index**. Measured the average number of interruptions a customer experiences and is calculated as the ratio of the total number of interruptions and the total number of disruptions.

- **CAIDI – Customer Average Interruption Duration Index**. It is the ratio of SAIDI and SAIFI and expressed the average outage duration experienced by a customer.

Reactive power: is a component of alternating current power, namely the portion of power due to stored energy in loads such as induction motors which returns to the power source in each cycle. It is measured in volt-ampere reactive (VAR). There are several related definitions to consider:

- **Apparent power S** (also call 'complex power') is the vector sum of the active power and the reactive power

- **Active power P** (also called 'real power') is the actual power that is being delivered (MW)

- **Reactive power Q** (also called 'wattless power') is the notional power that arises when the voltage and current are out of phase

- **Power factor = P/S** is the ratio of the active power to the apparent power, which is equivalent to the cosine of the angle θ in the power triangle.
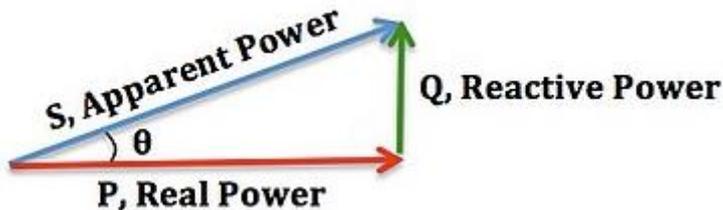
The power factor is important because a low power factor implies there are higher circulating current (due to energy stored in the load returning to the source) and hence higher losses, which reduces transmission efficiency. Tariff structures often include a **Power factor charge**, which is a penalty for having a low power factor and constitutes an incentive for the customer to install **power factor correction** equipment (such as capacitors).

Recovery factor: Factor used to mimic an annuity. Applying a recovery factor to the net present value of the costs of a major project (these being incurred in different years of the project) gives an annualised equivalent capital cost.

Regression analysis: See **demand forecast.**

Reliability of a power system is its ability to ensure continuity of supply. The reliability of an existing power system is assessed through quality of service measures (*see **Quality of service***). When planning the expansion of a power system, there are a number of reliability-related terms which are used:

- **Loss of load probability (LOLP)**: a measure of the probability that a system's load will exceed the generation and firm power contracts available to meet that load. The reliability criterion of a system can be specified as a maximum LOLP.

- **Reserve margin:** amount of capacity over and above the expected peak demand (usually expressed as a percentage of peak demand). For stand-alone systems 15% would be a common reserve margin, but consideration also needs to be given to the largest single generation unit on the system. In interconnected systems, reserves can be shared and a lower national reserve margin can be adopted for planning purposes (or, equivalently, a lower LOLP).

- **Expected Energy Not Served (EENS):** the amount of electricity demand that is expected not to be met by supply in a given year.

- **N-1 reliability level:** specifies that the system should be able to meet peak demand even if one transmission line, main transformer or main generator is out of service.

- **Cost of unserved energy:** economic cost arising from customers being denied access to electricity. Strictly the cost is related to the time of day and season when the demand for electricity is not met, but is typically calculated as an average value (the amount of energy that is not provided multiplied by the value of lost load).

- **Value of Lost Load (VoLL)** The value of lost load is a measure of the economic cost arising from demand for electricity not being met. VoLL is typically an order of magnitude higher than the prevailing tariff (eg $1/kWh when the tariff is 10 c/kWh). It is often imputed from data about the economy, but can be empirically determined through surveying customers about their willingness to pay to avoid a disruption in their electricity supply.

Renewable energy (RES) refers to generation technologies which do not rely on the combustion of fossil fuels. Many renewable energy sources are variable as they are intermittent and depend on external resources, such as sunshine (PV), the amount of water that is available (hydropower), or the amount of wind. Such sources are also referred to as *variable renewable energy (VRE).* A key limitation of VRE is that it may not match the system load profile. For example, solar generation may not coincide with a peak load in the evening. Due to the intermittency of VRE it is important to assess it in the context of a system-wide planning model that balances VRE with other plant to meet the overall load profile.

Screening curves provide the LCOE for a range of load factors and technologies. An example is shown in the figure below. This can help identify which generation options are economic for base or peak load generation. For example, coal plants are clearly uneconomical as a peaking plant due to the relatively high cost at low load factors.

Figure 6 Screening curve for a Southern African country
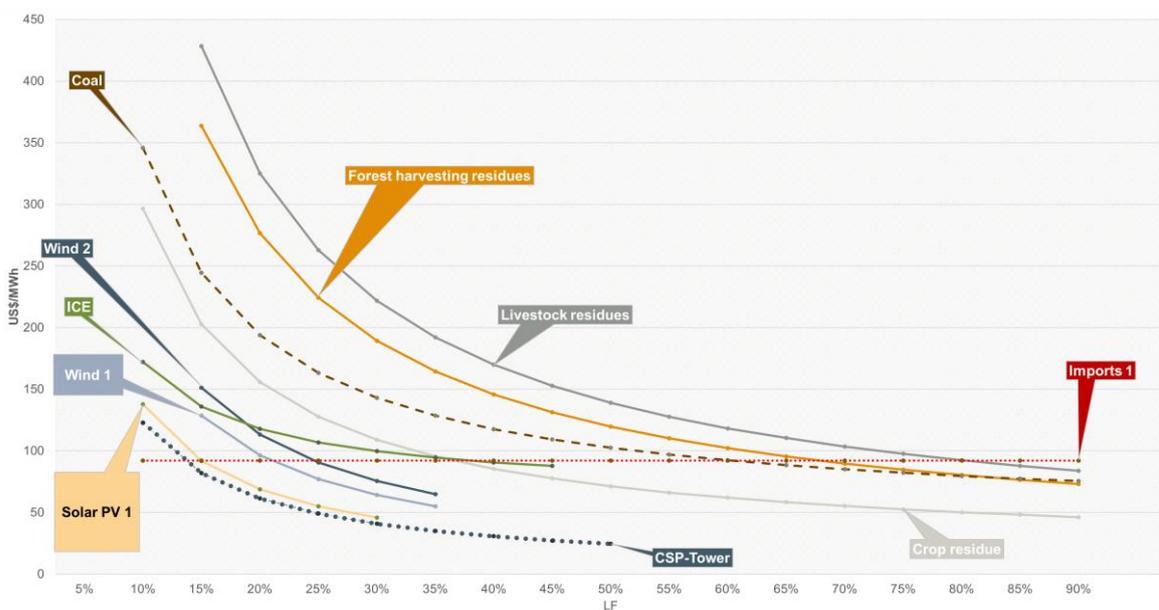
Service provision management as applied to electricity: the deployment of electricity generation capacity to meet the demand of consumers. Two broad approaches to the management of service provision can be distinguished:

- ***Supply-oriented approach***: an approach in which demand is largely taken as 'given' and the responsibility of the electricity provider is deemed to be to meet that demand through augmentation of generation capacity. The level of demand is often artificially high, in that for social reasons the price of electricity is deliberately kept below the costs of supply, with the result electricity is used by those that have access to it in a wasteful and inefficient manner.

- ***Economic approach***: an approach which values electricity as an economic good and which seeks, through effective tariff mechanisms and other electricity demand management strategies, to ensure that electricity is used efficiently (in both the usage and allocative sense of efficiency). The economic approach is progressively supplanting the supply-oriented approach.

Single buyer: this is a situation where a single agency buys electricity from generators (which may be competing), has a monopoly on transmission, and sells electricity to distributors and large power users without competition from other suppliers.

Shadow price: Notional price used in social cost-benefit analysis to reflect the economic opportunity cost of a resource (in relation to government objectives and policies).

Social, environmental and climate change tools (SECT): The set of tools needed to analyse to the impacts of different generation options on the environmental and local communities. These include an analysis of greenhouse gas emissions, and ***Environmental and social impact (ESI) assessments,*** which consider the impact on the local environment, communities and economy. In SAPP countries, the ***Environmental and Social Management Framework (ESMF)*** is a tool which ensures that the analysis aligns with the compliance and safeguarding guidelines of the World Bank and AfDB.

Social cost-benefit analysis: an example of a SECT which can be used for the systematic analysis of projects or programmes from a national or 'social' viewpoint. This involves considering the benefits incurred from a project or programme (such as generated employment, lower energy bills) and comparing it to the costs (such as the impact on the environment and public finances).

Social equity: considers the fairness of the allocation of resources across a given population. This can be applied to various aspects of IRP planning. For example, tariffs should be socially equitable and avoid low-income households paying a disproportionally large share of their income on electricity. In the context of generation planning, it should be considered in social impact assessments of different generation options.

Social rate of discount: rate of discount to be used in calculating present values in social cost-benefit analysis - it is the rate which reflects society's preference for present as opposed to future consumption, ie measure of society's inter-temporal and inter-generational preferences. See 'discounting'.

Stranded assets are assets which are not able to make an economic return prior to the end of their economic life. This means that they have been written-down earlier than expected or experienced a devaluation. Stranded assets are often the result of a policy change. For example, if a government imposes a policy to rapidly move away from coal, coal generators may become stranded assets.

Supply: the quantity suppliers are willing to sell at a given price.

Tariff: the price of electricity charged by a supplier to a consumer. There are several related definitions which are useful to have in mind for tariff-setting:

- *Allowed or required revenue*: the level of revenue that a regulator would consider reasonable for a utility to recover from the tariffs it charges its customers.

- *Building block approach*: a systematic approach to estimating allowed revenue with three main elements – operation and maintenance costs, return of capital (also known as depreciation or capital maintenance) and return on capital (to allow for investment).

- *Regulatory asset base (RAB)*: the value of existing and proposed new assets that is relevant to calculating the allowed revenue. The RAB will usually be somewhat different to the asset base that is reflected in the utility's financial accounts.

- *Tariff level:* the average level of tariff which is determined by the required or allowed revenue

- *Tariff structure*: the ratios of charges (fixed and consumption-related) between customer categories and ratio of charges within each category. To achieve economic efficiency, tariff structures should reflect marginal costs.

- *Cost recovery tariffs:* revenues from tariffs fully recover efficient costs (ie, the allowed or the required revenue)

- *Cost reflective tariffs*: the tariffs charged to different customers reflect difference in the cost of service between those customers.

- *Time of use [ToU] pricing:* tariffs which vary by the time of day with the objective of reducing the system peak demand. Tariffs are therefore higher during the peak hours to provide an incentive to consumers to shift their consumption to off-peak periods for which lower tariffs apply.

- *Seasonal time of day [STOD] pricing:* tariffs which vary by the time of day and season, often reflecting different levels of demand resulting from heating and cooling.

- *Maximum demand [MD] charges*: a monthly charge applied to the highest level of a customer's demand during the peak hours. MD charges have the same objective as ToU tariffs (reducing system peak demand) but the way the incentive is structured is different.

- *Power factor [PF] charges*: these charges are levied as a component of the tariff structure to provide an incentive to large consumers with reactive power loads to install power factor correction equipment such as capacitors (see 'Reactive power' for details).

Tariffs may recover costs while not being cost reflective across different customer categories (for example if cross-subsidies have deliberately been introduced to meet social objectives).

Time preference is preference for resources (such as energy) now or in the near future over having the same resources at some later time.

Transmission: the movement of electricity from generators to electrical substations (where it enters the distribution network). The transmission network is managed by a *Transmission system operator (TSO).* See also 'wheeling'.

Vertically integrated utility is a utility which provides services across the spectrum of generation (G), transmission (T), distribution (D) and supply. T&D are sometimes described as the 'wires business' or network businesses which constitute natural monopolies that are the main trigger for regulation of the power sector. Generation and supply (the direct commercial interface with final customers) are potentially competitive. **Power sector reform** requiring as a first step the unbundling of traditional, vertically integrated state-owned national utilities and the subsequent development of wholesale and eventually also retail competitive markets was in vogue at one time and shows signs of coming back into fashion.

Weighted average cost of capital [WACC]: average cost of finance, usually composed of equity and loan finance. The WACC is commonly referred to as the firm's cost of capital. The WACC represents the minimum return that a company must earn on an existing asset base to satisfy its creditors, owners, and other providers of capital, or they will invest elsewhere.

Typically the most difficult element in estimating the WACC to use in an IRP is the determination of the cost of equity. The most commonly used approach is the **capital asset pricing model [CAPM]**.

Wheeling: wheeling is the transportation of electric power over transmission lines. 'Wheeling' and 'transmission' can be used interchangeably, but wheeling tends to be used when a specific/unusual transmission arrangement is being referred to, for example the transfer of power from a distributed generator (see **Distributed generation**) or the wheeling of power through an intermediate country in a regional trade arrangement.

Transmission tariffs are also referred to as wheeling tariffs. A more precise term is 'transmission use of system' (TUOS) tariffs.

Wholesale competition: Electricity is traded between generators and retailers before being delivered via the grid.