This thesis addresses some pricing issues associated with deregulated electricity markets. Since electricity is treated as a commodity in a restructured environment, its pricing and associated ancillaries becomes vital for the successful operation of an electricity market. Inherent in this statement is the framing and implementation of policies to support the restructured environment. The research work carried out aims at extensively studying pricing practices of energy and transmission markets and suggest improvements.

DCOPF is extensively used in North American electricity markets. Locational Marginal Prices (LMPs) are used to settle the energy markets. Two important issues associated with loss compensated DCOPF models have been tackled in this thesis: appropriate loss distribution and choice of slack bus in reference dependent DCOPF models.

Marginal loss modelling in DCOPF has been used to overcome the drawback of neglecting losses in the lossless DCOPF model. Various models have been proposed in literature that incorporate losses in different ways. However, there has been no unique way of distributing losses across the network. The approaches suggested in literature have some arbitrariness in distributing losses. Since change in loss distribution can lead to different solutions, a clear rationale is required in this regard because it has financial implications. In this thesis, the use of location based schemes is explored, traditionally used for transmission pricing and/or loss allocation, to overcome the arbitrariness in loss distribution for various models proposed in literature.

Different performance metrics for comparison with ACOPF have been defined, which provide benchmark results. Better performance indices for line power flows and LMPs is observed when choosing loss distribution using the loss distribution strategy suggested in this thesis.

Though reference independent DCOPF models exist, some reference dependent models that bear certain good virtues pose a research problem of making them reference independent, without touching the original characteristics. For the reference dependent models, changing the reference bus has an effect on the LMP, its components and the resulting objective function. Based on the literature available, marginal loss DCOPF models can be classified into iterative and non-iterative techniques. Losses are estimated using either AC power flow (ACPF) or DC approximation. The iterative techniques are better at estimating losses when compared to non-iterative techniques. All the techniques necessitate the specification of a reference bus and the solution of some techniques depend on this choice. This further has implications on cost of supplying load and losses. This thesis addresses the reference dependency issue of the iterative DC technique, and to overcome this drawback, proposes the use of a two-step iterative technique that eliminates the need to pre-specify a reference, thus overcoming this ambiguity. Optimal reference selection on the fly leads to least cost solution compared to other reference independent models. Alternatively, a less time consuming distributed slack approach for the iterative DCOPF model is suggested, where the set of participation factors are updated based on solution obtained after every iteration.
The decomposition of LMP obtained from ACOPF is disputable due to its dependency on the choice of energy reference. The dispute arises because the difference of congestion component, on which the FTR payments are made, is not constant and depends on the energy reference. Prior art aimed at obtaining reference independent decomposition. This thesis looks at this dispute as a fairness issue and formulates the decomposition as a fairness problem. The fairness issue is addressed by invoking max-min fairness criteria which ensures that the FTR Payment (FP) received (made) is not at the expense of other ill-positioned FTR holders. Max-min fairness algorithm is used to arrive at an energy reference choice that aims at maximizing the FP of each FTR. This in turn ensures that revenue received (payment made) is the maximum (minimum) possible under the set of constraints, without adversely affecting the FP of other FTR holders.

The decomposition of Locational Marginal Price (LMP) obtained from ACOPF has been labelled as a ‘policy’ decision because of its non-unique nature. This has prompted researchers to look into the problem keeping a certain objective, which forms the basis of the policy, in mind. This usually requires the selection of slack to be made a decision variable in an optimization problem, analogous to the max-min fair LMP decomposition suggested in this thesis. This thesis will re-visit the notion and role of slack (reference) in LMP decomposition and enlist the implications of this selection.

Frequency linked Unscheduled Interchange (UI) pricing is one of the characteristic features of Indian power system operation. This peculiar mechanism, associated with power deficit grids, helps in grid discipline. The mechanism, in its original form, has lacuna of losses not being accounted for. In other words, existence of same UI price throughout the grid does not allow this mechanism to be a zero sum settlement. This has further implications in terms of non-parity amongst various types of transactions. This thesis proposes remedy to this shortcoming of the mechanism by providing a locational bias to UI curve. An optimization problem is solved to make it a zero sum settlement. Real time data from the Western Regional Grid of India is employed to obtain the results.

Different transmission fixed cost allocation methods lead to different nodal charges. Development of new transmission pricing scheme is guided by generic principles of transmission pricing. Each method available in the literature and used in practice, conforms to a certain set of principles, if not all. A transmission pricing mechanism for a system is chosen so that it tries to satisfy most of the country and system specific requirements. The ever conflicting requirements do not allow choice of a single method that satisfies all principles. This thesis proposes a new transmission pricing paradigm based on flexible mix and match approach. Aim here is to create a generic flexible toolbox that considers viewpoints and preferences of all stake-holders in terms of principles of transmission pricing, rather than devising a new transmission fixed cost allocation methodology. Thus, the final constitution of nodal transmission charges embeds relative weights given to each principle by each stakeholder. Analytical Hierarchical Process (AHP) is used as a tool for the said approach. Additionally, a quantitative comparison of various transmission pricing methods is performed using Jain’s Fairness Index.
The methodologies suggested in this thesis have been extensively studied on test systems and detailed discussions have been provided. The results and discussions provide further insights into the nature of the problem addressed.