7.1 Conclusions

Karnataka power sector underwent various reforms since 1990 to solve the prevailing problems in the sector, which became insurmountable by late 1980s. It was imperative that the bottlenecks in the sector were speedily removed, to enable adequate supply of quality power, which is crucial for the growth of the economy. The present study has made an attempt to analyse the trend and pattern of electricity consumption, supply, and investment in the power sector. It also investigates the performance of Karnataka power sector in the backdrop of the power sector reforms.

7.1.1 Chapter 1 is an introduction to the thesis. It first provides statement of the problem which enlists the main problems and issues with Karnataka power sector. There were multitudes of reforms in power sector which basically endeavoured to improve the situation in the sector at central and state level. Despite its great importance, electricity industry in India has been facing many challenges in various aspects, including basic access to electricity, per capita consumption level, energy and peak deficits, capacity utilisation, quality supply, financial health of the distribution utilities etc. From the policy perspective, it is of great importance to carefully analyse and understand the power sector dilemmas in Karnataka, which is persistently posing issues of peak and energy deficits, which were as high as 6.8% and 4.4% respectively in 2015-16 (Central Electricity Authority, 2016), despite being one of the first states to start electricity generation in India.

Secondly, the theoretical and empirical literature review is presented. Theoretical background reveals that electricity industry has been traditionally treated as a 'bundled' industry, where integrated planning and development of generation, transmission, and distribution was considered necessary for reaping the scale benefits of operation and co-ordination. The large integrated state monopolies were, however, found to be inefficient in supplying sufficient and reliable electricity. This has led to major structural, institutional and regulatory changes in the electricity industry, to usher in more investment, insulate the utilities from political intervention, and enhance competition and efficiency. A few important theories on public utility pricing
included marginal cost pricing, Ramsey pricing and allocation of common cost problem.

Empirical literature highlighted the overall scenario in power sector, including emerging issues, how reforms were introduced to improve the financial and technical conditions, and the lingering problems. However, there was lack of a comprehensive study focused on all aspects of Karnataka power sector. From the literature review, some important researchable issues are identified. The first main issue is the persisting power deficit in Karnataka even after a decade of reforms, which reflects bottlenecks in supply, demand, investment and performance of the sector. Secondly, there seems to be concerns with the components and implementation of the reforms, which need to be critically reviewed. The third issue lies with the highly subsidised pricing of certain consumer categories, which had substantial adverse effects in the form of cross-subsidization, subsidy burden on government, and financial losses of the utilities.

Based on the researchable issues, four objectives are framed for the thesis. First, to critically analyse the power sector reforms in Karnataka. Second, to track the trends in consumption of power, and to analyse the supply of power in Karnataka in the pre- and post-reform period. Third, to analyse the trend and composition of power sector investment in Karnataka during the pre- and post-reform period. Finally, to assess the impact of power sector reforms on the performance of power sector in Karnataka.

The methodologies used in the thesis are presented in brief. Lastly, the organisation of the chapters is provided.

7.1.2 Chapter 2 has presented a critical review of the power sector reforms and policies. The reforms, policies and schemes at central and state level addressed the fundamental problems of lack of universal electricity access, eliminating power deficit and financial turnaround of utilities, mainly through encouragement of private sector participation in 1991, restructuring of vertically integrated KEB in 1999, creation of independent regulatory commissions in 1999, and introduction of competition and efficiency measures in 2003. Notwithstanding, there were loopholes in planning and implementation process of the policies and schemes, which led to considerable under achievement of targets.
A number of policies, such as National Electricity Policy 2005, Rural Electrification Policy 2006 have explicitly targeted at universal electricity access and good quality power supply to all households by 2012. However, till date there are a number of households in Karnataka which still do not have electricity access, partly due to lack of implementation of electrification schemes, and partly because of the erroneous definition of 'village electrification', which considers merely a coverage of 10% of households and areas of basic amenities, for the village to be deemed electrified.

There is much room for improvement in terms of availability as well, as the per capita electricity consumption in the state is lower than many major Indian states. Another major concern is the poor reliability of the power supply in rural areas, as compared to urban areas. New initiatives undertaken to improve rural power supply, like the feeder separation between agricultural and non-agricultural consumers, as endeavoured in Niranthara Jyothi Yojana, have not been successful till date. The performance audit of NJY in Karnataka by CAG highlighted flaws in planning as well as implementation process, due to which the targets of feeder bifurcation were not met within the scheduled time.

There were also other central government schemes, like the R-APDRP, and UDAY, launched to improve the financial condition of the utilities, to relieve their debt burden and give time to recover losses in a phased manner. Nonetheless, most of the policies and schemes seem to be curative in nature, and in the direction of relieving debt burden, without providing long term and permanent solutions to the underlying cause of the issues. The root cause of most of the financial hurdles is the subsidized provision of power to certain consumer groups, leading to cross-subsidization by other consumers. The large and uncovered costs lead to large subsidy burden on the government. These phenomena have substantial negative spill-over effects, like revenue-generating industrial and commercial consumers resorting to more costly captive power generation, leading to reduction in their competitiveness. The Tariff policy and EA 2003 address the issue of rationalizing tariffs, however, the implementation has not been completely effective, since the revenue realisation as percentage of cost from agricultural and domestic consumers is still much lower than 100%, implying existence of tariff differential.
Another critical concern that has not been sufficiently addressed is the accurate measurement of actual T&D losses and IPS consumption, as the IPS consumption cannot be measured scientifically due to the lack of meters. One of the critical loopholes in power sector, which has not been adequately addressed in the policy circle, is the lack of accurate and continuous data availability till date, on all the important variables in the sector, most importantly, the total private sector investment, the financial costs of incentives accruing to private sector, accurate agricultural consumption, and T&D loss. Such data could be utilised for in-depth empirical analysis, which can effectively reveal the true progress of power sector development and help understand if the reforms have been successful or failed in their endeavour to make it competitive, efficient and profitable.

7.1.3 Chapter 3 has dealt with the trend in electricity consumption, its linkage with economic growth, and prediction of future consumption. The pattern of electricity consumption by major consumer categories has considerable implications on the growth of various sectors, utilities' financial health as well as on government coffers. The degree of electricity use in a sector is expected to have a corresponding effect on the growth of the sector. The highest electricity consumption is by the "Agriculture" category. While the electricity supply to agriculture should ideally be contributing to the agricultural growth, the current policies and the inadequate and poor quality power supply to the sector has been a major source for concern. In addition, issues, such as its inaccurate measurement, poor contribution to agricultural output, and most importantly, minimal or zero tariff, which harms the utilities' finances and burdens the government with growing subsidy, that impinge on the state's fiscal health. The increasing trend of consumption by "Industry (HV)" along with higher AAGR in the post-reform period is conducive for revenue realisation for the utilities. The pattern is, thus, improving in recent period, as the agricultural share is declining and industrial share is rising.

Cross-subsidization of the agricultural consumers by the industries and the poor quality power from grid results in industries setting up more captive capacity, despite higher production cost. Industrial electricity use from captive power generation is rising over time. The utility, thus, loses the remunerative consumers on account of supplying subsidised power to agriculture, which is not ideal for the utilities' finances.
The per capita electricity consumption (PCEC) in Karnataka has increased tremendously with an AAGR of 8.5% in the post-reform period, as compared to 2.4% before reform. Nonetheless, it is inadequate, given the state's huge potential for growth. In addition, it lags behind some major Indian states like Maharashtra, and Gujarat, and thus, requires further augmentation, in terms of extending more connections to rural areas, as well as supplying adequate and quality power to connected loads.

The linkage between electricity and growth in Karnataka, at aggregate and sectoral levels, is examined using the causality tests. The empirical results show that according to the standard Granger causality test, there is no causality between the two variables at the aggregate level, as well as for agriculture and industry. According to literature, the neutrality hypothesis implies that energy conservation policies could be undertaken without severe effect on economic growth. However, this implication might not hold good for Karnataka, as the state's vital sectors such as agriculture, industry and service sector's growth is largely dependent on adequate and quality power supply, and their growth would certainly be affected by the absence of it. Karnataka has been one of the leading states in industrial development and to nurture it, future power supply becomes critical. Thus, the neutrality hypothesis does not hold good for developing economies.

In the context of the industrial power consumption, the present study, however, could not capture the consumption from captive power generation, which is speedily rising over time, due to lack of data. As for agricultural electricity consumption, the power supply to this sector is erratic, inadequate and unreliable, thereby leading to poor impact on the sector performance. In addition, there is a great need to accurately measure the consumption by agricultural sector, which is currently combined with the T&D losses. It is crucial to record the exact quantity of power used in a sector in order to examine its impact on growth.

Further, the present study has made an attempt to predict the future electricity consumption in Karnataka till 2019-20, using the Holt-Winters exponential smoothing (no seasonal) method. The result reveals to be around 69347GWh by 2019-20. Such a forecast is essential to assist in planning and managing resources for adequate, good quality, and reliable supply of electricity in future, which necessitates timely and
adequate amount of investment in power generation, transmission, and distribution. It is important to supply adequate, reliable and good quality power in all the sectors in order to achieve optimal economic growth as electricity is a key catalyst of growth.

7.1.4 In the fourth chapter, the trends and patterns of power supply in Karnataka have been examined. The power sector reforms endeavoured to enhance electricity supply, particularly from private sector, and ultimately eliminate power shortage in the state. The study reveals that the total installed capacity has increased substantially after the reforms, primarily contributed by the private sector. It is reiterated by the result of the trend break analysis, which shows that the total IC significantly increased in 1998, perhaps because of the growing private sector contribution in the late 1990s. The share of the public sector in the total installed capacity and actual generation is declining over time, as against the rising private sector share. The reforms succeeded to usher in private investment to power sector, however by resorting to numerous incentives. The financial costs are currently not estimated, nonetheless, the benefits in the form of rising private investment are believed to be more than the costs.

The increasing IC is dominantly contributed by the thermal and renewable sources, as the hydro capacity has been stagnant in recent years. The rising thermal share has implications on increasing demand for scarce fossil fuels, which leads to environmental degradation.

Although the IC growth is prominent, the actual electricity generation growth rate lags behind that of IC. The analysis highlights significant break in the trend of total electricity generation in 2003, although the total IC shows trend break in 1998. This implies that the capacity utilisation of the existing capacity has been quite low and lagging behind. The low PLF of thermal plants is attributed to technical reasons, like age of plants, technical efficiency, outdated technology as well as lack of demand from distribution companies. Moreover, the PLF of RES generally tends to be very low because of the limitations on the number of hours and availability of the natural resources, like wind and solar rays. Thus, the actual generation from RES is not optimal, although the RES capacity has risen tremendously.

In terms of transmission, the T&D losses have declined enormously after reforms, to the tune of 11.5% in 2014-15, which is lower than most of the Indian states, except Tamil Nadu, thus proving to be a major success factor of the reform initiatives.
Nonetheless, the issue of accurate measurement of the loss is still unresolved, and requires immediate attention. Regarding distribution, the collection efficiencies and AT&C losses of the ESCOMs, in general, have progressed well with time, although much improvement is still necessary for some ESCOMs, like CESCOM, which has the lowest CE and highest AT&C losses. Without adequate and efficient transmission mechanism, the Technical and Distribution (T&D) loss as well as the AT&C losses would mount up and reduce the flow and quality of power supply in the state.

Rural electrification in Karnataka is 99.9% by 2015, however, its definition is highly questionable and likely to underestimate the actual number of households electrified. These lacunas in the Karnataka electricity industry require prompt attention from the policy-makers. The thrust in policy making should be towards strengthening of the capacity utilisation rate, rationalizing tariffs, redefining rural electrification more realistically, achieving universal electrification, and establishing accurate measurements of T&D loss. This would accelerate the development of electricity industry in Karnataka.

The policy initiatives to reduce power deficit and improve sector performance have been predominant on the supply side. Nonetheless, it is highly essential to undertake Demand Side Management (DSM), in order to improve efficiency of electricity use, to conserve energy and alter the consumption load appropriately. Under the DSM program, BESCOM has taken up several actions, such as, implementing WENEXA scheme to replace inefficient IPS with efficient ones at Doddaballapur as a pilot project, giving incentive for installation of solar water heaters, installing timer switches for street lights, initiating the Surya Raitha scheme which would replace inefficient IPS with solar powered pumpsets and supply excess power to grid to benefit the farmers with extra income, and the Domestic Efficient Lighting Program (DELP) in which four LEDs would be distributed to each households at lower costs to reduce peak demand. However, it is still in a very nascent stage in India as well Karnataka. The barriers that hamper DSM program implementation in India are paucity of technical know-how, lack of awareness, and insufficient capital, especially in the backdrop of the subsidised power supply to certain categories.

7.1.5 Chapter 5 has presented the trend and composition of power sector investment in Karnataka. The share of power sector outlays and expenditures in the total outlays
and expenditures for all sectors in Karnataka have come down significantly over time, from Seventh plan to Twelfth plan, which is consistent with other major Indian states which also witnessed falling power sector share. This reflects the greater policy emphasis on private sector investment for electricity industry development, with public sector taking back seat. In addition, the utilities are expected to function as commercial entities, which generate resources and incur expenditures.

The expenditures made by the Karnataka government on power sector are mainly towards revenue expenditures. The expenditures on capital formation have come down tremendously since mid-1990s, compared to the revenue expenditures. A major proportion of the revenue expenditures goes to 'Assistance to Electricity Boards', which, in turn, primarily constitutes subsidy for IP sets and BJ/KJ consumers. Thus, much of the public spending is on behalf of the subsidy payment for agricultural electricity supply. Maximum electricity consumption is by the IPS category, nonetheless, the agricultural consumption is not found to have any causal relation with agricultural GSDP, as shown in Chapter 3. Thus, it is time to reflect on the policy support extended by way of free power supply, as its erratic nature and poor quality is not supporting the growth of agricultural sector in a significant manner. Studies have empirically proved that farmers are willing to pay for adequate and quality power supply. The current subsidy policy of the government needs to be evaluated and amended accordingly.

The 'Loans and Advances' extended by the state government, mainly for schemes and capital formation, also remained meagre, compared to revenue expenditure. Although the growth of overall public investment faced fluctuations over the years, the total installed capacity grew at a steady rate. This is reflective of the fact that the corporations incur their own capital expenditure from the internal revenue, plus other sources.

The private sector installed capacity, which mirrors the private investment, is growing at a fast pace since late 1990s. Private investment, primarily made on RES and thermal plants, augments the electricity supply by public sector, although at the cost of the incentives. The huge government spending on the 'unproductive' activity of meeting subsidy burden and not towards capital formation is economically and financially unviable for the sector.
The gross profit margin of KPCL is positive and rising, and while that of KPTCL is positive and fluctuating from 2013-14 to 2015-16. The profit margin for ESCOMs, however, varies widely across the utilities during 2010-11 to 2015-16.

7.1.6 Chapter 6 has presented the analysis of the progress in Karnataka power sector performance after the reforms, using select indicators. The study revealed mixed results. Some indicators have performed fairly better in post-reform period, nonetheless, lagged behind other major Indian states. For instance, the energy and peak deficits in the state showed a declining trend in recent years, however, the gap has been high over a long period as compared to other major states of India, like Gujarat, Tamil Nadu, and Kerala. Hence, the deficits still need to be reduced drastically, by enhancing increase in supply and capacity utilisation.

Among the economic indicators, the average revenue recovery as percentage of unit cost of supply showed tremendous increase in the post reform period, which is very conducive for a healthy financial status of utilities. However, the recovery rate is still not 100%, which should be the ideal case. Moreover, a critical issue that emerges from the empirical evidence is the wide difference in the cost recovery rate across different consumer categories. Industrial and Commercial consumers pay more than cost-of-supply, while the recovery rates for agricultural and domestic consumers has been way lower than 100%. The unrecovered cost of supply to agriculture and domestic consumers has to be provided to the utilities by the government as subsidy, as well as through cross-subsidization by other categories. This gives rise to critical issues of high subsidy burden to government, ill financial health of utilities, and industries resorting to costlier option of captive generation. The average revenue realisation also depends on the collection efficiencies of the ESCOMs. Among the 5 ESCOMs, HESCOM has the highest collection efficiency and MESCOM has the lowest AT&C loss, while CESCOM turns out to be least performing in this context.

To investigate the overall performance of Karnataka power sector after reform and vis-a-vis other major states, the Power sector Performance Index (PPI) is calculated for pre- and post-reform periods for 17 major Indian states. The Index value for Karnataka increased substantially after reform, implying better power sector performance in the post-reform period. Karnataka occupied 12th rank vis-a-vis other states before reform, however, it climbed up to 2nd position in the post reform period.
The PPI highlights that the relative position of Karnataka vis-à-vis other major states, in terms of overall power sector performance, has improved after reform. It reveals that the power sector performance has improved in the post reform year, and the values of technical and economic indicators have increased in post-reform period.

While the PPI reflects a very rosy picture regarding the performance of Karnataka electricity industry, it is important to note that there are many variables, like the specific PLFs of plants, which could not be captured in the index due to discontinuous data availability across all states. It should also be noted that the performance reflected by the index is at best the relative performance as compared to the other states. At this juncture, it is important to note that power sector has been underperforming in many states, hence, while it might be gratifying to note that in relative terms, there is an improvement, there are a number of critical issues that need to be addressed. Thus, the future policies should focus on the current weak spots, like eliminating power deficits, increasing rural household electrification rate, reducing the differences in tariffs among consumer categories, which ultimately affect the financial condition of the utilities negatively.

### 7.2 Policy Recommendations

The present study reveals many insights of Karnataka power sector which hold significant policy implications for future growth. One of the crucial observations is the failure of providing electricity access to all households in Karnataka till date, despite considerable emphasis in policy deliberations. There is still lack of good quality and reliable power supply to end-users, which has adverse effect on households, agriculture as well as industries. Before discussing the underachievement of universal electricity access, it is of utmost importance to first review and revise the definition of 'village electrification', according to which the requirement is to have 10% of households to be electrified for the village to be deemed electrified. It is high time this definition is altered in such a way as to mandate 100% of households in the village to be electrified, to enable universal access to all households in the country. Otherwise, the claim of even 100% village electrification would not invariably have all the households in the state electrified.

Schemes like Niranthara Jyothi Yojana (NJY) endeavoured to provide good quality power supply to rural areas by segregating the feeders between agricultural and non-
agricultural consumers, to provide 24 hours supply to the latter group, and efficiently control the supply to former. However, it failed to achieve its goal, mainly because of faulty planning and implementation process, as discussed in Chapter 2. It gives an important lesson for future policy initiatives, which is to first critically assess the results of the pilot programs, and to make a realistic and comprehensive project plan before hastening to implement the schemes in all parts of the state. It would prevent wastage of funds and resources due to delays in implementation of programs.

Another revelation from the study is that there is no causality between electricity consumption and economic growth of Karnataka, at aggregate and sectoral levels. The result is consistent for agriculture, because power supply to this sector is erratic, inadequate and unreliable, which probably explains its poor contribution to agricultural growth. Moreover, the measurement of agricultural consumption is inaccurate and unscientific, as it was de-metered, which makes the consumption figures unreliable. For industries, the study uses the amount supplied by the utilities, and excludes the consumption from self-generation, which is speedily rising over time. The expensive captive power plants add to the cost of production, which make them less competitive. The cross-subsidization by industries which forces them to pay higher tariffs for unreliable power also make them depend on their own generation, although it is more costly. Such factors result in the no causality relation between electricity consumption and growth. Future policies should, therefore, revise the overall concept of cross-subsidization, and gradually phase it out. Much focus should also be placed on faulty measurement and pricing issues with agricultural electricity consumption, which could be resolved through insulation from political intervention in decision making.

On the supply front, there was indeed significant trend break in total installed capacity and actual generation in 1998-99 and 2003-04 respectively. However, the low capacity utilisation is the major concern. The computed capacity utilisation of installed capacity under each type of sources in the state is quite low, which might be due to technical reasons, like age of plants, technical efficiency, outdated technology, availability of natural resources, as well as lack of demand from distribution companies. Policies should emphasize on technological upgradation, and maintenance of the existing system. Low demand from ESCOMs is because of their ill financial health, hence, it needs to be resolved through measures like tariff rationalisation.
devoid of political agenda. A few DSM measures have initiated in Karnataka, however, there is a great need to further strengthen the program by tackling the challenges and barriers like lack of capital, technical sophistication, awareness, and policy emphasis.

A large portion of the government spending on Karnataka power sector pertains to revenue expenditure, which is largely comprised of subsidy to IP, BJ/KJ consumers. A very small proportion is used for capital expenditure, which implies lesser contribution to capital formation from the government. The utilities have their internal revenue generation from sale of electricity, which is used for capital formation. If the future policies make strict deliberations on phasing out such large-scale subsidies, the huge amount thus released for power sector could, in turn, significantly contribute to extensive development of generation, transmission and distribution segments.

The overall performance of the sector in Karnataka, as reflected in the PPI value and state ranking, presents a very optimistic and rosy picture. However, energy and peak deficits are still rampant in Karnataka. Sales revenue as ratio of cost still varies widely across consumer categories, indicating high cross-subsidization. Many households are still devoid of electricity access, and the connected loads suffer from unreliable and poor quality power. A grey area which is largely ignored, nonetheless, requires considerable emphasis in policy domain is the lack of reliable, accurate, continuous data on important variables in power sector, which hinders academic and expert analysis of numerous critical issues in the sector. Data availability will vastly enhance research and development in the sector, which is very essential for resolution of present dilemmas and development of the electricity industry. The future policies should, thus, focus on the current weak spots, like eliminating power deficits, increasing rural household electrification rate, boosting capacity utilisation, improving data availability, reducing the differences in tariffs among consumer categories, which ultimately affect the financial condition of the utilities negatively.