The Applications of System Dynamics in Power Generation Planning

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Background & Introduction

The introduction of power markets in the electric supply industries (ESI) has called for a different approach to system planning and expansion. The traditional monopolistic vertically integrated system has been replaced by competing companies in the generation and retail sectors. Some of the effects on the generation planning process are:

- ❖ Uncertainties are increased since a department that coordinates a national planning ceases to exist
- ❖ Companies are no longer obligated to have generation surplus as the ESI become profit oriented
- ❖ Limited information is disclosed by competing companies, creating imperfect foresight on investments
- ❖ Non-technical factors such as market conditions, economics and social aspects are becoming more significant in building new power plants

Based on these impacts, it is difficult for the power generators to decide when to invest in new power plants. Each country has its own unique environment that makes it difficult to simply adopt measures done in other countries.

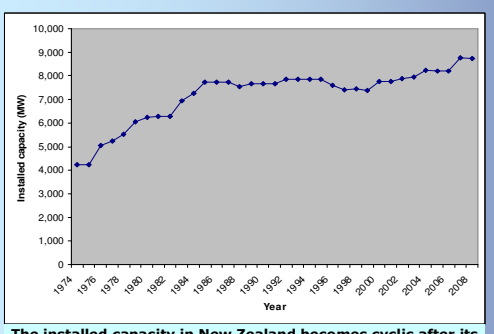
Hence, this study proposes to
- ❖ study the impact of deregulation on power generation capacity growth in New Zealand
- ❖ investigate suitable national policies that will ensure the reliability of the industry

Research Methods

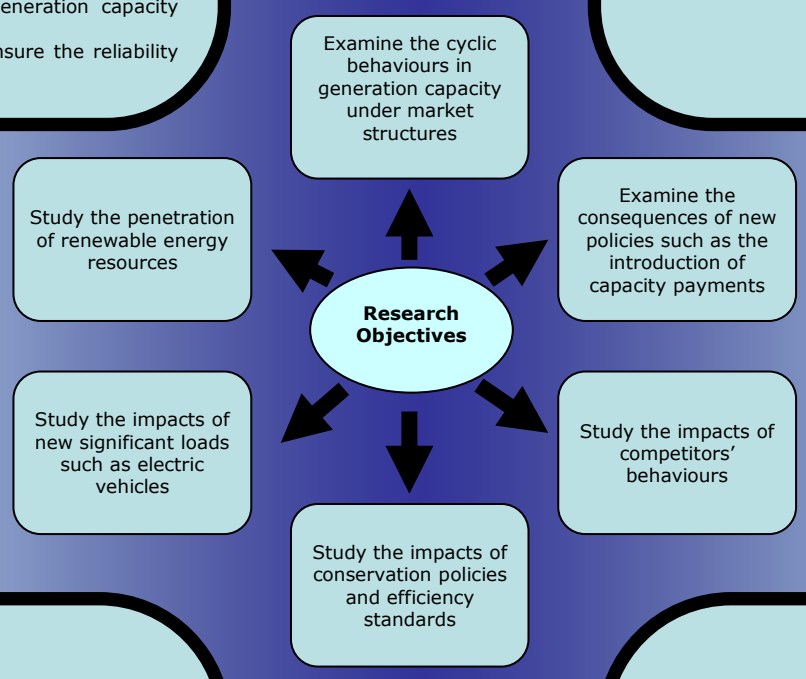
This study proposes to utilise system dynamics to fulfil its objectives. System dynamics (SD) is a simulation modeling technique to understand the dynamic behaviour of complex systems. It can demonstrate how policies, decisions, structure and delays are interrelated to influence growth and stability.

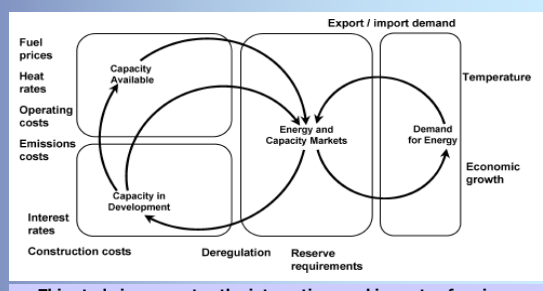
SD is applicable to any field of study and allows modeling for interactions between the fields. It was created during the mid-1950s by Professor Jay Forrester of the Massachusetts Institute of Technology, United States.

This study will adopt the following approaches:
- ❖ include factors such as economics, market, environment and social aspects into the engineering planning of New Zealand's generation capacity.
- ❖ identify and measure the impacts of relevant factors that contributes to supply security
- ❖ model for worst case scenarios to test new policies on the existing market structure



The installed capacity in New Zealand becomes cyclic after its ESI was deregulated

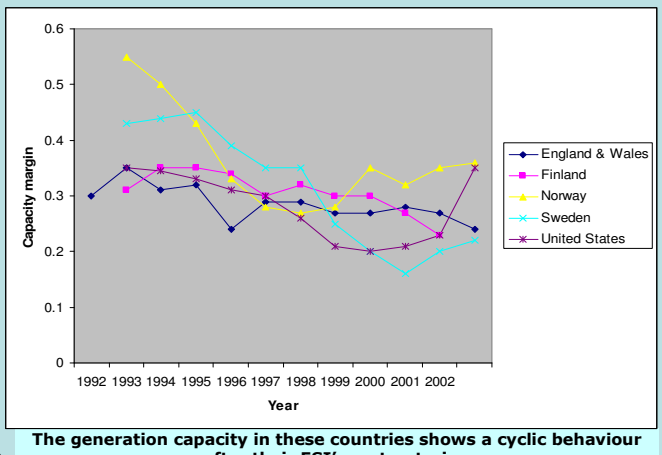




This study incorporates the interactions and impacts of various multidisciplinary factors into generation planning

The Impacts of Deregulation

One of the impacts of deregulation is volatility in wholesale electricity prices. The prices varies throughout the day, seasons and years, making investment decisions difficult and risky. Investors wait for the price to increase and only build new power plants when they are certain on making profits. However, several competitors may decide to invest at the same time, causing capacity excess. These behaviours create cycles in the generation capacity. Cycles of boom (excess capacity) and bust (under capacity) have been observed in New Zealand as well as United Kingdom, Finland, Norway, Sweden and the United States [1].



The generation capacity in these countries shows a cyclic behaviour after their ESI's restructuring

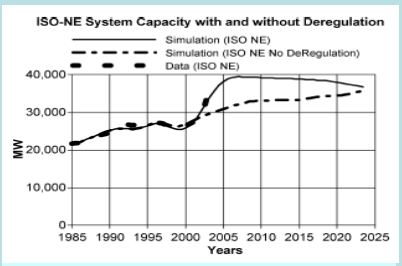
Building a power plant takes a long time which makes a capacity bust a significant threat to supply reliability

Benefits

The unique approach of this study yields the following benefits to the country and society:
- ❖ the electricity supply can be more sustainable by studying realistic scenarios resulting from the interaction of multidisciplinary factors
- ❖ the reliability and affordability of the electricity supply can be ensured by adopting the appropriate national policies
- ❖ generation investments becomes more holistic and integrated rather than based simply on technical and profit reasons

Conclusions

This study allows for policy makers to take preventive measures to avoid supply insecurity or even excess capacity. This is especially useful for the ESI industry where any policy changes can have a major impact on the whole country. This study can also be used to help countries embarking on deregulation to decide the best market structure for their power system.



This example is the generation capacity forecast for the Independent System Operator New England, US with and without deregulation using SD. A similar approach can be applied in designing a suitable market structure for a country