Use of Financial SD Models in Local Government

(Preliminary Paper)

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Abstract

While much has been written about the insights that SD modelling can bring to the understanding of complex systems less has been written about the value of SD models as interactive communication devices. The work outlined below focused on this communication aspect of SD models by taking the standard accounting data from the organisations' financial spreadsheets and incorporated them into a model that captured the key dynamics of their long-term financial strategy. Built with the assistance of the accounting staff the model translated the accounting rules into the stock/flow language utilising the ithink[a] software. As a result the accounting rules around concepts such as depreciation and realisable and unrealisable assets were made very clear and understandable by explaining them in the language of stocks and flows. In addition, the software enabled managers and councillors to explore the consequences of different assumptions and financial strategies. The end result was a much greater understanding of the dynamics of financial performance and an awareness of the levers that influence financial performance. This work is illustrated with extracts from the model used.

1. Introduction

Over the last 10 years I have been trying to come to grips with the technical and client demands of System Dynamic (SD) modelling. The technical demands have been well articulated in articles in the System Dynamics Review and on the SD listserv. The client demands, while less documented, are no less challenging. For many clients the technical niceties of such concepts as DT are of no interest. Whilst such concepts are important to us as modellers, of paramount concern to our clients is whether or not the model and the modelling process can tell them anything they didn't already know.

This paper is about the use of SD modelling in a local government setting. Its focus is on how the use of SD modelling tools helped reveal what was already known by the financial 'experts', to those who had limited financial knowledge yet had all the power of decision-making. It shows how the model helped unveil the mysteries of depreciation, compound interest, and key financial ratios to people who had little if any training in financial matters yet were charged with making decisions that had major financial implications. It also converted static, 'hardwired' assumptions such as the level of rate revenues into dynamic variables that were impacted by such things as population growth. It showed, I believe, that an important aspect of SD is that the nature of the SD 'language' enables complex concepts to be explained simply. In our search for increasing insights into increasingly complex systems we must not forget that much of our audience is still grappling with the most basic ideas and that much can be gained by 'lowering' our sights and making basic systemic understandings more accessible.

For many years Local Government in New Zealand has been - and still is - under pressure to become more accountable and transparent in its behaviour. This is especially the case with

financial expenditure where the Government has legislated the requirement for every Council in the country to produce a long-term financial strategy (LTFS) which specifies its expenditure commitments over the next ten years and the expected level of debt and rate revenues. Operating within the levels of debt and rates specified within its LTFS is a major and public challenge for every Council in the country.

Managing the LTFS is complicated by the fact that many councillors have limited training and little experience in considering broader financial issues. Councillors are often elected on a single agenda item and spend their time promoting their cause. Whilst the legislation requires a long-tem perspective, day-to-day political pressures often force short-term, expedient decisions. A long-term and systemic perspective becomes very difficult to achieve when you combine limited experience and political pressure for immediate results. Furthermore, the commonly used tools are static and not suited to exploring long-term perspectives which have many interacting variables. The dominant planning tool is the traditional spreadsheet which does not readily show relationships between key variables and makes testing of assumptions and experimentation with different strategies very difficult. Furthermore, the assumptions that underlie the numbers in the spreadsheets are often unknown to anyone other than the accountants who put them together. What is needed to improve the level of debate and to provide a counterbalance to the short-term pressures is a tool that enables people to see the long-term consequences of current decisions. SD and supporting dynamic simulation software is perfect for this purpose.

The questions this paper attempts to address are how the use of the stock flow language and dynamic simulation tools can enable people with limited financial experience to:
− better understand the financial dynamics of their organisation, and
− become aware of the levers that impact financial performance.

Can SD models be used to assist people with limited financial and organisational experience to understand key financial concepts and the financial dynamics that affect their organisations? Furthermore, will this understanding assist them to become better stewards of their City's finances?

The answer that this work has come to is a resounding yes. A yes based on four key contributions that the model has made to the level of understanding amongst councillors and managers. These were the ability of the model to:

  i. unravel, step-by-step the key variables. Using stock-flow language – as opposed to accounting terminology – financial concepts such as depreciation are explained in logical terms,
 ii. show the clear links between key variables and how they affected each other,
iii. allow councillors to see the long-term consequences of decisions made with a short-term perspective,
 iv. enable people to discover the key variables that affect long-term performance.

The body of this paper looks at each of four these contributions in more detail. Before moving onto each of these however, the next section provides some background on the model and how it was built.
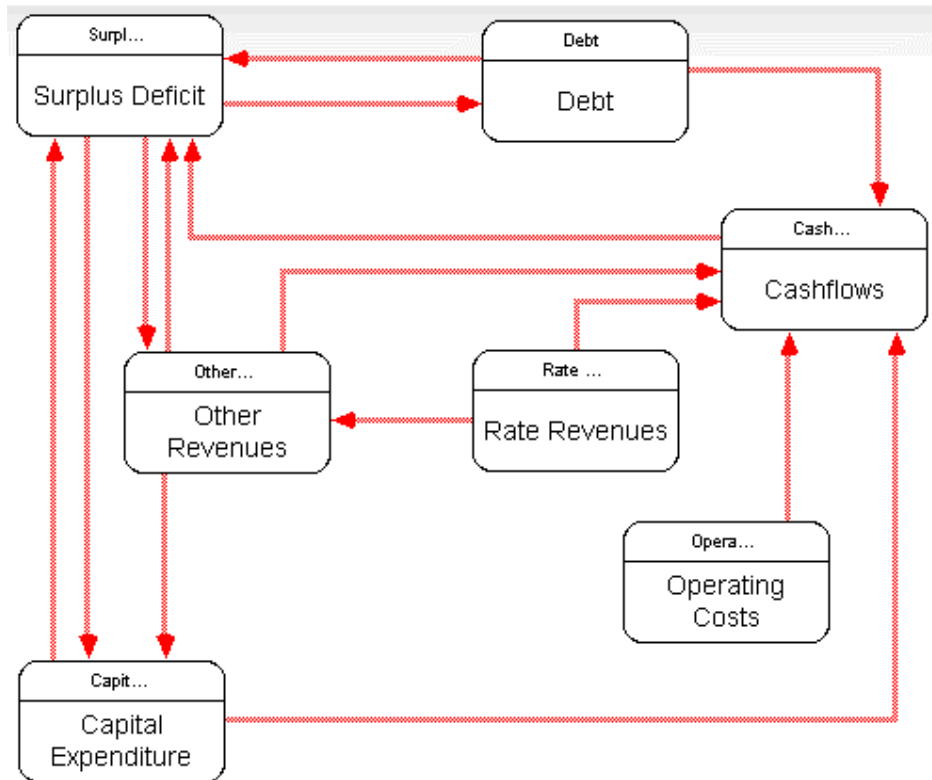

2   Building the LTFS Model

The initial impetus for the model came while I was facilitating a planning session with the senior management team. It was established that the current LTFS did not take account of changes that had occurred in the three years since it had been adopted and now bore little resemblance to actual patterns of expenditure. The Council was not therefore in a position to state, with confidence,

whether or not it was sustainable and whether the adopted levels of debt and rates could in fact be achieved. Of particular concern were the vastly increased levels of capital expenditure already underway and planned for over the next three years. I suggested incorporating existing spreadsheet data into a dynamic model, which would reveal the long-term outcomes of current and proposed plans[1]. This was agreed and over a two month period I worked with the accounting staff to 'translate' the spreadsheet into a dynamic model.[2]

In building the model we used Excel to provide the key initialisation data. By linking the model to Excel we were able create a degree of familiarity and allow the accounting staff to run the model with new initialisation data without having to develop ithink® modelling skills. This was helpful as the organisation was in the process of reviewing its financial plans for the next 10 years and we wanted an easy way to change the data using a tool they were already familiar with.

The model was built, sector by sector, translating standard accounting terminology into the language of stocks and flows. A high-level view of the model is shown below[3].

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[1] The management team had a basic understanding of SD modelling as it had been used as part of a process improvement programme that the author had worked with them on over the previous twelve months.
[2] The model formula are included in appendix 1
[3] Note: some of the linkages between the variables have been removed for clarity. The linkages in the diagram are therefore indicative rather than comprehensive.

3 Contributions of the Model

This next section describes some of the major contributions that the model has made to the understanding and the level of debate within the Council concerning financial performance.

3.1 Unravel core concepts

One of the most powerful aspects of SD is that its 'language' of stocks and flows is a visual language and as such makes the description of complex ideas often very simple. For example, in
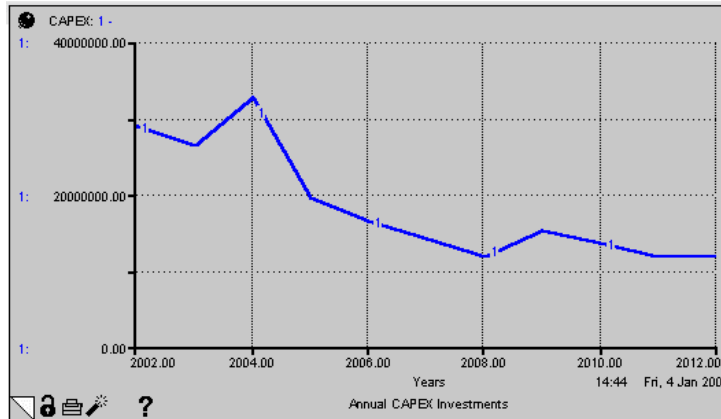

Figure 1: Annual CAPEX Investments

one of the very early runs of the model the proposed pattern of capital expenditure was seen by us, as modellers, to be unrealistic. As shown in figure 1, expenditure was expected to be high in the initial years of the plan and then taper off. This is not an untypical profile in that people want things now, and then expect expenditure, to be curtailed. Always after they have got their own project off the ground – of course. What we wanted to get across to the Councillors was that as the capital expenditure was to

be financed largely out of borrowings, and there was no repayment plan, they would suffer the impact of compound interest. We wanted to explain, as clearly and simply as possible, that the
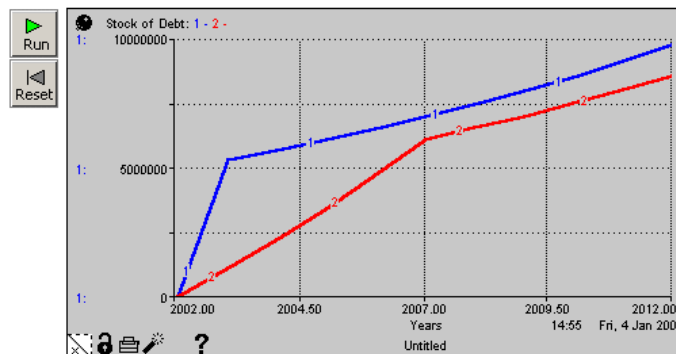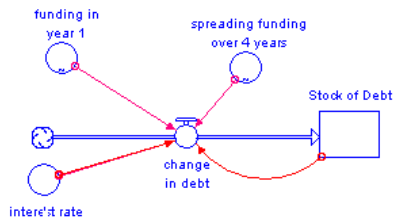

Figure 2: Compound Interest

same level of expenditure spread more evenly would have an enormous impact on the total level of expenditure over the ten years. To achieve this sub-models were used as learning devices, designed to explain some core concepts. The one we put together to describe the impact of compound interest is shown below. It is a very basic one stock, one-flow model. The only complicating factor is that we have built into the model two distinct runs. The first in which a capital programme, in this case $5 million, is funded in year one. In the second the same level of borrowing is spread out over four years. The final expenditure levels of $9.8

million and $8.6 million respectively were a surprise to many.[4] The fact that spreading the funding over four years had such a significant impact was also a surprise. As a result the debate moved one step further forward. Along with the options of proceeding or not proceeding with that item of expenditure, were the questions of when and at what speed. As a result the debate moved to a fundamentally different and more constructive level, aided by a very simple explanation of compound interest using the stock flow language.

The ability of the stock flow language to explain concepts which are often confusing to people has been well described by those working in the education sector, but less well articulated by those of us working with adults in organisational settings. My work in this area indicates that adults are in as much need as children to have key concepts unravelled for them using the language of SD. As has been documented by many people the dynamics of exponential growth, for example, are poorly understood[56].

3.2   Show links between key variables

Another powerful feature of SD models is their ability to make explicit the links between key variables. In building this model the issue of rate revenues was key as rates provide the Council with its greatest source of revenue. In the spreadsheet the rate revenues were 'hardwired' in, based on assumptions about land values and population growth. Firstly, these assumptions were not explicit to anyone using the spreadsheet and secondly they were quite difficult to change. The model overcame both of these constraints very easily. Rather than hardwire the numbers in, the rate revenues were calculated using the relationship between household and average rate per household. A fragment of the model showing these key linkages is shown below. Again the insights here are not earthshattering. However they did once again shift the debate. Once these relationships were
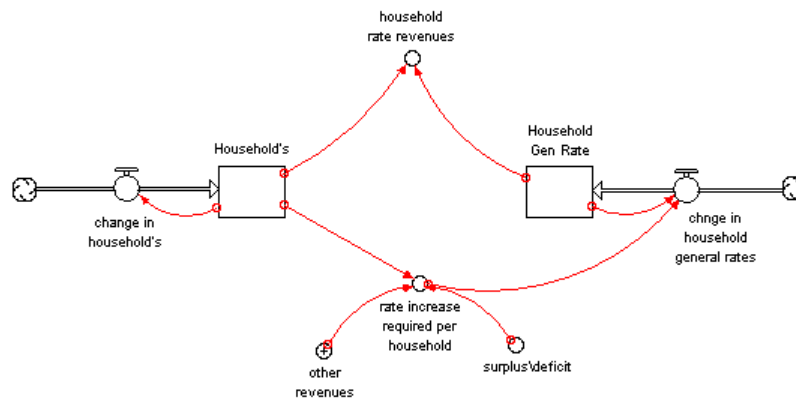

Figure 3: Rate Revenues

made very clear and people were able to see the impact of different rates of population growth, the issue of population growth and strategies to promote growth entered the debate. This was fundamental as the City had experienced no significant growth over the last ten years. This simple linkage allowed them to see the impact on rate revenues and the resultant impact on rates and debt over a range of population growth scenarios. A direct result was that a key question now being applied to all programmes being proposed by councillors is, "what impact will it have on population growth"? The model makes it abundantly clear that if the City wants to continue extending the facilities available to its citizens then it must do something about the rate of population growth otherwise the rate and debt burden will simply become unsustainable. The issue for this City is not too much growth but too little. The impact of a 1.5% population growth rate

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[4] NOTE. The default interest rate was 7 per cent.
[5] Sterman, J. D. Business Dynamics: Systems Thinking & Modeling for a Complex World. 2000
[6] Gladwell, M. Tipping Point: How Little Things Cam Make a Big Difference. 2001

upon rate levels for the current planned level of capital expenditure is shown below. In this scenario not only do rates rise at a slower rate but they level off after three years. Given that the City had historically invested very little and had no coherent strategy for growth the model has had a significant impact upon their thinking.

Figure 4: Cumulative Rate Revenues

3.3 Allow people to see long-term consequences of decisions made with a short-term perspective

One of the key characteristics of local government is the pressure to respond to Community desires. There is always someone wanting some new facility or new funding. Add to this the fact that many councillors are elected on promises they made to deliver this new funding or facility and the conditions are rife for opportunistic overspending. Comparison with the rise in the Consumer Price Index (CPI) against rises in rates shows that local government has rarely been successful in managing this situation with rate rises far outstripping rises in the CPI. Data from the New Zealand Department of Statistics show a rise of 5% in the CPI over the years 1995 to 1998. The corresponding rise in property rate revenues over that same period was 15%[7]. What the model allowed us to do was to 'plug in' every new request for spending and see how the consequences played out. The fact that this could be done in 'real-time' during meetings only served to add to its value. Furthermore the fact that the model could respond to questions such as, "Well a 2% rise in rates would solve the problem wouldn't it", helped raise the level of debate above unsubstantiated assertions. People were able to see the impact of the options being proposed and rather than get into a simple yes or no debate, were able to look at the range of factors at work and the possible options available. Its immediate impact was to put a big brake on short-term expediency. Councillors pushing their particular cause now had a more rigorous hurdle to jump over and any proposal was now put under much great scrutiny.

To facilitate this process an input screen was built allowing access to key assumptions in the model. This screen served two purposes. Firstly it made the major assumptions underlying the model clear to those using the model and secondly it allowed them to change those assumptions easily. A screen shot of the assumptions screen is shown below:

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[7] The CPI data was obtained from the Department of Statistics (www.stats.govt.nz). The data on property rate rises was obtained from Local Government New Zealand (www.lgnz.co.nz).
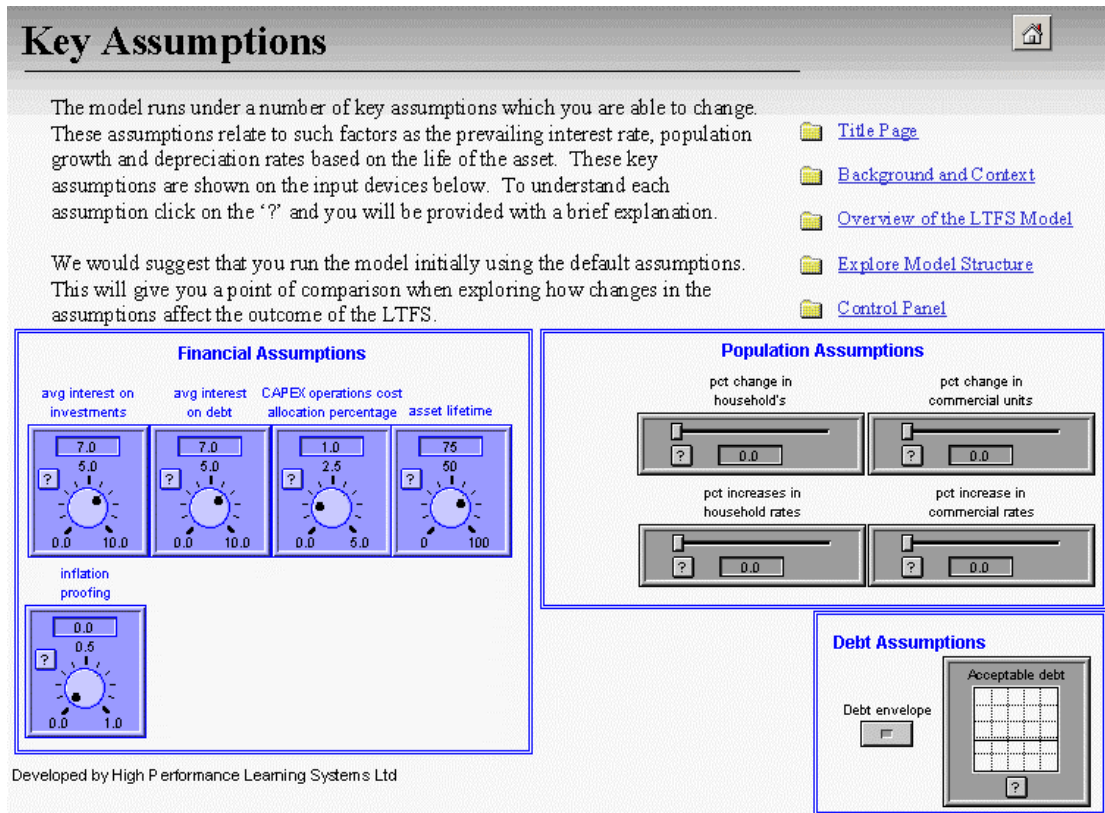
Figure 5: Model Assumptions Screen

Two assumptions that may need clarifications are "CAPEX operations cost allocation percentage" and "inflation proofing". The "CAPEX operations cost allocation percentage" acknowledges the fact that capital expenditure has an effect on ongoing operations cost in that the new facility may need staff to operate it, require ongoing maintenance etc. A very conservative 1% was allocated in the default setting. "Inflation proofing" refers to the interest earned from their investment fund. At the default setting of 0% all interest earned was treated as revenue with nothing being returned to the fund, which stays static as a result. At a setting of 1.0, 100% of the interest earned from the fund would be returned to the fund and thereby grow the fund. This process, which they termed 'inflation proofing' was the focus of much debate.

3.4 Allow people to discover key variables that affect long-term performance

Having the assumption screen proved to be a very powerful part of the model. By making the assumptions explicit and allowing them to be changed easily enabled both councillors and managers to explore additional options. Issues about whether or not to proceed with certain financial strategies were treated as a different debate to that which dealt with available what funding mechanisms were available. For example, when the issue of population growth became a 'hot issue' some saw it as the panacea. It would cut down debt and allow the Council to still progress with planned expenditure. The model showed however that while population growth was important its effect was delayed and secondly, because of the borrowing rules, the effect of population growth was to restrict rate rises, not lower debt. Population growth had no impact upon debt unless run at unrealistically high levels. Seeing the impact of key variables and exploring how they played out over time has led this Council to become much more sophisticated in the way it

looks at its financial performance. It has allowed them to 'test out' their ideas within the safety of the simulation. Furthermore, when results are seen which surprise people they want an explanation of why they are occurring. This requires the accountants and other finance staff to explain, in terms of logic rather than accounting terminology, what is happening and why the results that are seen are being created. It has helped create a closer understanding between those who are the financial experts and those who make the major financial decisions. It has also dramatically improved the level of Councillor and management governance accountability by increasing the integrity of their planning and decision-making processes and by revealing the implications of the decisions they make on behalf of the city they serve.

4   Conclusion

This model has had an impact upon what happens in the Council debating chamber and has increased financial understanding amongst councillors. It has also supported councillors and managers in their attempts to take a more rigorous look at their financial performance and what is required for a sustainable LTFS.

The model itself is quite simple. Whilst there were a few surprises, the model results were in line with accounting predictions. Interestingly, the accountants themselves came to consider the results emerging out of the dynamic model more accurate than their spreadsheet model as the influence across variables was much better articulated. However it produced no significant insights for those of us building the model. The point is that it has provi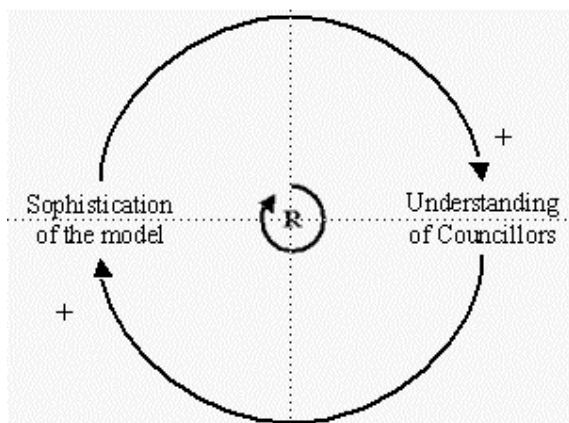ded and continues to provide learning – it was able to assist people with limited financial knowledge – how to grasp the financial complexities of their organisation. It is this capability which I believe the SD community must not lose sight of. Simple models, showing simple systemic concepts can have a significant impact upon the understanding of people who operate and have to make decisions in this increasingly complex world. Interestingly as the level of understanding has gone up there have been requests to continually refine and add further detail to the model with the result that the model and the users have created a reinforcing loop which enhances both. The model has gone through and continues to go through a process of refinement. Of significance is that this refinement is being driven less and less by the accountants and more and more by the managers and councillors who are asking more and more sophisticated and searching questions.

Figure 6: Model Development

Appendix 2: Equations for LTFS Model

Capital Expenditure
Accumulated_Depreciation(t) = Accumulated_Depreciation(t - dt) + (depreciation_expense - recovering) * dt
INIT Accumulated_Depreciation = 10000000

INFLOWS:
depreciation_expense = Capital_Assets*depreciation_rate
OUTFLOWS:
recovering = retiring
Capital_Assets(t) = Capital_Assets(t - dt) + (investing - retiring) * dt
INIT Capital_Assets = 776252000

      TRANSIT TIME = varies

      INFLOW LIMIT = INF

      CAPACITY = INF

INFLOWS:
investing = if (Sustainable_CAPEX_scenario=0) then (new_CAPEX_data*1000+renewal_CAPEX+non_cash_revenues) else (sustainable_$_available_for_new_CAPEX+non_cash_revenues)
OUTFLOWS:
retiring = CONVEYOR OUTFLOW

      TRANSIT TIME = asset_lifetime
Cum_New_CAPEX(t) = Cum_New_CAPEX(t - dt) + (new_CAPEX) * dt
INIT Cum_New_CAPEX = 0

INFLOWS:
new_CAPEX = new_CAPEX_data*1000+Additional_CAPEX*1000
Cum_Renewal_CAPEX(t) = Cum_Renewal_CAPEX(t - dt) + (renewal_CAPEX) * dt
INIT Cum_Renewal_CAPEX = 0

INFLOWS:
renewal_CAPEX = renewal_CAPEX_data*1000
asset_lifetime = 75
CAPEX = if (Debt_envelope=0) then (desired_CAPEX)*(CAPEX_Sensitivity)*((100-Works_Programming)/100) else min (desired_CAPEX,(Acceptable_debt-(Cumulative_Debt-depreciation_expense)))
CAPEX_Sensitivity = 1
Cumulative_CAPEX = Cum_New_CAPEX + Cum_Renewal_CAPEX
Debt_envelope = 0
depreciation_rate = 1/asset_lifetime
desired_CAPEX = renewal_CAPEX+new_CAPEX
gap_ = Acceptable_debt-Cumulative_Debt
pct_write_off = 15

total_annual_CAPEX_ = renewal_CAPEX + new_CAPEX
Works_Programming = 0
write_offs = renewal_CAPEX_data*pct_write_off/100
Acceptable_debt = GRAPH(time)
(2002, 7.5e+007), (2003, 7.5e+007), (2004, 7.5e+007), (2005, 7.5e+007), (2006, 7.5e+007), (2007, 7.5e+007), (2008, 7.5e+007), (2009, 7.5e+007)
Additional_CAPEX = GRAPH(time)
(2002, 0.00), (2003, 0.00), (2004, 0.00), (2005, 0.00), (2006, 0.00), (2007, 0.00), (2008, 0.00), (2009, 0.00), (2010, 0.00), (2011, 0.00)
renewal_CAPEX_data = GRAPH(time)
(2002, 5173), (2003, 5289), (2004, 5220), (2005, 4958), (2006, 5015), (2007, 5351), (2008, 5012), (2009, 5012), (2010, 5012), (2011, 5012)

Cashflows
Cash(t) = Cash(t - dt) + (normal_cash_inflow + cash_inflow_from_borrowing - cash_outflow) * dt
INIT Cash = 4500000

INFLOWS:
normal_cash_inflow = non_rate_cash_revenues+total_rate_revenues
cash_inflow_from_borrowing = borrowing
OUTFLOWS:
cash_outflow = (cash_operating_costs+paying_interest_on_debt+CAPEX+repaying_principal)

Debt
Cumulative_Debt(t) = Cumulative_Debt(t - dt) + (borrowing - repaying_principal) * dt
INIT Cumulative_Debt = 45000000

INFLOWS:
borrowing = borrowing_requirements-drawing_down_investment
OUTFLOWS:
repaying_principal = 0
Cum_Interest(t) = Cum_Interest(t - dt) + (change_in_interest) * dt
INIT Cum_Interest = 0

INFLOWS:
change_in_interest = paying_interest_on_debt
avg_interest_on_debt = 7
paying_interest_on_debt = (Cumulative_Debt*avg_interest_on_debt)/100

Operating Costs
additional_costs_incurred_by_capital_expenditure = (new_CAPEX_data*CAPEX_operations_cost_allocation_percentage/100)*1000
CAPEX_operations_cost_allocation_percentage = 1
cash_operating_costs = (additional_costs_incurred_by_capital_expenditure+(staffing_costs*1000)+(ad_hoc__expenditures*1000)+(non_staffing_costs*1000))*((100-Process_Improvement)/100)
Process_Improvement = 0
ad_hoc__expenditures = GRAPH(time)
(2002, 0.00), (2003, 0.00), (2004, 0.00), (2005, 0.00), (2006, 0.00), (2008, 0.00), (2009, 0.00), (2010, 0.00), (2011, 0.00), (2012, 0.00)
non_staffing_costs = GRAPH(time)
(2002, 23700), (2003, 23180), (2004, 23919), (2005, 23919), (2006, 23919), (2008, 23919), (2009, 23919), (2010, 23919), (2011, 23919), (2012, 23919)

staffing_costs = GRAPH(time)
(2002, 20153), (2003, 20153), (2004, 20153), (2005, 20153), (2006, 20153), (2008, 20153), (2009, 20153), (2010, 20153), (2011, 20153), (2012, 20153)

Other Revenues
Investment_Reserves(t) = Investment_Reserves(t - dt) + (increasing_investment - drawing_down_investment) * dt
INIT Investment_Reserves = 74226000

INFLOWS:
increasing_investment = investment_income*inflation_proofing
OUTFLOWS:
drawing_down_investment = borrowing_requirements*Reserves_Scenario
avg_interest_on_investments = 7
fees_and_charges =
base_level_fees_&_charges+(base_level_fees_&_charges*pct_change_in_household's)/100
inflation_proofing = 0
investment_income = Investment_Reserves*(avg_interest_on_investments/100)
non_cash_revenues = donations_subdivisions*1000
non_rate_cash_revenues =
((fees_and_charges+dividends_&_interest+non_operating_purposes+revenue_from_activities)*1000)+(investment_income*(1-inflation_proofing))
Reserves_Scenario = 0
base_level_fees_&_charges = GRAPH(time)
(2002, 6616), (2003, 6616), (2004, 6616), (2005, 6616), (2006, 6616), (2007, 6616), (2008, 6616), (2009, 6616), (2010, 6616), (2011, 6616)
dividends_&_interest = GRAPH(TIME)
(2002, 200), (2003, 200), (2004, 200), (2005, 200), (2006, 200), (2007, 200), (2008, 200), (2009, 200), (2010, 200), (2011, 200)
donations_subdivisions = GRAPH(time)
(2002, 2000), (2003, 2000), (2004, 2000), (2005, 2000), (2006, 2000), (2007, 2000), (2008, 2000), (2009, 2000), (2010, 2000), (2011, 2000)
non_operating_purposes = GRAPH(time)
(2002, 2270), (2003, 1750), (2004, 8750), (2005, 1750), (2006, 1750), (2007, 1750), (2008, 1750), (2009, 1750), (2010, 1750), (2011, 1750)
revenue_from_activities = GRAPH(time)
(2002, 10296), (2003, 10360), (2004, 10296), (2005, 10296), (2006, 10296), (2007, 10296), (2008, 10296), (2009, 10296), (2010, 10296), (2011, 10296)

Rate Revenues
Commercial_Gen_Rates(t) = Commercial_Gen_Rates(t - dt) + (change_in_commercial_rates) * dt
INIT Commercial_Gen_Rates = 8153

INFLOWS:
change_in_commercial_rates = (Commercial_Gen_Rates*pct_increase_in_commercial_rates)/100
Commercial_Units(t) = Commercial_Units(t - dt) + (change_in_commercial_units) * dt
INIT Commercial_Units = 750

INFLOWS:
change_in_commercial_units = (Commercial_Units*pct_change_in_commercial_units)/100
Cum_Pct_Increase_in_General_Rates(t) = Cum_Pct_Increase_in_General_Rates(t - dt) + (annual_pct_increase_in_general_rates) * dt
INIT Cum_Pct_Increase_in_General_Rates = 0

INFLOWS:
annual_pct_increase_in_general_rates =
pct(chnge_in__household_general_rates/Household_Gen_Rate)
Household's(t) = Household's(t - dt) + (change_in_household's) * dt
INIT Household's = 27475

INFLOWS:
change_in_household's = (Household's*pct_change_in_household's)/100
Household_Gen_Rate(t) = Household_Gen_Rate(t - dt) + (chnge_in__household_general_rates) *
dt
INIT Household_Gen_Rate = 763

INFLOWS:
chnge_in__household_general_rates = if (rate_envelope=0)then
(((Household_Gen_Rate*pct_increases_in_household_rates)/100)+rate_increase_required)else(Ho
usehold_Gen_Rate*pct_increases_in_household_rates)/100
commercial_rate_revenues =
(Commercial_Gen_Rates*Commercial_Units)+(Commercial_Units*water_universal_charge)+(Co
mmercial_Units*other_universal_charge)
cumulative_increase_in_household_general_rates =
Cum_Pct_Increase_in_General_Rates+annual_pct_increase_in_general_rates
household_pct = household_rate_revenues/total_rate_revenues*100
household_rate_revenues =
(Household_Gen_Rate*Household's)+(Household's*water_universal_charge)+(Household's*other_
universal_charge)
pct_change_in_commercial_units = 0
pct_change_in_household's = 0
pct_increases_in_household_rates = 0
pct_increase_in_commercial_rates = 0
rate_envelope = 0
rate_increase_required = (if (surplus\deficit-special_revenues>0) then 0 else (surplus\deficit-
special_revenues)/Household's)*-1
special_revenues = (donations_subdivisions + non_operating_purposes)*1000
total_rate_revenues = commercial_rate_revenues+household_rate_revenues
other_universal_charge = GRAPH(time)
(2002, 164), (2003, 164), (2004, 164), (2005, 164), (2006, 164), (2007, 164), (2008, 164), (2009,
164), (2010, 164), (2011, 164), (2012, 164)
water_universal_charge = GRAPH(time)
(2002, 145), (2003, 145), (2004, 145), (2005, 145), (2006, 145), (2007, 145), (2008, 145), (2009,
145), (2010, 145), (2011, 145), (2012, 145)

Surplus Deficit
available_cash = surplus\deficit-non_cash_revenues+depreciation_expense+write_offs
borrowing_requirements = if (Sustainable_CAPEX_scenario=0) then (CAPEX-available_cash)
else (sustainable_$_available_for_new_CAPEX-available_cash)
surplus\deficit = non_cash_revenues+normal_cash_inflow-cash_operating_costs-
depreciation_expense-write_offs-paying_interest_on_debt
Sustainable_CAPEX_scenario = 0

Not in a sector
Non_Realisable_Assets(t) = Non_Realisable_Assets(t - dt) + (investing_in_NR_Assets -
retiring_NRA) * dt

INIT Non_Realisable_Assets = 645379000

TRANSIT TIME = varies

INFLOW LIMIT = INF

CAPACITY = INF

INFLOWS:
investing_in_NR_Assets = infrastructure*1000+restricted_assets*1000+renewal_CAPEX
OUTFLOWS:
retiring_NRA = CONVEYOR OUTFLOW

TRANSIT TIME = NRA_lifetime
Stock_of_Debt(t) = Stock_of_Debt(t - dt) + (change_in_debt) * dt
INIT Stock_of_Debt = 0

INFLOWS:
change_in_debt = if ('=1) or ('=3) or ('=5) or ('=7) or ('=9) or ('=11) or ('=13) or ('=15) or ('=17) or
('=19) or ('=21) or ('=23) or ('=25) or ('=27) or ('=29) then
(funding_in_year_1)+(funding_in_year_1*interest_rate/100)+(Stock_of_Debt*interest_rate/100)
 else
(spreading_funding_over_4_years)+(spreading_funding_over_4_years*interest_rate/100)+(Stock_
of_Debt*interest_rate/100)
' = RUNCOUNT
annual_operating_revenue = normal_cash_inflow-non_operating_purposes
current_assets = 17191000
current_period = COUNTER(0,11)
debt_as_%_of_realisable_assets = 35
debt_as_%_of_total_assets = 10
Debt_as_%_realisable_assets = pct(Cumulative_Debt/Realisable_Assets)
Debt_as_%_total_assets_ = pct(Cumulative_Debt/total_assets)
interest_as_%_revenue = pct(paying_interest_on_debt/annual_operating_revenue)
interest_cover = 2
interest_paid_as_%_of_revenue = 15
interest_rate = 7
level_of_interest_cover = operating_activities_net_cashflow/paying_interest_on_debt
maximum_debt_servicing_costs = operating_cash_surplus-depreciation_expense
maximum_sustainable_debt = maximum_debt_servicing_costs/(avg_interest_on_debt/100)
new_CAPEX_data = general_fixed_assets+infrastructure+restricted_assets
non_curent_assets = 10954000
NRA_lifetime = 75
operating_activities_net_cashflow = (annual_operating_revenue-cash_operating_costs)
operating_cash_surplus = total_rate_revenues+non_rate_cash_revenues-
(non_operating_purposes*1000)-cash_operating_costs
Realisable_Assets = total_assets-Non_Realisable_Assets
sustainable_$_available_for_new_CAPEX = maximum_sustainable_debt-Cumulative_Debt
time_left = 11-current_period
total_assets = Capital_Assets + Investment_Reserves + current_assets + non_curent_assets
total_operating_revenues = non_rate_cash_revenues+total_rate_revenues
funding_in_year_1 = GRAPH(time)
(2002, 5e+006), (2003, 0.00), (2004, 0.00), (2005, 0.00), (2006, 0.00), (2007, 0.00), (2008, 0.00),
(2009, 0.00)

general_fixed_assets = GRAPH(time)
(2002, 12605), (2003, 4046), (2004, 4975), (2005, 4482), (2006, 4199), (2008, 2590), (2009, 2804), (2010, 3342), (2011, 1305), (2012, 1305)
infrastructure = GRAPH(time)
(2002, 7416), (2003, 8243), (2004, 7587), (2005, 8679), (2006, 6925), (2007, 5168), (2008, 3898), (2009, 7103), (2010, 5020), (2011, 4820)
restricted_assets = GRAPH(time)
(2002, 3921), (2003, 8172), (2004, 15245), (2005, 1434), (2006, 297), (2007, 379), (2008, 342), (2009, 284), (2010, 700), (2011, 700)
spreading_funding_over_4_years = GRAPH(time)
(2002, 1e+006), (2003, 1e+006), (2004, 1e+006), (2005, 1e+006), (2006, 1e+006), (2007, 0.00), (2008, 0.00), (2009, 0.00)

Appendix 2: Excel data input sheet for the model

LTFS Data input sheet for ithink model.

Date	CAPEX			OPERATING COSTS			NON-RATE REVENUES				
	General fixed Assets	Restricted Assets	Infrastructure Assets	Staffing Costs	Non-Staffing Costs	Ad hoc Expenditures	Base Level Fees & charges	Dividends & Interest	Revenue from Activities	Non-Operating Purposes	Donations & Subdivisions
Jun-02	12605 ,	3921 ,	7416 ,	20153 ,	23700 ,	0 ,	6616 ,	200 ,	10296 ,	2270 ,	2000 ,
Jun-03	4046 ,	8172 ,	8243 ,	20153 ,	23180 ,	0 ,	6616 ,	200 ,	10360 ,	1750 ,	2000 ,
Jun-04	4975 ,	15245 ,	7587 ,	20153 ,	23919 ,	0 ,	6616 ,	200 ,	10296 ,	8750 ,	2000 ,
Jun-05	4482 ,	1434 ,	8679 ,	20153 ,	23919 ,	0 ,	6616 ,	200 ,	10296 ,	1750 ,	2000 ,
Jun-06	4199 ,	297 ,	6925 ,	20153 ,	23919 ,	0 ,	6616 ,	200 ,	10296 ,	1750 ,	2000 ,
Jun-07	2590 ,	379 ,	5168 ,	20153 ,	23919 ,	0 ,	6616 ,	200 ,	10296 ,	1750 ,	2000 ,
Jun-08	2804 ,	342 ,	3898 ,	20153 ,	23919 ,	0 ,	6616 ,	200 ,	10296 ,	1750 ,	2000 ,
Jun-09	3342 ,	284 ,	7103 ,	20153 ,	23919 ,	0 ,	6616 ,	200 ,	10296 ,	1750 ,	2000 ,
Jun-10	1305 ,	700 ,	5020 ,	20153 ,	23919 ,	0 ,	6616 ,	200 ,	10296 ,	1750 ,	2000 ,
Jun-11	1305	700	4820	20153	23919	0	6616	200	10296	1750	2000