



NISMOD

Hands-On 2 – Identifying future infrastructure needs and targets

This hands-on exercise helps learners to identify scenarios of future infrastructure needs by inputting demand drivers into the National Infrastructure Systems MODel – International (NISMOD-Int) excel tool, using the case study of Saint Lucia. The exercise also demonstrates how to input performance targets into the tool.

Learning objectives

Change the population-based scenarios used in the model to determine infrastructure needs Incorporate assumptions around per capita infrastructure use to align with different demand scenarios Change and update targets in the model.

Introduction

The tool is available on Github [here](#) or on Zenodo [here](#), which will need to be downloaded to undertake this hands-on session. Here we focus on two steps of the National Infrastructure Systems MODdelling (NISMOD) excel tool:

- *‘Defining future infrastructure needs’*
- *‘Targets for infrastructure performance.’*

In the NISMOD excel tool, these steps are encoded under the following tabs:

- **‘SCENARIOS’**: to define the possible range of future infrastructure needs based on the selected drivers
- **‘NEEDS’**: to translate these scenarios to future demand for infrastructure at the national level
- **‘TARGETS’**: to define the performance values by which the next step will select infrastructure investments and policies to meet this demand.

The ‘Scenarios’ tabs allow users to describe future population forecasts – in the case of Saint Lucia, this incorporates residential and tourist scenarios. The ‘Needs’ tabs translate this to national demand based on assumptions around per capita infrastructure use. The ‘Targets’ tabs will use values defined by stakeholders and policy documents as performance objectives in each sector.



The tool has been developed by the Infrastructure Transitions Research Consortium in partnership with the United Nations Office for Project Services (UNOPS) (Adshead et al. 2020).

USER INPUT	USER INPUT
<p>The B. SCENARIOS tabs describe future residential and tourist forecasts, and the B. NEEDS tabs apply these forecasts to calculate sector-specific infrastructure needs.</p>	<p>The C. TARGETS tab allows users to input performance objectives for future infrastructure provision. Targets for two default strategies are provided, and the user can specify two</p>
<p>B. SCENARIOS residents B. SCENARIOS tourists B. NEEDS electricity B. NEEDS water B. NEEDS wastewater B. NEEDS waste</p>	<p>C. TARGETS</p>

Figure 2.1: Tabs used in the NISMOD tool to define future infrastructure needs and set targets

Activity 1: Assigning residential population scenarios

First, users are introduced to the population scenarios which drive future infrastructure needs in the tool. Residential population growth is a driver that places equal demand on infrastructure across all different sectors. The ‘SCENARIOS Residents’ tab uses a series of population projections taken from the [UN DESA World Population Prospects](#). Of the proposed UN scenarios, three were selected as the default high (‘high fertility rate’), moderate (‘moderate fertility rate’) and low (‘low fertility rate’) scenarios as shown below.

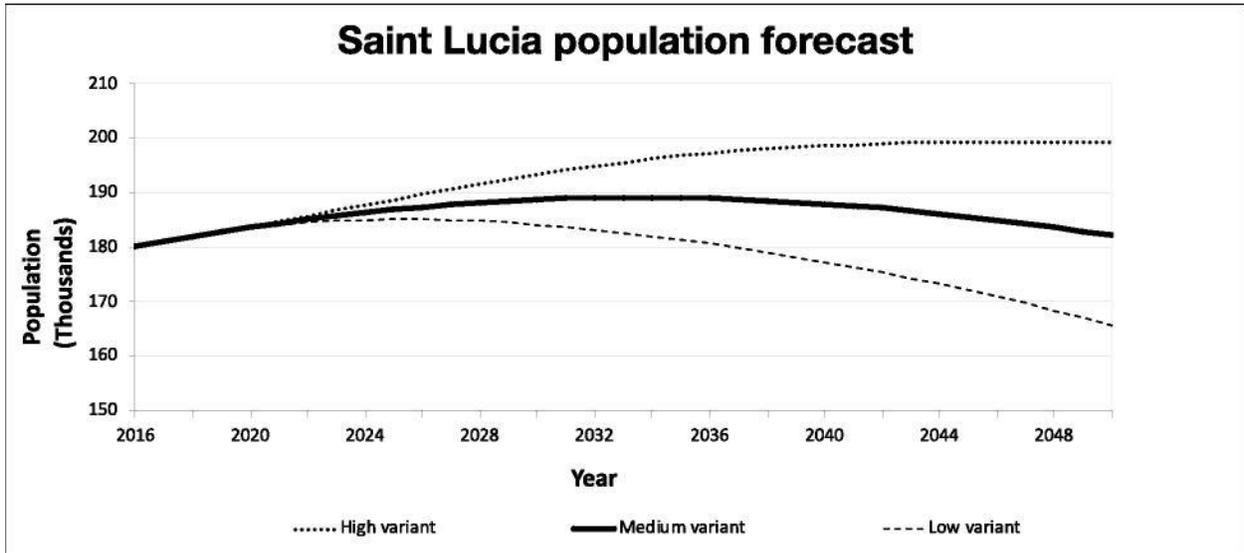


Figure 2.2: Low, moderate and high population scenarios used as a driver of infrastructure needs in the NISMOD tool

However, the tool allows users to assign and input up to three population variants in the analysis by using the drop-down menu.

Using the drop-down menus, select three scenarios to represent low, moderate, and high residential population growth

Scenarios	2016	2017	2018	2019	2020	2021	2022
Low variant	180,028	180,955	181,890	182,795	183,629	184,151	184,550
Medium variant	180,028	180,955	181,890	182,795	183,629	184,401	185,112
High variant	180,028	180,955	181,890	182,795	183,629	184,647	185,677

High variant
Instant-replacement
Momentum

Figure 2.3: Selection of alternate population variants in the tool

Try it: Assign alternate population variants to the low, medium, and high scenarios. See how this changes the range of population forecasts by 2050.

Activity 2: Considering the impact of tourism on small-island infrastructure needs

Next, users are encouraged to input key data determining the impact of tourist arrivals on future infrastructure needs. Projections for incoming passengers at each of Saint Lucia’s airports, cruise ports and marinas have already been inputted, including expected growth numbers from expanded facilities such as the international airport and main cruise terminal.



The data entered in the table in Figure 2.4 will determine the average number of tourists on the island on any given day. For example, tourists arriving by airport are expected to stay for a longer period than those docking in the marina. Notably, cruise ship tourists are considered in a separate category from ‘stay-over tourists’ in terms of their infrastructure demand, since they generally stay for a few hours and rely to a much larger extent on infrastructure services provided on the ship.

Parameters	
Peak stay over tourist per day (Dec 2016)	9,000
Peak cruise tourists per day (Dec 2016)	5,000
Nights/tourists/year (average)	7
Nights/tourist/year (marinas)	2.0
Current capacity airports	500,000
Capacity airport expansion	1,000,000
Average port growth rate (low)	0.00%
Average port growth rate (moderate)	1.0%
Average port growth rate (high)	3.0%

Figure 2.4: Adjustable parameters for tourism as a driver of infrastructure need

Together with the residential tourism scenarios developed in the previous tab, the total number of infrastructure users on the island can be established, which is shown in the ‘SCENARIOS (aggregated)’ tab (Figure 2.5). The estimates include: residential population, peak daily stay-over tourists, and peak daily cruise ship tourists. In addition, the figure shows the relative contributions and uncertainties from the different sources of population growth.

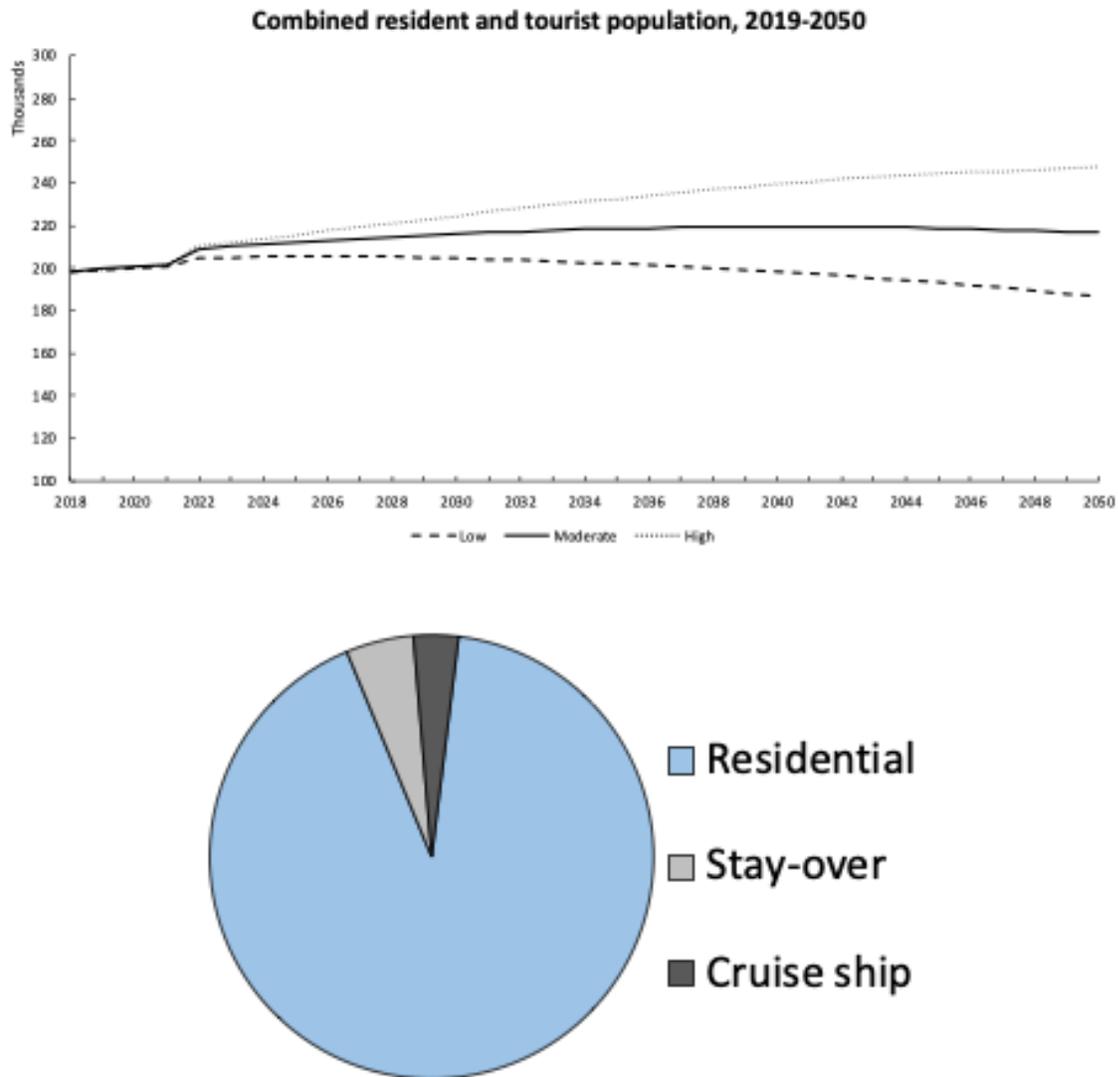


Figure 2.5: Total number of infrastructure users, with breakdown by residential and tourist

Try it: Imagine you are planning expansions to the airport capacity in Saint Lucia. Change the ‘Capacity airport expansion’ to see how much growth in this key tourism facility will add to the island’s number of infrastructure users.



Activity 3: Translating demand drivers into infrastructure needs

Having established these scenarios around projected infrastructure users, we now move on to considering what this means for future demand on each type of infrastructure. This requires inputting parameters to define per capita uses.

Here, we look specifically at the energy (electricity) sector. In this instance, the per capita values have been estimated using the ‘Current’ tabs on residential and tourist (i.e. hotels and boats) use (Figure 2.6). Putting together all sources of demand, we can project energy demand across low, moderate, and high scenarios to 2050 (Figure 2.7). The calculation in year *i* for infrastructure sector *j* is:

$$Demand_{i,j} = (ResPop_i \times ResPC_j) + (StayOver_i \times StayOverPC_j) + (Cruise_i \times CruisePC_j)$$

Where *ResPop*, *StayOver*, *Cruise* denote the population of each group, and *ResPC*, *StayOverPC*, *CruisePC* denote per capita use of each group.

A. Country parameters		
Parameter	Value	Unit
Population (2018)	150,000	Residents
Tourist nights (stay-over)	3,291,509	Nights (2018)
Electricity demand (resident)	0.001702	GWh/resident/year
Electricity demand (tourist)	0.000044	GWh/tourist/day
Electricity demand (tourist)	0.015957	GWh/tourist/year
Peak demand (resident)	0.000255	MW
Peak demand (tourist)	0.002391	MW

Figure 2.6: Per capita demand parameters for the energy sector

The “B. NEEDS <sector>” tabs describe expected per capita and tourist demand for electricity, water, wastewater and waste treatment from the present to 2050. Below, we see the example of electricity.

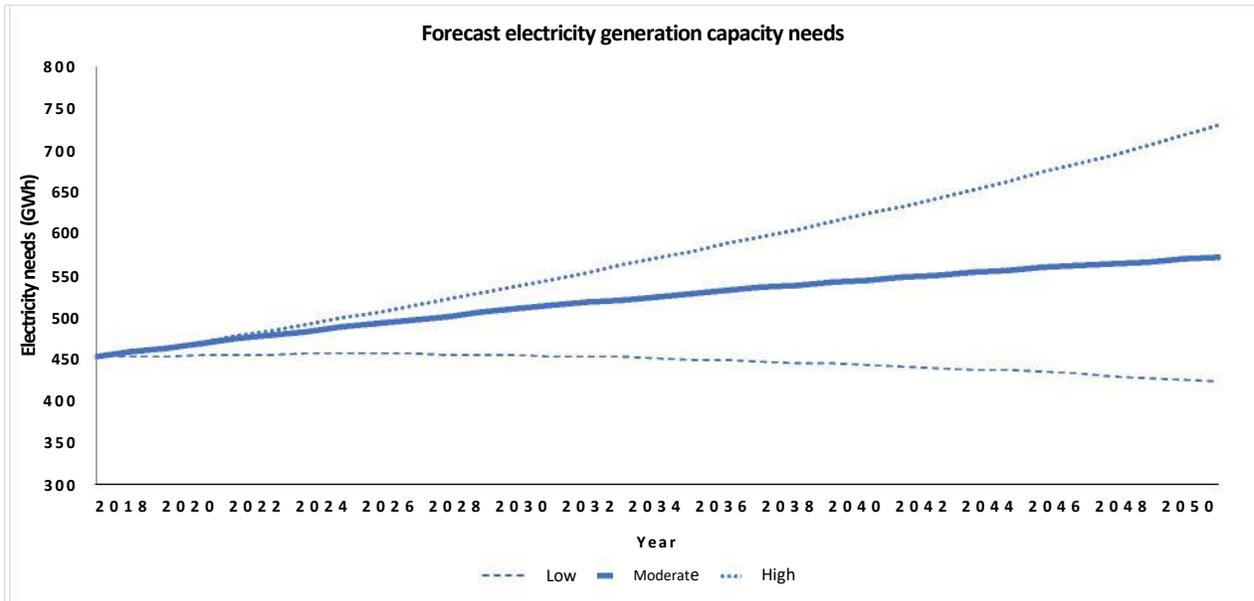


Figure 2.7: Electricity generation needs derived from population and tourist scenarios

This model also considers the fact that this per capita electricity use may not remain static across scenarios. For example, higher per capita usage may be paired with high-growth scenarios, or lower usage in the case of austerity and population decline. The tool thus offers different per capita use assumptions equivalent to other countries and regions that can be paired with each growth scenario. Users may incorporate the assumption, for instance, that a high-growth future for Saint Lucia will bring about electricity use on a par with upper middle income countries, or the European Union.

C. User definitions		
Scenario	Equivalent GWh/per capita	Value
Low growth	Saint Lucia (BAU)	0.001702
Moderate growth	Saint Lucia (BAU)	0.001702
High growth	Saint Lucia (BAU)	0.001702

Use drop-down menus to select per capita energy usage for each of the three scenarios

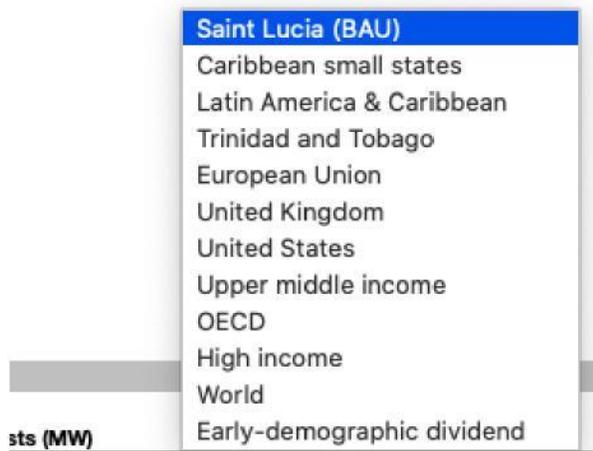


Figure 2.8: Assigning per capita infrastructure use in future demand scenarios

Try it: Test a different scenario of per capita energy use. By selecting from the drop-down menu, you can assign per capita use of energy equivalent to another country or region. You may assume, for example, that a ‘high growth’ population scenario may be associated with increased economic activity and household income, leading to energy use more in line with the EU or OECD average rate. You can do the same for a low and moderate growth scenario. **See how this changes the range of forecast electricity generation capacity needs into the future.**

Activity 4 – Generating targets

Finally, we look at how targets are inputted into the NISMOD tool, through the ‘Targets’ tab. The generation of these targets was described in mini-lecture 5.4. For example, by consulting [Saint Lucia’s first NDC](#), we can obtain targets for renewable energy generation and emissions reductions, associated with a particular achievement date. Figure 2.9 shows an abbreviated list of targets used for the Saint Lucia case study, which were informed by discussions with stakeholders. This includes a ‘business-as-usual’ strategy (BAU), which maintains targets at current performance levels, and a ‘national infrastructure strategy,’ which aims to achieve more ambitious targets. The formulation of these strategies is discussed in more depth in the Hands-on 3. In the rows below, users may create a strategy of their own, based on a specific set of targets and indicators of their choosing. Similarly, new targets may be added to existing strategies in the additional columns.



Select using drop-down menu:

Demand scenario		Performance indicators							
		elec_cap_m argin (2030)	elec_renewabl es (2030)	co2_emissions _waste_2025	co2_emissions_ elec_2030	co2_emissions_ waste_2030	new_target	new_target2	new_target3
Low									
Moderate									
High									
BAU		1.41	0.122		381,481	68,000			
NIS		1.4	0.35	57,120	293,740	52,360			
User_1									
User_2									
User_3									

Figure 2.9: Target input table in the NISMOD-Int tool

Where applicable, the target input table will also adjust target values to correspond to low, moderate, and high demand scenarios developed in the ‘Needs’ tabs. For example, the amount of electricity generation capacity required to meet a capacity margin target expressed as a percent of demand will change based on whether a low, moderate, or high scenario is chosen.

Try it: Consider the ‘National Infrastructure Strategy’ or NIS. Change the renewable generation target for 2030 from 35% to 50% (i.e. by inputting 0.5 instead of 0.35). Now check the results in ‘Pathways – electricity.’ How far off the new target is the NIS strategy with the current selected interventions?

Summary

In the exercises above we introduced users to the ‘Needs’ and ‘Targets’ tabs of the NISMOD-Int Excel tool. We experimented with different inputs to the model – specifically those concerning future infrastructure users, both in terms of total numbers and of per capita infrastructure use. Finally, users were able to inspect the ‘targets’ table and observe the impact of changing target values.

Bibliography

Adshead, Daniel, Lena Fuldauer, Scott Thacker, Orlando Roman Garcia, Sapphire Vital, Fabien Felix, C Roberts, et al. 2020. “Saint Lucia: National Infrastructure Assessment.” August. United Nations Office for Project Services.