NISMOD

Hands-On 4 - Developing infrastructure pathways

This hands-on session focuses on the "Strategy analysis" and "Pathways Development" steps of the NISMOD-Int excel tool. These steps are encoded under the "ANALYSIS" and "PATHWAYS" tabs. **The tool is available on Github here or on Zenodo here, which will need to be downloaded to undertake this hands-on.** The tool has been developed by the Infrastructure Transitions Research Consortium in partnership with the United Nations Office for Project Services (Adshead et al. 2020).

The "ANALYSIS" tab allows users to evaluate the performance of different infrastructure strategies over the future, this tab uses inputs from the "NEEDS," "TARGETS" and "STRATEGIES" tabs. The "PATHWAYS" tab helps to visualise the selected pathways or portfolio of projects over the future and how they achieve (or don't) determined targets and needs. These tabs are the model outputs, so they mainly facilitate visualisation and analysis. They support continuous iterations and modifications of previous assumptions, targets and interventions.

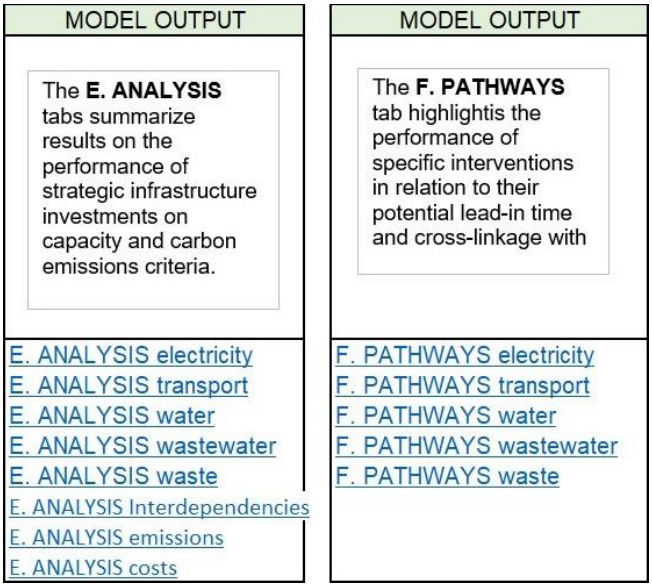

Figure 4.1: Relevant tabs for this hands-on session (Adshead et al. 2018)

Learning objectives

- Visualise and describe the performance of infrastructure strategies

- Modify strategies and evaluate the changes
- Describe a pathways visualisation.

Activity 1: Developing infrastructure strategies by grouping interventions

Building on Hands-On 3, in the "STRATEGIES" tab users can assign interventions to existing strategies by inputting a 0 (not part of the strategy), 0.5 (half of the intervention) or 1 (complete intervention) in the columns titled "Strategy Mapping."

Start by developing four strategies for the electricity sector. "Inaction" is already filled with "zeros" and is used as a benchmark to evaluate how current supply will perform if no intervention is added. "Business-as-usual" (BAU) and "National Infrastructure Strategy" (NIS) are predefined strategies. Fill in the BAU and NIS columns as shown in Figure 4.2. Check what projects are included in each of the strategies; can you relate the strategy names with the portfolio of projects?

Try It: Create a "User Strategy 1" with your own set of projects. You can follow the example in Figure 4.2 to start with. Can you think of a narrative to name your strategy? You can name them as "Renewables" or "Efficiency" or "Recovering from Waste." Select the appropriate interventions accordingly. Assume that projects can be built by halves, so the values can be 0.5 or 1.0 when selecting an intervention.

Strategic alternatives				Strategy mapping			
sector_1	type_1	type_2	Year	*Inaction*	*Business-as-usual (BAU)*	*National Infrastructure Strategy (NIS)*	User strategy 1
electricity	supply	Solar - Micoud	2022		1.0	1.0	1.0
electricity	supply	Dennery Wind Farm	2022		1.0	1.0	1.0
electricity	demand	Energy Efficiency in buildings	2020				1.0
electricity	demand	Energy efficient appliances and street lighting	2021				1.0
electricity	supply	New diesel plant	2023		0.5		
electricity	supply	Solar 20 MW initial deployment	2024			0.5	
electricity	demand	Consumption reduction, hotels (10%)	2022		0.5		1.0
electricity	supply	Solar deployment up to 28 MW	2023				
electricity	efficiency	Waste Heat Recovery	2030				
electricity	efficiency	Transmission efficiency improvements	2025				1.0
electricity	supply	Geothermal (Phase 1)	2025				
electricity	supply	New diesel plant	2028		0.5		
electricity	supply	Distributed Small Scale PV	2028				
electricity	supply	Storage 14 MWh (42 MW of instantaneous capacity)	2028				
electricity	supply	Anaerobic Digestion to Heat/Energy	2030		1.0	0.5	
electricity	supply	Waste to Energy Facility	2032				
electricity	supply	Geothermal (Phase 2)	2035			0.5	
electricity	supply	Natural Gas	2030		1.0		
electricity	supply	Anaerobic Digester expansion	2035				
electricity	supply	Wind expansion	2040				1.0
electricity	supply	Large-scale PV expansion	2045				

Figure 4.2: Creating your own strategy (Adshead et al. 2018)

Activity 2: Evaluating strategic performance

Go to the "ANALYSIS Electricity" tab and evaluate how the four strategies perform over the planning period until 2050. Figure 4.3, Figure 4.4 and Figure 4.5 show the strategic performance on three selected indicators: Capacity Margin (%), Annual Emissions (CO_2 Eq) and Share of Renewable Electricity (%). Remember that in Hands-on 3, the "TARGETS" tab was filled with predetermined targets that can be modified.

Figure 4.3 presents the capacity margin performance of the four strategies under the low, moderate and high scenario. The BAU baseline target was established by assuming that the current capacity margin should be maintained until 2050. A lower capacity margin of 35% was defined as the NIS target. Remember that a capacity margin of 0% means that the system is barely meeting all the demand.

Inaction strategies are clearly performing worse than the rest, and reaching negative capacity margins for the high scenario (red dashed line). In general, Saint Lucia does not have problems of energy capacity, but needs to restructure the energy system given its climate adaptation commitments. The BAU and NIS strategies meet the BAU and NIS targets for the planning period. How does your strategy perform?

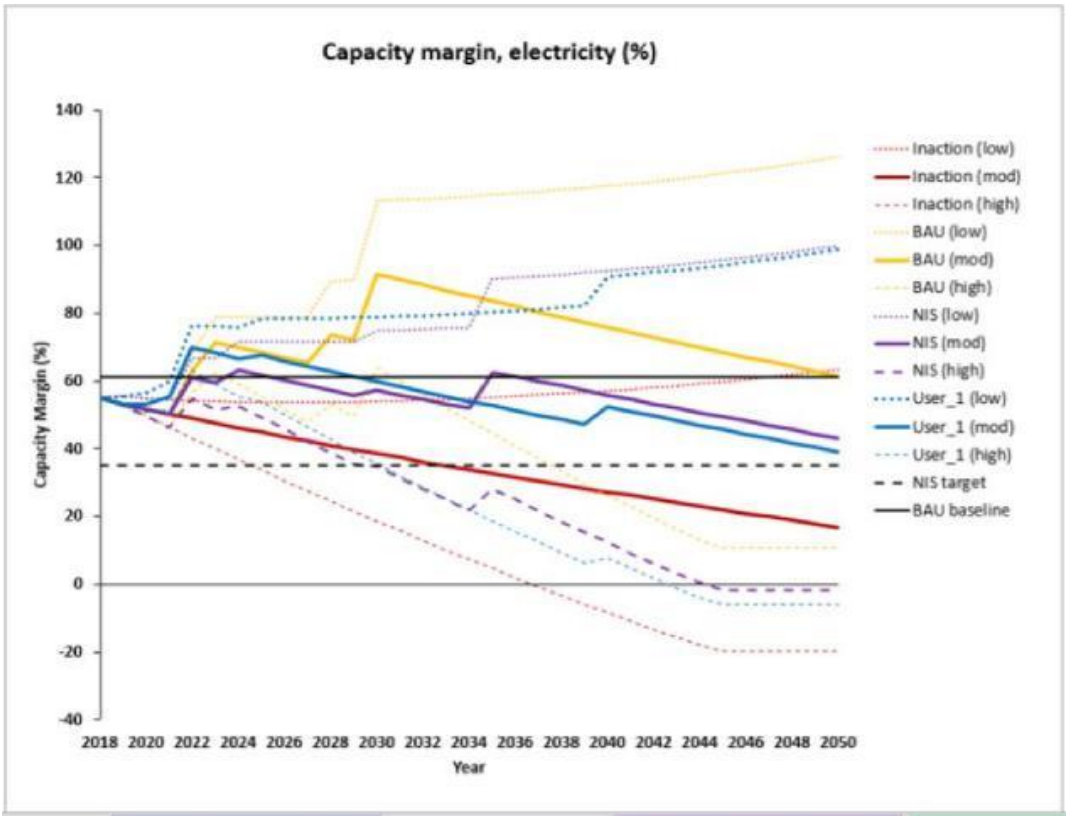

Figure 4.3: Strategic performance against the capacity margin indicator (Adshead et al. 2018)

Figure 4.4 presents the annual emissions performance of the four strategies only for the moderate scenario. Saint Lucia expects to reduce its carbon emissions by between 16% and 23% by 2025 and 2030, respectively. This expectation is reflected in the NIS target. The BAU strategy increases emissions throughout the planning period (it relies on diesel and gas) and the NIS strategy is not able to meet the island´s expectation. How does your strategy perform?

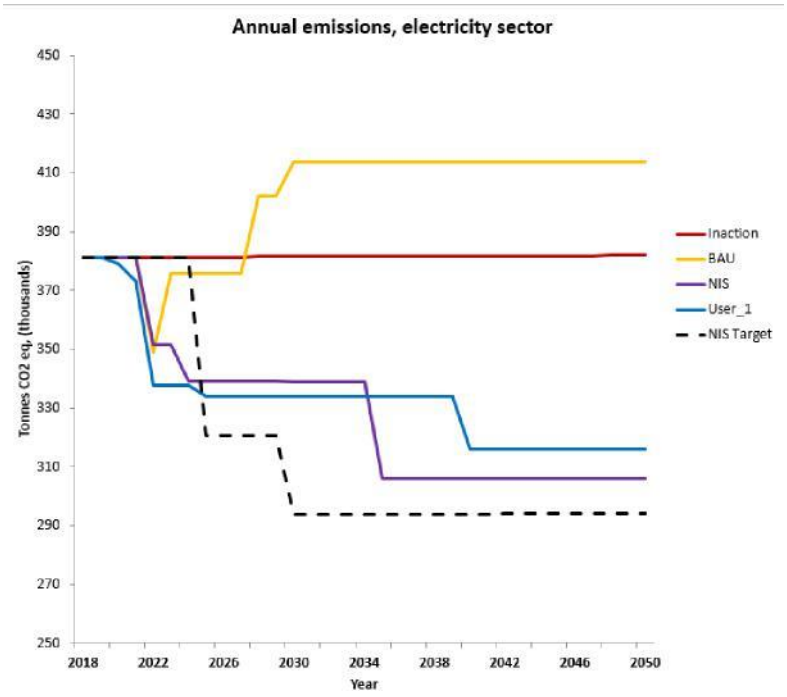

Figure 4.4: Strategic performance against the annual emissions indicator (Adshead et al. 2018)

Figure 4.5 presents the share of renewables (%) indicator of the four strategies only for the moderate scenario. Saint Lucia expects to reach 35% of renewables by 2030. This expectation is reflected in the NIS target. As previously stated, the BAU strategy does not increase the share of renewables throughout the planning period, as it relies on diesel and gas, and the NIS strategy is not able to meet the island´s expectation. How does your strategy perform?

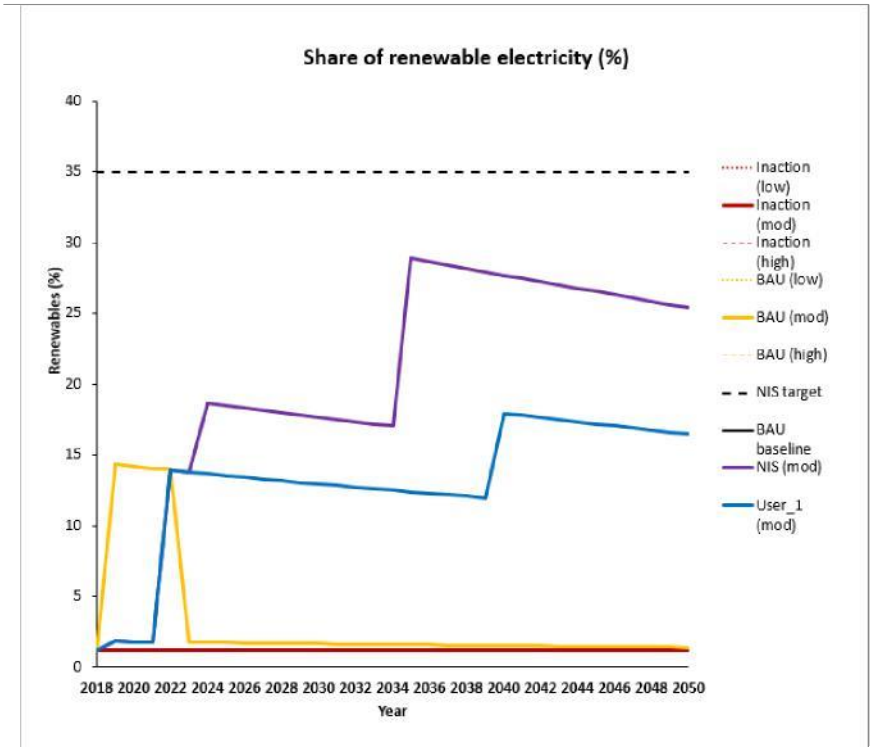

Figure 4.5: Strategic performance against the share of renewables indicator (Adshead et al. 2018)

Try It: Both BAU and NIS do not reach the expected level of reduction in carbon emissions and share of renewables (%). Can you propose a strategy that meets both indicators? Change the set of interventions for the "User Strategy" and see how its performance varies.

Do you see a high capacity margin for the BAU strategy in 2030? That is caused by a New Diesel Plant, an Anaerobic Digestion Plant and a Natural Gas Plant proposed by 2028, 2030 and 2050 respectively. Can you delay these investments while still meeting capacity margin targets? You can change the year of any of those projects and see how the performance analysis changes.

Try modifying the targets. You can create a staggered target (such as the reduction of carbon emissions) for the share of renewables. Build a share of renewables target of 35% by 2030 and 45% by 2040 in the excel spreadsheet, as shown in Figure 4.6. Now, can you propose a strategy that meets this target?

Select using drop-down menu:

Demand scenario
Moderate

	elec_cap_margin (2030)	elec_renewables (2030)	elec_renewables (2040)
BAU	1.61	0.139	0.139
NIS	1.35	0.35	0.50
User_1	1.30	0.35	0.45
User_2			
User_3			

Figure 4.6: Building a share of renewables target (Adshead et al. 2018)

Activity 3 Visualise infrastructure pathways

Once the User strategy has been modified to achieve all the proposed targets, it can be visualised in the "PATHWAYS electricity (User1)" tab. Here you can see how your projects stack through time. In Figure 4.7 it is easier to visualise how demand management strategies reduce demand through time (red lines), and when you reach (or don't) your expected share of renewables. The grey area represents the energy that is still supplied by diesel to meet demand.

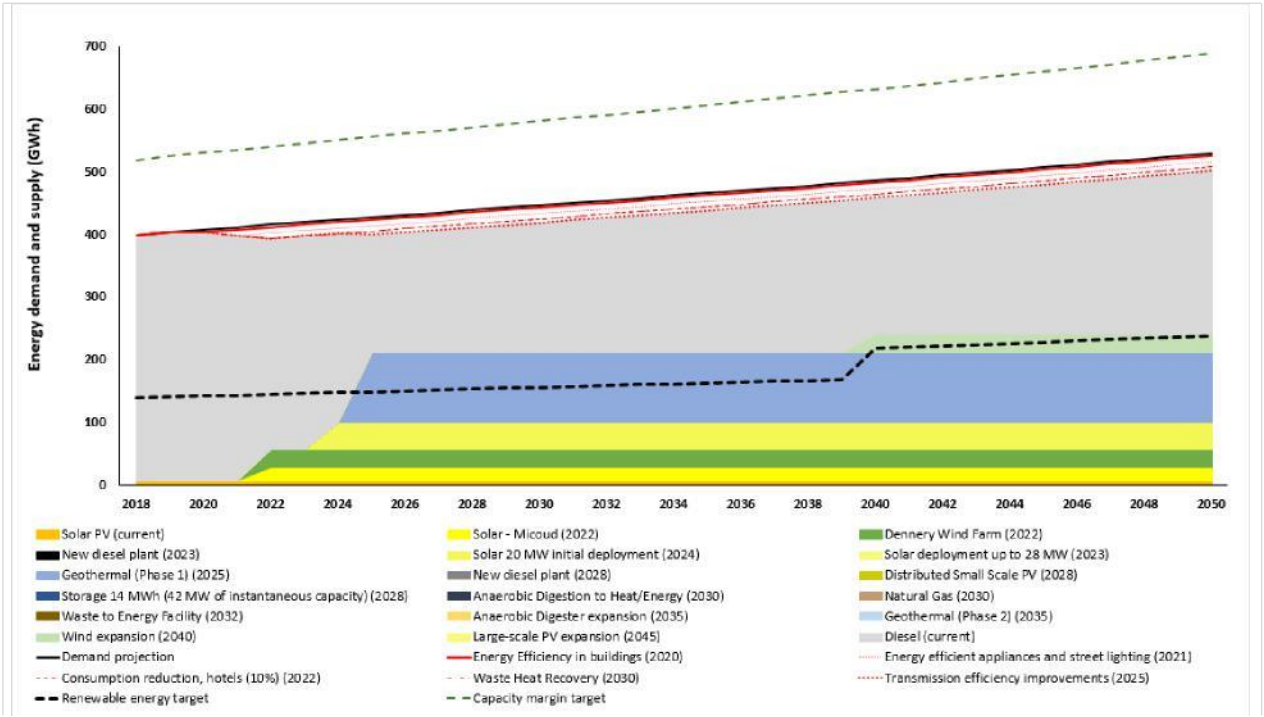

Figure 4.7: How demand-management strategies reduce demand over time (Adshead et al. 2018)

Try It: Pathways visualisation offers more detail on the specific interventions needed through time. Can you optimise the interventions by achieving exactly the renewable targets without outperforming? Is it possible to reach 70% of renewables by 2050? What interventions are needed? Iterate with the tool and create your own strategies.

Can you repeat the process for the other sectors?

Summary

In this hands-on we explored evaluations and visualisations of infrastructure strategy performance. In this way, we looked at performance indicators in order to improve strategies in an iterative fashion. Finally, we visualised the selected portfolio as a pathway through to the future.

Bibliography

Adshead, Daniel, Orlando Roman Garcia, Scott Thacker, Fabien Felix, Lena Fuldauer, and A. J. Hickford. 2018. “Long-term strategic infrastructure planning model for Saint Lucia: Version 1.0.” University of Oxford; United Nations Office for Project Services.

Adshead, Daniel, O. Roman, S. Thacker, F. Felix, and L. I. Fuldauer. 2020. “Long-term strategic infrastructure planning model for Saint Lucia.” Oxford, UK: University of Oxford; United Nations Office for Project Services.