# NISMOD

## Hands-On 3 – Developing infrastructure strategies

This hands-on tutorial focuses on the 'Strategy development' step of the National Infrastructure Systems MODdelling (NISMOD) excel tool. This step is encoded in the NISMOD excel tool under the 'STRATEGIES' tab. **The tool is available on Github here or on Zenodo here, which will need to be downloaded to undertake this tutorial.** 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 'Strategy' tab allows users to define different future visions for infrastructure, which are introduced in this methodology as different 'strategies'. A strategy is defined as a set of interventions across the infrastructure sectors that reflects different priorities for Saint Lucia's approach to infrastructure development (see Lecture Block 6). Interventions can include sector-level policies, technology investments, and specific projects that have been proposed or have been committed to by stakeholders in Saint Lucia.


**Figure 3.1:** The 'strategies' tab

# Learning objectives

- Input infrastructure interventions into the NISMOD-Int tool
- Illustrate how the confidence of infrastructure interventions can be embedded in the NISMOD-Int tool
- Construct your own infrastructure strategy.

# Activity 1: Extract infrastructure interventions from existing documents and literature and input into tool

As a first step, users are encouraged to extract infrastructure interventions that have either been confirmed in ministry, or sectoral documents, or that have been proposed or suggested by infrastructure operators or stakeholders. Using a recently published document 'Saint Lucia's Third National Communication' (highlighted on the official UNFCCC website) as an example, a user can locate information on a proposed infrastructure intervention, for example for the energy sector on page 325:

| | | |
|---|---|---|
| Wind Energy | 12MW Wind Farm development<br>**Agency:** Wind Tex Inc./ LUCELEC/GOSL<br><br>**Policy decision pending.** | The Department has continued to participate in discussions between a potential developer, Wind Tex Inc, and LUCELEC for the development of a 12MW Wind Farm. The Test tower has been up and over 1 year of wind data collected. Agreement to lease private lands has been completed. Government needs to facilitate access to the lands required for the Project and acquire remaining lands. Environmental Impact Assessment |

**Figure 3.2:** Relevant energy sector data from Saint Lucia's Third National Communication

Next, users can input this intervention in the NISMOD Int tool, tab 'STRATEGIES' as shown in the below screenshot (Figure 3.3). This involves adding the sector (energy), an ID, whether it is a supply or demand side option, the name, a status for the strategy (e.g. has it been *confirmed* by in-country stakeholders, specifically *proposed* in a document, or has been stated as a *potential* option (see Adshead et al. (2021)), a time, and a capacity value at the minimum. We will explore in activity 3 how additional information, such as cost or carbon emissions, can be added.


## Strategy Overview

This tab is closely linked to the previous 'C. TARGETS' tab, and details the investments that are part of each strategy in the different sectors. Each row illustrates a particular investment and its characteris
Within the 'Strategy mapping' column (S13-V13), a '1' denotes that the investment is part of the strategy, whereas a '0' denotes that the investment is not part of that relative strategy.

Users are encouraged to **add further investments within each sector, and/or change whether an investment is part of a user-defined strategy by inputting a 0 ( = not part of strategy) or 1 ( = part of st characteristics of proposed investments in the Capacity/Demand value tab (I, J)**

| Currency conversion | |
|---|---|
| 1 | XCD |
| 0.37 | USD |

| Sector | Strategic alternatives | | | | | Capacity/ demand | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ID | sector_1 | type_1 | type_2 | Status | Unit | Year | Generation Value | Peak Value |
| Energy | ene1 | electricity | supply | Solar - Micoud | Confirmed | GWh/MW | 2022 | 21.0 | 10 |
| | ene2 | electricity | supply | Dennery Wind Farm | Confirmed | GWh/MW | 2022 | 29.4 | 12.0 |
| | ene3 | electricity | demand | Energy Efficiency in buildings | Proposed | GWh/MW | 2020 | -3.7 | -3.7 |
| | ene4 | electricity | demand | Energy efficient appliances and street lighting | Proposed | GWh/MW | 2021 | -9.8 | -9.8 |
| | ene5 | electricity | supply | New diesel plant | Proposed | GWh/MW | 2023 | 85.8 | 12.4 |
| | ene6 | electricity | supply | Solar 20 MW initial deployment | Proposed | GWh/MW | 2024 | 42.0 | 20.0 |
| | ene8 | electricity | demand | Consumption reduction, hotels (10%) | Proposed | GWh/MW | 2022 | -8.1 | -8.1 |
| | ene9 | electricity | supply | Solar deployment up to 28 MW | Proposed | GWh/MW | 2023 | 16.8 | 8.0 |
| | ene10 | electricity | efficiency | Waste Heat Recovery | Proposed | GWh/MW | 2030 | -35.0 | -4.0 |
| | ene11 | electricity | efficiency | Transmission efficiency improvements | Proposed | GWh/MW | 2025 | -6.0 | -6.0 |
| | ene12 | electricity | supply | Geothermal (Phase 1) | Proposed | GWh/MW | 2025 | 111.7 | 15.0 |
| | ene13 | electricity | supply | New diesel plant | Potential | GWh/MW | 2028 | 85.8 | 12.4 |
| | ene14 | electricity | supply | Distributed Small Scale PV | Potential | GWh/MW | 2028 | 8.8 | 5.0 |
| | ene15 | electricity | supply | Storage 14 MWh (42 MW of instantaneous capacity) | Proposed | GWh/MW | 2028 | 0.0 | 42.0 |
| | ene16 | electricity | supply | Anaerobic Digestion to Heat/Energy | Proposed | GWh/MW | 2030 | 24.0 | 2.7 |
| | ene17 | electricity | supply | Waste to Energy Facility | Proposed | GWh/MW | 2032 | 131.4 | 15.0 |
| | ene18 | electricity | supply | Geothermal (Phase 2) | Proposed | GWh/MW | 2035 | 111.7 | 15.0 |
| | ene19 | electricity | supply | Natural Gas | Proposed | GWh/MW | 2030 | 69.2 | 10.0 |
| | ene20 | electricity | supply | Anaerobic Digester expansion | Potential | GWh/MW | 2035 | 24.0 | 2.7 |
| | ene21 | electricity | supply | Wind expansion | Potential | GWh/MW | 2040 | 29.4 | 12.0 |
| | ene22 | electricity | supply | Large-scale PV expansion | Potential | GWh/MW | 2045 | 42.0 | 20.0 |
| | ene23 | electricity | supply | *User intervention 1* | Test | GWh/MW | | | |
| | ene24 | electricity | supply | *User intervention 2* | Test | GWh/MW | | | |

**Figure 3.3:** Screenshot showing how to input new intervention

**Try it: Add your own intervention:** Search for further infrastructure interventions in published documents, and insert them into the NISMOD Int tool, tab '**STRATEGIES',** in one of the cells under the respective sector of your infrastructure intervention, e.g. cells 34-36, 'ene23,' which state 'User intervention 1.' If you want, you can also add new interventions under other sectors by scrolling down in the NISMOD Int excel tool.

**Tip:** Real-world applications show that, at times, data for all different attributes of an infrastructure intervention are not always available. For instance, in the above example on wind, the MW value of 12 MW is available, but the timing of the year is not specified. Users are encouraged to engage with local stakeholders where possible, and identify when these projects might be feasible. Embedding data confidence intervals can enable visualisation of where additional data must be collected. We will explore how to embed data confidence intervals in Activity 2.

# Activity 2: Identify and adjust data confidence and add sources based on information inputted

As a second step, users are encouraged to add the data confidence of their inputted information from Activity 1. Light red shading denotes the literature is collected from an in-country stakeholder; moderate red shading represents literature based on regional context information; dark red shading denotes that the literature is based on a world average or an anonymous primary source.

| Confidence level of source | | Source example |
|---|---|---|
| | high | Primary source from in-country stakeholder |
| | med | Literature based on regional context |
| | low | Literature based on world average<br>Anonymous primary source |

**Figure 3.4**: How to denote level of confidence of source information

Given that the data for our first infrastructure intervention in the energy sector was extracted from in-country literature (Saint Lucia's government report to the UNFCCC), the cell with the infrastructure interventions information can be shaded in light red:


**Figure 3.5:** Identifying which cell to shade in light red

Further, users can add the source of the data in the corresponding cell as a comment. This includes right clicking on the cell and adding a comment with the source of information (e.g. Government of Saint Lucia (2017) 'Saint Lucia's Third National Communication')

**Try it: Add your confidence interval:** For your own intervention which you added under Activity 1, highlight the confidence interval by clicking on '**Home', 'Fill Colour'**, and further adding the corresponding source in a comment, through a **right click** on the respective cell for the inputted data, e.g. 12 MW, and adding the source webfile of where the data was obtained from.

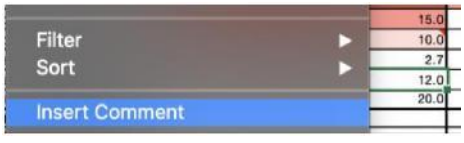


**Figure 3.6:** Screenshot showing how to add a comment to describe your data source

# Activity 3: Propose additional interventions within and across sectors and inputting further attribute information

As a third step, users can propose additional interventions, for example based on regional average data or global averages. For demonstration purposes in Figure 3.7 below, a new solar expansion project has been added (ene23).

| Sector | Strategic alternatives | | | | |
|---|---|---|---|---|---|
| | ID | sector_1 | type_1 | type_2 | Status |
| Energy | ene1 | electricity | supply | Solar - Micoud | Confirmed |
| | ene2 | electricity | supply | Dennery Wind Farm | Confirmed |
| | ene3 | electricity | demand | Energy Efficiency in buildings | Proposed |
| | ene4 | electricity | demand | Energy efficient appliances and street lighting | Proposed |
| | ene5 | electricity | supply | New diesel plant | Proposed |
| | ene6 | electricity | supply | Solar 20 MW initial deployment | Proposed |
| | ene8 | electricity | demand | Consumption reduction, hotels (10%) | Proposed |
| | ene9 | electricity | supply | Solar deployment up to 28 MW | Proposed |
| | ene10 | electricity | efficiency | Waste Heat Recovery | Proposed |
| | ene11 | electricity | efficiency | Transmission efficiency improvements | Proposed |
| | ene12 | electricity | supply | Geothermal (Phase 1) | Proposed |
| | ene13 | electricity | supply | New diesel plant | Potential |
| | ene14 | electricity | supply | Distributed Small Scale PV | Potential |
| | ene15 | electricity | supply | Storage 14 MWh (42 MW of instantaneous capacity) | Proposed |
| | ene16 | electricity | supply | Anaerobic Digestion to Heat/Energy | Proposed |
| | ene17 | electricity | supply | Waste to Energy Facility | Proposed |
| | ene18 | electricity | supply | Geothermal (Phase 2) | Proposed |
| | ene19 | electricity | supply | Natural Gas | Proposed |
| | ene20 | electricity | supply | Anaerobic Digester expansion | Potential |
| | ene21 | electricity | supply | Wind expansion | Potential |
| | ene22 | electricity | supply | Large-scale PV expansion | Potential |
| | ene23 | electricity | supply | *Solar expansion* | Test |
| | ene24 | electricity | supply | *User intervention 2* | Test |
| | ene25 | electricity | demand | *User intervention 3* | Test |

**Figure 3.7:** Example of adding a solar expansion intervention

If new investments are added to the tool, each one requires information regarding the impact and timing – by how much does capacity grow, or demand reduce? When is the impact of the investment expected to begin? These details are added in columns I and J (Capacity/demand). As shown in figure 3.8 below, the example new solar expansion project is expected to begin in 2036, adding 50 GWh to the generation capacity.

| Sector | Strategic alternatives | | | | | Capacity/ demand | | | | Cost | | Other | Carbon | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ID | sector_1 | type_1 | type_2 | Status | Unit | Year | Generation Value | Peak Value | CAPEX (US$) | OPEX ($/year) | Renewable | Id | $CO_2$eq (gross) | $CO_2$eq (net) | Unit |
| Energy | ene22 | electricity | supply | Large-scale PV expansion | Potential | GWh/MW | 2045 | 42.0 | 20.0 | 30,700,000 | 460,500 | 1 | 10 | 2,018 | -24,178 | t $CO_2$eq/year |
| | ene23 | electricity | supply | Solar expansion | Test | GWh/MW | 2036 | 50.0 | | | | | | | | |
| | ene24 | electricity | supply | User intervention 2 | Test | GWh/MW | | | | | | | | | | |
| | ene25 | electricity | demand | User intervention 3 | Test | GWh/MW | | | | | | | | | | |

**Figure 3.8:** Further detail of the solar expansion intervention

Each new value inputted (e.g. the capacity/demand; cost value, etc.) is then to be encoded with the respective confidence interval using red shading.

For the carbon data to be updated, each new investment also requires the modification of one of the formulae in this tab. The 'Id' **column O** should be changed to the type of investment, by allocating a specific code. The list of available codes is given in the "Annex 1. CO2 Emissions table" tab, Column A. In the example, solar projects are allocated Id code '10' ("Solar PV—utility" in the lookup tab).

| O | P | Q | R |
|---|---|---|---|
| | Carbon | | |
| Id | $CO_2$eq (gross) | $CO_2$eq (net) | Unit |
| 10 | 1,009 | -12,089 | t $CO_2$eq/year |
| 11 | 324 | -18,013 | t $CO_2$eq/year |
| 28 | 0 | -2,313 | t $CO_2$eq/year |
| 28 | 0 | -6,117 | t $CO_2$eq/year |
| 28 | 53,461 | 53,461 | t $CO_2$eq/year |
| 10 | 2,018 | -24,178 | t $CO_2$eq/year |
| 28 | 0 | -5,076 | t $CO_2$eq/year |
| 10 | 807 | -9,671 | t $CO_2$eq/year |
| 28 | 0 | -21,830 | t $CO_2$eq/year |
| 28 | 0 | -3,790 | t $CO_2$eq/year |
| 5 | 4,244 | 4,244 | t $CO_2$eq/year |
| 28 | 53,461 | 53,461 | t $CO_2$eq/year |
| 9 | 359 | -5,098 | t $CO_2$eq/year |
| 28 | 0 | 0 | t $CO_2$eq/year |
| 19 | 13,714 | -1,209 | t $CO_2$eq/year |
| 19 | 75,229 | -6,633 | t $CO_2$eq/year |
| 5 | 4,244 | -65,339 | t $CO_2$eq/year |
| 23 | 12,745 | 12,745 | t $CO_2$eq/year |
| 19 | 13,714 | -1,209 | t $CO_2$eq/year |
| 10 | 2,018 | -24,178 | t $CO_2$eq/year |

**Figure 3.9:** Illustration of how to update the carbon data for the solar expansion intervention

Note that emissions associated with demand reductions are shown as the emissions saved by implementing the policy or intervention. For energy, for example, this assumes that total diesel generation is being reduced by an amount equivalent to the demand reduction, and thus the ID number for diesel is used. For the water, wastewater and solid waste sectors, the demand reductions replace an equivalent amount of desalination, wastewater plant treatment, and landfill use, respectively.

**Try it:** Add an additional intervention of your choice, and input attribute information, such as cost and carbon data, using the ID column under the Carbon category.

# Activity 4: Develop an infrastructure strategy by grouping sets of interventions

As a fourth step, users can assign interventions to existing strategies by inputting a 0 (not part of strategy) or 1 (part of strategy) in the columns titled 'User strategy.' Users are also encouraged to check and update the characteristics of proposed investments in the Capacity/Demand value tab (I, J). A value such as 0.5 indicates that half of the proposed capacity is implemented.

| Sector | Strategic alternatives | | | | Strategy mapping | | |
|---|---|---|---|---|---|---|---|
| | ID | sector_1 | type_1 | type_2 | User strategy 1 | User strategy 2 | User strategy 3 |
| Energy | ene1 | electricity | supply | Solar - Micoud | | | 1.0 |
| | ene2 | electricity | supply | Dennery Wind Farm | | | 1.0 |
| | ene3 | electricity | demand | Energy Efficiency in buildings | | | |
| | ene4 | electricity | demand | Energy efficient appliances and street lighting | | 0.7 | |
| | ene5 | electricity | supply | New diesel plant | | | |
| | ene6 | electricity | supply | Solar 20 MW initial deployment | | | |
| | ene8 | electricity | demand | Consumption reduction, hotels (10%) | 1.0 | | |
| | ene9 | electricity | supply | Solar deployment up to 28 MW | | 0.5 | |
| | ene10 | electricity | efficiency | Waste Heat Recovery | | 1.0 | |
| | ene11 | electricity | efficiency | Transmission efficiency improvements | | | |
| | ene12 | electricity | supply | Geothermal (Phase 1) | 1.0 | | 1.0 |
| | ene13 | electricity | supply | New diesel plant | | | |
| | ene14 | electricity | supply | Distributed Small Scale PV | | | |
| | ene15 | electricity | supply | Storage 14 MWh (42 MW of instantaneous capacity) | | 1.0 | |
| | ene16 | electricity | supply | Anaerobic Digestion to Heat/Energy | | | |
| | ene17 | electricity | supply | Waste to Energy Facility | 1.0 | | |
| | ene18 | electricity | supply | Geothermal (Phase 2) | | | 1.0 |
| | ene19 | electricity | supply | Natural Gas | | | |
| | ene20 | electricity | supply | Anaerobic Digester expansion | 0.6 | | |
| | ene21 | electricity | supply | Wind expansion | | 1.0 | |
| | ene22 | electricity | supply | Large-scale PV expansion | | | |
| | ene23 | electricity | supply | *User intervention 1* | | | |
| | ene24 | electricity | supply | *User intervention 2* | | | |
| | ene25 | electricity | demand | *User intervention 3* | | | |

**Figure 3.10:** Mapping out your strategy

**Try it: Assign new interventions to a strategy:** For your own intervention which you added, highlight which strategy this is part of by **adding a 1, 0, or 0.5** in columns S-U.

## Activity 5: Build your own infrastructure strategy

Lastly, users can create their own strategy. This requires changing the name of the strategy and assigning the different possible interventions.

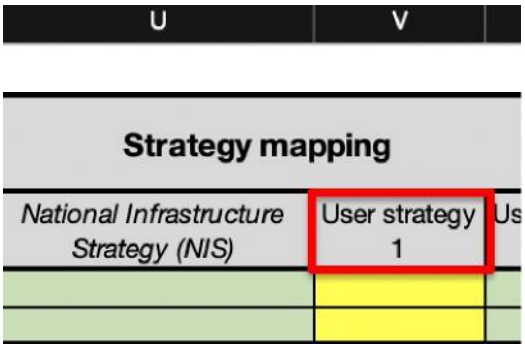


**Figure 3.11:** How to build your own strategy

**Try it: Create a new strategy:** Choose a strategy name, and insert it in column V. Assign interventions to this strategy by adding '0's and '1' to your created strategy. Hands-on exercise 4 will explore how to analyse your created strategy.

# Summary

In the exercises above we introduced users to the 'Strategy' tab of the NISMOD-Int excel tool. We extracted infrastructure interventions from policy documents, added these to the tool, added a confidence interval, and assigned infrastructure interventions to different infrastructure strategies. Lastly, users were encouraged to create their own strategy.

# Bibliography

Adshead, Daniel, Orlando Román Garcia, Scott Thacker, and Jim W. Hall. 2021. "Infrastructure strategies for achieving the global development agendas in small islands." *Earth's Future*, January. https://doi.org/10.1029/2020EF001699.

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.