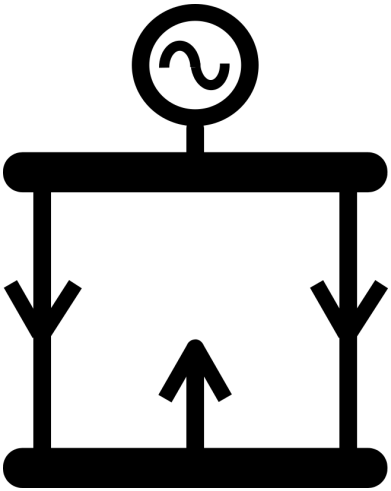
Simplex Nodal

version 2.1



Electricity Market Tutorial

www.simplexnodal.com

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Introduction

This tutorial document explains nodal electricity markets and the simplex algorithm, supported by worked examples using the Simplex Nodal app.

In a nodal electricity market the electricity price takes account of the cost of producing the electricity and also the cost of transporting it to the location where it is consumed. Most nodal electricity markets produce their results using some version of the simplex algorithm.

Layout of this document

The first section provides an overview of electricity markets and electricity networks, so that you can make sense of the system being modelled.

Before starting the tutorials there is a section that covers the Simplex Nodal app. You can start the tutorials without reading this section; the tutorials tell you which buttons to tap as you go along, but if you want to get the full picture up front then read this section. It is divided into two parts. The first describes how to use the app to build and solve electricity market models. The second is more for reference purposes; it lists all of the controls and displays of the app and describes how to use them.

The third section consists of tutorials explaining nodal electricity markets and the simplex algorithm, making use of the app to create illustrative examples. You can start the tutorials without having read the previous section that covered the app.

The first tutorial uses a small model to explain in general terms how a nodal electricity market is modelled mathematically and the meaning of the prices that are produced when this model is solved.

The remaining tutorials demonstrate and explain the various features of a nodal electricity market; modelling transmission and losses, the impact of parallel line flows, the impact of binding constraints, the spring washer effect, risk and reserve, ramp rates, HVDC links, HVDC risk and risk subtractor, and HVDC reserve sharing. There is also a tutorial that describes how to model part of an actual electricity market.

The simplex algorithm is mentioned throughout; the final tutorial explains the simplex algorithm in detail, covering the initial tableau, basic and non-basic variables, the steps that the simplex algorithm takes in order to improve the objective value, and how the results are extracted from the final tableau.

A brief introduction to nodal pricing

If you are not sure what nodal electricity pricing is then the following brief example may help you to decide if you want to learn more.

Nodal prices incorporate the cost of transmitting electricity through the network, as demonstrated by the model shown in Figure 1; the generator is paid $70/MWh while the purchaser pays $84.531/MWh.

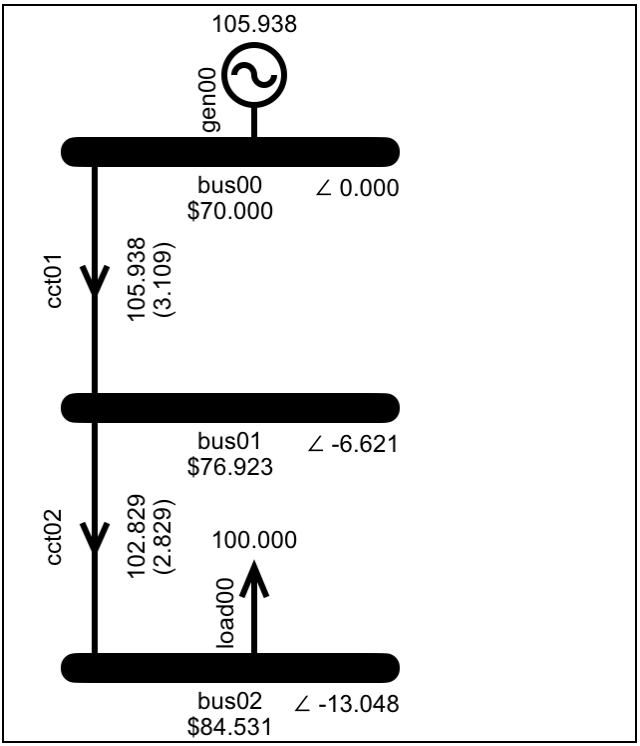

Figure 1: Nodal electricity prices incorporate the cost of transmission

The price differences are due to the transmission losses; 3.109MW on transmission circuit cct01 and 2.829MW on cct02.

The software ensures that the scheduled generation results in the lowest overall cost. This is illustrated by Figure 2, which shows what happens when a new generator is sited closer to the load.

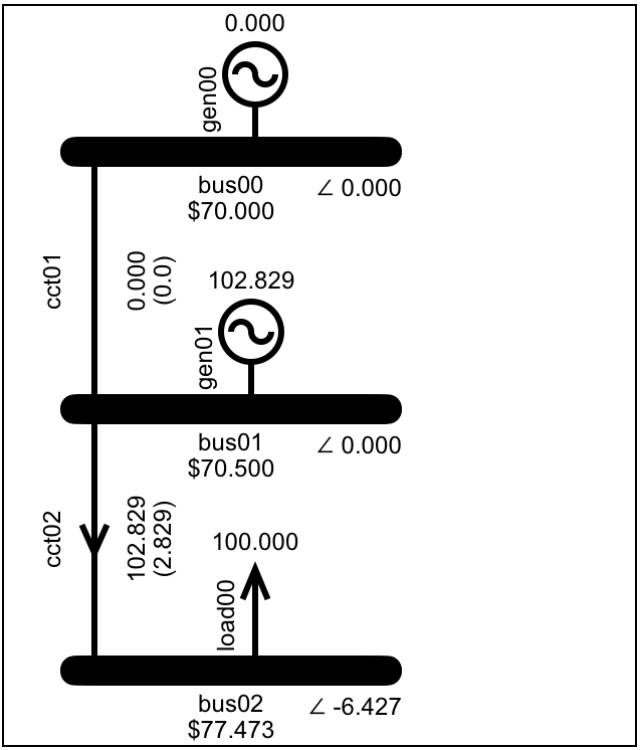

Figure 2: Solution takes total cost into account

Even though the $70.50/MWh offer price of the new generator gen01 is higher than the $70/MWh of the original generator gen00, the new generator is scheduled to meet the load because this results in fewer losses and therefore a lower overall generation cost.