University of Basel

Exploring Possible Futures

Video Transcript

Model fundamentals: supply and demand

We have discussed the questions ’what is a model’ and ’why are economic models useful’ on a fairly general level. Let us now go a step further and start to build and analyse our own energy economic model.

When we build a model to explore possible futures, it is often useful to start by investigating the constraints that need to be described in such a model. That is, how much choice do we actually have to design possible futures? One important constraint in most economic models is that we need to produce what we want to consume. In other words, supply has to equal demand.

In energy economics, this is of particular relevance. Electricity, which is a major energy carrier in most countries, cannot be easily stored.

Thus, at every point of time: supply - the production of electricity - has to equal demand - how much electricity we want to consume. This means that if we have a given demand, we have to find different means to meet this demand. For example, we could use a conventional coal-fired power plant, or we could go nuclear, or we could use renewables, like wind or solar. If demand is larger, we might need to use a mix of different technologies to produce a sufficient amount of electricity. Thus, we have different options available for our energy future. Do we want to have a future based solely on renewables? Or do we dream of nuclear power?

Or do we want to stay with conventional power plants? We can design different energy systems, but they all have to meet one basic requirement supply has to equal demand. In energy economics, there is an additional complexity. Demand changes over time. We need less energy in the night and more energy if it's cold outside. Also, production can change over time. Solar power is not available at night, and the production of wind turbines depends on seasons in most countries. Thus, we cannot only design a system that works well on a sunny summer day, but also have to think of a cold night in winter.

Thus, this is your first task in using the model: design an electricity supply that can cope with different situations. Imagine a country of modest size in terms of energy demand. This country can build coal-fired power plants, gas-fired power plants, nuclear power plants, or can use solar power or wind power. You decide what is to be done.

However, your power system must be able to supply a sufficient amount of electricity in four rather different situations a sunny hour in the summer, an hour in a summer night, an hour of a clear day in winter, and an hour during a cold and foggy winter night. We have designed a model that describes this challenge. You see the demand in those four different hours and have to decide how to meet this demand. The sliders represent the capacity of the different technologies for producing electricity.

In addition, you can choose which of the controllable technologies that is nuclear, gas, and coal have precedence if capacity exceeds demand.

The renewable technologies have their own production characteristics. For example, photovoltaics, or PV, yields electricity only when the sun is shining. We have designed the model to represent a country of

moderate size. And as you will see in later rounds, it used current cost and production structures to describe the different technologies. By playing around with those sliders, you can decide in which technologies this country invests. The model tells you where the demand is met in all situations and how much of the capacity that has been built is actually used. To give you an example, I can increase PV capacity so that demand is met on a sunny day.

However, this helps not much in a cold winter night. Thus, I need to back up my system with a second technology, such as gas or wind.

I would like to ask you to play around with this model. Get a feeling how much leeway you have in setting up a future energy system for this country. This is important. The basic constraint that supply has to equal demand is a centre of most models in energy and environmental economics. Understanding this constraint and its implications for the design of energy systems is central for building and using these models.

Once you have designed a number of future energy systems, tell us what has made you decide for a particular system. Then, we will look at a mathematical representation that is behind the model so that you can see how such a model is built. Have fun!