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Concepts and Case Studies

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This book is dedicated to my children Dragos Cristian and Diana Catrinel, for understanding and support, and with apologies for the little time spent together.

Preface

The energy market will be the vector of progress of all economies. The diversity of production sources, users and the geopolitical environment will lead to multiple contractual agreements between all parties involved. In this complex economic universe, unpredictable and sometimes disastrous phenomena of natural or anthropogenic origin are also present. Under these conditions and in certain situations, the fulfillment of the assumed contractual obligations will not be fulfilled. Force majeure is a legal way of managing risk in a contractual agreement between two parties. The unpredictable events were commonly mentioned used to be terrorist attacks, wars and epidemics, but in the last period of time, extreme natural phenomena have become the most invoked reasons to terminate a commercial contract.

This book is written based on personal experience as a technical expert involved in the process between a large energy producer in Romania and several beneficiary companies. The contents of this book intend to bring to highlight the complete contexts in which force majeure was invoked to terminate contracts of all kinds. I believe that this experience will be useful both to energy companies and to the beneficiaries or traders of electricity, and also to the courts that are put in charge of the decision-making in such cases.

There are many law firms or legal departments that can provide legislative advice to companies. But the challenge is to correlate the contractual specifications with the extreme cases that may occur and that may affect the performance or termination of the contract assumed by the parties.

I would like to thank all the lawyers I worked with throughout the process for their interest in the technical details and the judges who made the effort to understand these unique issues in the case law between companies.

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2022

Daniel Constantin Diaconu

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Chapter 1
The Energy Context in Romania

Abstract Water and energy are major components of the development system of human society. Given that the interdependence between the two components is very high, the demands on one element exert indirect pressures on the others as well. Global changes in climate, the structure of the economy, and consumers' habits are making the energy–energy system a permanent change. Knowledge of this context of its mechanisms must be the basis for future decisions.

Keywords Water · Energy · Sustainability

Water and energy are two vital components of the sustainability of increasing the number of inhabitants on Earth. Under these conditions, the exploitation of the resources we have must be carried out efficiently and sustainably to not jeopardize humankind's future development (Mikulčić et al. 2020; Ke et al. 2022; de Oliveira et al. 2022; Grubert and Marshall 2022).

Emerging economies will account for most of the new demand for water and energy, driven by the rapid growth of the economy and population, the need to generate more goods and services and to intensify policy toward electrification, water supply and sewerage networks. Only the engine systems used in the Chinese industry will account for almost a fifth of the increase in the total international electricity demand by 2040. A similar increase in space cooling needs is expected, with the number of home air conditioners in developing economies rising to 2.5 billion units, from about 600 million today (https://www.iea.org/reports/world-energy-outlook-2018/electricity) (Zhang et al. 2022). Accelerating the absorption of electric vehicles and electric water heaters could rapidly increase demand in developing economies.

In 2016, primary energy consumption in the European Union (EU) was 1543 million tons of oil equivalent, 4.0% above the 2020 target.

Between 2005 and 2016, primary energy consumption in the EU fell by 10%. This has been due to improved energy efficiency, increasing the share of renewable energy sources (hydro, wind and solar photovoltaic energy) in total energy consumption, economic recession and climate change (https://www.eea.europa.eu/data-and-maps/indicators/primary-energy-consumption-by-fuel-6/assessment-2/) (Chen et al. 2021; Krkošková 2021).

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Based on preliminary estimates from the European Environment Agency, in 2017 primary energy consumption was 1563 million tons of oil equivalent in the EU. This represents an increase of 1.3% compared to 2016.

Fossil fuels (including non-renewable waste) continued to dominate primary energy consumption in the EU, but their share fell from 78% in 2005 to 72% in 2016. The share of renewable energy sources almost doubled in the same period, from 7% in 2005 to 14% in 2016, increasing at an average annual rate of 5.4% per year between 2005 and 2016. The share of nuclear energy in primary energy consumption decreased slightly, from 15% in 2005 to 14% in 2016 (https://www.eea.europa.eu/data-and-maps/indicators/primary-energy-consumption-by-fuel-6/assessment-2/).

The EU's dependence on imports of fossil fuels (gas, solid fuels, and oil) from third countries increased slightly, from 52% in 2005 to 54% in 2016, expressed as a percentage of total gross domestic energy consumption plus bunkers. In 2016, oil accounted for 59% of total net imports, gas 30% and solid fuels 11%.

Primary energy consumption in the EU increased by 9.2%, from 1570 million tons of oil equivalent (Mtoe) to 1713 Mtoe between 1990 and 2005. Between 2005 and 2016, primary energy consumption in the EU decreased by 10.8%, reaching 1583 Mtoe in 2016. Various factors have caused this decline, in particular improving energy efficiency, increasing the share of energy in hydro, wind and solar photovoltaic (PV) energy, the economic recession and climate change (http://www.transelectrica.ro/web/tel/productie) (Wen 2022).

In line with the Energy Efficiency Directive, the EU has set a target of limiting primary energy consumption to a maximum of 1483 Mtoe by 2020. In 2016, the EU's primary energy consumption was below the linear trajectory between 2005 and 2020 targets. However, the sum of all 2020 targets for primary energy consumption by the 28 Member States was 1526 Mtoe (https://www.anre.ro/ro/energie-electrica/rapoarte/puterea-instalata-in-capacitatiile-de-productie-energie-electrica). It is 43 Mtoe (3%) higher than the EU target for primary energy consumption in 2020 of 1483 Mtoe. Based on preliminary estimates by the European Environment Agency (EEA), in 2017 primary energy consumption in the EU was 1563 Mtoe, 1.3% higher than in 2016. This level is 34 Mtoe (2.2%) higher than the level set in the linear path toward the 2020 target (Dascalescu and Kleps 2010).

The national energy system consists of all interconnected electricity in producers and consumers. The data published by Transelectrica company in 2019 indicate a capacity of 24,406.01 MW of installed capacity. The higher installed power uses the hydropower potential of watercourses. The 943 hydropower groups have a total installed capacity of 6758.78 MW (Table 1.1).

The diversified production of electricity in Romania aims to ensure a supply of basic, permanent energy and peak energy, when higher amounts of energy are required for relatively short periods of time.

Thus, we meet operators that operate continuously, stopping and restarting production groups lasting over time and being very expensive as well as operators operating in periods of wind or sun. Hydroelectric power plants with significant water accumulations operate when needed, their start and stop lasting only a few minutes. In addition, they are the only ones that can provide services regarding the safety of the

Table 1.1 Situation of the installed capacity (MW) at the national power grid level from 01.04.2019

	Combustible	Groups	Installed power	Installed capacity	Net power	Permanent discounts	Power available
1	Coal	38	6232.20	4822.20	4128.00	1691.00	4541.20
2	Hydrocarb	254	5456.07	3565.98	3044.72	2078.73	3377.34
3	Water	943	6758.78	6696.82	6317.84	382.72	6377.34
4	Nuclear	2	1413.00	1413.00	1300.00	0.00	1413.00
5	Eolian	123	3031.57	3031.53	2977.19	24.85	3005.63
6	Biomass /biogas	53	131.98	131.15	122.32	4.01	127.95
7	Solar	633	1382.36	1382.36	1297.59	61.35	1320.15
8	Geothermal	1	0.05	0.00	0.00	0.05	0.00
	Total	2047	24,406.01	21,043.04	19,187.66	4242.71	20,162.61

Data source http://www.transelectrica.ro/web/tel/productie.

national energy system and the quality of the energy supplied (Dascalescu and Kleps 2010; Nastase et al. 2017; Zelenakova et al. 2018).

The installed capacity in the electricity production capacities in Romania is approximately 19,581,543 MW, at the level of 2021. This capacity is structured as follows: 33.9% hydro, 21.2% coal, 15.4% wind, 14.5% hydrocarbons, 7.2% nuclear, 7.1% solar, 0.5% biomass and others in lower proportions (biogas, waste, residual heat, etc.) (https://www.anre.ro/ro/energie-electrica/rapoarte/puterea-instalata-in-capacitatiile-de-productie-energie-electrica).

Any unit of electricity production, which uses fossil fuels (oil, gas, coal), nuclear, wind, solar or hydropower, also uses, directly or indirectly, quantities of water, in different proportions (https://www.anre.ro/ro/energie-electrica/rapoarte/puterea-instalata-in-capacitatiile-de-productie-energie-electrica) (Connors et al. 2002).

1.1 Conclusion

The evolution of Romania's energy system is given by the available energy sources and by the structure of producers and consumers, in the context of Romania's integration in the energy market of the European Union. The changes registered during the last decade, under the influence of the implementation of measures imposed by global climate change, the transition to electric mobility, the abandonment of the use of fossil fuel, widespread migration and armed conflicts have also produced changes in production costs and the amounts of energy generated.

In this context, there is an upward trend in electricity consumption, an increase in sales tariffs, but also the closure of production units that use fossil fuels, an increase in the photovoltaic and wind sector, but also plans to expand energy production to nuclear.

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Chapter 2
Water for Energy Versus Energy for Water

Abstract Water and energy are the facets of the same coin. The two are inseparable, ensuring the social and economic development of mankind. The numerical growth of the population as well as the development of the society has led to the increase of water and energy consumption. Both are needed to increase agricultural and industrial production and daily comfort. The analysis of the duality of water and energy is necessary to understand the implications on sustainable development, their tariffs and also the implications on the environment. Both the aspects regarding the water consumption required for each energy branch and the energy aspect for the treatment and purification of the water destined for consumption were analyzed. All this for understanding the relationship between water and energy and making the best choices related to the integrated management of water resources by decision makers.

Keywords Water · Energy · Usage

Water and energy resources represent an interdependence of enormous significance for global economic growth, the well-being of the population and the existence of life on earth.

Energy is required for a number of processes related to the collection and treatment of water, its transport to users and wastewater treatment.

In its report on global risks, the World Economic Forum calls on experts to present a ranking of potential global threats according to their likelihood and impact (https://www.weforum.org/reports). Thus, starting with 2016, the following problems are presented: a failure of mitigation and adaptation policies to global climate change, a sharp rise in energy prices and a water crisis.

Water has long been considered an inexhaustible resource. The current reality indicates that we have less and less water, especially due to the deterioration of its quality. The amount of renewable water resources available to each country varies greatly globally. However, many countries face a certain stress in allocating water resources, given the particularities of the hydrological regime, water quality or the large number of inhabitants. More than a billion people live in areas with significant water stress, a figure that is expected to increase at least threefold by 2025 (https://unesdoc.unesco.org/ark:/48223/pf0000225741) (WWAP 2012).

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Water stress is defined as when the annual supply of drinking water from freshwater sources falls below 1700 m^3 per person; water deficit is when the quantity is less than 1000 m^3 per person and the absolute deficit when the quantities are below 500 m^3 per person.

Over the next 25 years, water demand is projected to increase by almost 10% from 2014, while consumption will increase by more than 20% over the same period (https://iea.blob.core.windows.net/assets/e4a7e1a5-b6ed-4f36-911f-b0111e49aab9/WorldEnergyOutlook2016ExcerptWaterEnergyNexus.pdf). Regional patterns of water abstraction and consumption may vary within wide limits due to the country's economy structure.

As I mentioned before, intensive agriculture is already the largest consumer of water globally, accounting for about 70% of total freshwater abstractions worldwide and up to 85% in some developing countries. Agriculture also leads to the deterioration of freshwater quality, especially surface and groundwater, due to the excess of fertilizers and pesticides used to increase production and control pests.

The increase in living standards and the number of people living in urban areas makes water sampling represent 13% of the total volume of water taken for use in 2014, and it is estimated that this amount will increase to 17% in 2040 (https://iea.blob.core.windows.net/assets/e4a7e1a5-b6ed-4f36-911f-b0111e49aab9/WorldEnergyOutlook2016ExcerptWaterEnergyNexus.pdf). Three-fifths of the growth comes from India, Africa and other developing countries in Asia (excluding China).

This increase in water demand is taking place in a context where more than 650 million people, mainly in sub-Saharan Africa, do not have access to a source of drinking water and 2.4 billion people do not have access to sanitation services (https://iea.blob.core.windows.net/assets/e4a7e1a5-b6ed-4f36-911f-b0111e49aab9/WorldEnergyOutlook2016ExcerptWaterEnergyNexus.pdf; https://www.unicef.org/romania/stories/unicef-and-sustainable-development-goals-0). One of the United Nations Organization's goals of sustainable development is to ensure the availability and sustainable management of water and sanitation for all (but we refer to domestic wastewater collection services and their treatment). Pursuing this goal requires investment in raw water treatment plants and domestic wastewater treatment. All this implies a higher energy consumption, which supports their construction and operation. The industry and the production of electricity through hydropower plants generally keep the volume of water taken (about 10%) and consumed, as before. This is due to the modernization of industrial technological processes as well as a temporary cap in the construction of large hydropower plants.

Water has an important contribution to almost all forms of energy production. Large amounts of water are used in the use of fossil fuels, nuclear and biofuels (Table 2.1).

The total amount of water taken by the energy sector, in 2014, amounted to 398 billion m^3 (Fig. 2.1). The differences are generated by the cooling technologies of power plants, which are adapted to the fuel used. For example, gas-fired boilers require less water for cooling than coal-fired boilers. Also, in the case of renewable sources, solar or wind energy uses water to clean the panels. Geothermal energy has

Table 2.1 Amount of water taken and consumed according to the type of energy sector (Spang et al. 2014)

No.	Fuel[a]	Capacity factor	Water consumption factor m^3/GJ		
			Estimate	Min	Max
1	Coal	0.85	0.722	0.505	1.157
2	Gas/oil	0.85	0.768	0.589	1.157
3	Nuclear	0.90	0.757	0.610	0.936
4	Biomass	0.68	0.581	0.505	1.015
5	Solar	0.32	0.852	0.778	0.904
6	Wind	0.20	0.006	0.001	0.027

[a]Steam turbine, cooling tower

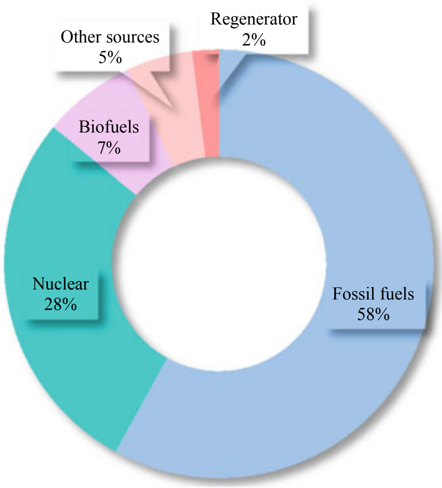

Fig. 2.1 Water withdrawals by the energy sector, at the level of 2014 (The United Nations World Water Development Report 2014)

low water consumption if the quantities taken are reinjected after the heat exchange has taken place. Hydropower plants rely on water passing through turbines to generate electricity or store surplus energy produced. Most of the water taken returns to the rivers; however, water consumption in the hydropower sector varies depending on a number of factors, such as the type of technology (tank versus river), the size of the water tank, climatic characteristics and so on.

2.1 Water for Energy

Water is an important component for almost all forms of energy production. Hydropower are the main sources of electricity generation globally, providing 71% of