Electricity markets

Natural Monopoly model

Overview

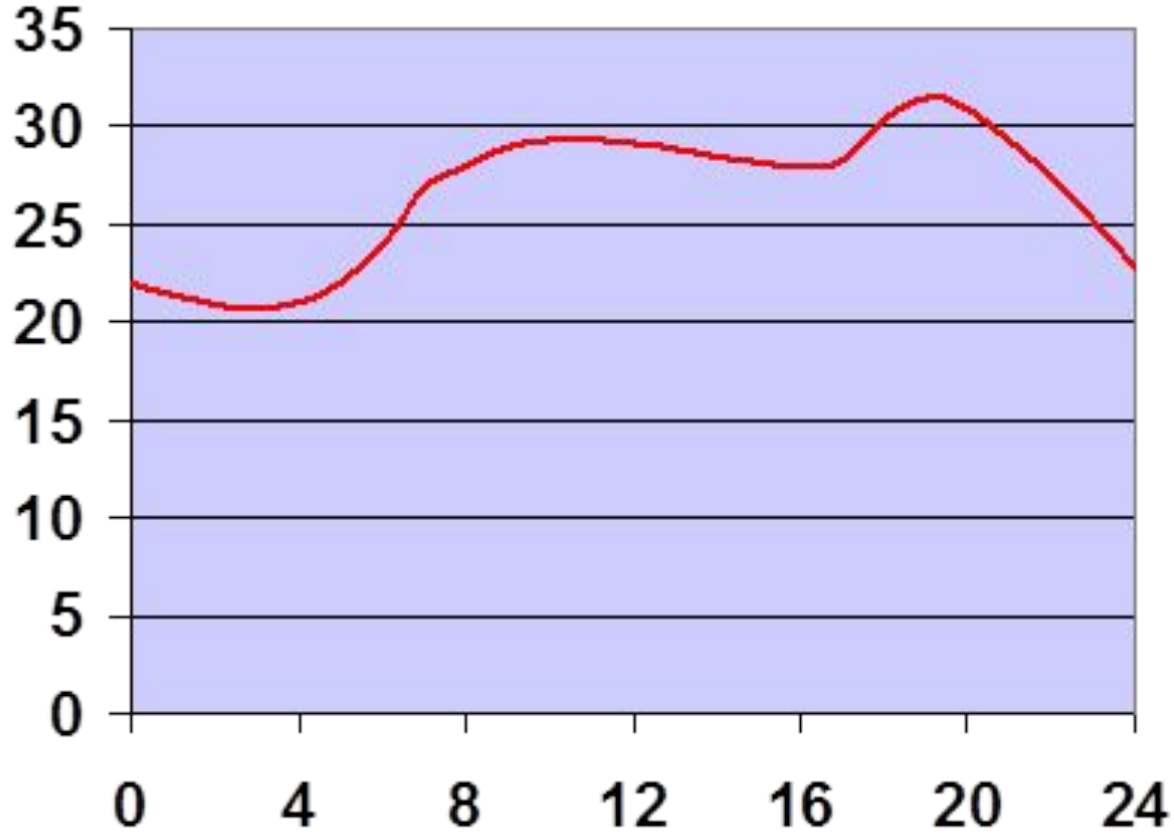
- Special features
- Stages of electricity production
- Production function and costs
- Natural monopoly
- Regulation
- Technological change

Special features

- Demand fluctuations
- within the day, across seasons

- Demand = load
- Peak vs. offpeak demand

Variations in hourly load
California system, GW vs. hour



Special features

- Not storable (electricity today is not a substitute for electricity tomorrow)

Special features

- High costs of shortages
- Blackouts or brownouts

- Capacity >= load
- “peak load problem”

Special features

- Electricity is a secondary source of energy
- Electricity is both an output and an input with respect to other energy products
- E.g. output with respect to …?
- E.g. input with respect to …?

- Electricity is a substitute to some of its inputs

Special features

- Electricity consuming capital is long lived (… years)
- Electricity producing capital is long lived (40 years)
- Technology used often is not the most optimal

Special features Summary

- Demand fluctuations (within the day, across seasons)
- Not storable (electricity today is not a substitute for electricity tomorrow)
- High costs of shortages
- Complex relations with respect to other energy products

Production process

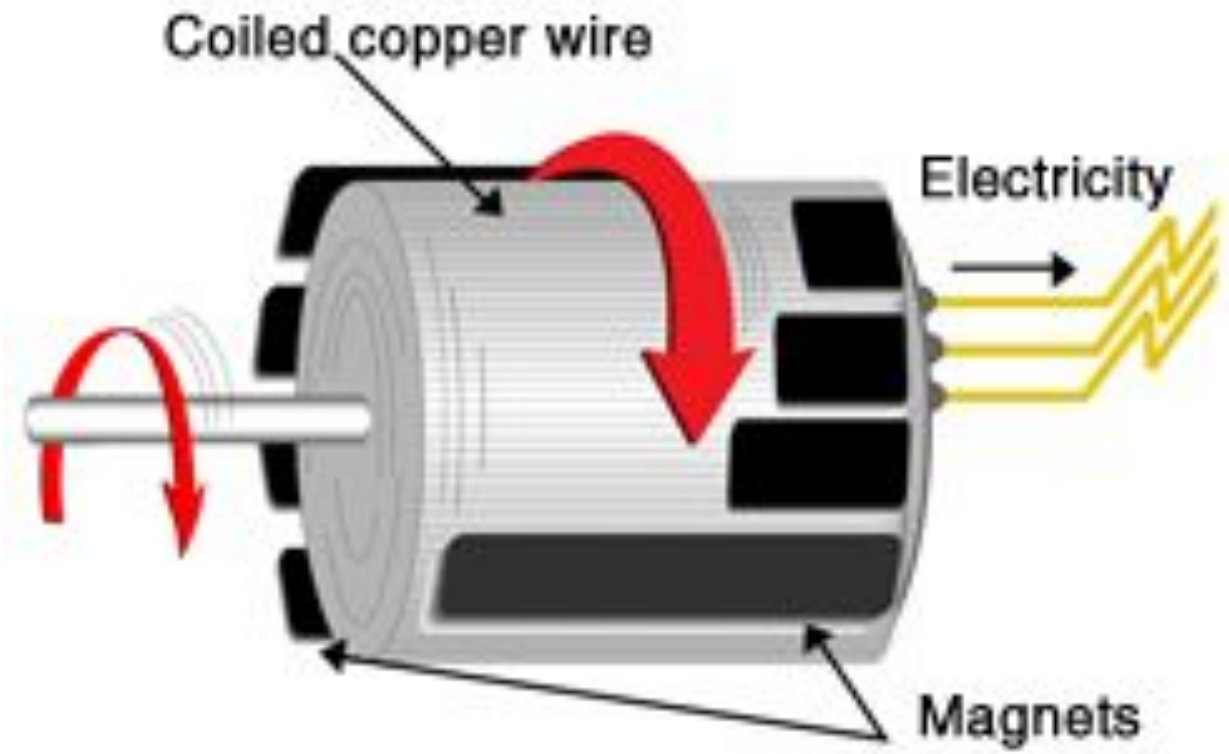
- Generation
- Transmission
- Distribution

Production process

- Generation
- Electricity is a secondary energy source
- Transformation of one energy into electricity
- Mechanical power into electric power:
- Hydropower and wind
- Thermal (coal, gas, oil)
- Solar
- Nuclear

How is electricity generated?

http://www.eia.gov/energyexplained/index.cfm?page=electricity_generating



Supply chain video

- https://www.youtube.com/watch?v=20Vb6hlLQSg

Electricity supply chain

- Generation: transformation of other energy into electric energy
- Transmission: high voltage transport of energy
- Distribution: low voltage transport of energy

Minimum efficient scale

- MES is the level of output that minimizes average cost relative to the demand

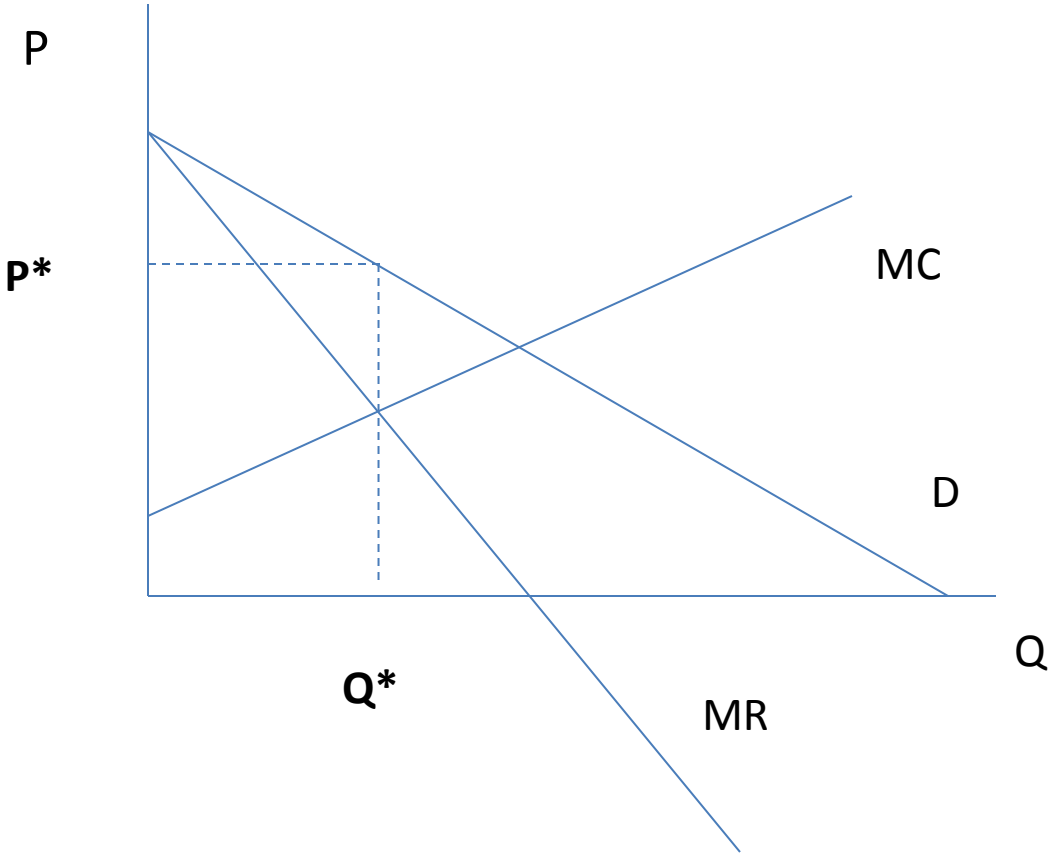
Demand relative to minimum efficient scale. (A) If demand is large relative to the minimum efficient scale, a competitive market is likely to result. (B) If it is small, a monopolistic industry structure is possible.

Varian, Intermediate Microeconomics, Ch. 24

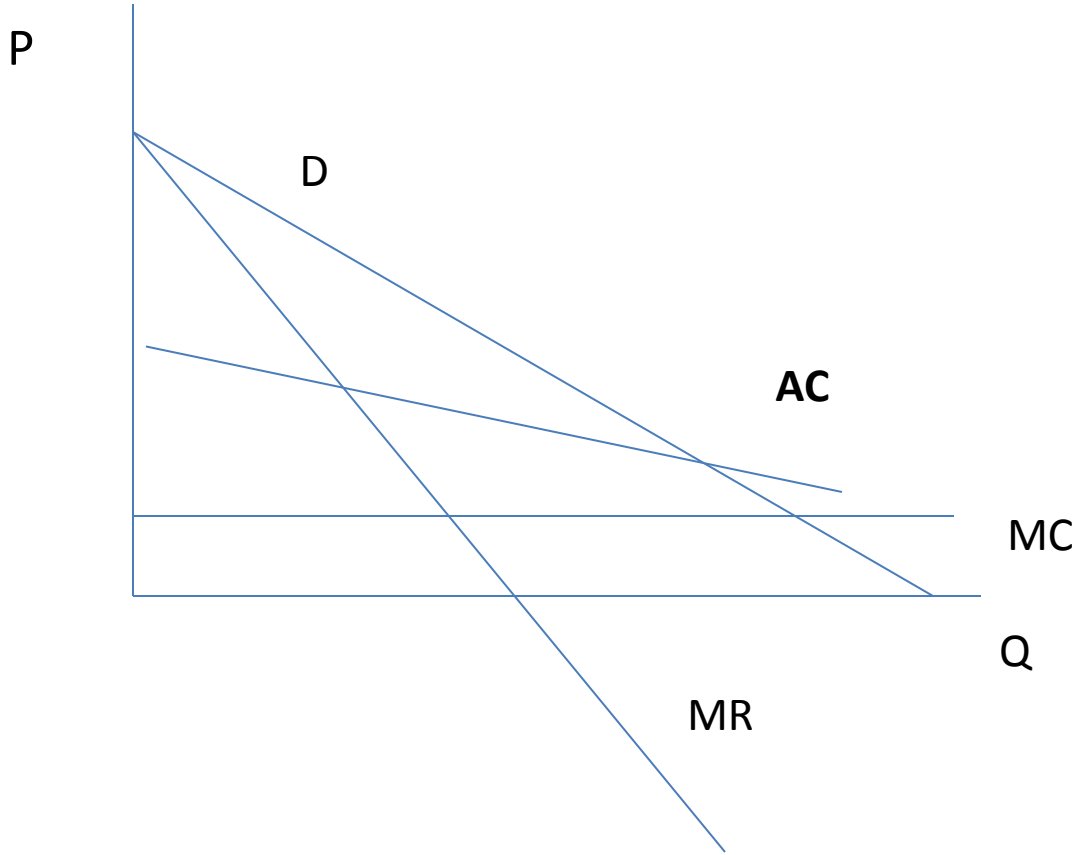
Modelling electricity markets

- High fixed cost
- Low variable cost
- Average cost declines as Q grows

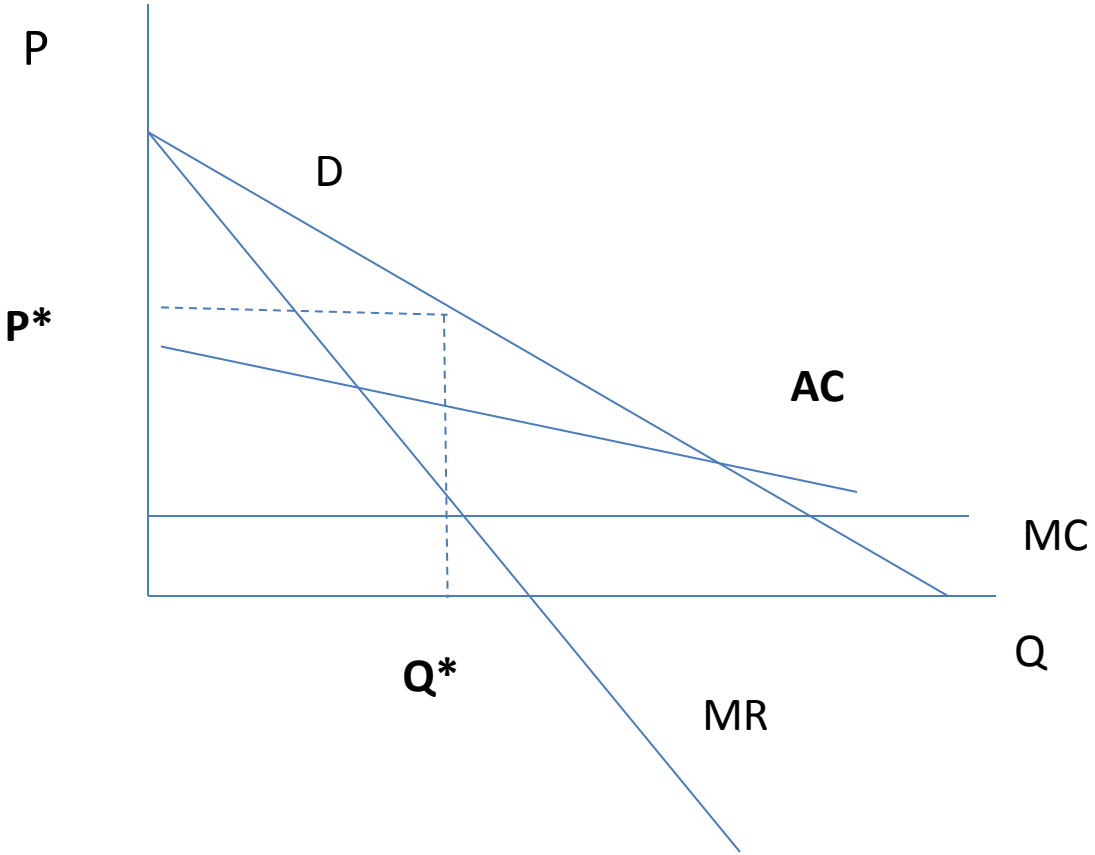
Traditional Monopoly



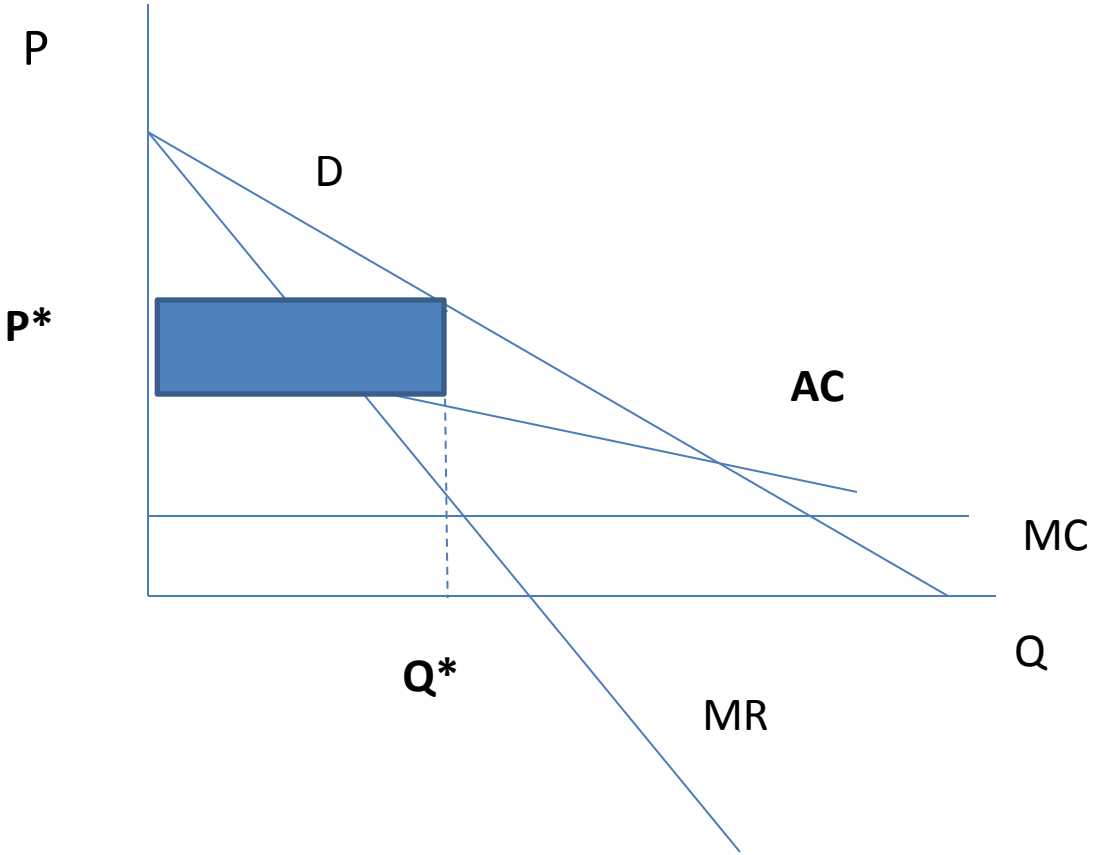
Natural Monopoly



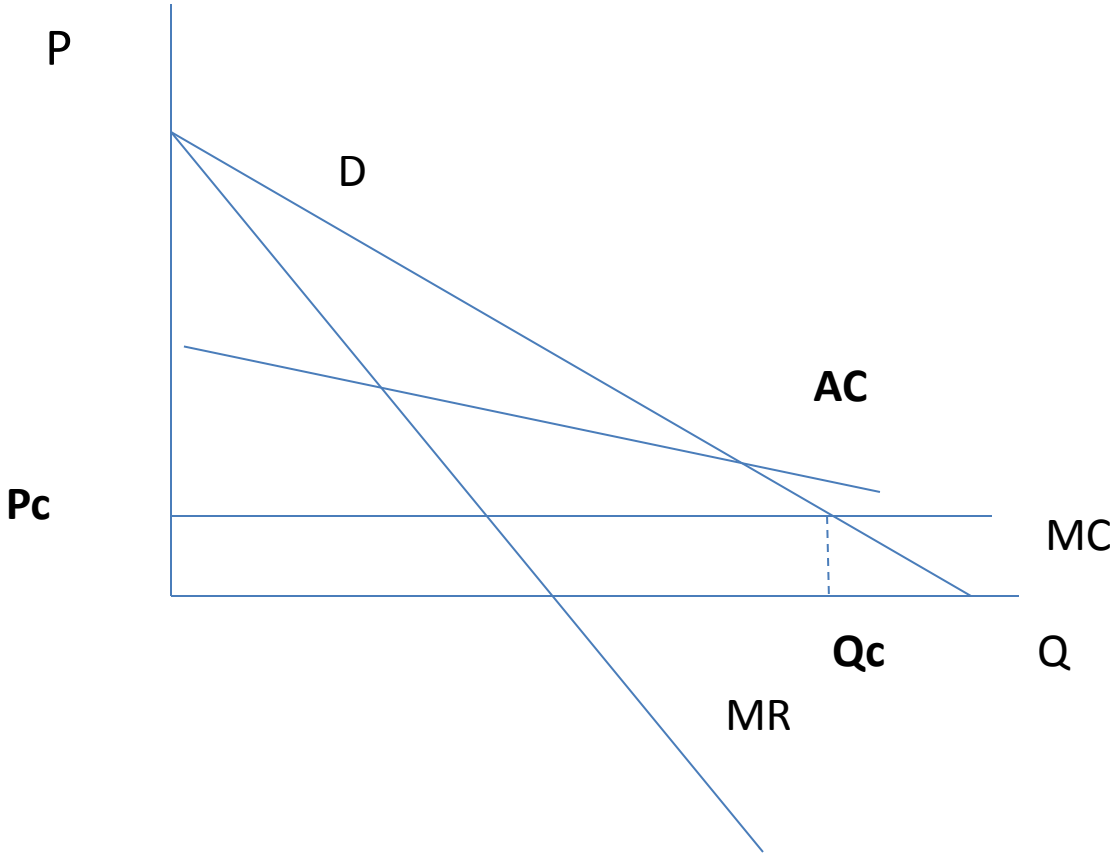
Natural Monopoly profit-max outcome



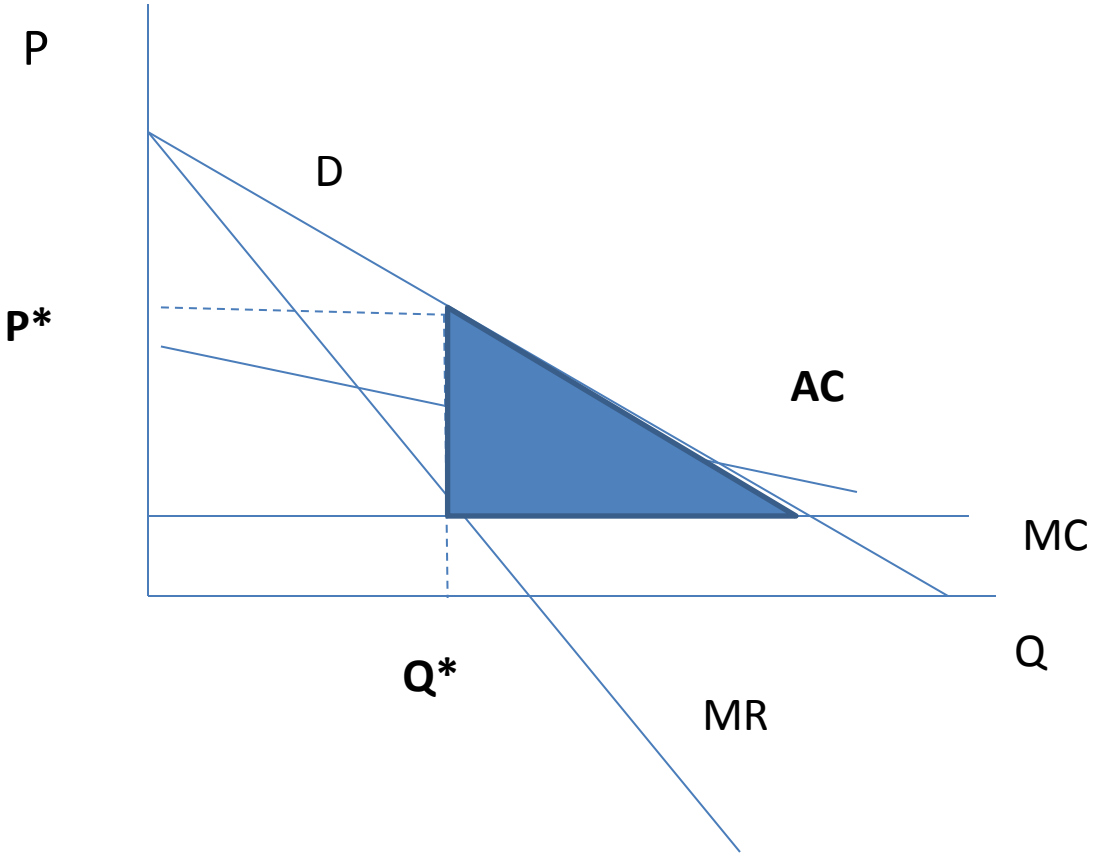
Natural Monopoly profit-max outcome



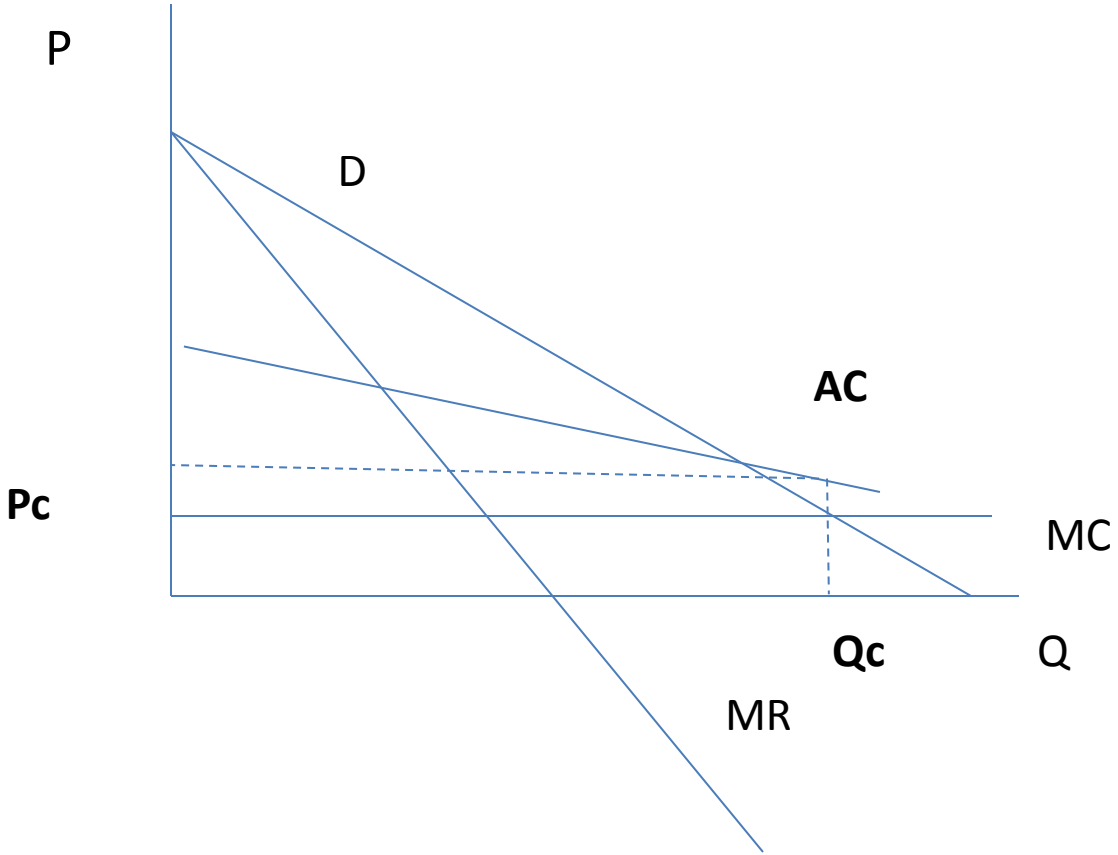
Natural Monopoly
socially efficient outcome



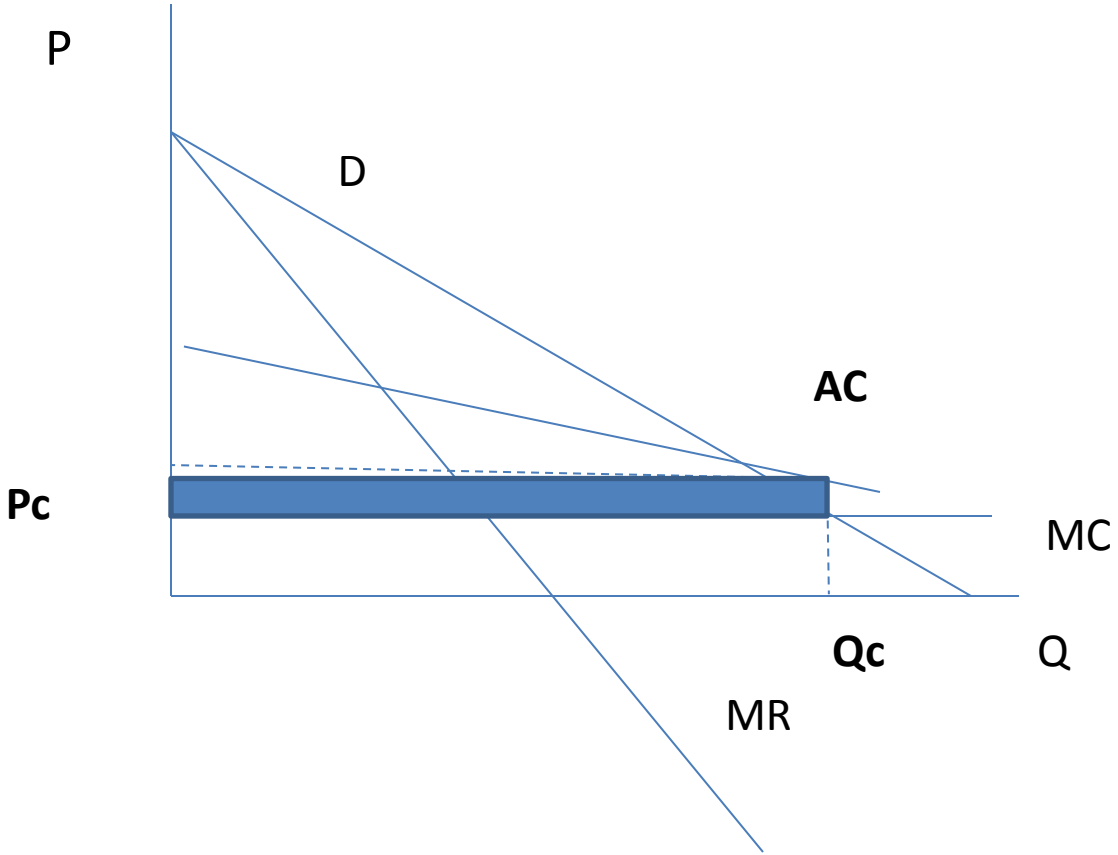
Natural Monopoly
DWL



Natural Monopoly socially efficient outcome



Natural Monopoly socially efficient outcome

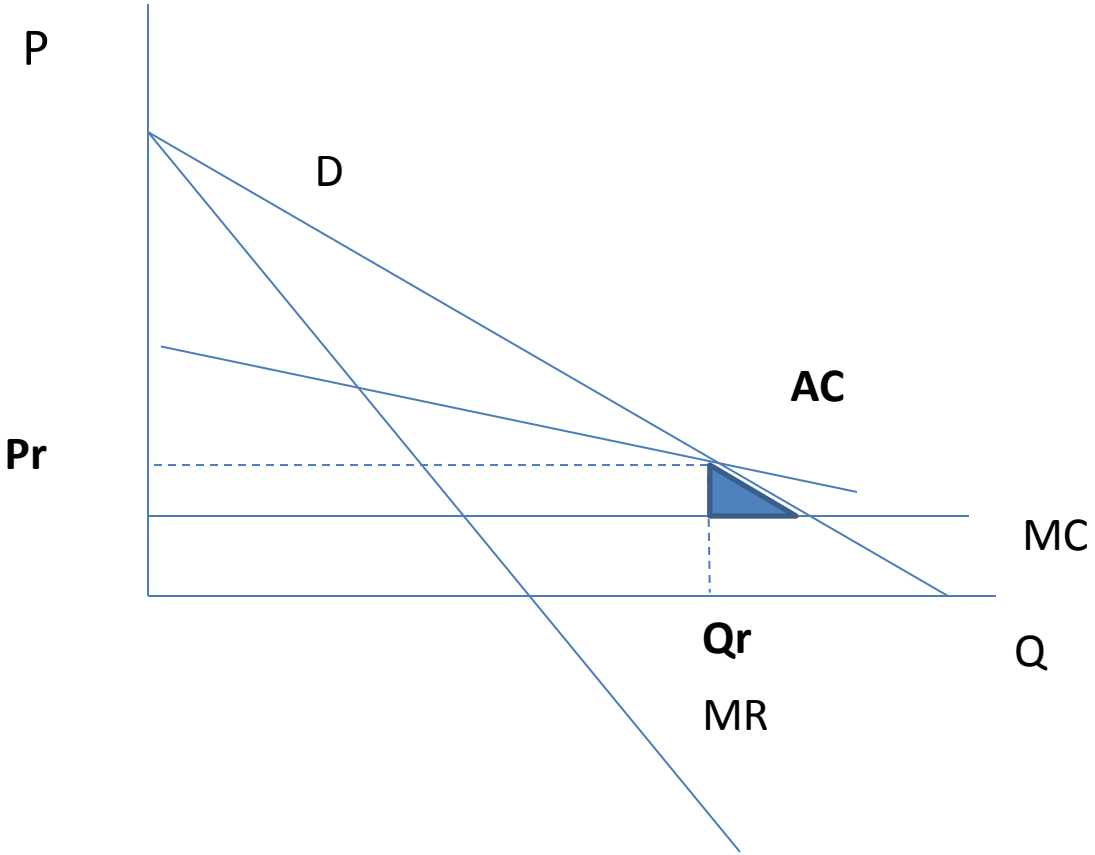


Natural Monopoly Policy

- 1. Public Ownership

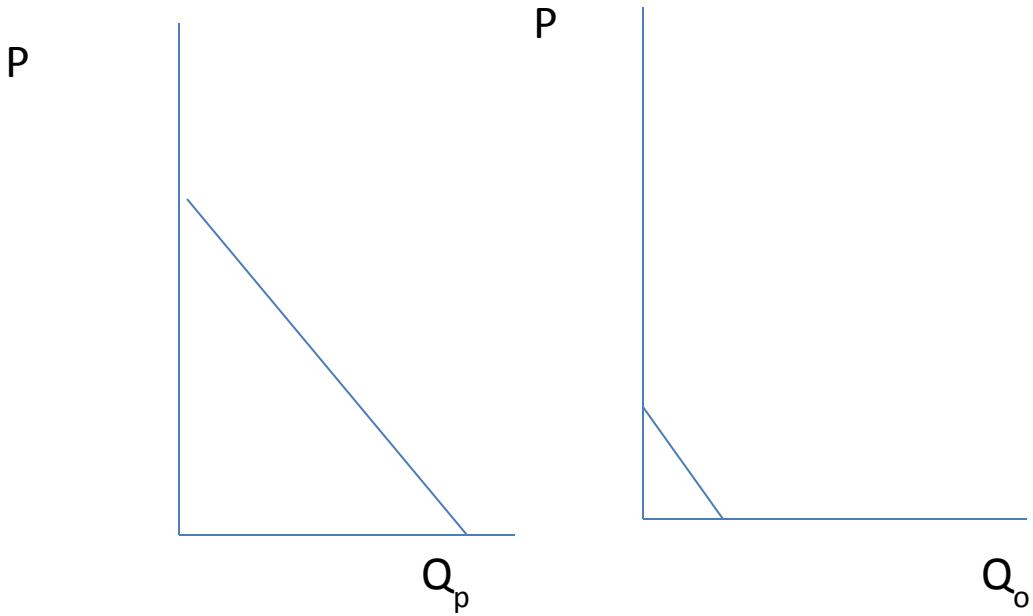
- 2. Private Ownership + regulation

Natural Monopoly
Average cost pricing outcome



Differentiating peak & off-peak demand

Peak & offpeak load

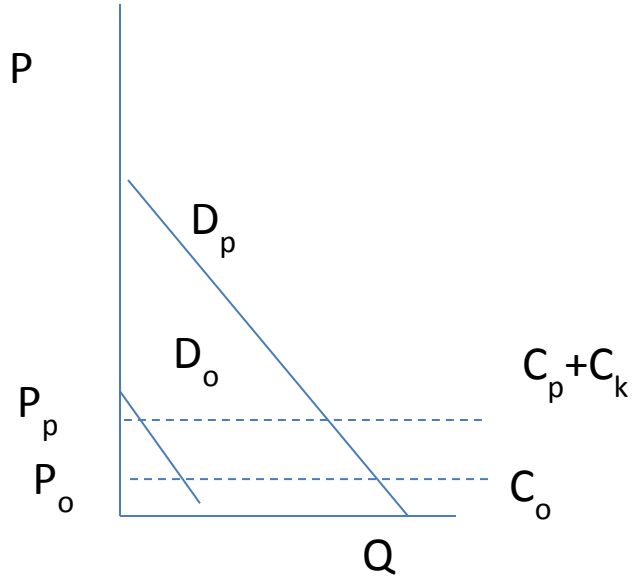


Which prices to charge?

- How to distribute costs among two consumer groups?
- Fixed cost? ~ “Capital cost” (Ck)
- Variable cost? ~ “Operating cost” (Cp – during peak hours; Co – during offpeak hours)

Peak & offpeak load

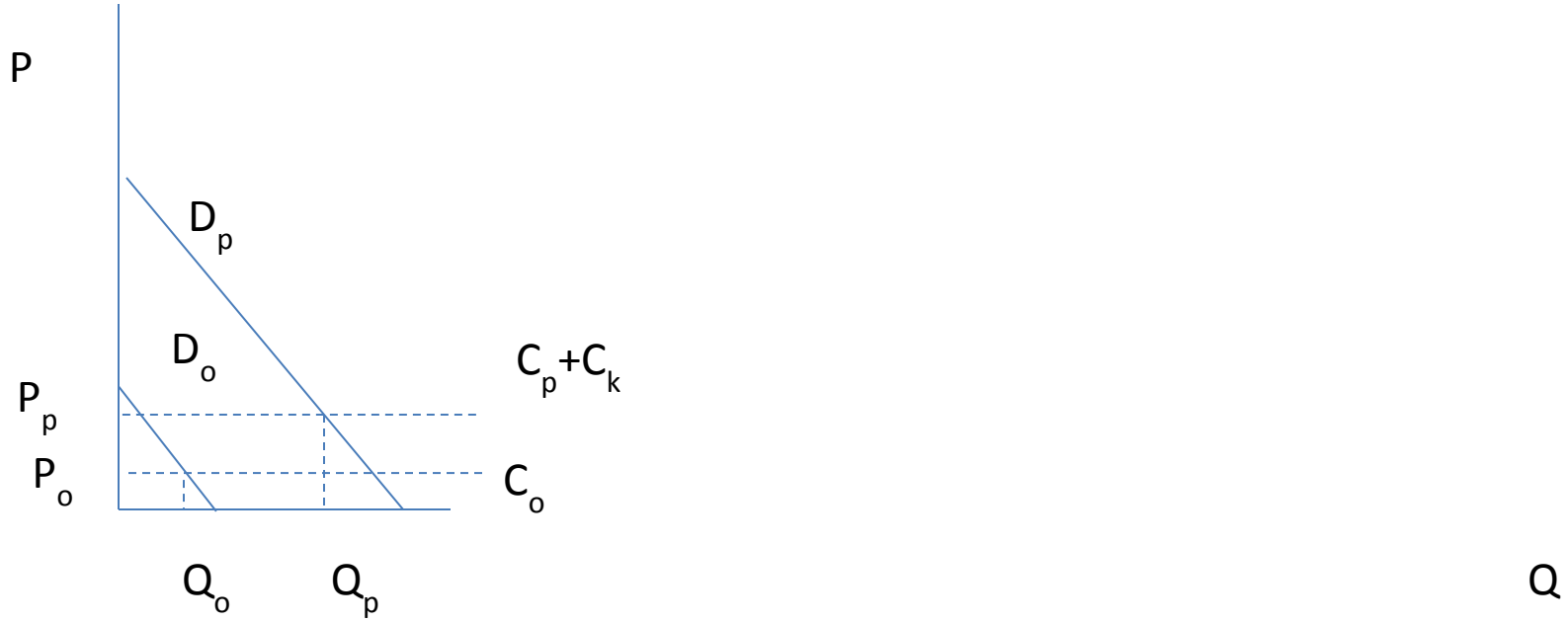
- Should the marginal unit be supplied during peak or offpeak? What should be its price?



Q

Peak & offpeak load

- Should the marginal unit be supplied during peak or offpeak? What should be its price?



Smart meters and differentiating peak & off-peak demand

Peak-load pricing

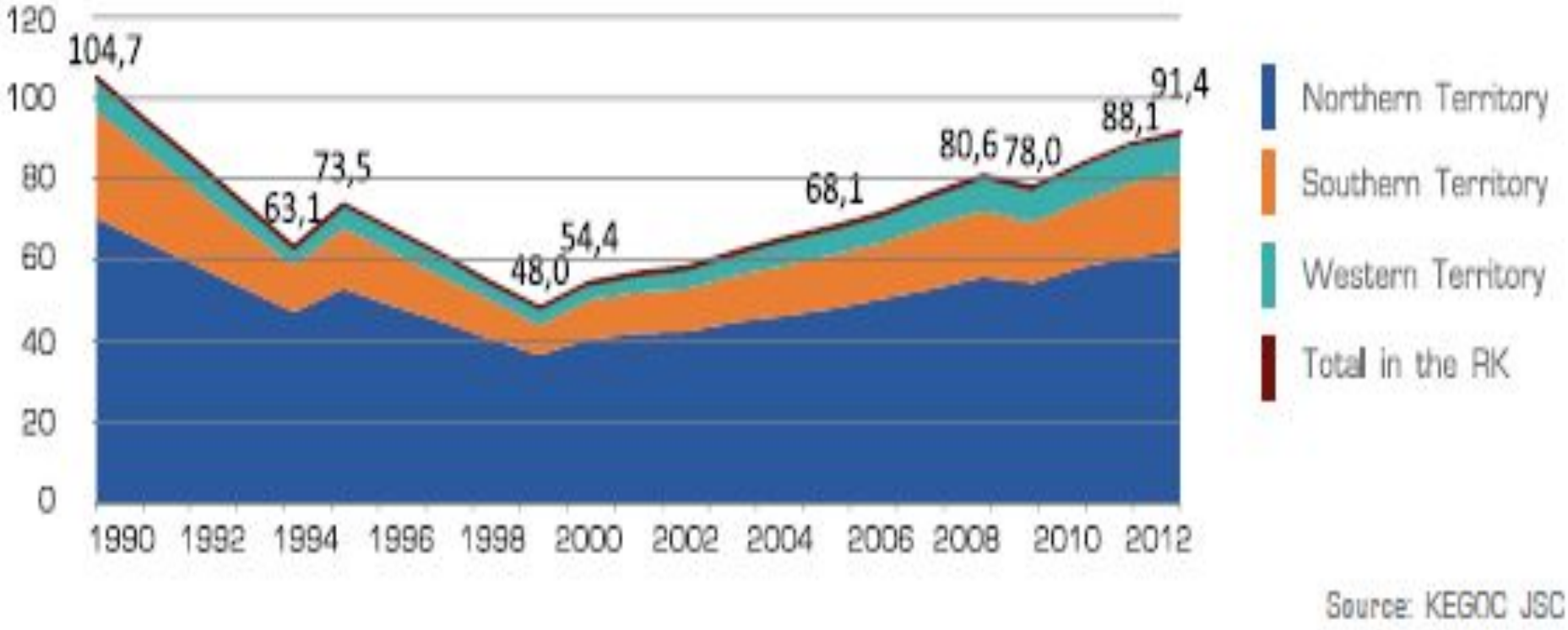
- Electricity prices in Astana:
- 23:00-7:00 => 3.21 KZT/ kWh
- 7:00-23:00 => 14.52 KZT/ kWh

Peak-load pricing

- Summary
- Peak-load pricing allows a utility to cover the fixed cost.
- Peak-load pricing became feasible due to advances in technology.

Electricity industry in Kazakhstan

Fig. 3.3.2. Power consumption in Kazakhstan in 1990–2012, respectively, TWh

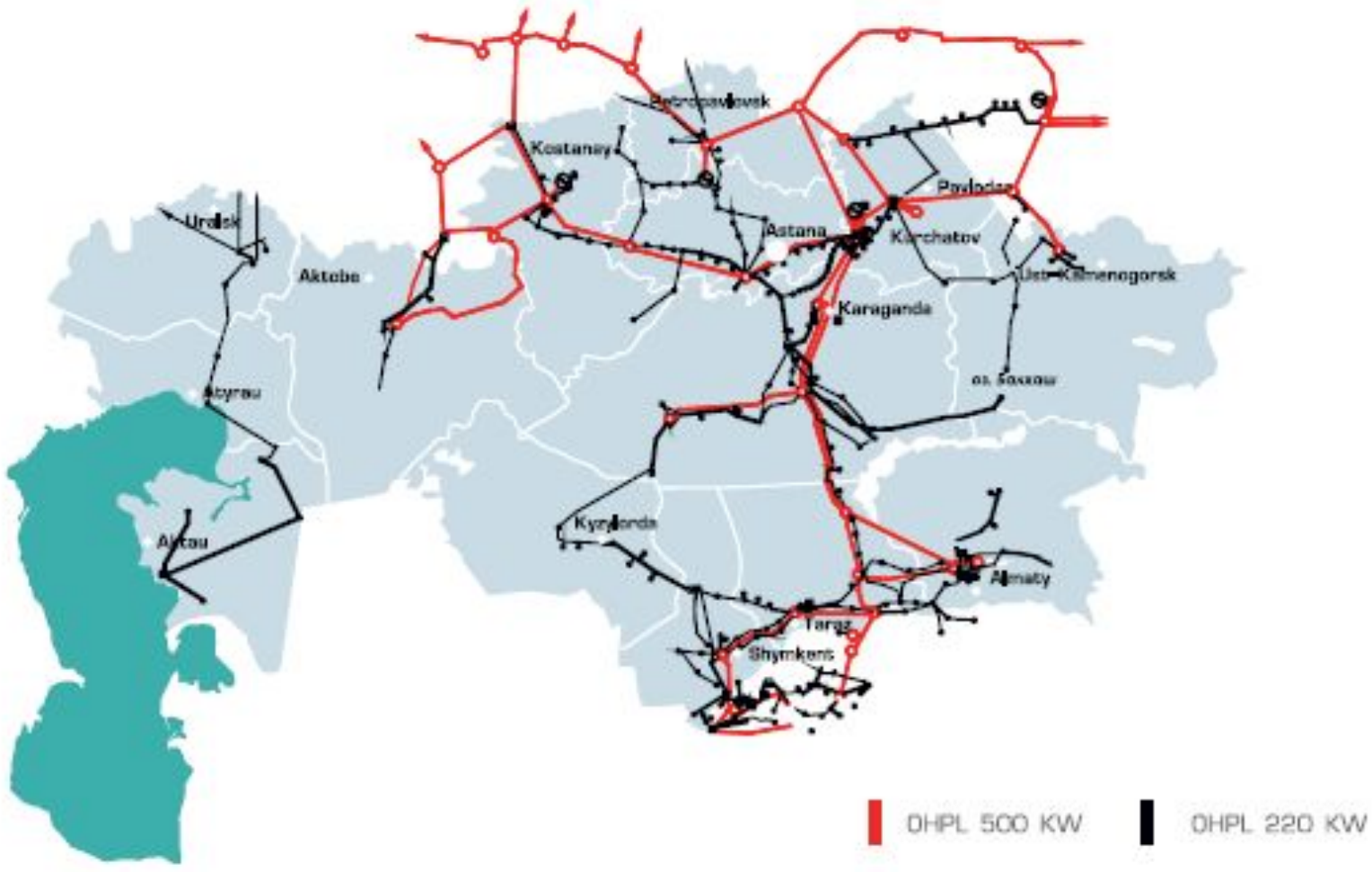


Source: KEGOC JSC

Industry structure

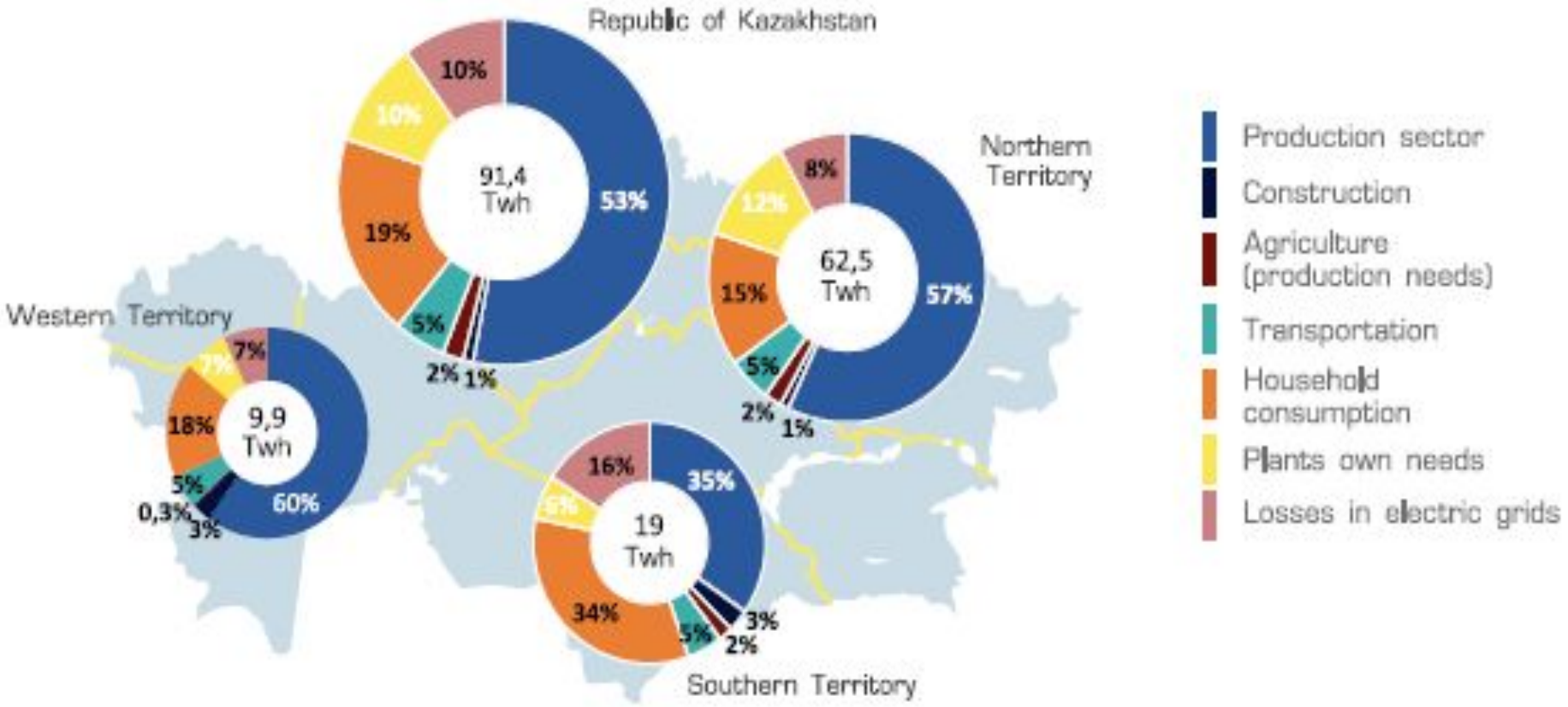
- Generation: mostly privately owned
- Transmission: KEGOC, state-owned
- Distribution: 15 regional distribution companies, state/privately owned

Fig. 3.5.2. Main power transmission lines 220–500 kV



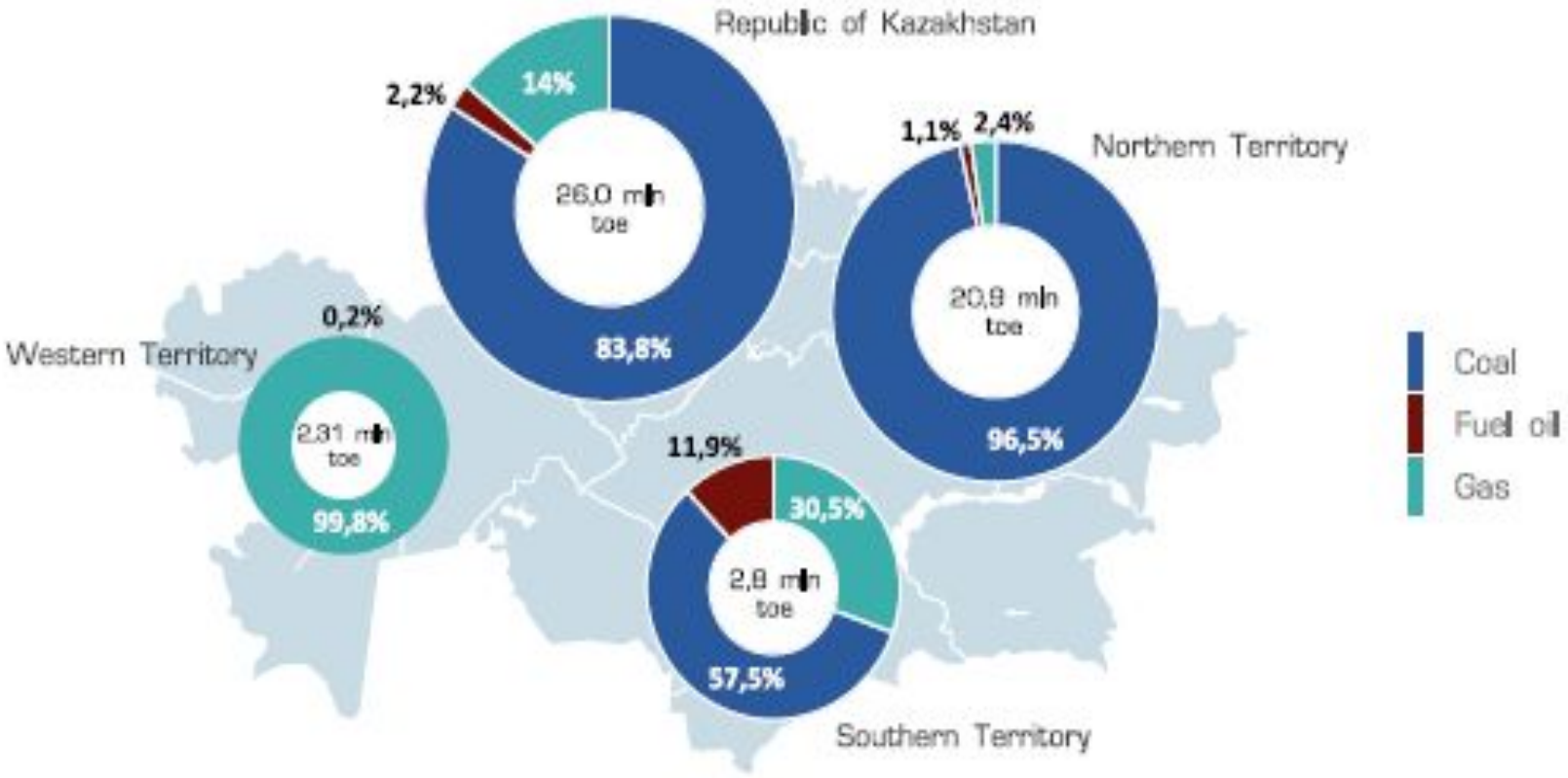
Source: «KEGOC» JSC

Fig. 3.3.4. Current power consumption structure in the RK



Source: Statistics Agency of the Republic of Kazakhstan, KEGOC JSC

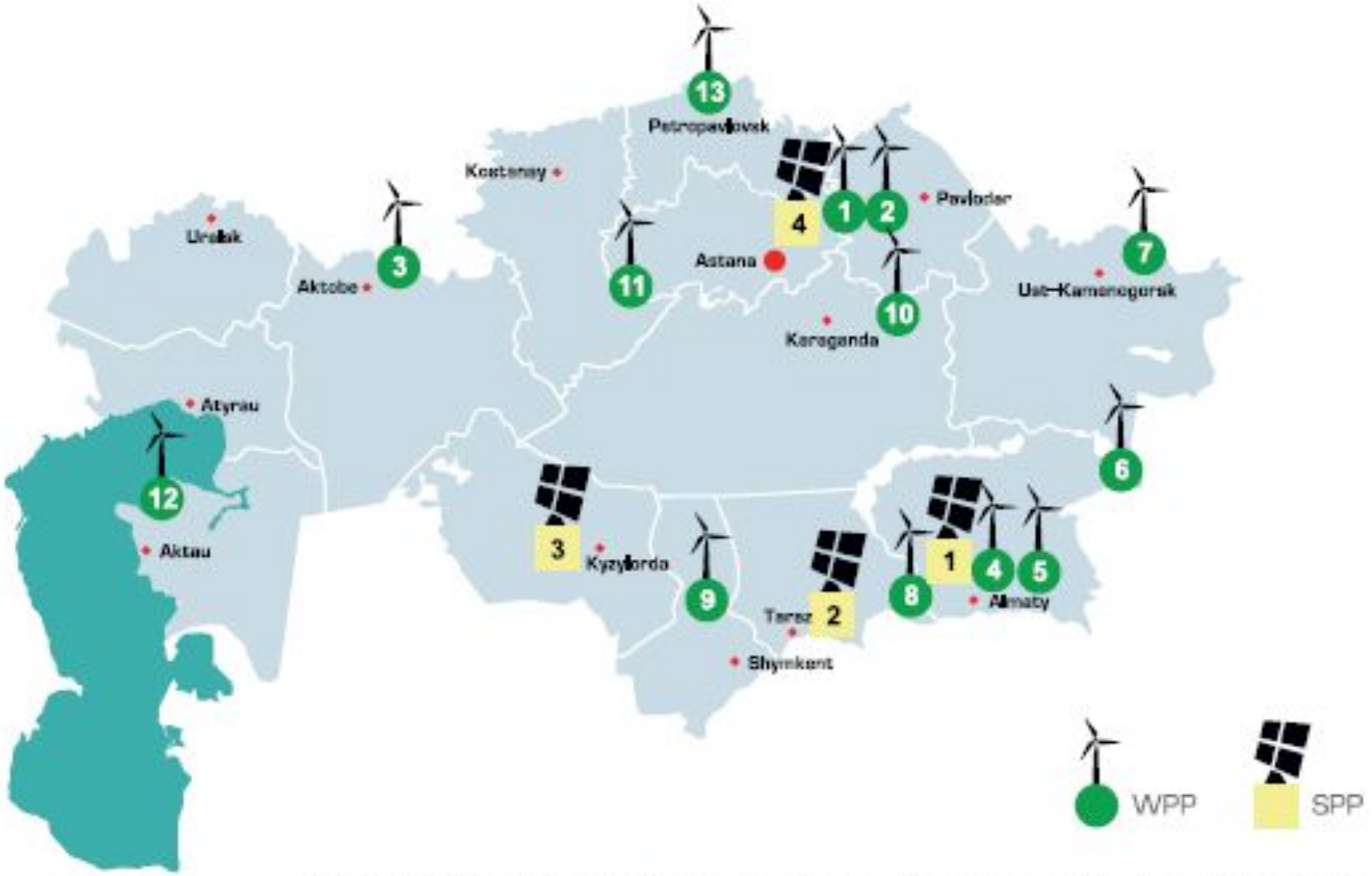
Fig. 3.4.5. Structure of fuel consumption in power plants of the RK



Source: KEGOC JSC

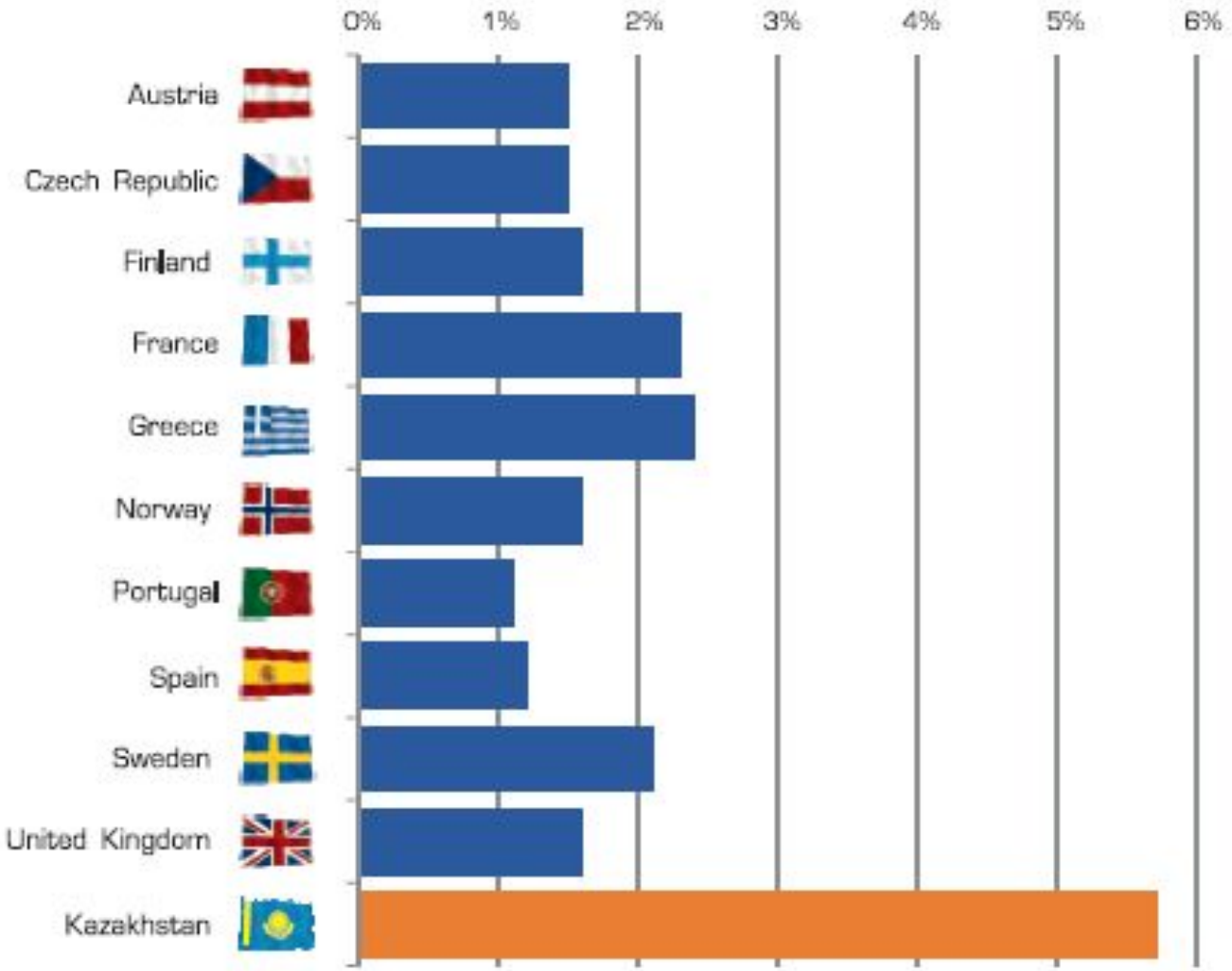
Note: according to NDC. Without considering boiler and gas turbine power plants

Fig. 3.4.7. Plan of RES objects construction in the RK until 2020



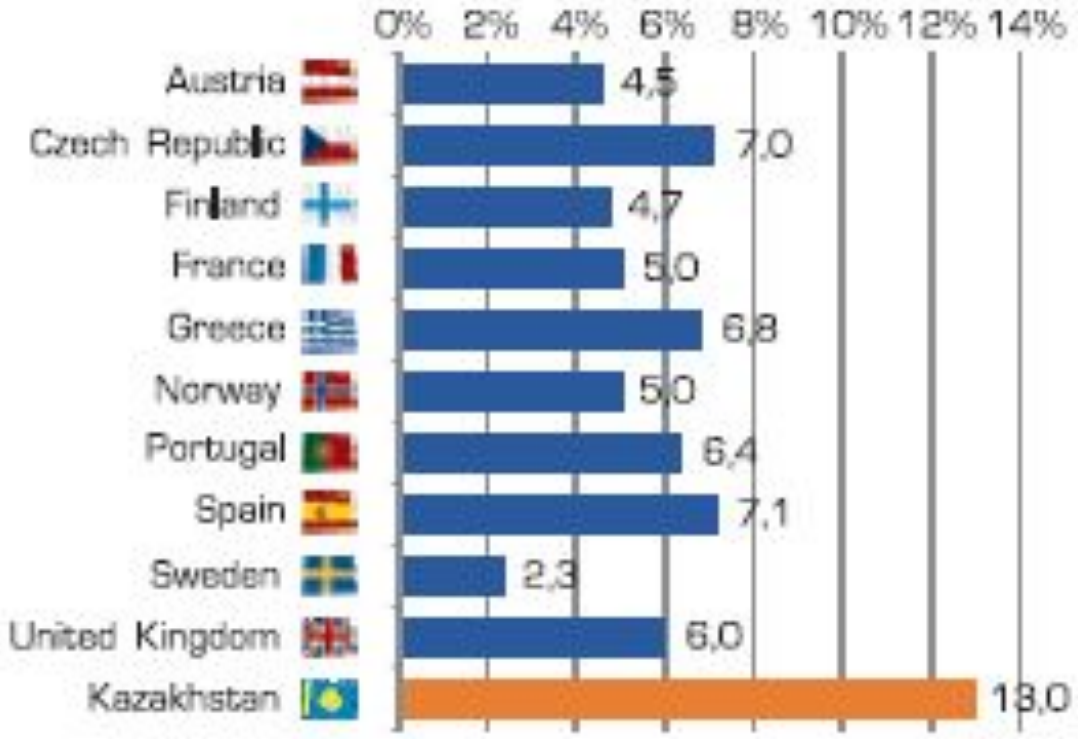
Source: Action plan for the development of alternative and renewable energy in Kazakhstan for 2013–2020

Fig. 3.5.4. Electricity losses in backbone grids, %



Source: Master plan for the development of electric power industry of the Republic of Kazakhstan till 2030, 2011

Figure 3.5.8. Power losses in distribution grids, %



Review

- Special features
- Stages of electricity production
- Production function and costs
- Natural monopoly
- Regulation

Readings

- Dahl, Ch. 4
- Kazenergy pp. 274-275, 290-291, 303-305.