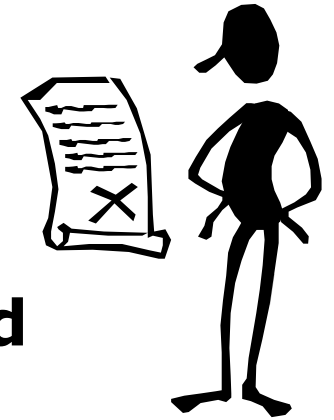
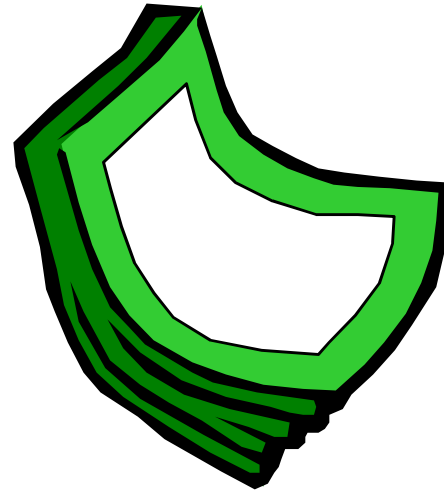


Introduction

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- ▶ **In the appendix, you'll find a list of the terms and acronyms used in this presentation.**
- ▶ **Concerning the documents mentioned in this presentation:**
 - ***At houmollerconsulting.dk, you can download the documents from the sub-page *Facts and findings*.***
- ▶ **This PowerPoint presentation is animated**
 - **It's recommended to run the animation when viewing the presentation.**
- ▶ **On most computers, you can start the animation by pressing F5.**
 - **Now the presentation moves one step forward, when you press Page Down. It moves one step backward, when you press Page Up.**



Green certificates

The basics

In this presentation, renewables are facilities producing electricity using renewable energy as input

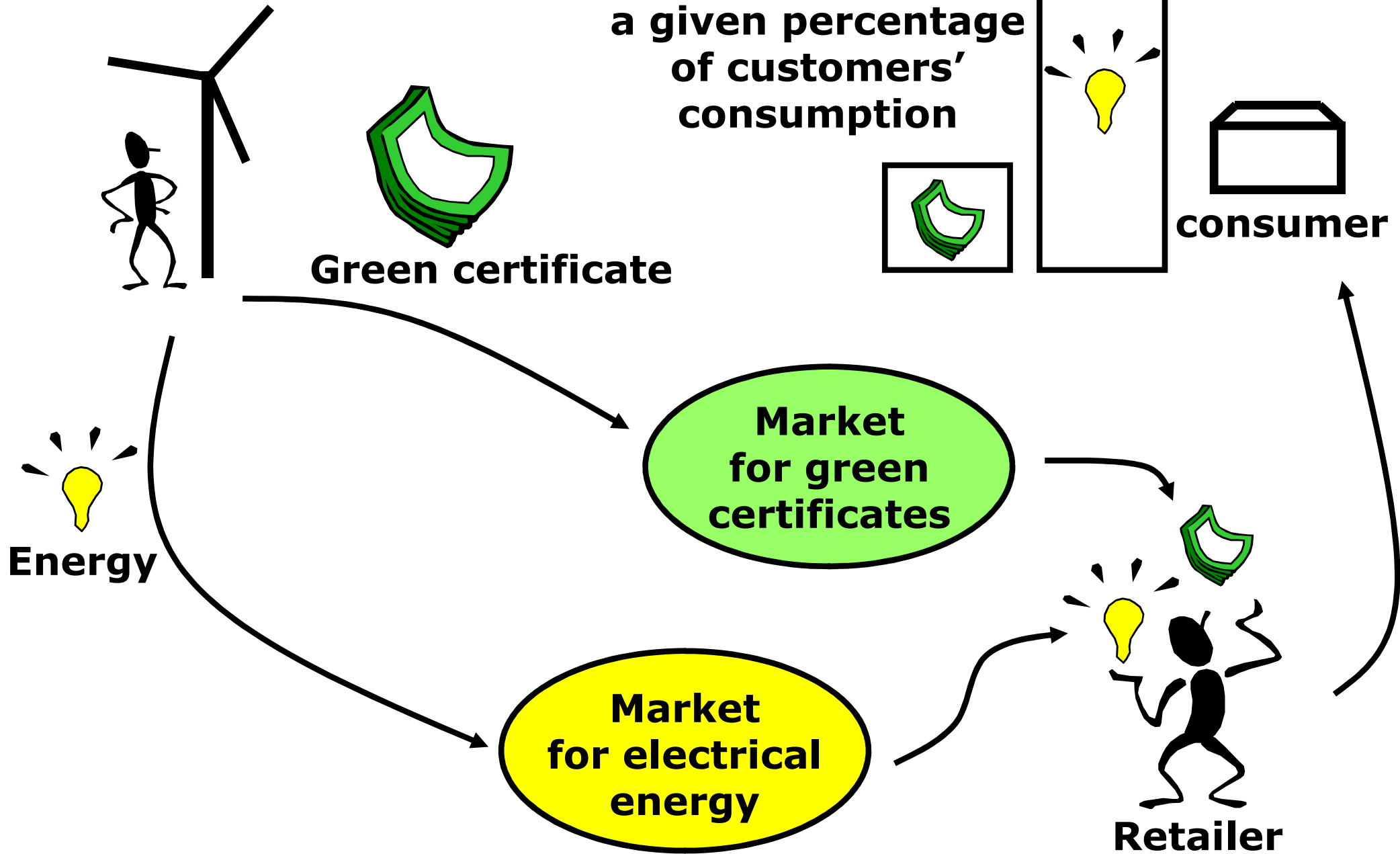


Green certificates: the principle

- ▶ **The owner of a renewable sells the electricity produced by the renewable at the market for electrical energy. Here the owner is competing against all other producers – both green producers and standard producers.**
- ▶ **However, for each MWh produced by the renewable, the owner also receives a green certificate. The certificate is a security, which can be sold at the market for green certificates. At this market, the owner is only competing against other green producers.**
- ▶ **The buyers at the markets are retailers (and big consumers who themselves buy at the whole-sale market).**
- ▶ **A retailer must buy electricity for his customers. However, the retailer is also obliged to buy a number of certificates corresponding to a certain percentage of his customers' consumption. The percentage is set by the politicians.**
- ▶ **Because of this obligation, there are always buyers at the market for green certificates.**
- ▶ **Hence, the owner of a renewable has two streams of revenues: one from the market for electrical energy and one from the market for green certificates.**
 - **The latter revenue stream is the subsidy.**
- ▶ **The size of the subsidy is determined by the competition at the market for green certificates.**

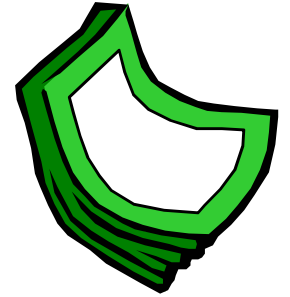
In this example, the renewable is a wind turbine

Buy certificates corresponding to a given percentage of customers' consumption



The basics of green certificates

Summary



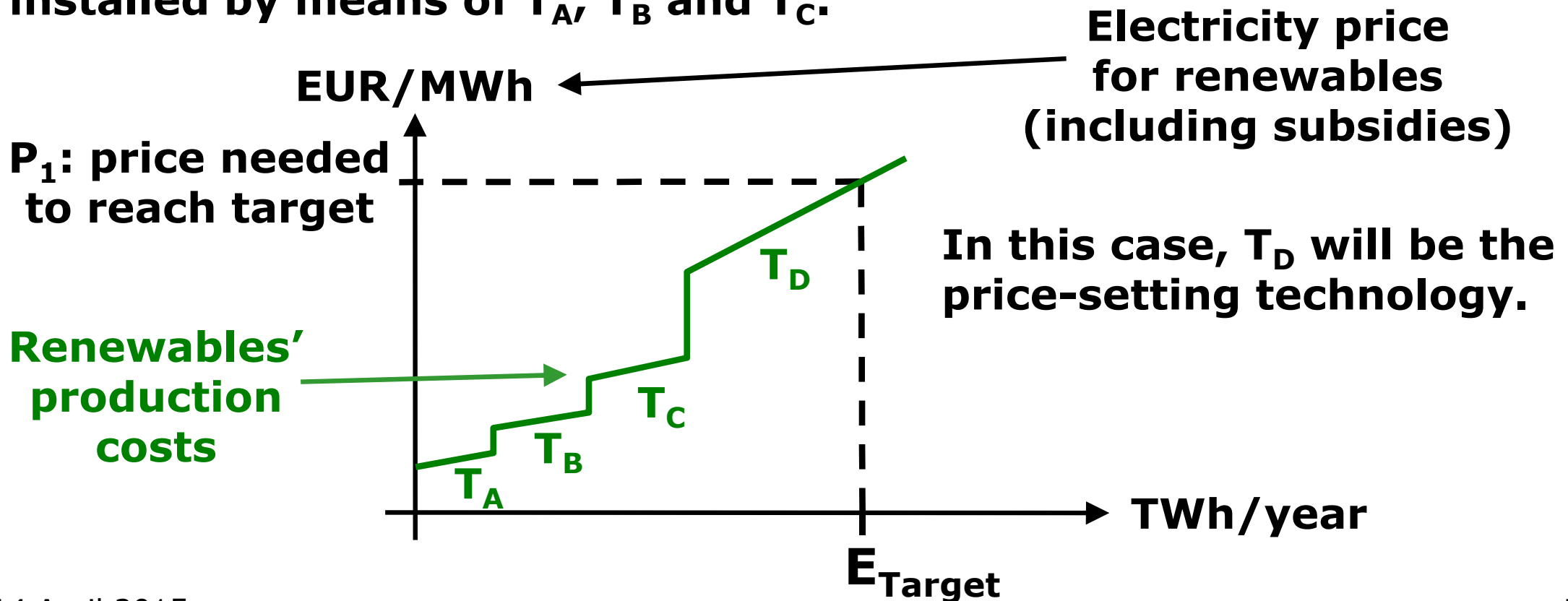
- ▶ **The target is set politically.**
- ▶ **How the target is met is decided by the market.**
Competition decides:
 - **The size of the subsidy.**
 - **The types of renewable technologies employed to meet the target.**
 - **For a multinational certificate market: the geographical location of the new renewables is decided by the market.**
- ▶ **This is a tool well suited to an well organized ends-and-means process**
 - **Where a target is first set.**
 - **And the road to the target is then decided**
 - **In this case: decided by the market.**

Setting the size of subsidies for renewables

The size of the subsidy – 1

**For a country (or a group of countries) – assume a target is set:
 At the end of a given period, the annual electricity production from
 renewables commissioned during the period must be a given
 number E_{target}**

**Assume the target is met by means of four different technologies
 T_A , T_B , T_C and T_D , where T_A , T_B and T_C are the most cost-efficient.
 For whatever reason, there's a limit to the capacity, which can be
 installed by means of T_A , T_B and T_C .**



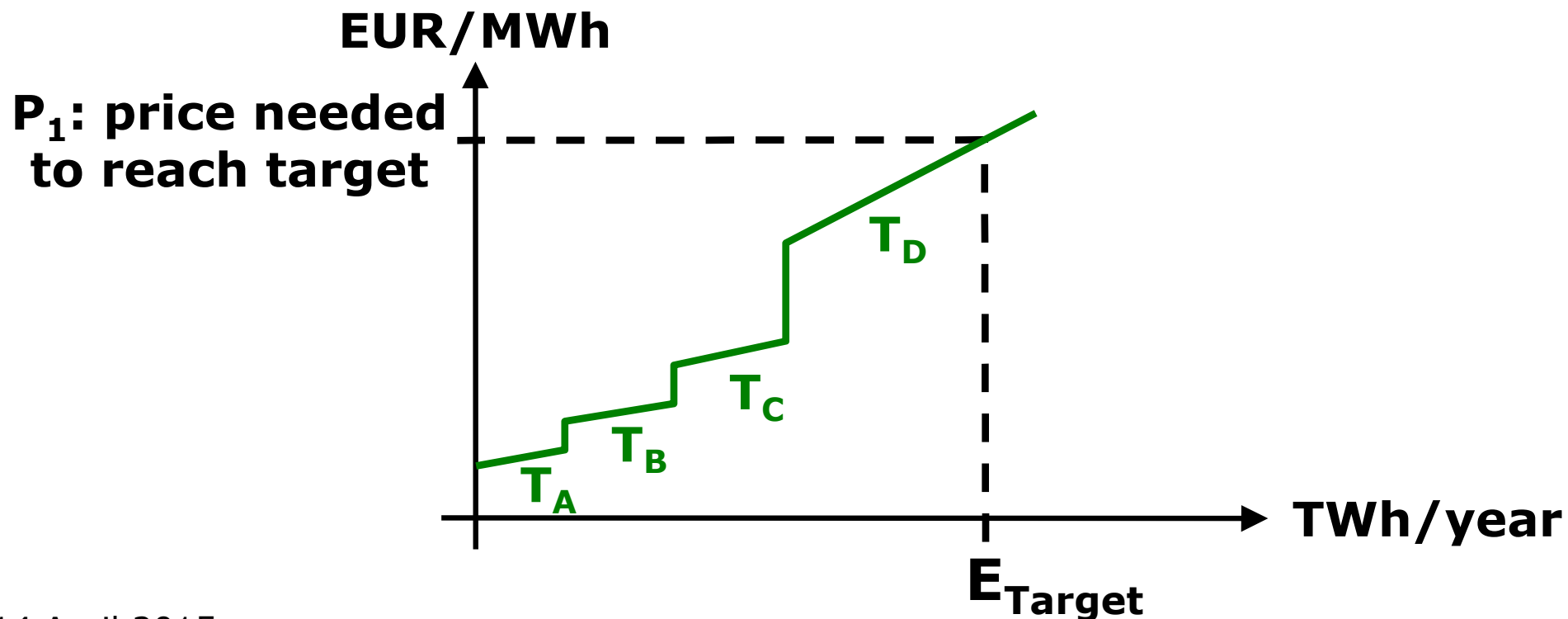
The size of the subsidy – 2

If a feed-in tariff system is used: the politicians must set the feed-in tariff, so the renewables receive the price P_1 .

However, this requires the politicians can determine the price P_1 .

With a green certificate system, at the start of the period, the price of the certificates will automatically settle at a level, which grants the renewables the price P_1 for their electricity.

The market will do the job of determining P_1 .



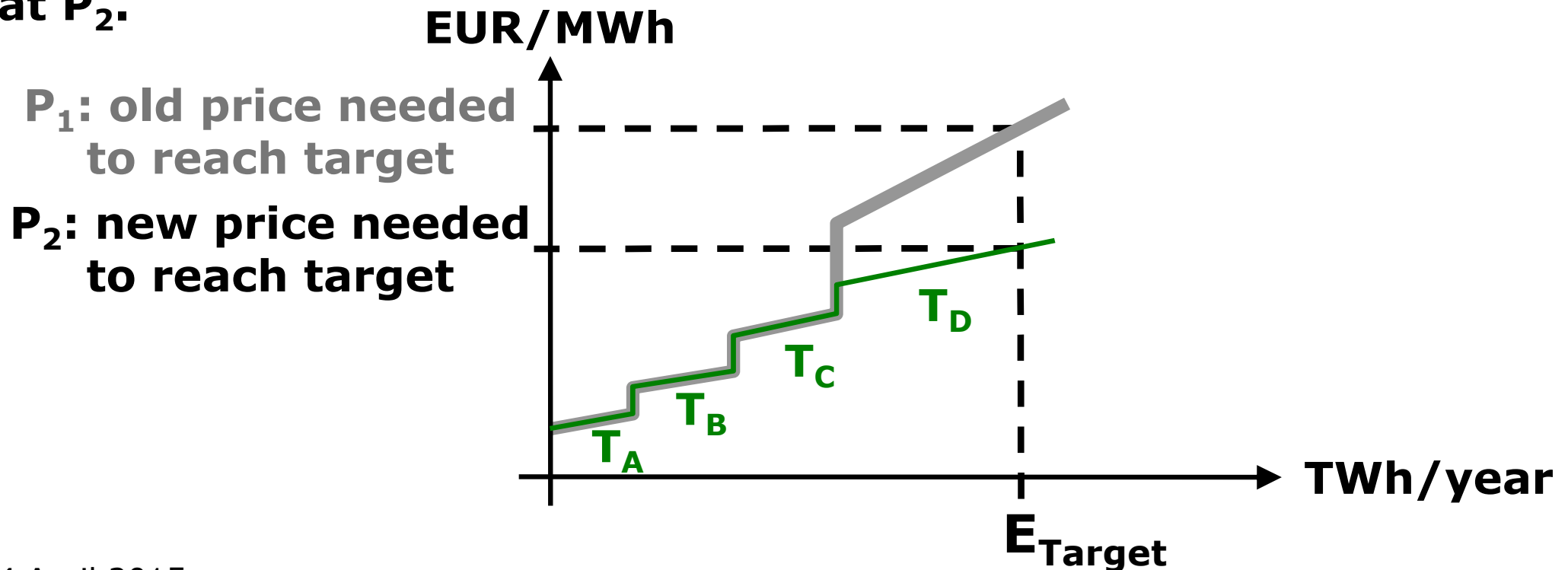
The size of the subsidy – 3

Assume the technology T_D develops: after some time, the price needed to reach the target becomes P_2 .

With a feed-in tariff system, the politicians should now lower the subsidies.

However, lowering subsidies has proven difficult. The task is made even more difficult, as only an estimate of P_2 is available.

With a certificate system, the prices of the certificates will automatically decrease – setting the renewables' electricity price at P_2 .

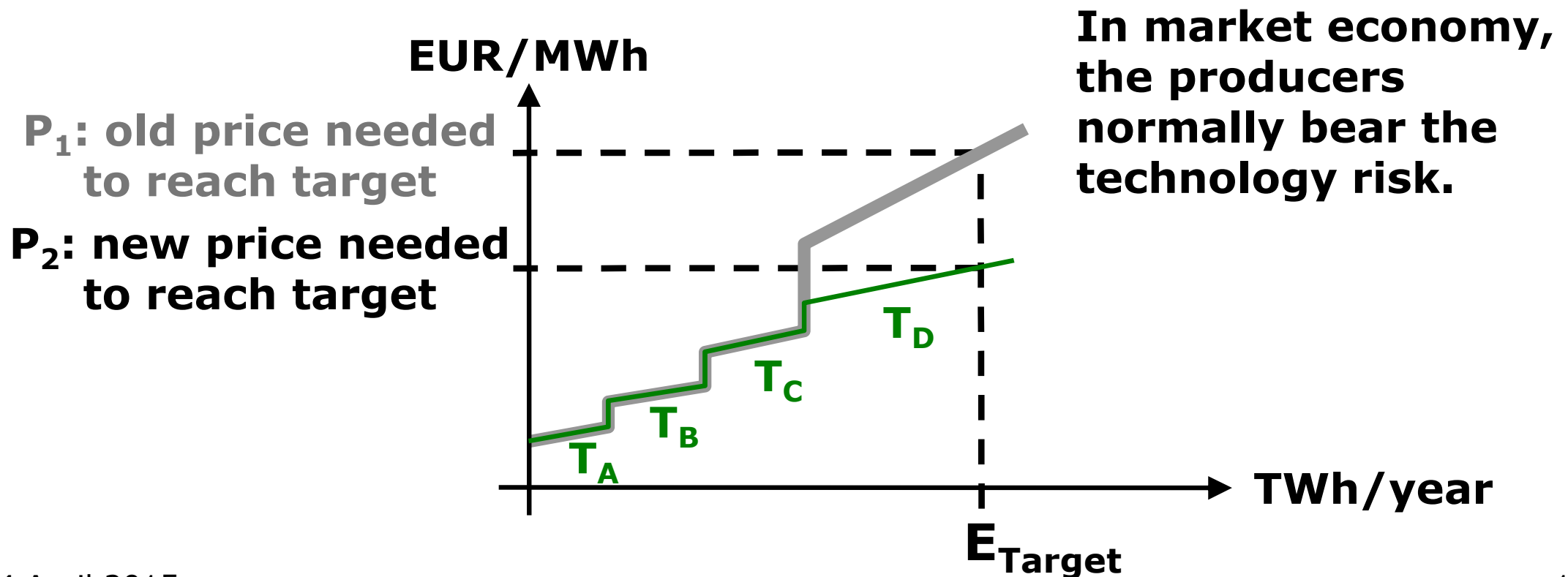


The size of the subsidy – risk allocation

For the renewables commissioned at the start of the period, this potential lowering of the electricity price is the technology risk.

After some time, the technological development may reduce their electricity price from P_1 to P_2 . This may make it difficult for the “old” renewables to make a decent profit.

With a feed-in tariff system, the consumers bear the technology risk: normally the feed-in tariff granted to “old” renewables will not change, even though the technologies have developed.





The common Swedish-Norwegian certificate market

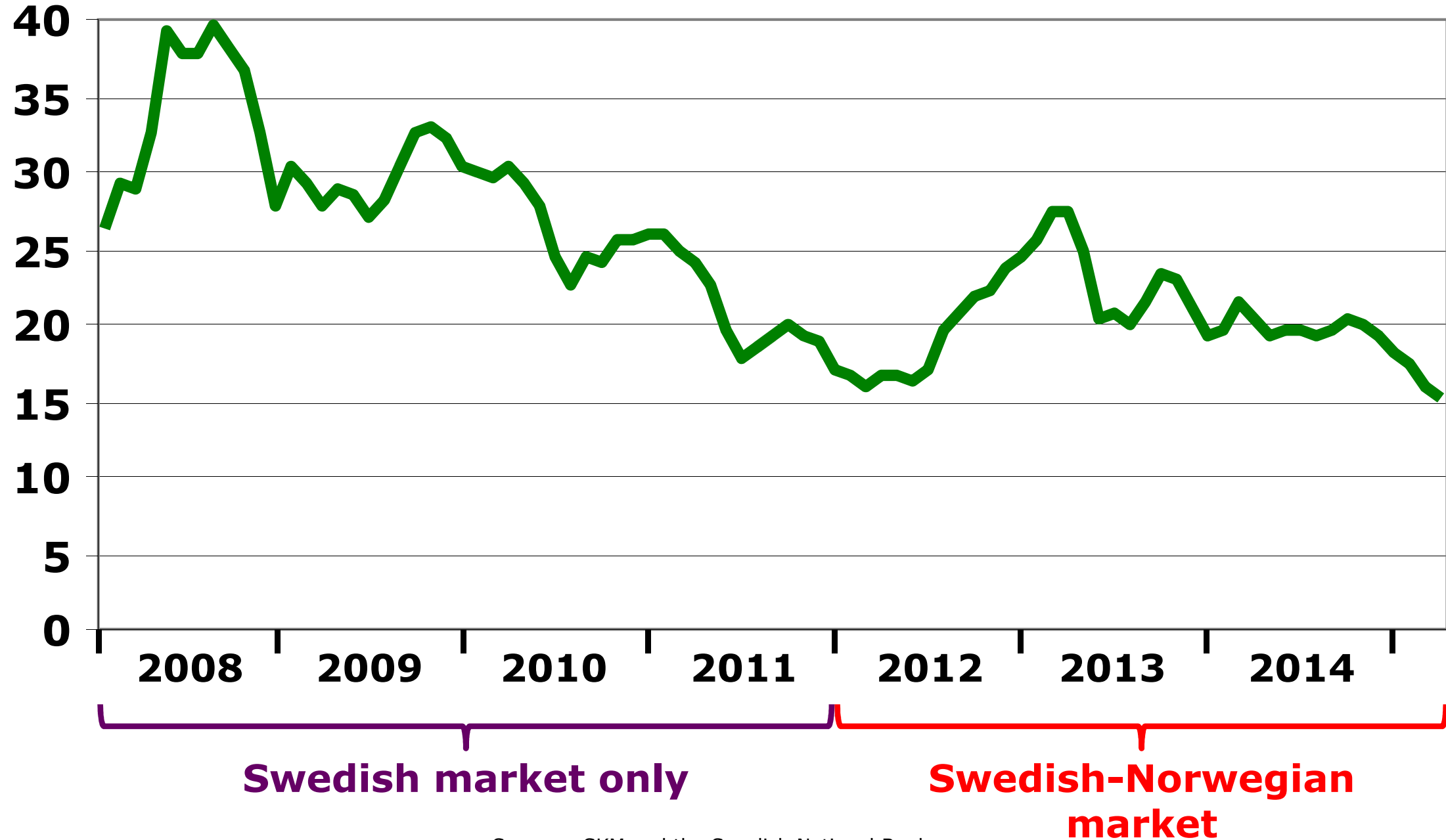
The Swedish-Norwegian certificate market



- ▶ **The common market was launched 1 January 2012**
 - **Before 1 January 2012, Sweden had a purely domestic certificate market.**
 - **No Norwegian certificate market before 1 January 2012.**
- ▶ **The target for the common market was derived from the 2020 goal allocated by EU to Sweden and Norway:**
 - **By the end of 2020, the electricity production from renewables commissioned in Sweden and Norway after 1 January 2012 should correspond to 26.4 TWh/year.**
 - **Currently, the plan is to change the 2020 target to 28.4 TWh**
 - **Swedish electricity consumers will finance 15.2 TWh.**
 - **Norwegian consumers will finance 13.2 TWh.**
- ▶ **At the outset: after 2020, the certificate system will gradually be phased out.**
- ▶ **The common certificate market is a tool to reach a specific target**
 - **The 2020 target for the production from new renewables.**

Prices of green certificates (nominal terms)

EUR/MWh Monthly average spot prices Jan. 2008 – March 2015



The lesson from the Swedish-Norwegian market for green certificates

- ▶ A multinational market for green certificates can provide **an economic sustainable road to an environmentally sustainable electricity supply.**
- ▶ For example, for the European Union: assume a group of Member States establish a common, multinational market for green certificates
 - This will give the group green electricity at competitive prices
 - ie, prices at a level not seen hitherto in the European Union outside Sweden.
- ▶ In a separate step, we can establish a single spot exchange for EU's Single Market for Electricity
 - This will give us an European spot market with cost efficiency, transparency, accountability and market surveillance
 - See the PowerPoint presentation *Single Spot Exchange for the Single Electricity Market.*

Appendix

Terminology and acronyms



▶ ***EU*** European Union.

▶ ***MWh*** 1 MWh is 1000 kWh.

In Denmark, the average, annual consumption of a household is 4000 kWh = 4 MWh.

▶ ***Renewable*** In this presentation, a renewable is a facility producing electricity by means of renewable energy.

Thank you for your attention!

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