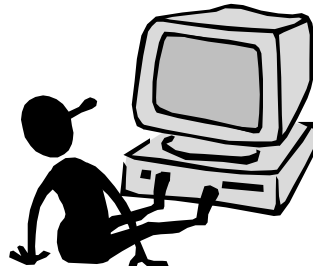


Introduction

- In the appendix, you'll find a list of the terms and acronyms used in this presentation.
- Concerning the documents referred to in this presentation:
 - ✓ Unless otherwise mentioned, you can download the documents from <http://www.houmollerconsulting.dk/facts-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.



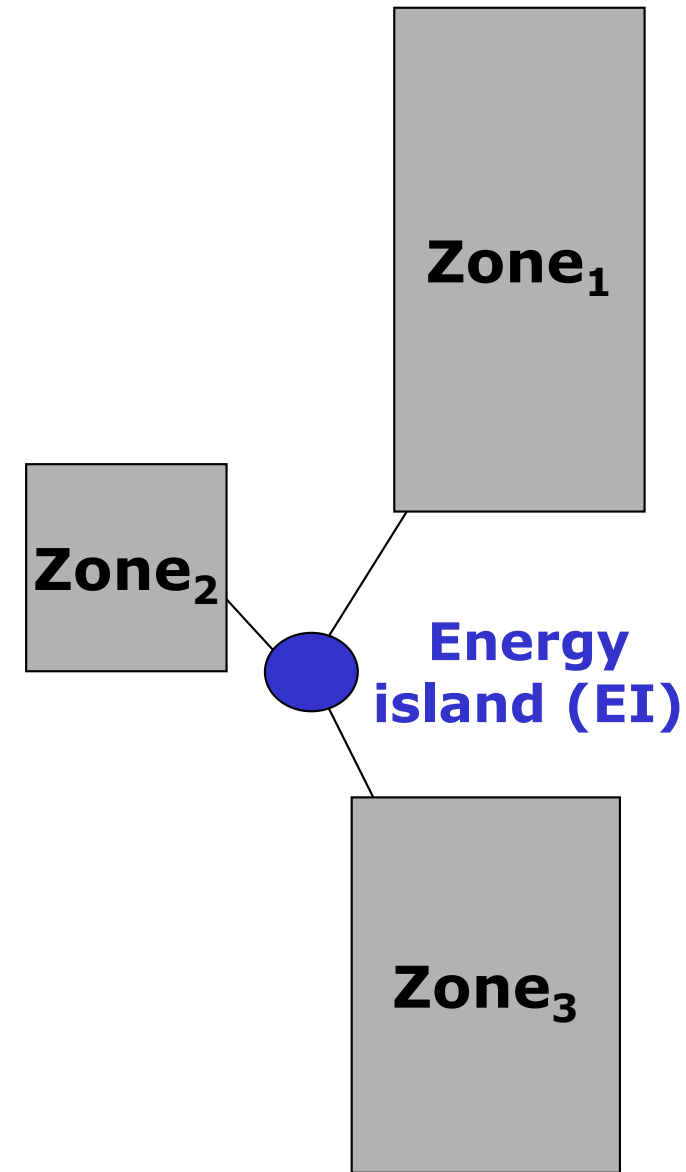
An energy island's spot prices and market coupling flows

- **Denmark has decided to build an energy island in the North Sea.**
- **Other European countries may launch similar projects.**
- **As pointed out by many stakeholders:**
 - ✓ **It is imperative an energy island is established as a separate bidding zone**
 - **Any other setup would greatly distort the energy flows and the market prices.**
- **As a case, this presentation discusses how to calculate the spot prices and the market coupling flows for an energy island connected to three bidding zones**
 - ✓ **The three zones may be on-shore zones and/or other energy islands.**



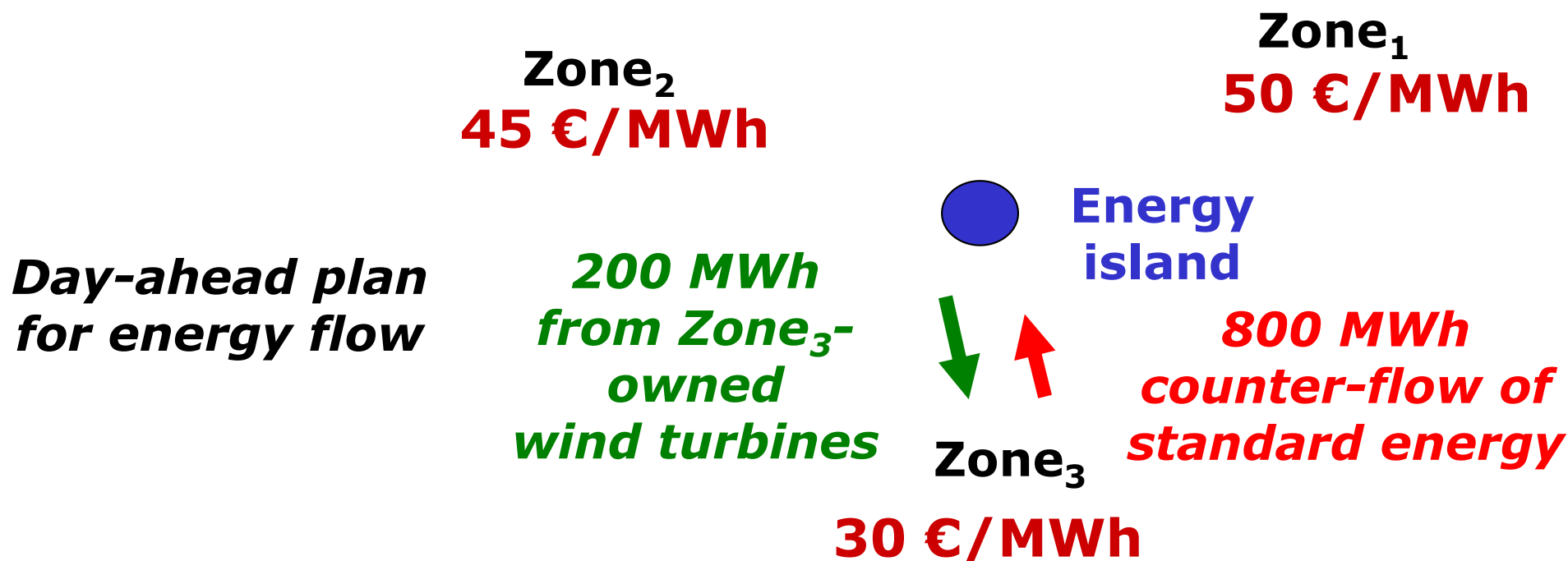
Simplifying assumptions

- **We assume there's no electricity consumption on the energy island (EI)**
 - ✓ **Actually, there will be consumption. There may even be flexible consumption in the form of PtX facilities, for example.**
- **We do not consider the option that EI's spot price may go so low that EI's producers do not want to sell.**
- **We disregard the fact that block bids and flow-based market coupling may cause interconnectors' capacity to be only partly utilized**
 - ✓ **Flow-based market coupling may even create counter-intuitive flows.**
 - ✓ **For information on such intricacies, see the PowerPoint presentation "Flow-based market coupling with block bids".**



Different wind energy subsidies in different countries?

- Assume, energy from wind turbines owned by legal persons in Zone₃ must be shipped to Zone₃ in order to get the subsidies granted in Zone₃.
- Assume each of the interconnectors between the energy island and Zone₁, Zone₂ and Zone₃ has capacity 600 MW.
- For an hour of tomorrow: assume, the forecast for the energy island's production is 500 MWh (200 MWh from Zone₃-owned wind turbines).

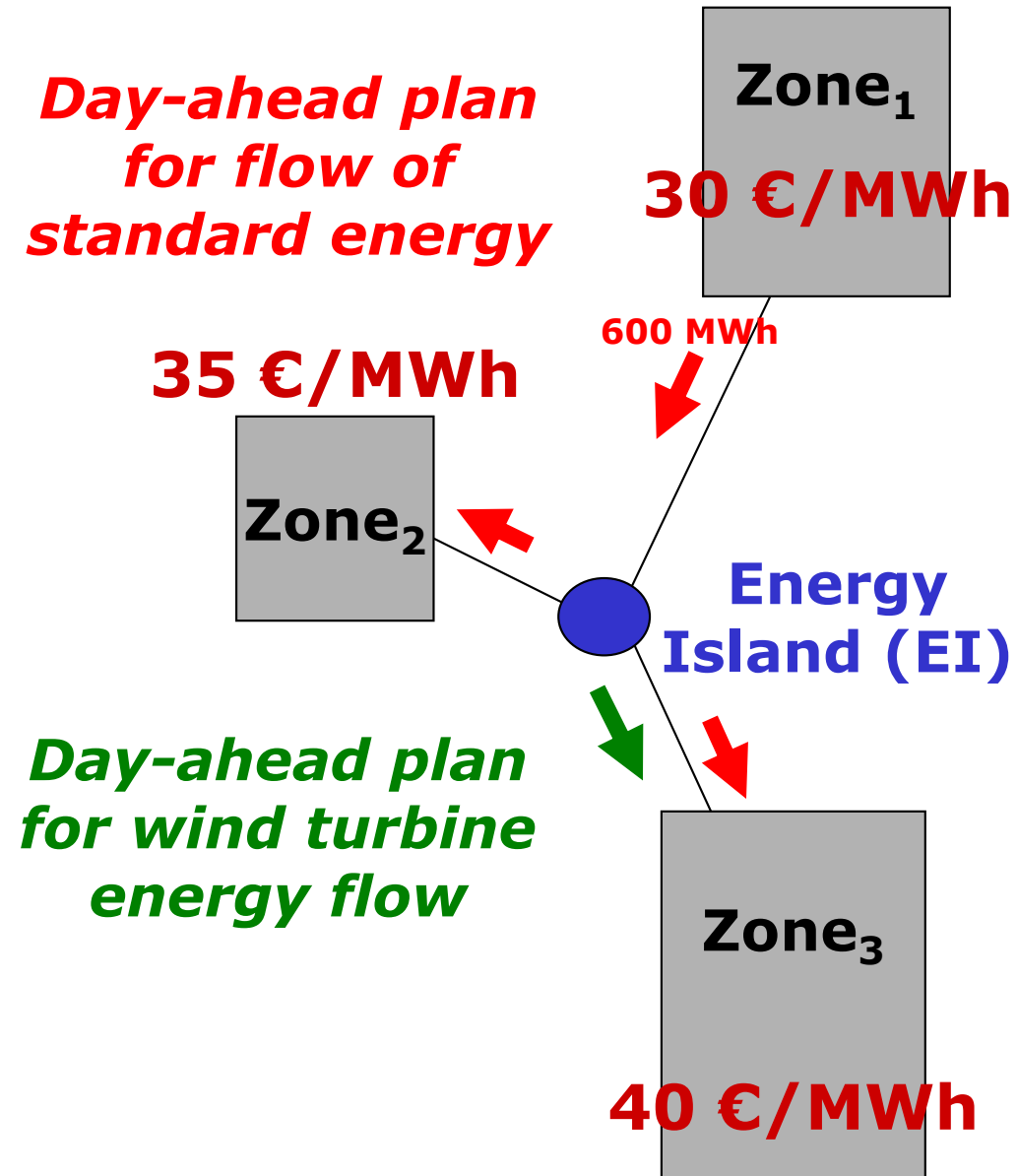


The market coupling flow and the spot price – 1

For one hour of tomorrow. EI is energy island.

E_{EI} is the expected energy island production for this hour

- For this and the following slides, we assume each of the three interconnectors has a capacity of 600 MW.
- $0 < E_{EI} < 600$ MWh
 - ✓ The wind energy is sent to Zone₃.
 - ✓ The remaining grid capacity is used to send energy from Zone₁ to Zone₂ & Zone₃.
 - ✓ Note: due to block bids, EI's spot price may not be 35 €/MWh, although the interconnector between EI and Zone₂ is uncongested.

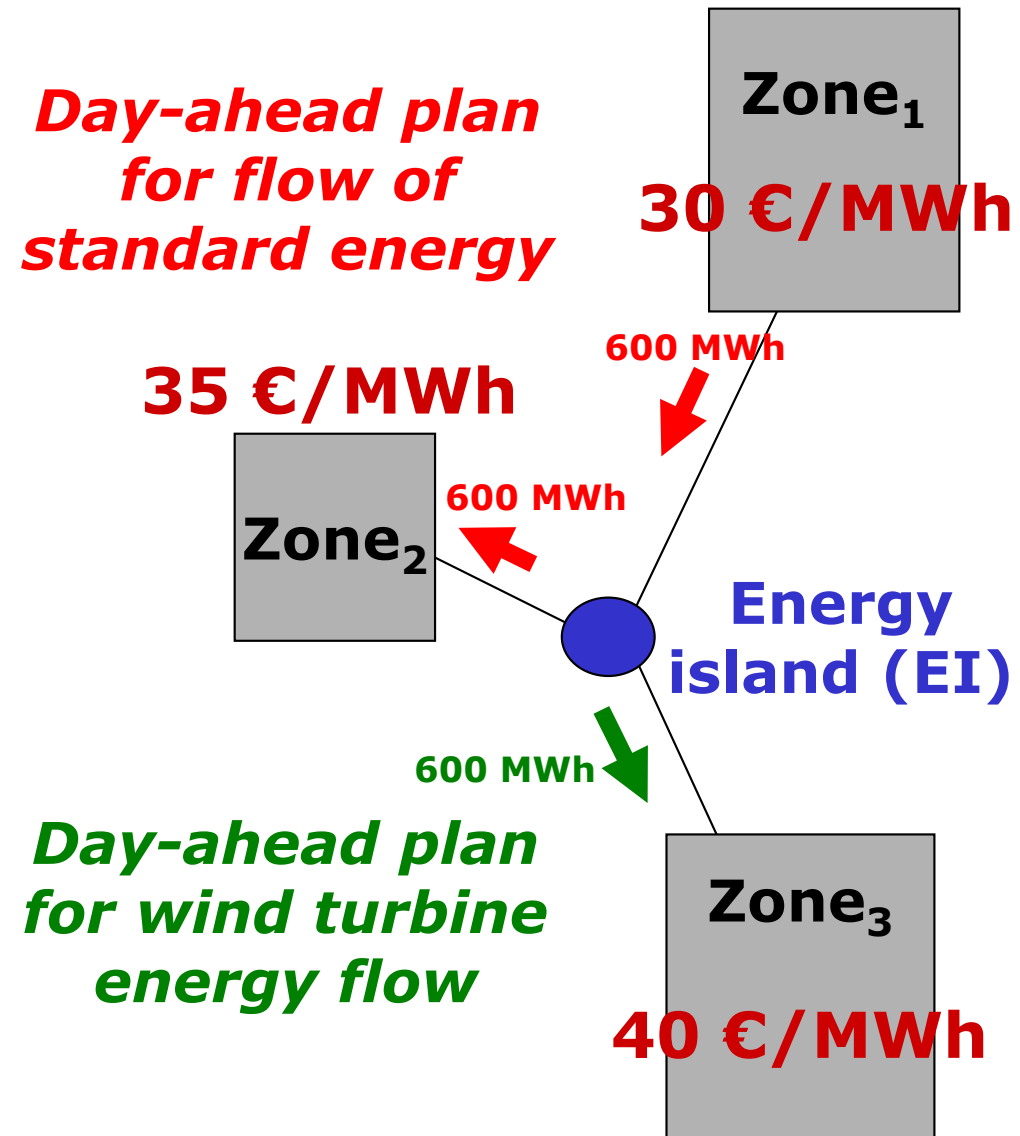


The market coupling flow and the spot price – 2

For one hour of tomorrow. EI is energy island.

E_{EI} is the expected energy island production for this hour

- $E_{EI} = 600 \text{ MWh}$
 - ✓ The wind energy is sent to Zone₃.
 - ✓ The remaining grid capacity is used to send energy from Zone₁ to Zone₂.
 - ✓ At the outset, for EI's spot price, you can choose any price in the interval 30 – 35 €/MWh.
 - For example, you may choose the mid-price.
 - However, block bids may cause EI's spot price to deviate from this.

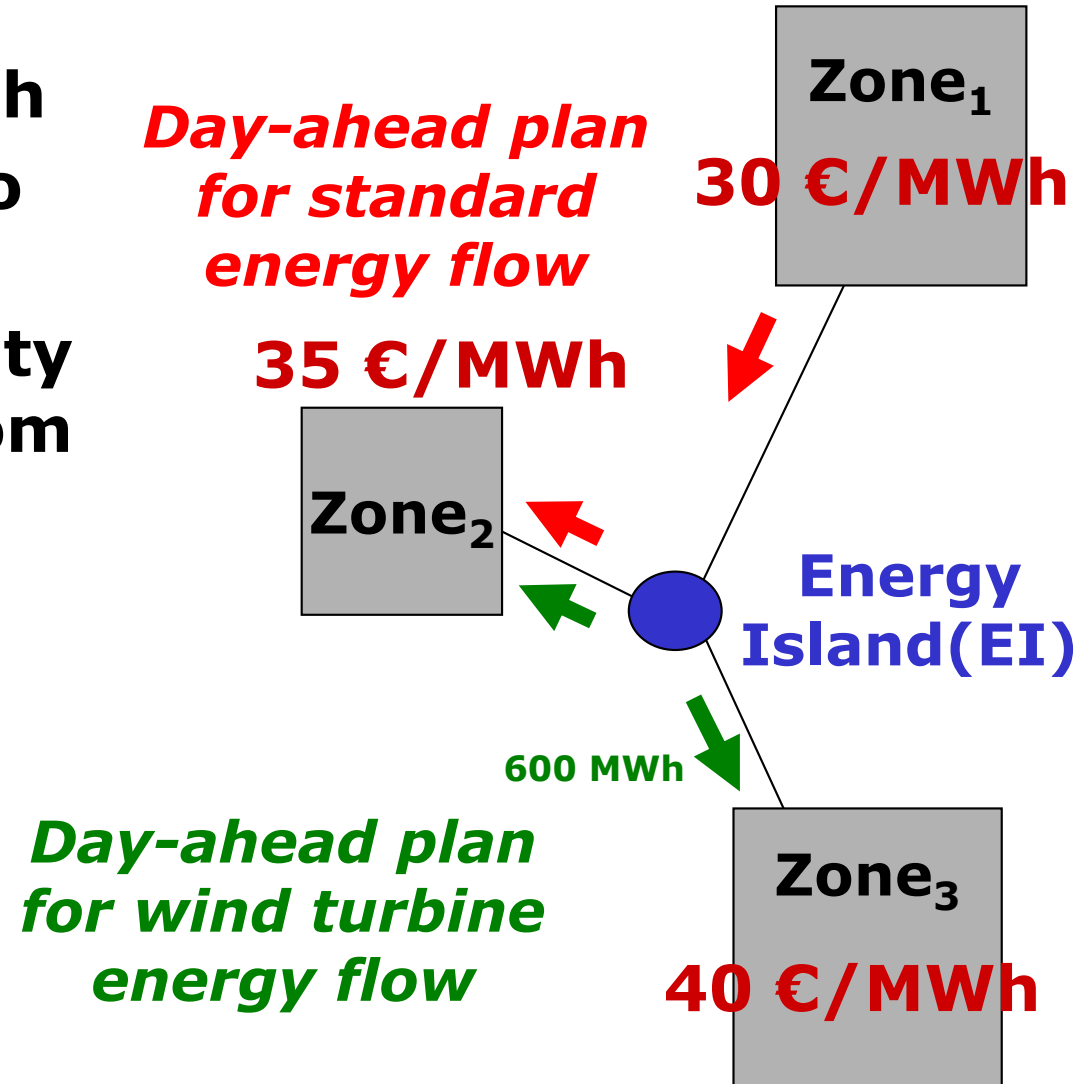


The market coupling flow and the spot price – 3

For one hour of tomorrow. EI is energy island.

E_{EI} is the expected energy island production for this hour

- $600 \text{ MWh} < E_{EI} < 1,200 \text{ MWh}$
 - ✓ The wind energy is sent to Zone₃ and Zone₂.
 - ✓ The remaining grid capacity is used to send energy from Zone₁ to Zone₂.
- Note: due to block bids, EI's spot price may not be 30 €/MWh, although the interconnector between EI and Zone₁ is uncongested.

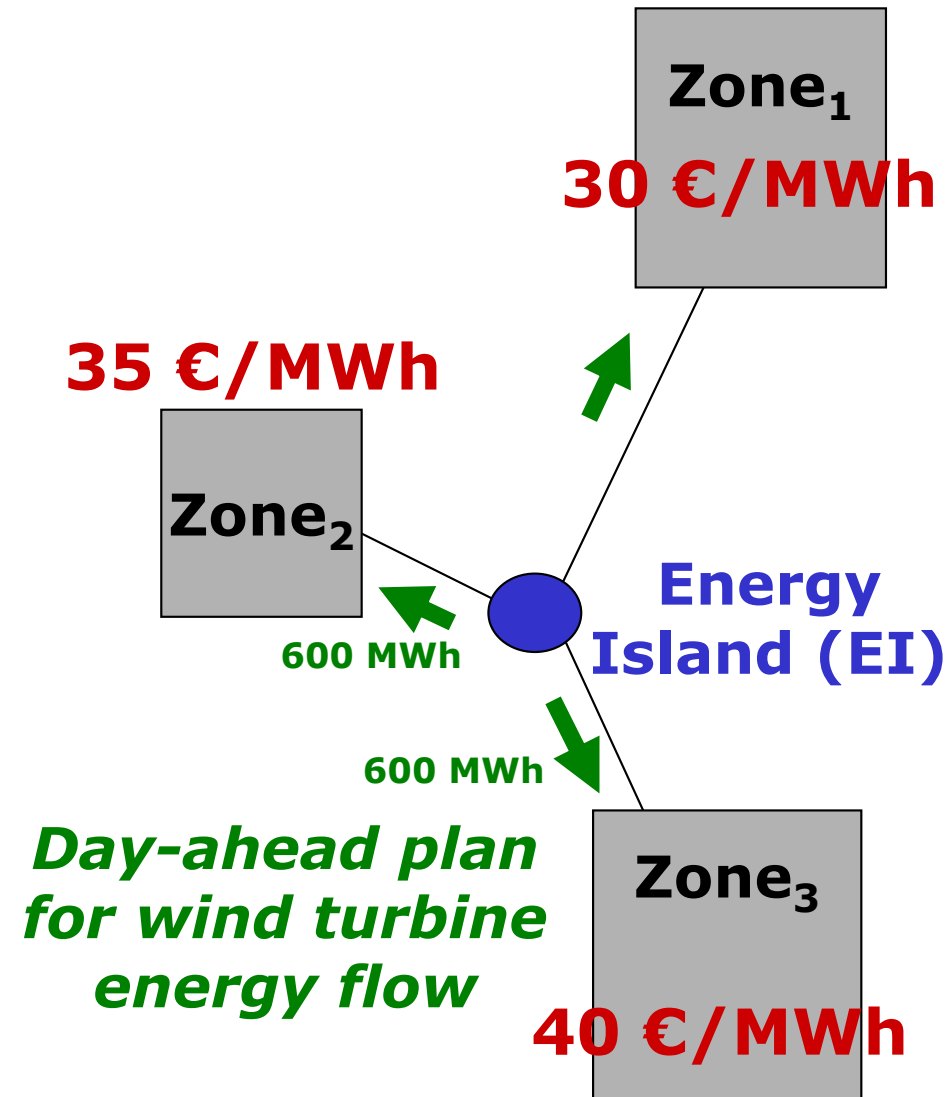


The market coupling flow and the spot price – 4

For one hour of tomorrow. EI is energy island.

E_{EI} is the expected energy island production for this hour

- $1,200 \text{ MWh} \leq E_{EI} < 1,800 \text{ MWh}$
 - ✓ The wind energy is sent to Zone₁, Zone₂, and Zone₃.
 - ✓ Note: due to block bids, EI's spot price may not be 30 €/MWh, although the interconnector between EI and Zone₁ is uncongested.
- $E_{EI} = 1,800 \text{ MWh}$
 - ✓ Unless the block bids interfere, you can set EI's spot price to 30 €/MWh.
- $1,800 \text{ MWh} < E_{EI}$
 - ✓ Without consumers at EI: unless EI's sellers have a sensible bid strategy, the production at EI will be curtailed, and EI's spot price will hit the price floor of the spot market.



Appendix – terminology and acronyms

- **Bidding zone** A geographical area, within which the players can trade electricity day-ahead without considering grid bottlenecks.
- **Block bids** Please refer to the PowerPoint presentation “Market coupling – European price coupling”.
- **Border** A border between two bidding zones. Hence, it need not be a border between two countries. It may be a border between two bidding zones in the same country.
- **Interconnector** In this document, this is a power line connecting two bidding zones.
- **Market coupling** A day-ahead congestion management system, where the plans for tomorrow’s cross-border energy flows are calculated using:
 - The purchase bids and sales offers sent by market players to spot exchanges.
 - The day-ahead cross-border trading capacity for each interconnector.
 - For more information, see the PowerPoint presentation “Maximizing the economic value of market coupling and spot trading”.
- **PtX** Power-to-X. Conversion of electrical energy to other energy forms (eg, chemical energy – for example production of hydrogen). PtX can also simply be the storing of electrical energy in batteries. For more information, you may refer to Wikipedia.
- **Spot exchange** See the PowerPoint presentation “Maximizing the economic value of market coupling and spot trading”. You may also refer to the PDF document “The Liberalized Electricity Market”.
- **Spot price** See the PowerPoint presentation “Maximizing the economic value of market coupling and spot trading”. You may also refer to the PDF document “The Liberalized Electricity Market”.

Thank you for your attention!

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