Commission for Energy Regulation
An Coimisiún um Rialáil Fuinnimh

Industry forum

Margadh Aibhléise na hÉireann – Irish Electricity Market

Citywest Hotel

8th May 2003

PA

AGENDA

Cathy Mannion, Head of Generation and Supply

- Welcome and objectives
- Proposals
- CfDs and LMPs
- Market modelling
- FTRs
- Open session
- Next steps

Agenda for today

Topic	Timing	Presenter
Welcome and objectives	9:30 – 9:35	Cathy Mannion, Head of Generation and Supply
Proposals for Irish Electricity Market	9:35 – 10:15	Tom Reeves, Commissioner
Contracts for Differences and Locational Marginal Pricing	10:15 – 11:00	John George and Stuart Curson, PA Consulting
Break	11:00 – 11:15	
Market modelling	11:15 – 12:00	Stephen Woodhouse, ILEX Energy Consulting
Financial Transmission Rights	12:00 – 12:20	Ed Kee, PA Consulting
Open Session	12:20 – 12:55	
Next steps	12:55 – 1:00	Keelin O’Brien, Manager Electricity Trading

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Tom Reeves, Commissioner

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Irish Electricity Trading Arrangements

Minister's Policy Direction

- Timetable for Review of Trading Arrangements

Market Review Consultation Process

- Consultation & Information Papers
- Industry Forums & Seminars
- Price & Dispatch Modelling
- Review of International Experience
- Individual Meetings

Review Completion & High Level Principles

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Proposed Decision

Sets Out:

- Type of Market (Market Structure / Pricing)
- Market Operation (Bidding and Dispatch Rules)
- Network Issues (Constraints / Ancillary Services)
- Risk Mitigation Measures (CFDs / FTRs)
- Institutional Issues (Generation Adequacy / Treatment of Dominance)

Centralised Market

Mandatory Centralised Pool

- All Electricity sold to and bought from System Market Operator (SMO) through the spot market

Energy-Only Market

- No separate payments for Capacity

VoLL (Value of Lost Load) price limit

- Limit applies in special situations, eg market doesn't clear

Allows for Demand-Side Bidding for interruptible or dispatchable load

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Market Pricing

Locational Marginal Pricing for Generators

- Output sold to SMO at locational marginal price associated with node

Uniform Price for Suppliers

- Uniform price regardless of location
- Load-Weighted Average Price

Prices could be Positive or Negative

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Dispatch

SMO to produce pre-dispatch runs with indicative pricing and dispatch

- Week-ahead and day-ahead

Generators are dispatched if their offers are accepted and then receive spot market revenue

Locational price reflects constraints and losses

Generators receive no constrained on or constrained off payments

SMO to use reserve services to manage trading interval contingencies

Reserves

Co-optimisation

- Reserves & Energy will be co-optimised in the Spot Market

SMO to purchase reserves

- Initially SMO could Contract for Reserve Services
- SMO may implement a Market for Reserves

Reserve Providers

- These may include Generators & Users

Generation Adequacy

The Fast Build Option is Proposed:

- Trigger set close to time when Capacity Required
- Site and Planning work Ready
- Peaking Plant only
- Unit will be sold when Commissioned

Advantages

- Minimises the level of market intervention;
- Provides the additional capacity if and when required

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Dominance

Measures currently being Considered:

- The Creation of a Central Trader to stand between ESB PG and ESB PES;
- Regulatory Measures
- Legal separation of PG

Minimum Required

- Vesting Contracts Imposed on ESB
- Ongoing Regulation of ESB PG and ESB PES.

Decision by end of May

Risk Management

Contracts for Differences

- Participants to enter negotiated hedge arrangements (CfDs)
- These will manage financial risk presented by Spot Market Prices

Financial Transmission Rights (FTRs)

- Hedge the Risk of Locational Price Differences

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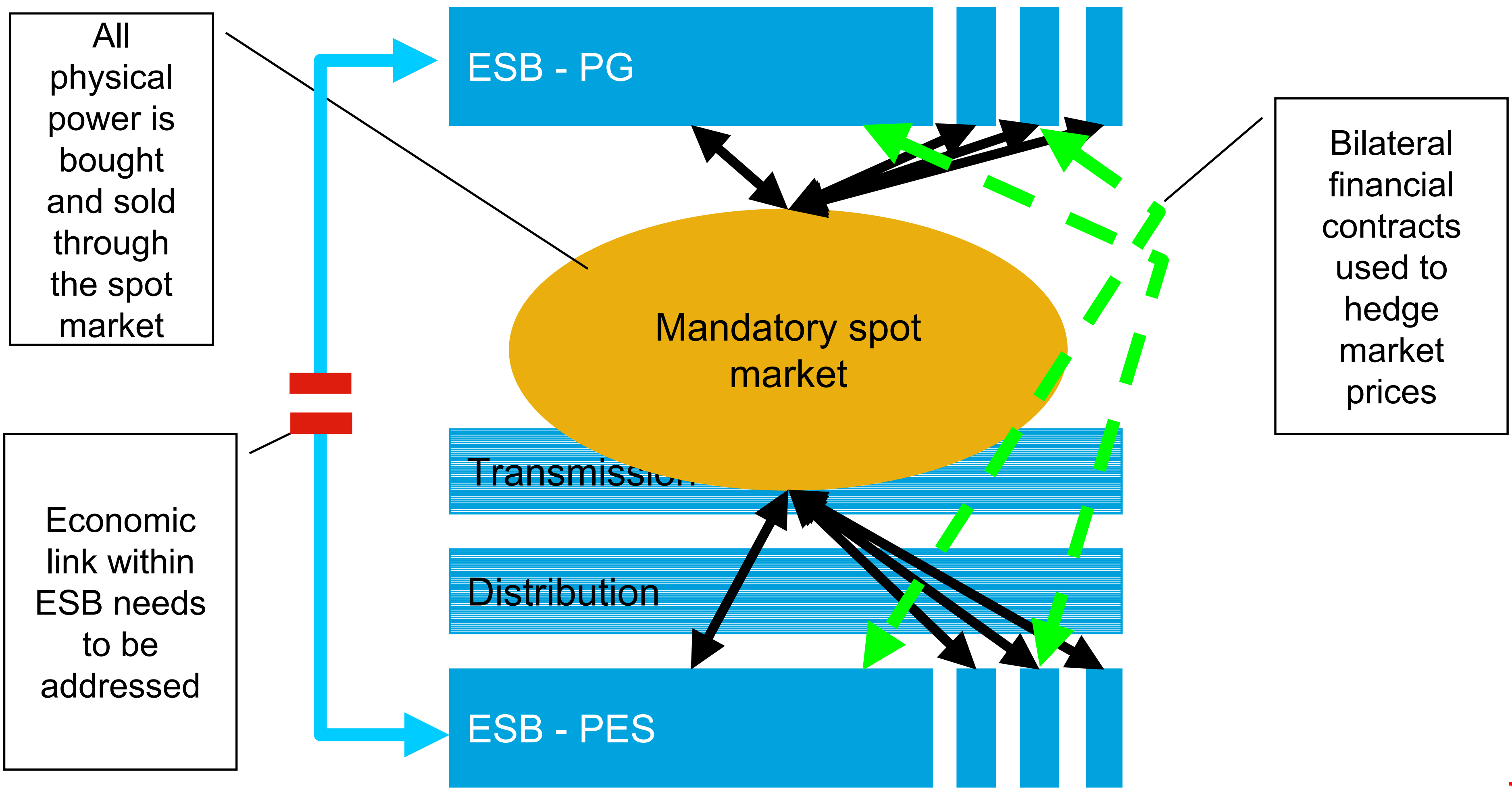
Centralised market



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AGENDA

Stuart Curson and John George, PA Consulting

- Welcome and objectives
- Proposals
- **CfDs and LMPs**
- Market modelling
- FTRs
- Open session
- Next steps

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A quick review – market clearing price concept

The spot market provides no separate payment for capacity

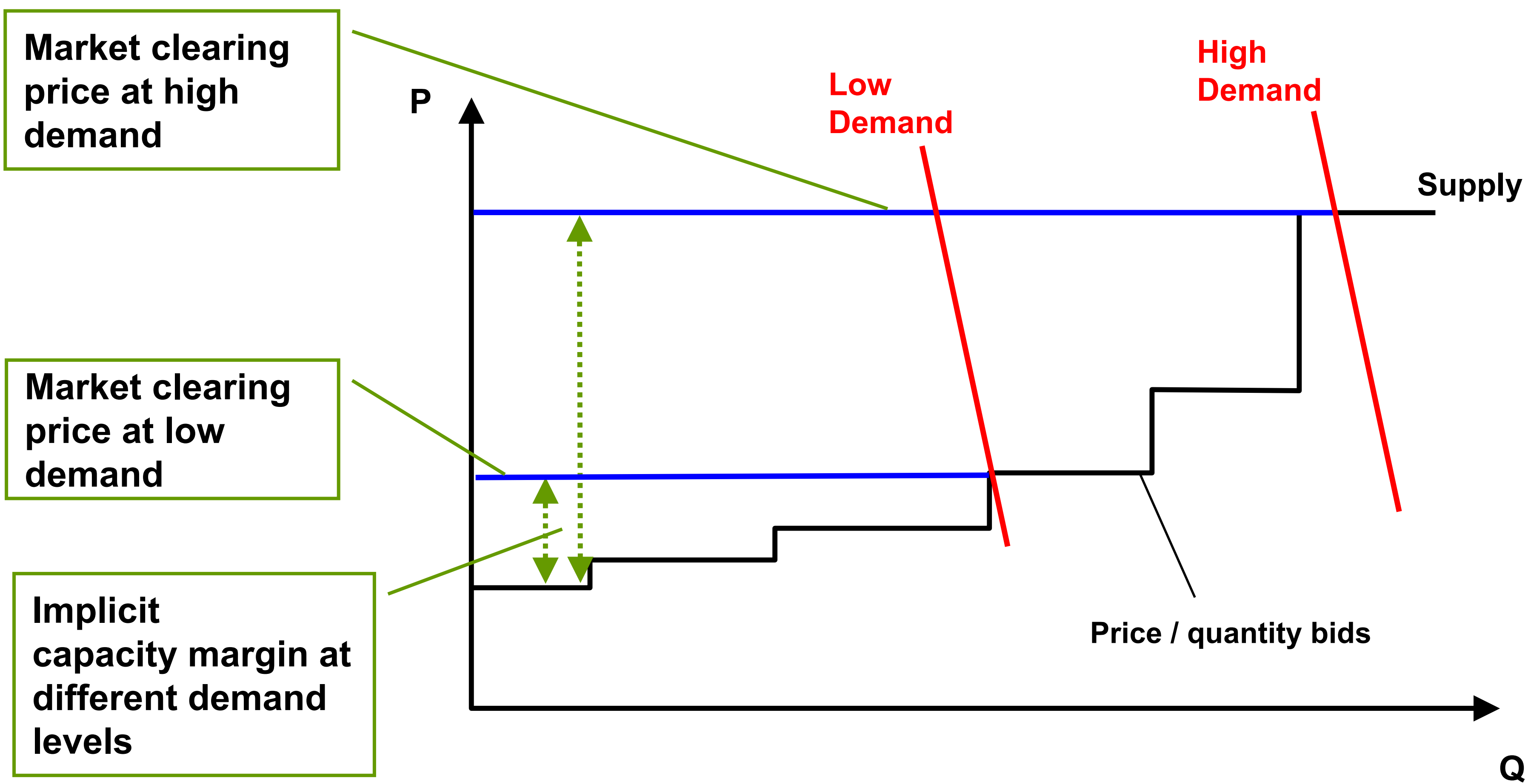
The marginal generator (last one dispatched) receives only the price bid

Infra-marginal (lower bids than the marginal bid) receive the pool price set by the marginal generator

So long as a generator's short-run marginal costs (ie, fuel costs) are lower than the spot price, a generator makes money that can be applied toward fixed operating costs, repayment of debt, and return on equity

A generator that is often on the margin may not have this fixed cost coverage unless its bids are above short-run marginal cost for financial viability

Market clearing price



Illustrative trading period (e.g., 1 hour)

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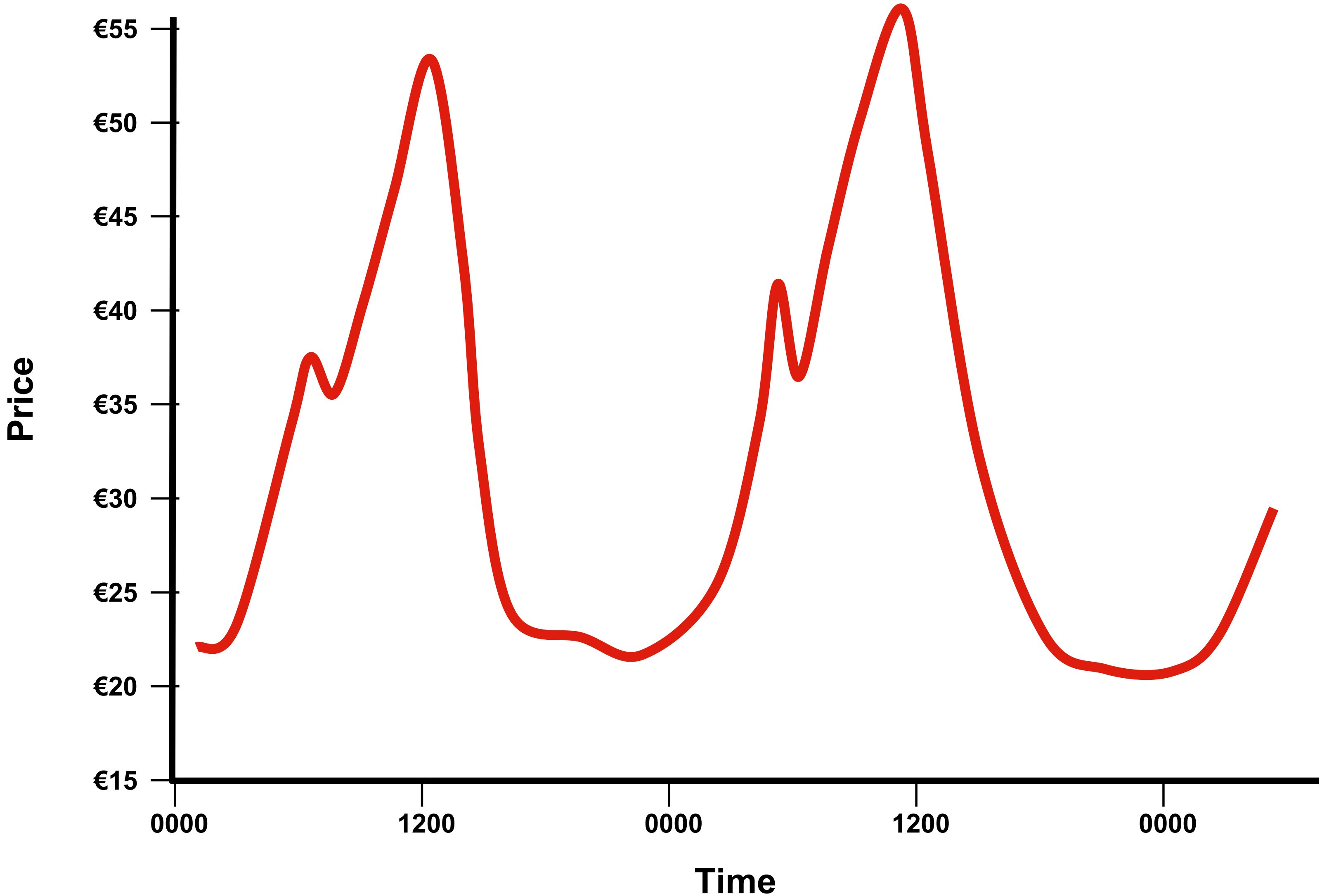
Spot prices can be volatile



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Hedge contracts

If generators and supply companies sold to and purchased from the market operator at the spot price, their revenue or costs would be volatile and present considerable financial risk.

In order to manage this risk, sellers and buyers in spot market have developed a range of hedge contract products, including:

- Swaps
- Cap
- Floors
- Collars

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Swap contract (2-way hedge)

A common hedge contract is a swap, sometimes known as a 2-way hedge. In this type of contract, the parties agree on a strike price and a volume. Typically, a generator and a supply company would enter into such a contract. While both parties transact with the market operator in the spot market, they enter into such financial agreements in order to limit their exposure to spot price risk.

We assume a swap with a €35 strike price.

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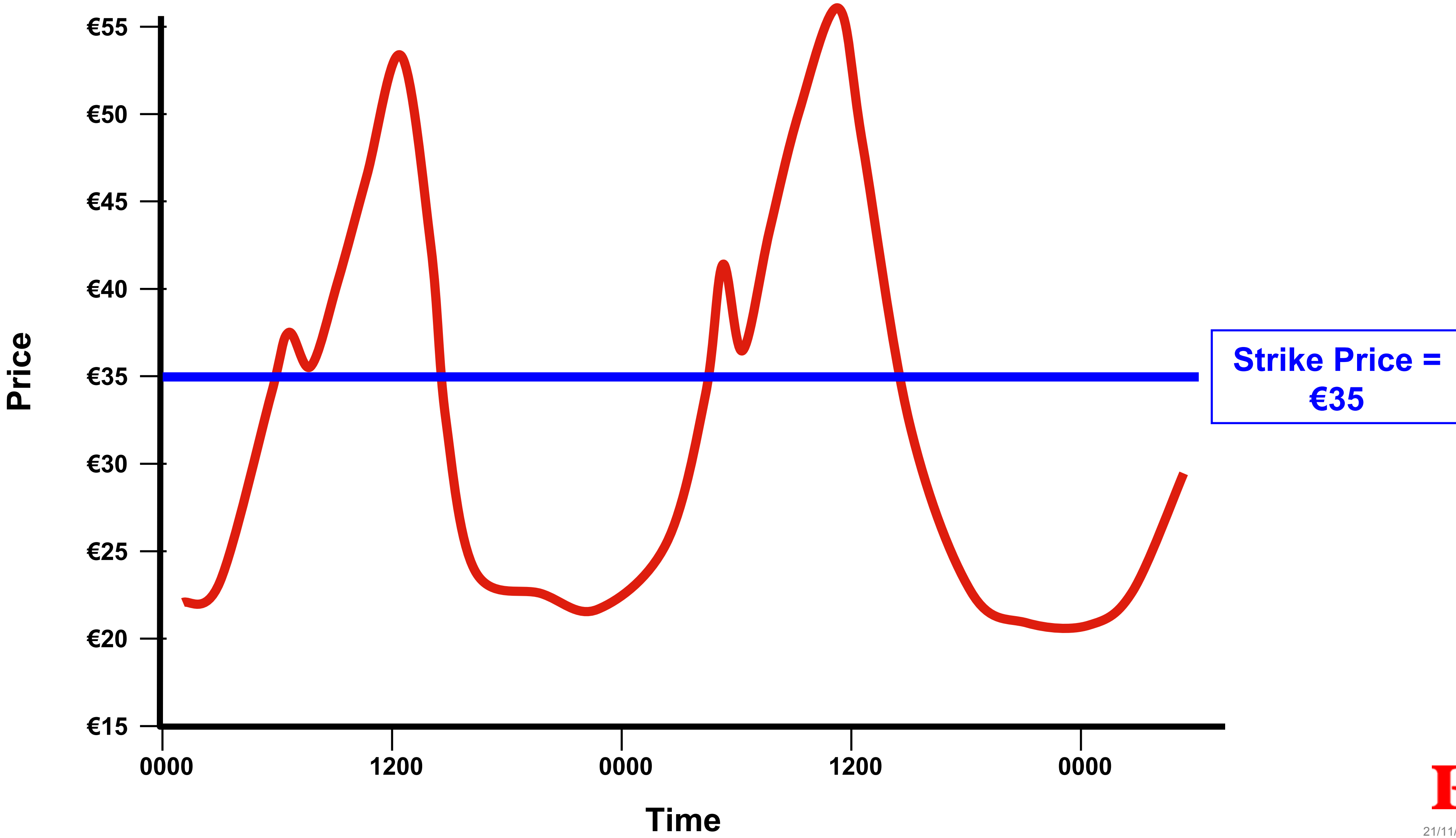
Swap contract (2-way hedge)



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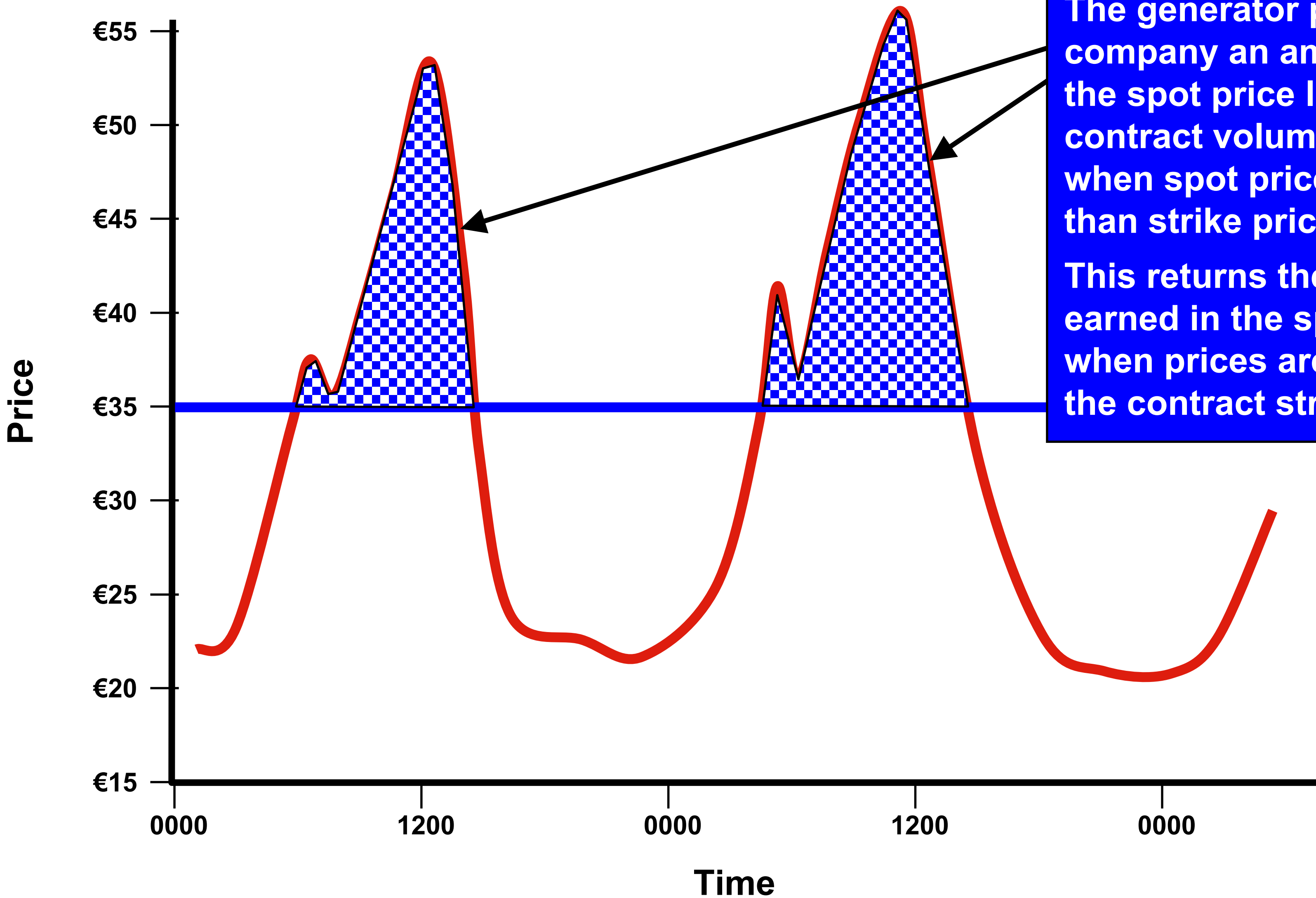
Swap contract difference payments - Generator



The generator pays the supply company an amount equal to the spot price less €35 times contract volume in each hour when spot price is greater than strike price.

This returns the revenue earned in the spot market when prices are higher than the contract strike price

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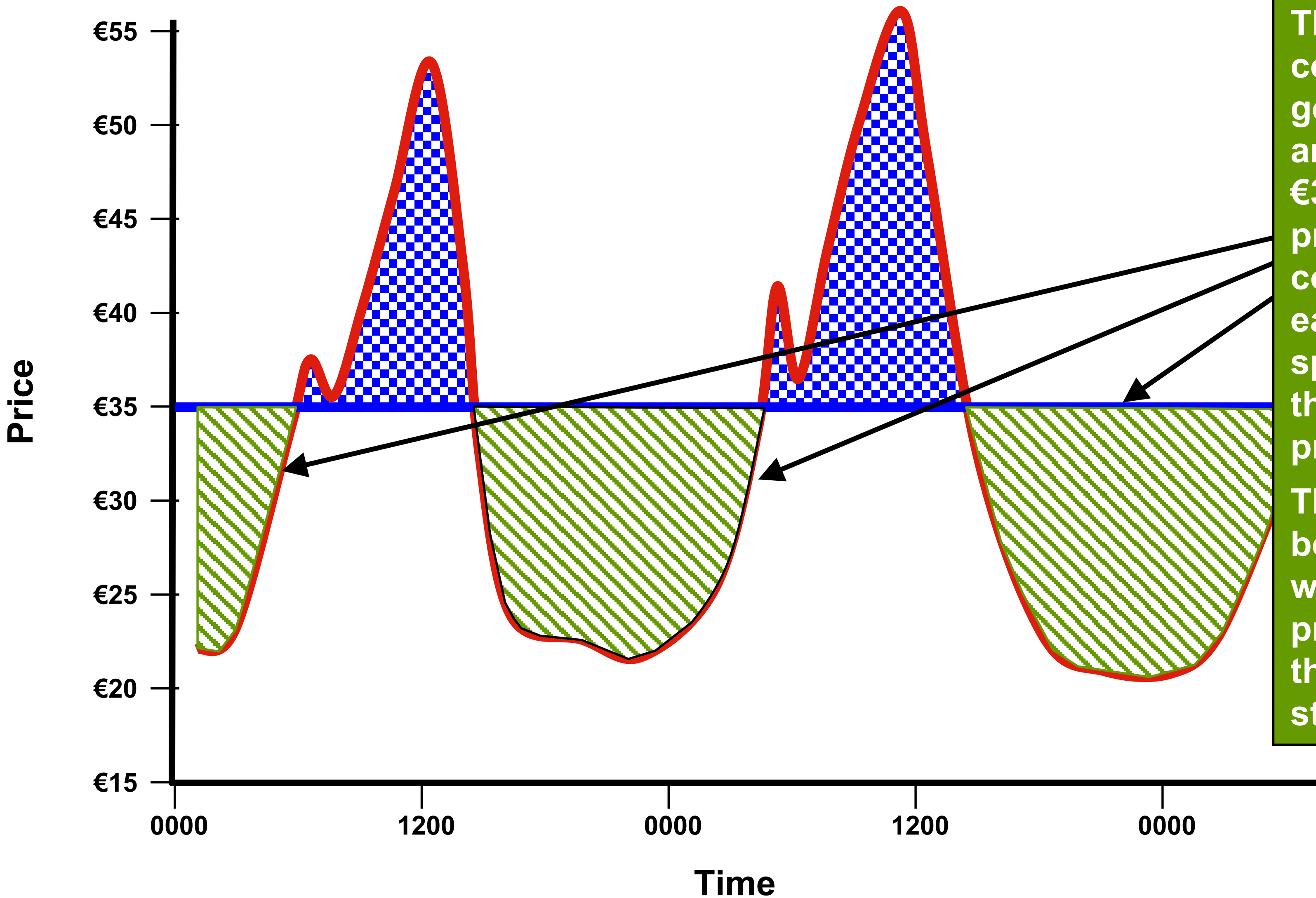
Swap contract difference payments – Supplier



The supply company pays the generator an amount equal to €35 less the spot price times contract volume in each hour when spot price is less than the €35 strike price.

This returns the benefit received when spot market prices are less than the contract strike price

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Swap contract (2-way hedge)

The result of a swap is that the power prices are fixed at the €35 strike price for the contract volume, no matter how high or low the spot price goes.

This provides a stable financial outcome to both parties.

There remains exposure when actual volumes are different from the contract volume

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Swap contract – worked example

Spot price lower than strike price

Spot Price	Strike Price	Contract amount
€30 per MWh	€35 per MWh	100 MW

The supplier makes purchases (and the generator makes sales) to the market operator at the €30 per MWh spot market price. Since this is lower than the Strike Price, the supplier pays the generator a difference payment of €500 (the difference between €30 and €35, times 100).

	Without Hedge		Difference Payment	With Hedge	
Party	**€**	**€/MWh**	**€**	**€**	**€/MWh**
The supplier	(3,000)	30	***(500)***	(3,500)	35
The generator	3,000	30	***500***	3,500	35

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Swap contract – worked example

Spot price higher than strike price

Spot Price	Strike Price	Contract amount
€40 per MWh	€35 per MWh	100 MW

The supplier makes purchases and the generator makes sales to the market operator at the €40 per MWh spot price. Since this is higher than the Strike Price, the supplier ***receives from*** the generator a difference payment of €500 (the difference between €35 and €40, times 100).

	Without Hedge		Difference Payment	With Hedge	
Party	**€**	**€/MWh**	**€**	**€**	**€/MWh**
The supplier	(4,000)	40	***500***	(3,500)	35
The generator	4,000	40	***(500)***	3,500	35

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Uncovered swap – generator dispatched off

Spot price lower than generator marginal cost

Spot Price	Strike Price	Contract amount
€20 per MWh	€35 per MWh	100 MW

A supplier with spot volumes of 100 MW (or more) has contracted with a generator that has a marginal cost that is higher than €20 MWh. Since the spot price of €20 per MWh is lower than the Strike Price, the supplier ***pays*** the generator a difference payment of €1,500. This represents a ***pure profit*** to the generator.

	Without Hedge		Difference Payment	With Hedge	
Party	**€**	**€/MWh**	**€**	**€**	**€/MWh**
The supplier	(2,000)	20	***(1,500)***	(3,500)	35
The generator	0	20	***1,500***	1,500	15

This example assumes that the spot price is below the marginal cost of the generator, so that the generator is dispatched off (assumes a marginal cost based bid) and has no output.

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Uncovered swap – generator outage

Spot price much higher than strike price

Spot Price	Strike Price	Contract amount
€5,000 per MWh	€35 per MWh	100 MW

The generator is not operating. The supplier makes purchases from the spot market at €5,000 per MWh. Since this is higher than the Strike Price, the supplier ***receives from*** the generator a difference payment of €496,500 (the difference between €5,000 and €35, times 100).

	Without Hedge		Difference Payment	With Hedge	
	€	**€/MWh**	**€**	**€**	**€/MWh**
The supplier	(500,000)	5,000	***496,500***	(3,500)	35
The generator	0	5,000	***(496,500)***	(496,500)	

The financial risk for an uncovered generator with a swap contract presents a powerful incentive to have power plants operating when spot prices are expected to be high. It is not possible to predict exactly when prices will be high (i.e., price spikes occur due to unplanned outages of other power plants or interconnectors), so a generator will make the power plant is available most of the time.

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Supplier with swap - interruptible load

Spot price much higher than strike price

Spot Price	Strike Price	Contract amount
€5,000 per MWh	€35 per MWh	100 MW

The supplier makes purchases from the spot market at €5,000 per MWh. Since this is higher than the Strike Price, the supplier ***receives from*** the generator a difference payment of €496,500 (the difference between €5,000 and €35, times 100). However, the supplier purchases only ***90 MW*** from the spot market due to interruptible load.

	Without Hedge		Difference Payment	With Hedge	
	€	**€/MWh**	**€**	**€**	**€/MWh**
The supplier	(450,000)	5,000	***496,500***	46,500	516.66
The generator	500,000	5,000	***(496,500)***	3,500	35

The supplier makes a net profit of €46,500 for the hour, the result of only purchasing 90% (and interrupting the other 10%) of the contract volume. A swap contract provides a supplier with a powerful financial incentive to locate and use interruptible load at times of high prices. This incentive exists regardless of end-use customer real-time metering or other features.

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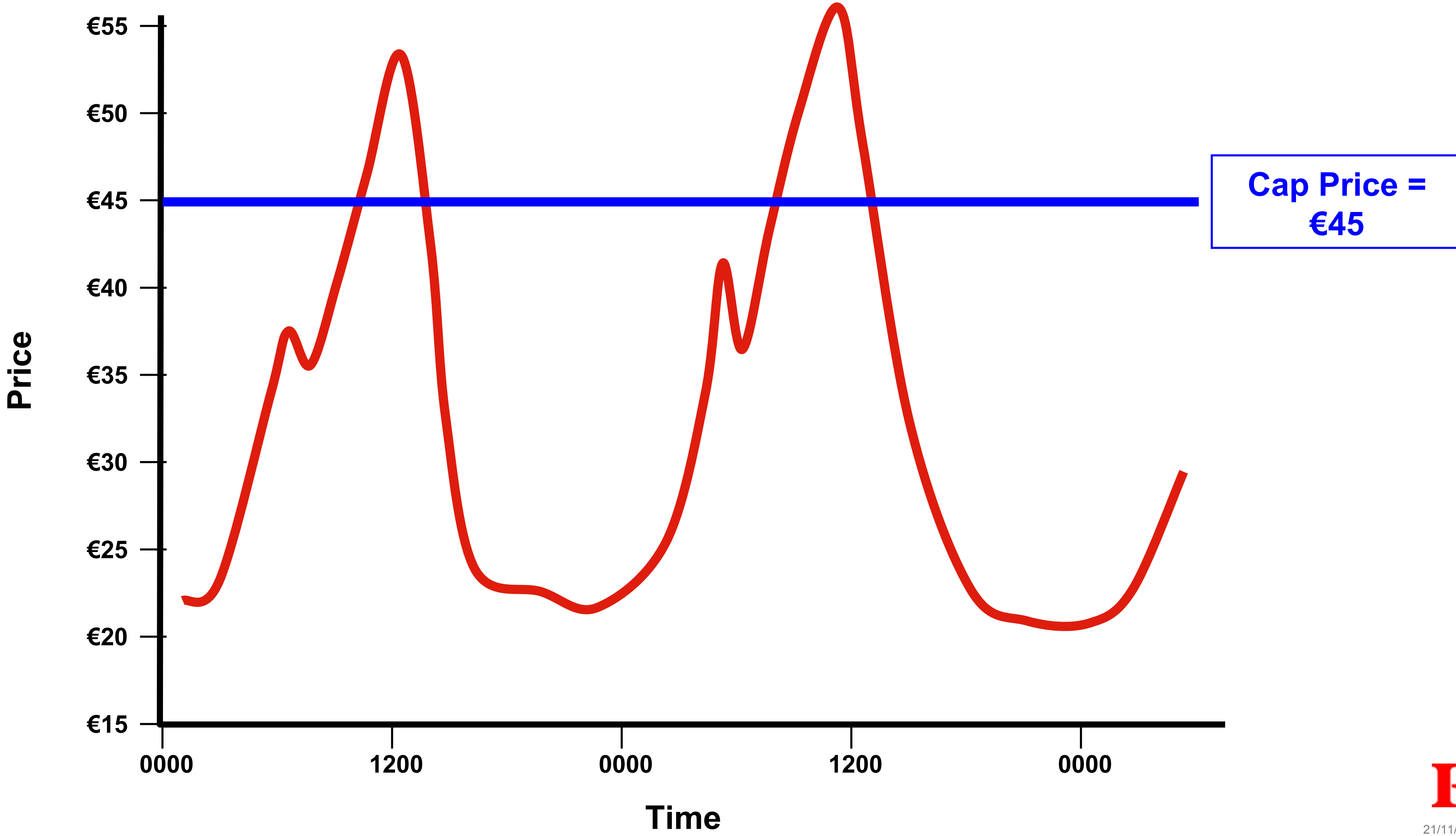
Cap contract (1-way hedge)

Another common hedge contract is a cap contract, one of several types of 1-way hedges. As in a swap, the parties agree on a strike price and a volume. Typically, a generator and a supply company would enter into such a contract.

Unlike a swap contract, a cap contract only has payments from the generator to the supply company

We assume a swap with a €45 strike price.

Cap contract



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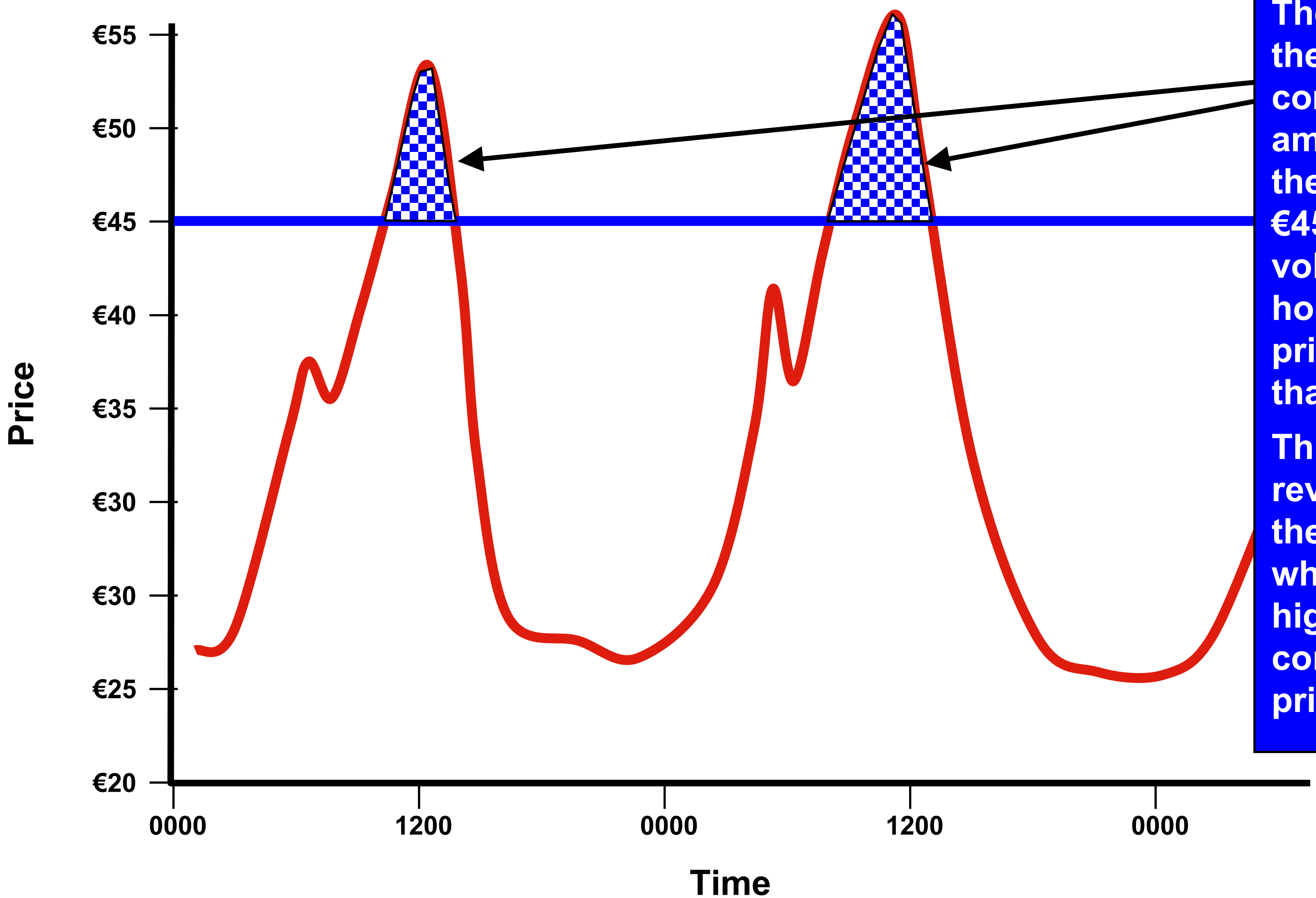
Cap contract difference payments - Generator



The generator pays the supply company an amount equal to the spot price less €45 times contract volume in each hour when spot price is greater than strike price.

This returns the revenue earned in the spot market when prices are higher than the contract strike price

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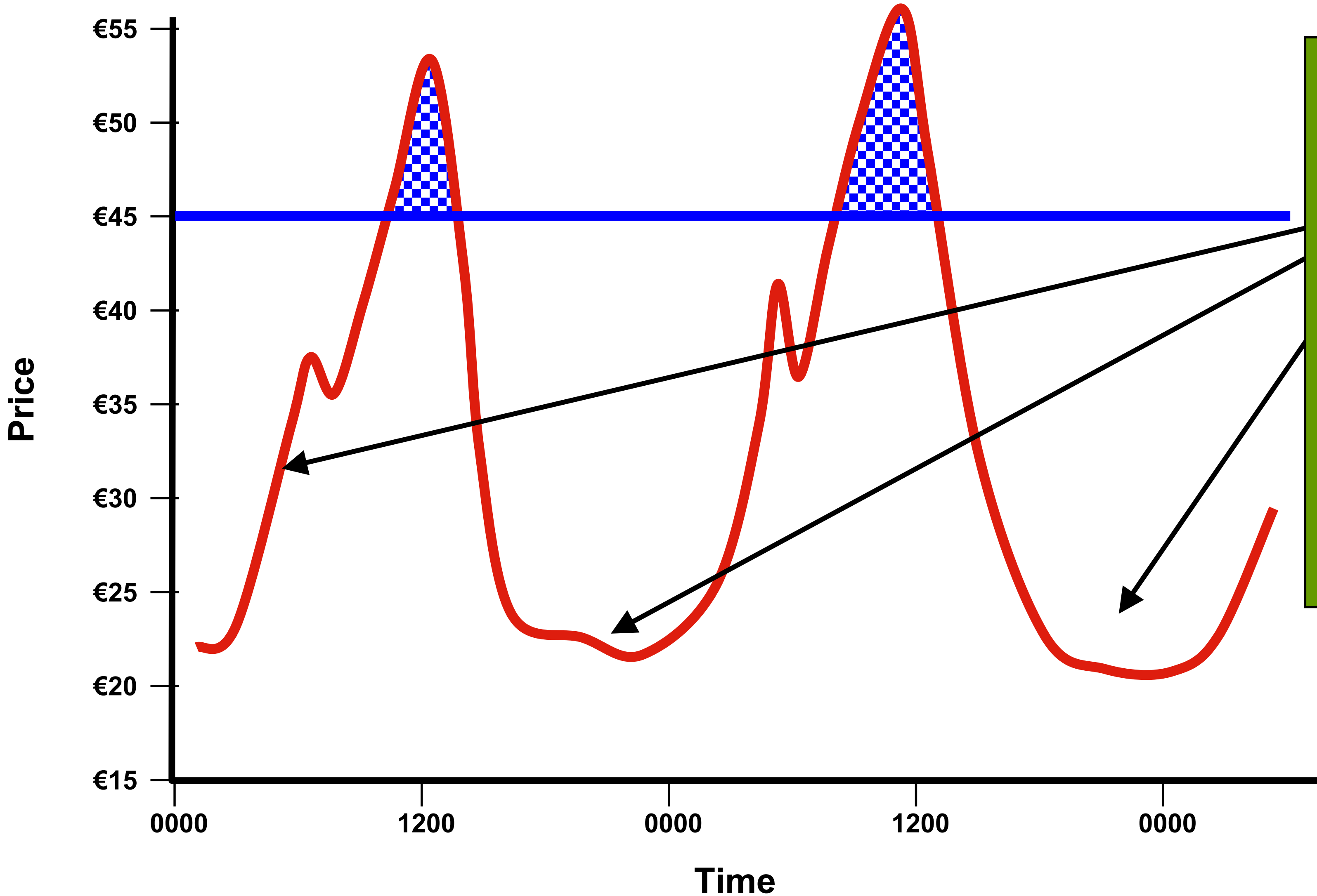
Cap contract – no payments when spot < strike



When the spot price is less than the strike price, both parties have NO hedge, so that the volumes are transacted at the spot price with no offsetting financial adjustments

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Cap contract – option fees

The effect of a cap contract is to limit the upside revenue to a generator, while providing no protection to the generator against low spot prices. Such a cap contract will usually be accompanied by a payment of an option fee to the generator.

One potential arrangement is for a peaking plant to provide a cap contract that limits the supply company exposure to high spot prices, with an option fee that provides coverage of the peaking unit's fixed costs.

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Floor contract

The result of a floor contract is that the generator is protected against very low spot prices. These contracts are rarely seen, except as a part of a more complicated arrangement (i.e., a collar arrangement).

Such a contract, if it existed, might well be accompanied by the payment of an option fee to the supply company.

In actual practice, the ability of the generator to purchase power in the spot market means that a power plant would shut down and purchase power in the spot market for resale when the spot price is lower than the power plant's variable cost.

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Collar contract

A collar contract is a combination of a cap contract and a floor contract.

A swap can be thought of as a special collar contract where the cap price is equal to the floor price.

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Financial hedges and physical output

These hedges are financial contracts only. However, the financial exposure of a hedge contract will provide powerful incentives for changes to physical output.

- **A generator holding a swap or a cap hedge contract will face considerable financial loss if spot prices are high and the generator is not selling to the spot market – essentially buying at high prices and selling at the hedge price**
- **A supplier with un-hedged volume will face considerable financial loss if spot prices are high – there are powerful incentives to pay customers to reduce load**
- **The portfolio of hedges held by a generator will likely cause changes in the generator's bidding behaviour**

……….Over to John

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Dispatch based pricing

Dispatch based pricing determines prices and dispatch in one operation.

Dispatch is optimal - determined by the least cost supply that meets power system requirements:

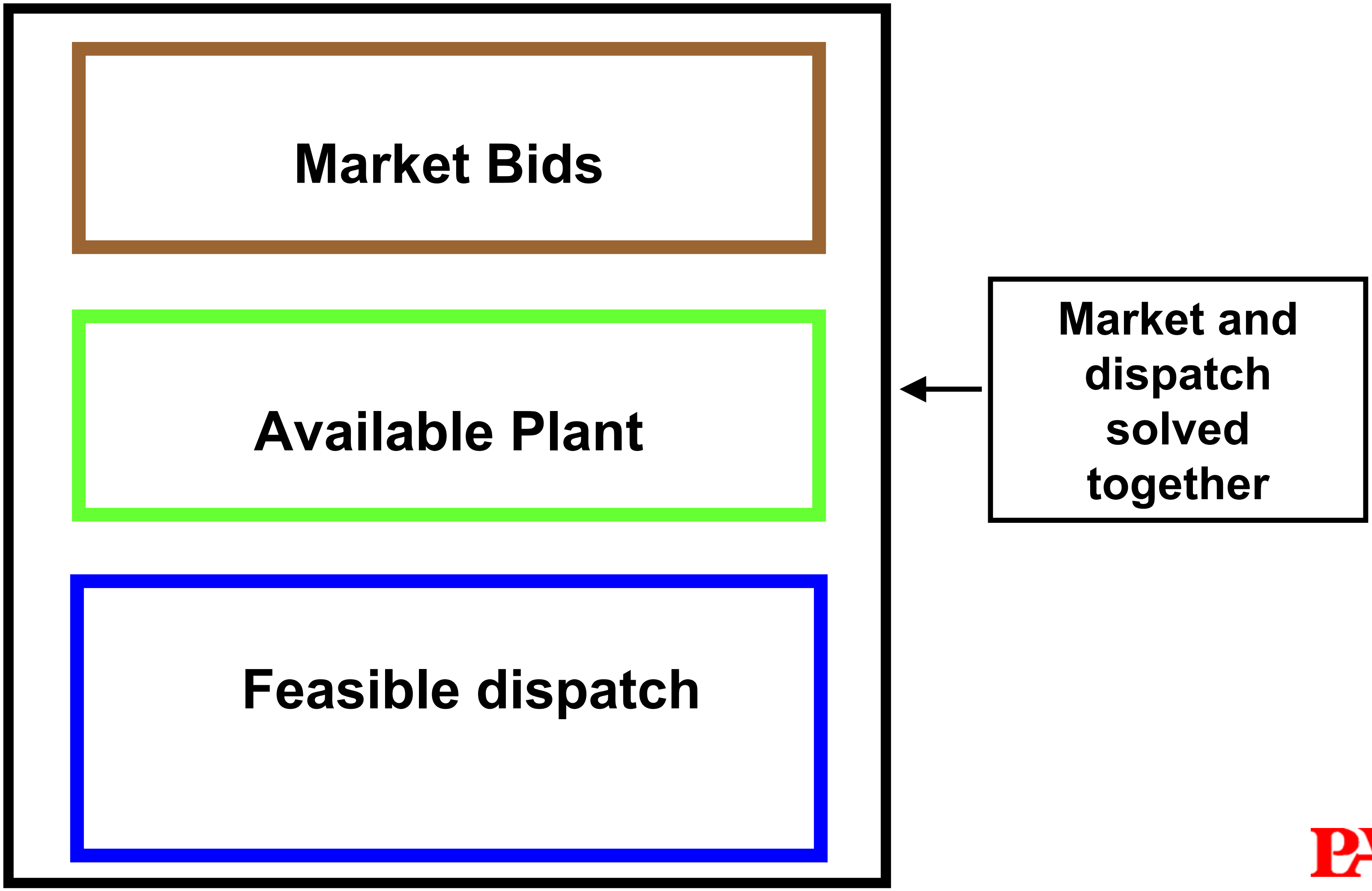
- Market cleared simultaneously solved as a “linear programming” optimisation – Market Clearing Engine (MCE)
- Market schedule automatically feasible for dispatch and optimal to the market
- Market schedule used by SMO as the physical dispatch schedule

Prices are a consequence of optimal dispatch:

- MCE automatically produces a price for every node - LMP (Locational Marginal Price)

Internationally accepted approach - simple to implement – well established software available

Feasible dispatch must account for locational issues



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Locational Marginal Pricing

Generation and load are locationally specific – accurate pricing and charging needs to account for locational differences

LMP (also known as nodal prices) are the market clearing price at each location in the grid

Each LMP:

- Is the cost of serving an increment of load at the node
- Includes
  - Congestion costs - the cost of an incremental increase of congestion
    - eg, line rental = the cost increasing a line limit by 1 MW
    - congestion rental is zero if there is no congestion
  - Losses - the cost of losses from an increment of flow

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LMP and Congestion Management

LMP uses market prices, not administrative restrictions, to manage transmission congestion:

- **The price of transmission service is based on locational price differences**
- **No need for restrictions on access to transmission grid or wholesale market**
- **No need for a separate congestion management process for system dispatch**
  - **No out-of-merit dispatch**
  - **No out-of-merit compensation payments**

Transmission losses are accounted for automatically in prices

- **No separate loss-attribution process**

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LMP and Operating in the Market

Spot market

- Each player sees the price at their own location – other prices are irrelevant to them
- Can offer / bid based on LMP and be assured of accurate dispatch scheduling
- “Well-located” players will be advantaged over “poorly-located” players

Contracting

- Locational price differences matter when dealing at a location not your own – eg contracts set at a price other than own LMP
- Manage locational price differences with FTRs

New investment

- Locational revenue will (and should) influence investments decisions

Operational Costs

- Cost of operating an LMP spot market is similar to (or cheaper than) alternatives

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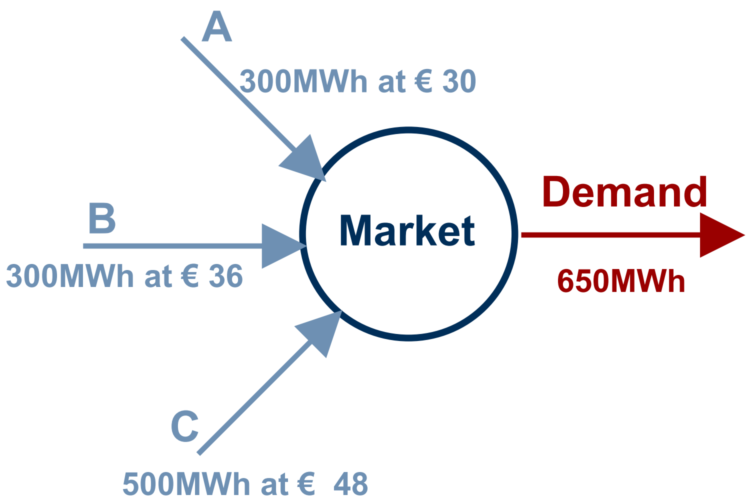
Centralised Market Example: Single Node Market

Three generating companies, with bid price at SRMC

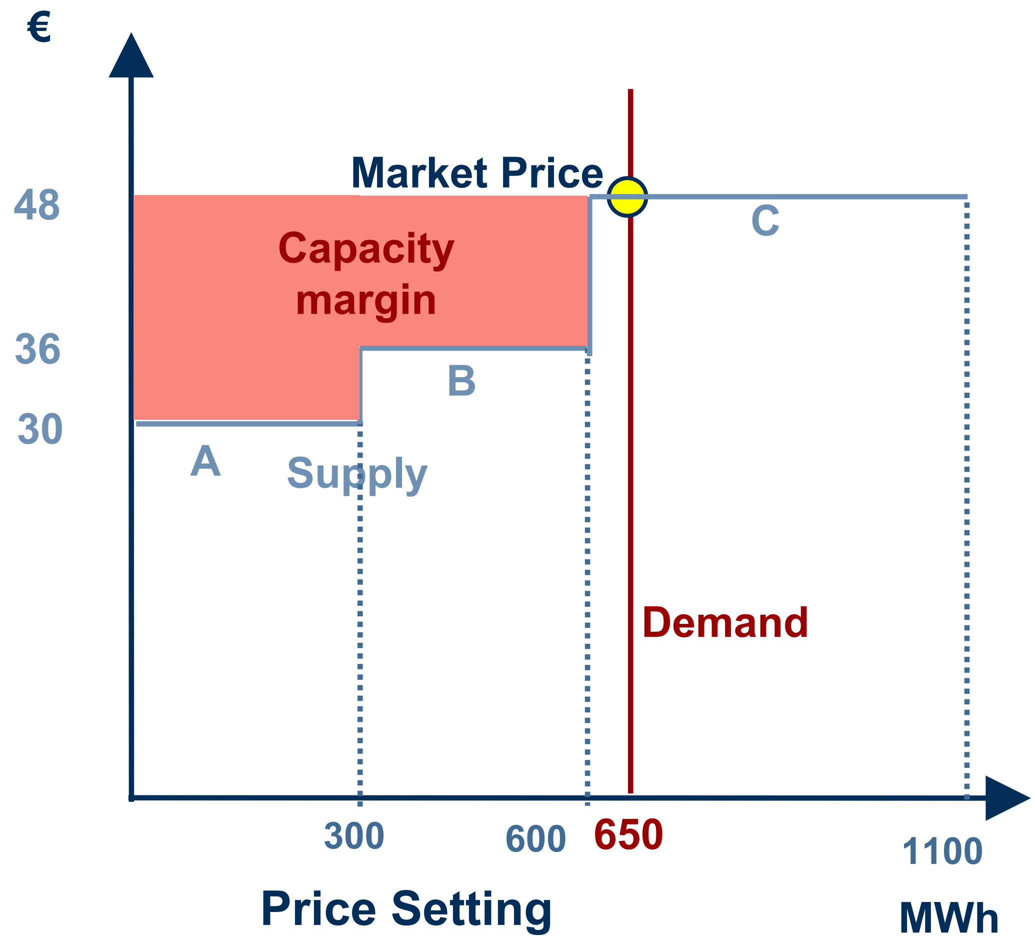
Genco	Capacity	Bid Price
A	300 MW	€ 30 / MWh
B	300 MW	€ 36 / MWh
C	500 MW	€ 48 / MWh

Demand of 650 MWh in the next 1 hour trading interval

Centralised Market Example: Single Node Market



Genco	Dispatch	Revenue	Margin
A	300 MWh	€ 14,400	€ 5,400
B	300 MWh	€ 14,400	€ 3,600
C	50 MWh	€ 2,400	€ 0



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Centralised Market Example: Two Node Market without Congestion

Market split into two "nodes" and a linking transmission line

Genco	Capacity	Offer Price	Node Association
A	300 MW	€ 30 / MWh	1
B	300 MW	€ 36 / MWh	1
C	500 MW	€ 48 / MWh	2

Transmission system between the nodes:

- Capacity of 250MW with 1% linear losses

Demand for next trading interval (hour)

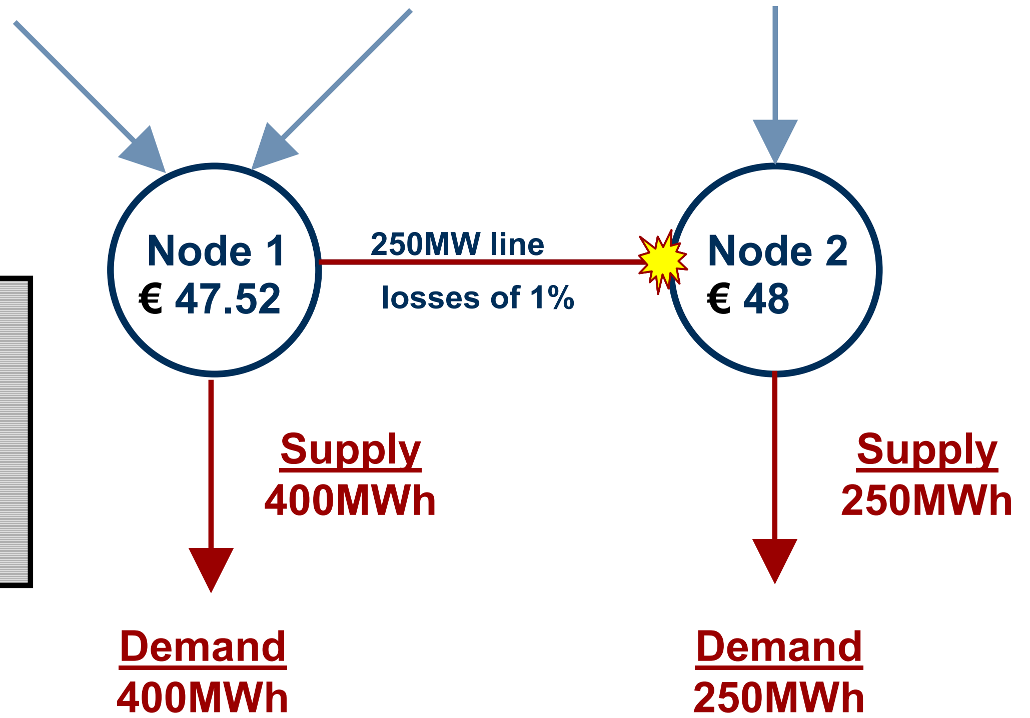
- Node 1: 400 MWh,
- Node 2: 250 MWh

Centralised Market Example: Two Node Market without Congestion

Genco A
Capacity:300MWh at € 30
Generation: 300MWh

Genco B
Capacity:300MWh at € 36
Generation: 300MWh

Genco C
Capacity:500MWh at € 48
Generation: 52MWh



Nodal price difference

= € 0.48 /MWh

Cost of losses

= € 0.48 /MWh

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Centralised Market Example: Two Node Market without Congestion

Genco	Dispatch MWh	Market Price € / MWh	Revenue €	Margin €
A	300	47. 52	14,256	5,256
B	300	47. 52	14,256	3,456
C	52	48	2,496	0
Total	652	Av = 47.558	31,008	8,712

Load	Supply MWh	Export (Import) MWh	Market Price € / MWh	Cost €
1	400	200	47. 52	19,008
2	250	(198)	48	12,000
Total	650	Av = 47.705		31,008

Centralised Market Example: Two Node Market with Congestion

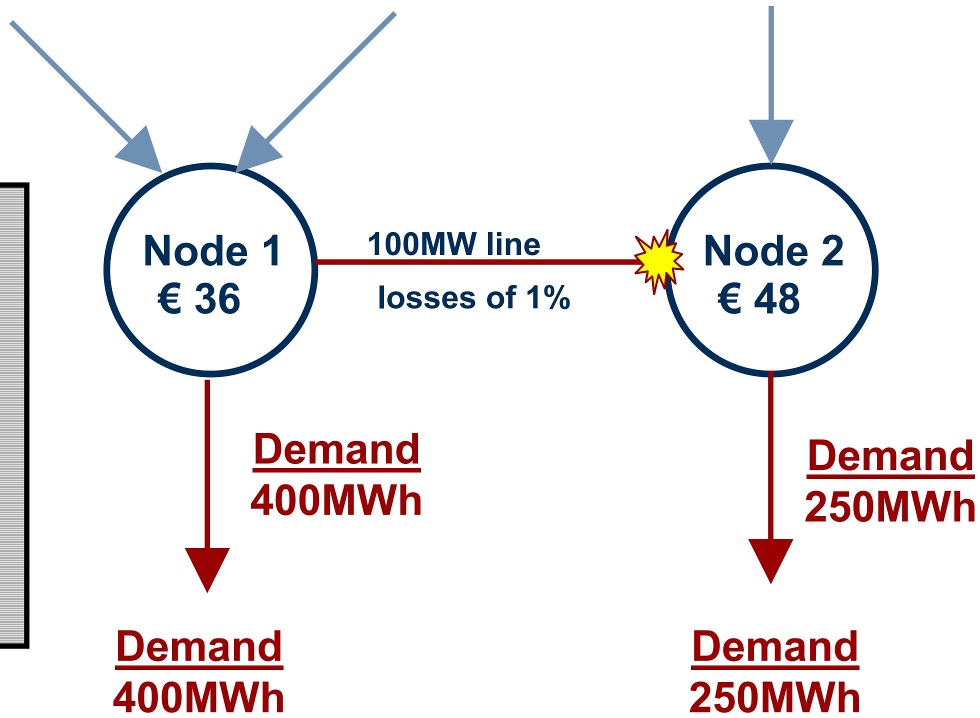
As before but with line capacity reduced from 250 MW to 100 MW – this means that the line will not be able to move power as before and is congested

Centralised Market Example: Two Node Market with Congestion

Genco A
Capacity:300MWh at € 30
Generation: 300MWh

Genco B
Capacity:300MWh at € 36
Generation: 200MWh

Genco C
Capacity:500MWh at € 48
Generation: 151MWh



Nodal price difference
= €12 / MWh
Cost of loss
= €0.48 / MWh
Settlement surplus
= €11.52 / MWh

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Centralised Market Example: Two Node Market with Congestion

Genco	Dispatch MWh	Market Price € / MWh	Revenue €	Margin €
A	300	36	10,800	1,800
B	200	36	7,200	0
C	151	48	7,248	0
Total	651	Av = 38.78	25,248	1,800

Load	Supply MWh	Export (Import) MWh	Market Price € / MWh	Cost €
1	400	100	36	14,400
2	250	(99)	48	12,000
Total	650	Av = 40.62		26,400

Settlement surplus = € 1,152 (also = 100 * 11.52)

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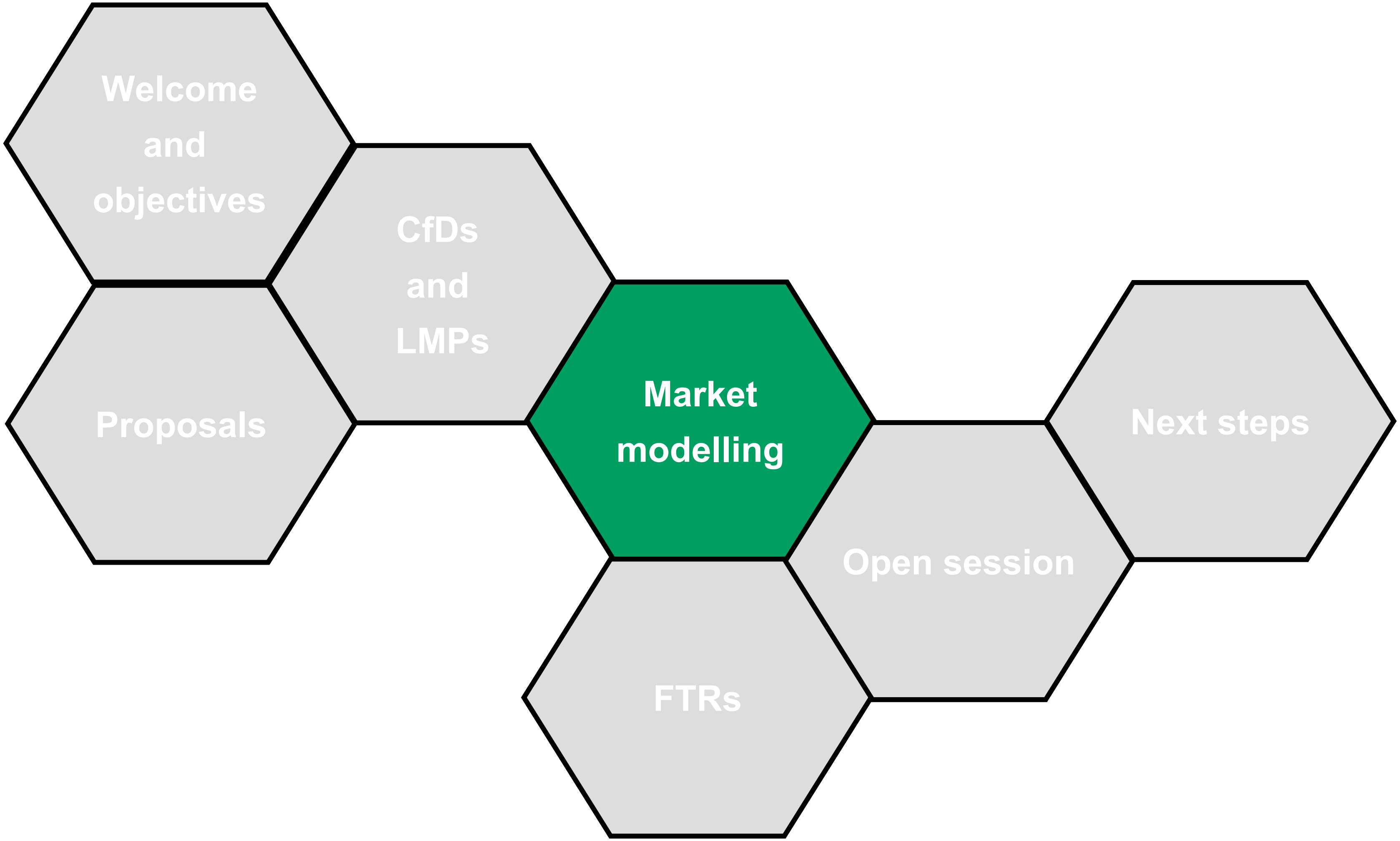
Stephen Woodhouse, ILEX Energy Consulting



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Ed Kee, PA Consulting

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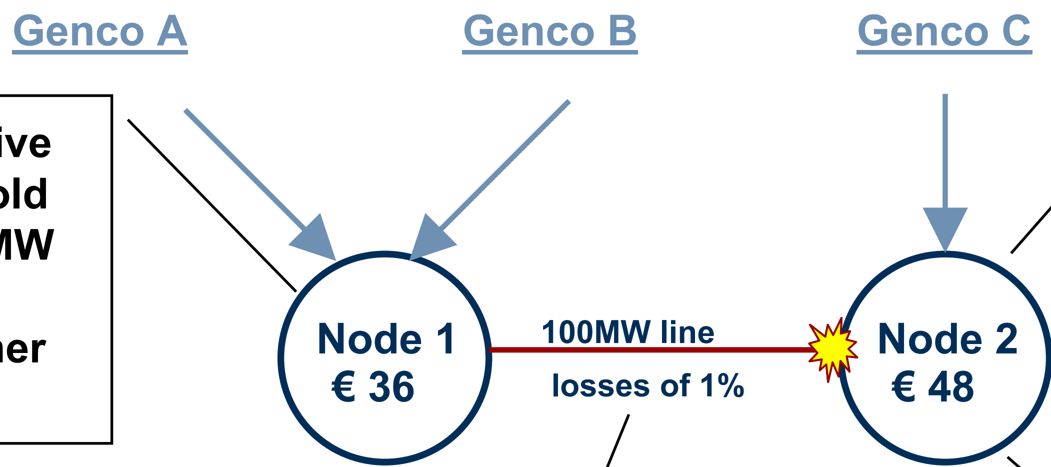
Financial Transmission Rights (FTRs) enable participants to hedge locational risk

FTRs allow hedges across nodes

Gencos A&B receive €36 for all units sold even though 100 MW (less losses) is purchased at higher priced node



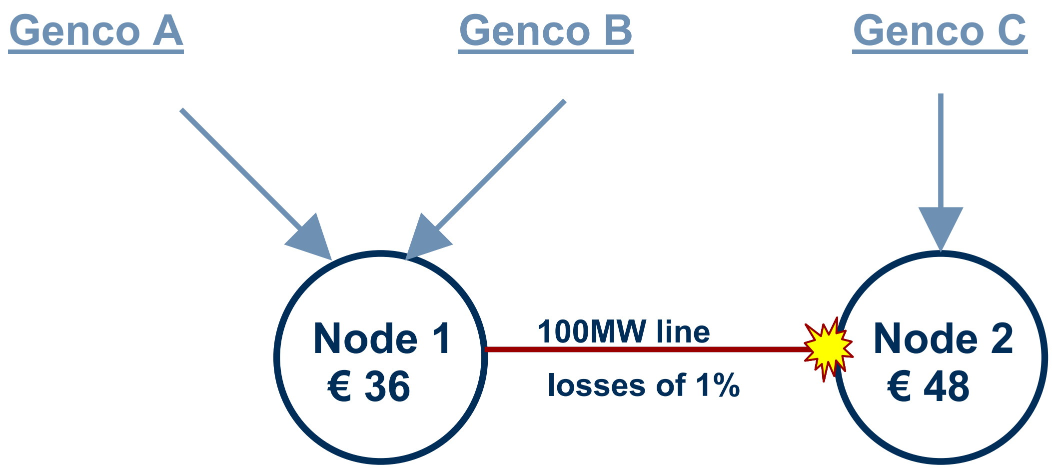
Supplier at node 2 pays €48 for all purchases

If Genco A or B had an FTR, they would be able to hedge a supplier at node 2 with no exposure to locational price risk

If either Genco A or B had a hedge contract with a supplier at Node 2 they would be exposed to the risk of prices diverging between nodes

FTR example 1

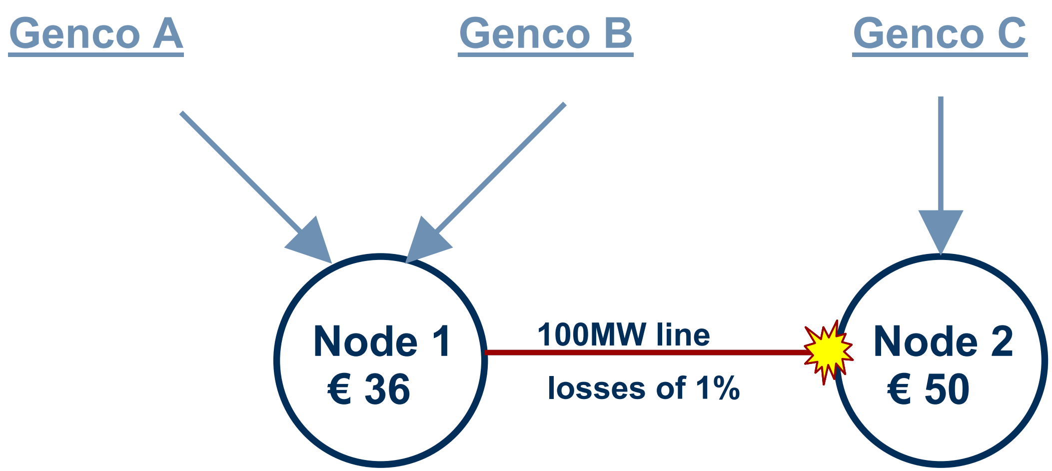
Using the same example as in the earlier LMP discussion, assume that Genco B has a CfD with a supplier at Node 2 for 100MW at € 48 and an FTR for the same volume.



Import/export quantity only	Spot market	CfD	Congestion rental	Total €
Genco B	3,600	0	1,200	4,800
Supplier	- 4,800	0	0	- 4,800

FTR example 2

Same CfD (100MW at € 48) and FTR; Node 2 price increases slightly



Import/export quantity only	Spot market	CfD	Congestion rental	Total €
Genco B	3,600	- 200	1,400	4,800
Supplier	- 5,000	200	0	- 4,800

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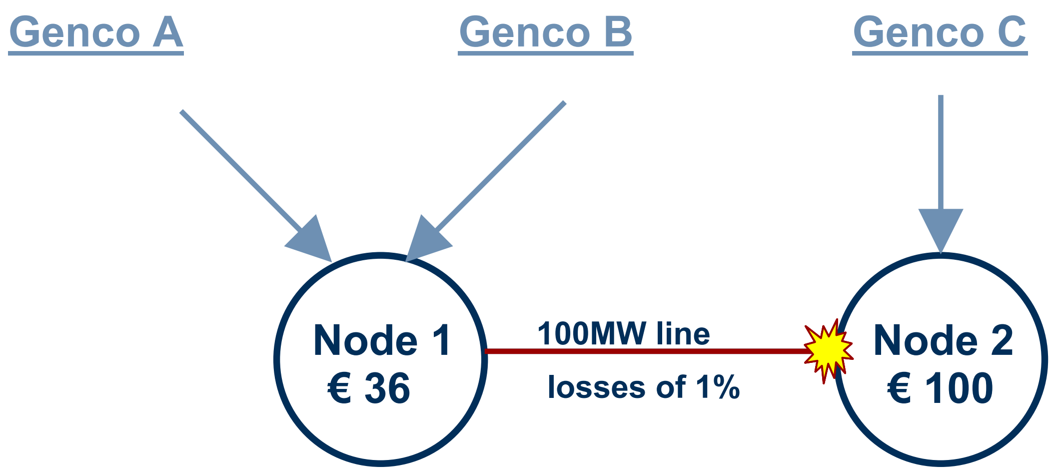
FTR example 3

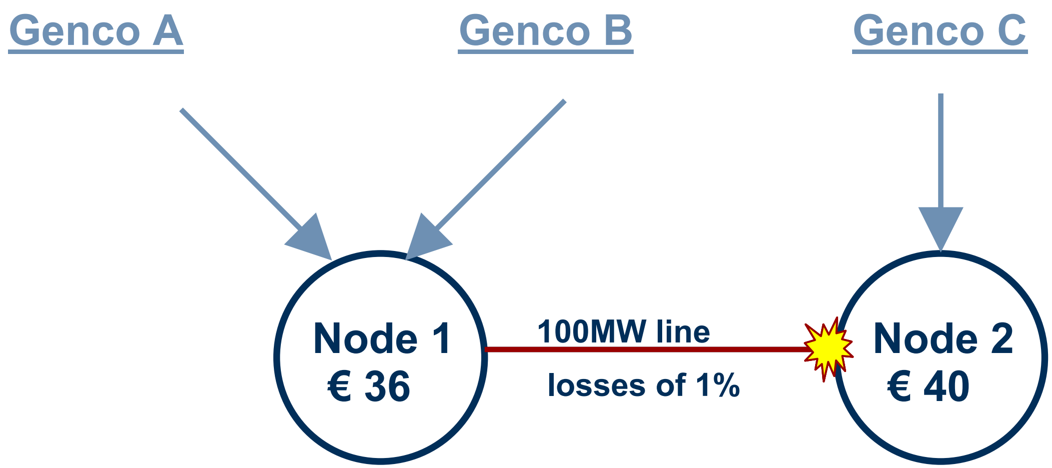
Same CfD (100MW at € 48) and FTR; Node 2 price increases a lot



Import/export quantity only	Spot market	CfD	Congestion rental	Total €
Genco B	3,600	- 5,200	6,400	4,800
Supplier	- 10,000	5,200	0	- 4,800

FTR example 4

Same CfD (100MW at € 48) and FTR; Node 2 price decreases



Import/export quantity only	Spot market	CfD	Congestion rental	Total €
Genco B	3,600	800	400	4,800
Supplier	- 4,000	- 800	0	- 4,800

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FTRs can be allocated in a number of ways

The most common ways of allocating FTRs are:

- Allocation by the regulator
- Auctioned to the highest bidder

Whichever allocation method is chosen it is important to ensure that FTRs are allocated to those that value them most to prevent market distortions.

Any revenues from FTRs could be used for a number of purposes, including:

- Reducing TUoS
- Reducing market running costs

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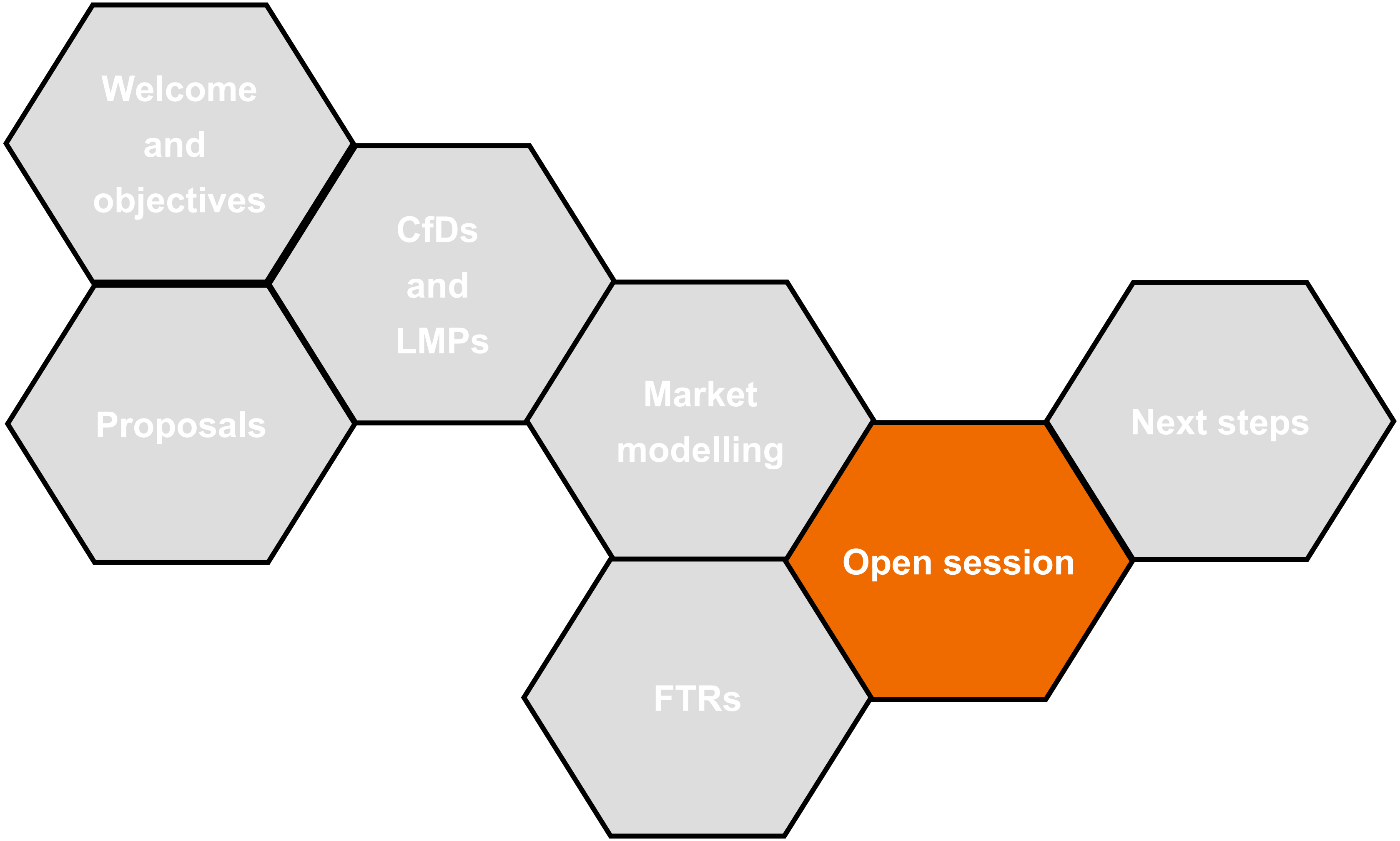

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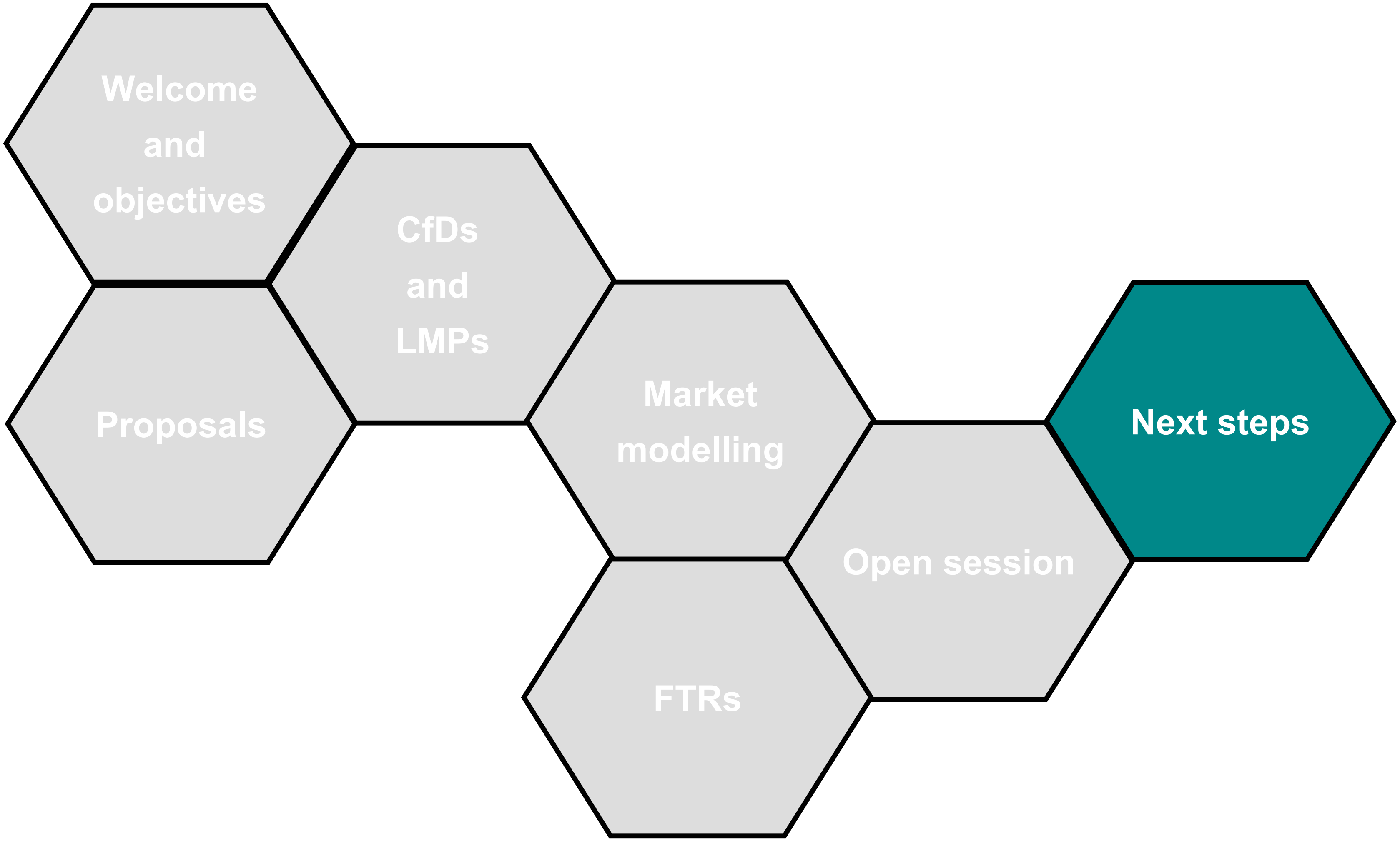
AGENDA

Keelin O’Brien, Manager Electricity Trading



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Next Steps

High Level Principles

- Comments on Proposals to CER by 16th May
- Commission Decision end May

Implementation Phase

- Details need to be Decided
- CER looking at Implementation Phase Planning
- Need for Industry Bodies in Governance Structure