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Renewable sources of energy, dispatching priority and balancing the system, facts and options: Part I

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22 May 2013

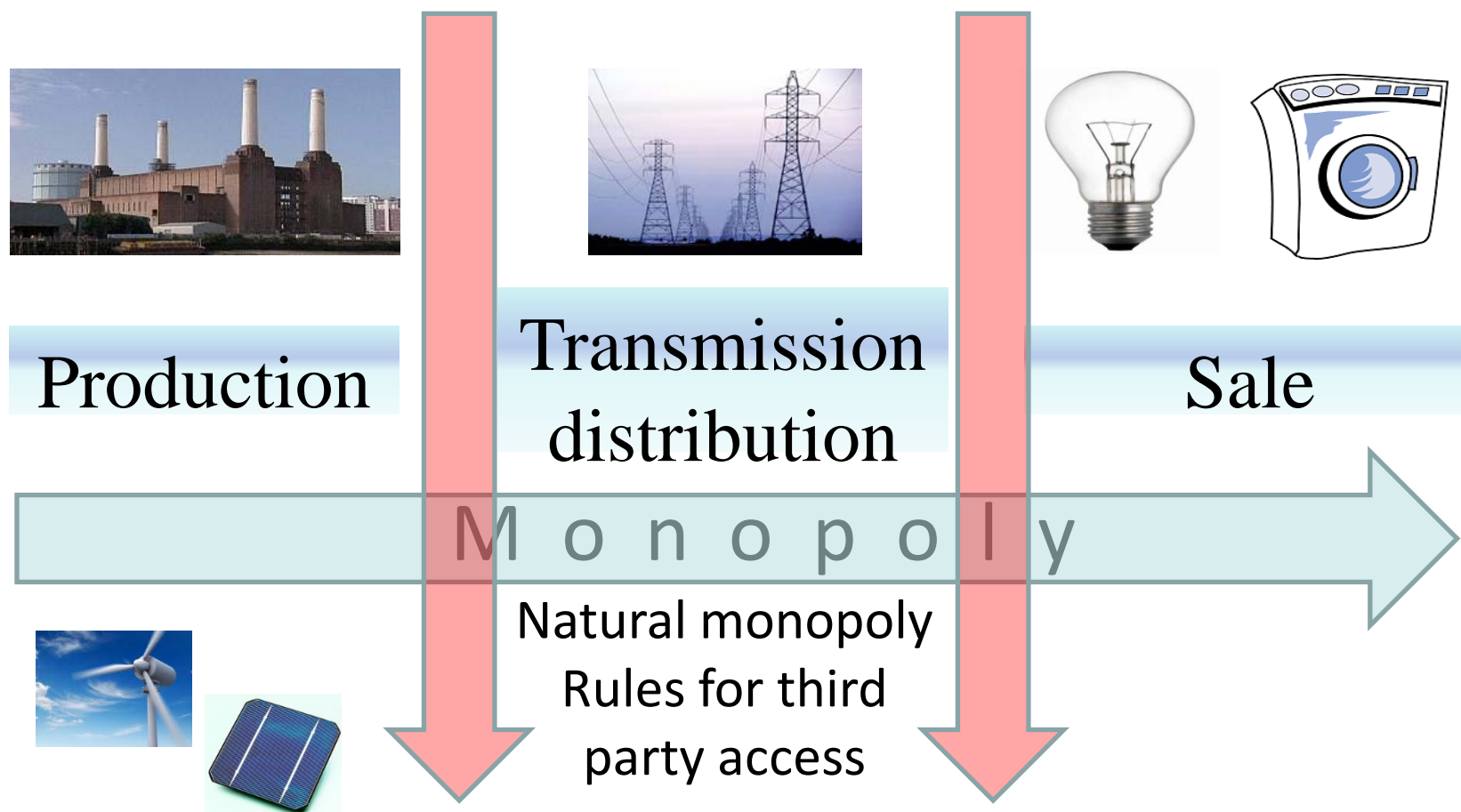


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Liberalized markets versus monopolies





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Connection to the grid

- Third Party Access right to the grid has to be regulated
- In a vertically integrated electricity system independent producers need to be protected with clear and transparent rules. In liberalized markets, the TSO is normally not used to RES, and SPP: a specific regulation needs to be introduced.
- Connection regards two stages:
 - The line from the PP to the substation
 - The grid enforcement requirement after plant/plants connection



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From the PP to the substation

- Normally the power producer pays full cost of connection. The producers need to know the costs in advance and need to be sure about the timing of connection
- The regulator may
 - Introduce standard connection costs: Connection cost may be defined in lump sum (according to km, aerial or underground line), for LV and MV connection, and be accurate for HV lines
 - Introduce a maximum time for quotation and a maximum time for final connection



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Grid reinforcement

- The producer may be asked to pay the necessary grid reinforcement (*deep connection charge*)
- The reinforcement costs are paid by the TSO and socialized into electricity tariff
- The regulator may introduce incentive for the TSO to reinforce the grid by allowing a higher remuneration on invested capital
- The TSO should follow the renewable planning and act accordingly. There is often a time lag between plant commissioning time and grid reinforcement.



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Grid access

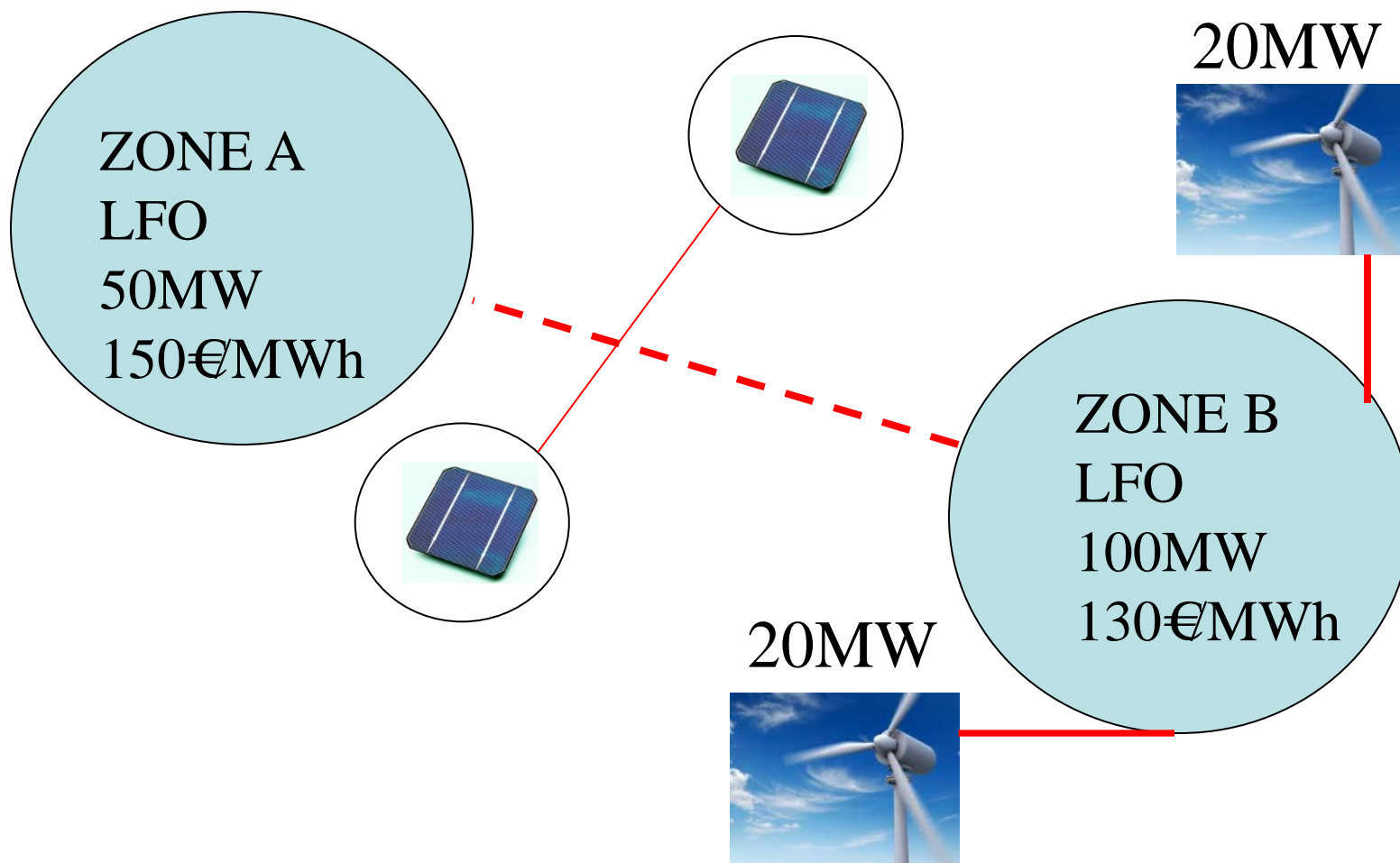
- When natural resources are concentrated in specific areas grid bottlenecks often occurs.
- Access may be given on an non-constrained approach or on a restricted queue-approach
- Curtailment rules need to be defined especially in countries with fragile grids.
- In case of queue approach the connection right may be given on
 - First time first served
 - Tendering of connection rights
- In case of first come first served maximum commitment time has to be introduced.
- This is often difficult to coordinate with licensing and planning permission.



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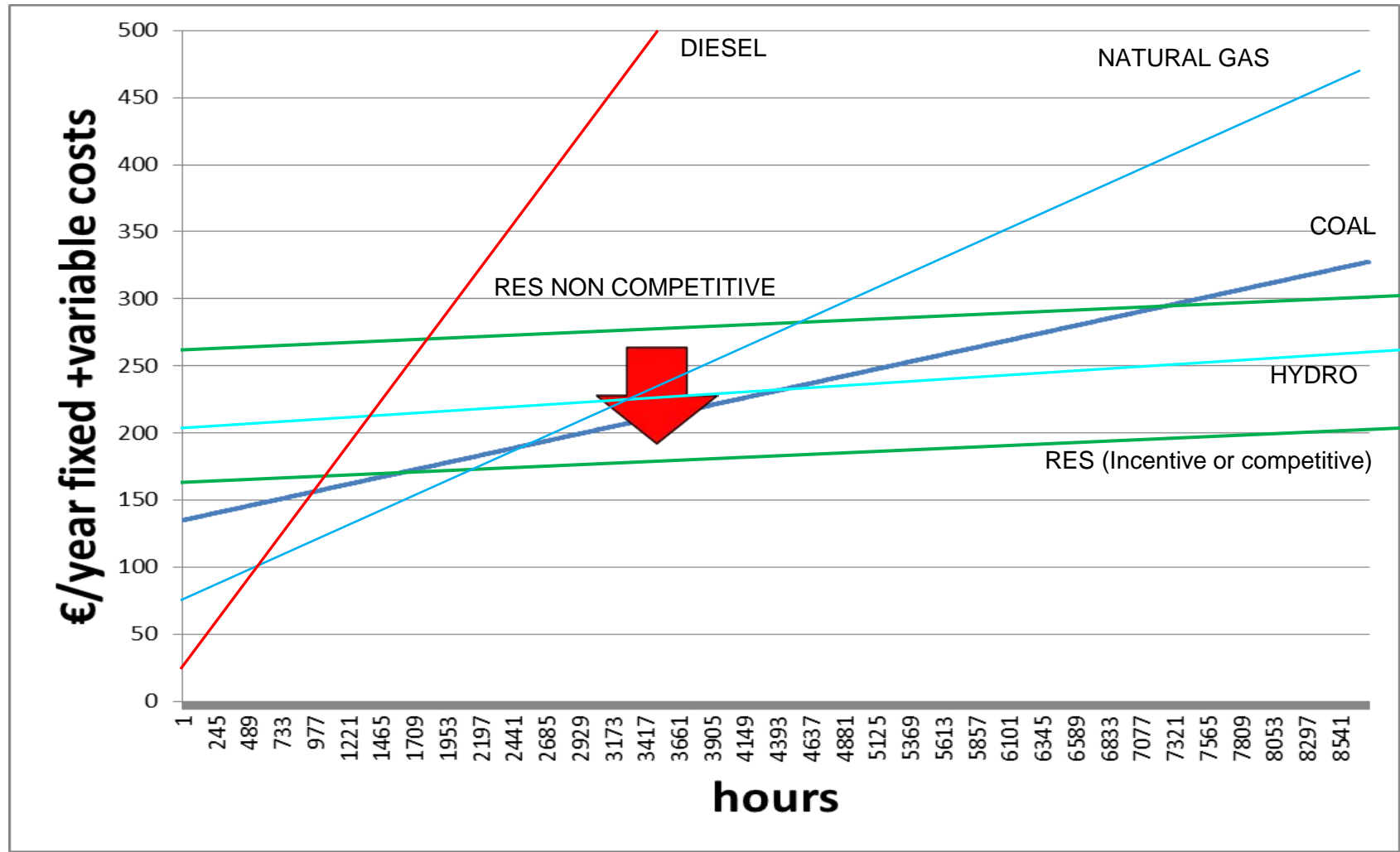


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Integrating renewables



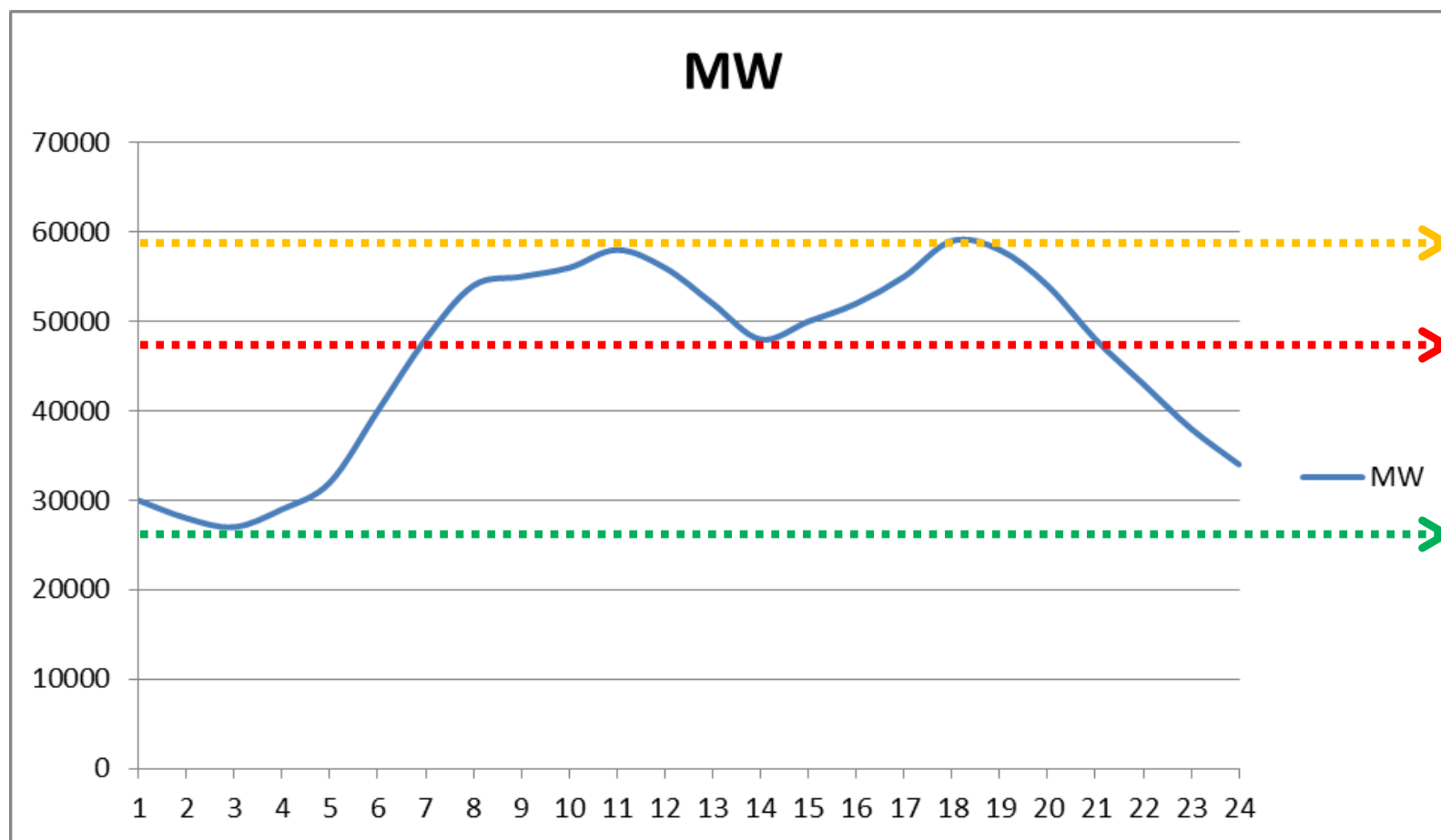


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Daily load



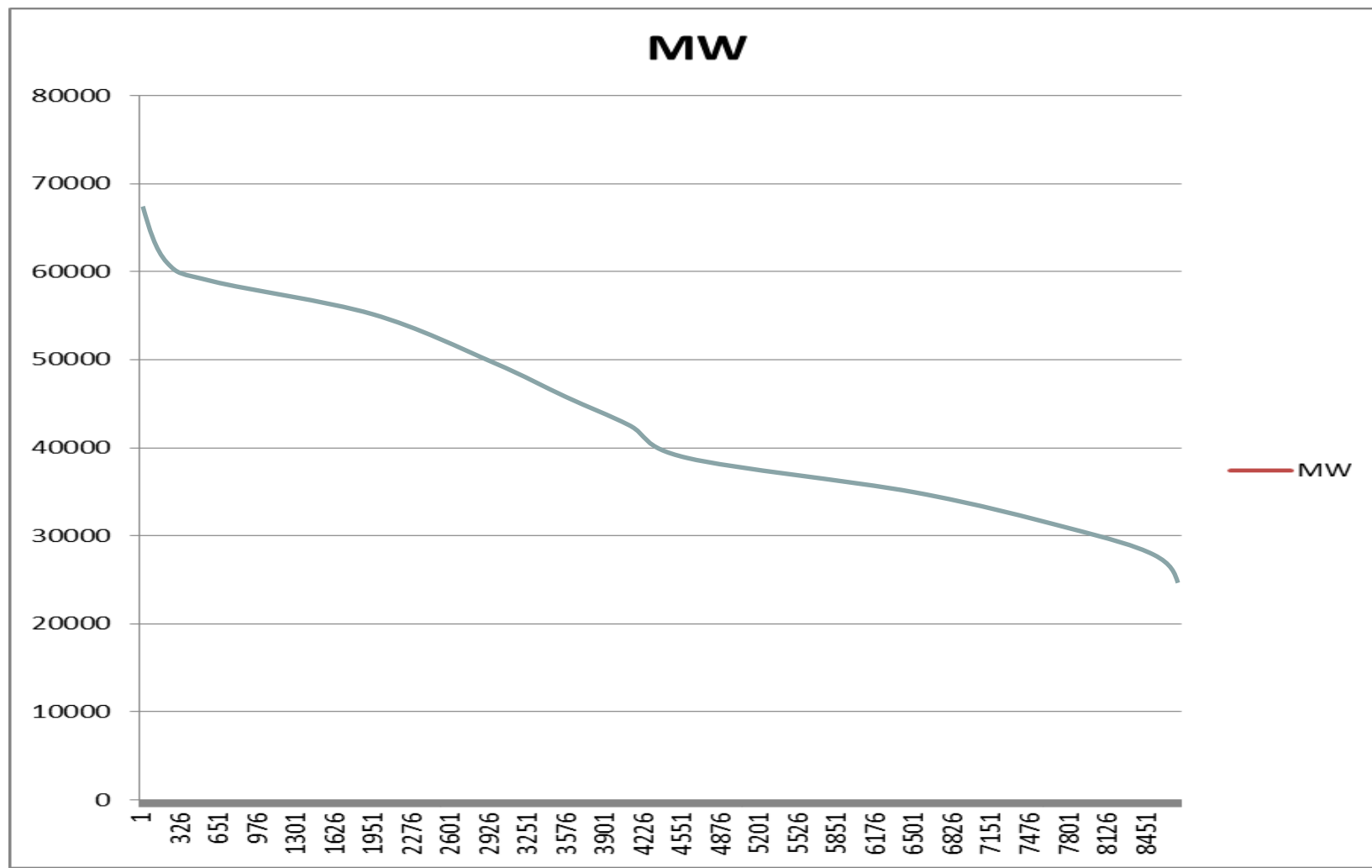


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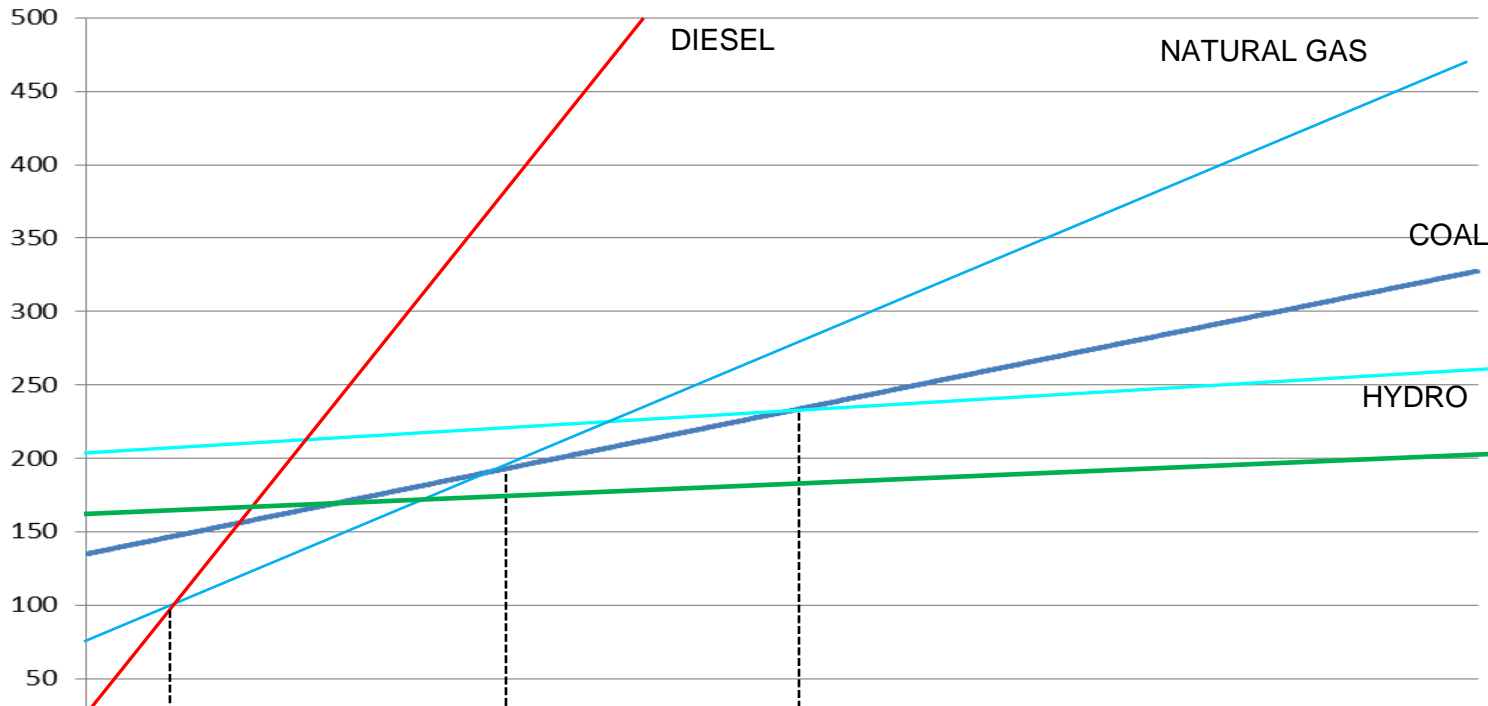


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Load duration curve



€/year fixed + variable costs



MW

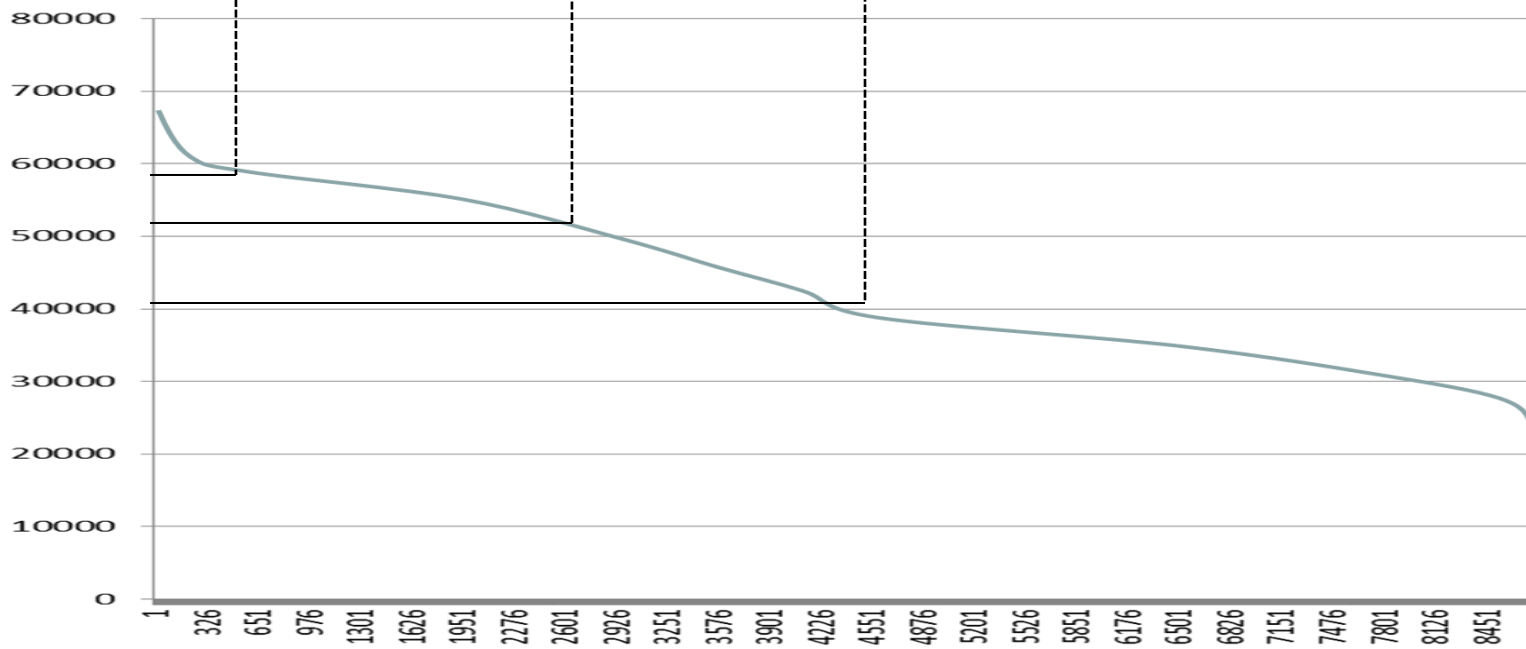
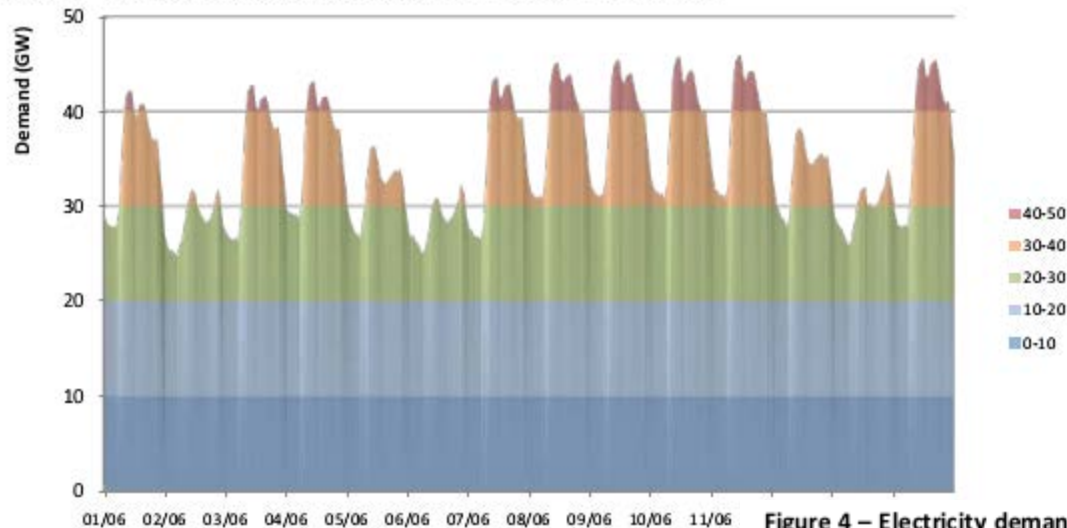


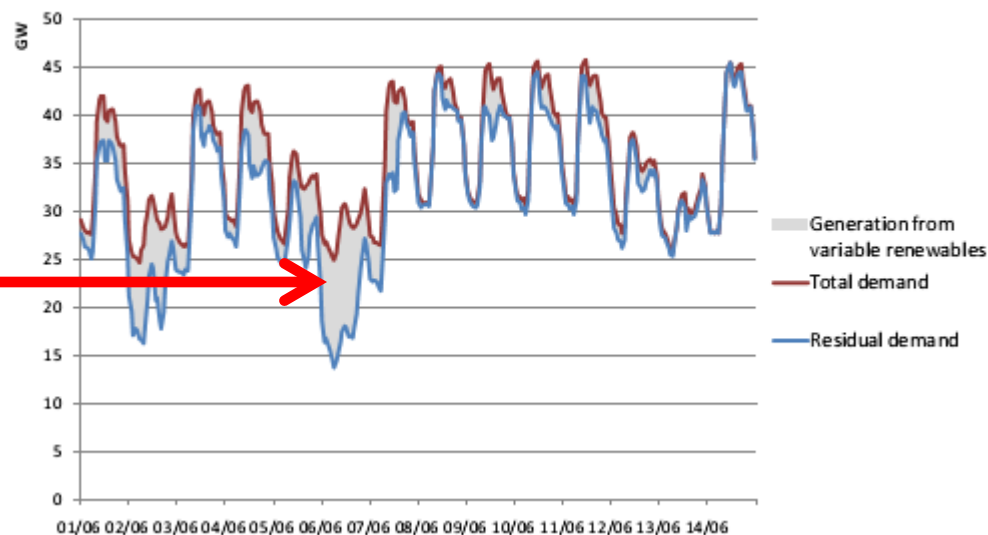
Figure 1 – Electricity demand in Italy, first two weeks of June 2010



Original data from Gestore Mercati Energetici (www.mercat)

The grey area represents the input from non predictable Renewable source of energy

Figure 4 – Electricity demand and example residual electricity demand in Italy, first two weeks of June 2010



Unpredictability and dispatching priority means that Unpredictable RES are better represented on the load curve rather than on the capacity one.

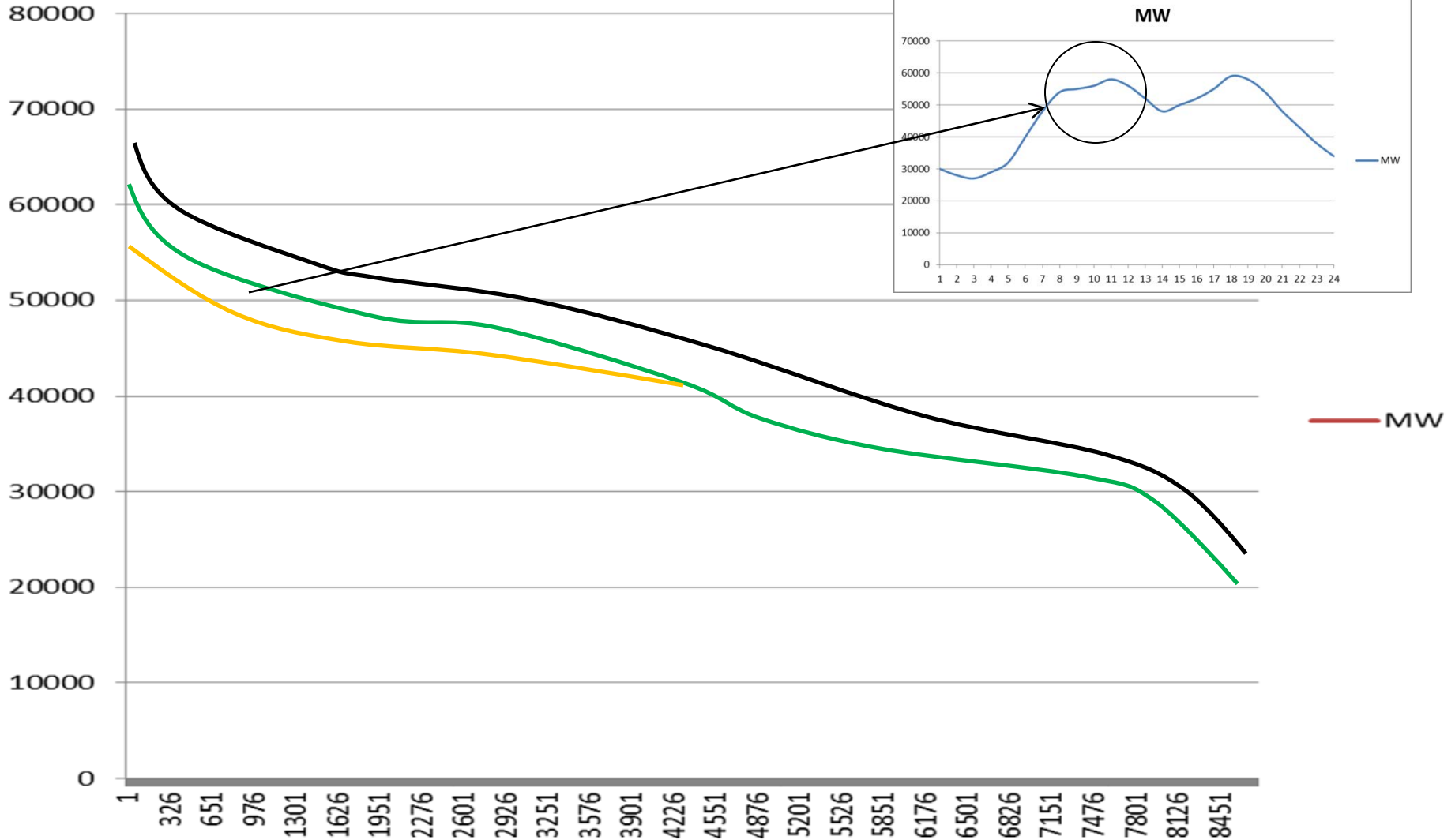


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MW





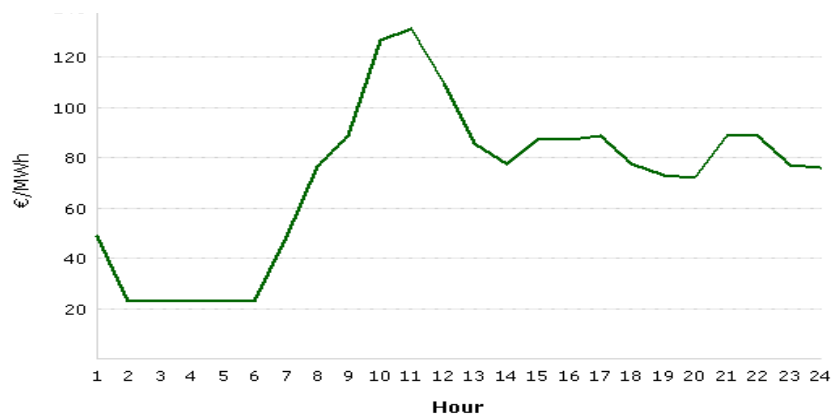
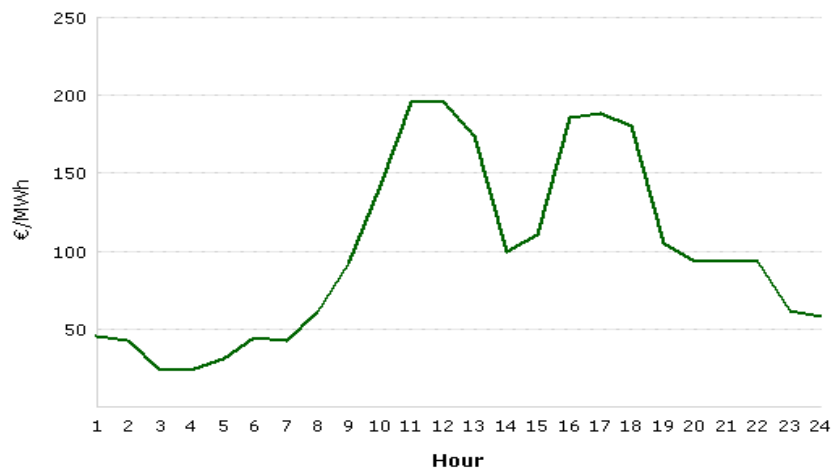
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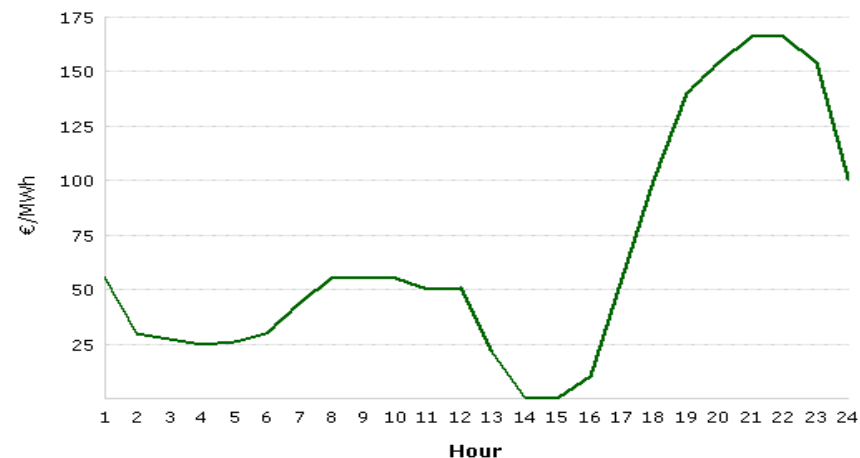
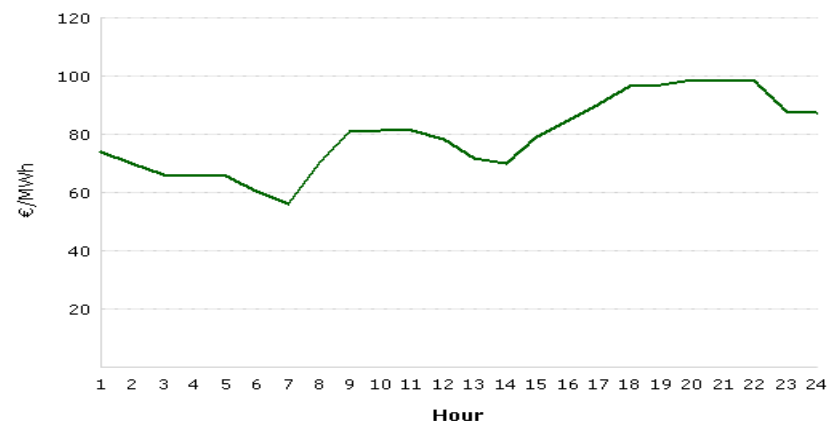
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Integration of PV system in Italy impact on pool prices (Italy 18 July 2007-2012; Sicily 16 May 2007-2013)

Zone: Italy



Zone: Italy



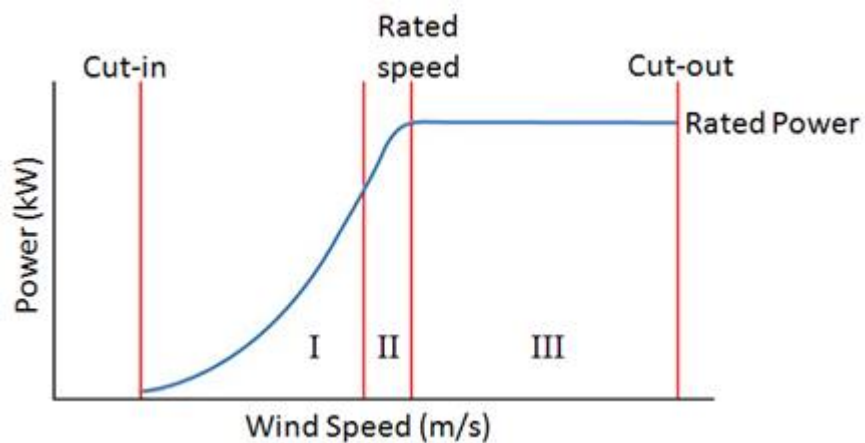


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Wind cut-in and cut out

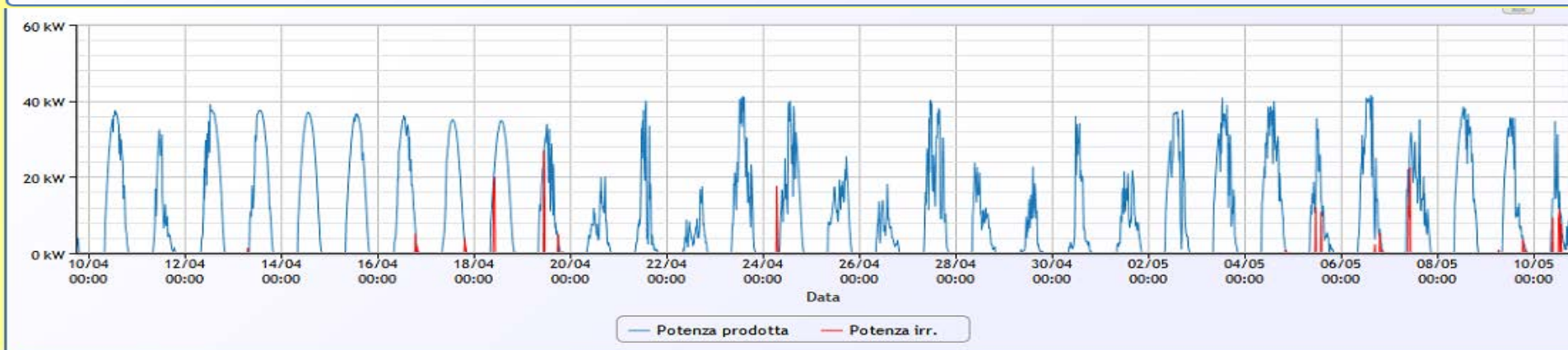
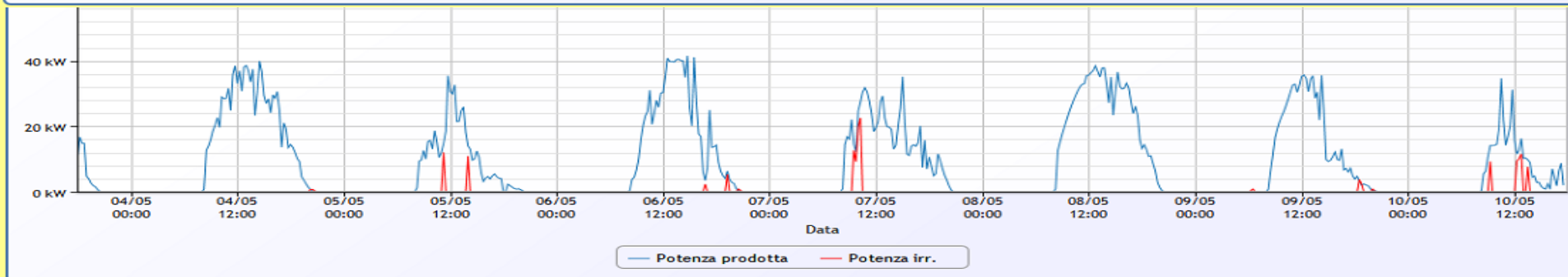
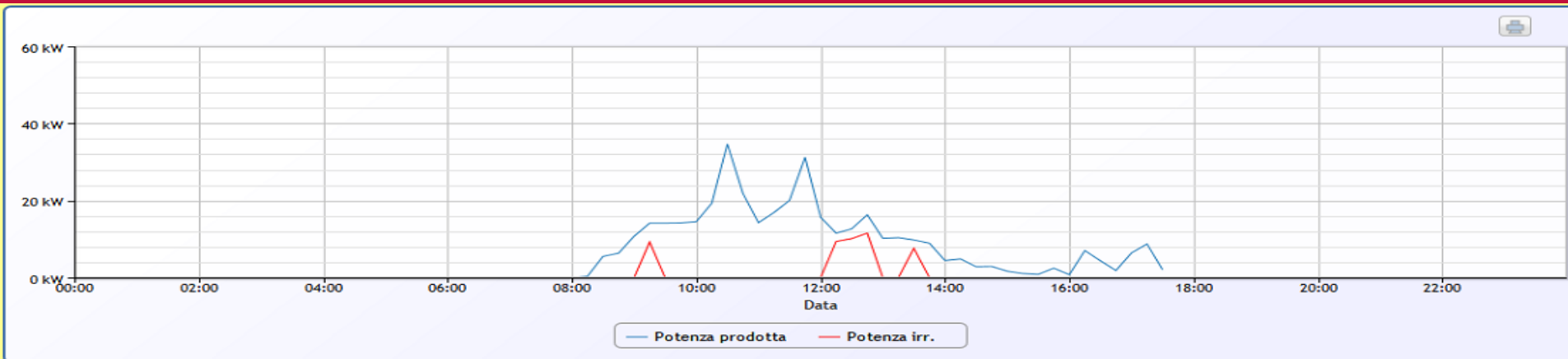




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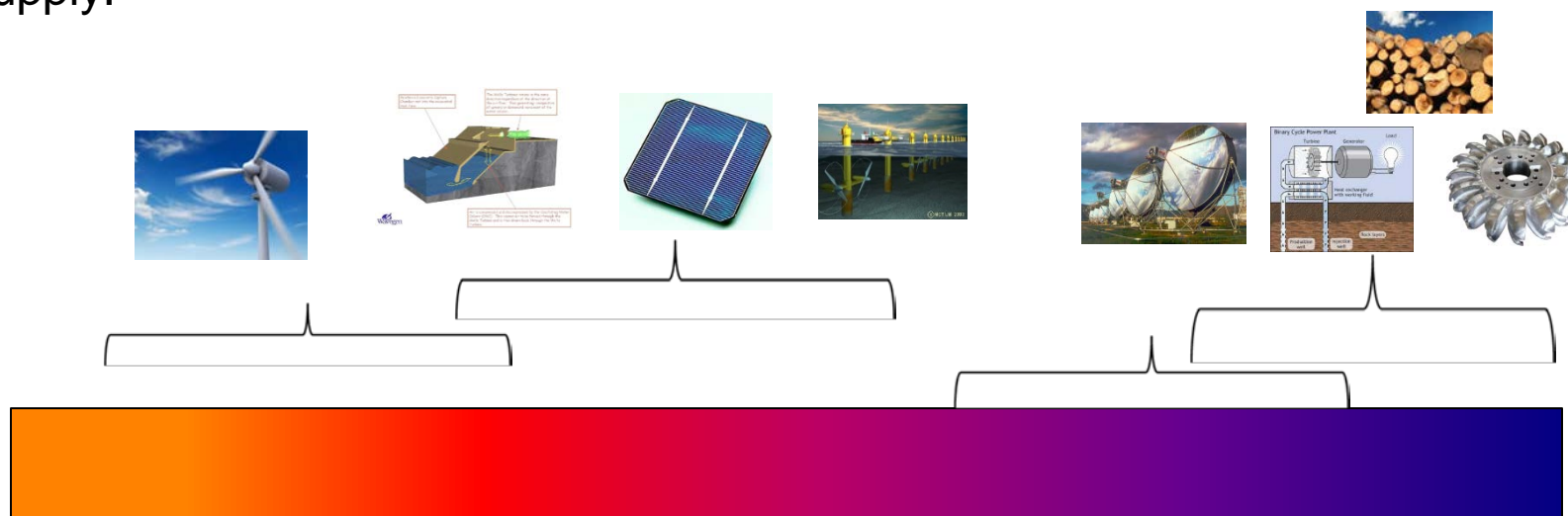


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Capacity credit

Capacity credit is the peak demand less the peak residual demand, expressed as a percentage of the variable renewables installed.

As a general rule low capacity credit renewables should not exceed 20-30% of load in order to guarantee “acceptable” standards for security of supply.



0%

100%



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Integrating renewables into electricity market

There are a number of instruments to regulate the integration of res into electricity market with particular reference to the unpredictable nature of the system.

- Improve communication between the TSO and RES producers (weather forecast, monitoring)
- Increase and improve interconnection
- Increase storage (hydro or batteries)
- Introduce economic signal to price fluctuation
- Curtail RES or load to balance the system
- Increase generation capacity with higher flexibility (NG)



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Increase interconnection

- Highly interconnected systems are more stable than small ones. Denmark has met 100% of hour demand with wind power without security of supply concerns given the large availability of interconnection. Reinforcing interconnection is probably the most efficient solution for RES integration.
- Possible regulatory instrument to increase interconnection are: higher cooperation at regional level; higher remuneration on capital given to new transmission lines;
- Fluctuation will be transferred to neighbor countries. This may cause regional problems.



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Storage

Storage infrastructure (hydro or batteries) may be considered as reserve capacity. They can be directly managed by the TSO.

Storage can be remunerated as a transmission infrastructure. Development costs are hence transferred into final tariff independently from the time of use.

In isolated contexts the installation of storage batteries poses additional regulatory complication in setting tariffs.

Block tariff can be used as a component for the remuneration of battery storage systems.

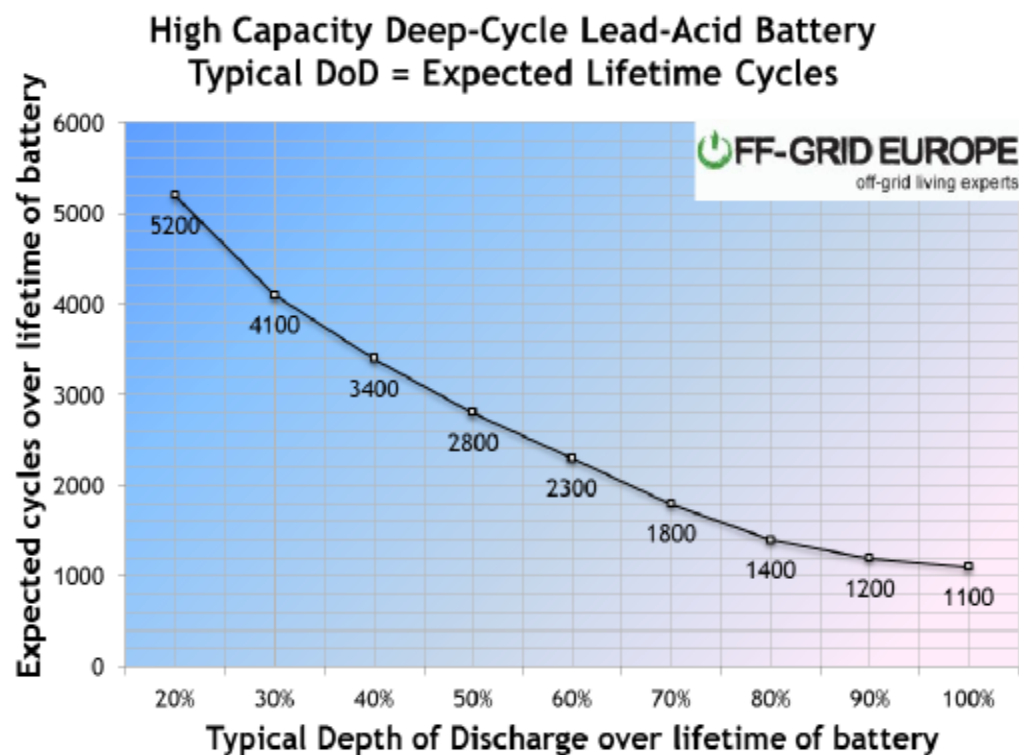


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Regulating storage in off-grid systems



Battery life span changes according to number of discharge cycles and depth of discharge. The deeper the discharge the shorter the life span of the battery. This can be transferred into a block tariff system.



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Off grid / peripheral areas

Electric systems that can accept lower levels of overall reliability may be able to manage the integration of RE into electrical power systems at lower costs than systems that demand higher levels of reliability, creating a trade-off that must be evaluated on a case-by-case basis.



Introducing peak hour incentive only

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Time of production FIT/premium may be introduced in order to orient programmable RES to produce during peak load

Year kWh generation	Peak hours	Base load
Up to 1 million	$(28,39 - P_p) / P + P_p$	P_p
Over 1 up to 2 millions	$(21,80 - P_p) / P + P_p$	P_p
Over 2 up to 3 millions	$(19,94 - P_p) / P + P_p$	P_p
Over 3 up to 4 millions	$(18,87 - P_p) / P + P_p$	P_p
Over 4 up to 5 millions	$(17,94 - P_p) / P + P_p$	P_p
Over 5 up to 10 millions	$(16,49 - P_p) / P + P_p$	P_p
Over ten millions	$(15,01 - P_p) / P + P_p$	P_p

- P_p is the pool price
- $P = 0.409$ (ratio of peak hours / 8760)



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Curtailments

- When non programmable renewable inputs exceed the capacity of the system to provide adequate reserve, curtailments rules have to be introduced.
- This can happen even if the renewable incentive scheme has posed a % cap over the development of non prog. RES. For instance if a technology reaches the grid parity, or if the natural resource (wind) is concentrated in some areas with a weak grid (bottle necks).
- Zone slots of MW may be allocated.
- In some cases curtailment occurs because of grid outages. Curtailment may significantly reduce the load factor of a technology. A specific regulation should be in place to reduce investment risk.



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Possible compensation for curtailments

- In case of grid outages a compensation may be given to the renewable producer, this increase overall costs. Alternatively the incentive period/PPA may be extended for a period long enough to compensate the avoided production. (ie: $\text{Compensation} = \text{time of curtailment} \times 8760 / \text{average technology load factor}$)
- In case of excess of capacity not all RES plants need to be curtailed. The incentive may be reduced for those dispatching electricity and savings assigned to curtailed ones as compensation.
- It is also possible to introduce compensation for voluntary curtailments of final consumer (high load ones) who accept to be curtailed at a given price.



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Natural gas

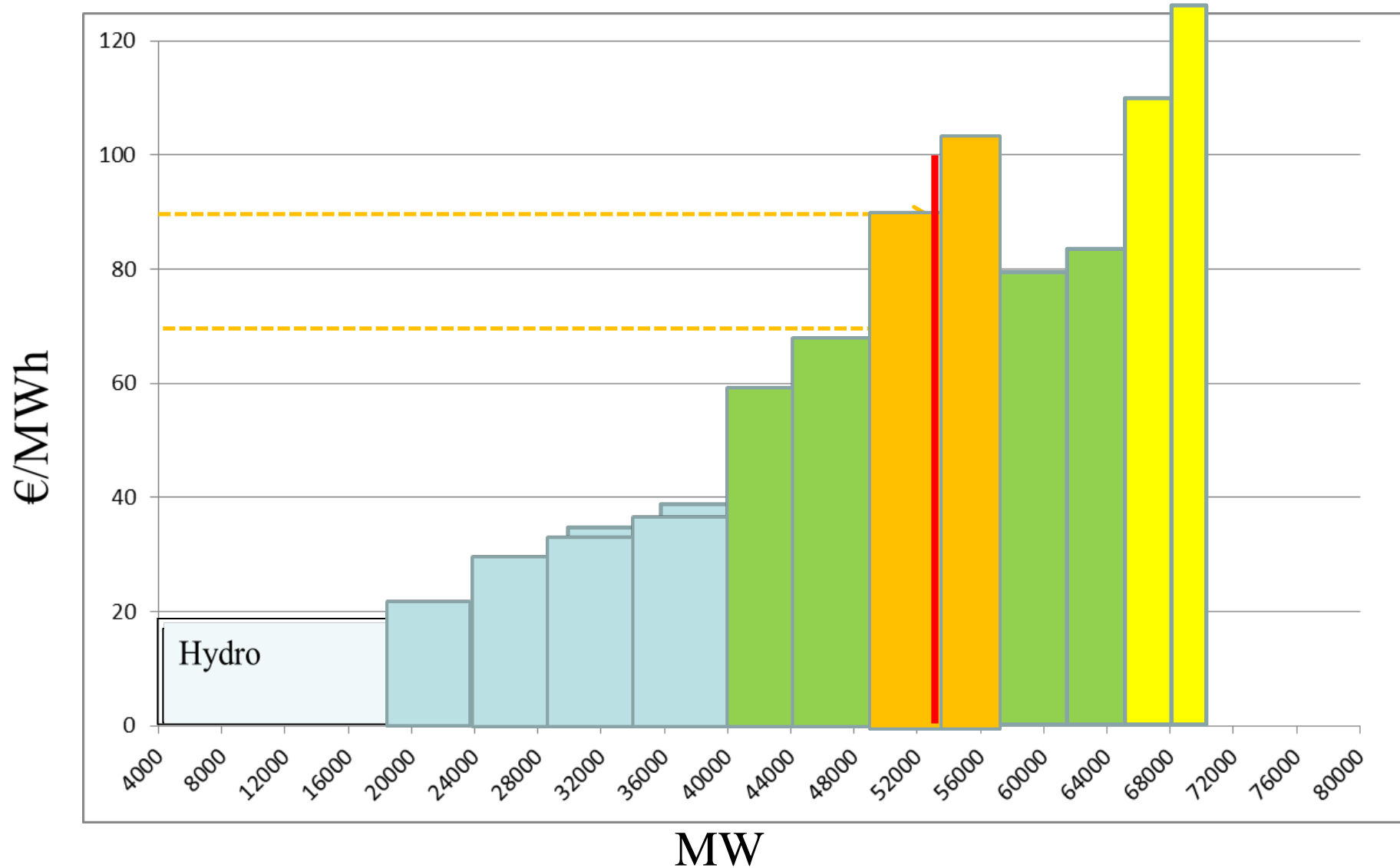
- Combined Cycle Gas Turbines are efficient and have short ramping time. They are a flexible technology with relatively low capital costs.
- CCGT are the ideal companion to respond to RES fluctuation



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Balancing cost +

- Balancing costs can be socialized, they can be paid by the TSO or by public utilities and then transferred to final tariff.
- Incentive/fine mechanisms may be introduced in order to stimulate accurate weather forecast and plant management to reduce as much as possible avoidable fluctuations.
- Cost are transferred to renewable producers through a balancing cost mechanisms. Cost may varies according to balancing services offered by other operators and by the overall balance of the area.



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Balancing cost for renewable producers

Sign of the area	Renewable producer balance
+	+ the producer is supposed to pay full balancing service
	- The producers is compensated as his <i>mistake</i> has improved the overall balance
-	+ The producers is compensated as his <i>mistake</i> has improved the overall balance
	- the producer is supposed to pay full balancing service