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Mechanisms to support the Balancing and Scheduling practices

Workshop on Forecasting, balancing and scheduling of renewable energy in India

Dehli, May 5. / 6., 2014

Dr.-Ing. Karsten Burges

Scheduling and balancing with high shares of renewables is a **regulatory challenge** rather than a technical (or scientific) one.

Interpretation of 'balancing' depends on context.

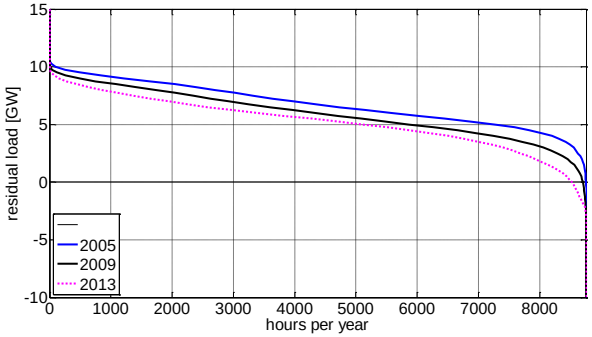
- The obvious interpretations:
  - **Scheduling dispatch** day ahead: preliminary equilibrium of load and generation
  - **Regulation and control reserves** in real time: compensation of instantaneous imbalances. These may result from unexpected outages or forecast errors.

- Less obvious interpretations:
  - Balance needs to be adjusted **regionally**: redispatch beyond market settling
  - Guaranteeing **system adequacy**: the investment perspective

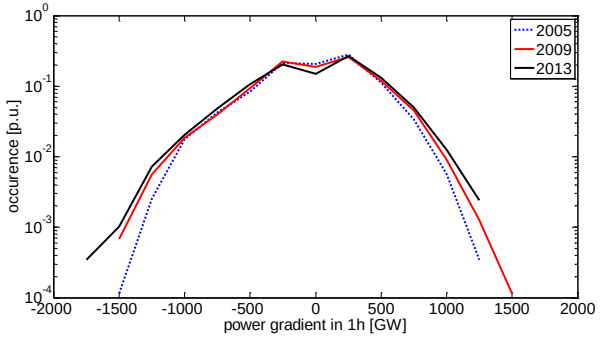
Balancing is particularly related to renewable generation because:

RES-E is

- non dispatchable



- fluctuating and, thus, predictable with limited accuracy for 1 h



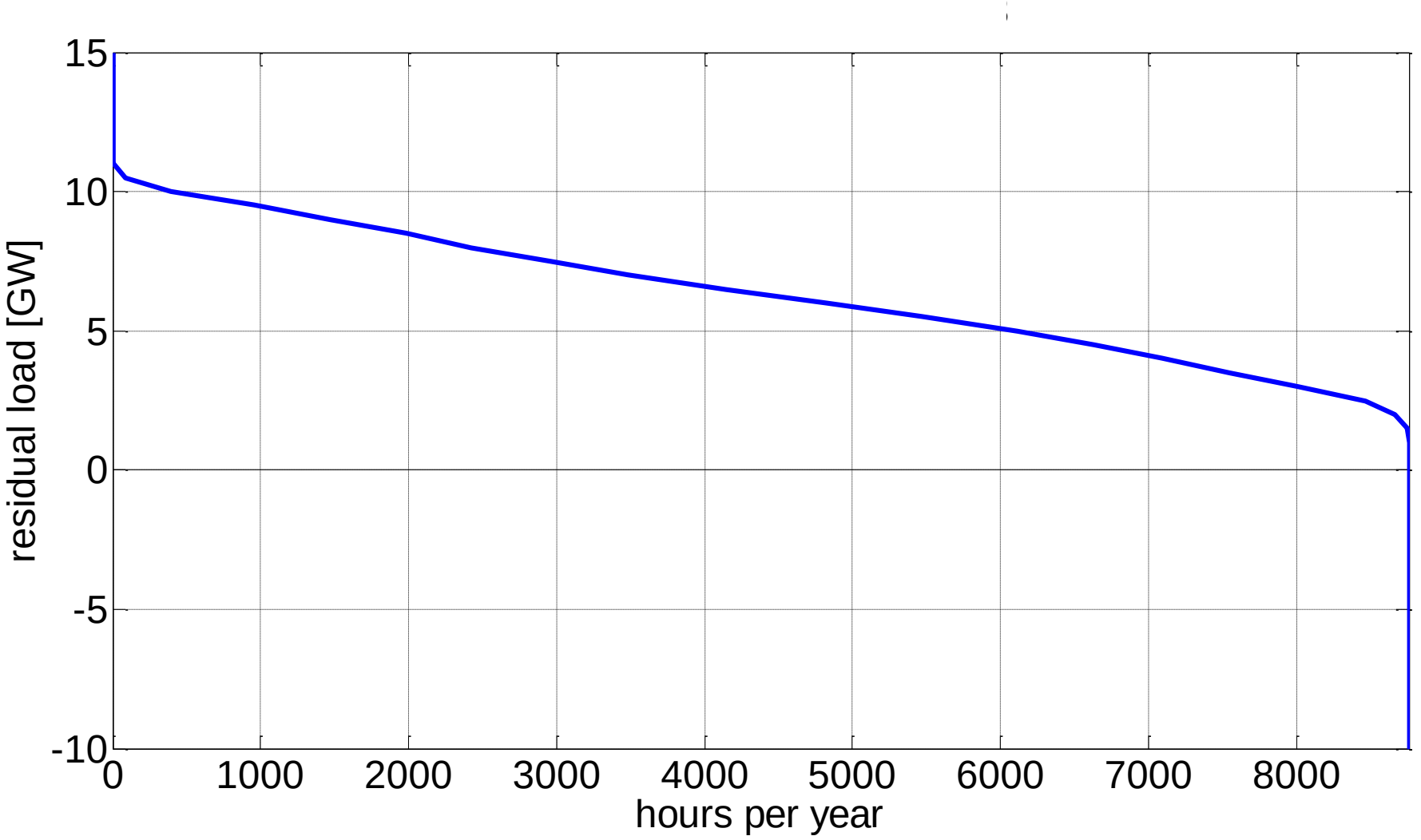
- RES-E is installed remotely with respect to load

Dispatchable plant needed for

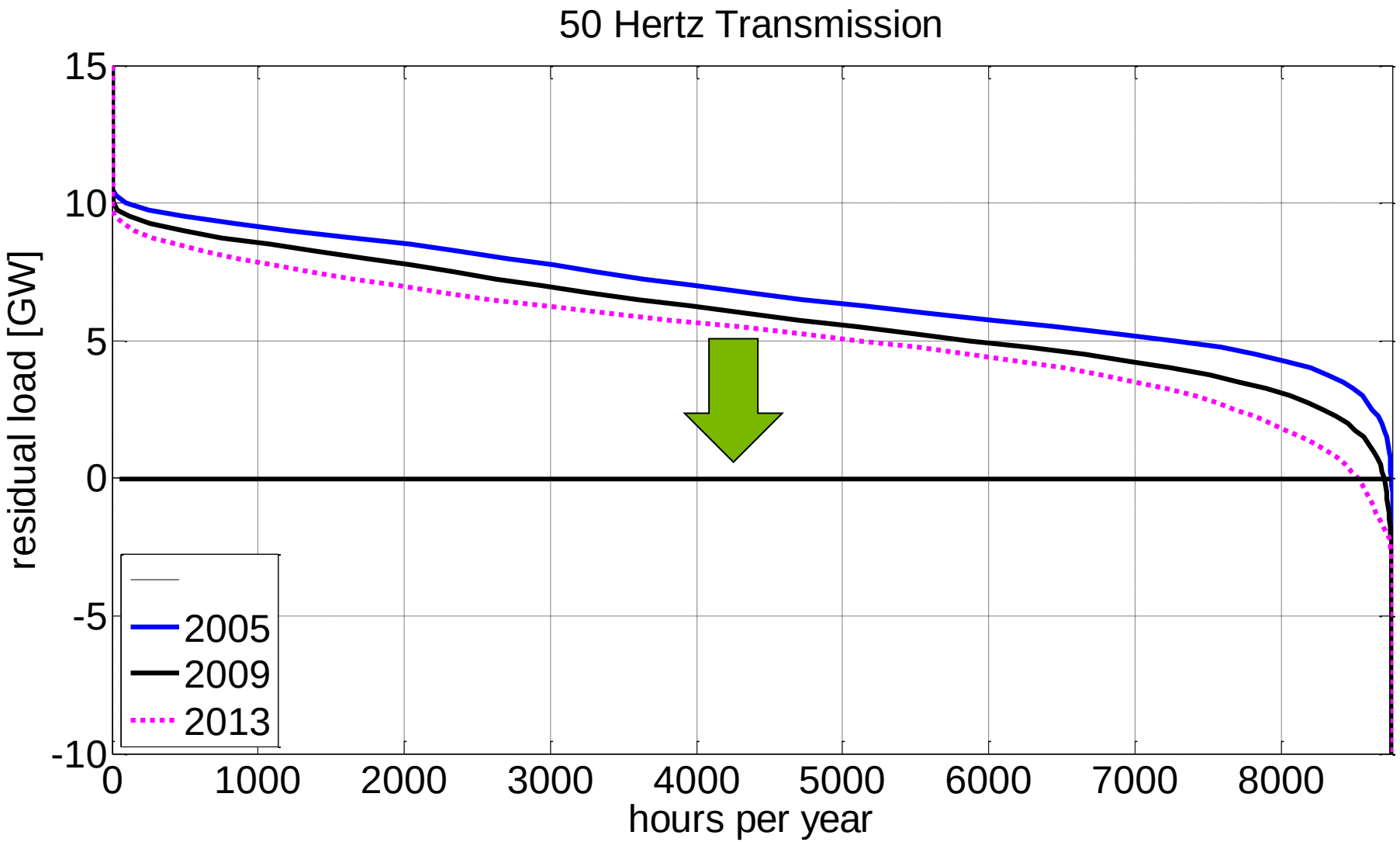
- equilibrium of load and generation
- compensation of forecast errors and outages
- Increased needs for transmission capacity

THE SCHEDULING PERSPECTIVE

The (residual) load duration curve of a TSO in Germany, 2003:



Growth of embedded generation shifts the **load duration curve of the residual load** downwards.



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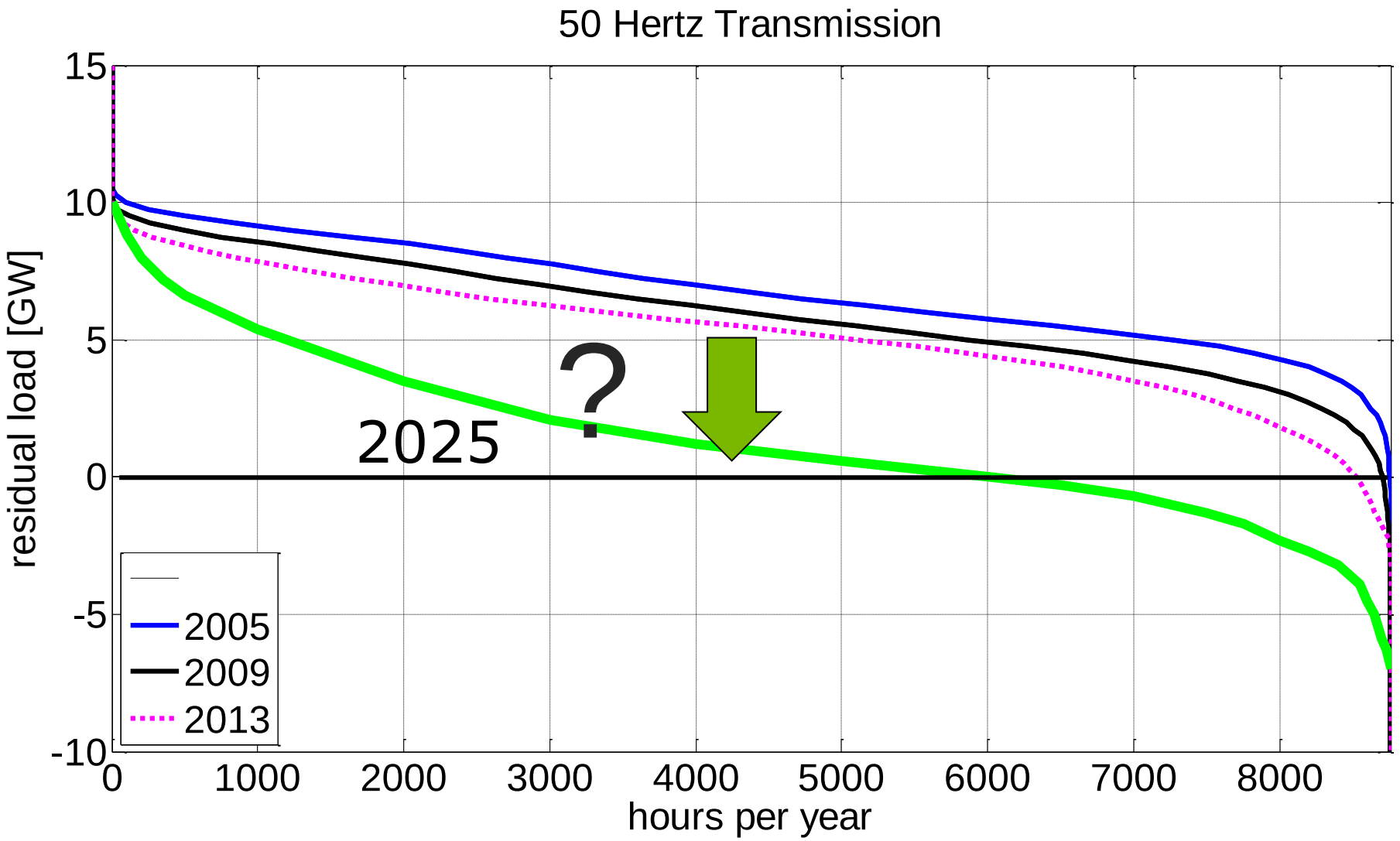
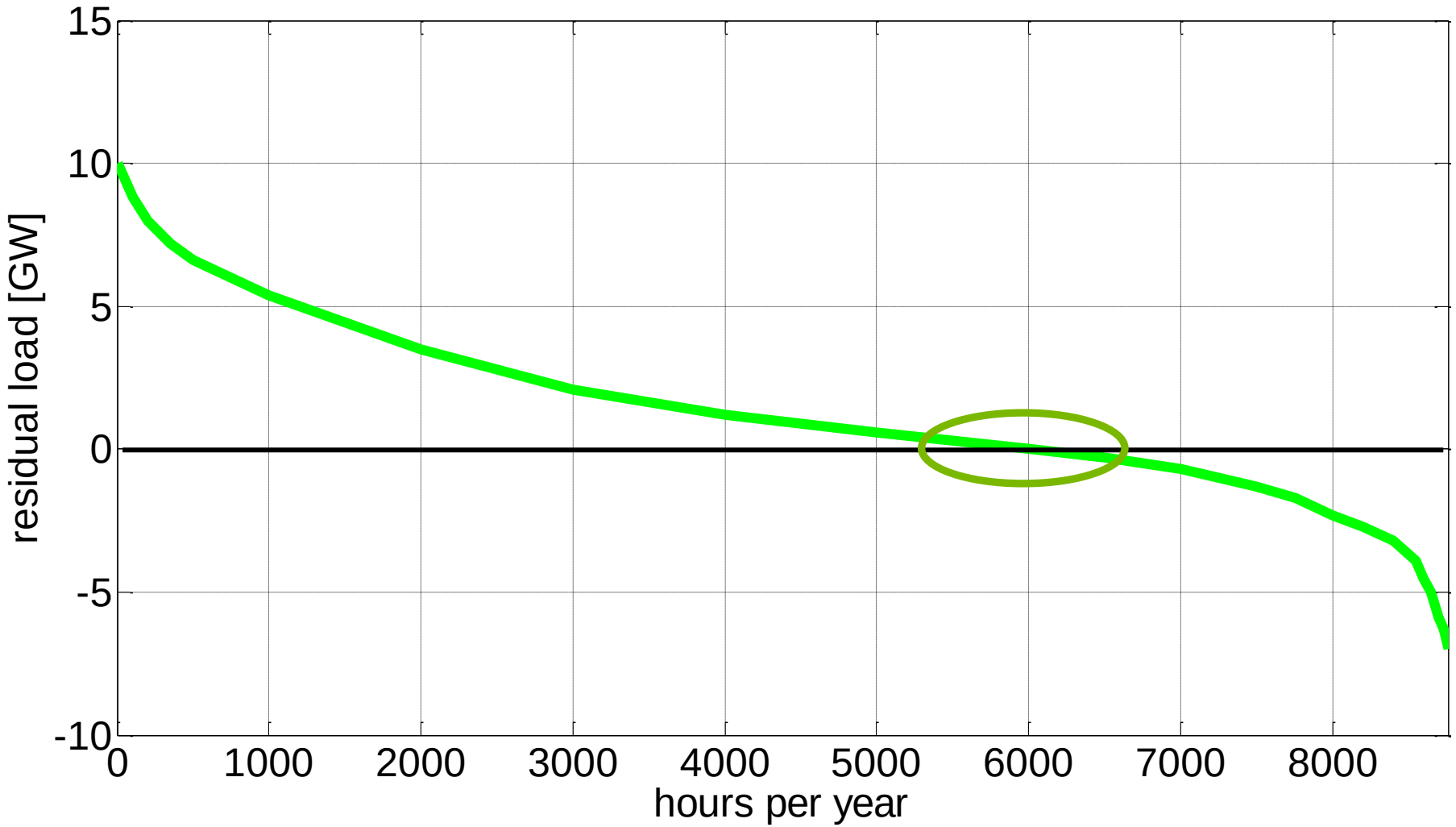


Embedded generation changes balancing requirements but does not make them obsolete.



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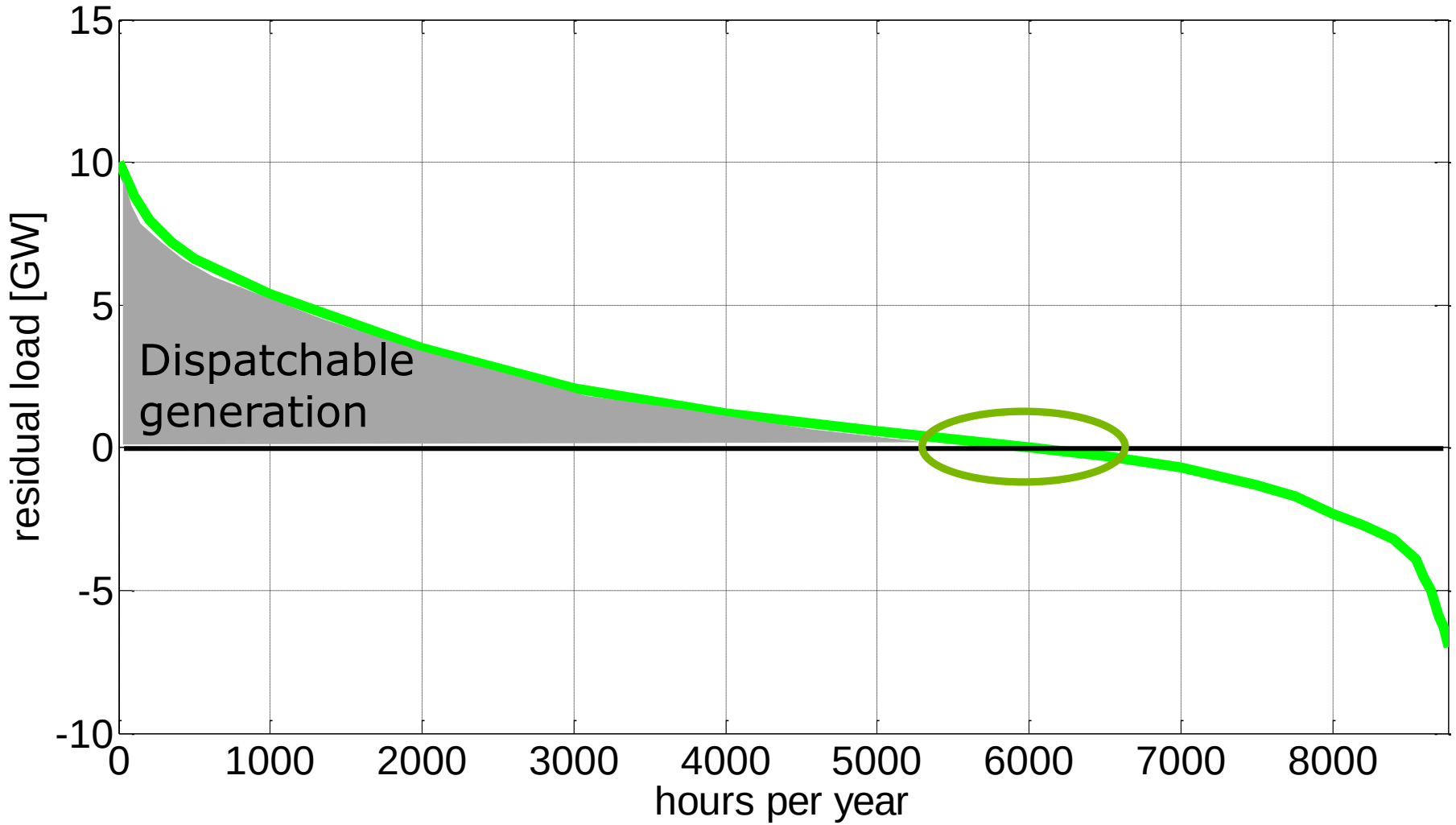

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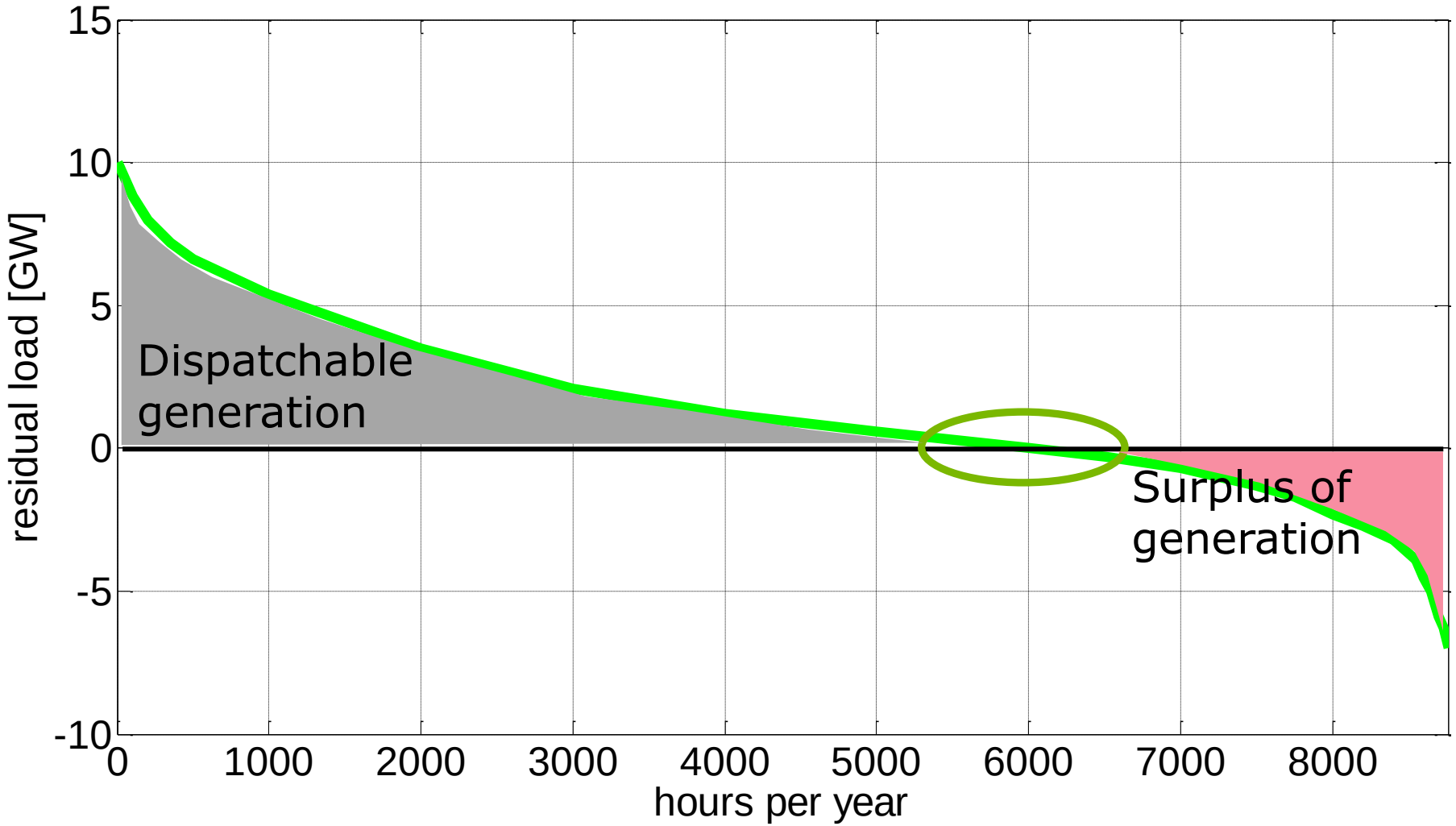
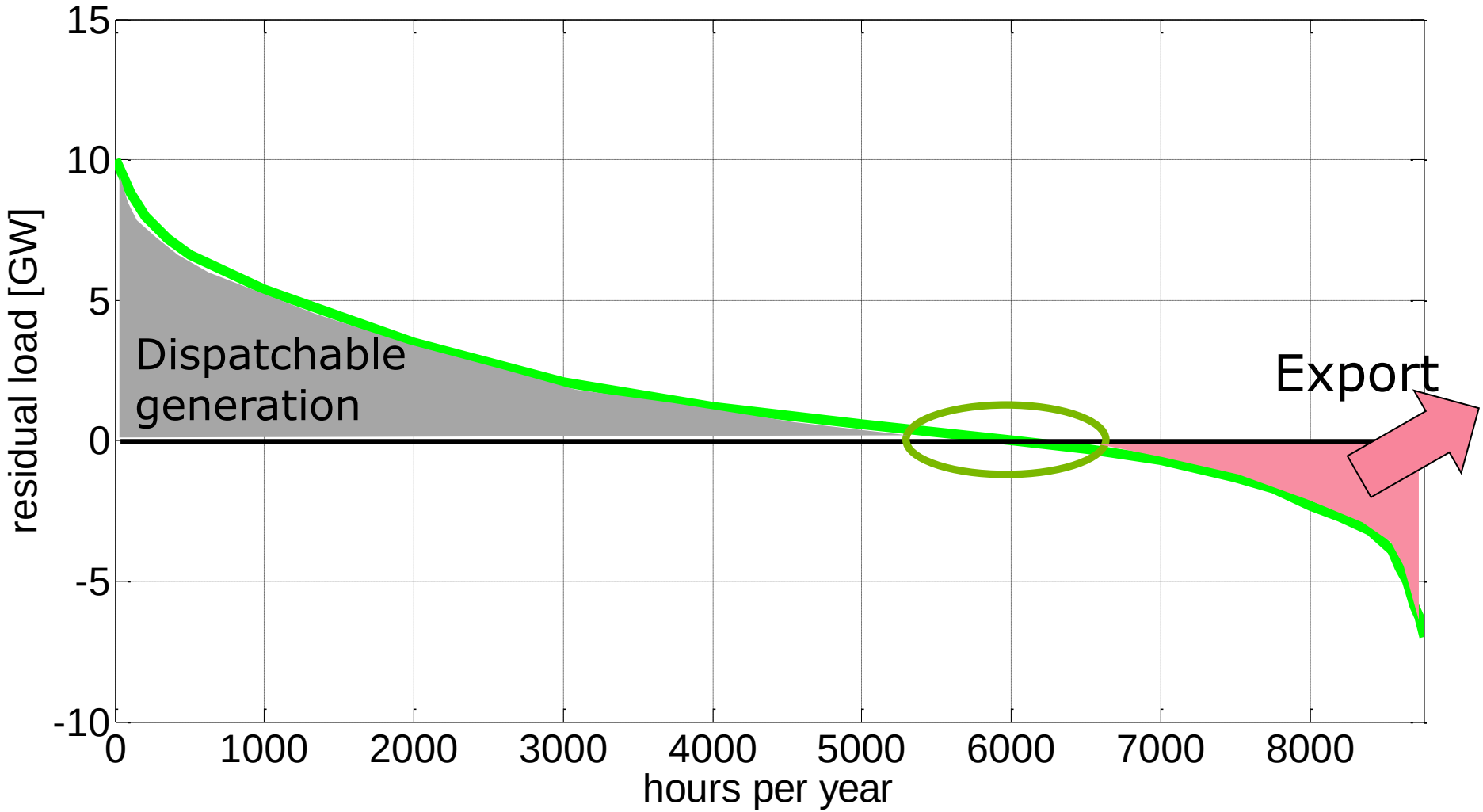
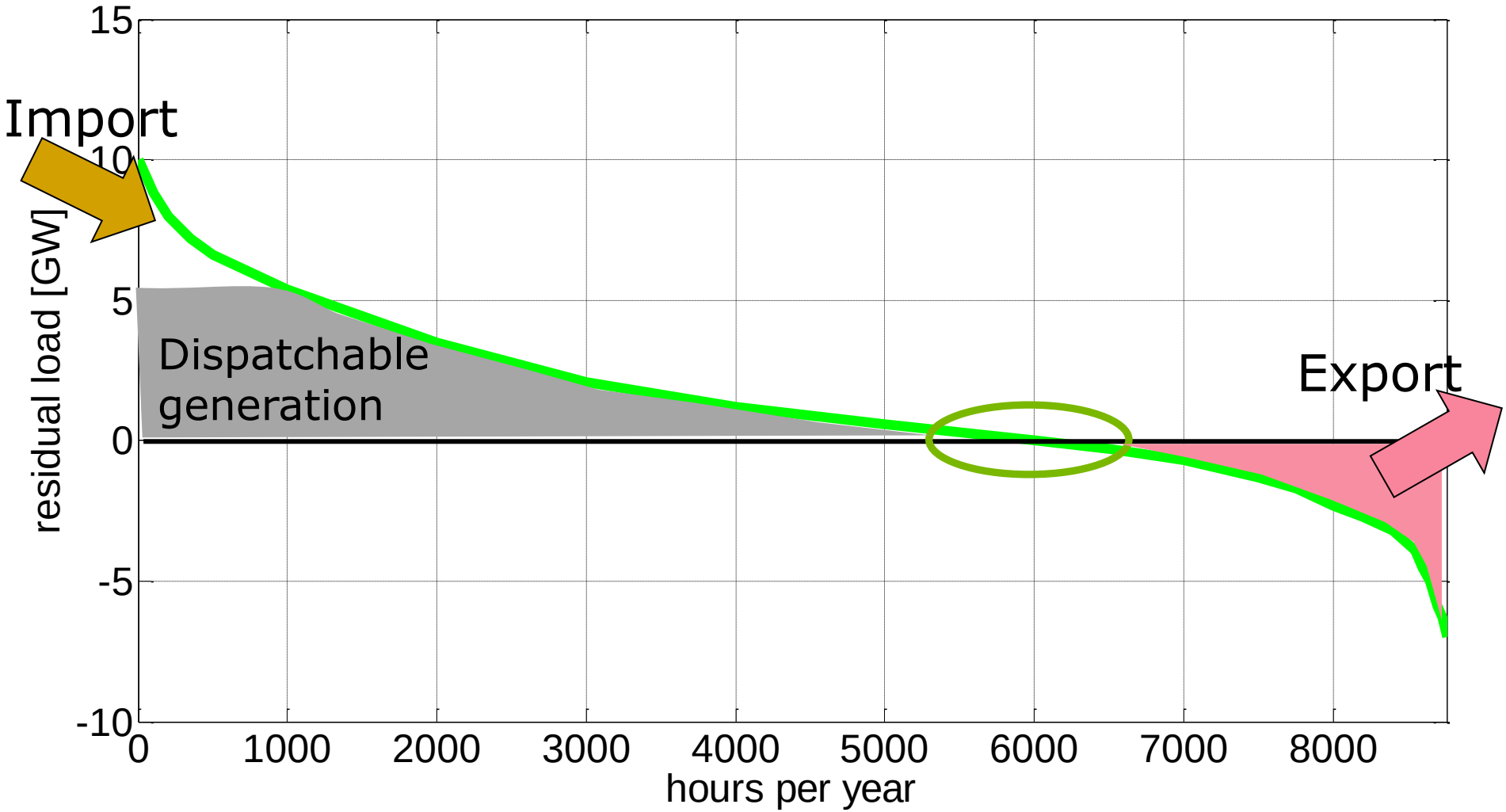


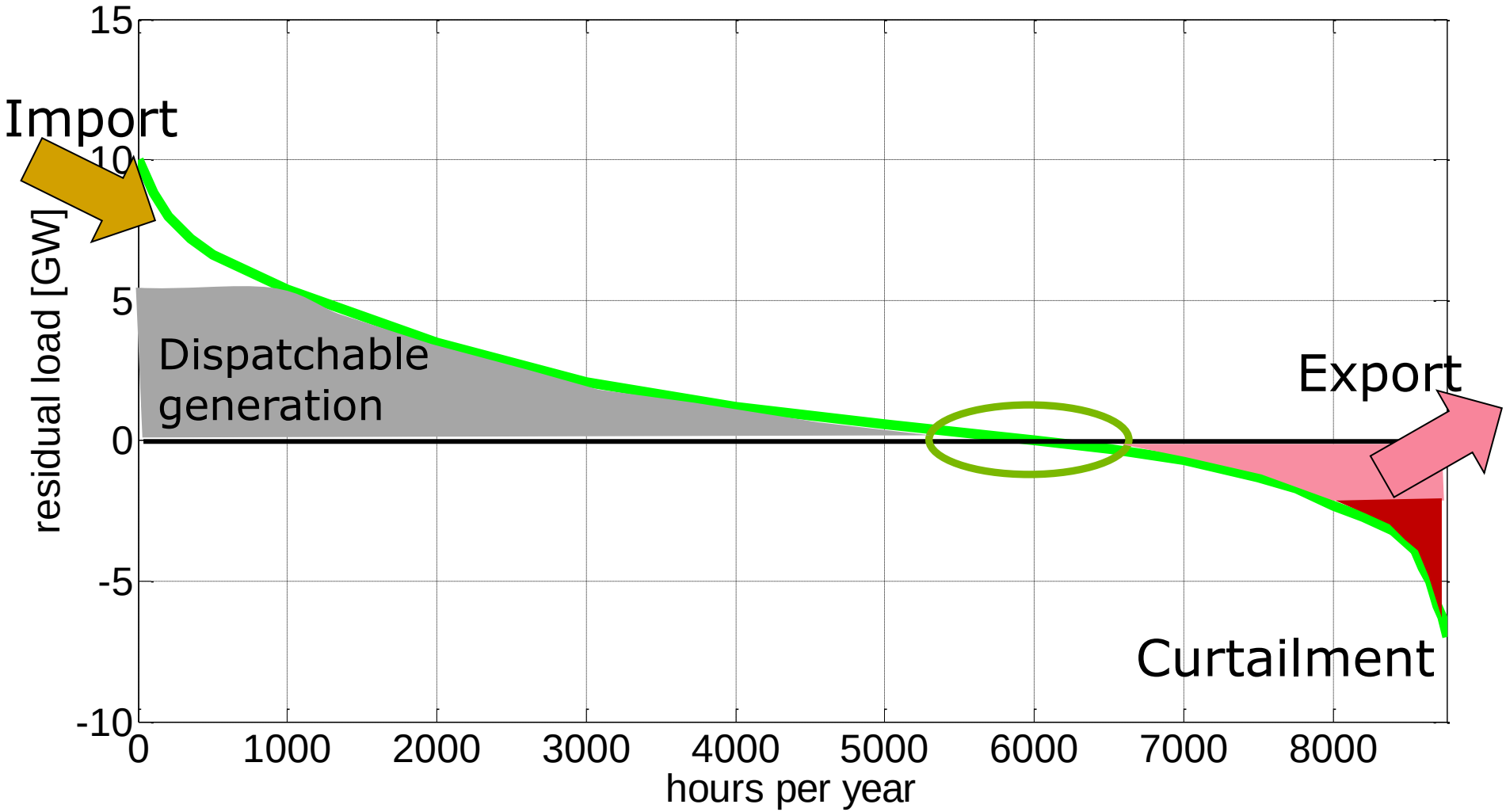
The options for coming closer to a balance (1): Export surplus



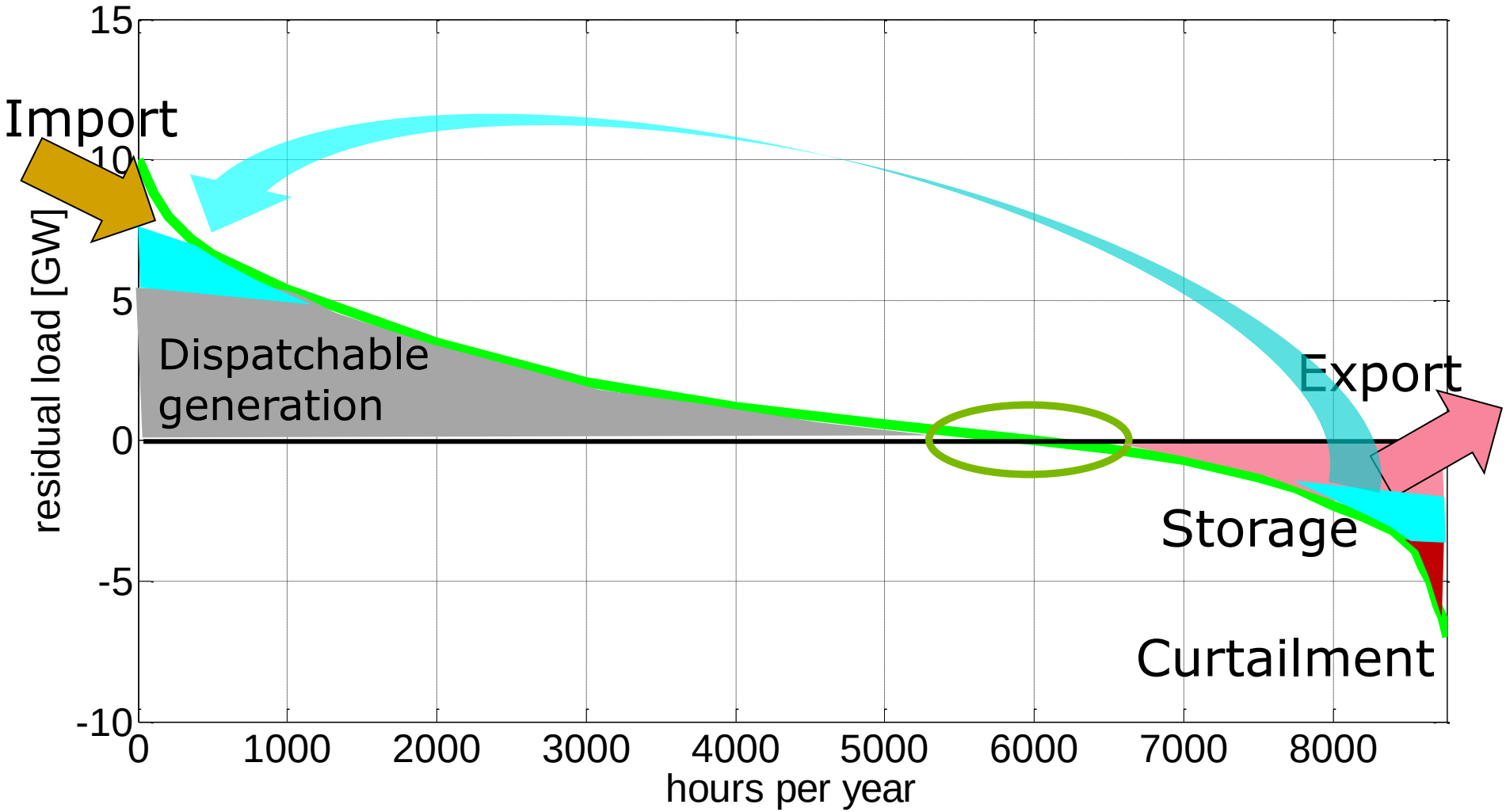
The options for coming closer to a balance (1): Export surplus and importing in case of shortage



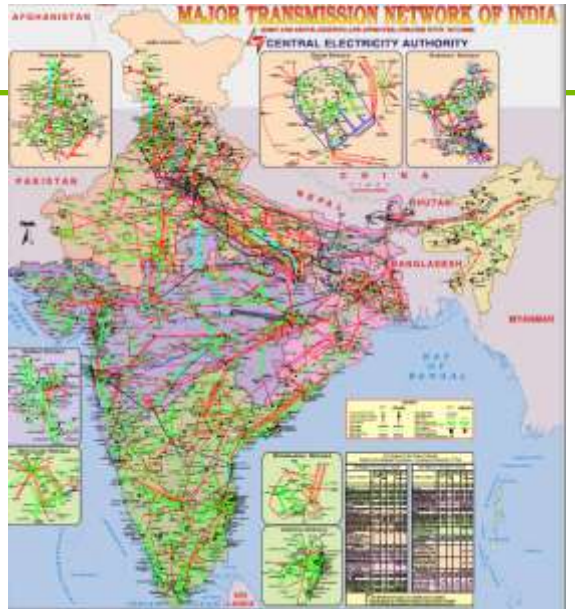
The options for coming closer to a balance (2): curtailing surplus

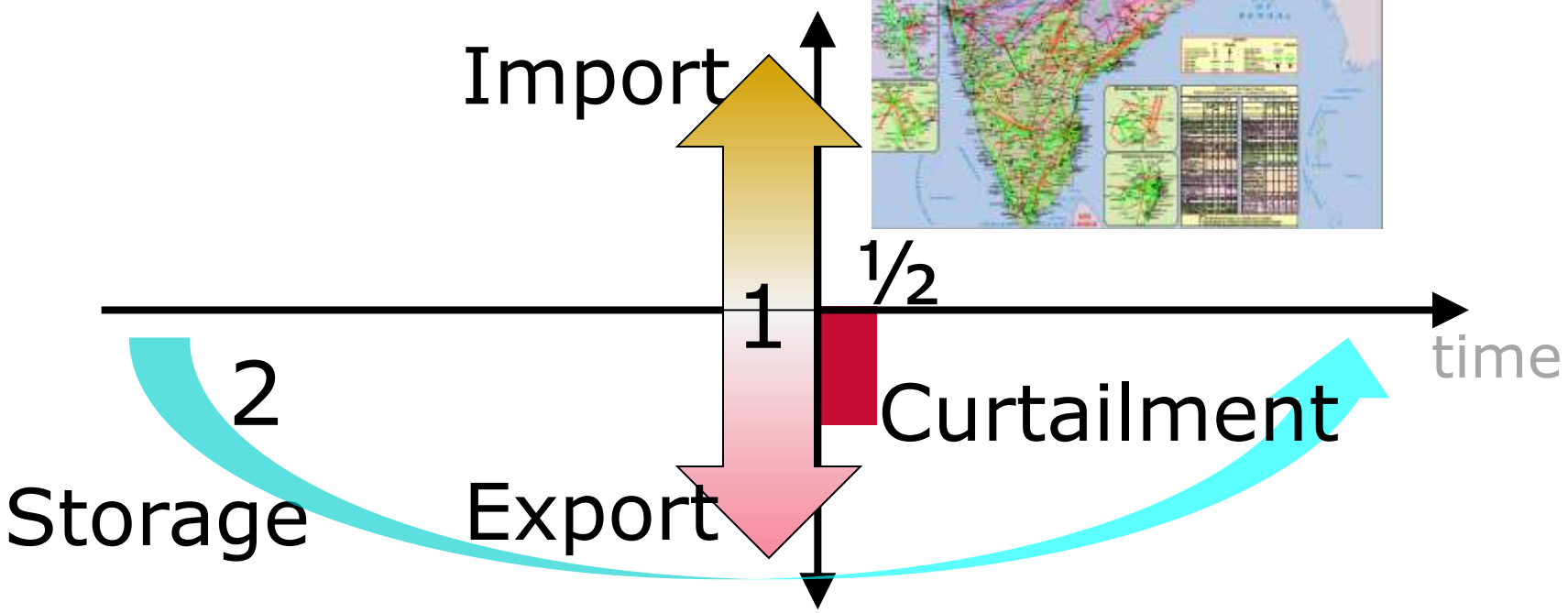


The options for coming closer to a balance (3): managing surplus and shortage by storage



We have just 2½ options for coming closer to a balance:





> For anything remaining we need dispatchable plant.

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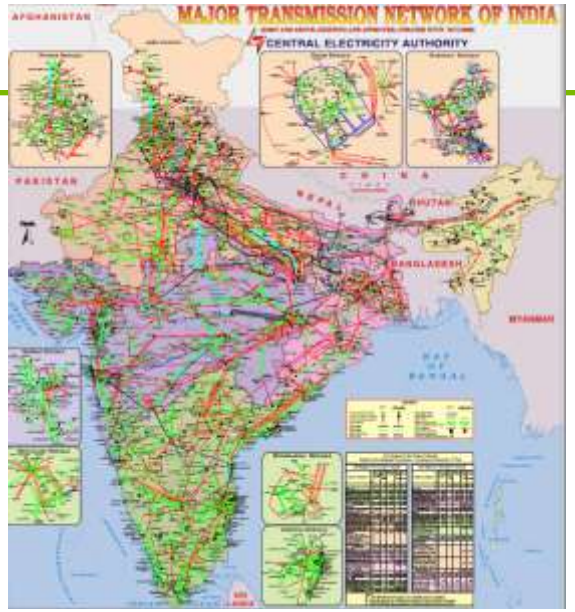
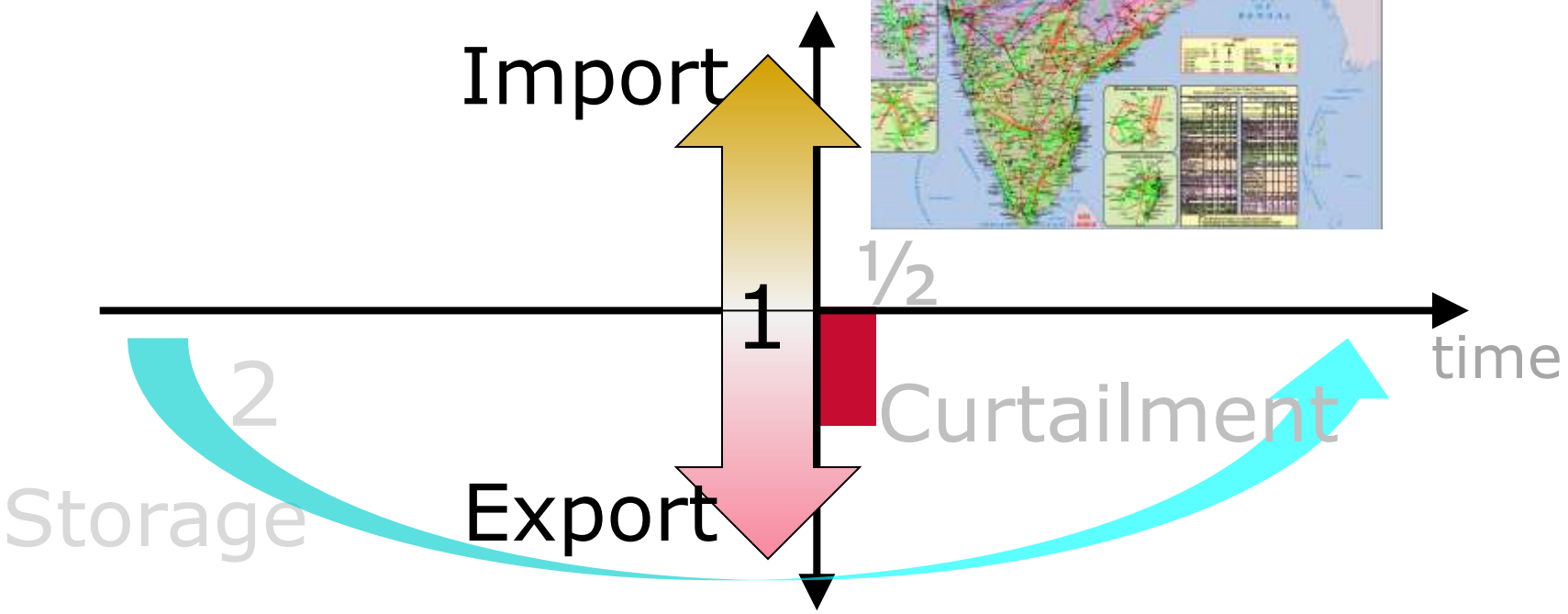




> For anything remaining we need dispatchable plant and a network facilitating respective power flows.

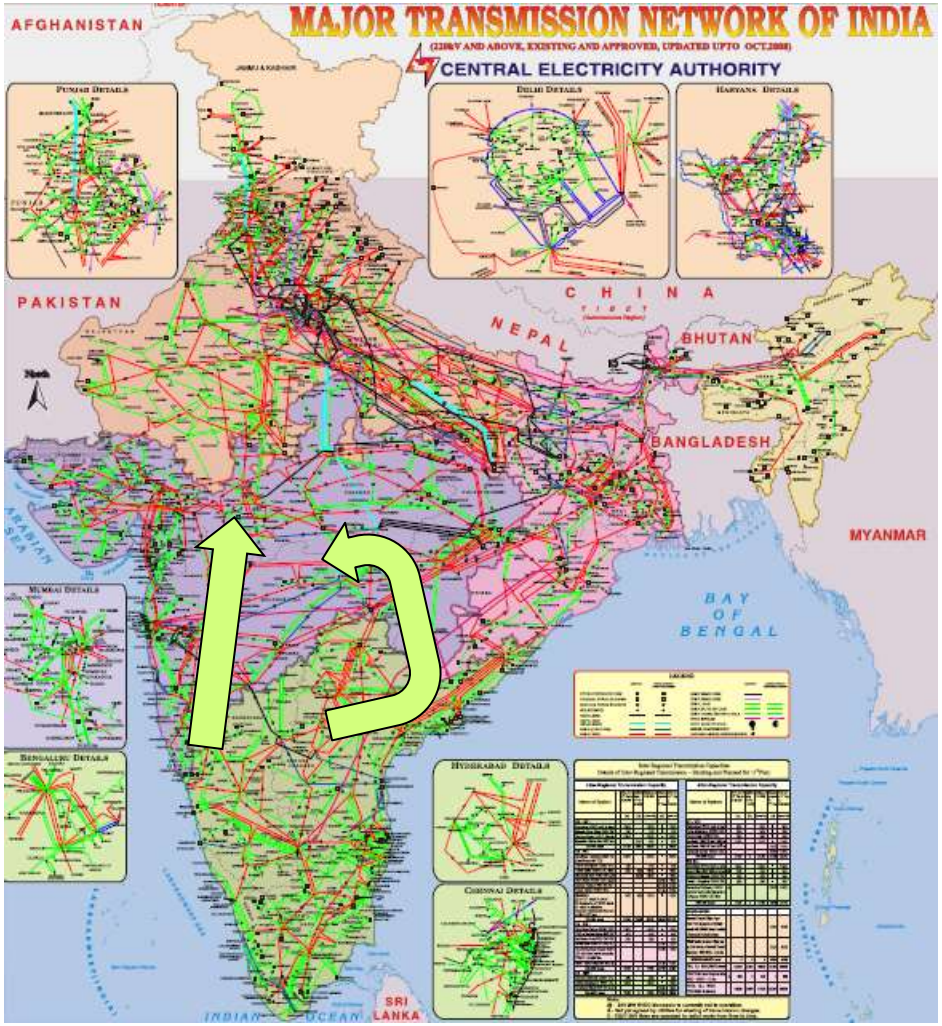
THE REGIONAL PERSPECTIVE

Congestion management, curtailment and redispatch

- Transmission capacity is finite,
- And does not necessarily reflect the geographical distribution of generation capacity. *This strongly depends on regulation.*
- The transmission system operator may need to curtail distributed generation and readjust generation power plant scheduling - deviating from the results of market clearing and forecasts.
- This also affects lower network levels.

Curtailment

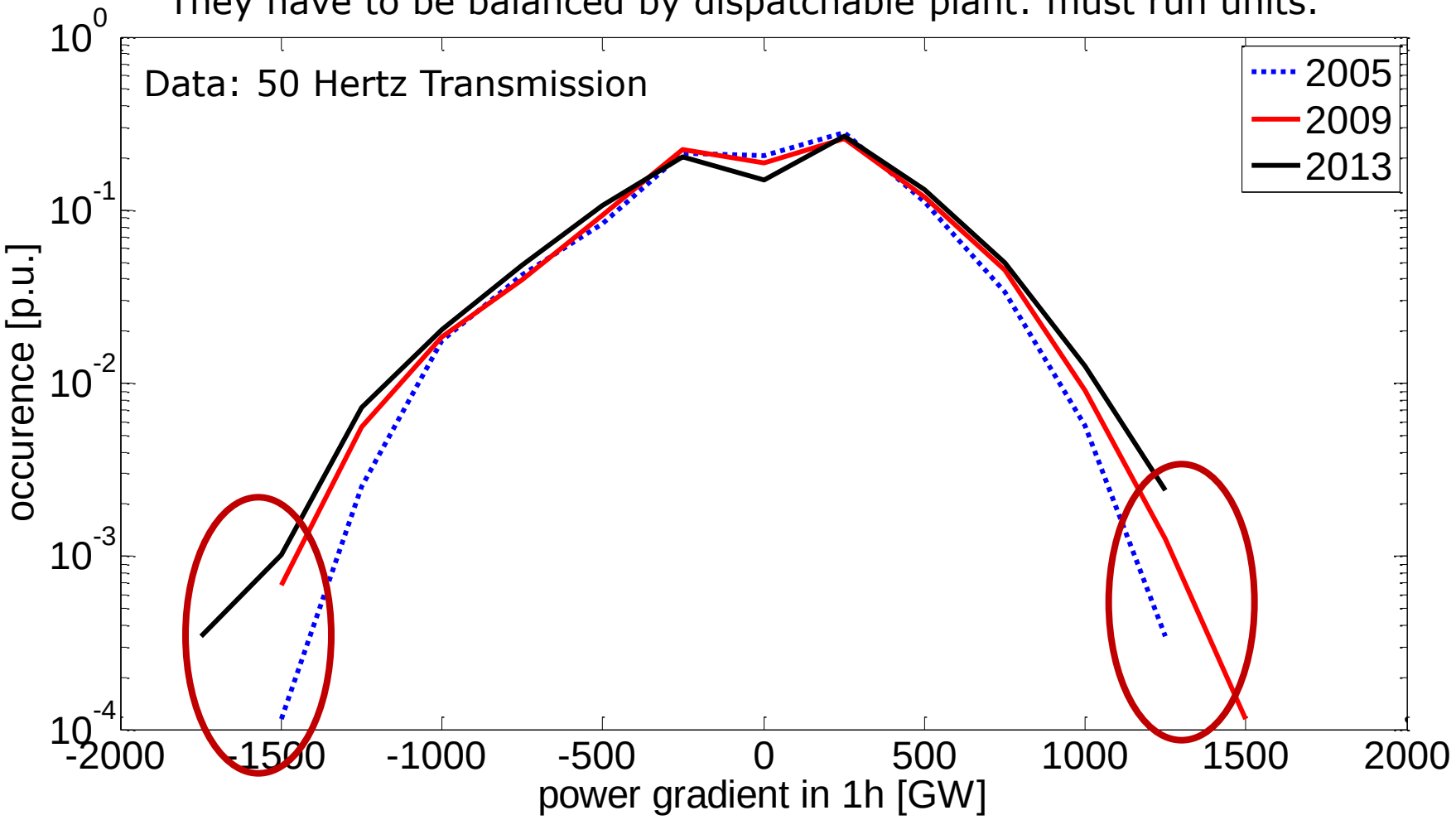
Redispatch of power plants



THE BALANCING PERSPECTIVE

Gradients of residual load increase with RES-E capacity.

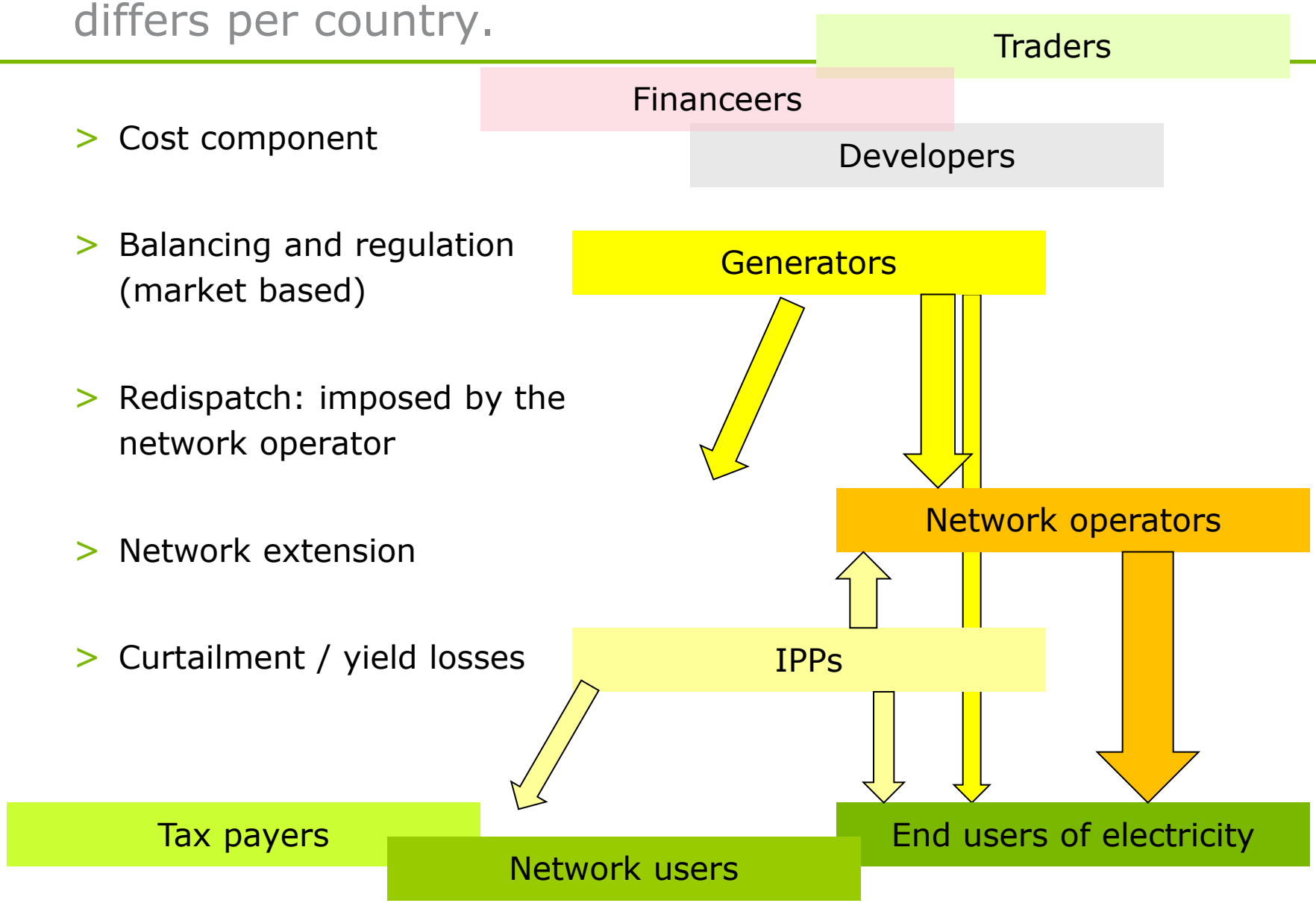
> Extreme gradients nowadays are more frequent (up to 10 times). They have to be balanced by dispatchable plant: must run units.



WHAT REGULATION MEANS

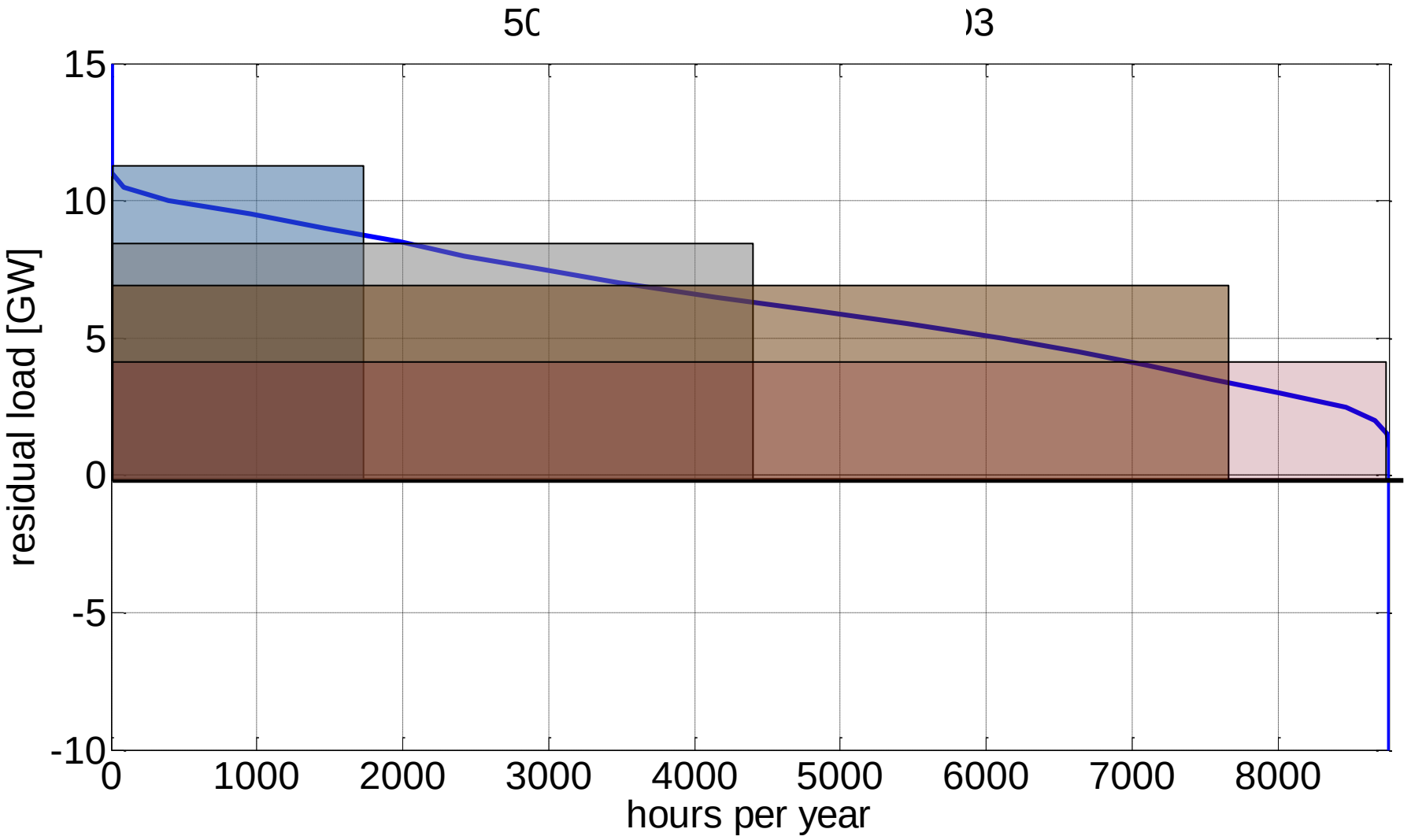
Allocation of cost depends on regulation and differs per country.

- Cost component
- Balancing and regulation (market based)
- Redispatch: imposed by the network operator
- Network extension
- Curtailment / yield losses

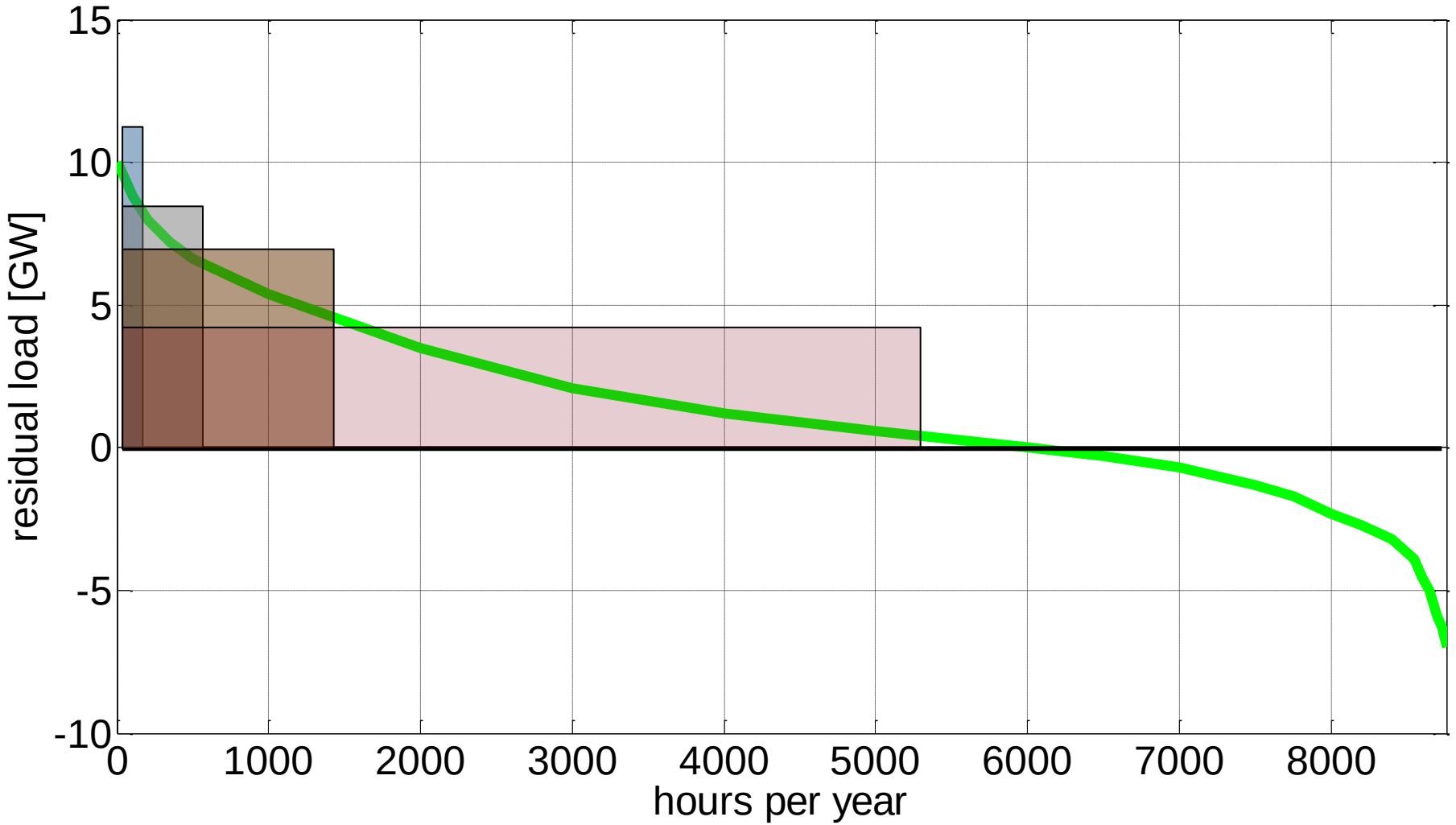


THE INVESTMENT PERSPECTIVE

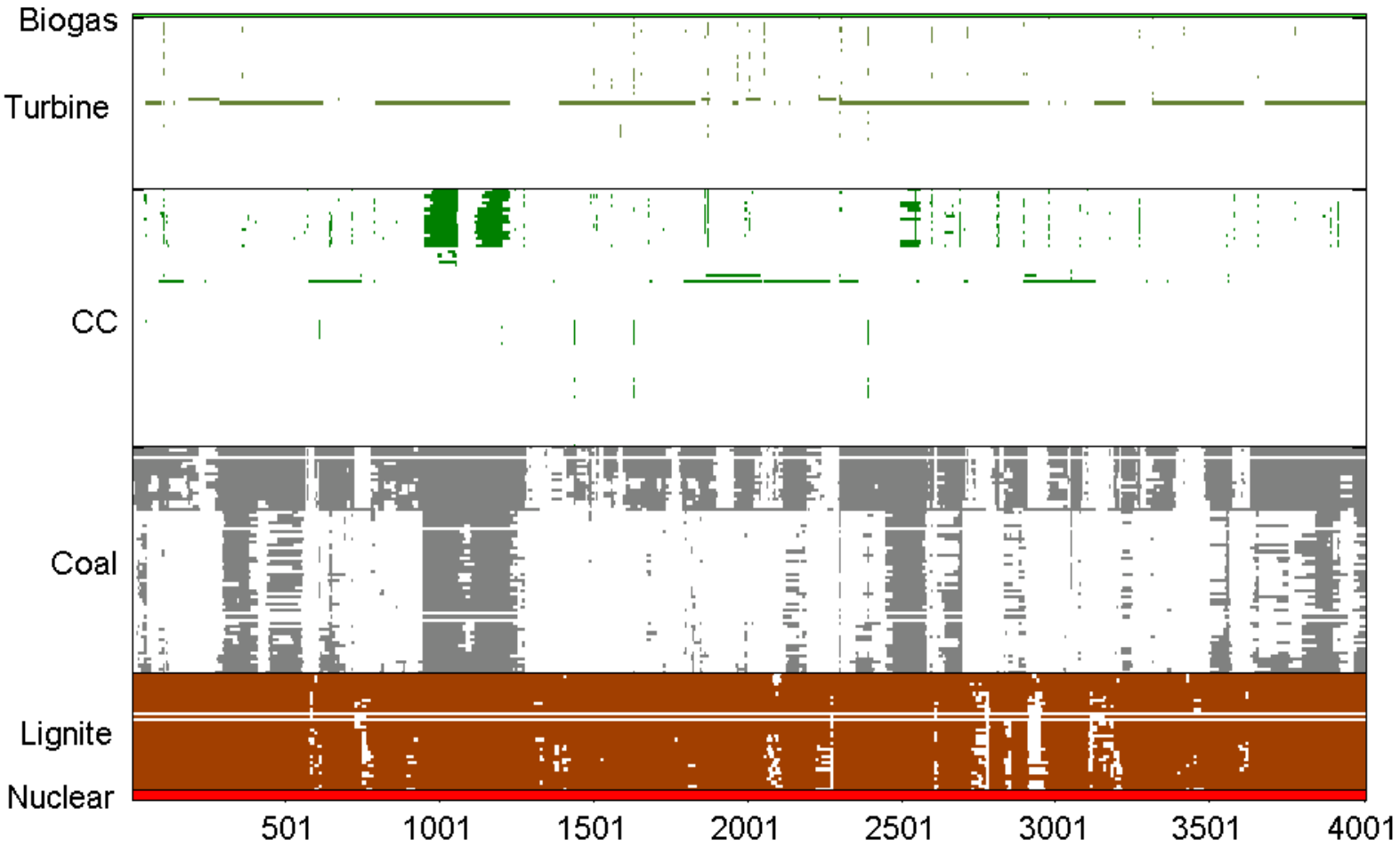
The merit order determines plant utilisation.



Reduced residual load (substantially) reduces utilisation of dispatchable plant in energy only markets.

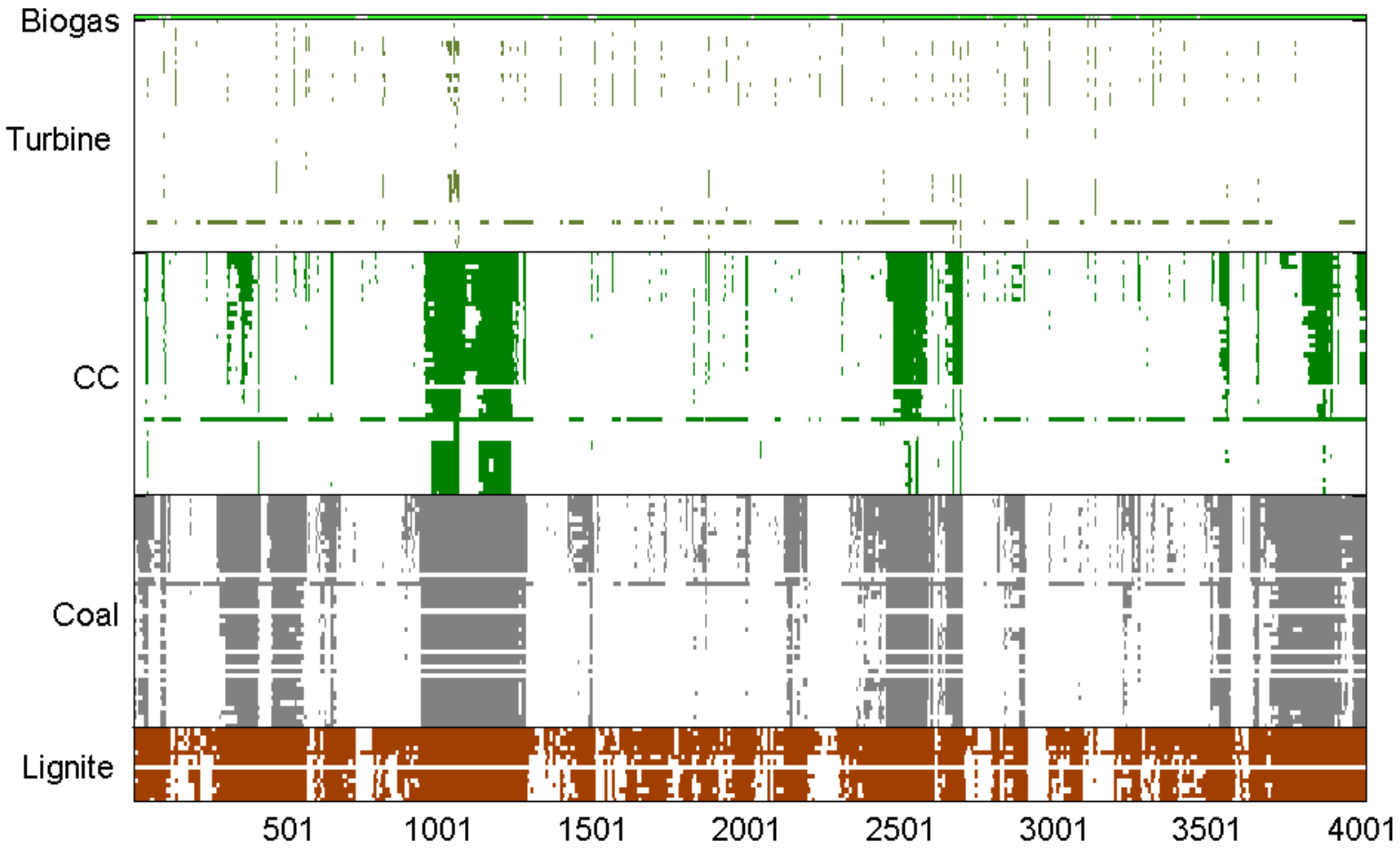


How far a plant is affected depends on technology – Germany with **110 GW** RES-E



- Each line represents ane individual power plant
- White ares: this plant is not dispatched.

How far a plant is affected depends on technology – Germany with **150 GW** RES-E



The long term challenge of scheduling and balancing:

- Reduced plant utilisation is perceived as a risk by investors.
- As a consequence, there is reluctance to change the existing structure of the power plant portfolio.
- This may be incompatible with high shares of renewables. (Lifetime of power plants is twice that of renewable projects.)
- Market mechanisms tend to fail – at least as long as regulation does not pay dedicated attention to the issue.

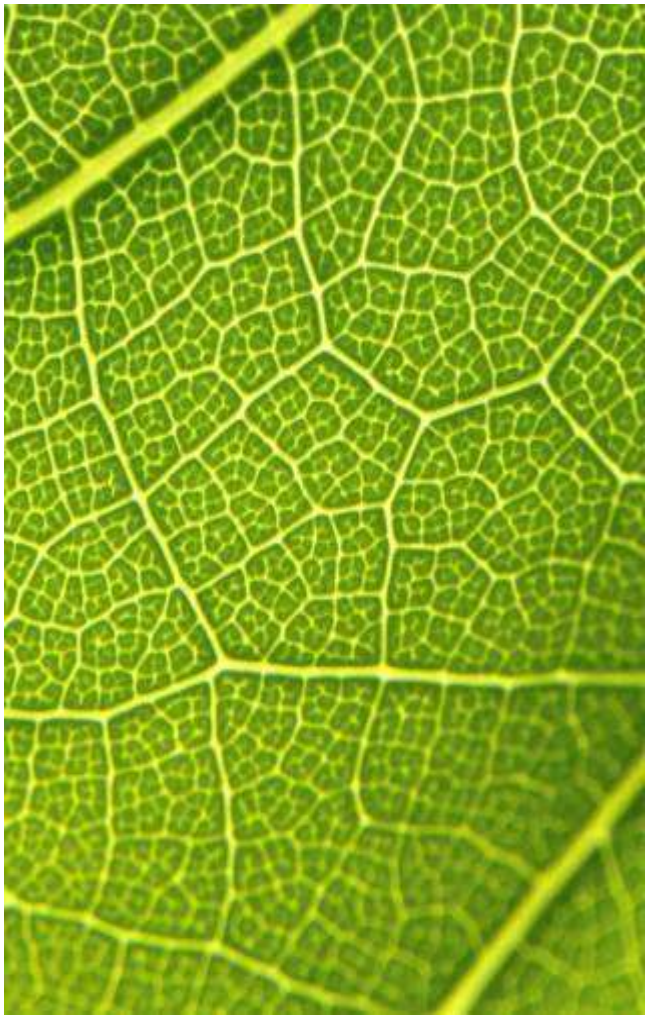
- Regulation has to provide an ambitious, reliable, long term framework.

Conclusion

- Due to balancing requirements dispatchable plants are an inevitable part of power systems with high shares of renewables – AND
- renewable capacity affects the operation of dispatchable power plants.

- The power plant portfolio changes comparatively slowly. This requires a long term view in planning and regulation. Otherwise the portfolio might become incompatible with RES-E.

Contact

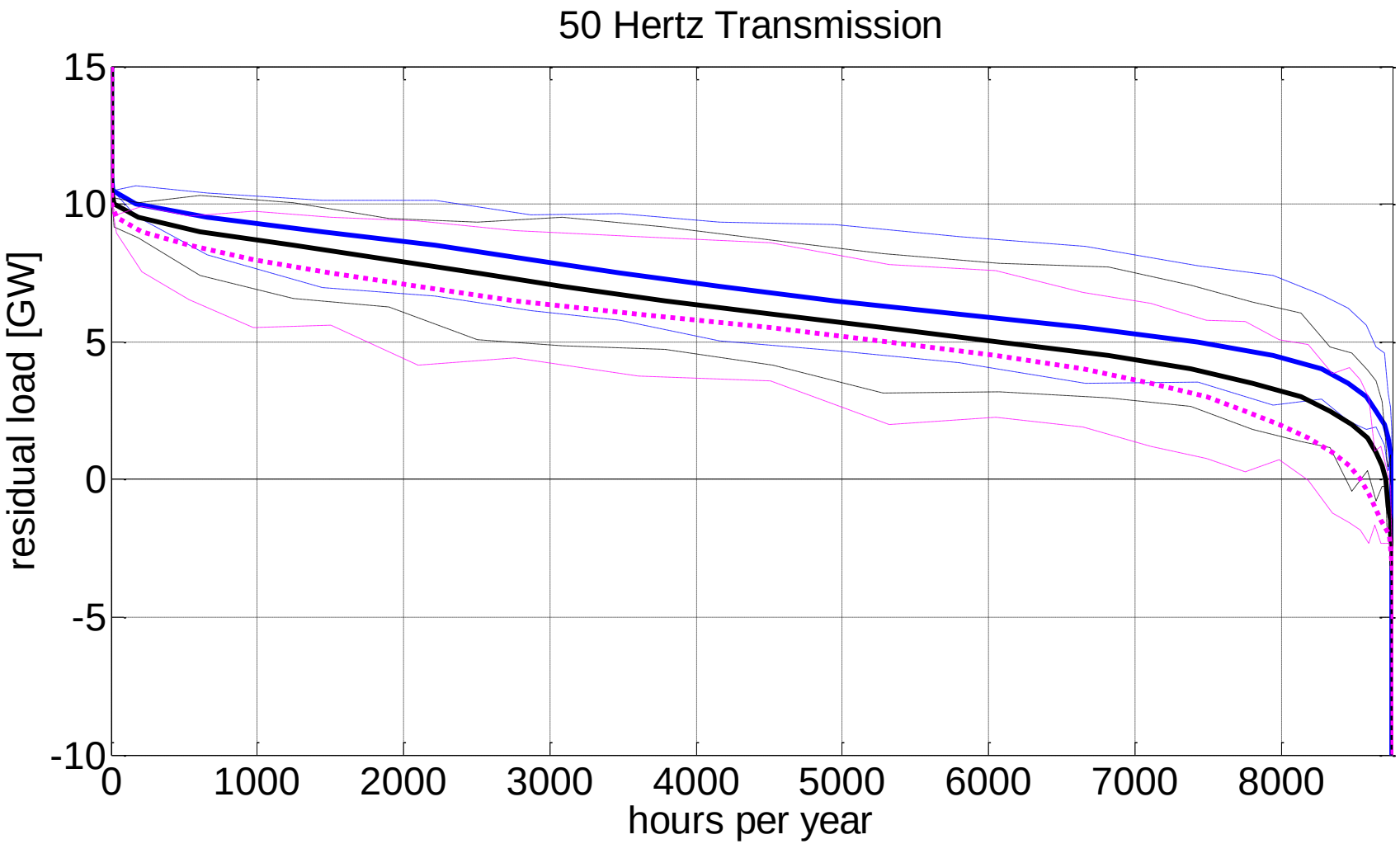


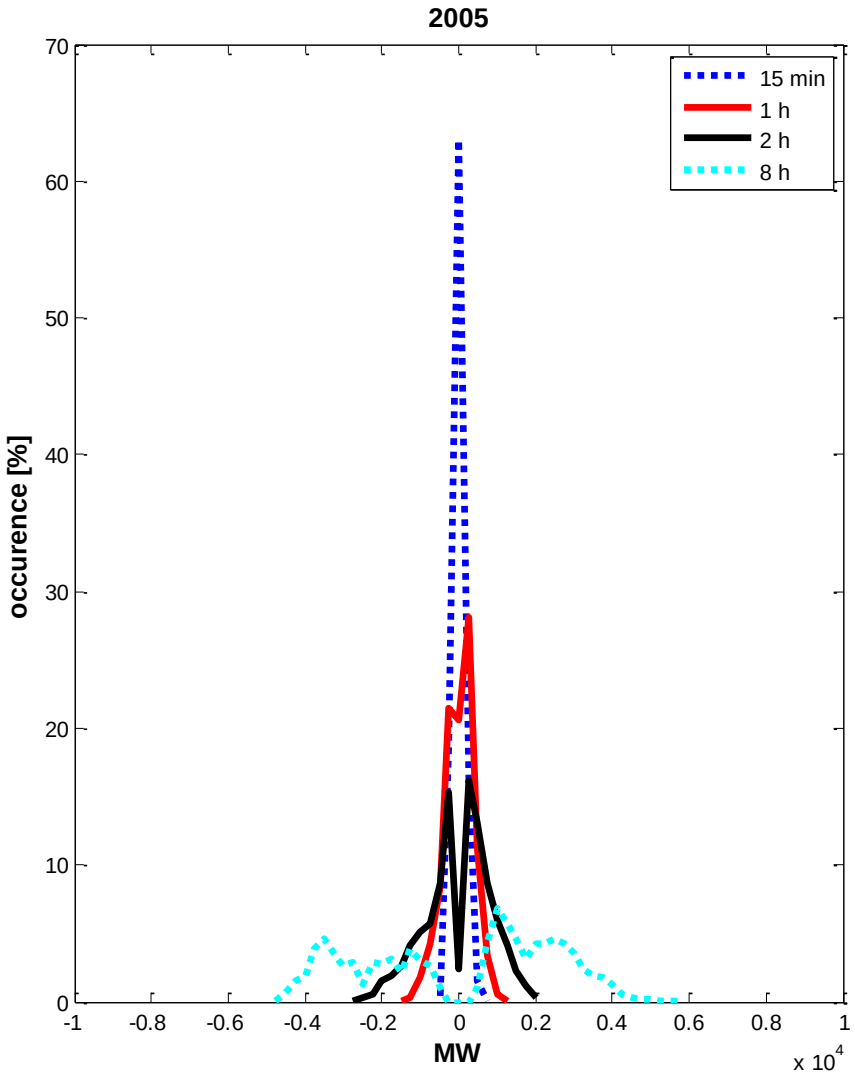
Dr.-Ing. Karsten Burges

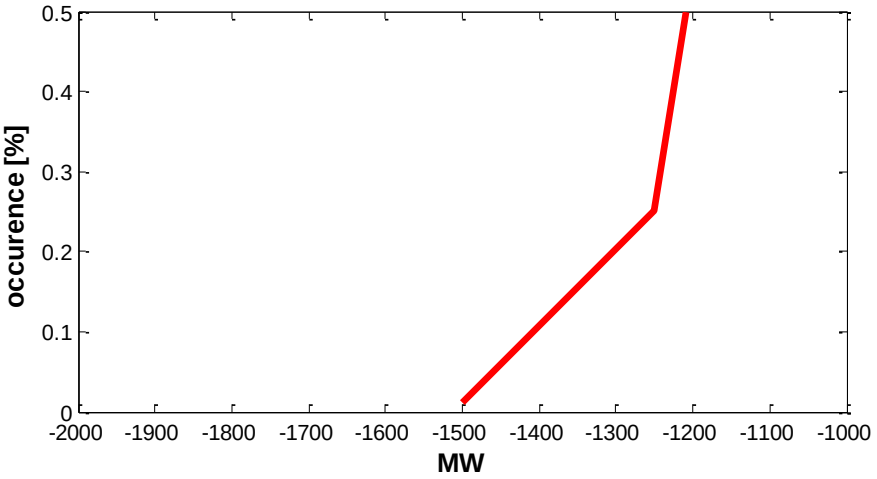
E-Mail: K.Burges@ecofys.com

Tel.: +49 (0)30 29773579-10

Max per 1 hour fluctuation in 2005, 2009, 2013




2005
15 min
1 h
2 h
8 h
occurence [%]
MW
x 10^4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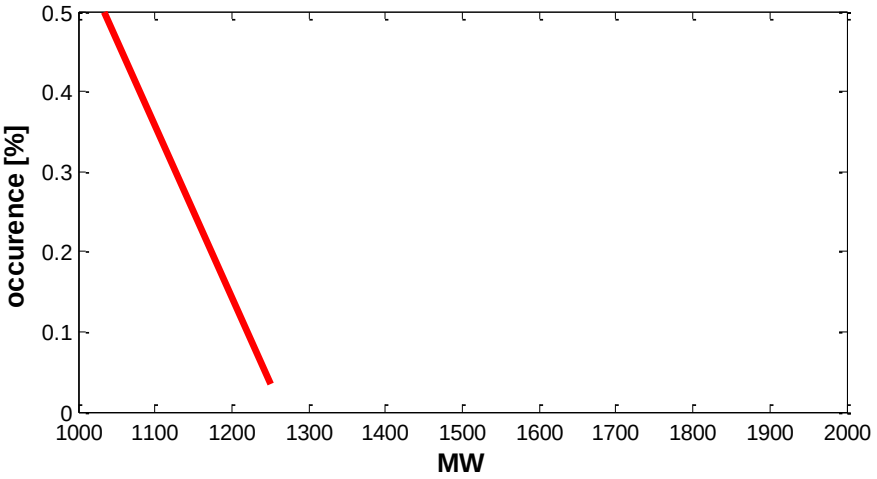
occurence [%]
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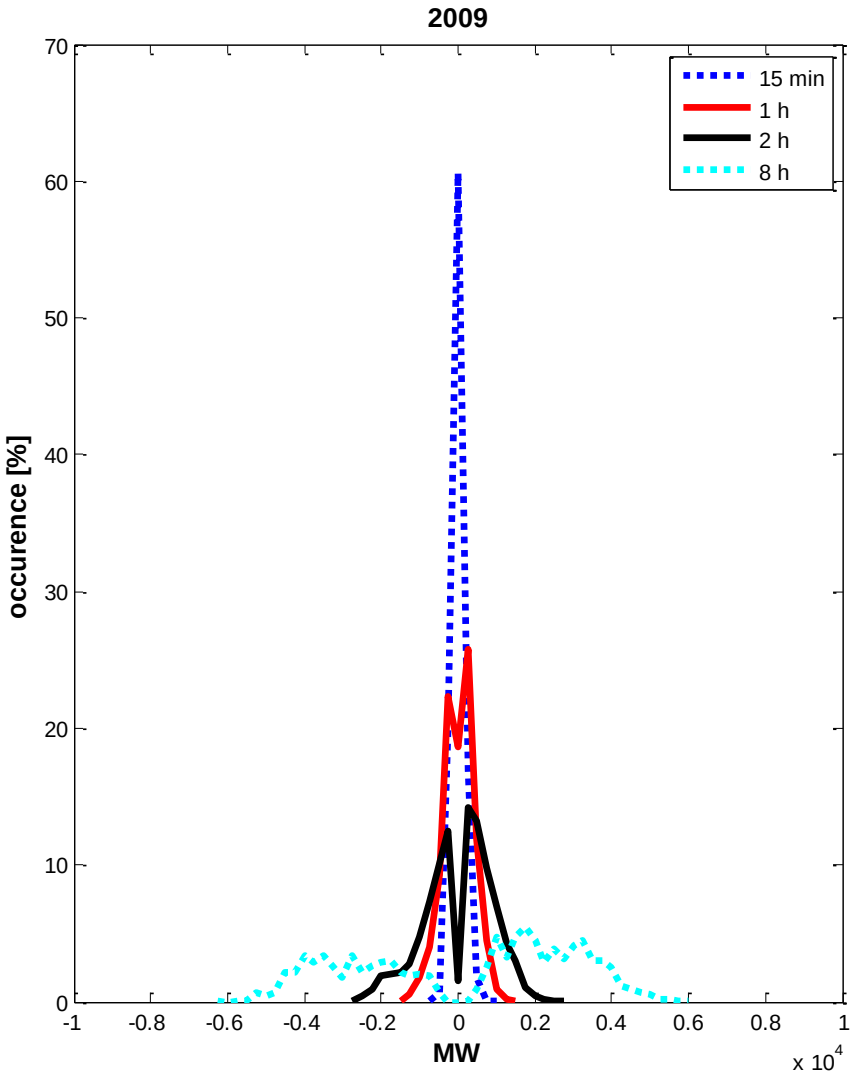
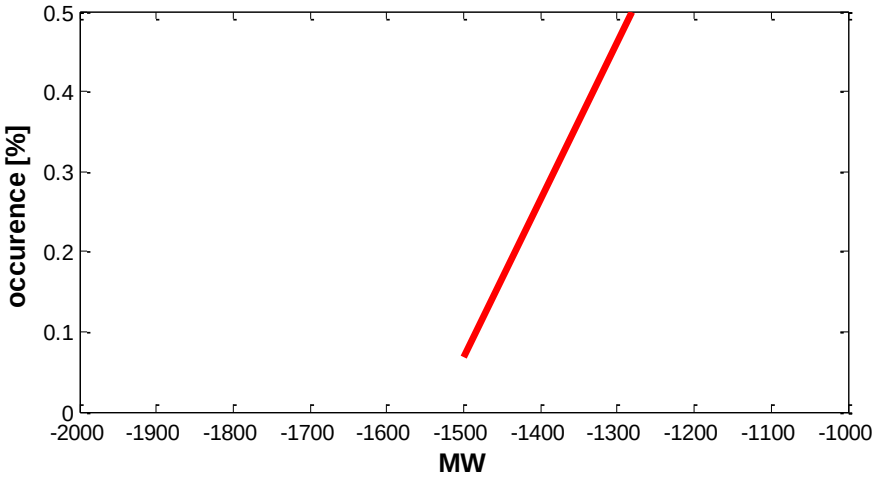

2009
15 min
1 h
2 h
8 h
occurence [%]
MW
x 10^4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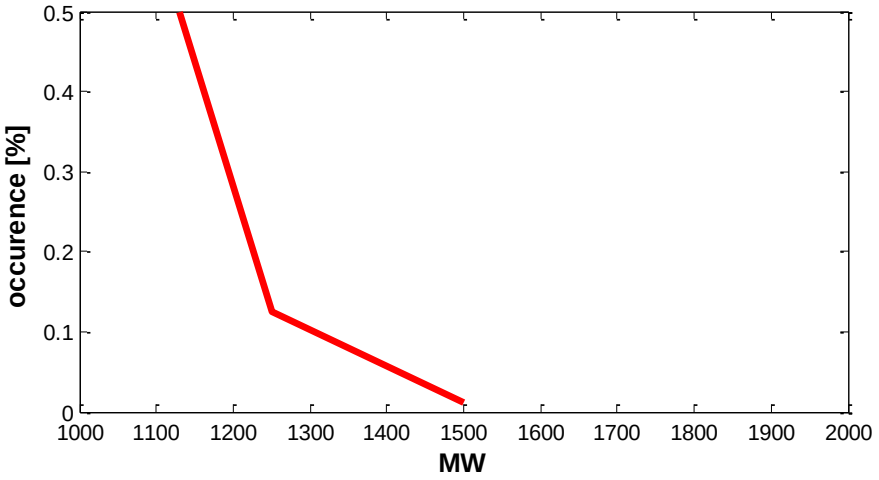
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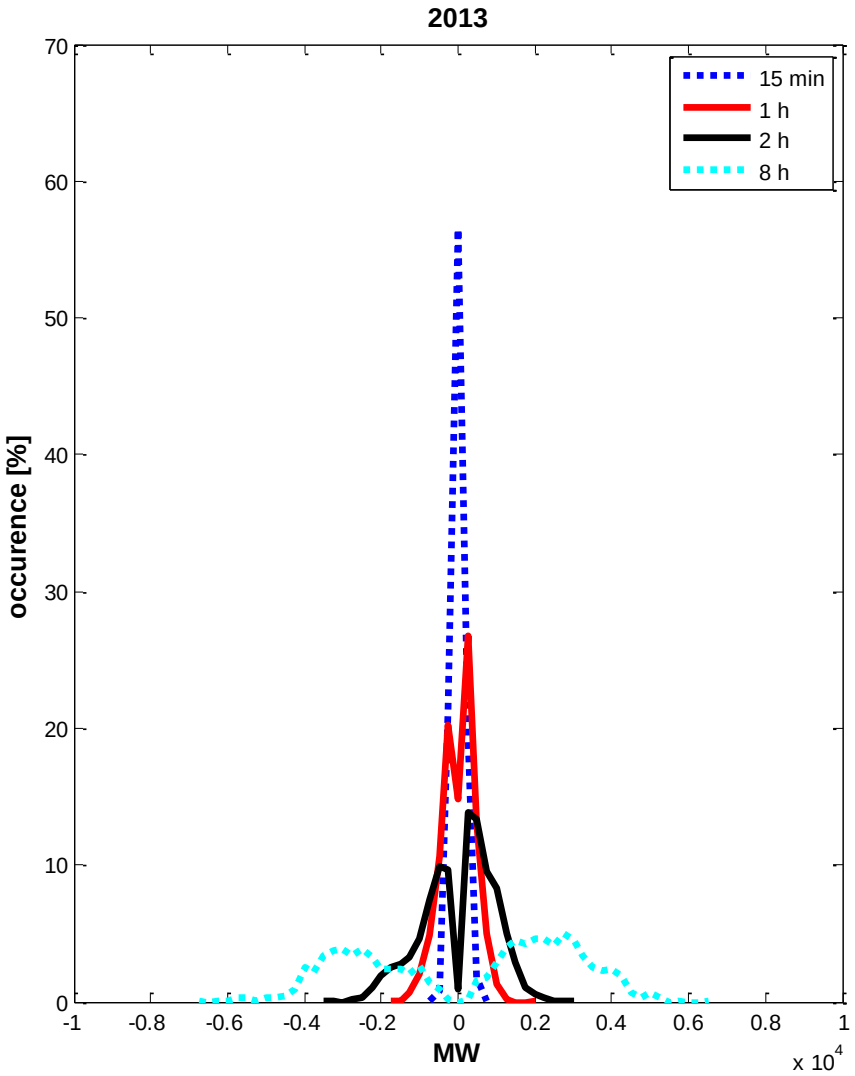
2013
15 min
1 h
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MW
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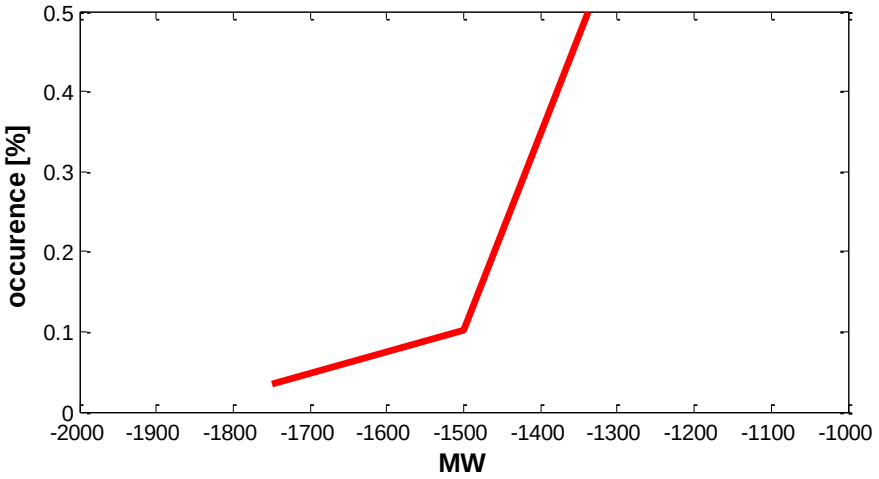
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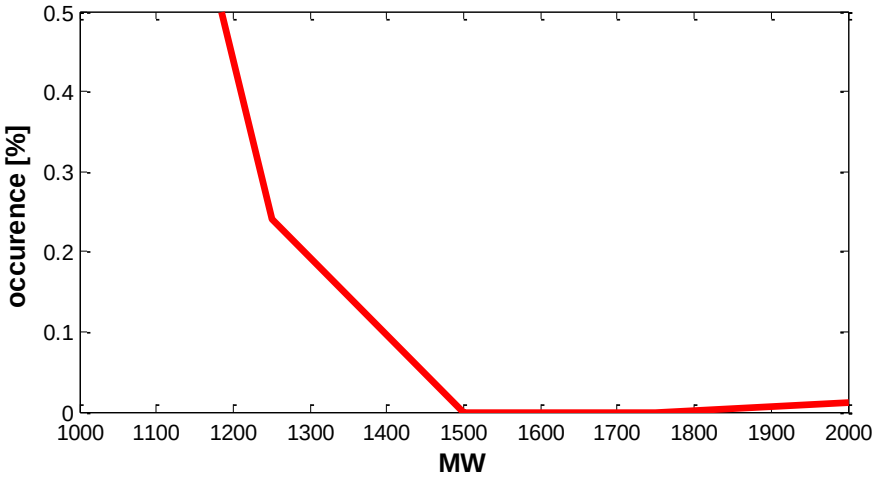
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