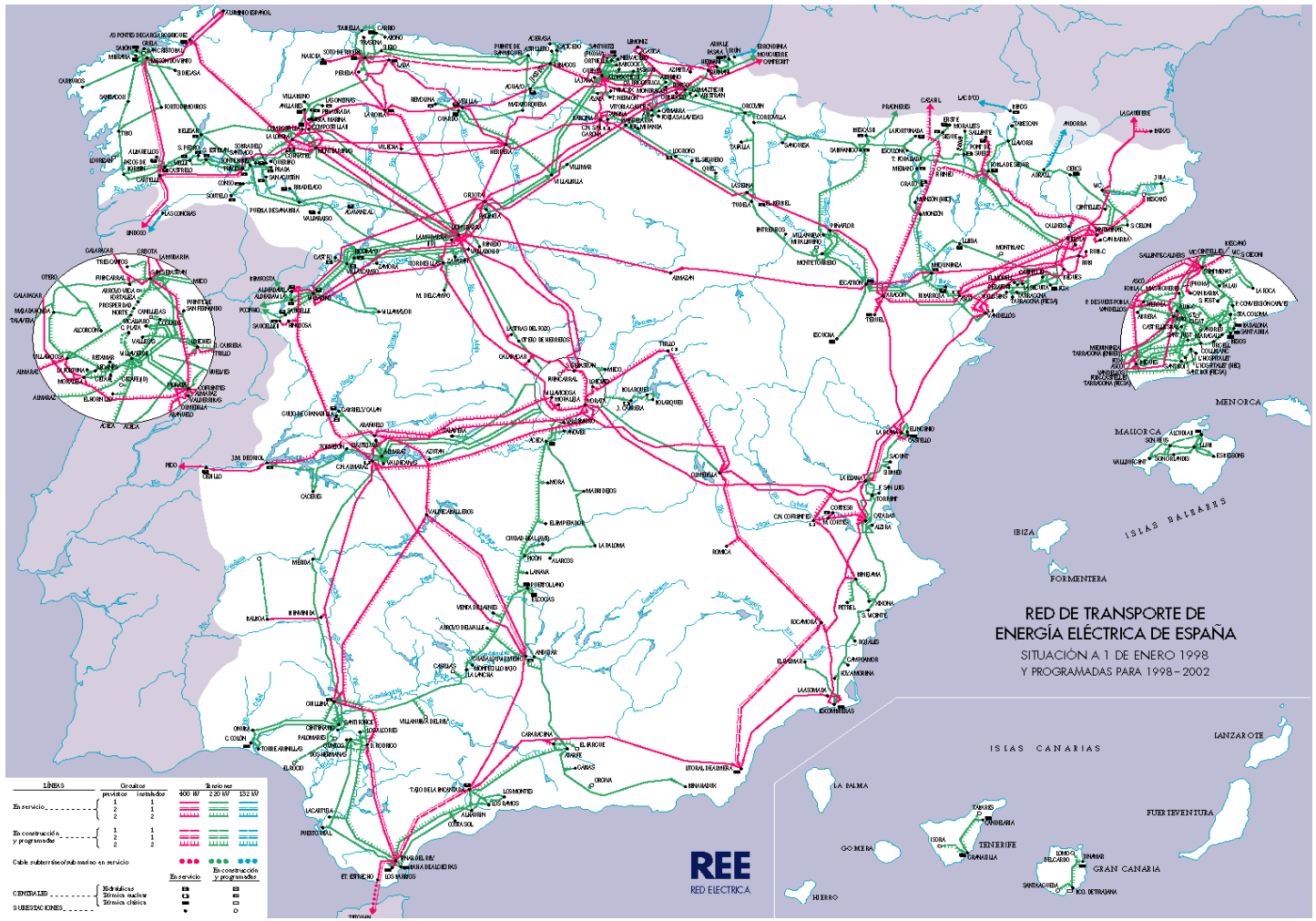
CEER Working Group on Cross-Border Tariffication

Development of the long-term mechanism for inter-TSO payments

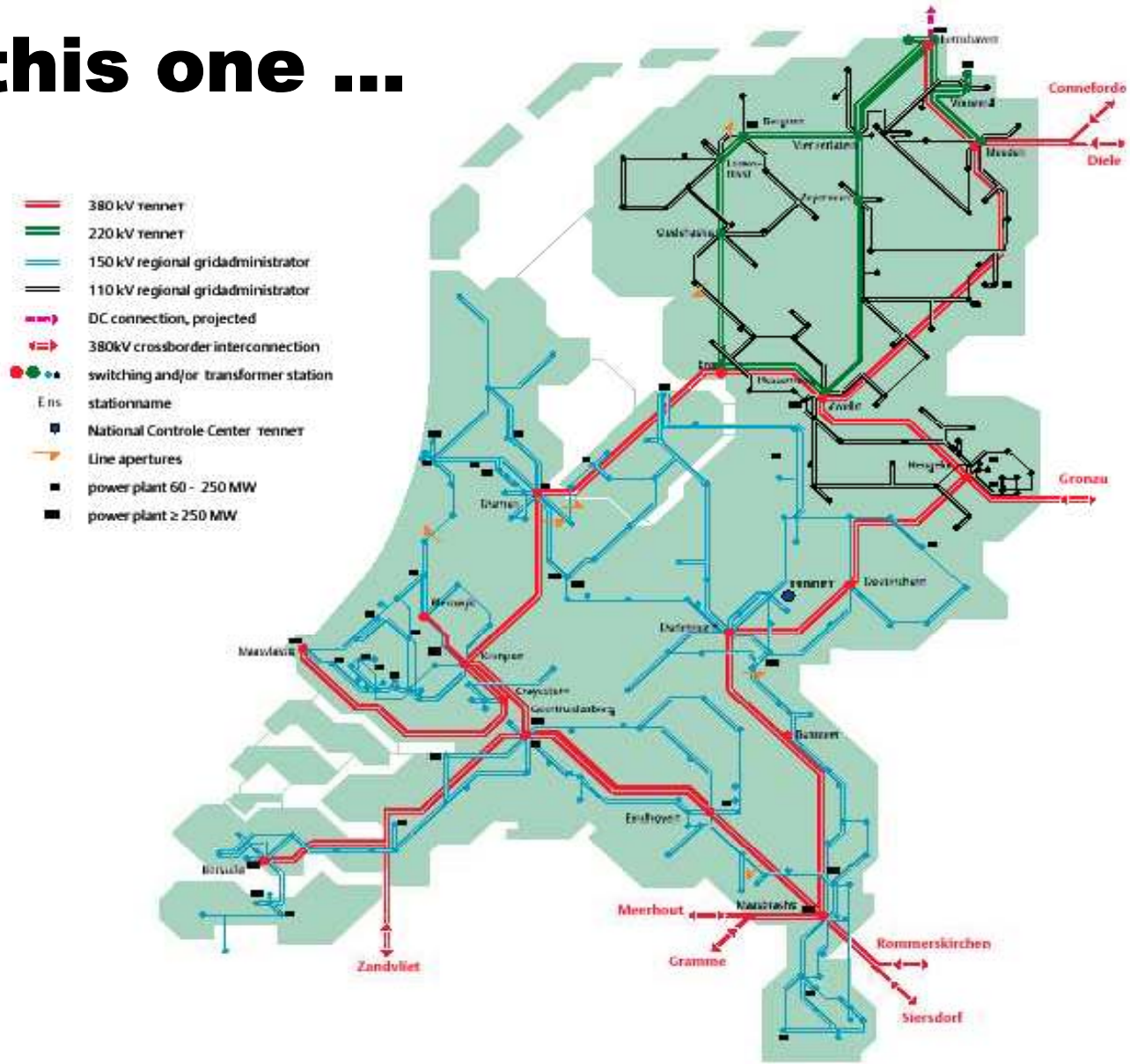
The challenge

- Producers & consumers in the Internal Electricity Market (IEM) of the EU have the right to buy & sell electricity freely, but ...
  - How much to charge for the use of the network?
  - Who pays for network losses?
  - What to do if the network is congested?
  - Who upgrades the network when needed?

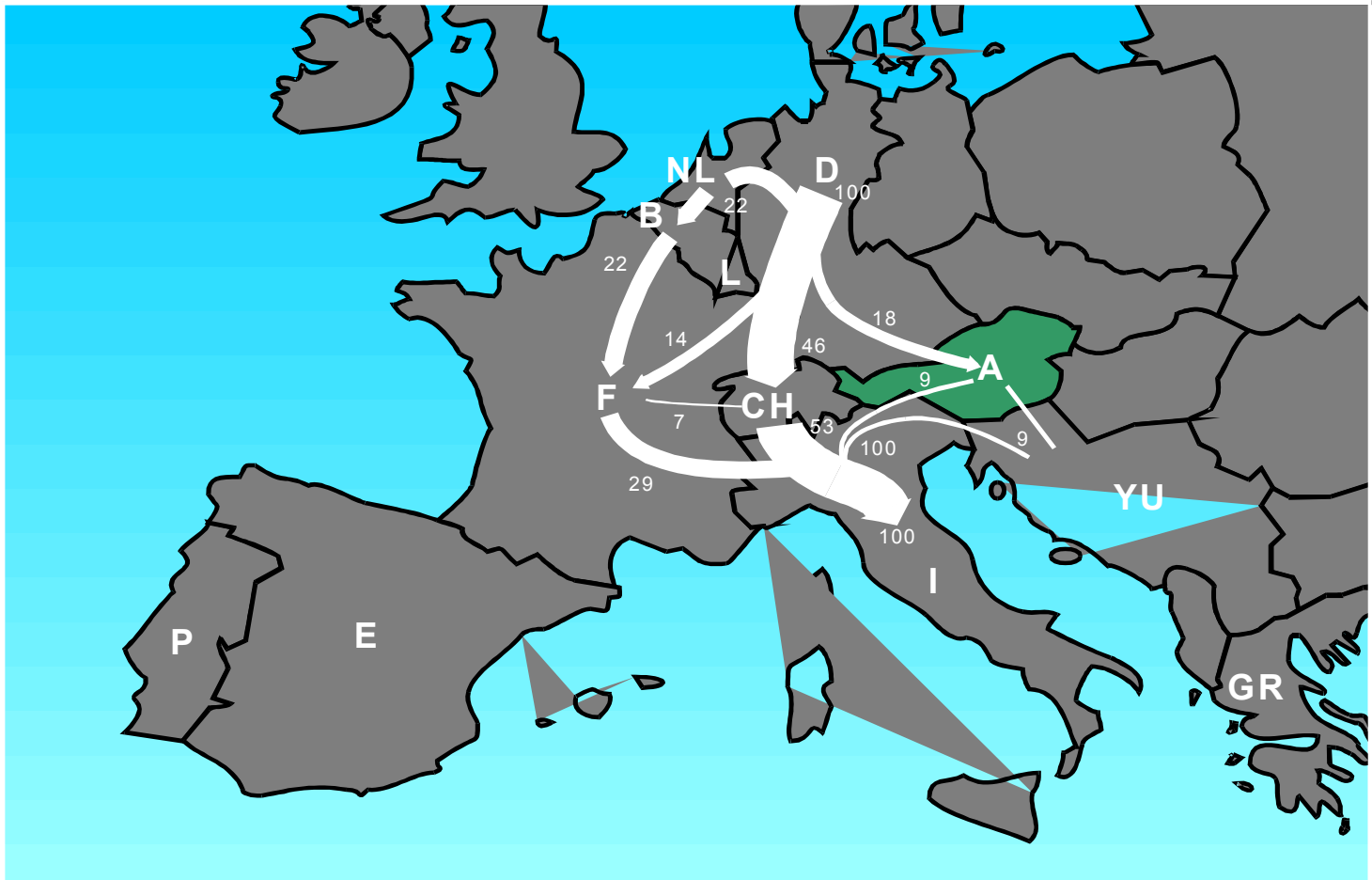
Note the complexity of just a national transmission network ...



… or this one …


380 kV TenneT
220 kV TenneT
150 kV regional gridadministrator
110 kV regional gridadministrator
DC connection, projected
380kV crossborder interconnection
switching and/or transformer station
Ens stationname
National Controle Center TenneT
Line apertures
power plant 60 - 250 MW
power plant ≥ 250 MW
Conneforde
Diele
Gronau
Meerhout
Rommerskirchen
Siersdorf
Gramme
Zandvliet

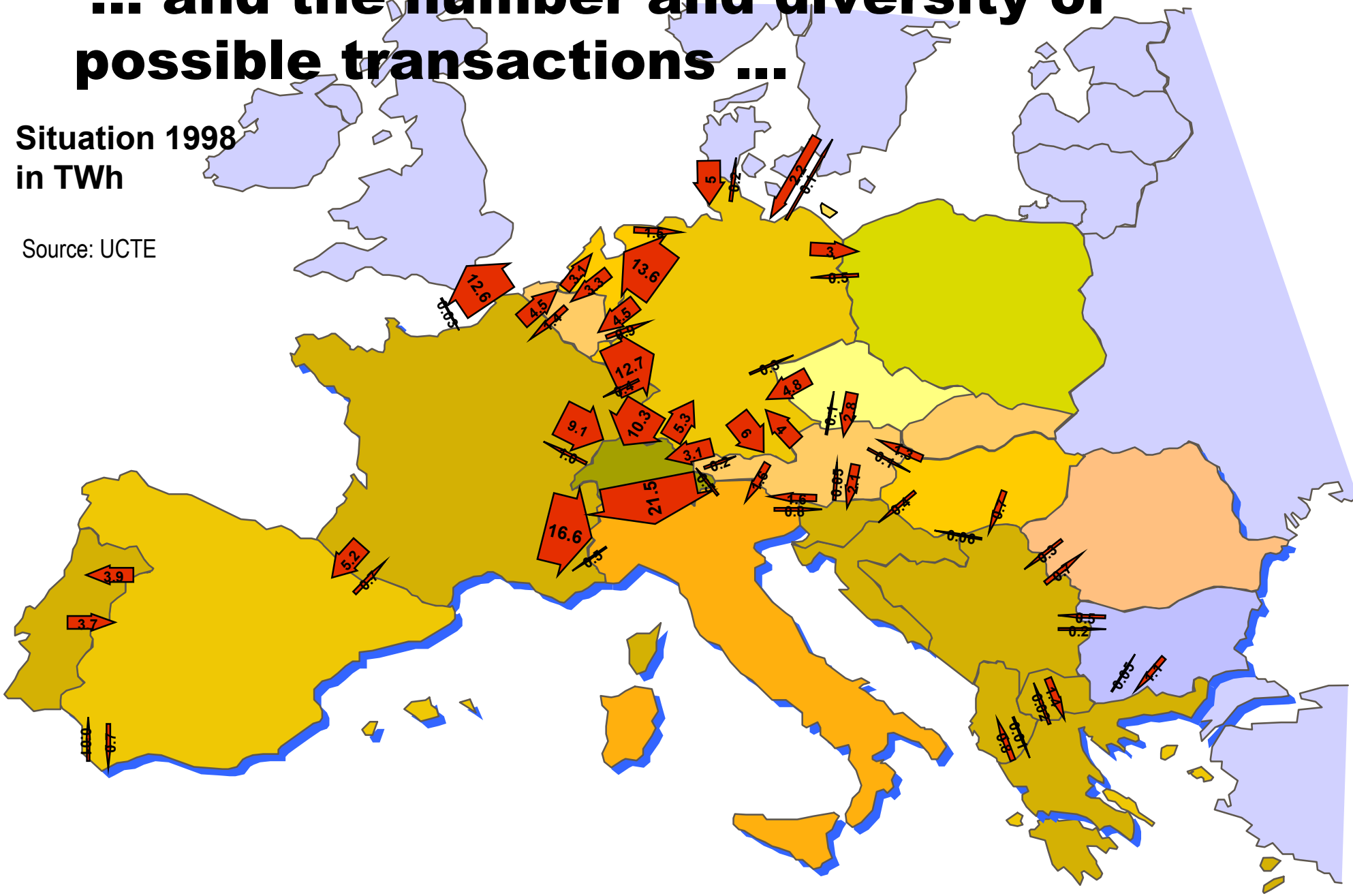
… and the flow pattern for a single transaction …



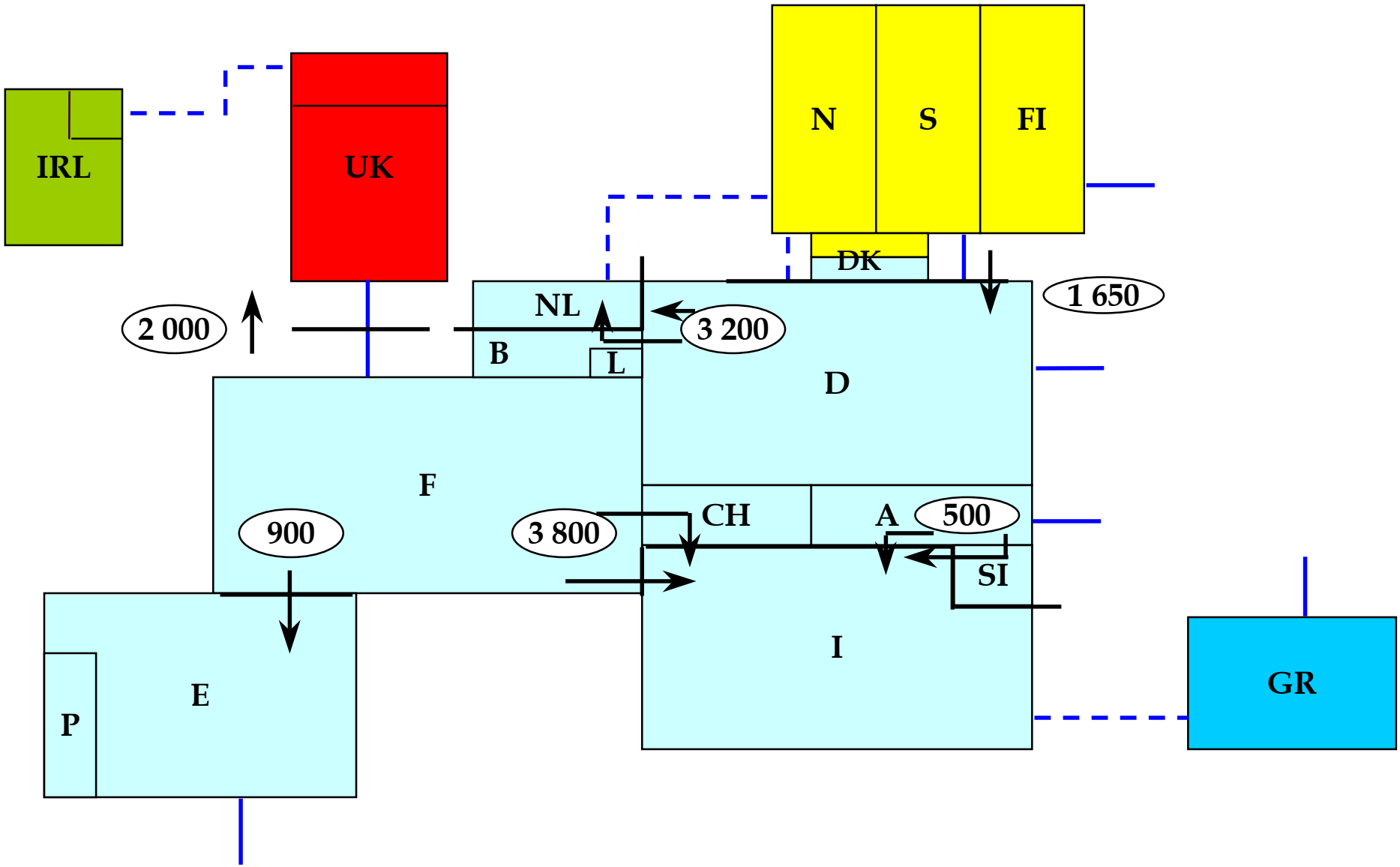
… and the number and diversity of possible transactions …

Situation 1998
in TWh

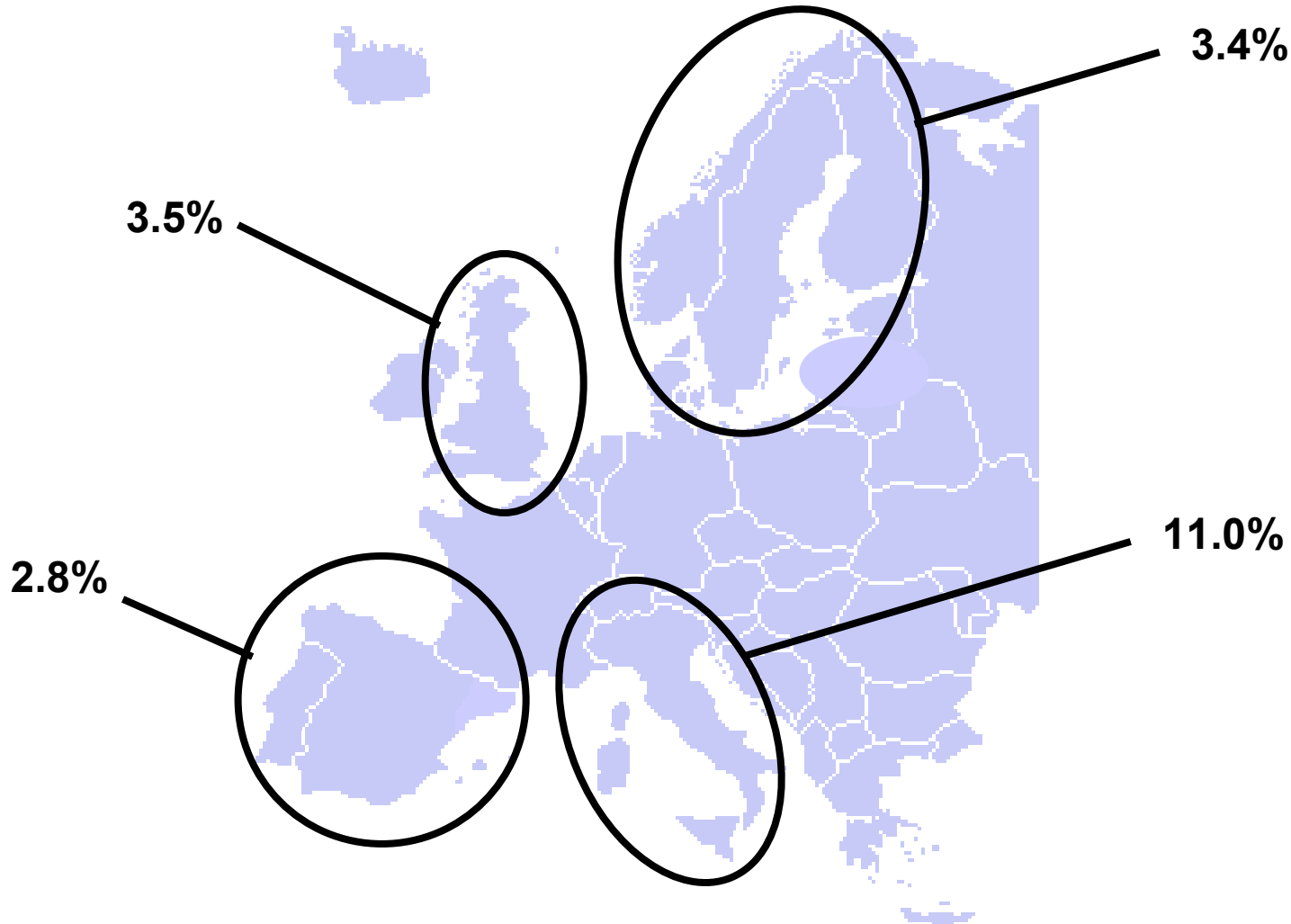
Source: UCTE



… in the presence of network capacity limits …



… resulting in poorly connected regions



Ratios between interconnection capacity and peak load

Sources: DGTREN, ETSO, Nordel y REE

The response to the challenge

- Regulation that results in a level playing field for the Internal Electricity market (IEM) of the EU, where all market parties could act on the basis of sound & effective economic signals for the wider benefit of European electricity consumers
- The CEER considers this as a highly ambitious goal, but it believes that a practical approach is possible

The response to the challenge

- The CEER agenda for development of the long-term mechanism for cross-border trade issues
- Three different but interrelated lines of action
  - inter-TSO payments
  - harmonization of national tarification methods
  - congestion management & other interconnection issues such as new investment

Outline

- **The long-term mechanism for inter-TSO payments**
  - **The principles**
  - The methodology

The principles (1)

- Separation (almost complete) of the economic signals for operation & for network cost recovery
  - Operation: congestion management & losses
  - Network cost recovery: (annual) network tariffs
- No cross-border tariffs, but inter-TSO payments
  - with the net balance of inter-TSO payments each country modifies its internal G & L tariffs
  - final G & L tariffs should not be transaction-based

The principles (2)

- The mechanisms of inter-TSO payments
  - Countries are compensated for their cross-border transaction incurred costs: losses & some measure of network use
  - Countries are charged for the cross-border transaction costs they cause in other countries
- The purpose of inter-TSO payments
  - Inter-TSO payments do not have the objective nor the capability of emulating precise EU-wide long-term locational signals in transmission tariffs

Open issues initially

- Definition of the horizontal network
- Determination of the assets of a country that are subject to cross-border transaction use
- Economic evaluation of these assets
- Allocation of the compensation due to a country as charges to other countries
- Procedure to apply the net result of compensations & charges of a country as a modification of its internal network tariffs G & L

Procedural issues

- CEER: responsible for the conceptual & regulatory framework
- ETSO: responsible for the detailed development & implementation, under the supervision of CEER
- Joint CEER / ETSO verification of results

Outline

- **The long-term mechanism for inter-TSO payments**
  - The principles
  - **The methodology**

The methodology for CBT

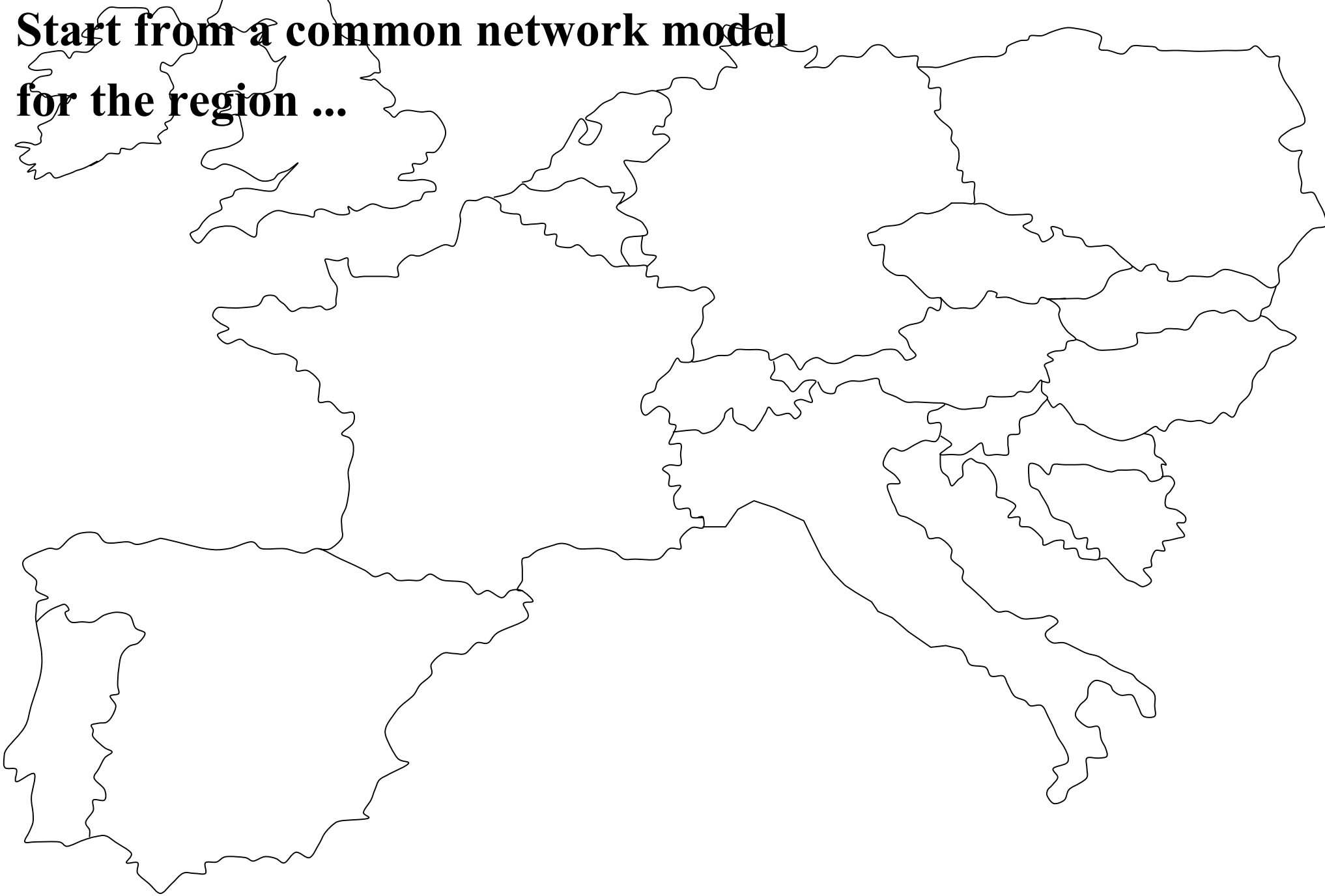
- **Step 1.** Determine the **compensation** that is due to each country/TSO on the basis of the external use of its network & standard network & energy costs
- **Step 2.** Determination of the **charges** to be applied to each country/TSO because of its responsibility in the extra costs of other countries
- **Step 3.** Application of the **net balance** of compensation & charges of a country/TSO to its internal network users

NETWORK COST ALLOCATION

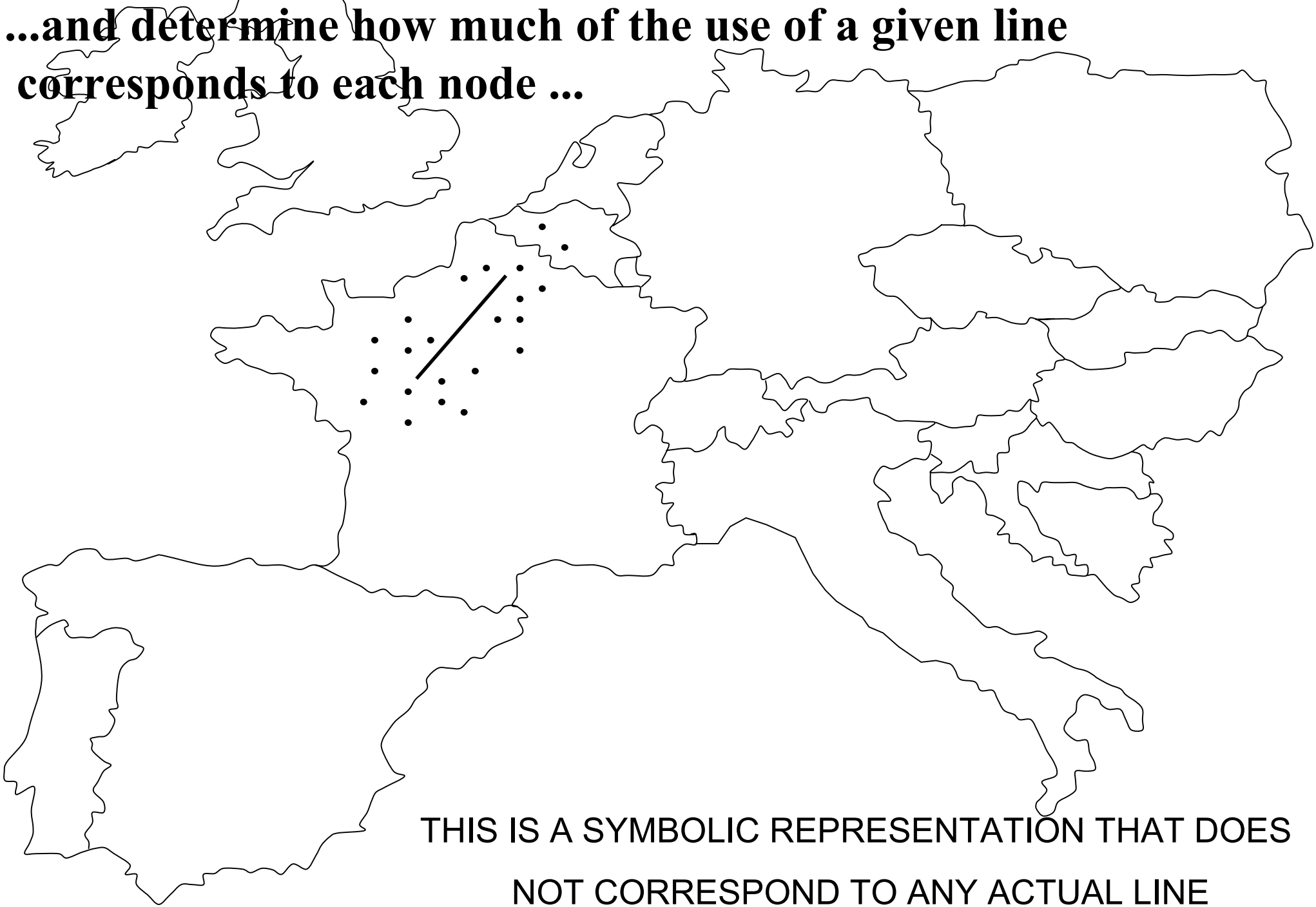
Steps 1 & 2 of the adopted mechanism
How to determine network use?

- Assume a satisfactory "network use allocation algorithm" exists
  - several algorithms have been proposed & the requirements of data & computation are not excessive
  - the algorithm, -ignoring political borders-, can assign the responsibility for the use of any line to the corresponding nodes
  - by aggregation it is straightforward to determine the fraction of the network of a country that can be attributed to external use and how much of it must be assigned to each external country

Start from a common network model for the region ...

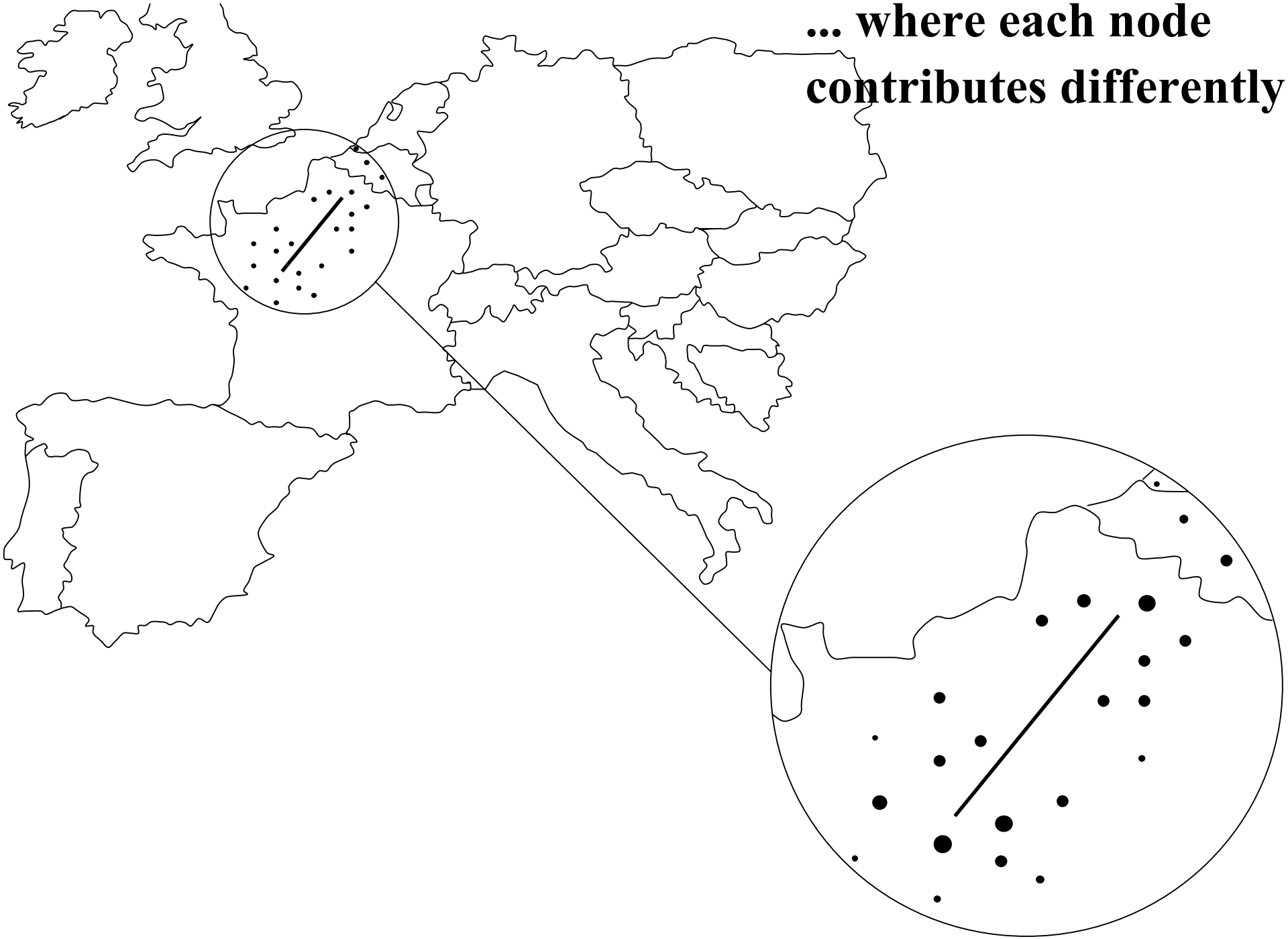


...and determine how much of the use of a given line corresponds to each node ...

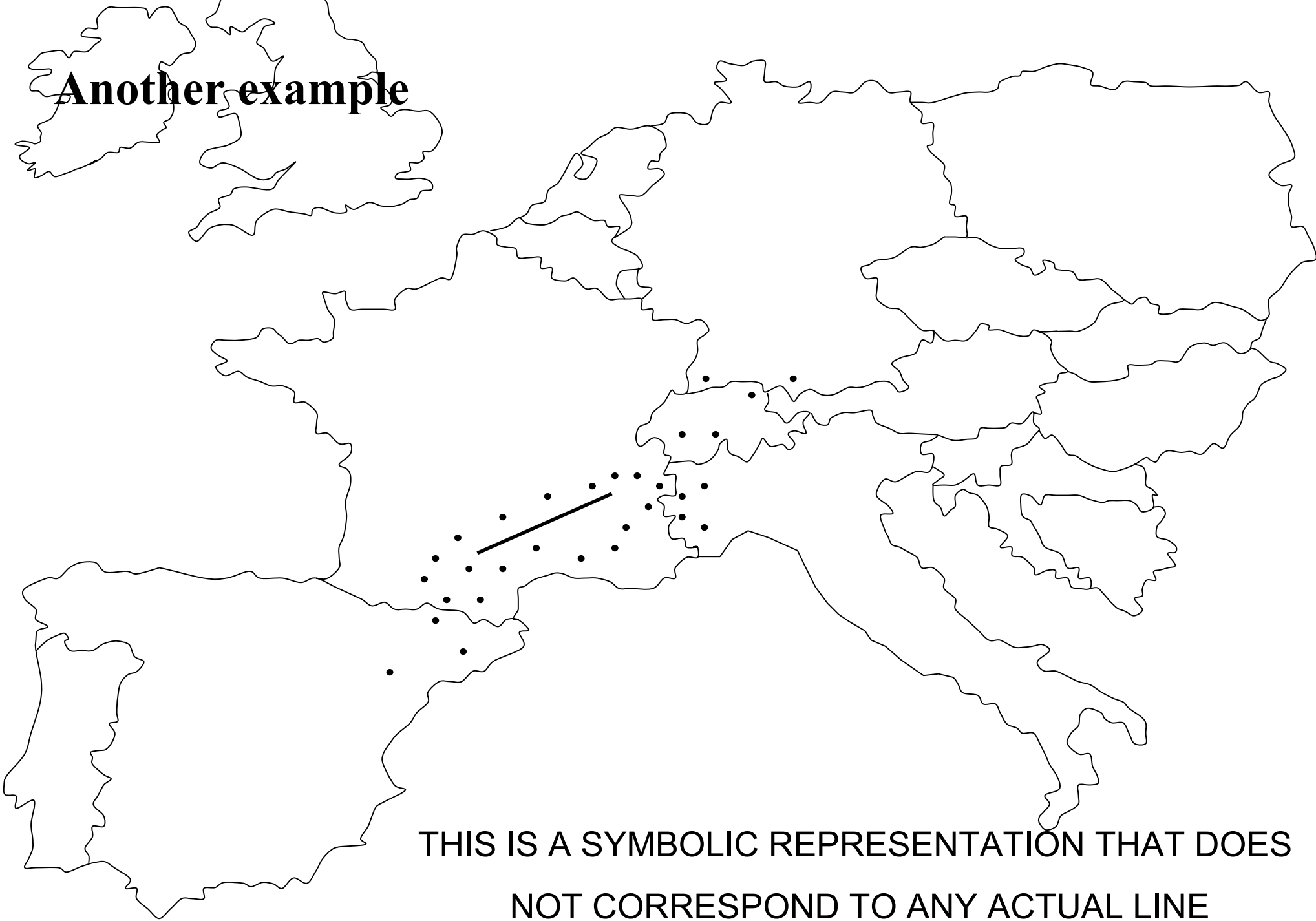


THIS IS A SYMBOLIC REPRESENTATION THAT DOES NOT CORRESPOND TO ANY ACTUAL LINE

... where each node contributes differently



Another example



THIS IS A SYMBOLIC REPRESENTATION THAT DOES NOT CORRESPOND TO ANY ACTUAL LINE

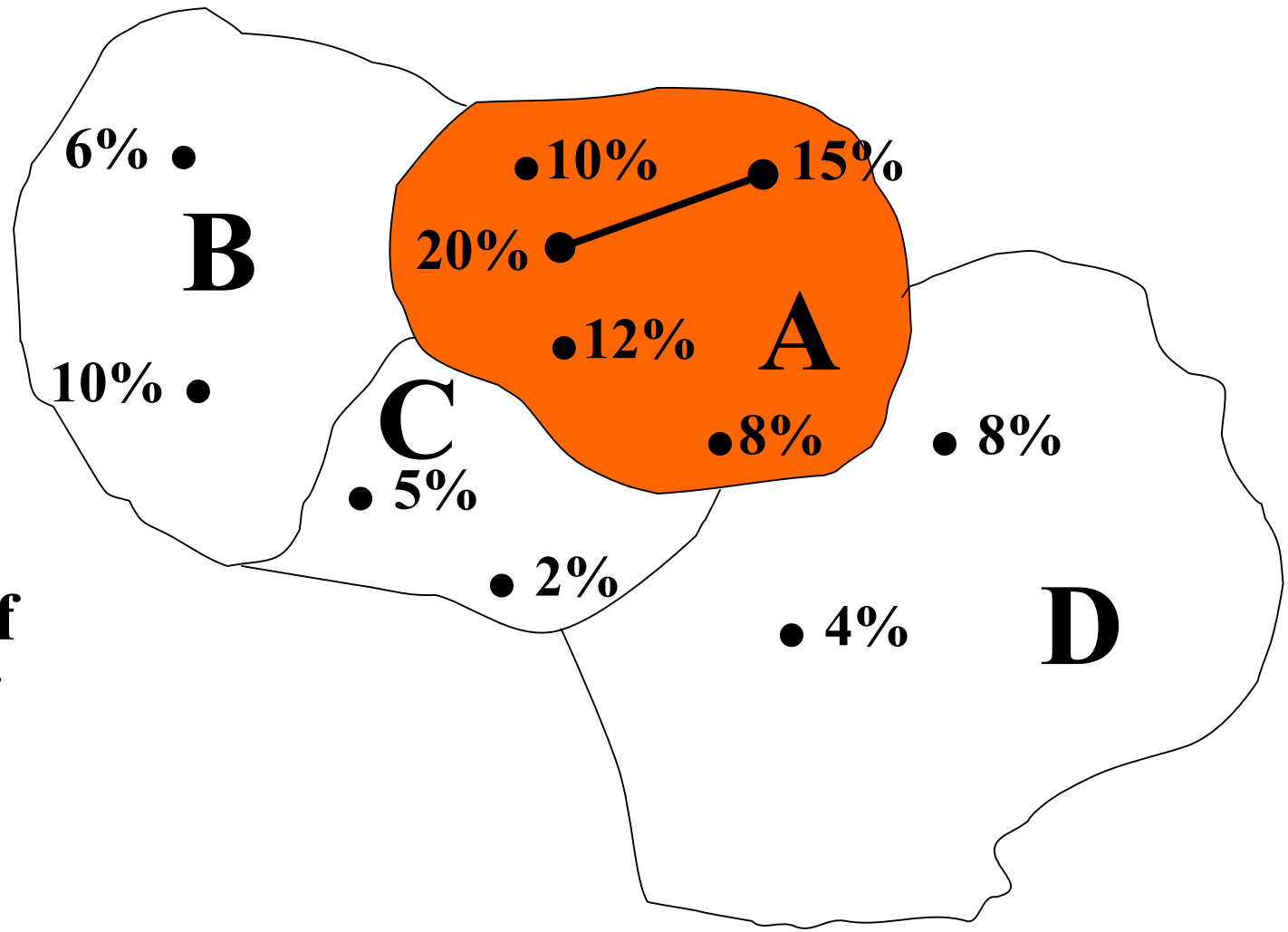
Example: a line in country A

B: 16% of use of the line in A

C: 7% of use of the line in A

D: 12% of use of the line in A

THEN: 35% of external use of the line in A



Example: aggregation of results for the line in A

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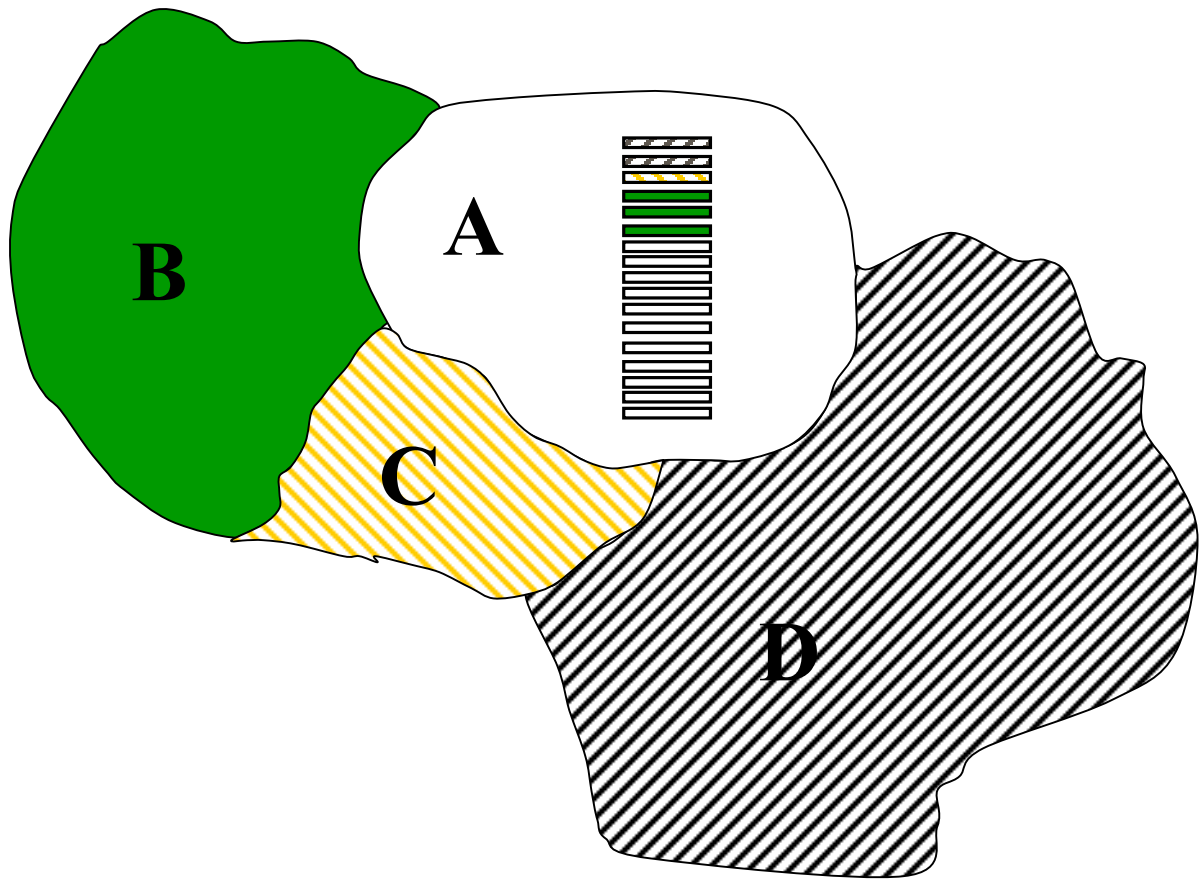
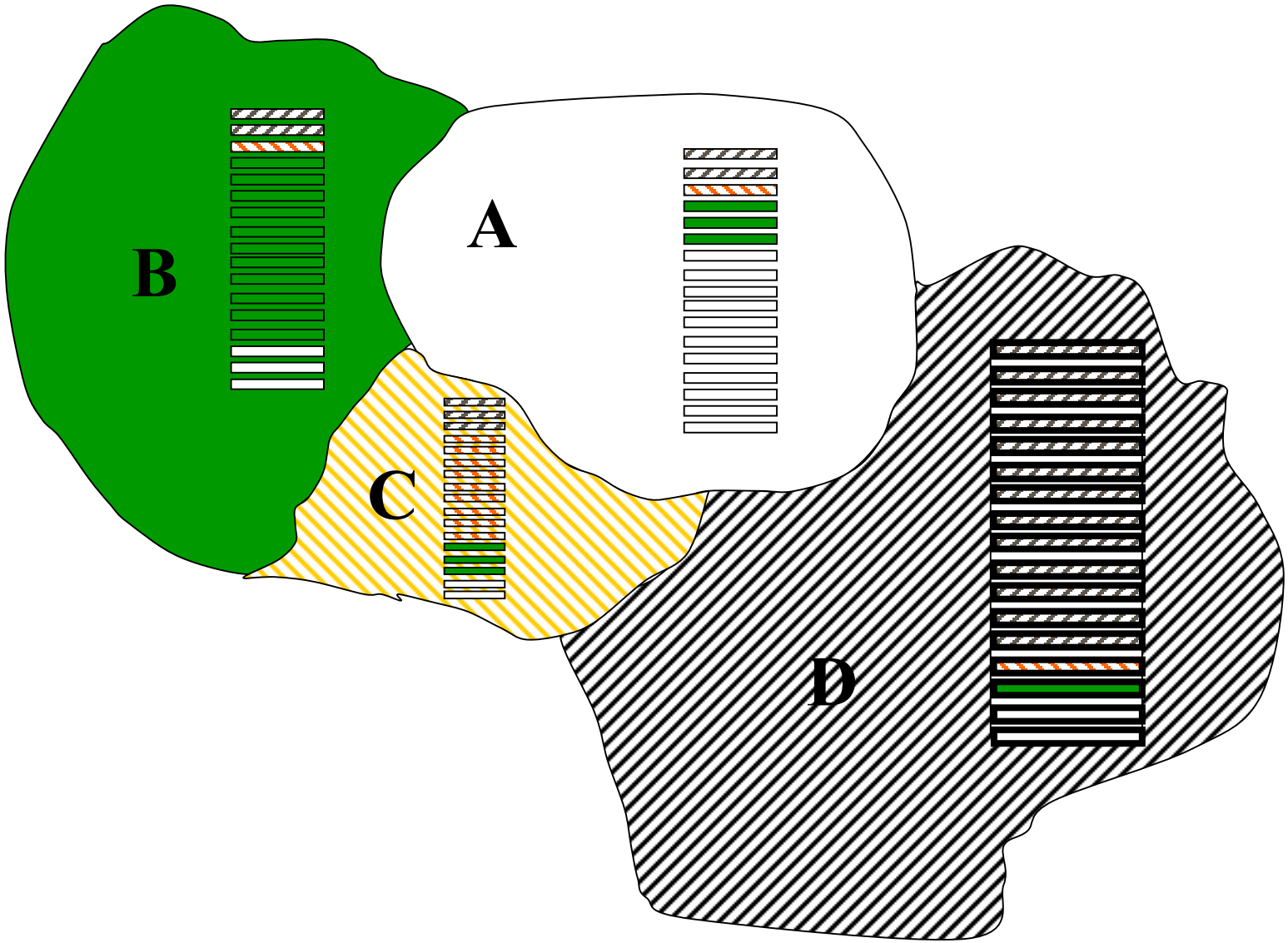
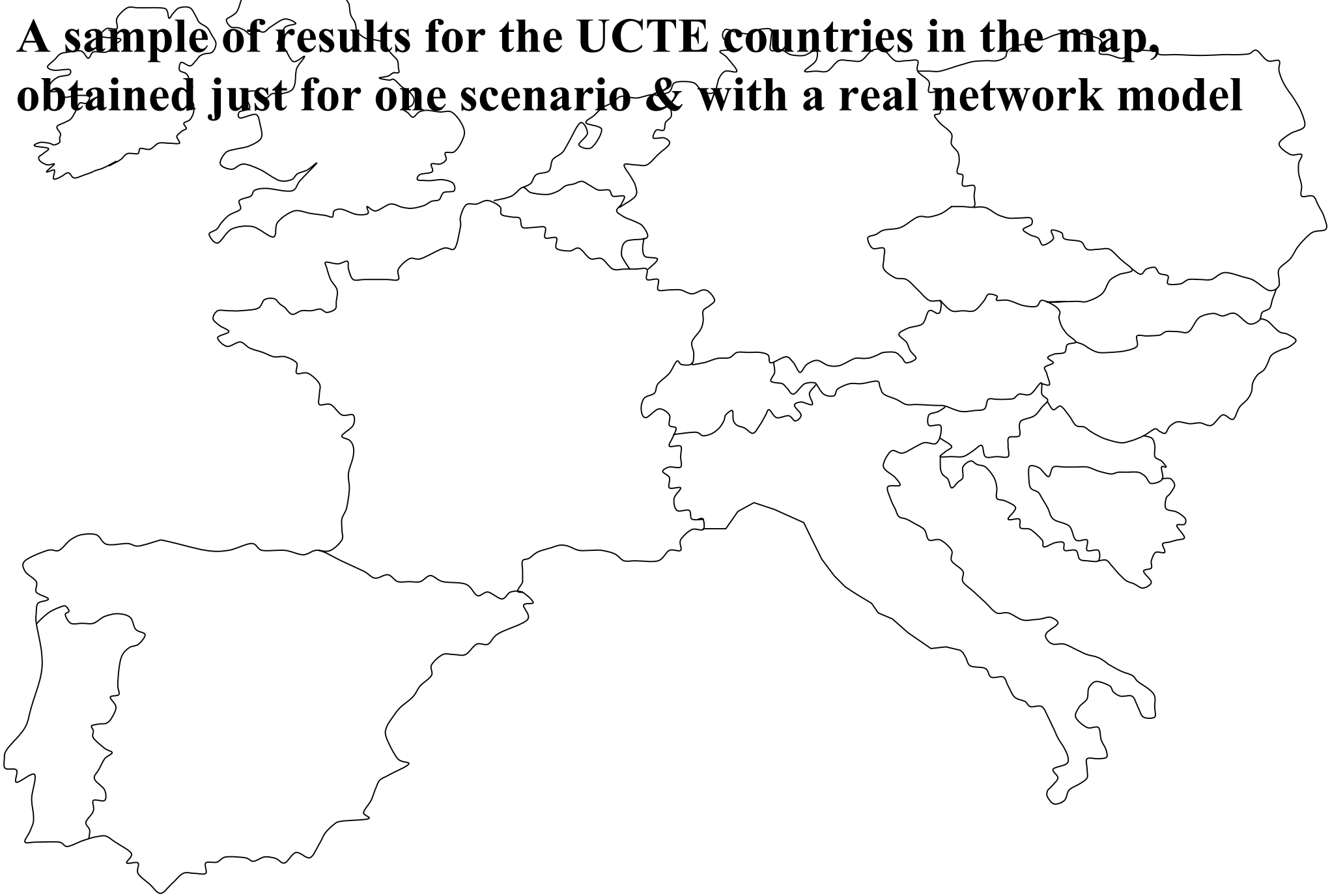


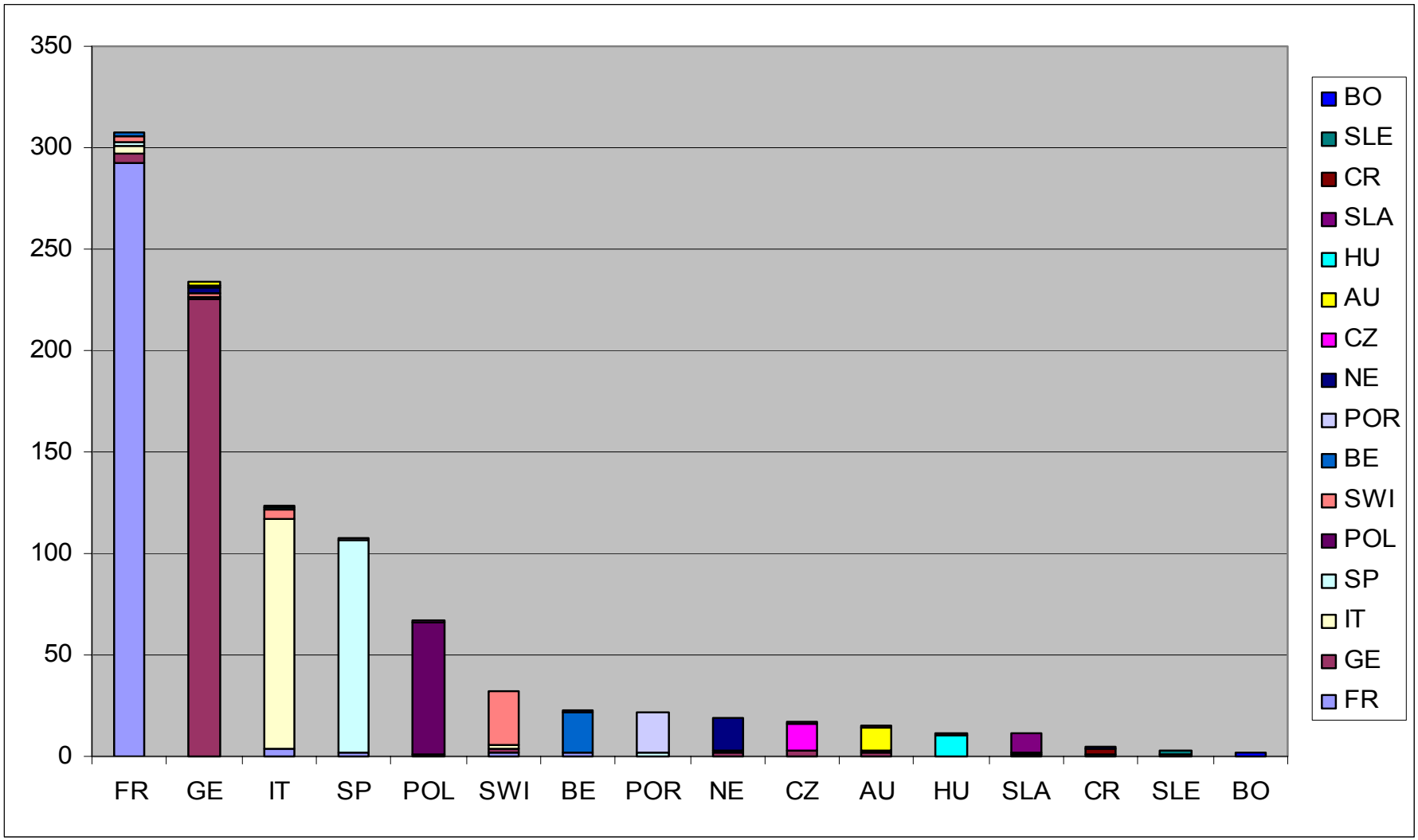
Example: aggregation of results for all lines in all countries



A sample of results for the UCTE countries in the map, obtained just for one scenario & with a real network model

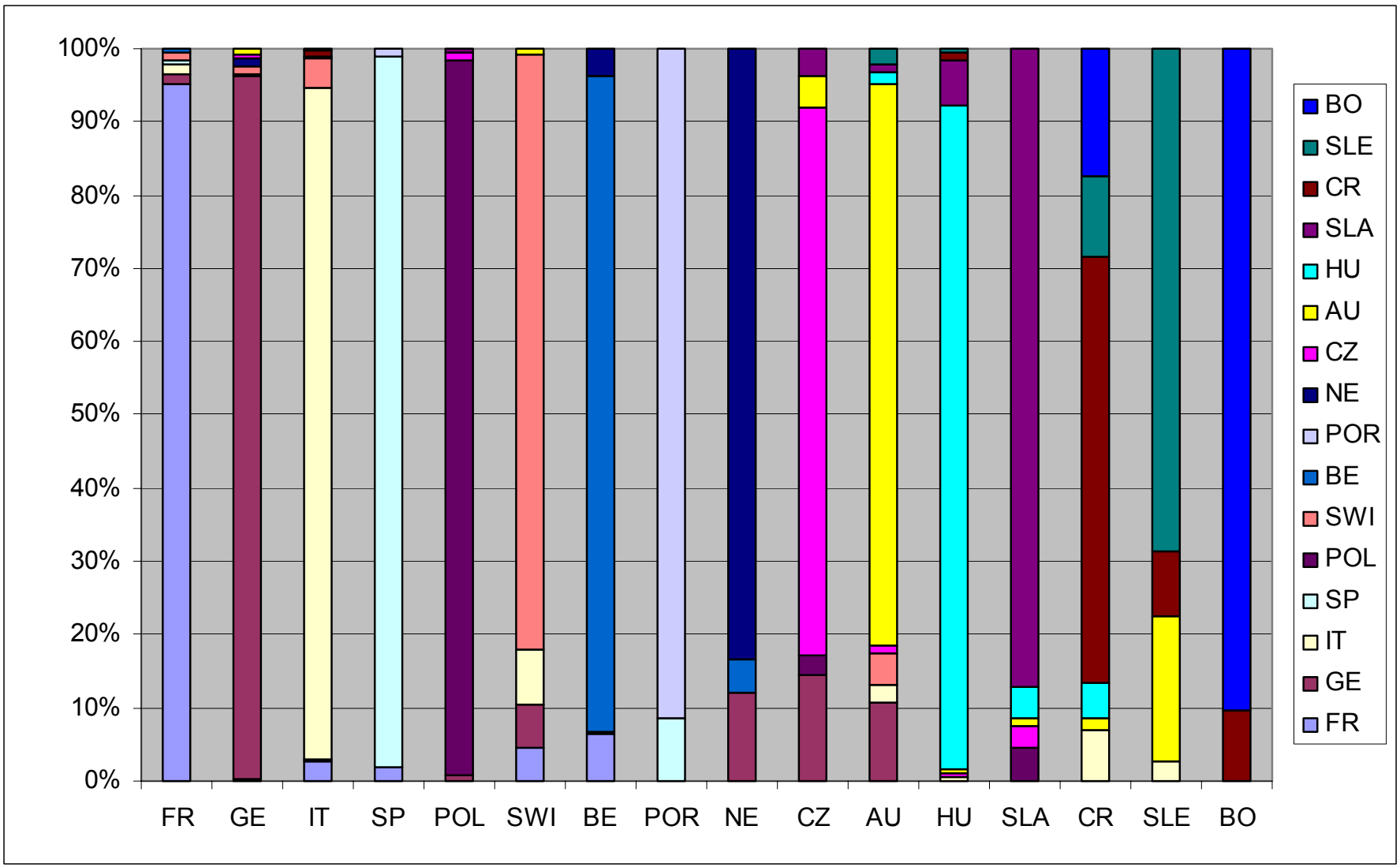


Sample case results for the 16 UCTE countries in the map



Results in number of equivalent lines (all assumed of equal length)

Same result in % for each country



Sample case results (Obtained with average participations. The figures represent % of total volume of UCTE network assets)

	FR	GE	IT	SP	POL	SWI	BE	POR	NE	CZ	AU	HU	SLA	CR	SLE	BO
FR	29.26	0.04	0.34	0.19	0.00	0.15	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GE	0.45	22.49	0.01	0.00	0.05	0.19	0.01	0.00	0.23	0.25	0.16	0.00	0.00	0.00	0.00	0.00
IT	0.40	0.00	11.32	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.04	0.01	0.00	0.03	0.01	0.00
SP	0.16	0.00	0.00	10.45	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
POL	0.00	0.09	0.00	0.00	6.56	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.05	0.00	0.00	0.00
SWI	0.33	0.22	0.49	0.00	0.00	2.61	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00
BE	0.13	0.01	0.00	0.00	0.00	0.00	2.04	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00
POR	0.00	0.00	0.00	0.11	0.00	0.00	0.00	2.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE	0.00	0.30	0.00	0.00	0.00	0.00	0.08	0.00	1.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CZ	0.00	0.08	0.00	0.00	0.07	0.00	0.00	0.00	0.00	1.28	0.02	0.01	0.03	0.00	0.00	0.00
AU	0.00	0.20	0.05	0.00	0.00	0.02	0.00	0.00	0.00	0.07	1.15	0.01	0.01	0.01	0.06	0.00
HU	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	1.00	0.05	0.02	0.00	0.00
SLA	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.06	0.01	0.07	0.96	0.00	0.00	0.00
CR	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.28	0.03	0.02
SLE	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.05	0.22	0.00
BO	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.21
	30.75	23.44	12.34	10.75	6.71	3.21	2.28	2.20	1.89	1.71	1.50	1.10	1.10	0.47	0.31	0.23

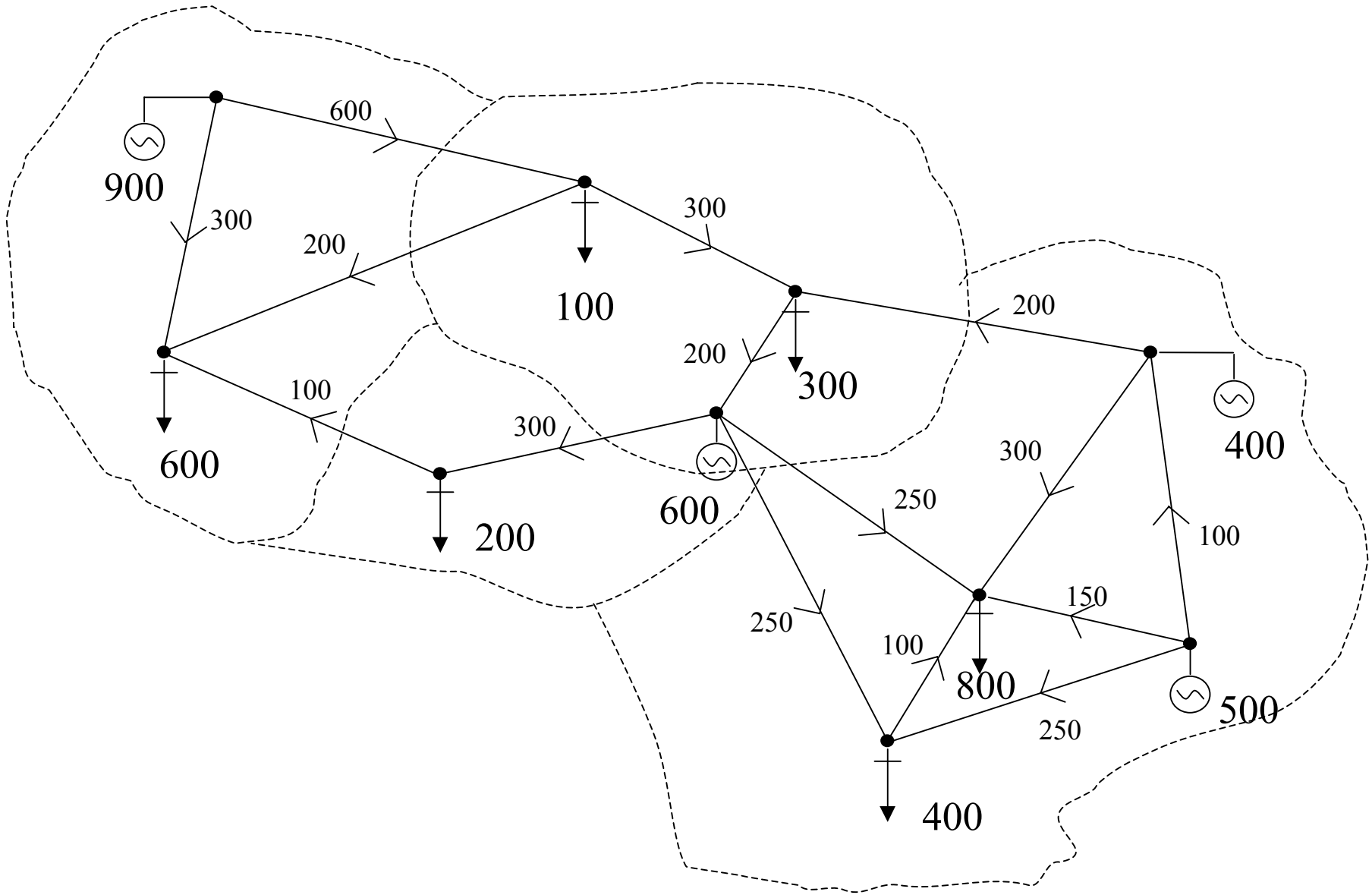
COLUMNS: use of the network of a country by every country (including itself)

ROWS: use by a country of the networks of all countries, including itself

Computation requirements

- The massive volume of computations that is required should not be considered a problem
  - A standard PC (Pentium II, 266 MHz, 128 MB of RAM) employed 3 minutes to run the example above (a winter peak load scenario, with 3655 lines, 3383 nodes & 16 countries)
- However, a major (but feasible) effort is needed to obtain the data to feed the real network models (a sufficient number of representative load flow scenarios)

This is how the “average participations” algorithm works (I)



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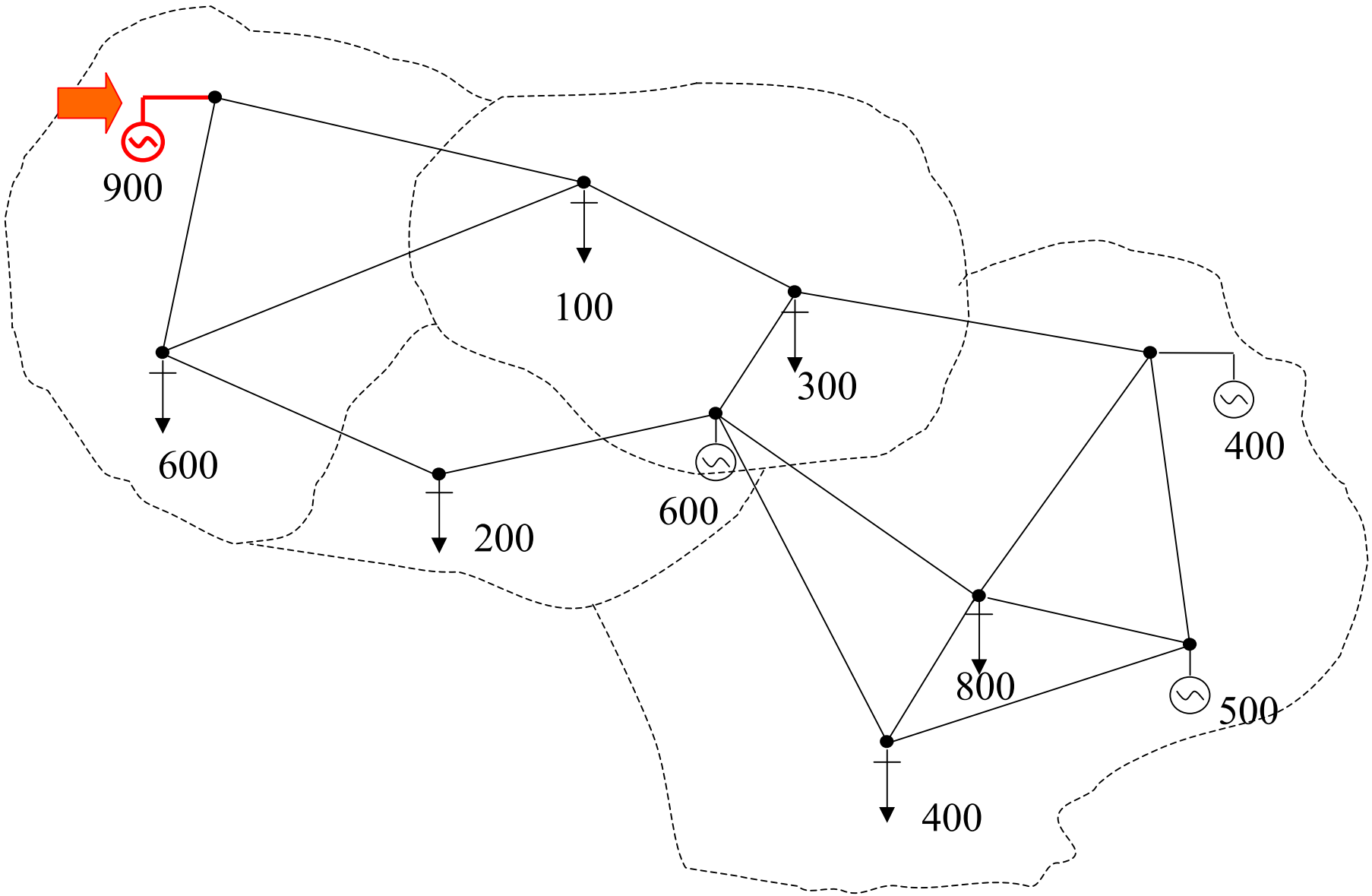

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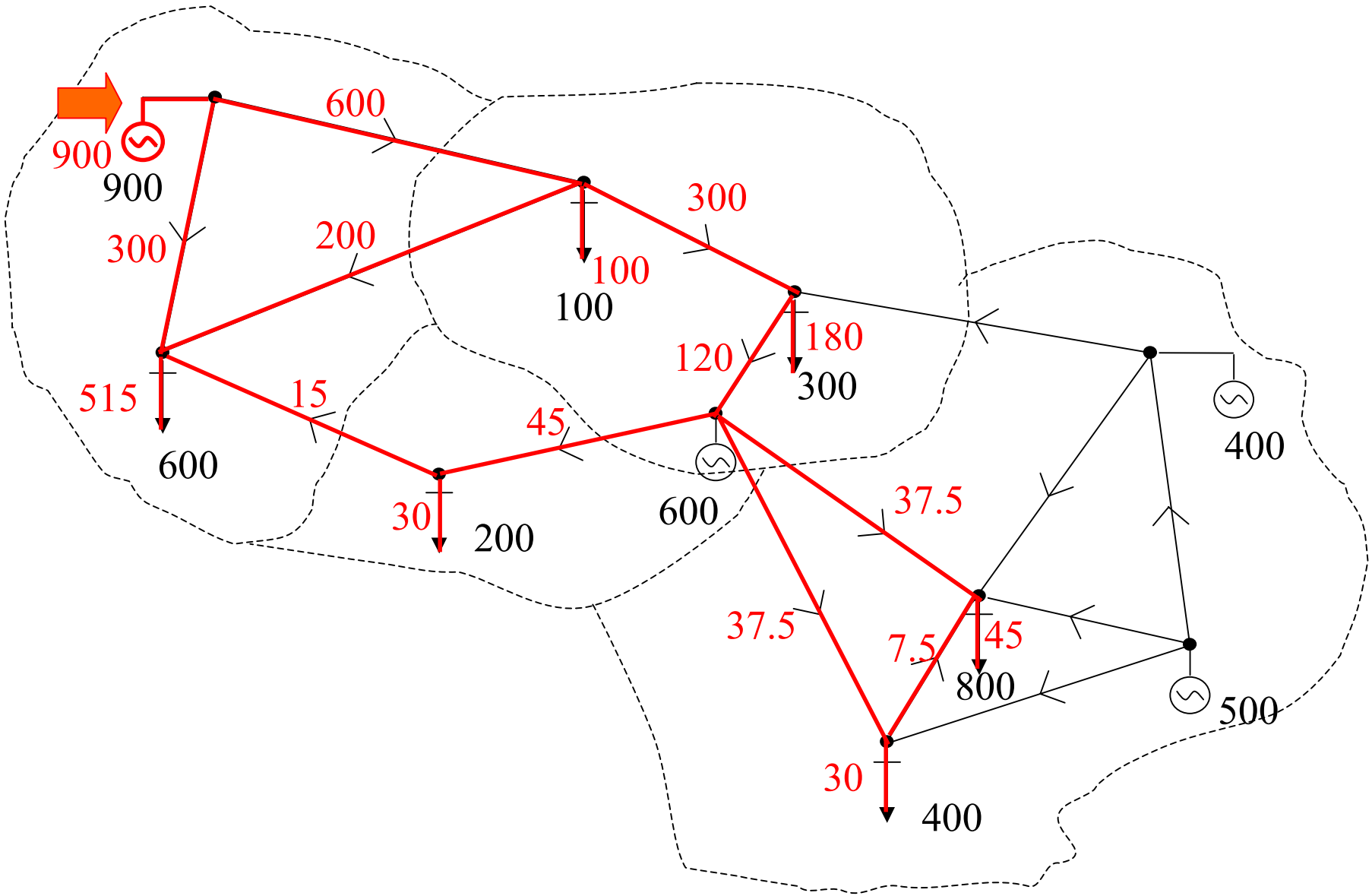
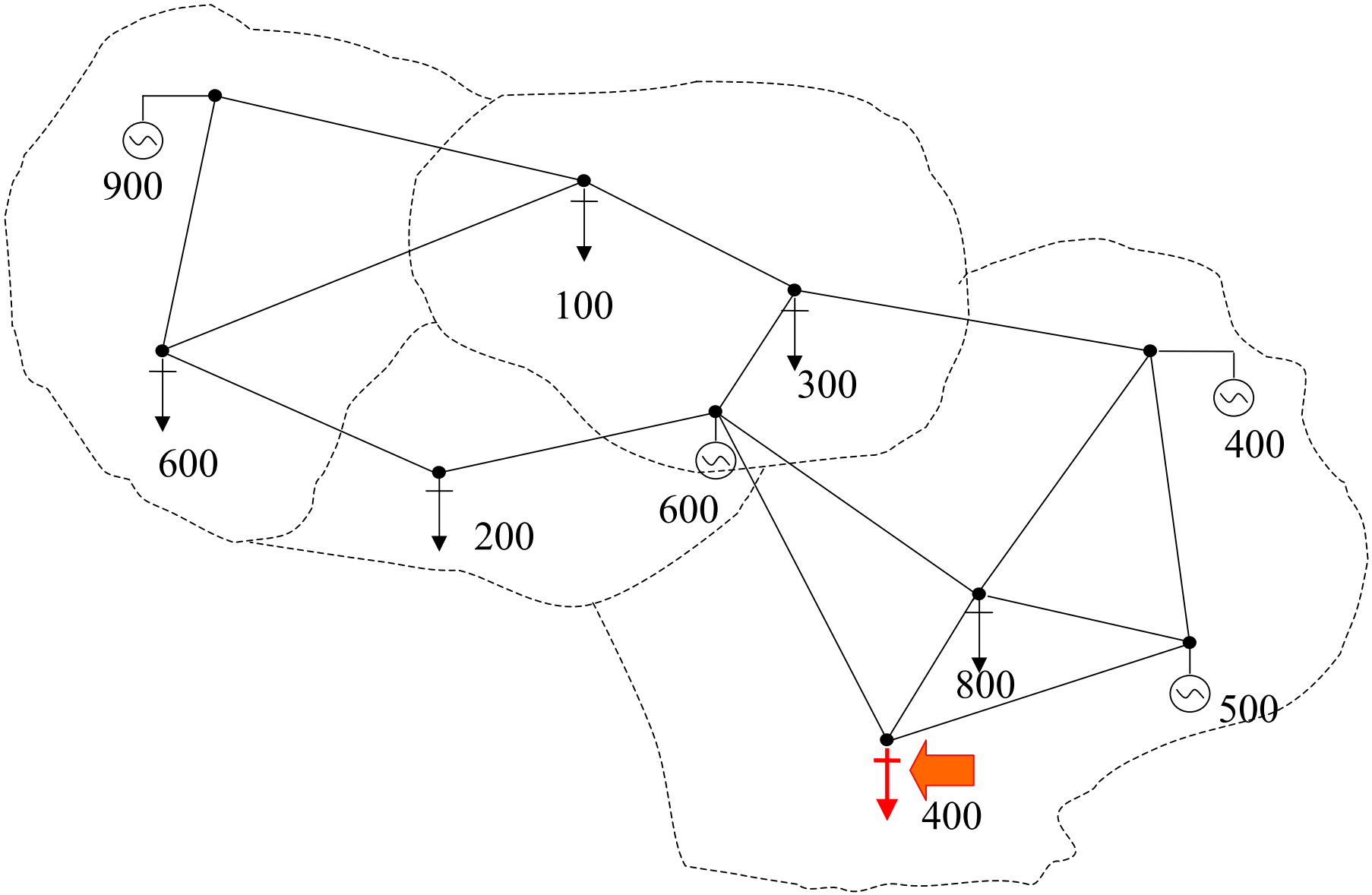


This is how the “average participations” algorithm works (II)



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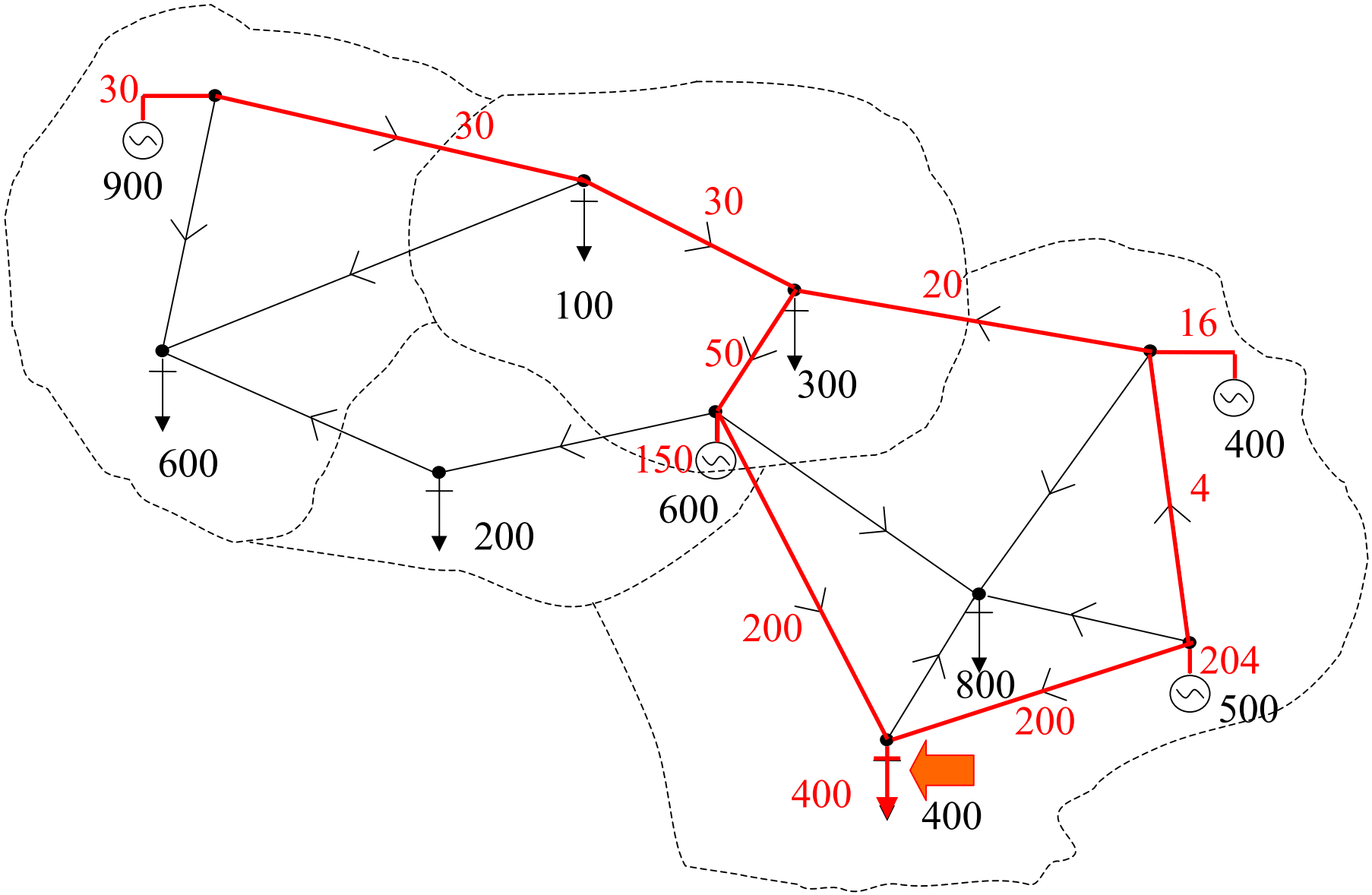
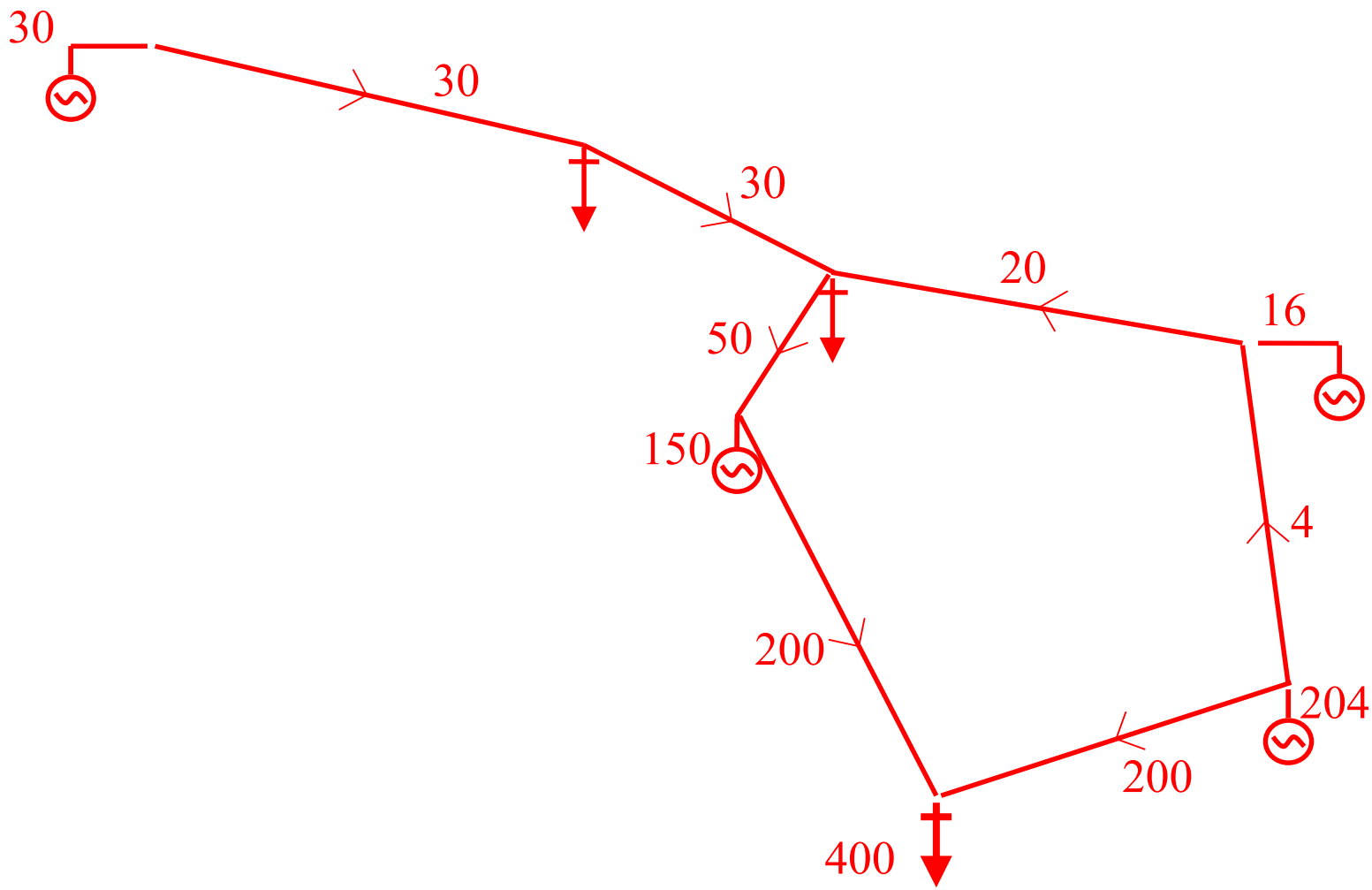
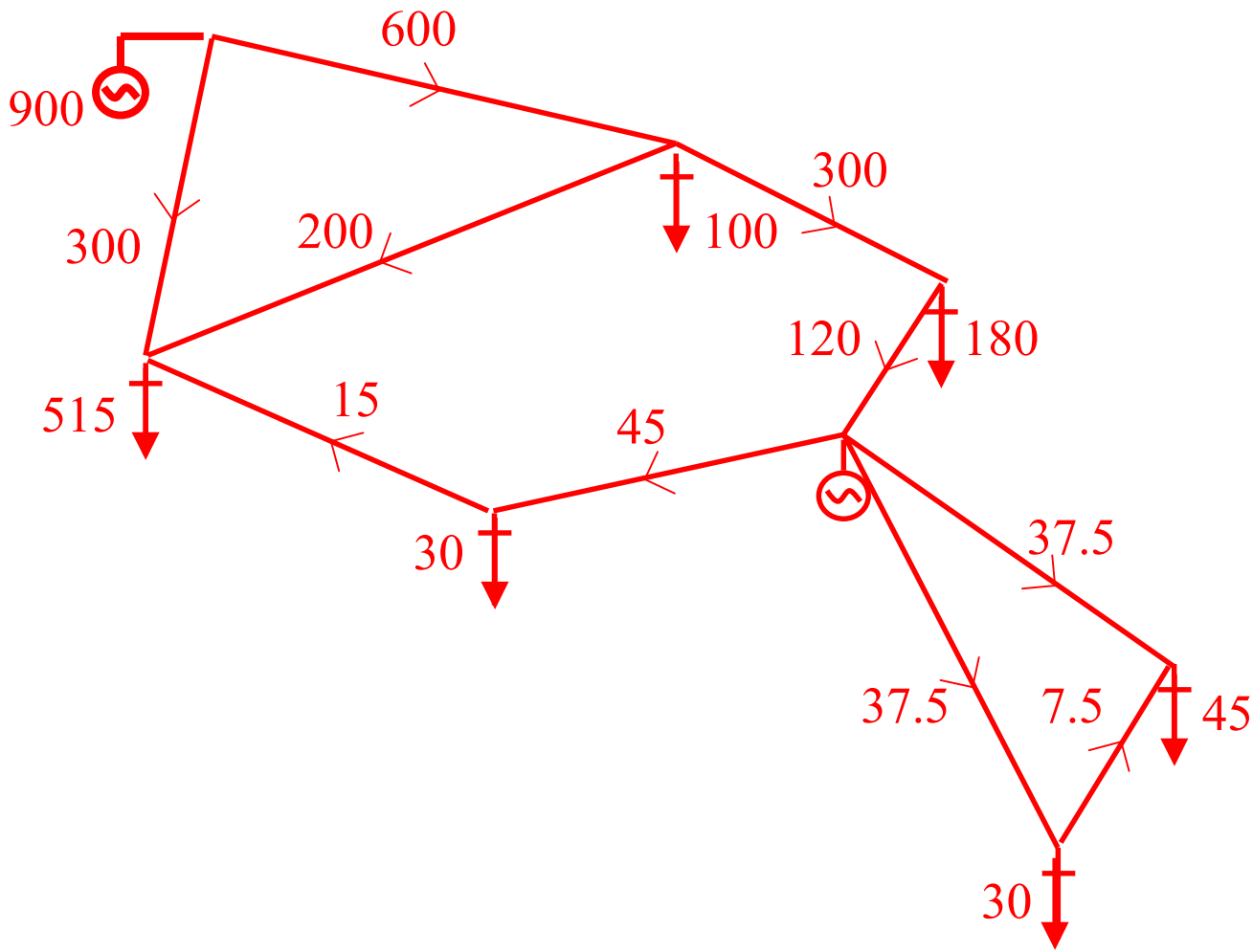


Flow pattern that feeds a load node



Flow pattern fed by a generation node



Example: Allocation of the flow of a branch to the nodes of the system

The branch to be considered in the example is the one between the nodes of LACHMAT and MUENCHWI, in Germany

Bus Name	Relative contribution to the branch flow
CHAMOSON	0.36%
LEIBSTAD	32.39%
DAXLANDE	1.75%
LACHMATT	50.86%
MITTELBE	4.60%
KK PHILI	6.11%
KUEHMOOS	3.94%

The need to use standard costs

- It is difficult to accept significant inter-TSO payments on the basis of presently authorized transmission costs that result in widely different per unit costs for comparable facilities
- A common standard of cost for each transmission component, just for the purpose of inter-TSO payments, has to be established
- The actual cost of future lines may be acceptable, if it is the outcome of a competitive bidding process

Other implications of the use of the "network cost allocation algorithm"

- An "exception rule" shall result as a side result of the method
  - establish a threshold based on the ratio of net economic compensations to internal network costs
  - The nature of the "network allocation algorithm" makes it more likely that "comparatively small & heavily transited countries" meet the threshold criterion
- The algorithm may help in the definition of the "horizontal network"
- The algorithm equally applies to existing or future network facilities

Step 3 of the adopted mechanism
Application of net balance

- Start from the net balance of compensation and charges
- The resulting modifications to the G & L charges cannot be transaction based
- The procedure should be consistent with any harmonization criteria for G & L

A pragmatic consideration

"The effort to be placed on perfecting the methodology must be in accordance with the quantitative economic significance of the inter-TSO payments on the ensuing cross-border tarification rules"

A pragmatic consideration *(continuation)*

- Inter-TSO payments do not have the objective nor the capability of emulating precise EU-wide long-term locational signals in transmission tariffs
  - This is consistent with the numerical results that have been obtained in a recent EU transmission benchmarking study and in the temporary methodology for cross-border tarification

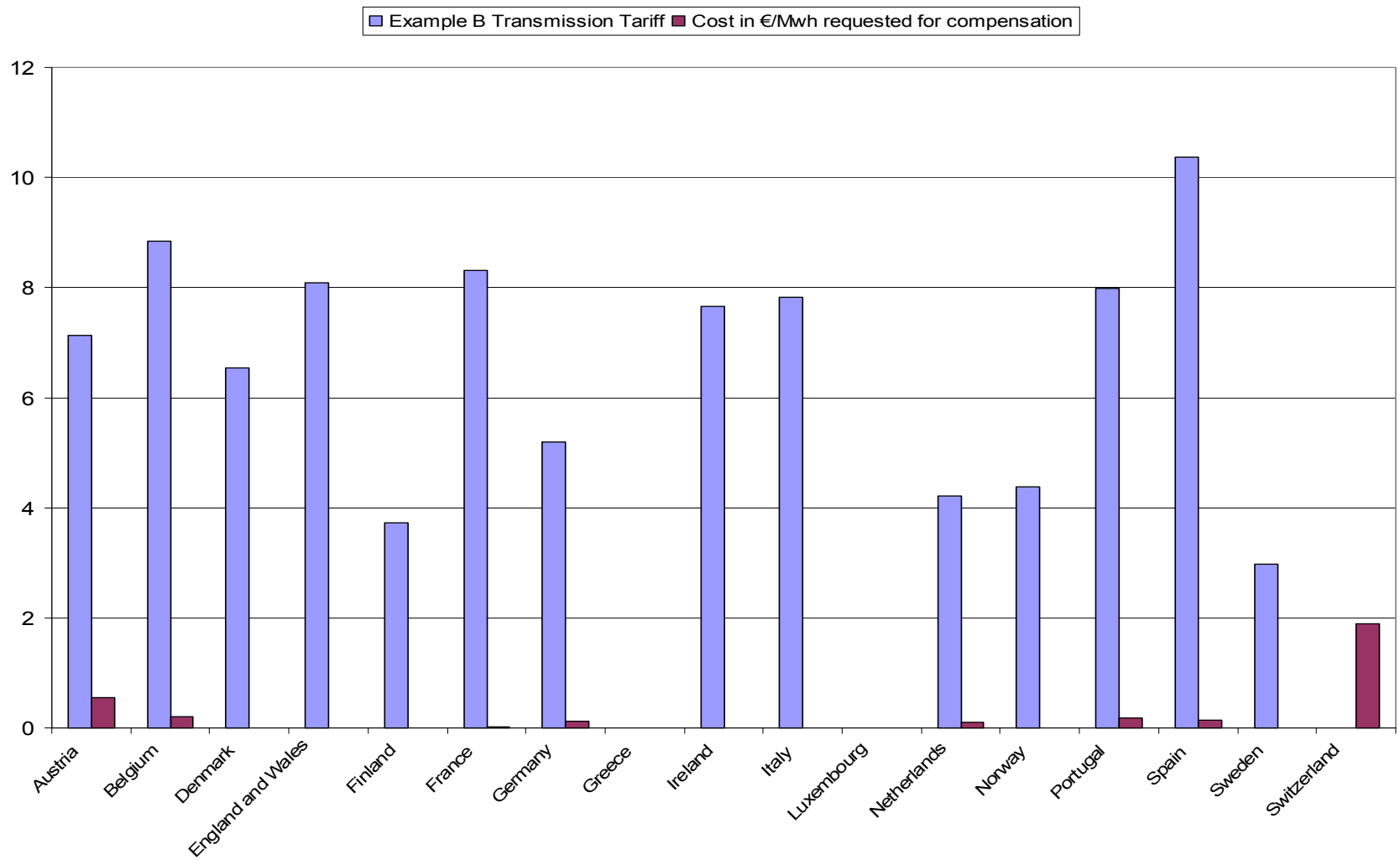
➔ Implications on

- Accepting or rejecting compensations for the existing network & the use of "exceptions"
- Criteria for internal allocation of net payments

Relevance of inter-TSO payments in transmission tariffs

(compensations from a total of 200M euros as pro-rata of volume of transits)

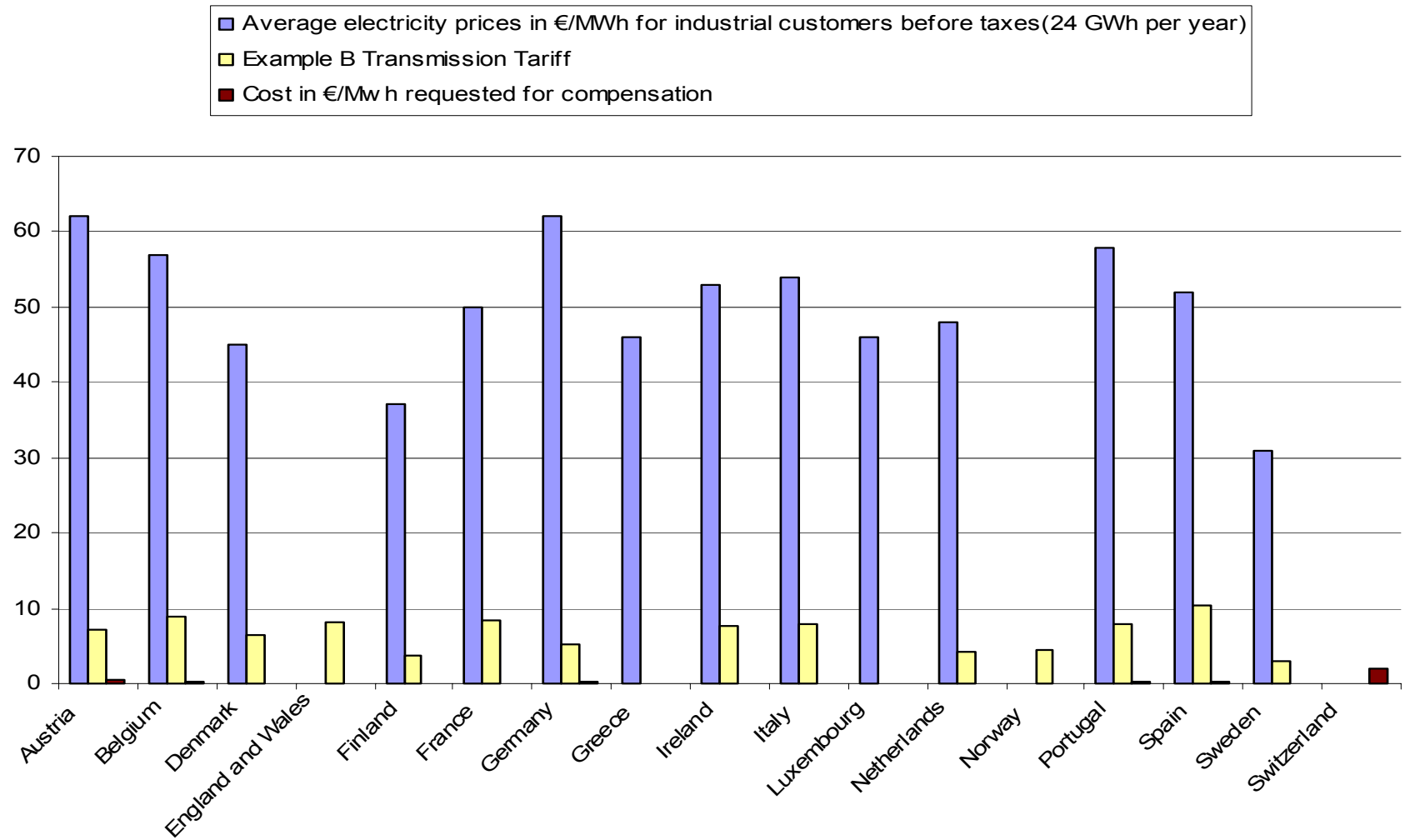
(these are just compensations, prior to netting out with charges)



The transmission components in the integral tariffs

(compensations from a total of 200M euros as pro-rata of volume of transits)

(these are just compensations, prior to netting out with charges)



ALLOCATION OF THE COST OF LOSSES

Loss compensation mechanism
Alternative approaches of interest

- Use nodal pricing as a reference
  - apply loss factors to the physical flows at the border nodes
  - the influence of the choice of "slack node"
- Compute losses for each country with & "without" transits
  - intuitive & easy to understand
  - "transit" is not a well defined concept

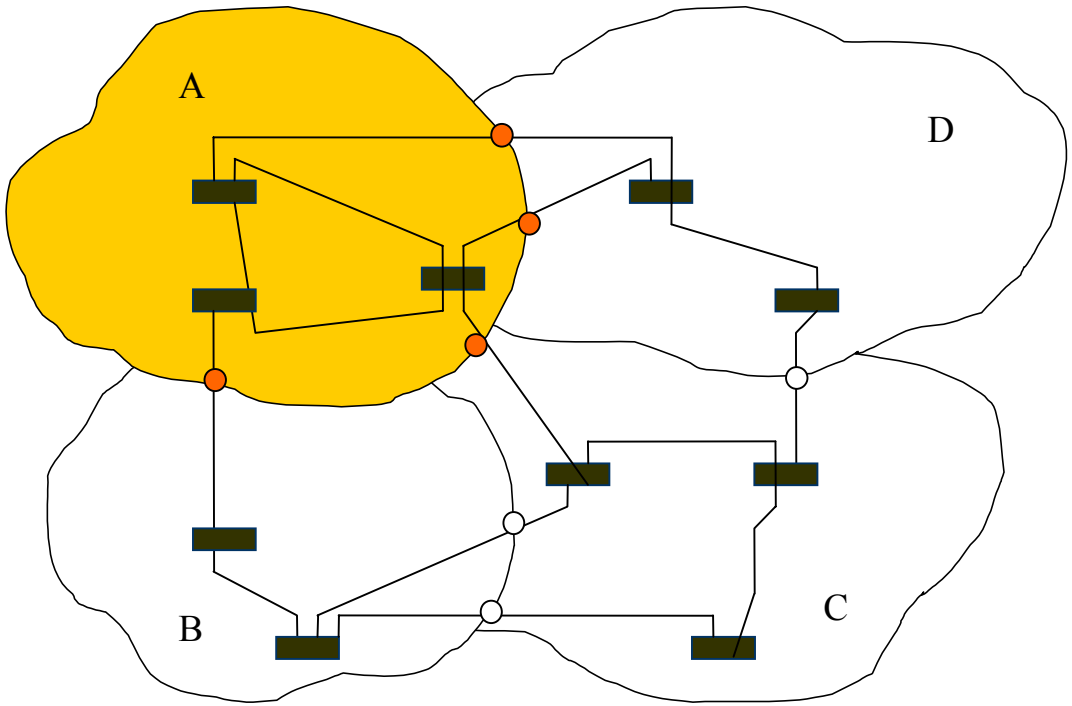
Loss compensation mechanism
Using nodal prices as a reference

- Compensation to a country A because of losses incurred by transits &/or loop flows

$$\sum_k LF_{BORk} \left(EXP_{BORk} - IMP_{BORk} \right)$$

where LF are loss factors at border nodes k of country A, EXP & IMP are export & import flows of country A

Loss compensation mechanism

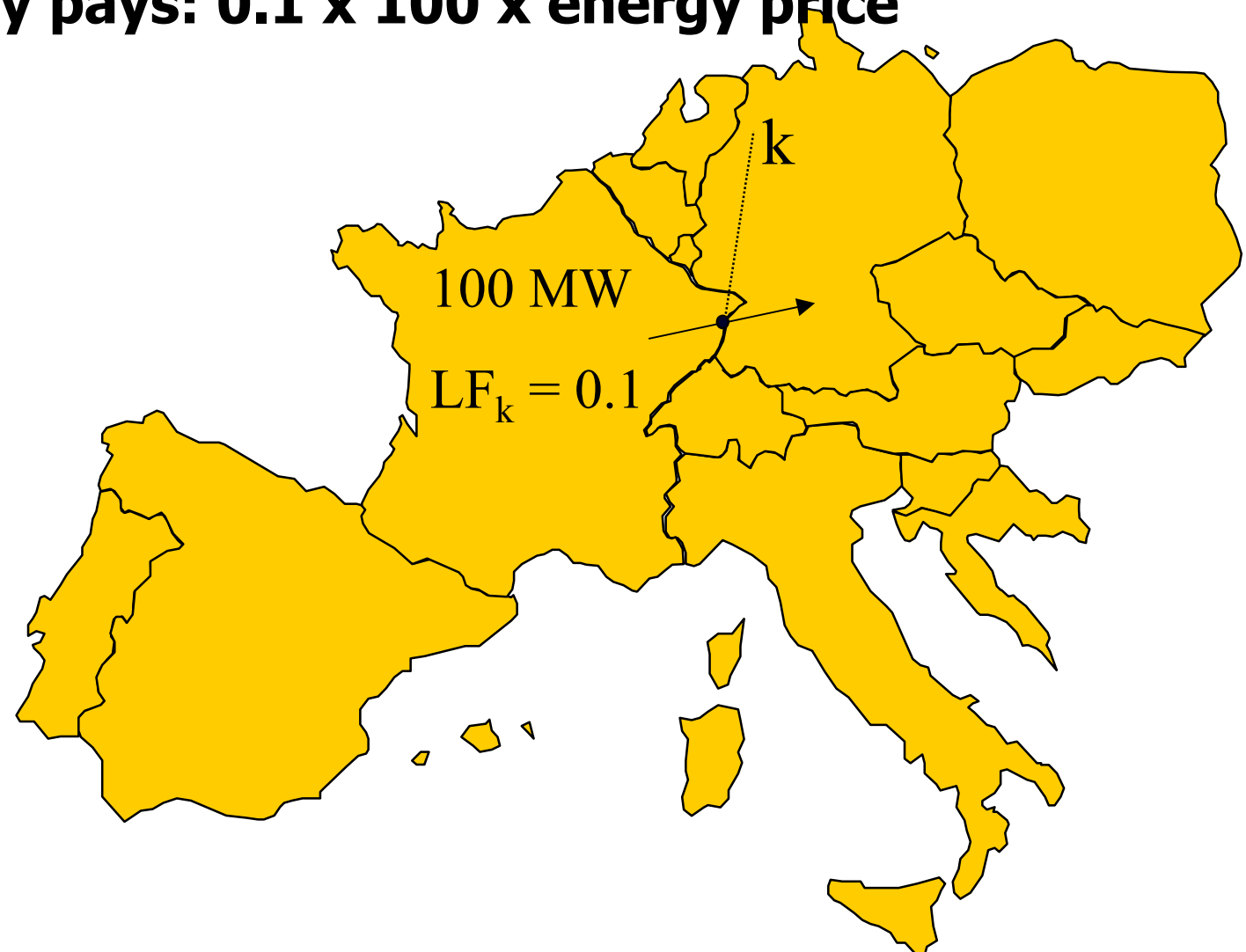


Virtual nodes at the borders
in a regional transmission network

Example

France receives: 0.1 x 100 x energy price

Germany pays: 0.1 x 100 x energy price

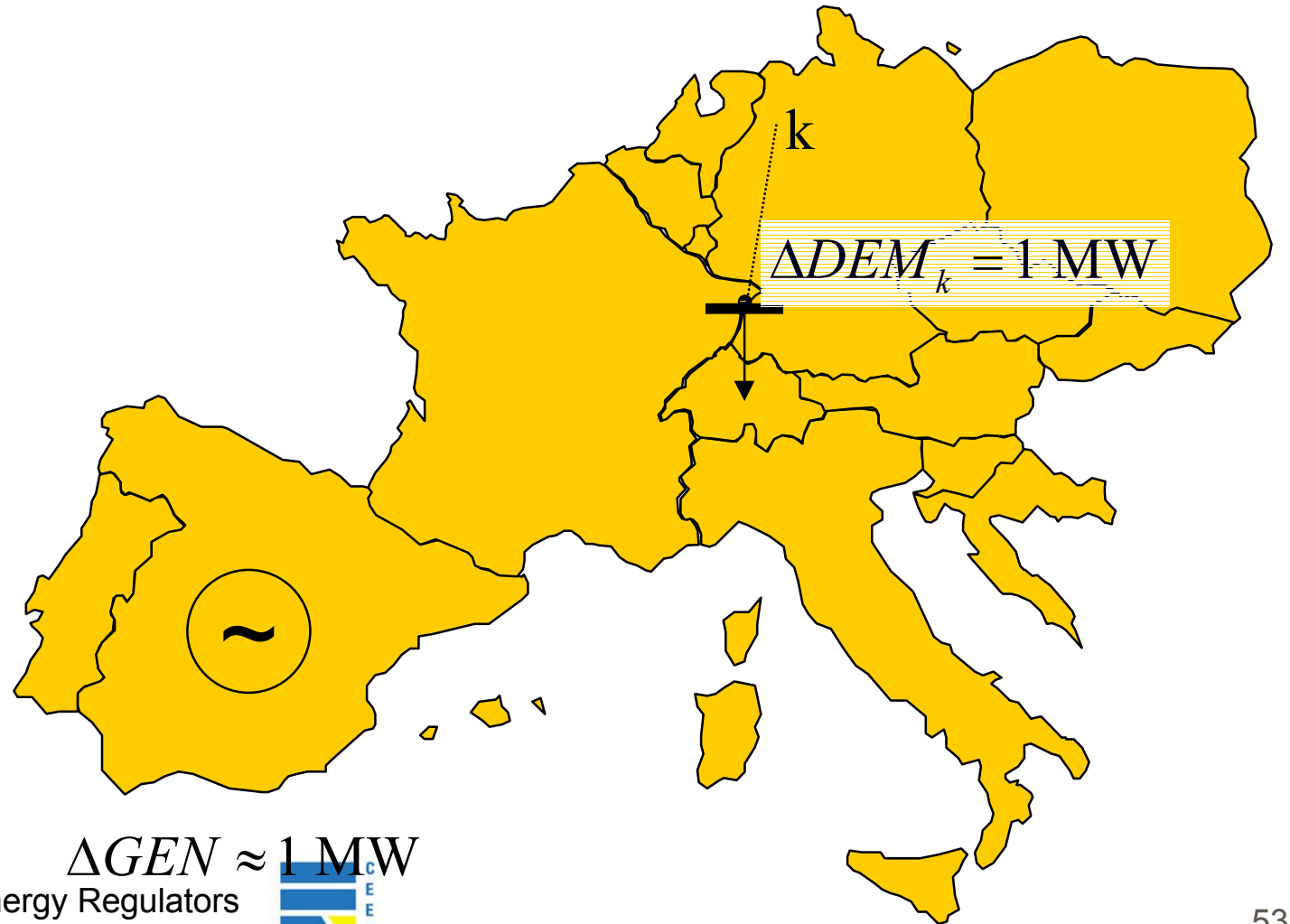


An open computational issue

- The computation of loss factors depends on the choice of the "slack node" *(i.e. the node that responds to the marginal increment in demand)*
- Choices
  - **Any specific node:** much sensitivity to distance to node
  - **Distributed demand:** Exporting countries pay more
  - **Distributed generation:** Importing countries pay more
  - **50/50 distributed generation & demand:** a more neutral situation

Alternative choices of slack

$$LF_k = \frac{\partial Loss}{\partial d_{k|slack}}$$



Alternative choices of slack

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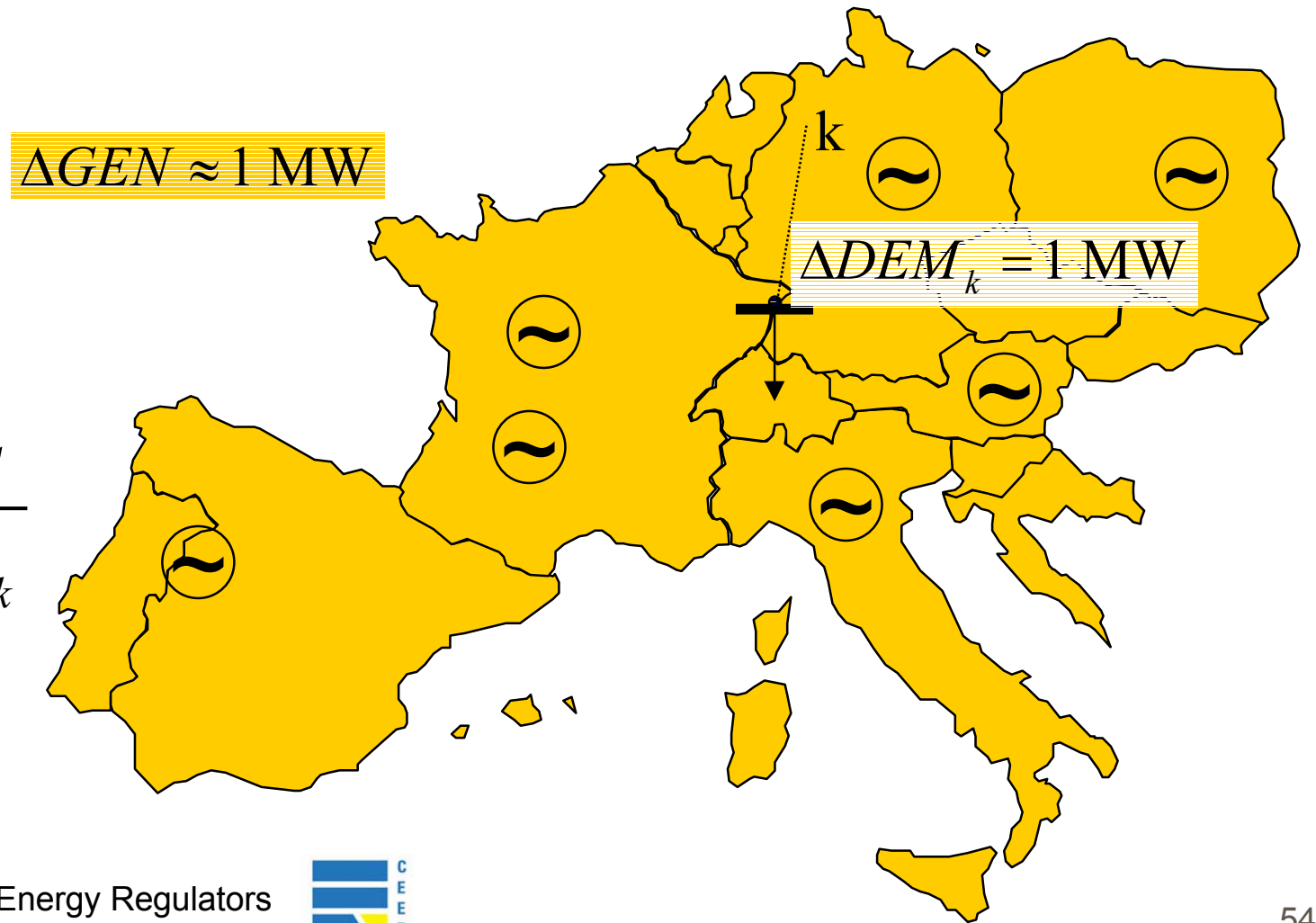

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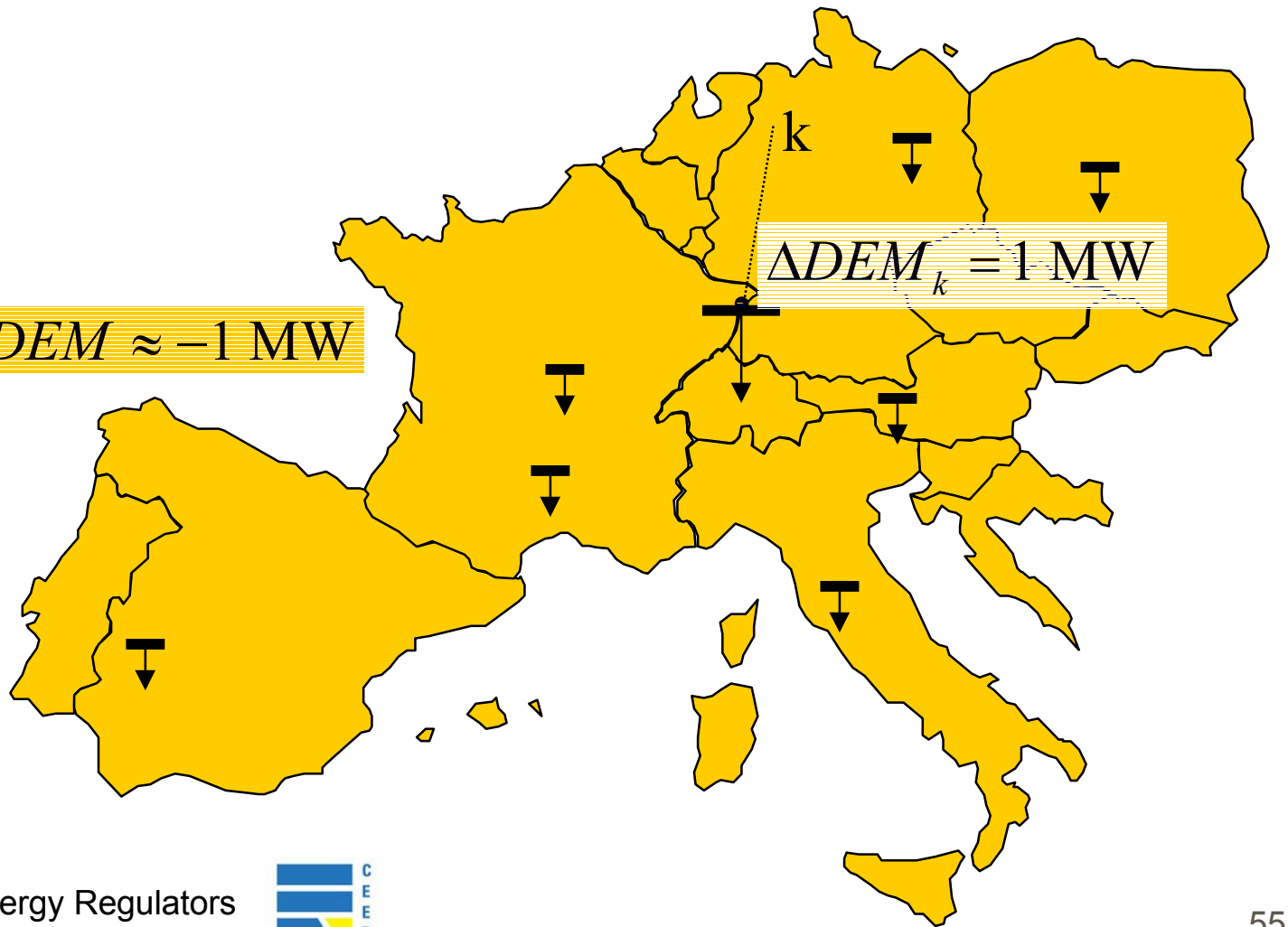

Results for winter peak
(Slack: distributed demand)

AREANUM	COMPENSATION(MW)	ZONE NAME	ZONE EXPORT (MW)
1	23	SPAIN	-1297
6	-7	PORTUGAL	394
8	-184	FRANCE	8293
31	9	ITALY	-5321
33	73	SWITZERLAND	82
34	66	GERMANY1	-6479
35	25	GERMANY2	5324
38	15	BELGIUM	-699
39	20	NETHERLANDS	-3597
40	2	SLOVENIA	49
41	7	AUSTRIA	1384
42	-38	CZECH REP	1307
43	-29	POLAND	608
45	14	BOSNIA	0
46	-5	CROATIA	49
47	15	HUNGARY	-352
48	-1	SLOVAKIA	2
55	-7	UKRAINE	249

Results for winter peak
(Slack: distributed generation)

AREANUM	COMPENSATION(MW)	ZONE NAME	ZONE EXPORT (MW)
1	-18	SPAIN	-1297
6	5	PORTUGAL	394
8	85	FRANCE	8293
31	-164	ITALY	-5321
33	76	SWITZERLAND	82
34	-144	GERMANY1	-6479
35	198	GERMANY2	5324
38	-7	BELGIUM	-699
39	-96	NETHERLANDS	-3597
40	3	SLOVENIA	49
41	52	AUSTRIA	1384
42	4	CZECH REP	1307
43	-10	POLAND	608
45	14	BOSNIA	0
46	-3	CROATIA	49
47	4	HUNGARY	-352
48	-1	SLOVAKIA	2
55	0	UKRAINE	249

Results for winter peak

(Slack: distributed demand & generation 50/50)

AREANUM	COMPENSATION(MW)	ZONE NAME	ZONE EXPORT (MW)
1	2	SPAIN	-1297
6	-1	PORTUGAL	394
8	-51	FRANCE	8293
31	-76	ITALY	-5321
33	74	SWITZERLAND	82
34	-37	GERMANY1	-6479
35	109	GERMANY2	5324
38	4	BELGIUM	-699
39	-36	NETHERLANDS	-3597
40	3	SLOVENIA	49
41	29	AUSTRIA	1384
42	-17	CZECH REP	1307
43	-20	POLAND	608
45	14	BOSNIA	0
46	-4	CROATIA	49
47	10	HUNGARY	-352
48	-1	SLOVAKIA	2
55	-3	UKRAINE	249

END OF PRESENTATION