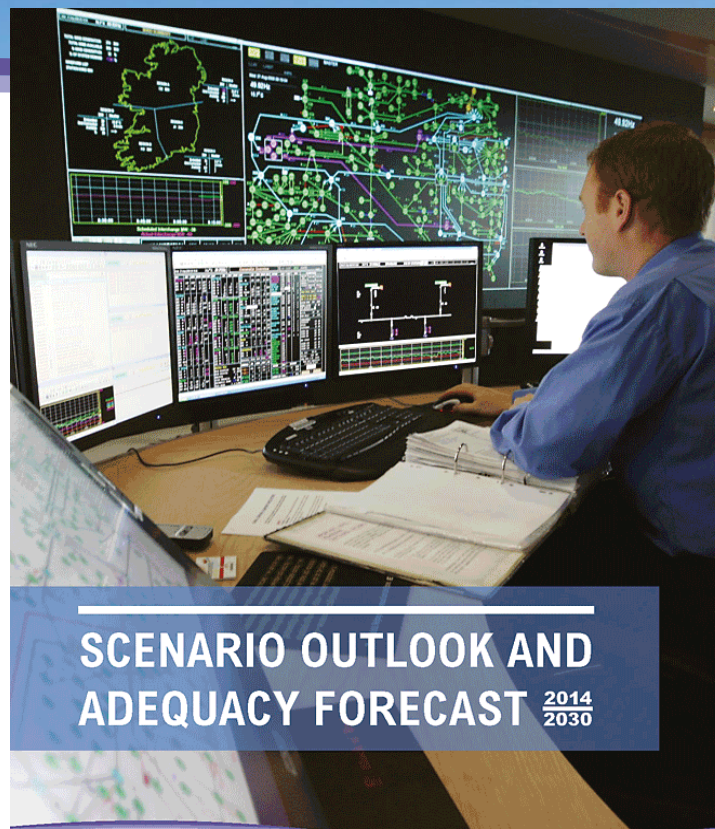


ENTSO-E scenarios- general overview

Daniel Huertas Hernando
ENTSO-E System Planning Adviser



SCENARIO OUTLOOK AND ADEQUACY FORECAST 2014 2030

European Network of
Transmission System Operators
for Electricity

entsoe

SOAF



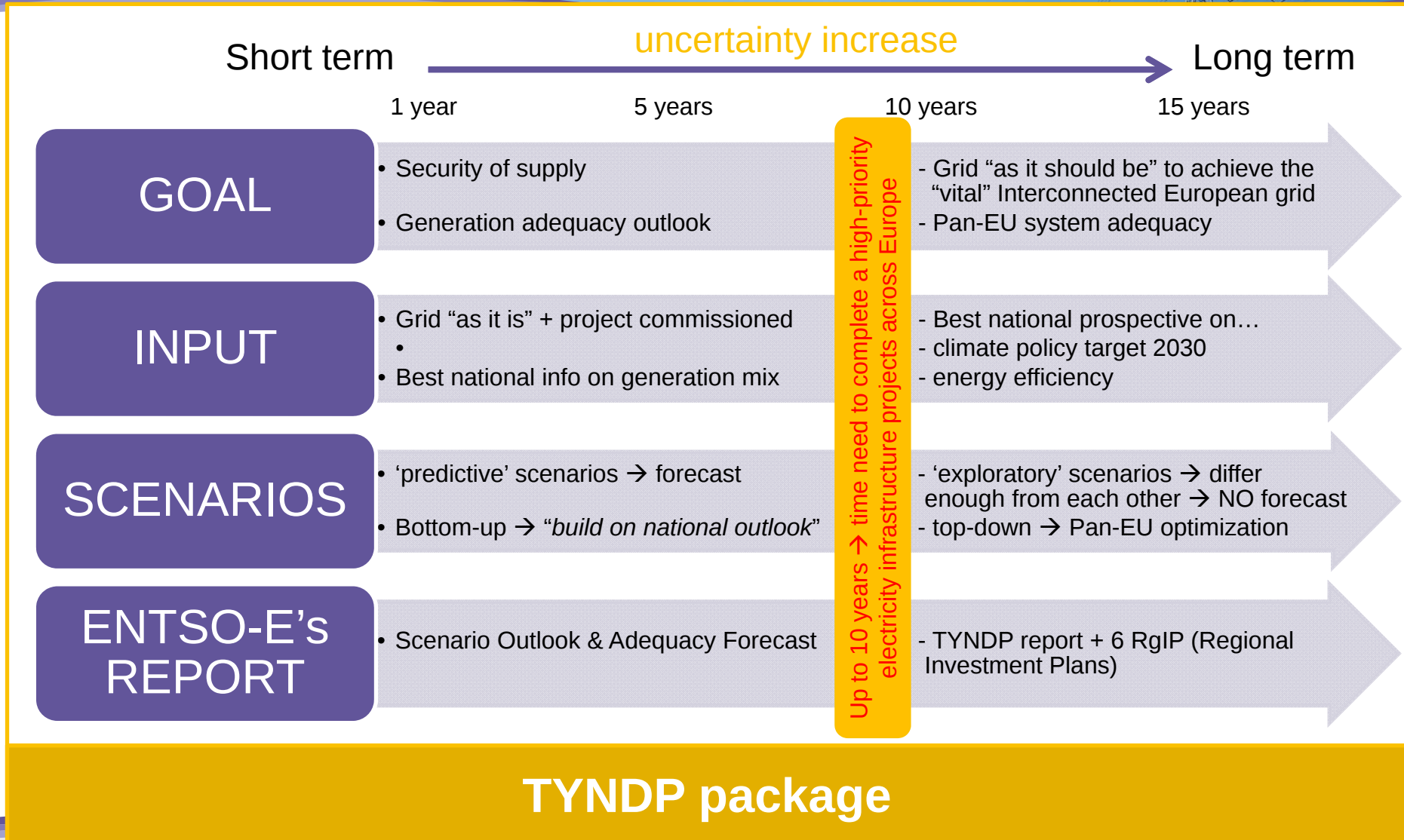
10-YEAR NETWORK DEVELOPMENT PLAN 2014

European Network of
Transmission System Operators
for Electricity

entsoe

TYNDP

Scenarios overall view

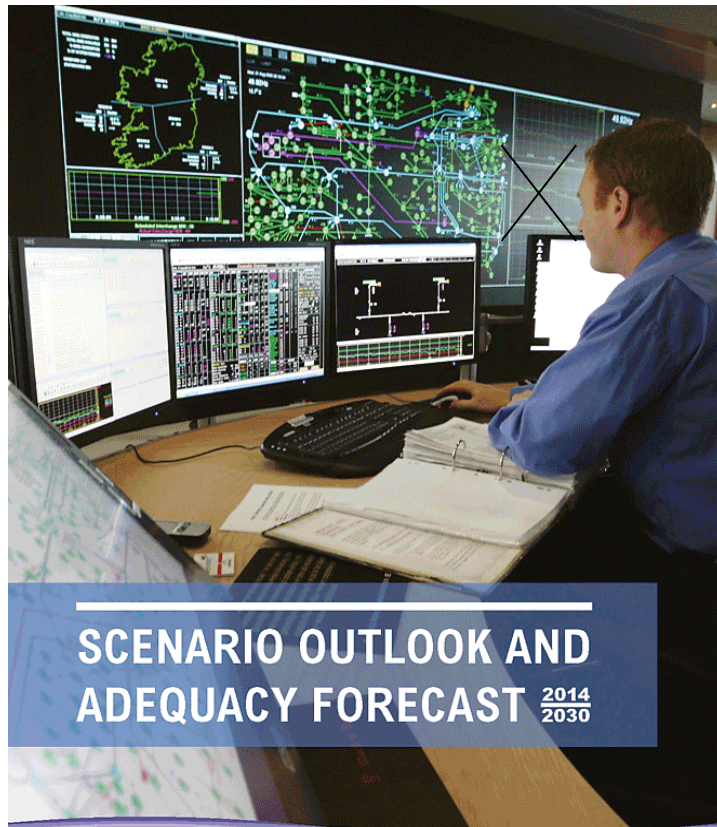




The SOAF – TYNDP ‘spot the difference game’

FORECAST

~~FORECAST~~



European Network of
Transmission System Operators
for Electricity

entsoe

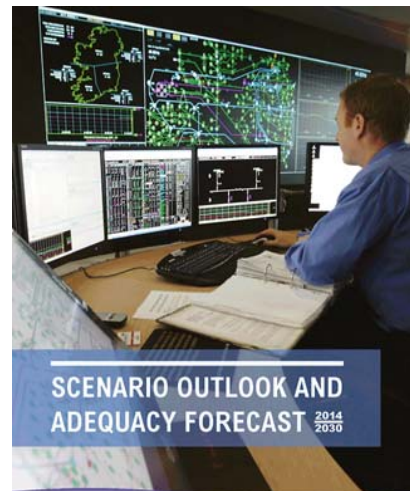
European Network of
Transmission System Operators
for Electricity

entsoe

entsoe

WHAT BASIS?

Existing
infrastructure
+
Infrastructure
projects
commissioned
+
Best national
information on
energy mix



European Network of
Transmission System Operators
for Electricity
entsoe

EU energy
efficiency
targets



EU 2030 targets



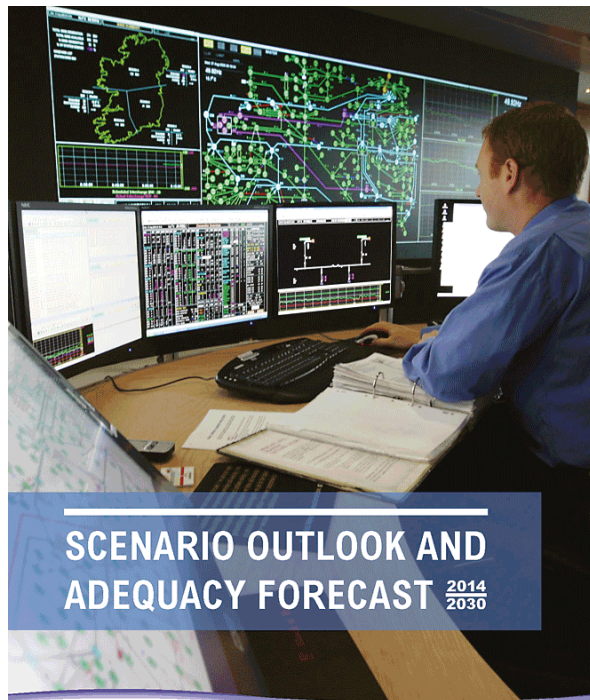
Best national
perspective(s)
on energy mix



European Network of
Transmission System Operators
for Electricity
entsoe

TIME HORIZON

2015 ➡ 2020



European Network of
Transmission System Operators
for Electricity

entsoe

2020 ➡ 2030

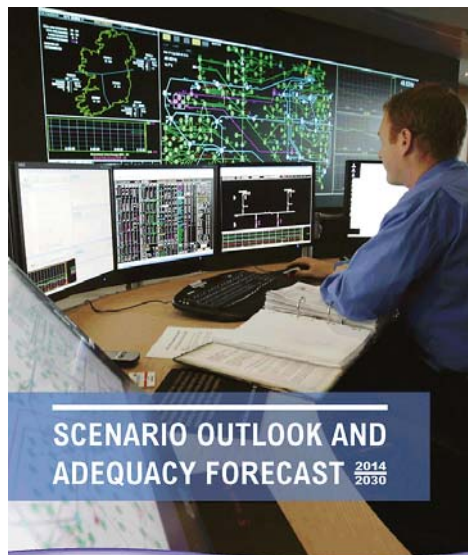


European Network of
Transmission System Operators
for Electricity

entsoe

entsoe

UNCERTAINTY



European Network of
Transmission System Operators
for Electricity

entsoe

10 years maximum horizon
for sound adequacy results



European Network of
Transmission System Operators
for Electricity

entsoe

SCENARIOS

PREDICTIVE

SCENARIO OUTLOOK AND
ADEQUACY FORECAST 2014
2036

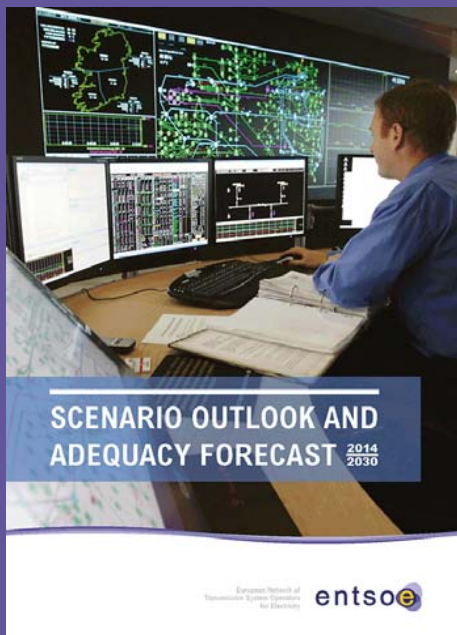
BOTTOM UP
Built on national outlooks

EXPLORATORY

10-YEAR NETWORK
DEVELOPMENT PLAN 2014

TOP DOWN
Pan-EU optimization

TYNDP PACKAGE



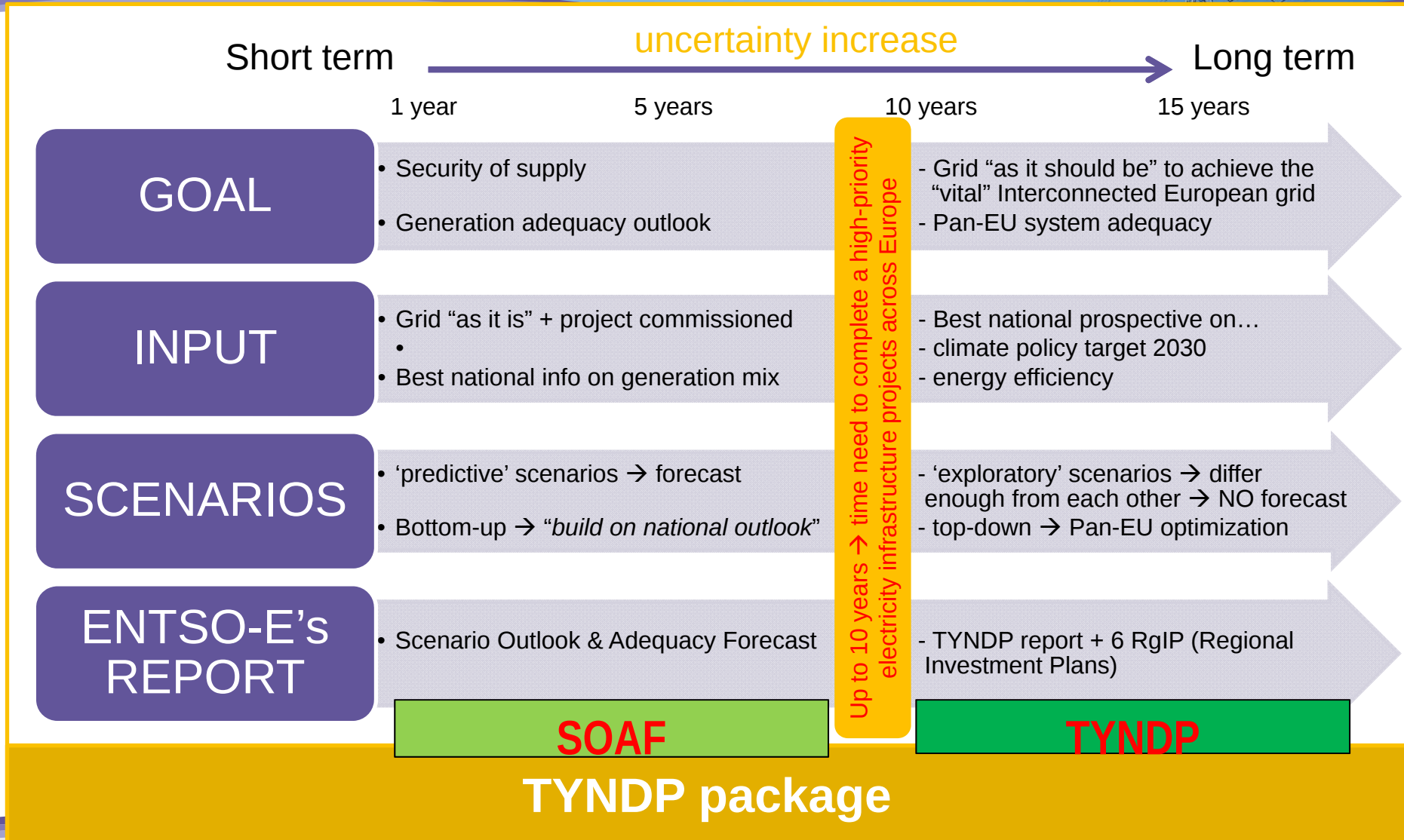
+

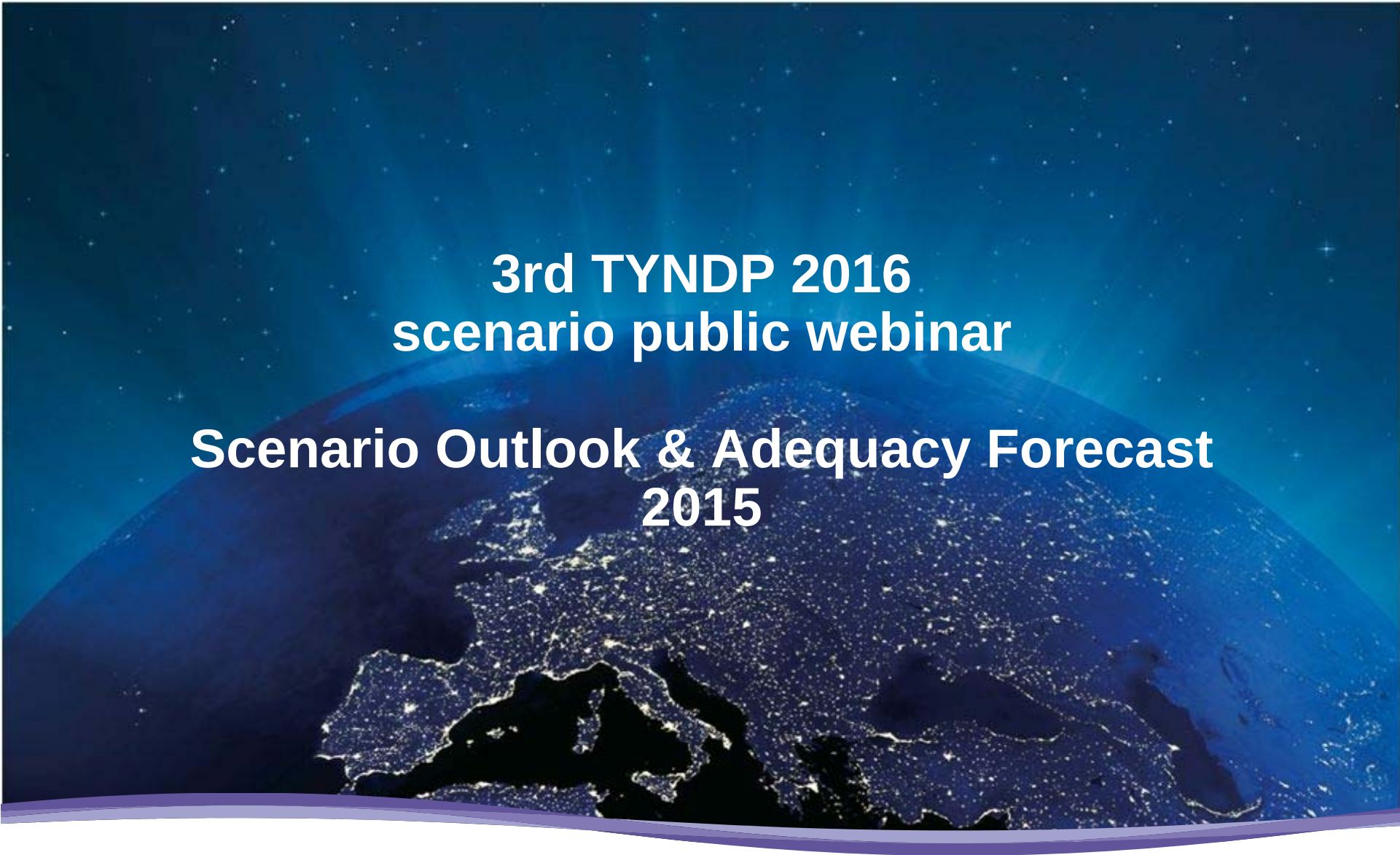


+



Scenarios overall view



A satellite image of Europe at night, showing city lights and the dark landmasses against the blue glow of the atmosphere and the starry night sky.

3rd TYNDP 2016 scenario public webinar

Scenario Outlook & Adequacy Forecast 2015

ENTSO-E

10 June 2015, 11:00-12:00 CET

What the regulation says?

- ENTSO-E to publish a **European generation adequacy outlook every two years within Community-wide network development plan** (TYNDP package) → **now published each year**
- **European generation adequacy outlook** to cover overall adequacy of the electricity system to supply **current and projected demands**
- **European generation adequacy outlook** to build on national generation adequacy outlooks prepared by each individual transmission system operator → **bottom-up approach!**

(Regulation (EC) 714/2009, Art 7)

Scenario Outlook and Adequacy Forecast
SO&AF

How do we construct the SO&AF scenarios?

SO&AF scenarios are:

- **predictive** → forecast → mid-term maximum (5 to 10 years)
- **bottom-up** → build on national generation adequacy outlooks prepared by TSOs
- **based a common assumption** → 2 different scenarios for generation against one common conservative forecast for demand

↳ Scenario A = 'Conservative'

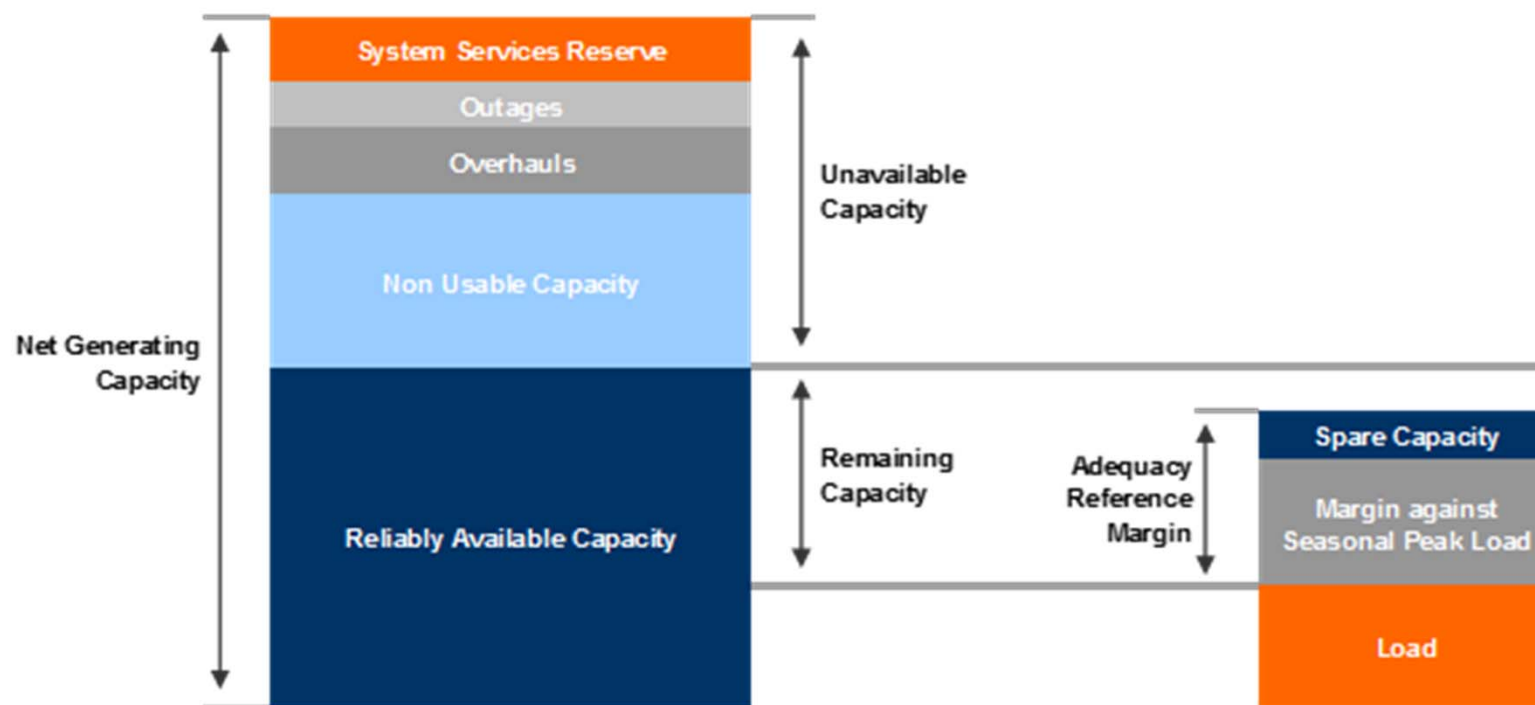
- › Additional investment in generation => Only if confirmed
- › Notifications of decommissioning => all + technical life time of units
- › Demand forecast => highest national estimate available to TSOs

↳ Scenario B = 'Best Estimate'

- › Additional investments in generation => all considered as reasonably credible by TSOs
- › Notifications of decommissioning => Only official communication
- › Demand forecast => highest national estimate available to TSOs

Definition and methodology

- System adequacy = **ability of a power system to supply demand**

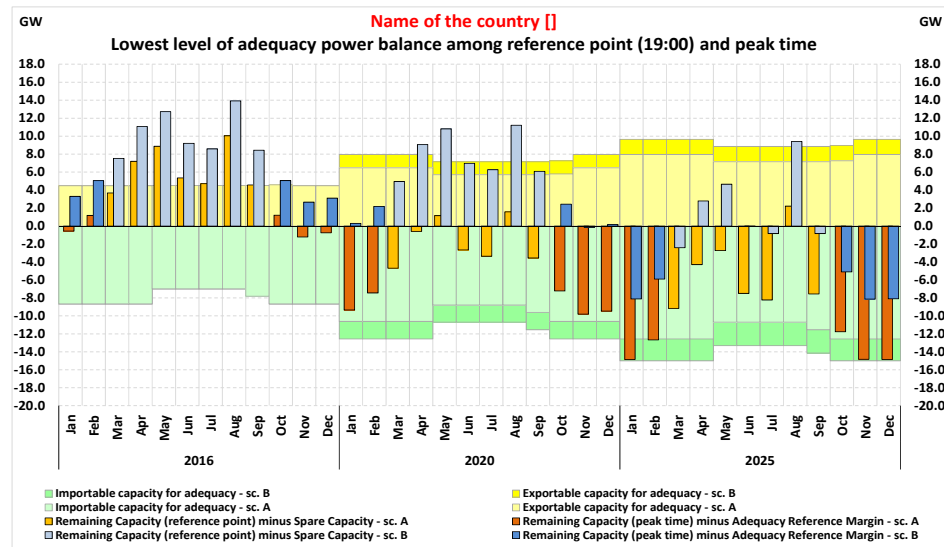


- Power balance = **monthly** assessment over the timeframe **2016-2020-2025**

Geographical perimeter

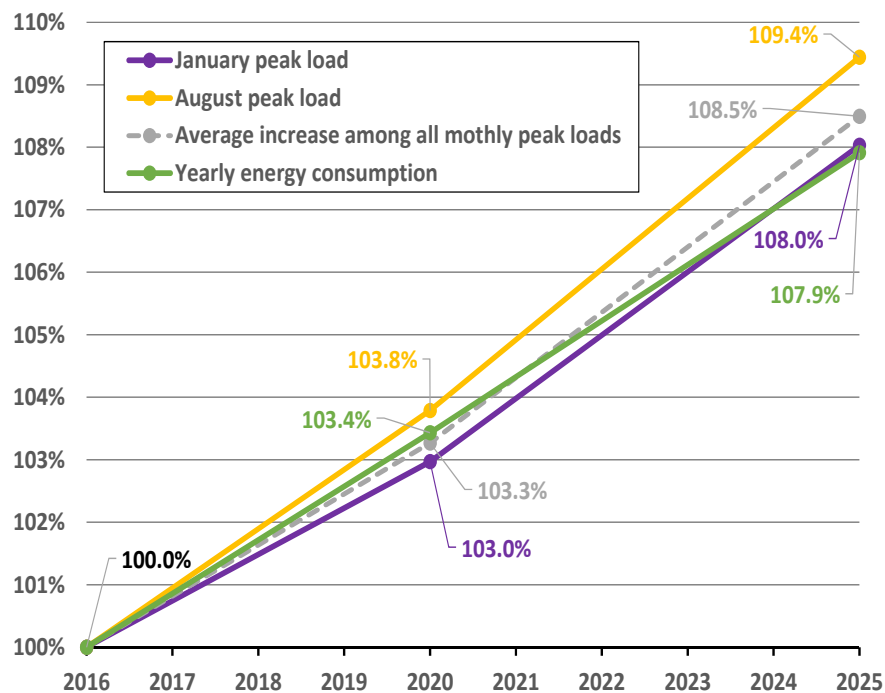


**Further the ENTSO-E members,
also countries synchronously
connected to the Continental
Europe Synchronous Area**

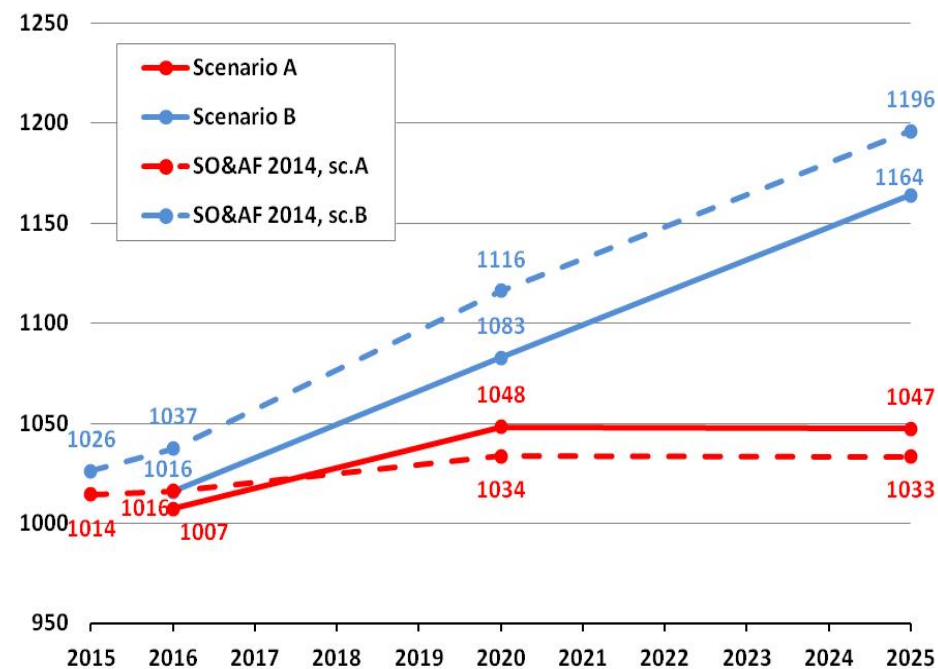


Scenario Outlook – general overview*

Load and energy consumption forecast



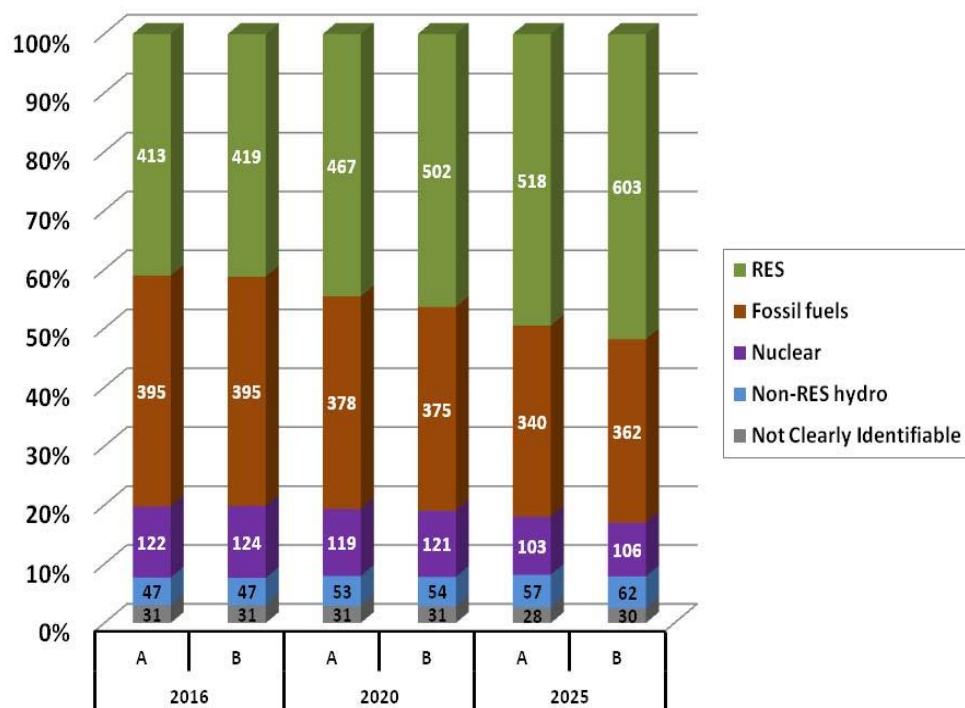
Net Generating Capacity forecast



* = provisional SO&AF 2015 data

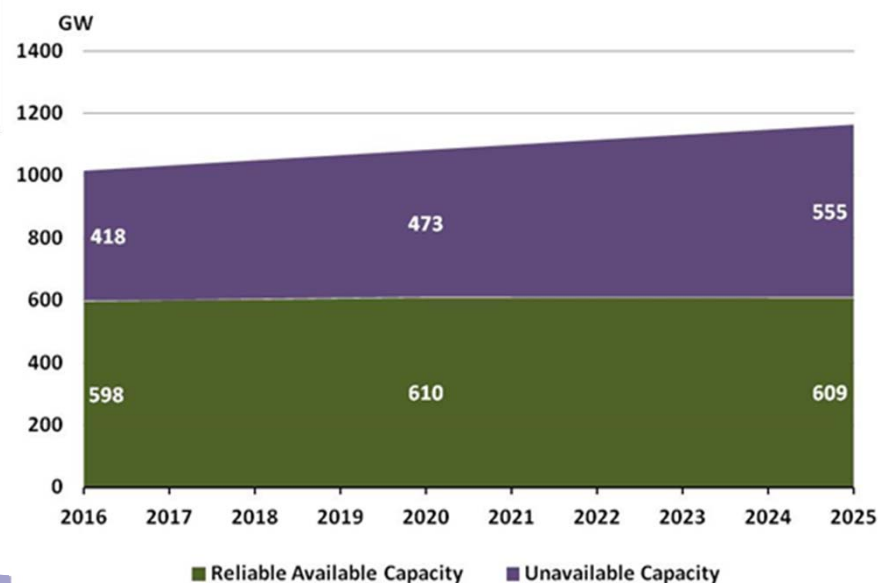
Scenario Outlook – general overview*

Decommissioning *smoothed* out by RES growth



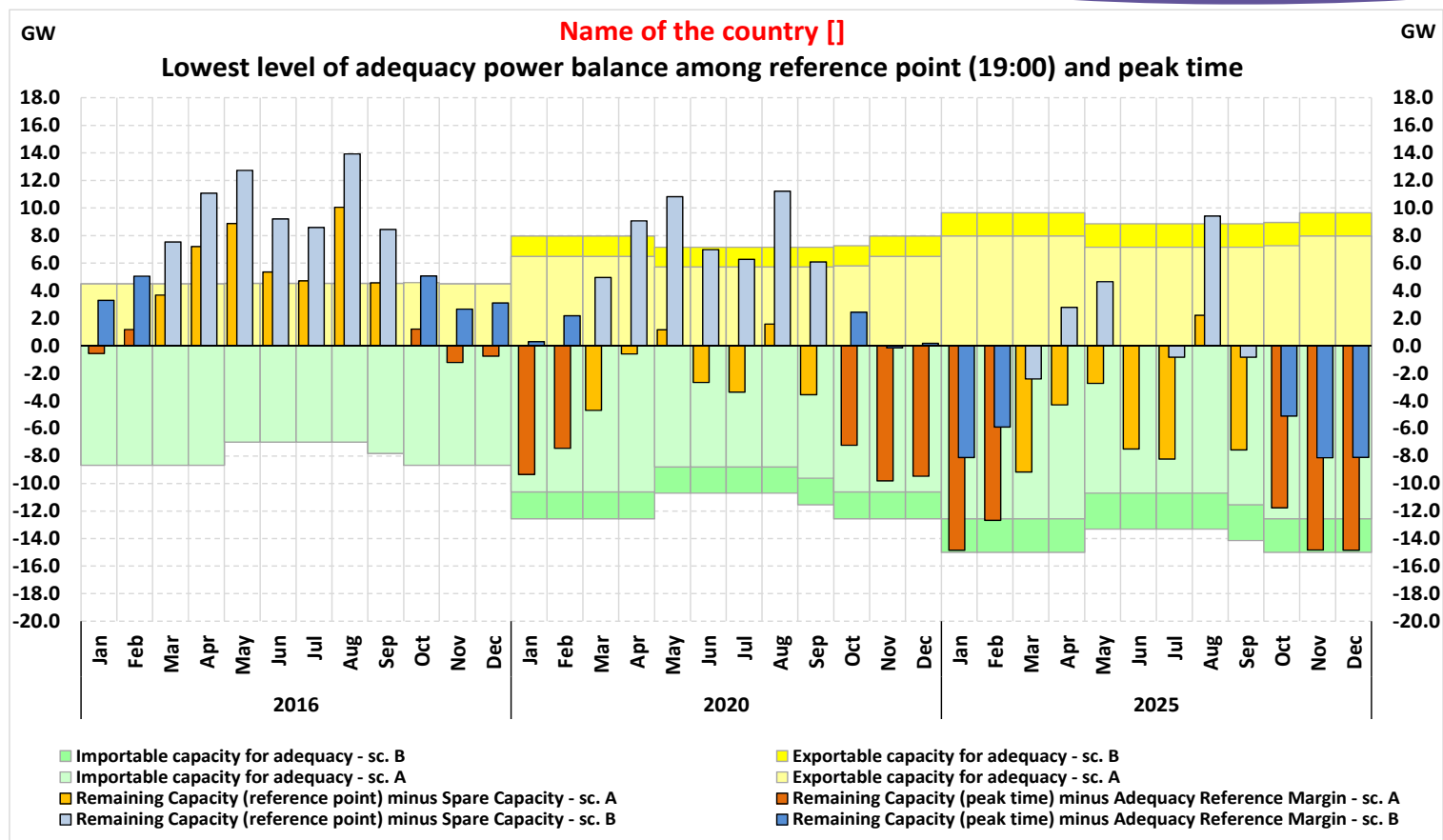
RES up to 46% of NGC in 2020 in scenario B / 44% scenario A

	Scenario	2016-2025	Fossil fuels	RES	Non-RES hydro	Nuclear
January 7 p.m.	A	[GW, total]	-55	105	10	-18
		[% , yearly]	-1.64%	2.55%	2.25%	-1.81%
	B	[GW, total]	-33	185	15	-17
		[% , yearly]	-0.97%	4.15%	3.12%	-1.67%



* = provisional SO&AF 2015 data

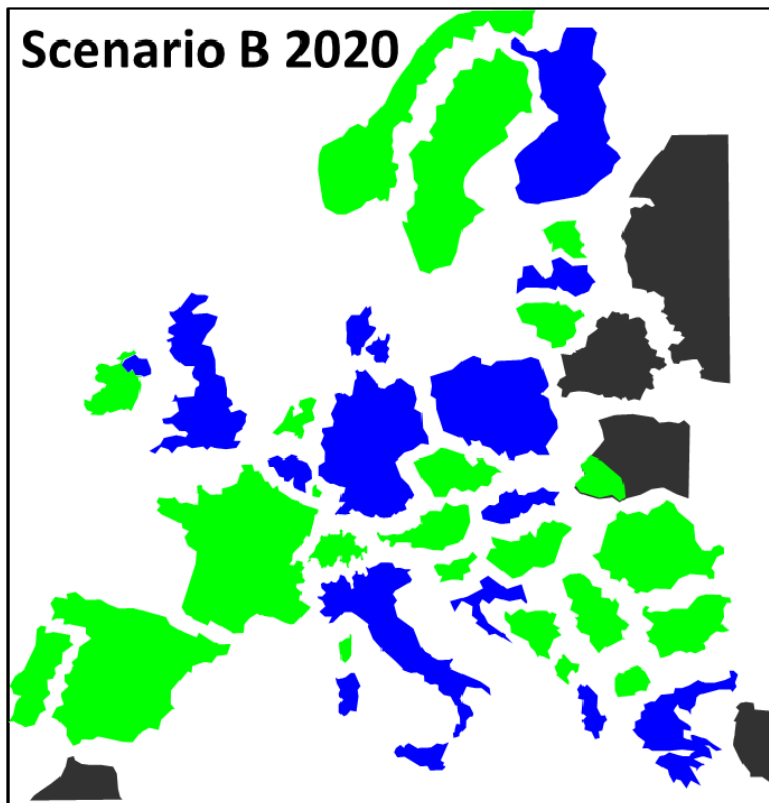
Adequacy Forecast – national upward generation adequacy



- Load and annual demand forecast
- Net Generating Capacity forecast
- Generation and System Adequacy forecast

Adequacy Forecast – Pan-EU upward generation adequacy

constrained linear optimization
problem to minimize the deficit in
power balance at Pan-European level



Scenario B 2020												
MONTH	1	2	3	4	5	6	7	8	9	10	11	12
AL												
AT												
BA												
BE												
BG												
CH												
CZ												
DE												
DK												
EE												
ES												
FI												
FR												
GB												
GR												
HR												
HU												
IE												
IT												
LT												
LU												
LV												
ME												
MK												
NI												
NL												
NO												
PL												
PT												
RO												
RS												
SE												
SI												
SK												
UA												
CY												

ENTSO-E Target methodology for adequacy

Integration with appropriate **market-based stochastic models** to assess adequacy

Hourly resolution

Probabilistic method using climate database to assess market prices & functioning, including during times of **scarcity**

More detailed view of **cross-border contributions** to a country's system adequacy

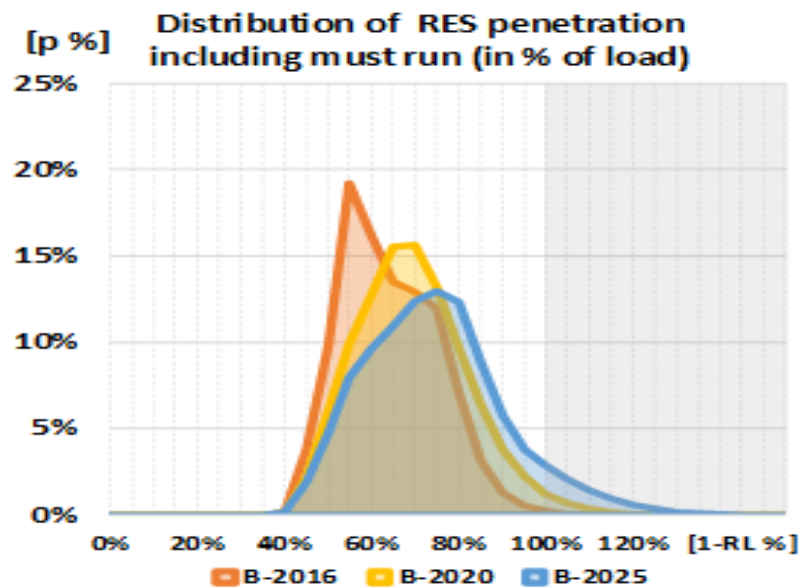
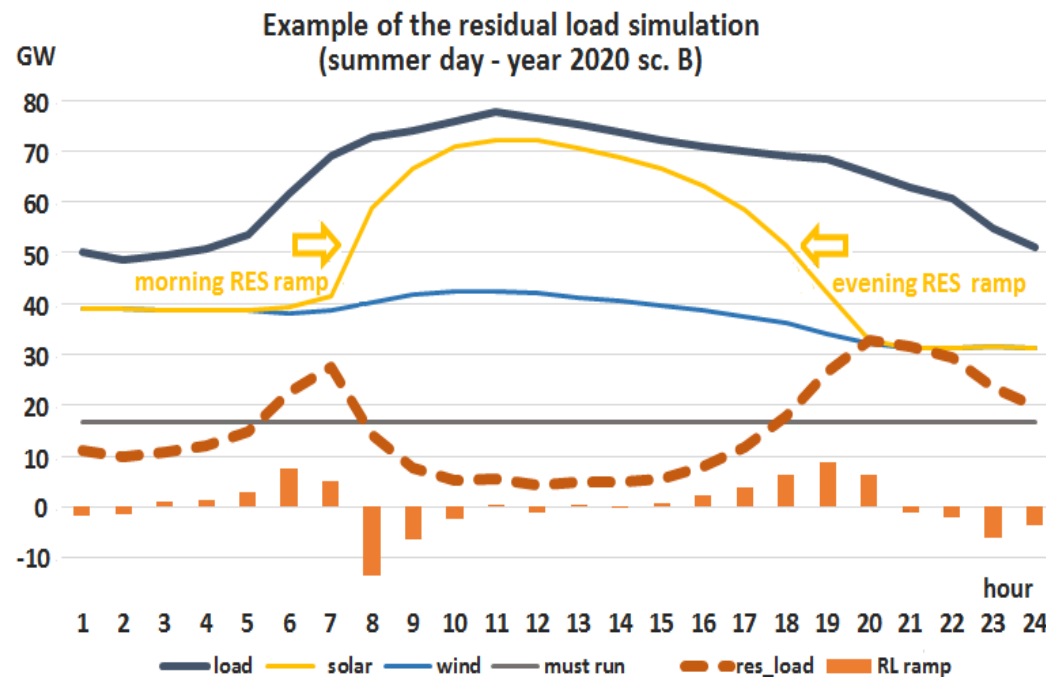
Assessment informs about the '**need for flexibility**'

Extensive range of indicators, e.g. **LOLE/ EENS/ LOLP, RES curtailments, capacity factor** (as indicator for likelihood of units staying online)

Adequacy Forecast – need for flexibility

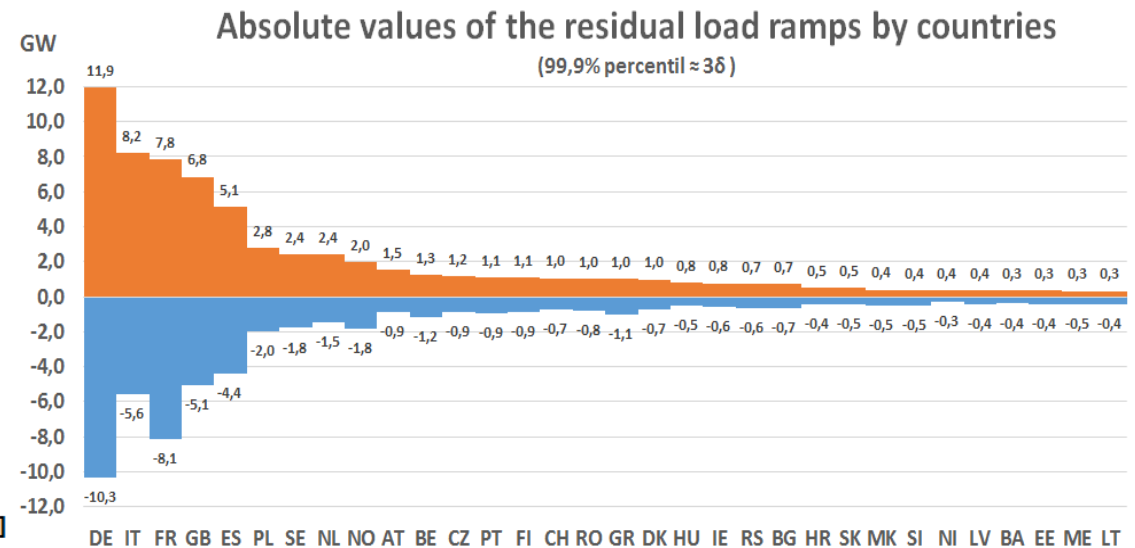
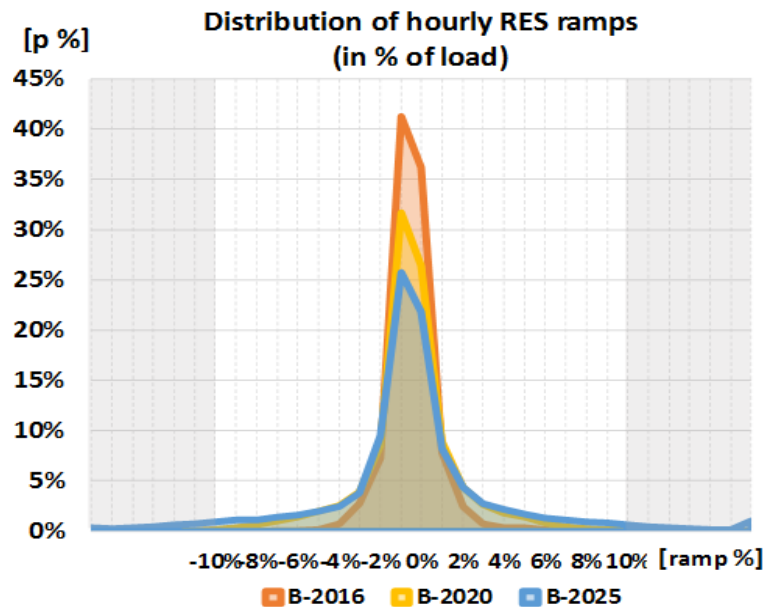
Probabilistic assessment of the residual load

$$RL = L - W - S - \text{must run}$$

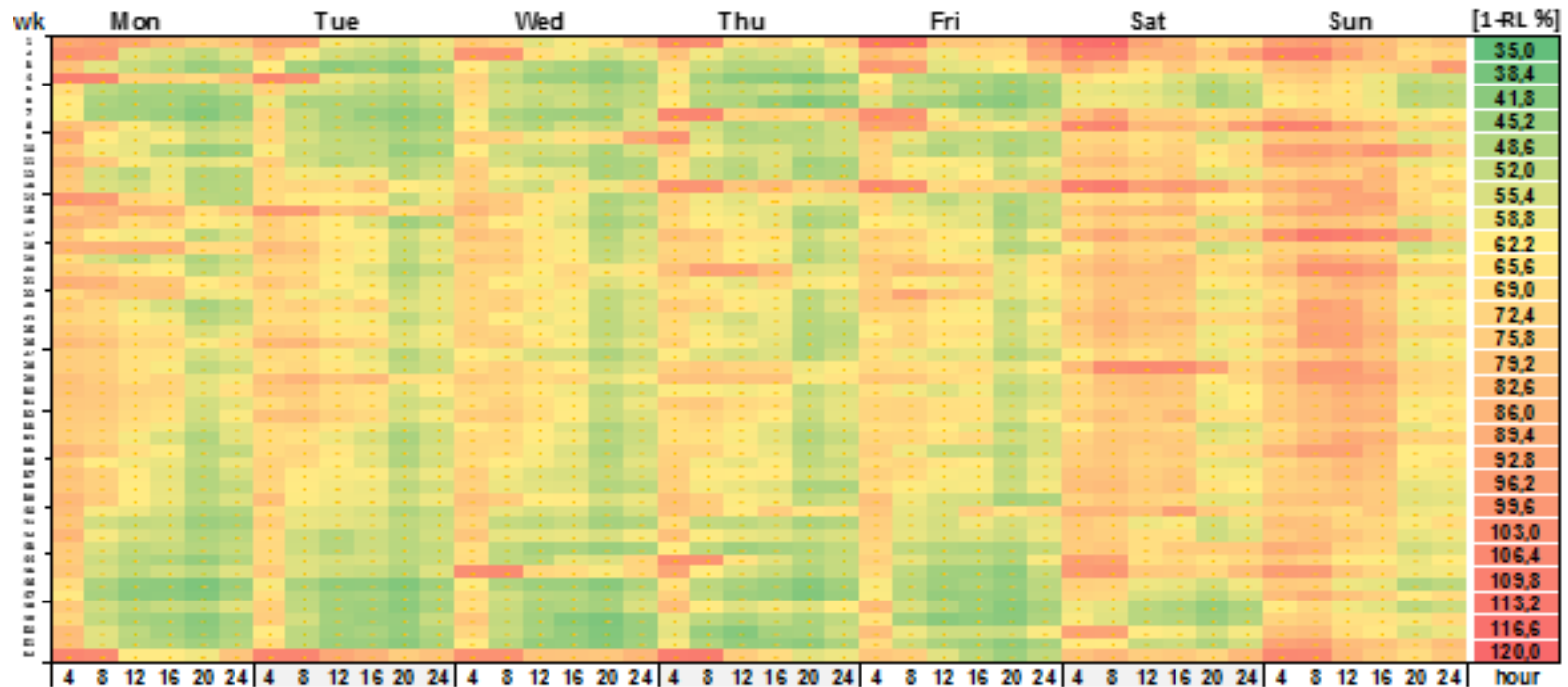


Adequacy Forecast – need for flexibility

residual load ramps → difference between consecutive hours

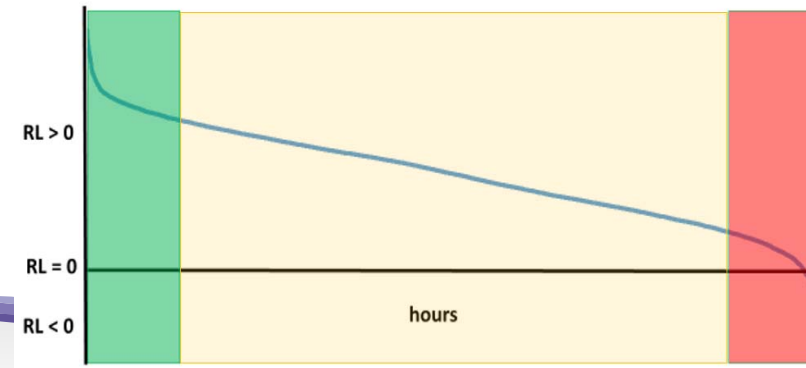


Adequacy Forecast – need for flexibility



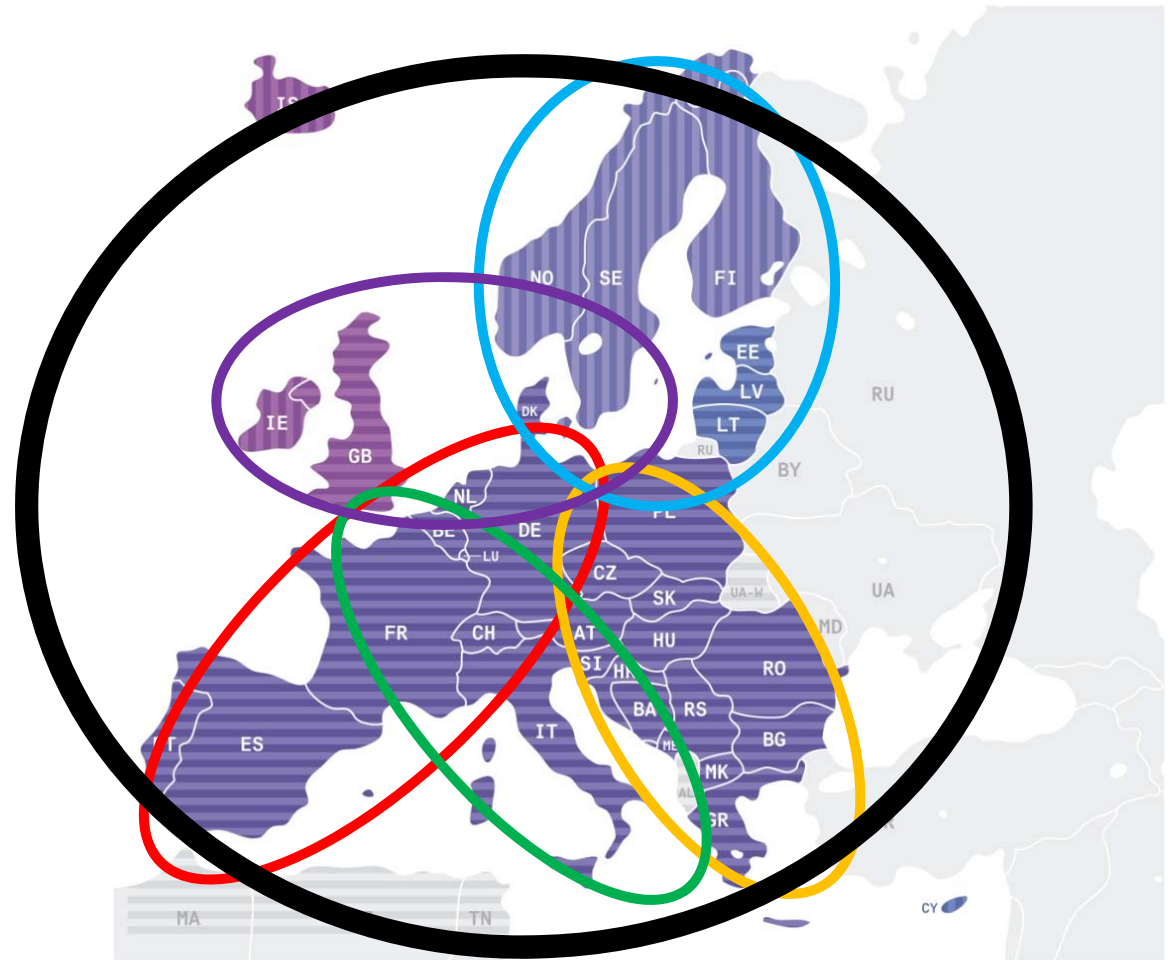
Residual Load [RL]

chromatic graph to demonstrate the hourly behaviour of the residual load in maximally possible resolution



Implementation of the Target Methodology in ENTSO-E reports

- Methodological choices and data gathering / transparency / quality
- Calibration & benchmarking of tools, robustness of results on assumptions and data
- Pan-EU study with tools exploring the regional knowledge of each tool & TSO modellers





THANK YOU
simone.biondi@entsoe.eu



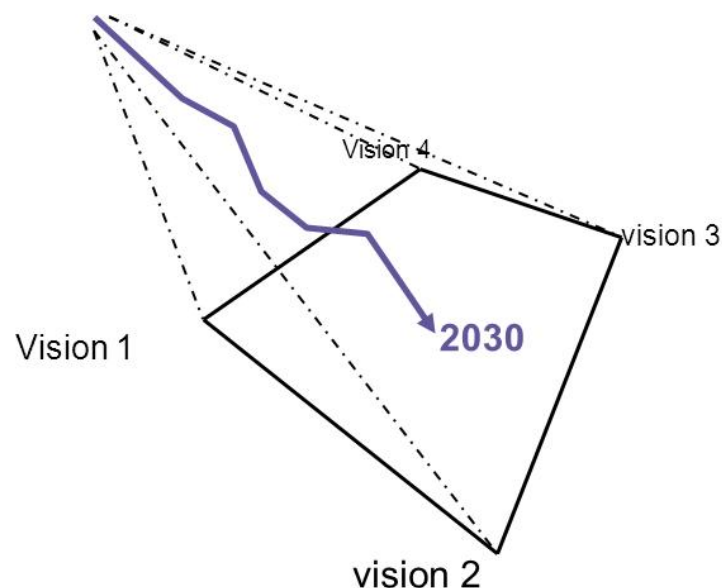
Webinar on scenarios TYNDP 2016 Scenarios for 2030 10-06-2015

Task Force Scenario Building
Niels Træholt Franck



TYNDP14: 4 Visions for 2030

2030 Visions: a bridge between the European energy targets for 2020 and 2050

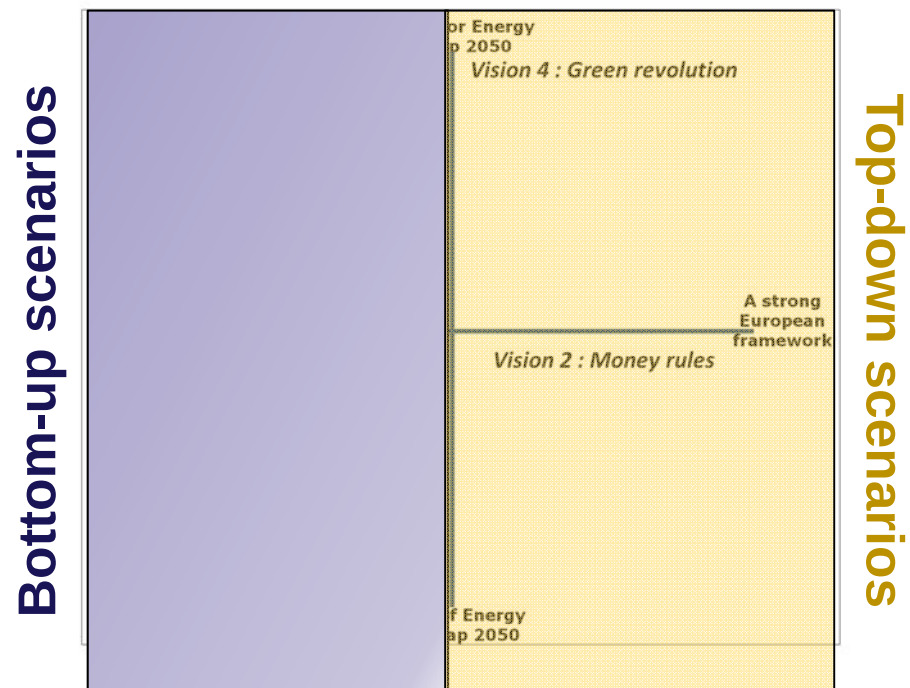


Objectives for the visions:

- Look beyond 2020
- Differ enough from each other
- The visions are not forecasts (no probability attached to the visions).

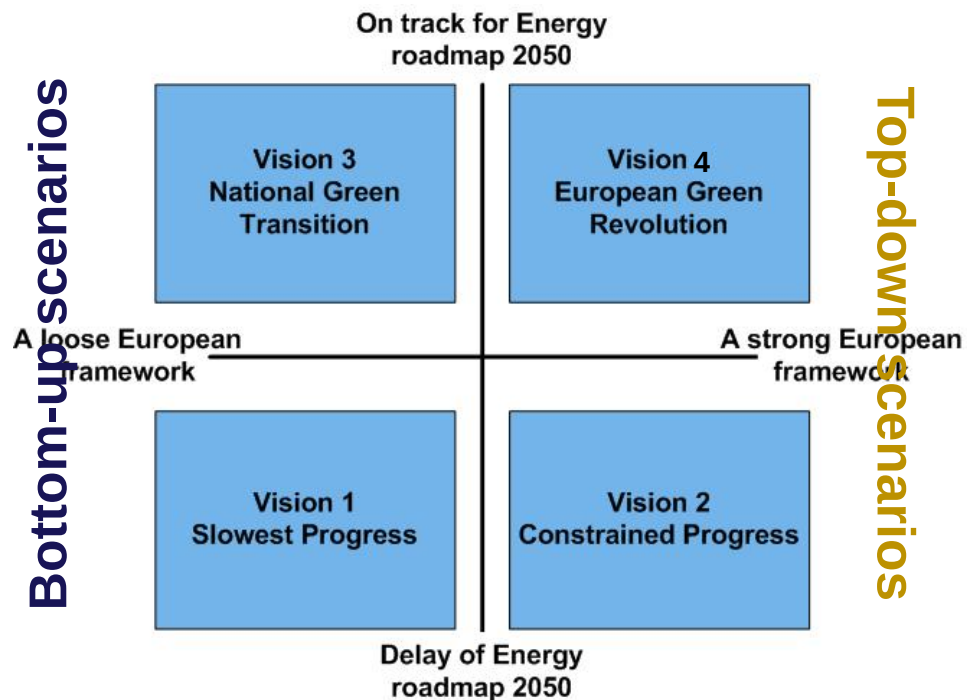
2030: the pathway realised in the future falls with a high level of certainty in the range described by the four visions

TYNDP14: 4 Visions for 2030



TYNDP14 Visions

TYNDP16 Visions: 4 altered and renamed visions



TYNDP16 Visions

TYNDP16:

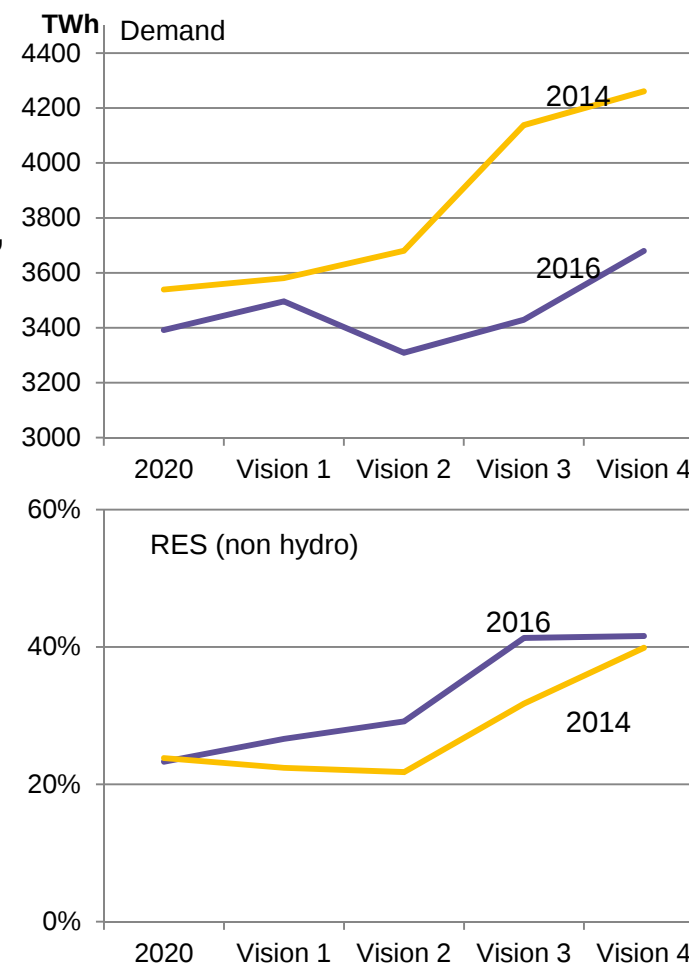
- Adjustments to ensure more spread between the scenarios.
- Slight adjustment to storyline
- Reflect inputs from stakeholders.

Names changed:

- To reflect the changes from 2014 (and avoid confusion)
- To better reflect the content of the visions

The big picture of changes compared to TYNDP14

- Demand: Level adjusted and including a decrease scenario
- Lower RES (in TWh) but higher (%)
- Change to adequacy requirements: V1 & V3 national, V2 & V4 European. Thermal optimisation
- Optimisation of solar and wind Vision 2 & 4
- **New input from TSOs for Vision 1 and Vision 3**



TYNDP16: The 4 visions in a brief

Vision 3: National Green Transition

Strong economic growth and a national focus on development towards the targets

Focus on energy efficiency

Lower demand for electricity due to energy savings

Some deployment of HP, EV's and demand response

National focus on adequacy (surplus of capacity)

Nuclear power unattractive from an economic viewpoint.

Vision 4: European Green Revolution

RES development towards targets.

Strong economic growth and an European framework and cooperation for ETS, RES, Adequacy.

European optimal development of RES

Strong development of HP, EV's and demand response

Higher electric demand

Centralised utilisation of storage technology (hydro and pumped hydro)

Nuclear phase out.

Vision 1: Slowest progress

Lack of European wide framework for ETS, RES and adequacy.

No policies for EU development of renewable energy beyond 2020. Some countries do nothing, others promote nuclear or RES.

No reinforcement of ETS -> low CO2 price

Little development of Heat pumps, EV and demand response

Modest growth of use of electricity

Old power plant kept online rather than being replaced

Vision 2: Constrained progress

Strong European framework but lack of financial strength

Cost cutting and energy savings

Lower demand for electricity due to energy savings

Some deployment of HP, EV's and demand response

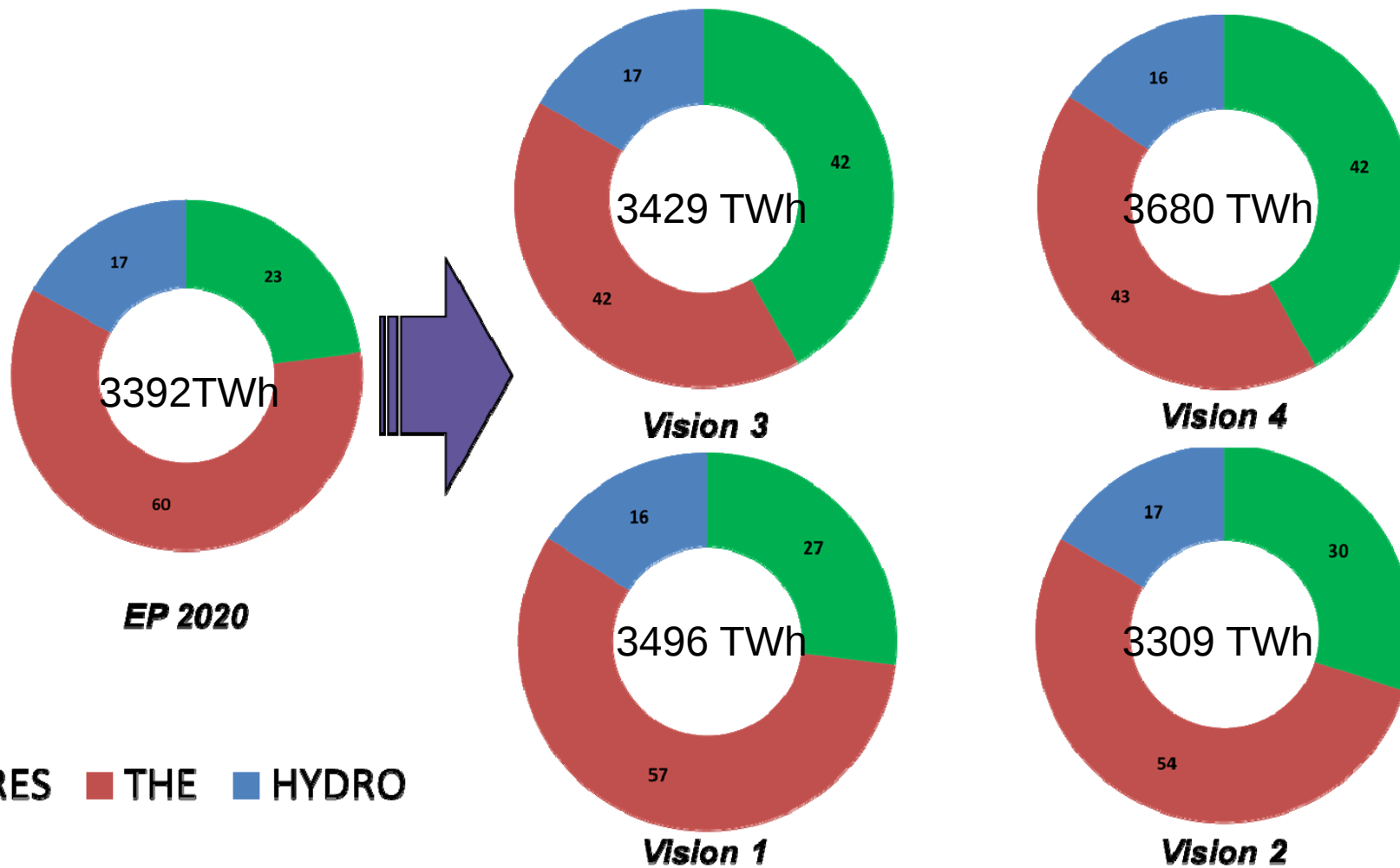
Deployment of RES in a more cost efficient way due to EU framework

European level adequacy measures.

Nuclear is accepted as part of the solution.

TYNDP 2016: 2030 Visions – general overview

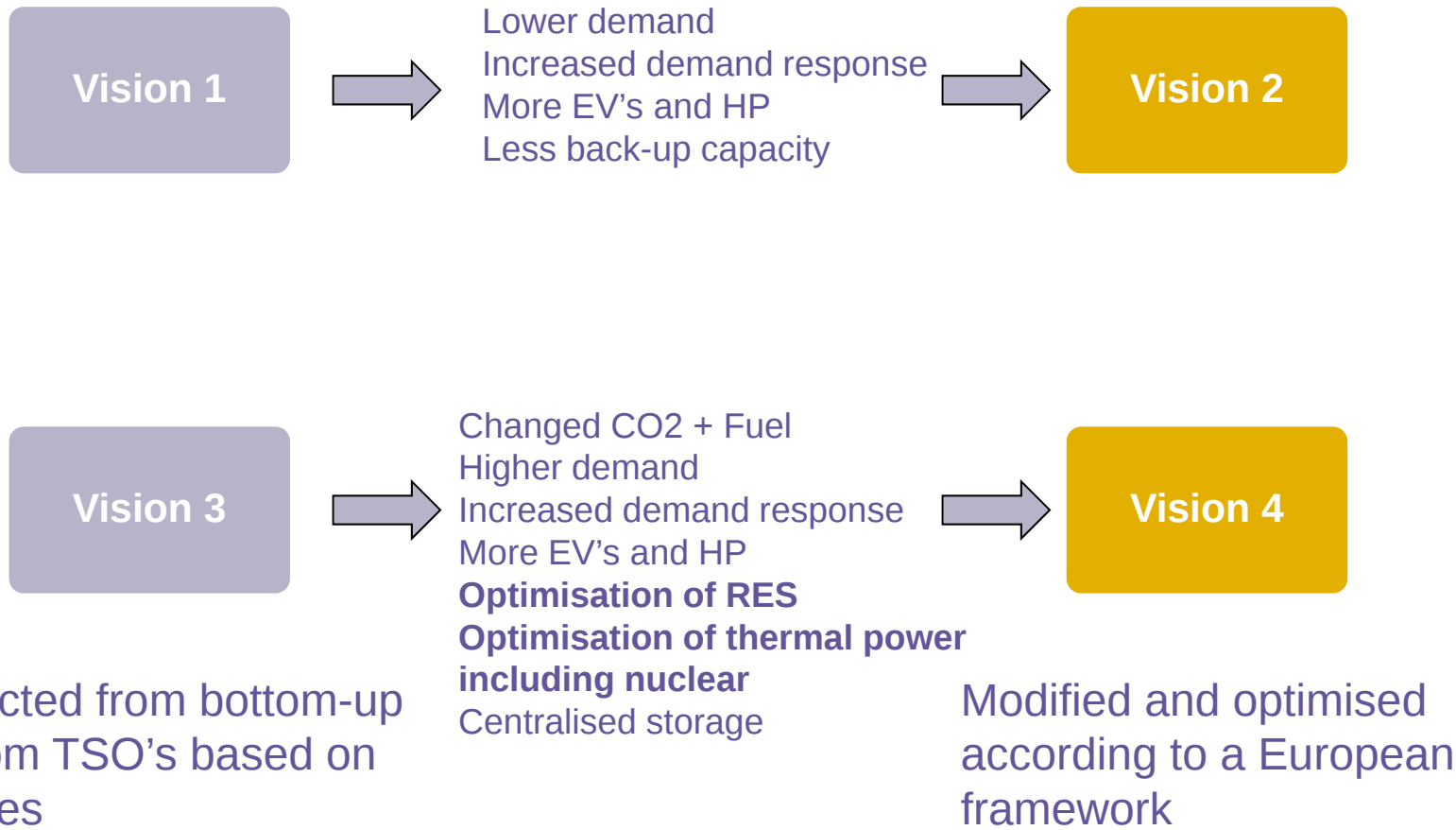
Generation mix [%]



Governing parameters for the visions

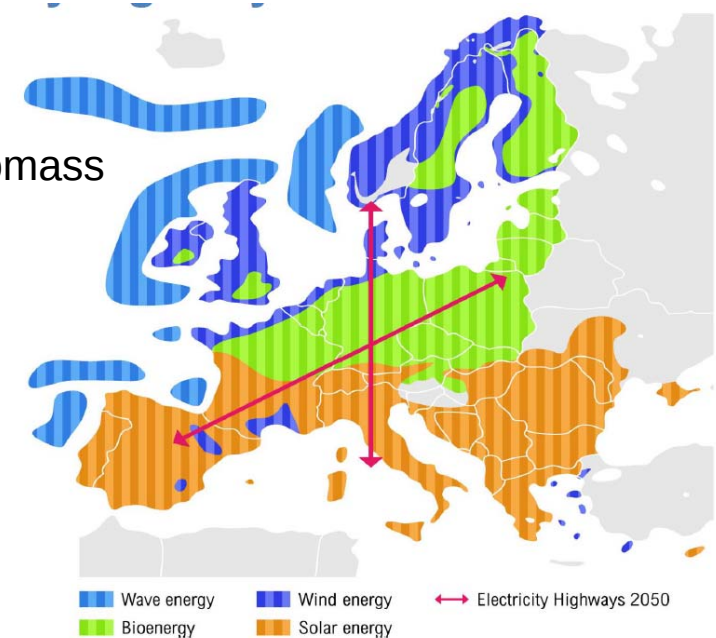
	Slowest progress	Constrained progress	National green transition	European green revolution
	V1	V2	V3	V4
Economic and financial conditions	Least favourable	Less favourable	More favourable	Most favourable
Focus of energy policies	National	European	National	European
Focus of R&D	National	European	National	European
CO₂ and primary fuel prices	low CO ₂ price, high fuel price	low CO ₂ price, high fuel price	high CO ₂ price, low fuel price	high CO ₂ price, low fuel price
RES	Low national RES (>■ 2020 target)	Between V1 and V3 !	High national RES	On track to 2050
Electricity demand	Increase (stagnation to small growth)	Decrease compared to 2020 (small growth but ! higher energy efficiency)	stagnation compared to 2020(!	Increase (growth demand)
Demand response (and smart grids)	As today	Partially used	Partially used	Fully used
	0%	5%	5%	20%
Electric vehicles	No commercial break through of electric plug-in vehicles	Electric plug-in vehicles (flexible charging)	Electric plug-in vehicles (flexible charging)	Electric plug-in vehicles (flexible charging and generating)
	0%	5%	5%	10%
Heat pumps	Minimum level	Intermediate level	Intermediate level	Maximum level
	1%	5%	5%	9%
Adequacy	National - not autonomous ! limited back-up capacity	European - less back-up capacity than V1	National - autonomous high back-up capacity !	European - less back-up capacity ! than V3
Merit order	Coal before gas	Coal before gas	Gas before coal	Gas before coal
Storage	As planned today	As planned today	Decentralized	Centralized

Construction process for 2030 visions



What is RES optimisation?

- Availability of RES resources : Solar, wind, hydro, biomass
- Price of utilizing RES
- Existing RES penetration
- Demand
- Interconnectors

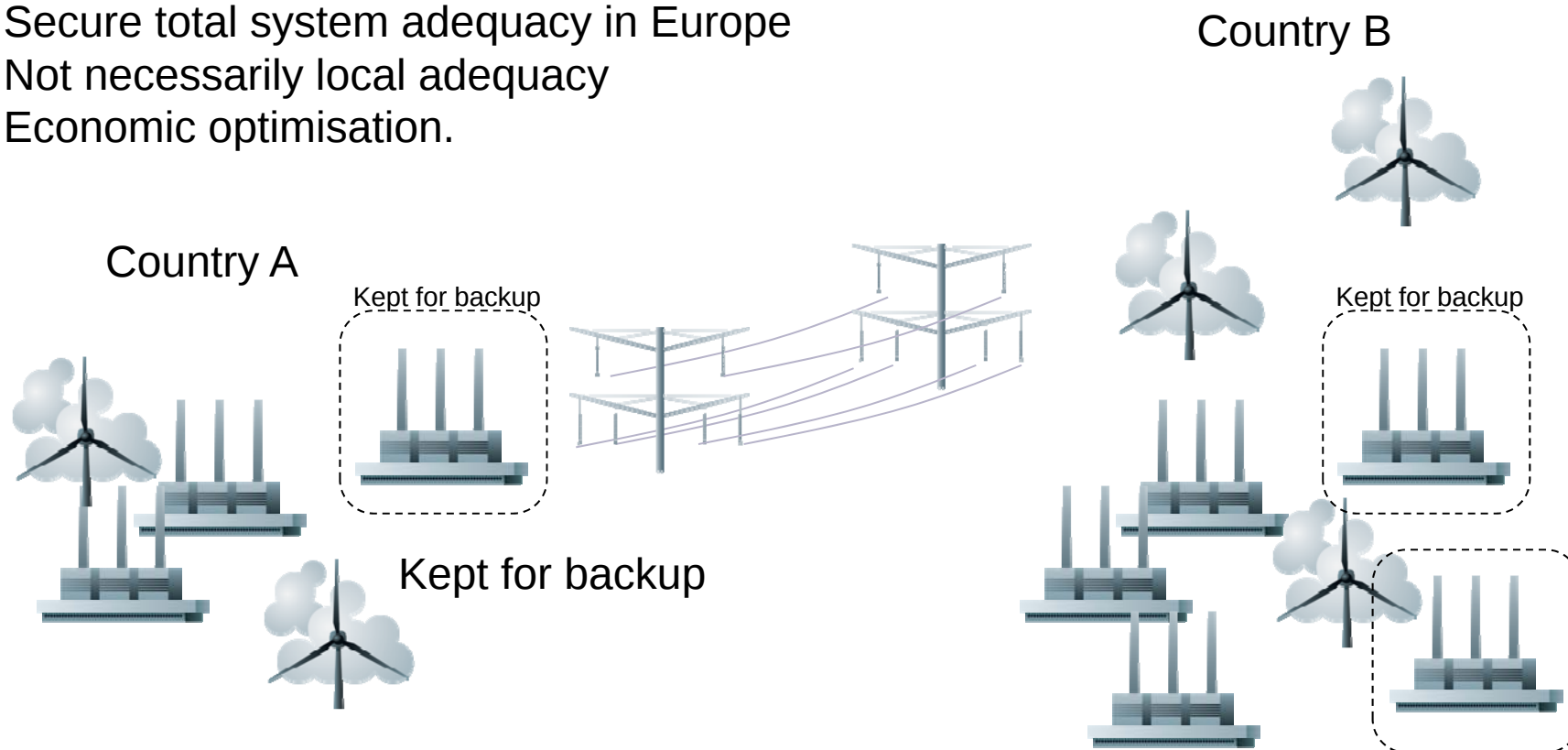


How to distribute RES in Europe in a cost effective way?

Optimisation of location of wind and solar with market models to find where RES is most valuable for the system!

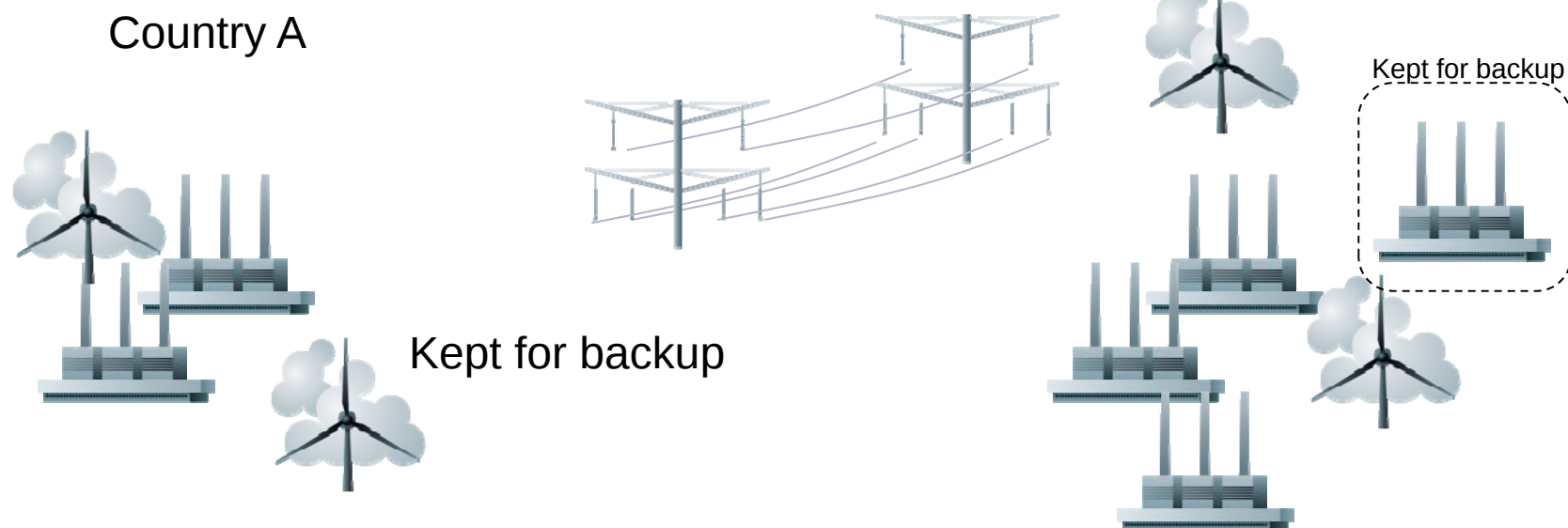
What is thermal optimisation?

Reduce oversupply of thermal power
Secure total system adequacy in Europe
Not necessarily local adequacy
Economic optimisation.



What is thermal optimisation?

Reduce oversupply of thermal power
Secure total system adequacy in Europe
Not necessarily local adequacy
Economic optimisation.





TYNDP 2016: Third Stakeholders WorkShop

2030 Visions – general overview

Fabrizio Vedovelli

Project Group Market Modelling

10th June 2015

TYNDP 2016: 2030 Visions – general overview

Agenda

- ✓ Pan European Market Study process

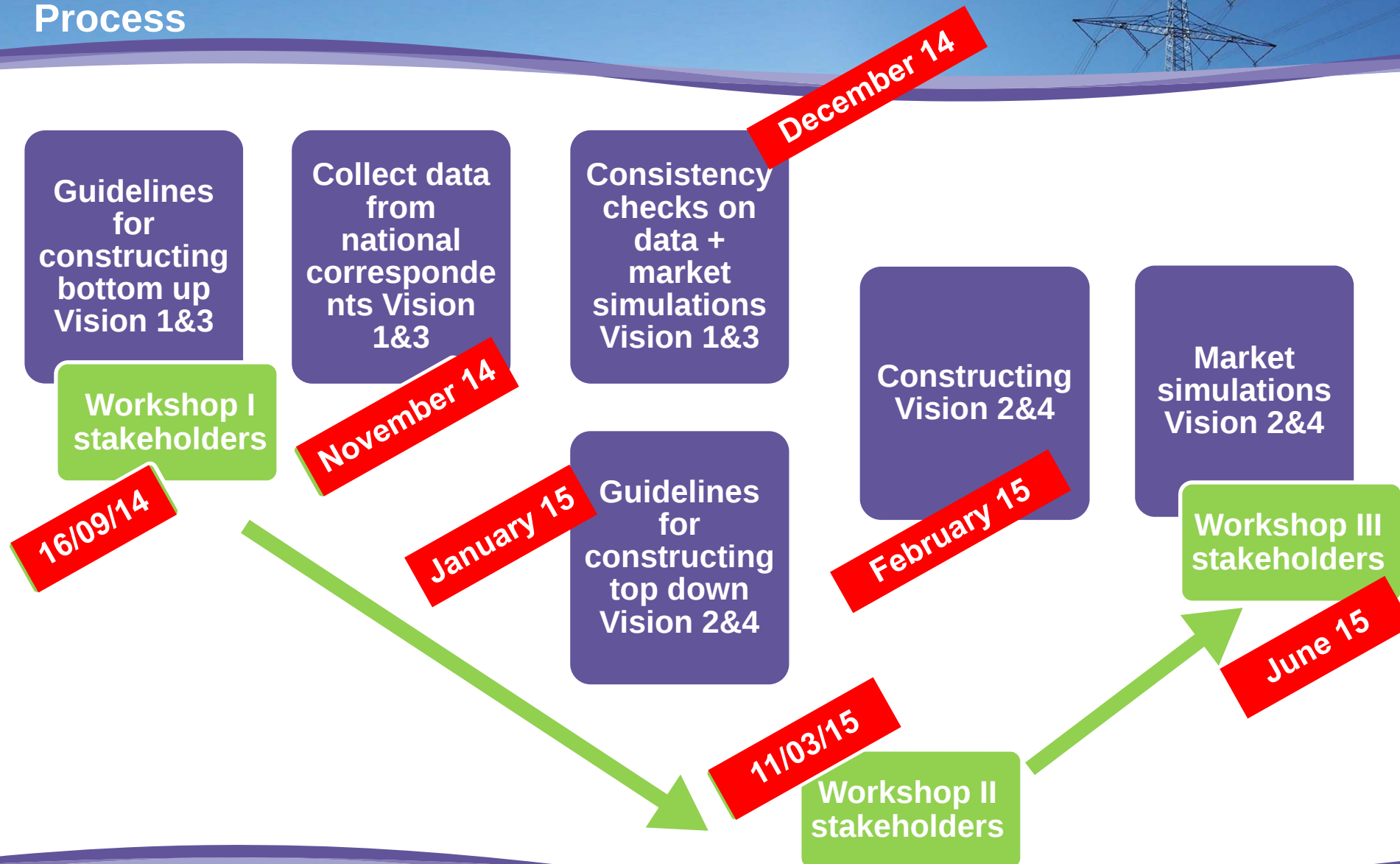
- ✓ Market Model

- ✓ Results:

- ✓ *Demand*
- ✓ *Hydro Generation*
- ✓ *RES Generation*
- ✓ *Thermal Generation*
- ✓ *Energy mix*
- ✓ *Balances & Market flows*

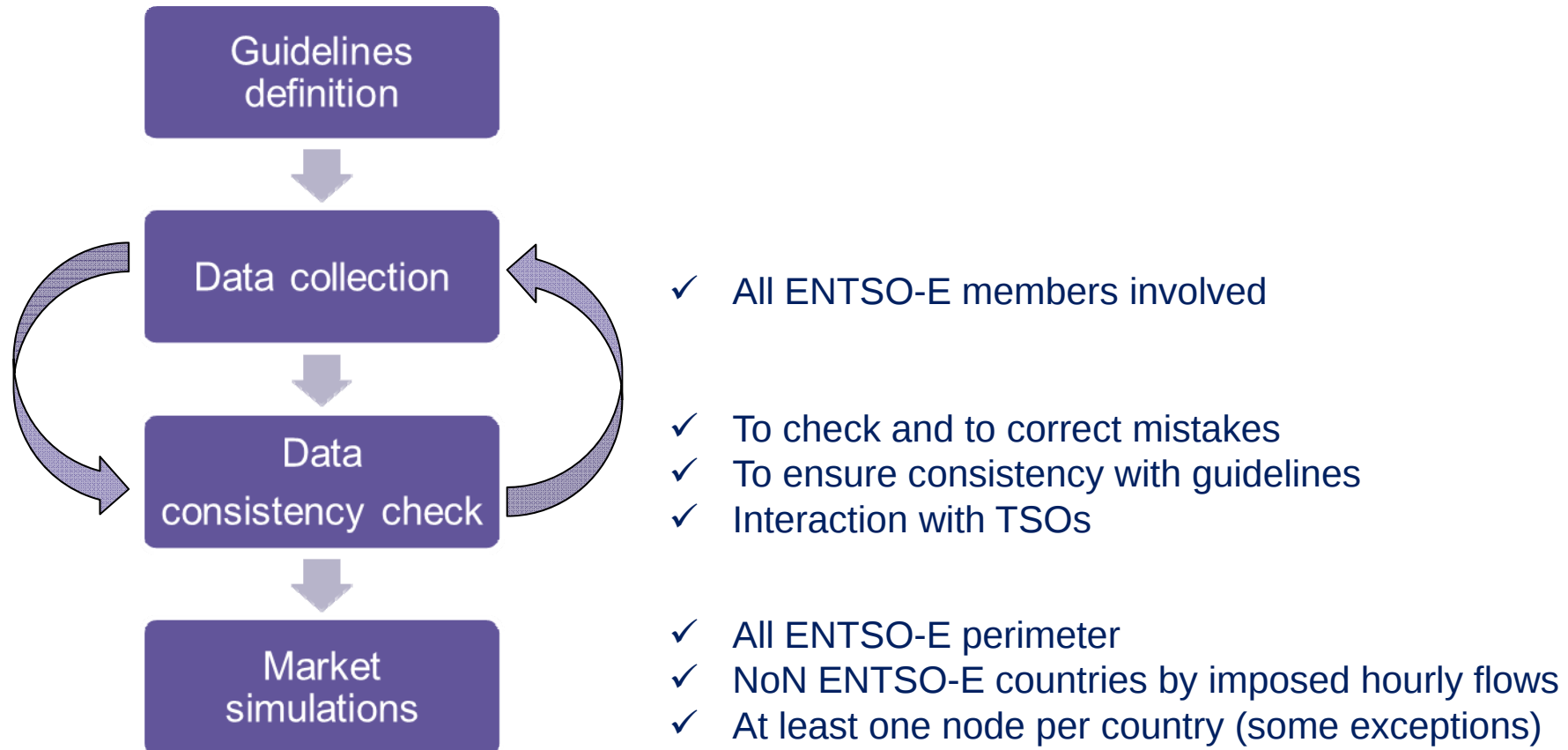
TYNDP 2016: 2030 Visions – general overview

Process



TYNDP 2016: 2030 Visions – general overview

Process



TYNDP 2016: 2030 Visions – general overview

Agenda

- ✓ Pan European Market Study process

- ✓ **Market Model**

- ✓ Results:

 - ✓ *Demand*

 - ✓ *Hydro Generation*

 - ✓ *RES Generation*

 - ✓ *Thermal Generation*

 - ✓ *Energy mix*

 - ✓ *Balances & Market flows*

TYNDP 2016: 2030 Visions – general overview

Market Model

Inputs

- Demand profile
- Generator charact.
- Other gen profile
- Wind and solar prof.
- Exchanges Non
ENTSO
- Fuel and CO2 prices
- Transmission
constraints

Modelling

- Chronologic. Unit
Comm.
- Hourly model
- System constraints
- **To minimise the
generation cost**

Outputs

- Balances
- Market Node
Marginal cost
- Hourly generation
pattern
- CO2 emission
-

TYNDP 2016: 2030 Visions – general overview

Market Model - perimeter and number of the nodes



TYNDP 2016: 2030 Visions – general overview

Market Model – key data



Data for each Market Node:

- ✓ Demand
- ✓ Thermal Dispatchable generation data set
- ✓ Hydro generation data set
- ✓ Wind generation data set
- ✓ Solar generation
- ✓ Other Renewable and NoN Renewable generation data set
- ✓ Exchanges capacities among Market nodes
- ✓ Exchanges with NoN ENTSO-E countries

TYNDP 2016: 2030 Visions – general overview

Agenda

- ✓ Pan European Market Study process
- ✓ Market Model
- ✓ Results:
 - ✓ *Demand*
 - ✓ *Hydro Generation*
 - ✓ *RES Generation*
 - ✓ *Thermal Generation*
 - ✓ *Energy mix*
 - ✓ *Balances & Market flows*

TYNDP 2016: 2030 Visions – general overview

Demand [GWh]

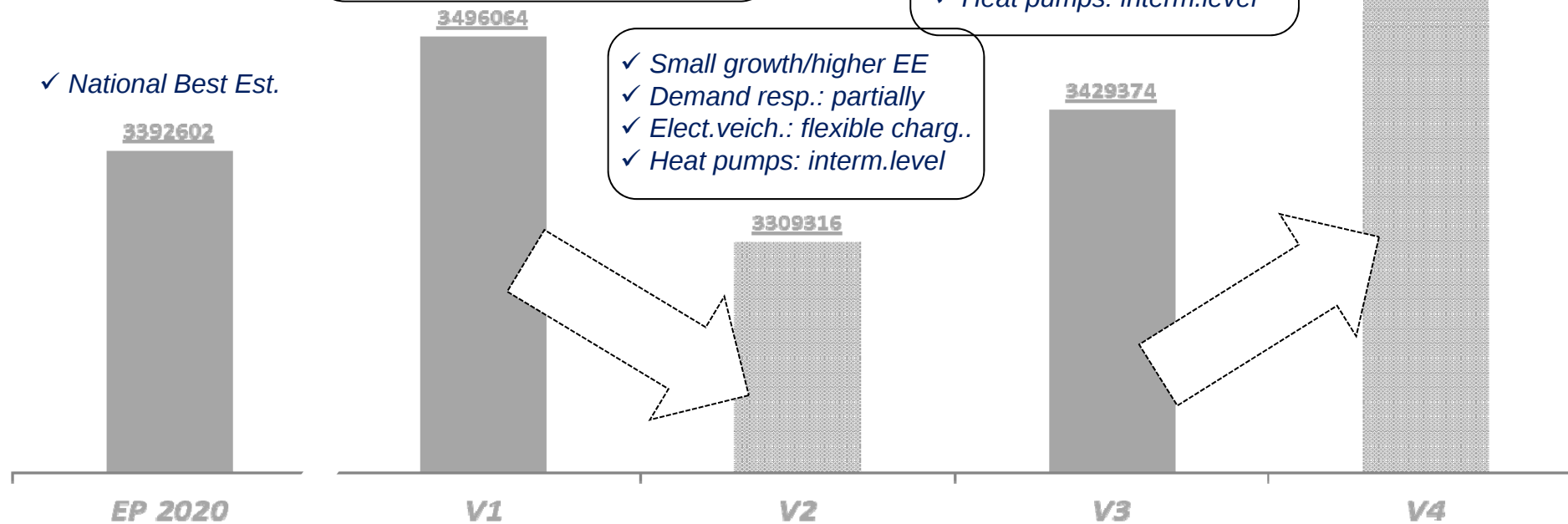
- ✓ Growth
- ✓ Demand resp.: fully
- ✓ Elect.veich.: flexible charg..and generating
- ✓ Heat pumps: maximum level

- ✓ Stagnation to small growth
- ✓ Demand resp.: as today
- ✓ Elect.veich.: no commercial break.
- ✓ Heat pumps: minimum level

- ✓ Growth/higher EE
- ✓ Demand resp.: partially
- ✓ Elect.veich.: flexible charg..
- ✓ Heat pumps: interm.level

- ✓ Small growth/higher EE
- ✓ Demand resp.: partially
- ✓ Elect.veich.: flexible charg..
- ✓ Heat pumps: interm.level

✓ National Best Est.



TYNDP 2016: 2030 Visions – general overview

Hydro Generation [GWh]

- ✓ Run Of River
- ✓ Storage

New pump storage
not very probable

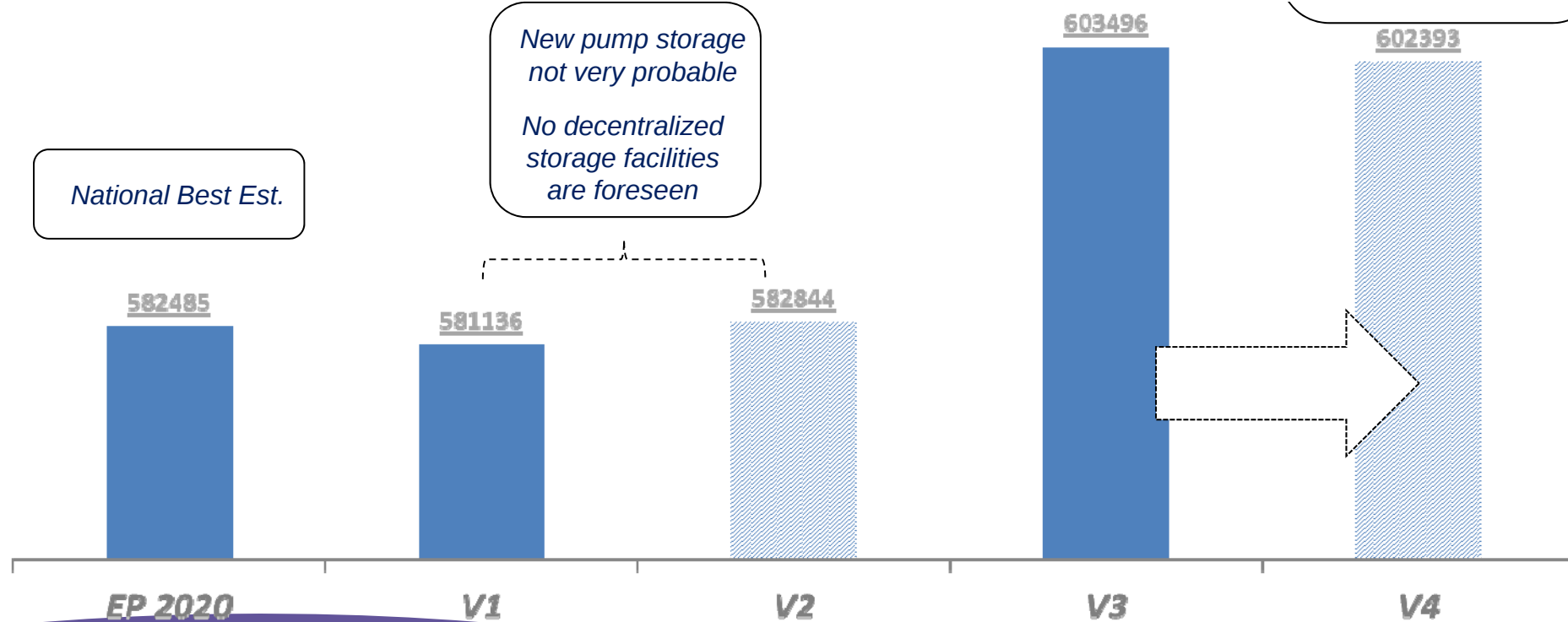
Decentralized
storage facilities
are implemented
(4-8%)

EC will subsidize
additional hydro
infrastructure for EC
system
Estimation of the
Max level of hydro x
country

National Best Est.

New pump storage
not very probable

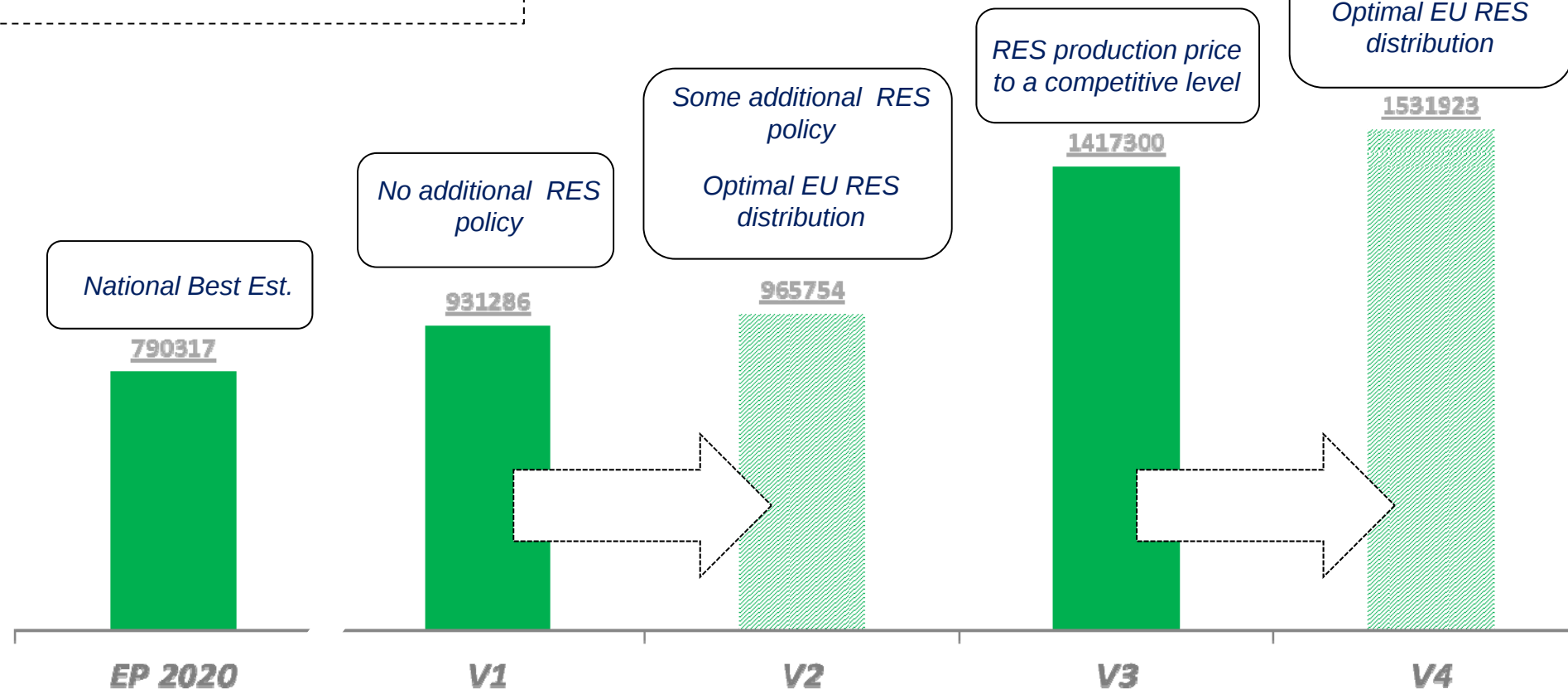
No decentralized
storage facilities
are foreseen



TYNDP 2016: 2030 Visions – general overview

Renewable Generation [GWh]

- ✓ Solar (PV + CSP)
- ✓ Wind (on-shore + off-shore)
- ✓ Other renewable sources

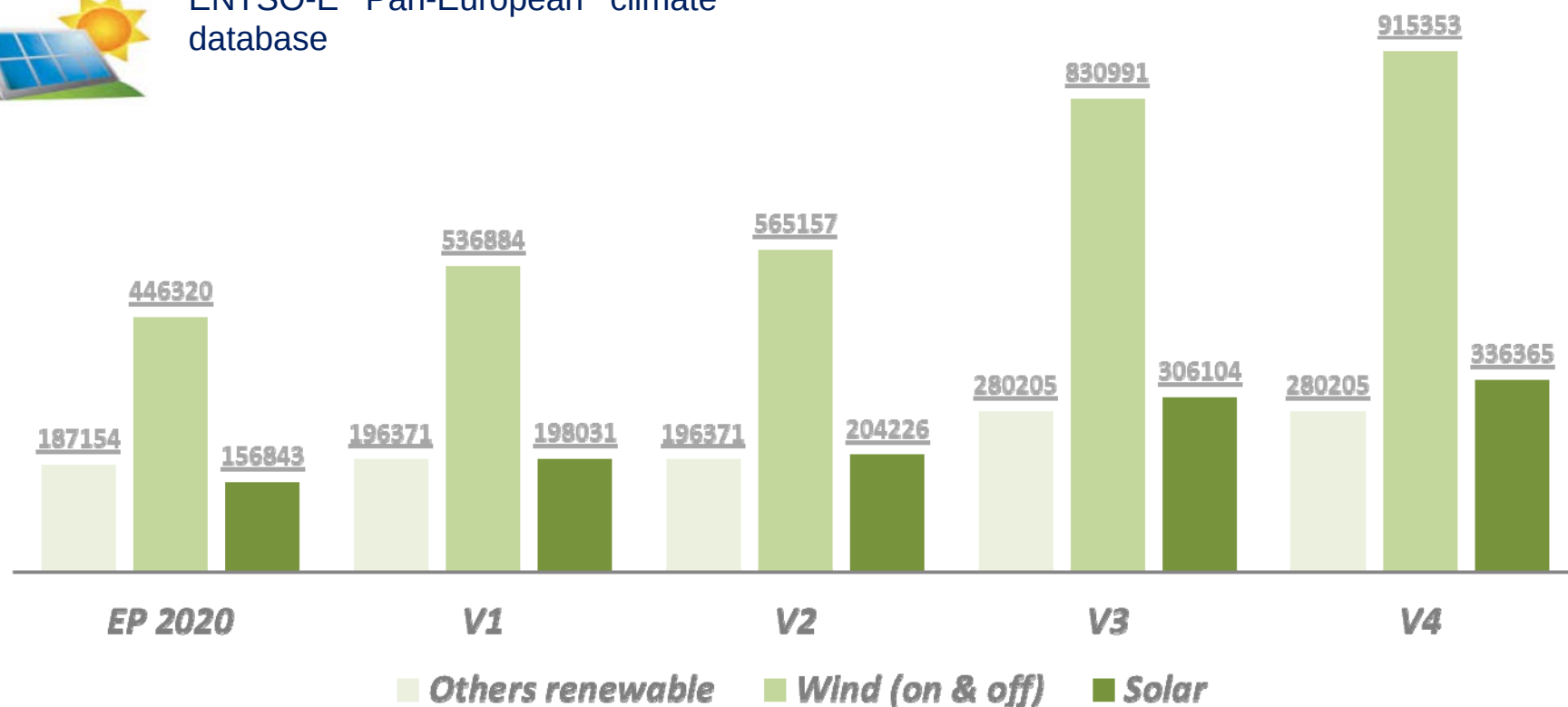


TYNDP 2016: 2030 Visions – general overview

Renewable Generation – per category [GWh]

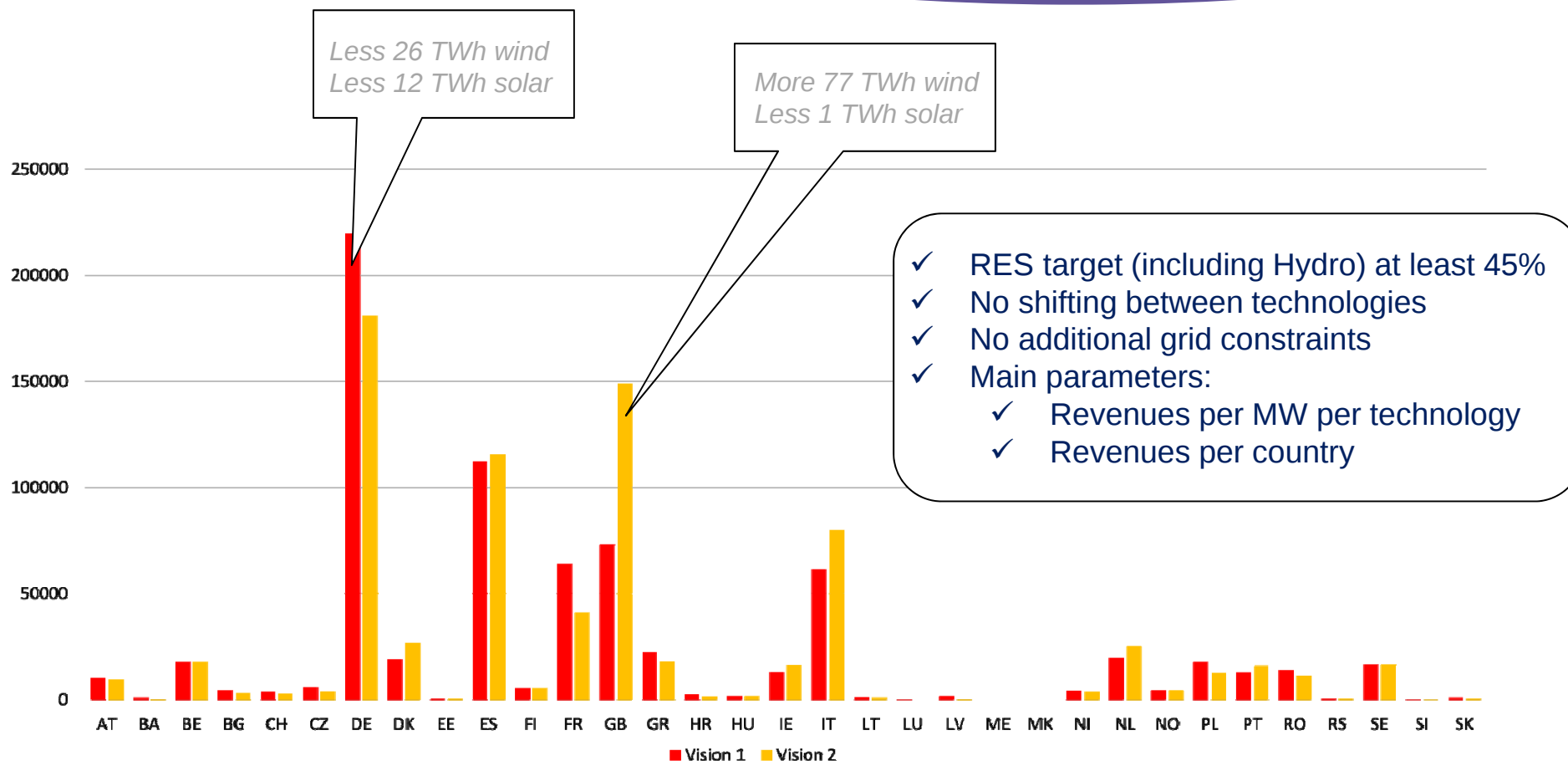


The derivation of the infeed time series of renewable energy sources will be based on the ENTSO-E Pan-European climate database



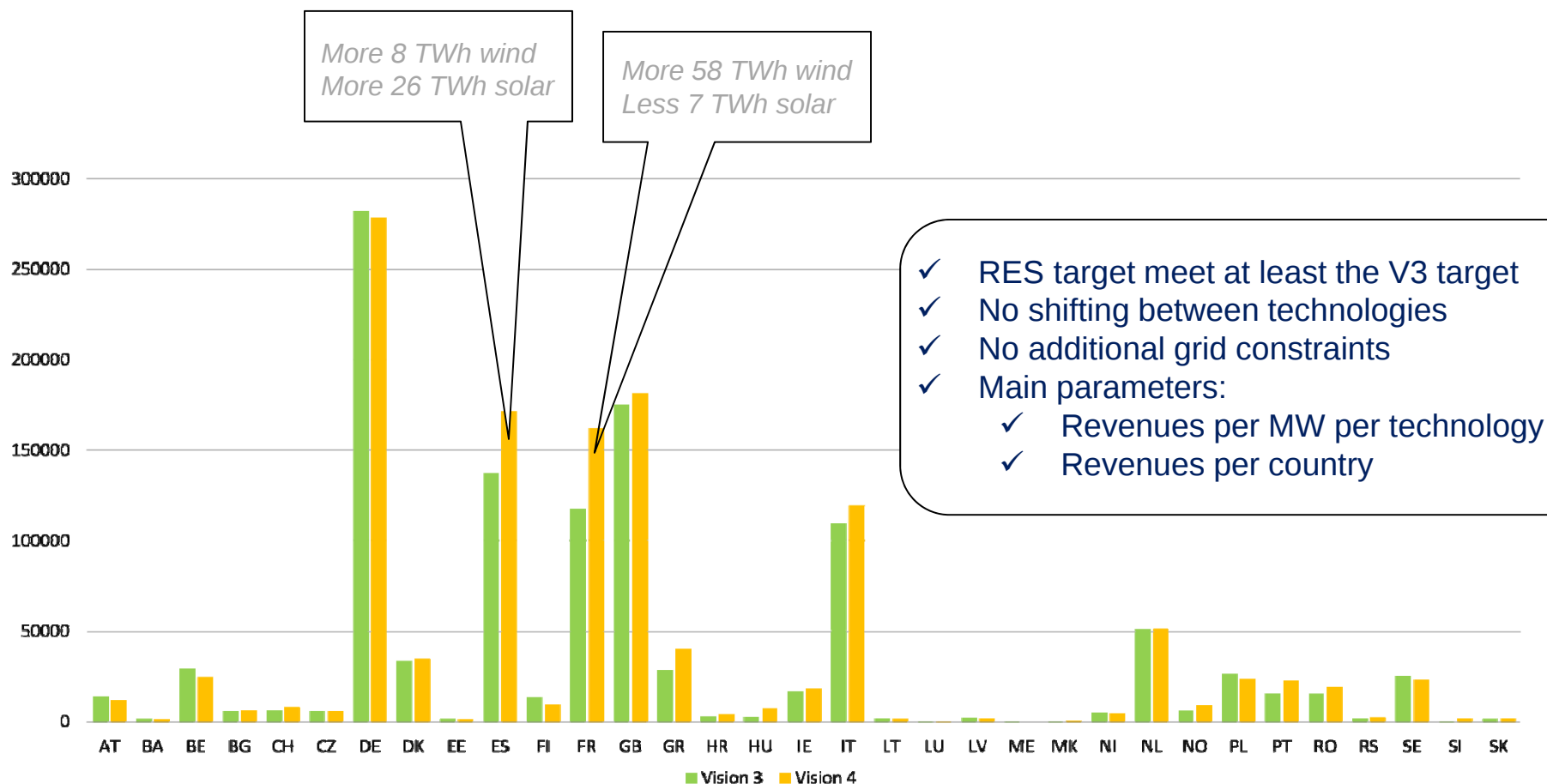
TYNDP 2016: 2030 Visions – general overview

Renewable Generation per country – V1 & V2 [GWh]



TYNDP 2016: 2030 Visions – general overview

Renewable Generation per country – V3 & V4 [GWh]



TYNDP 2016: 2030 Visions – general overview

Thermal Generation [GWh]

- ✓ Nuclear
- ✓ Fossil Fuels (Coal, Lignite, Gas, Oil,...)
- ✓ Other NoN renewable sources

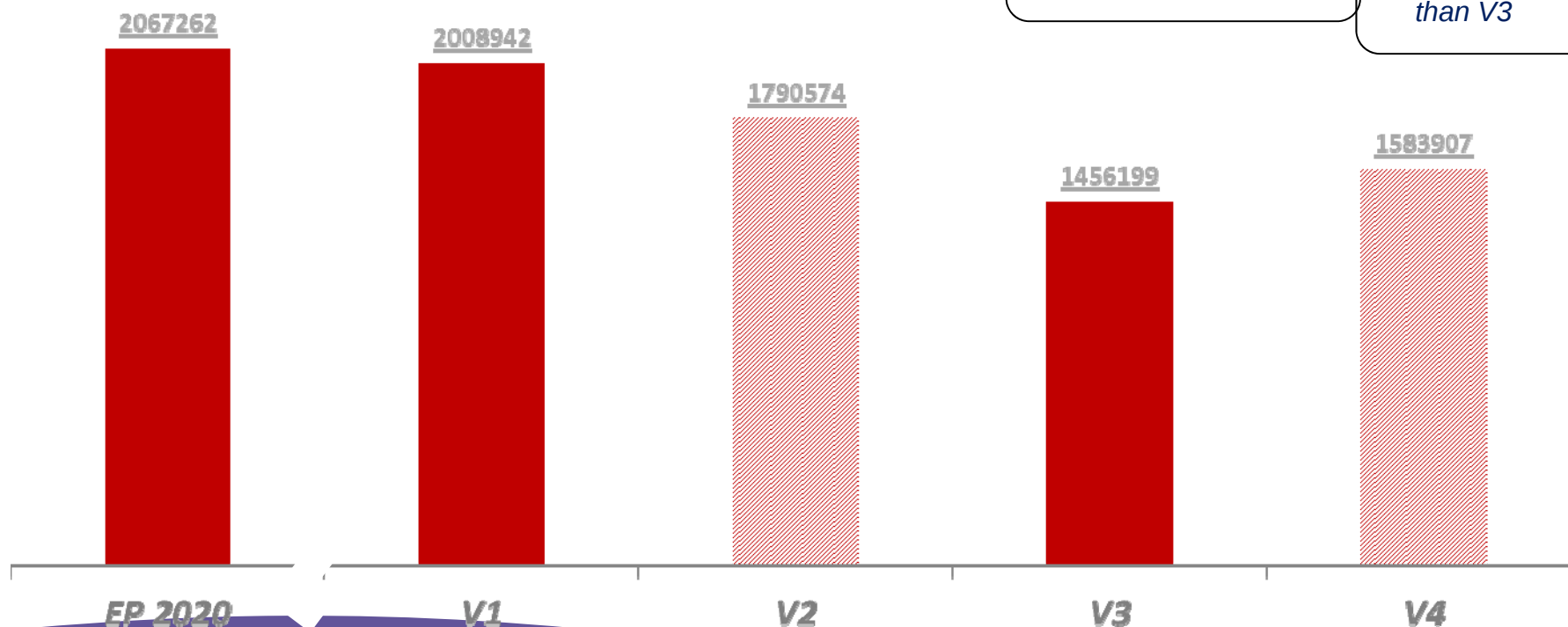
National Best Est.

- ✓ National adequacy
- ✓ Limited back up capacity

- ✓ European adequacy
- ✓ Less back up capacity than V1

- ✓ National adequacy - autonomous
- ✓ High back up capacity

- ✓ European adequacy
- ✓ Less back up capacity than V3



TYNDP 2016: 2030 Visions – general overview

Thermal Generation – per category [GWh]

National Best Est.

Coal before Gas

Coal before Gas

Gas before Coal

Gas before Coal

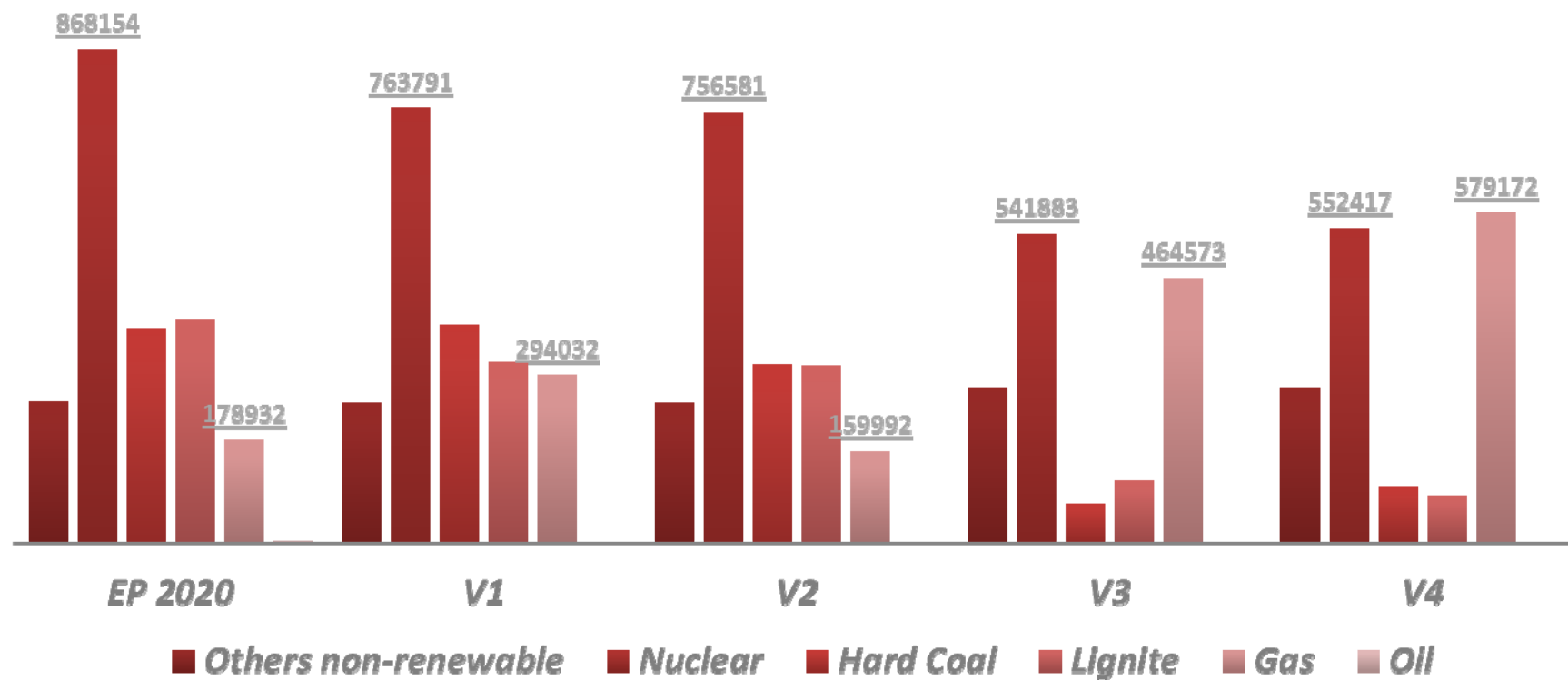
CO₂: 11 €/ton

CO₂: 17 €/ton

CO₂: 17 €/ton

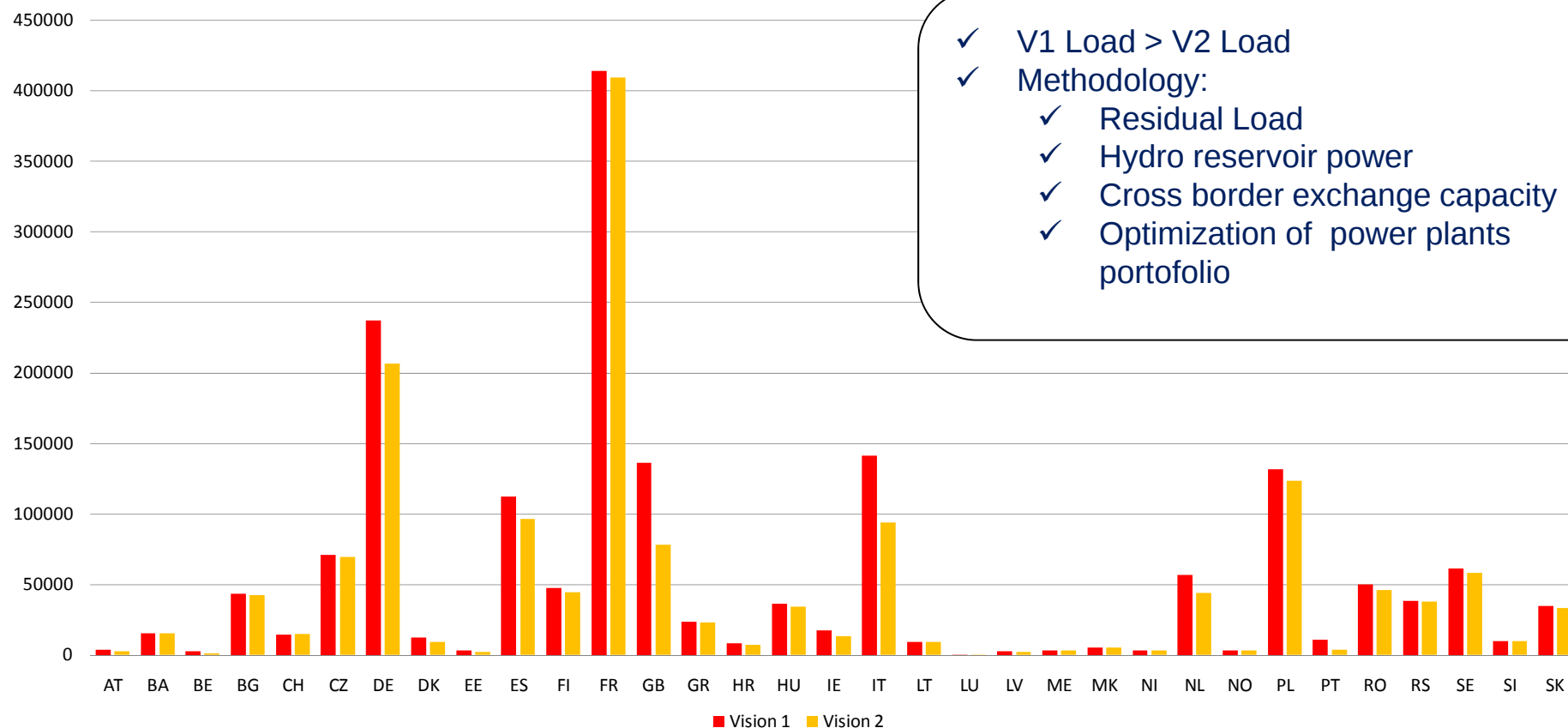
CO₂: 71 €/ton

CO₂: 76 €/ton



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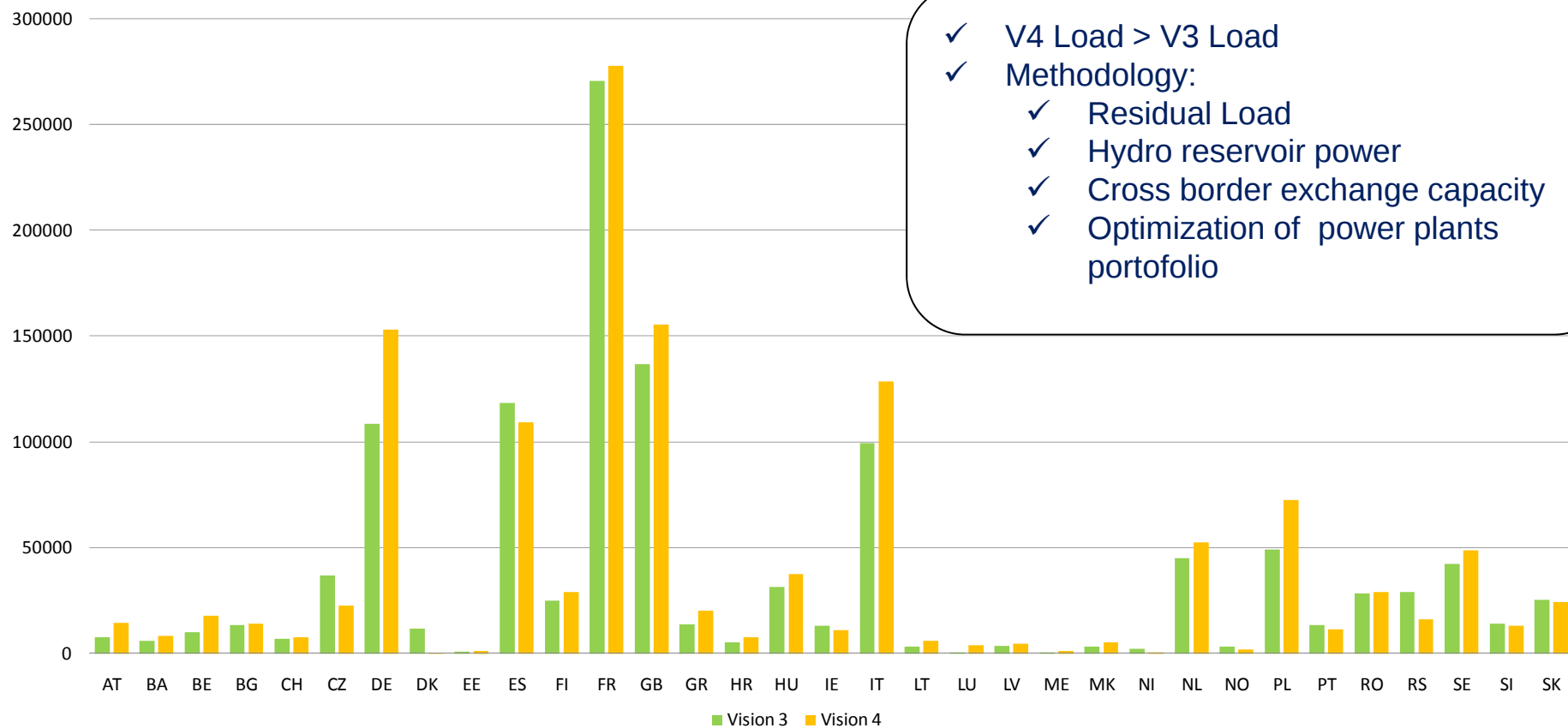
Thermal Generation per country – V1 & V2 [GWh]



- ✓ V1 Load > V2 Load
- ✓ Methodology:
 - ✓ Residual Load
 - ✓ Hydro reservoir power
 - ✓ Cross border exchange capacity
 - ✓ Optimization of power plants portfolio

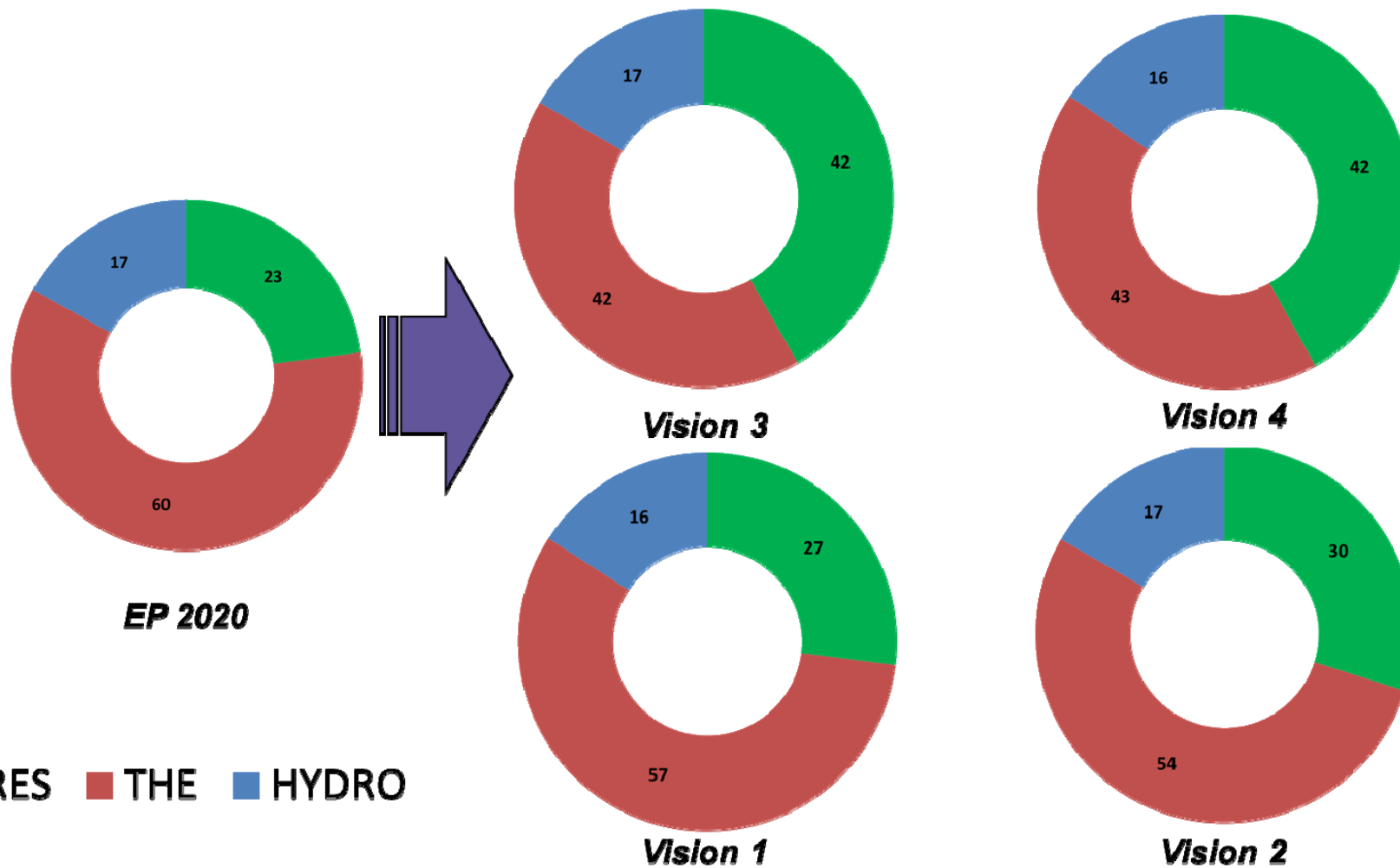
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Thermal Generation per country – V3 & V4 [GWh]



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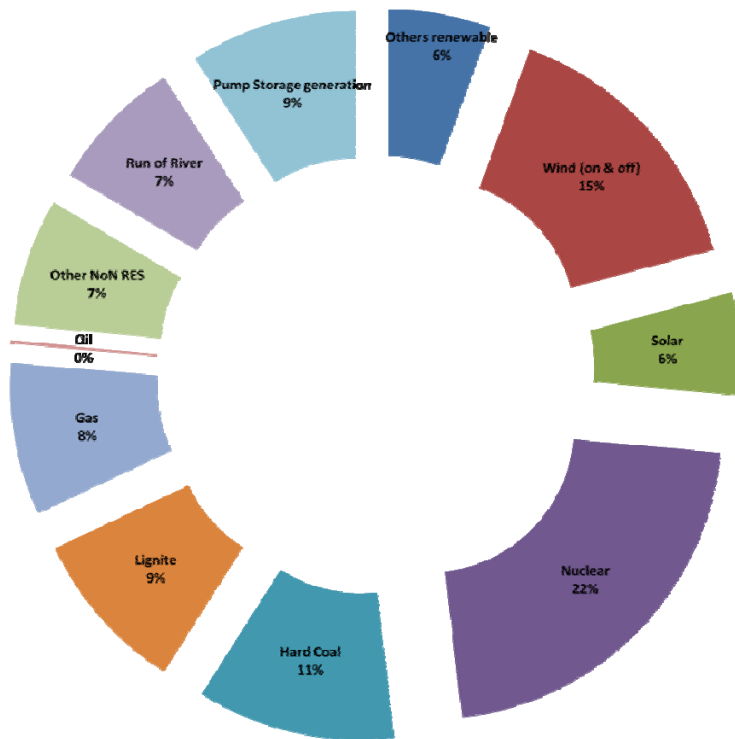
Generation mix [%]



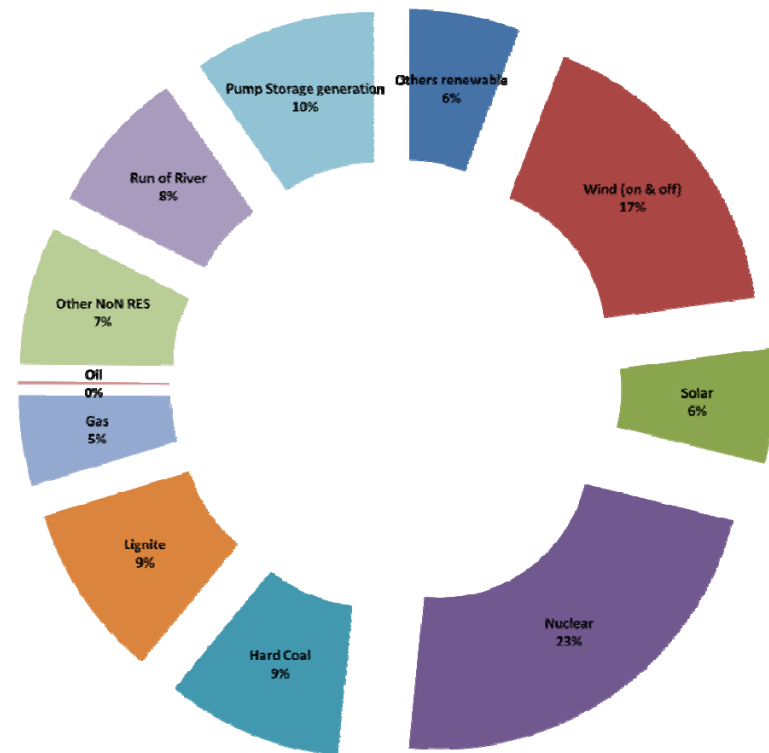
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Generation mix – V1 & V2 [%]

Vision 1



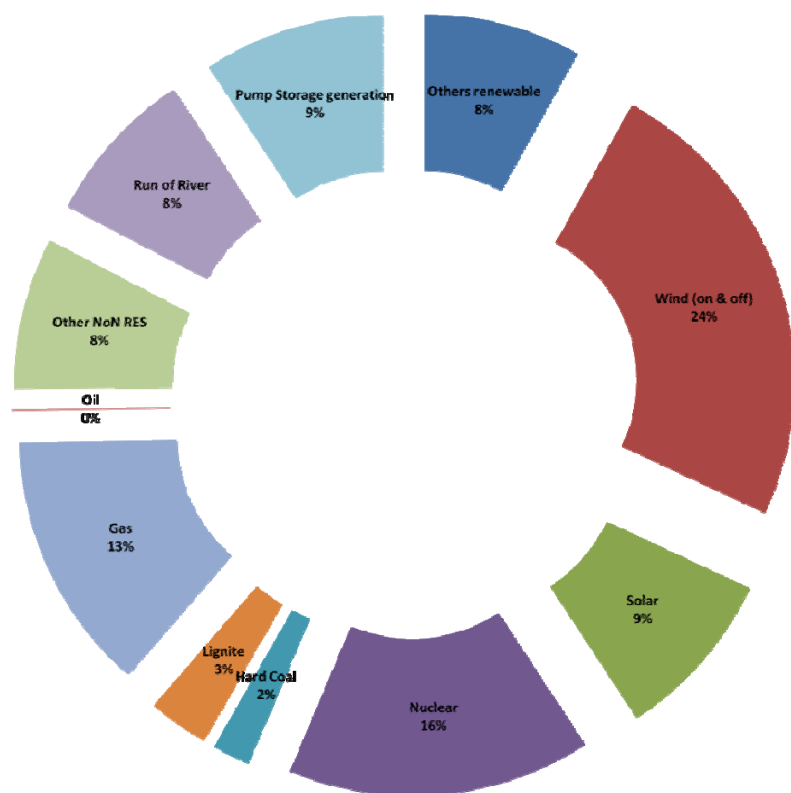
Vision 2



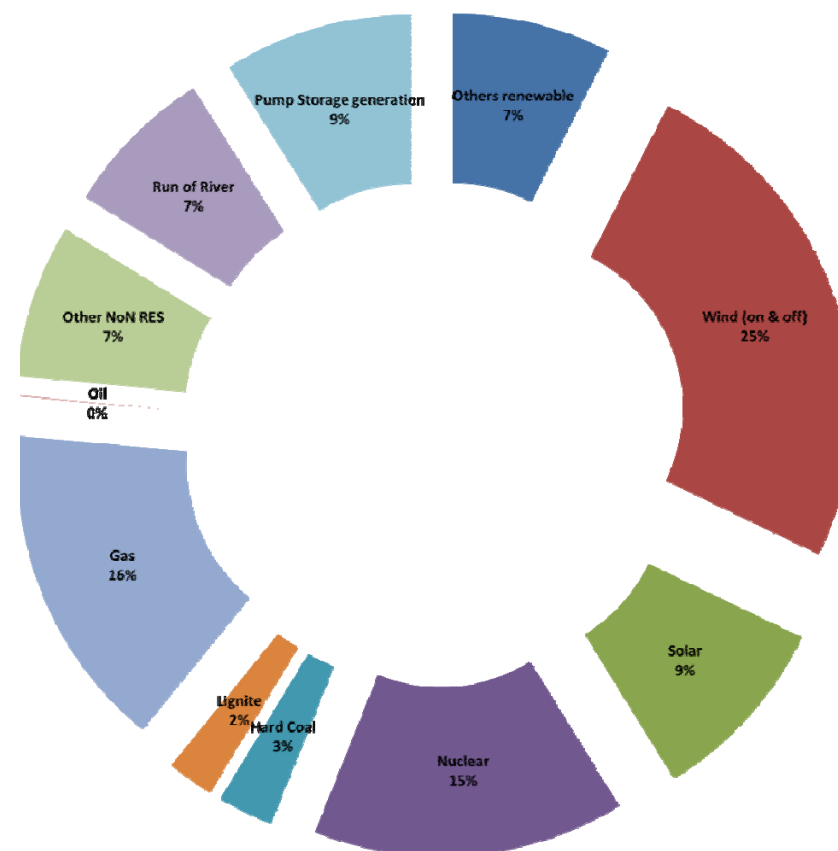
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Generation mix – V3 & V4 [%]

Vision 3

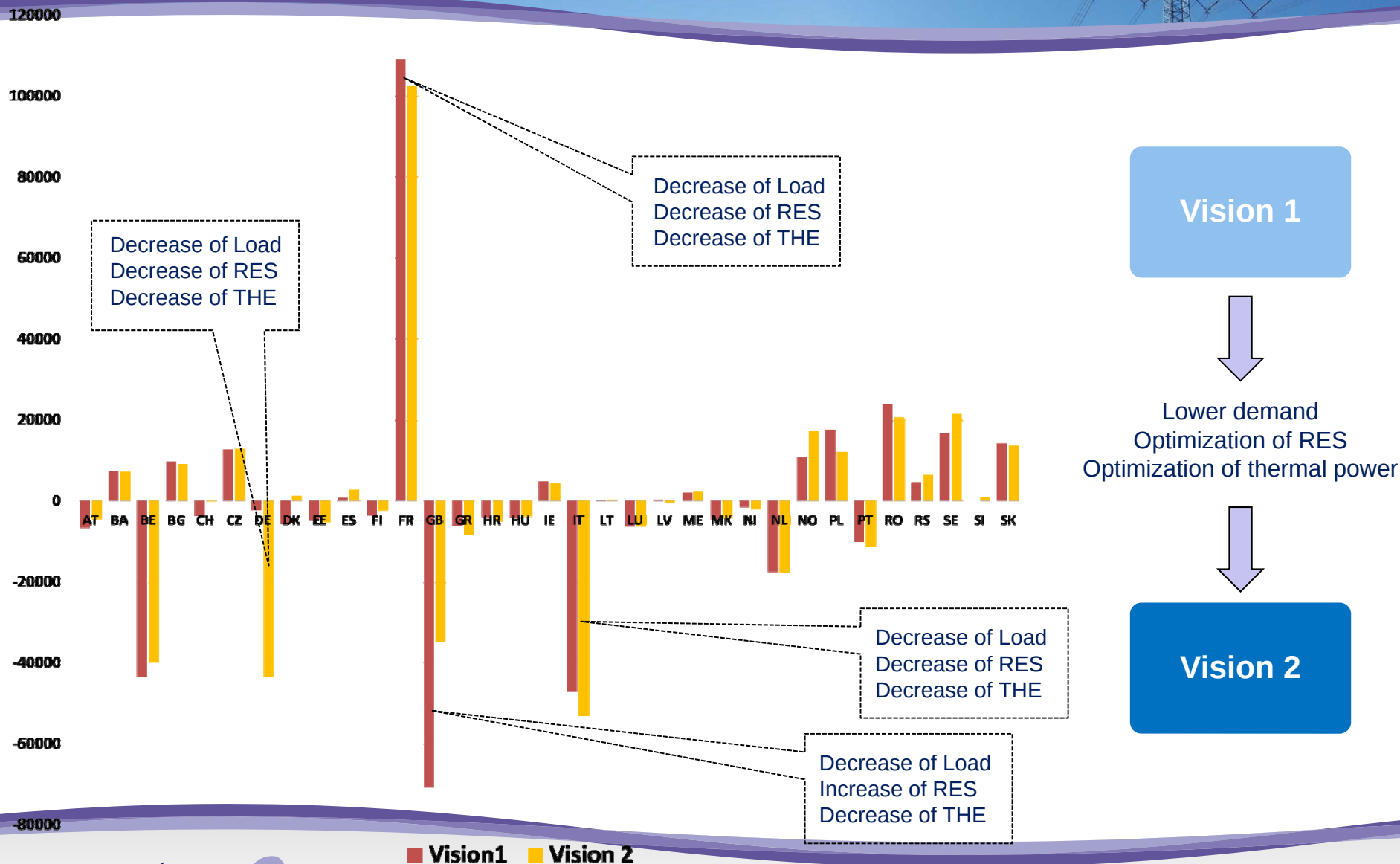


Vision 4



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Balances – Vision 1 & Vision 2 [GWh]



Vision 1

Lower demand
Optimization of RES
Optimization of thermal power

Vision 2

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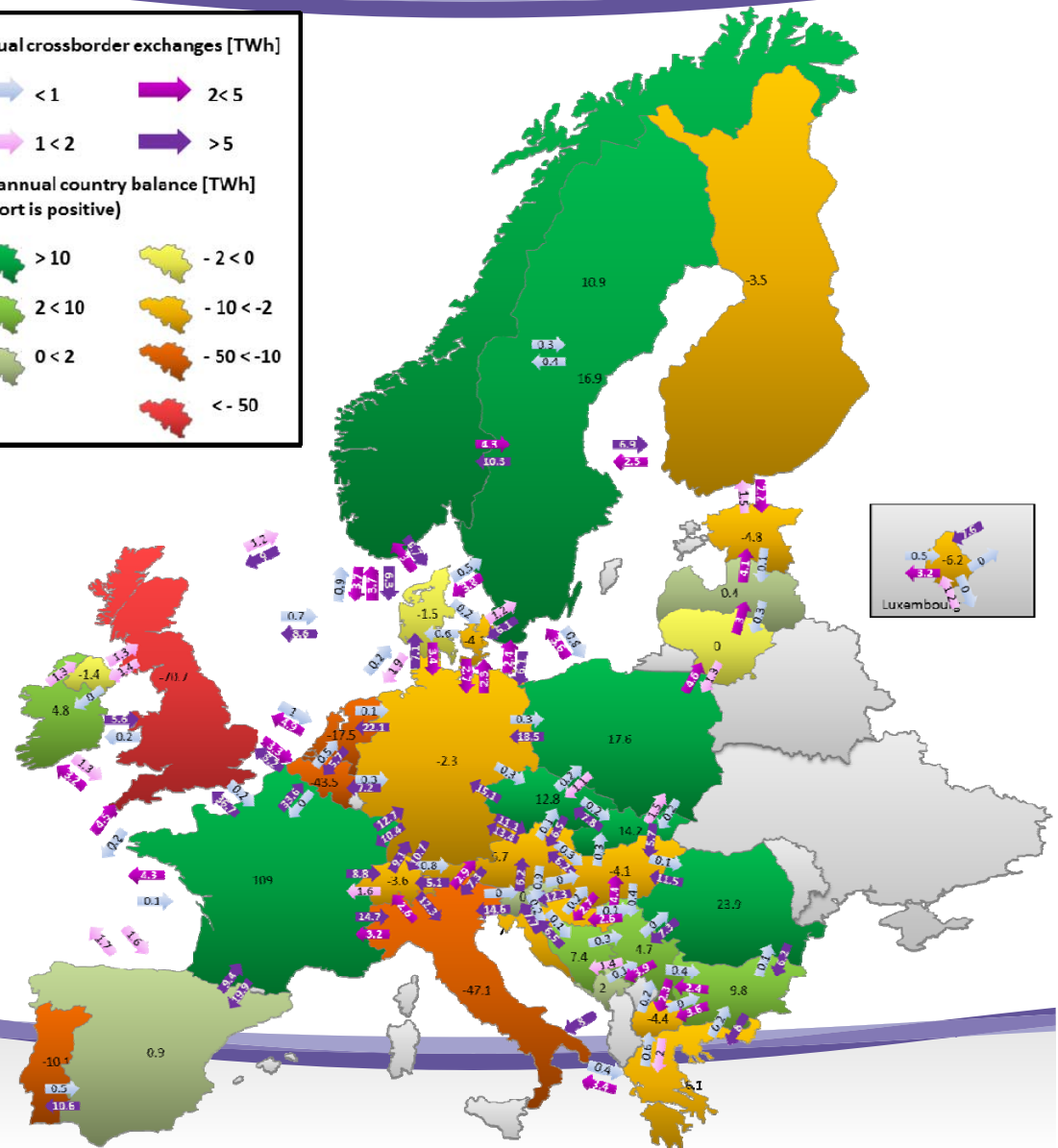
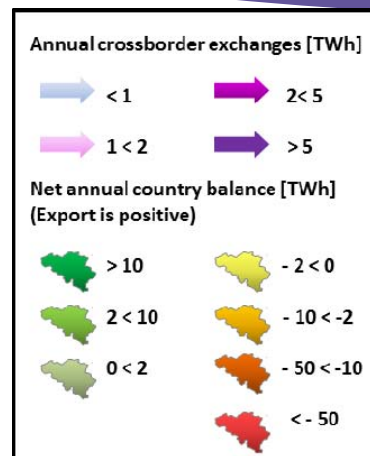
Energy Flows – Vision 1

✓ Main characteristics:

- ✓ Demand: Stagnation/small growth
- ✓ RES: no additional development
- ✓ THE:
 - ✓ Coal before Gas

✓ Main importer countries:

- ✓ *Great Britain*
- ✓ *Italy*
- ✓ *Belgium*
- ✓ *Netherland*



TYNDP 2016: 2030 Visions – general overview

Energy Flows – Vision 2

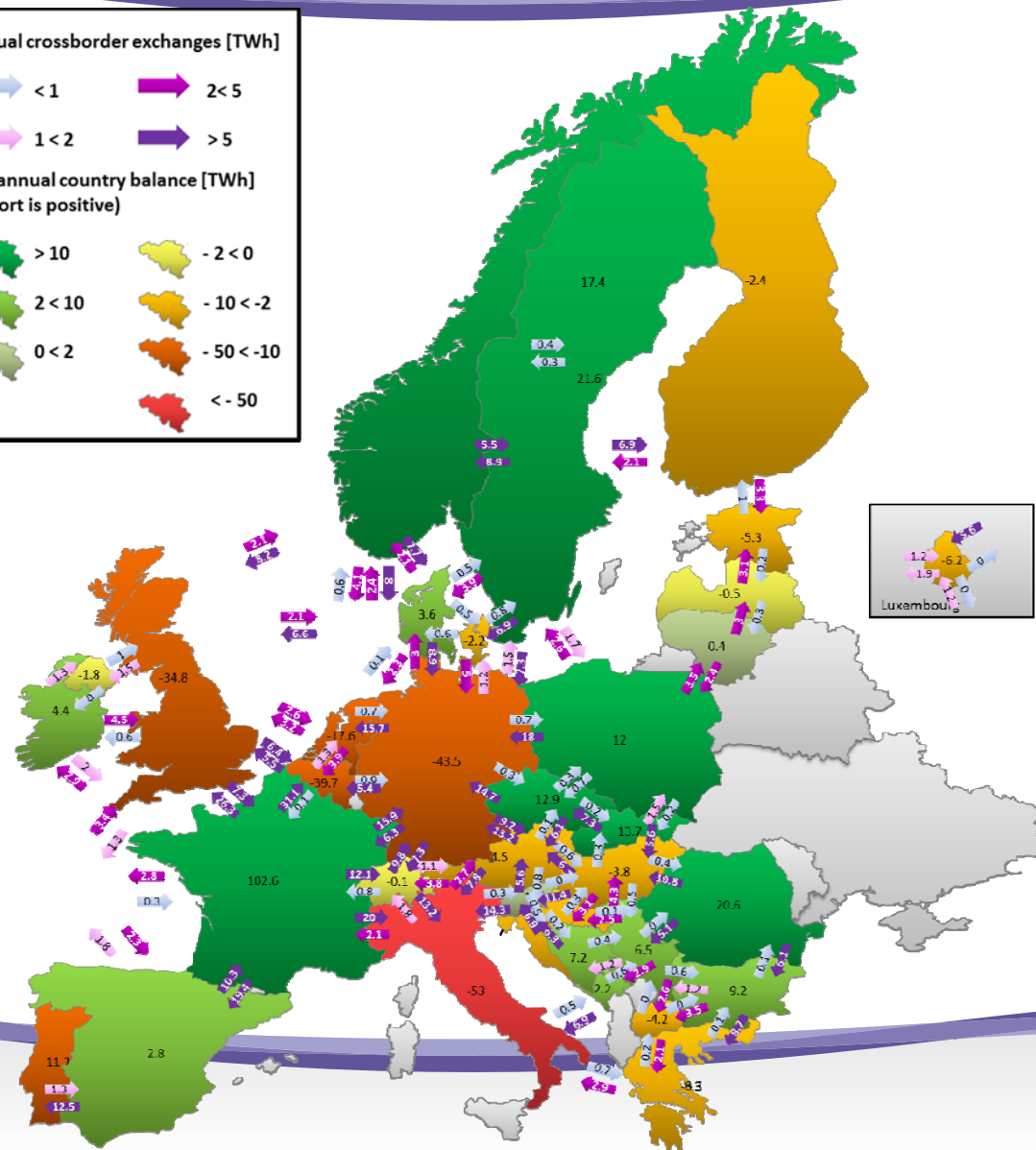
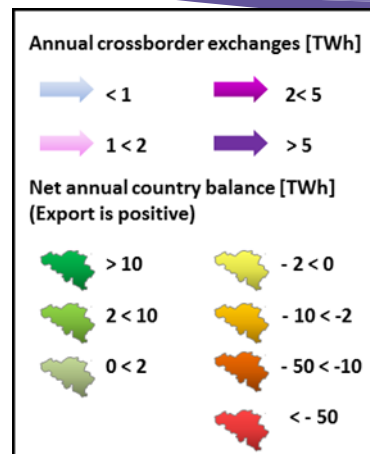
✓ Main characteristics:

- ✓ Demand decrease
- ✓ RES optimization
- ✓ THE:
 - ✓ Capacity reduction
 - ✓ Coal before Gas

✓ Main importer countries:

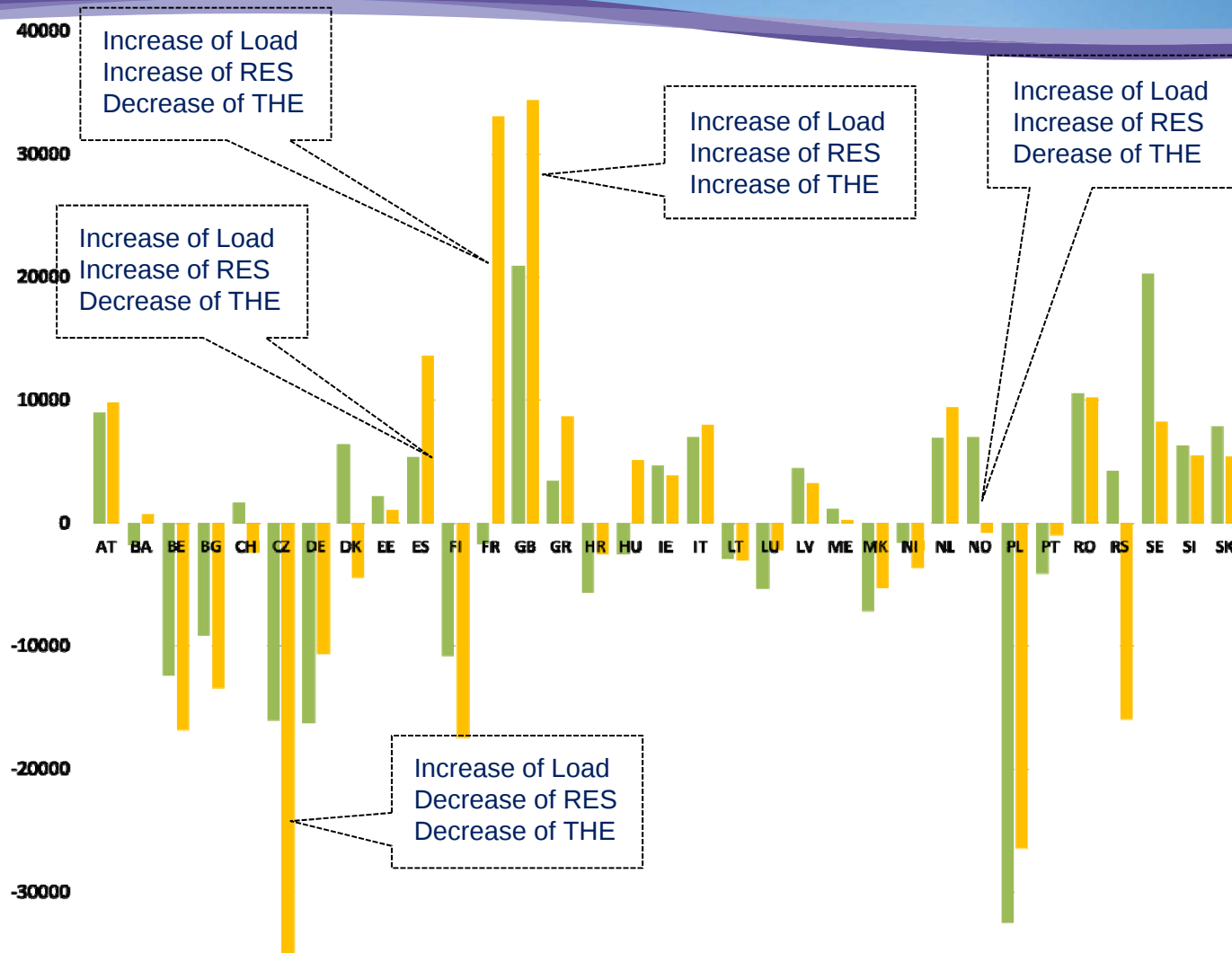
- ✓ Germany (increase respect V1)
- ✓ Great Britain (decrease respect V1)
- ✓ Italy (increase respect V1)
- ✓ Belgium (decrease respect V1)
- ✓ Netherland (increase respect V1)

- ✓ Increase of the flows from the peripheral countries to the center of EU



TYNDP 2016: 2030 Visions – general overview

Balances – Vision 3 & Vision 4 [GWh]



Vision 3

Higher demand
Centralised storage
Optimization of RES
Optimization of thermal power

Vision 4

TYNDP 2016: 2030 Visions – general overview

Energy Flows – Vision 3

✓ Main characteristics:

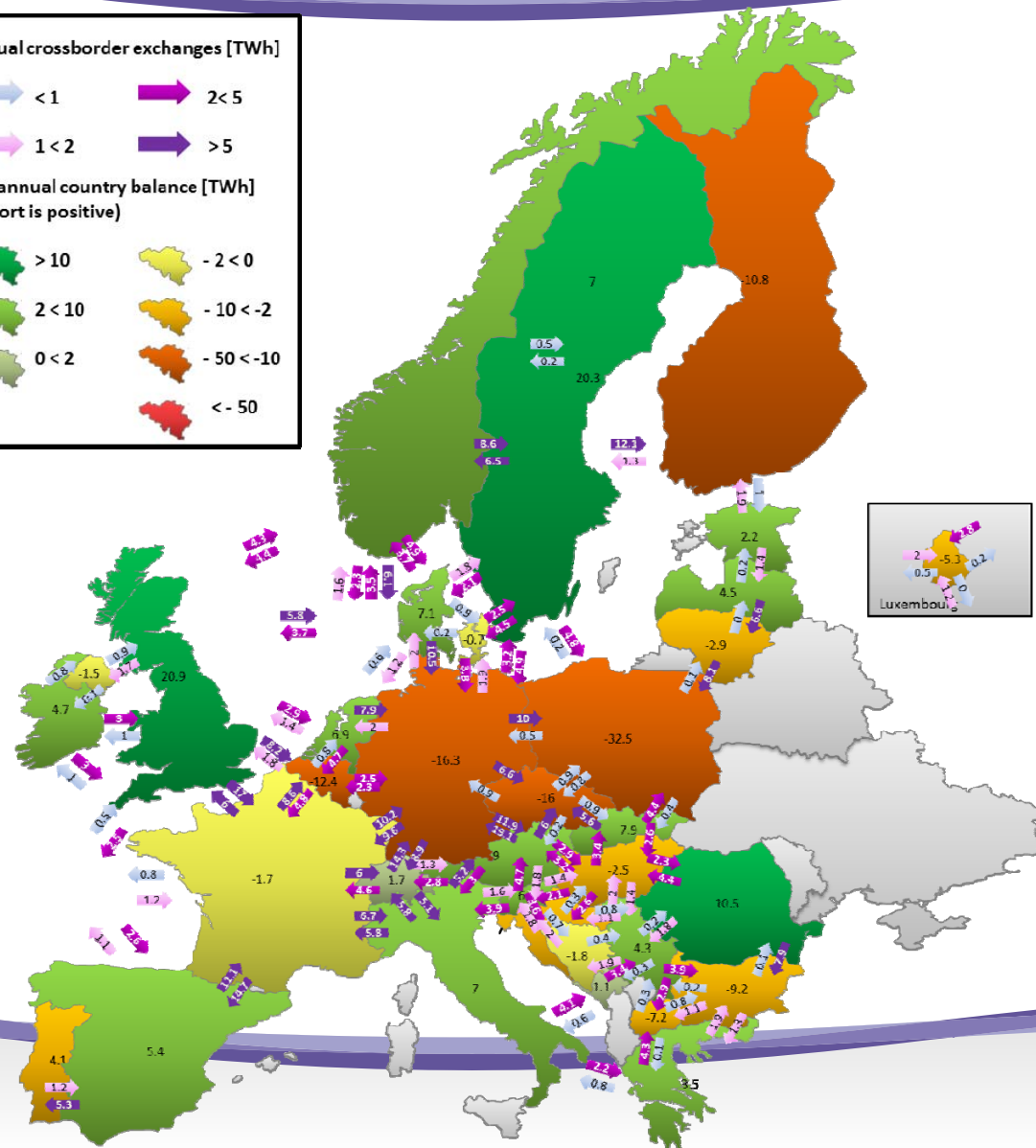
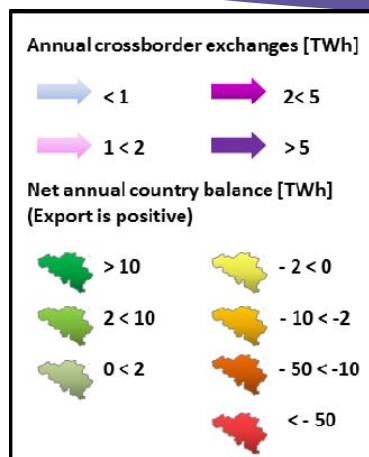
- ✓ Demand: Growth/high EE
- ✓ RES: additional development
- ✓ THE:
 - ✓ Gas before Coal

✓ Main importer countries:

- ✓ *Belgium*
- ✓ *Germany*
- ✓ *Czech Republic*
- ✓ *Poland*

✓ Main changes respect V1:

- ✓ *Great Britain*
- ✓ *Italy*



TYNDP 2016: 2030 Visions – general overview

Energy Flows – Vision 4

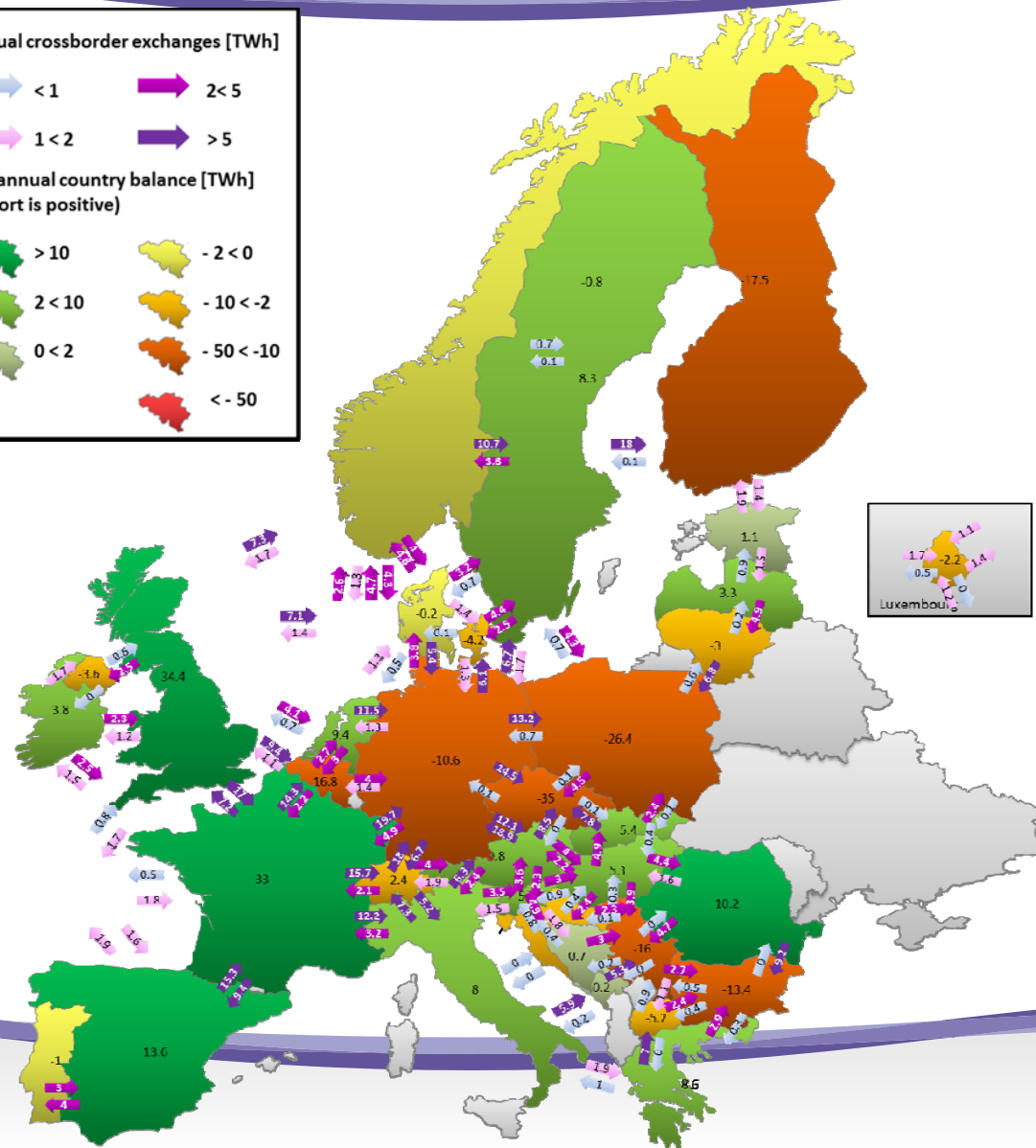
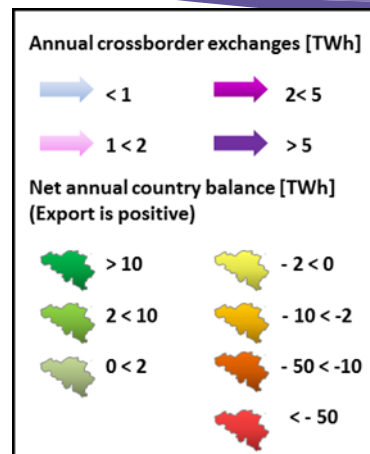
✓ Main characteristics:

- ✓ Demand increase
- ✓ RES optimization
- ✓ THE:
 - ✓ Capacity reduction
 - ✓ Gas before Coal

✓ Main importer countries:

- ✓ *Belgium (increase respect V3)*
- ✓ *Germany (decrease respect V3)*
- ✓ *Czech Republic (increase respect V3)*
- ✓ *Poland (decrease respect V3)*

- ✓ Increase of the flows from West and South parts of EU to the center of EU





entsoe

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