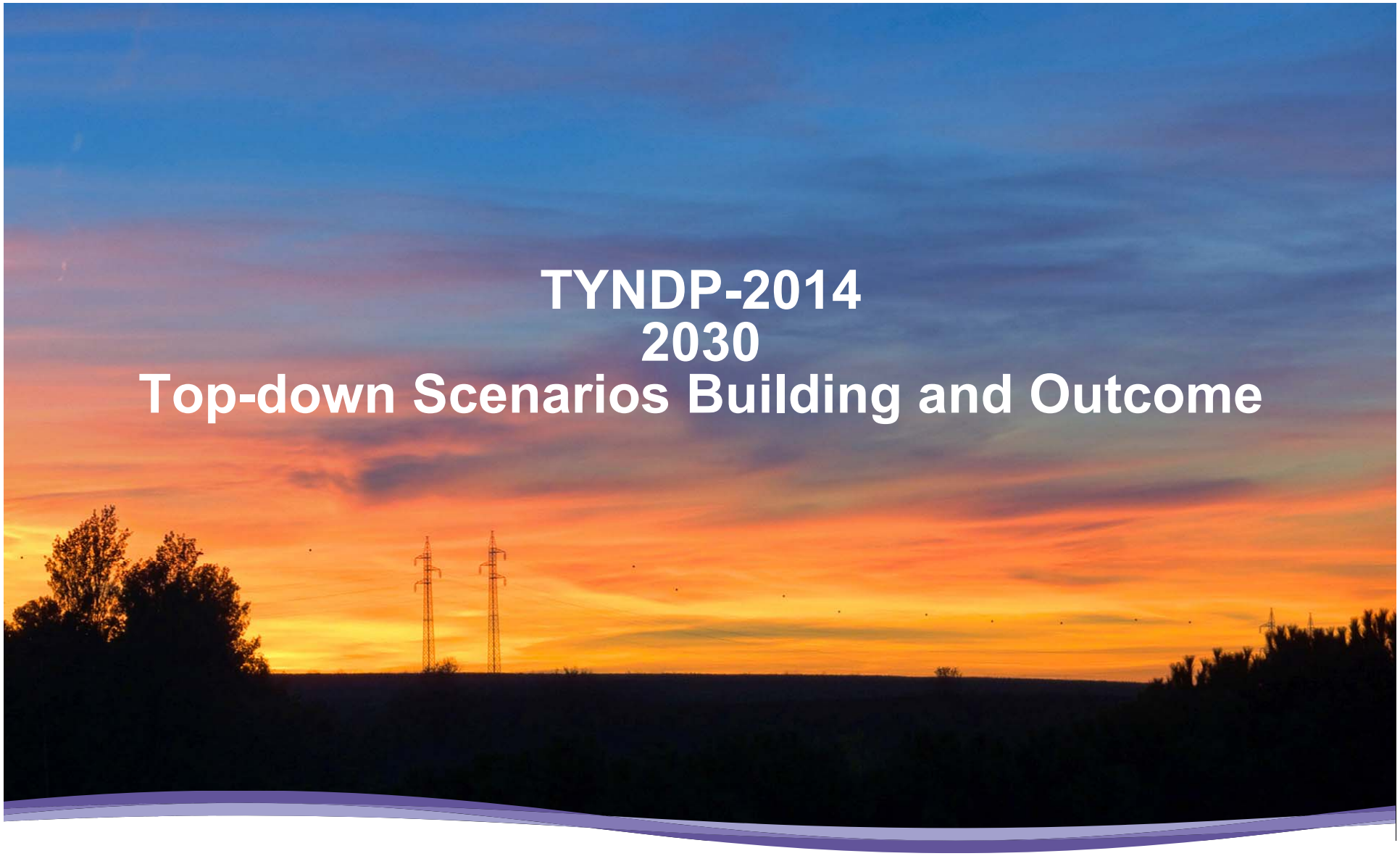

TYNDP-2014
2030
Top-down Scenarios Building and Outcome

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2nd July 2013

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Reliable Sustainable Connected

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  - Concerns for Vision 4 & Proposed Solutions
  - Stakeholders' feedback

Basic Assumptions of the Top-down Visions

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2030 Visions: a Bridge between the European Energy Targets for 2020 and 2050

On track for energy roadmap 2050

VISION 3: "GREEN TRANSITION"	VISION 4: "GREEN REVOLUTION"
VISION 1: "SLOW PROGRESS"	VISION 2: "MONEY RULES"

High degree of integration of the internal electricity market

General Characteristics of all 2030 Visions

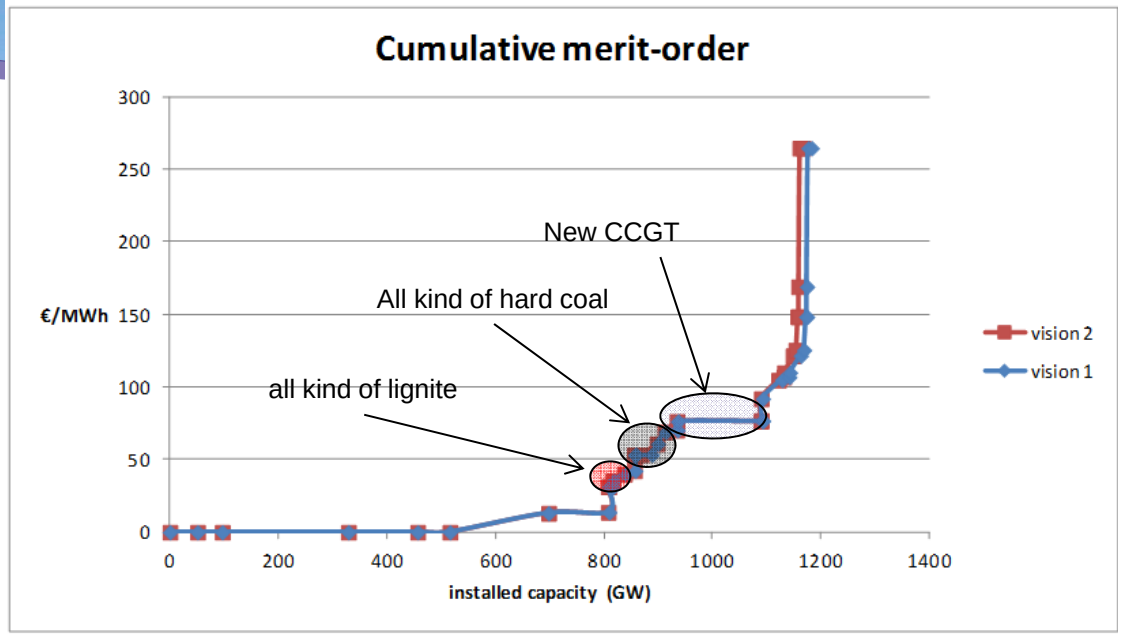
VISION 3: "GREEN TRANSITION" | VISION 4: "GREEN REVOLUTION"
VISION 1: "SLOW PROGRESS" | VISION 2: "MONEY RULES"

	Vision 1 : Slow progress	Vision 2 : Money rules	Vision 3 : Green transition	Vision 4 : Green revolution
Economic and financial conditions	Less favourable	Less favourable	Favourable	Favourable
Focus of energy policies	National	European	National	European
Focus of R&D research schemes	National	European	National	European
CO_2 prices and primary energy prices	Low CO_2 prices and high primary energy prices	Low CO_2 prices and high primary energy prices	High CO_2 prices and low primary energy prices	High CO_2 prices and low primary energy prices
Electricity demand	Lowest level	Higher than in Vision 1	Higher than in Vision 2	Higher than in Vision 3
Demand respons potential	Used as today	Partially used	Partially used	Fully used
Electric vehicles	No commercial break through of electric plug-in vehicles	Electric plug-in vehicles (with flexible charging)	Electric plug-in vehicles (with flexible charging)	Electric plug-in vehicles (with flexible charging and generation)
Heat pumps	Implemented (although not evenly spread around Europe)	Implemented (although not evenly spread around Europe)	Implemented (although not evenly spread around Europe)	Much more heat pumps implemented (although not evenly spread around Europe)
Back-up generation	Level of back-up generation higher than in Vision 2 but lower than in Vision 4	Lowest level of back-up generation	Highest level of back-up generation	Level of back-up generation higher than in Vision 2 but lower than in Vision 3
Nuclear	National view	Public acceptance	National view	Public acceptance
CCS	Not commercially implemented	Partially implemented	Not commercially implemented	Fully implemented
Storage	As planned today	As planned today	Decentralised storage (limited amount but higher than in Vision 4)	Mainly additional centralised hydro storage + some decentralised storage
Smart grid solutions	Partially implemented	Fully implemented	Partially implemented	Fully implemented

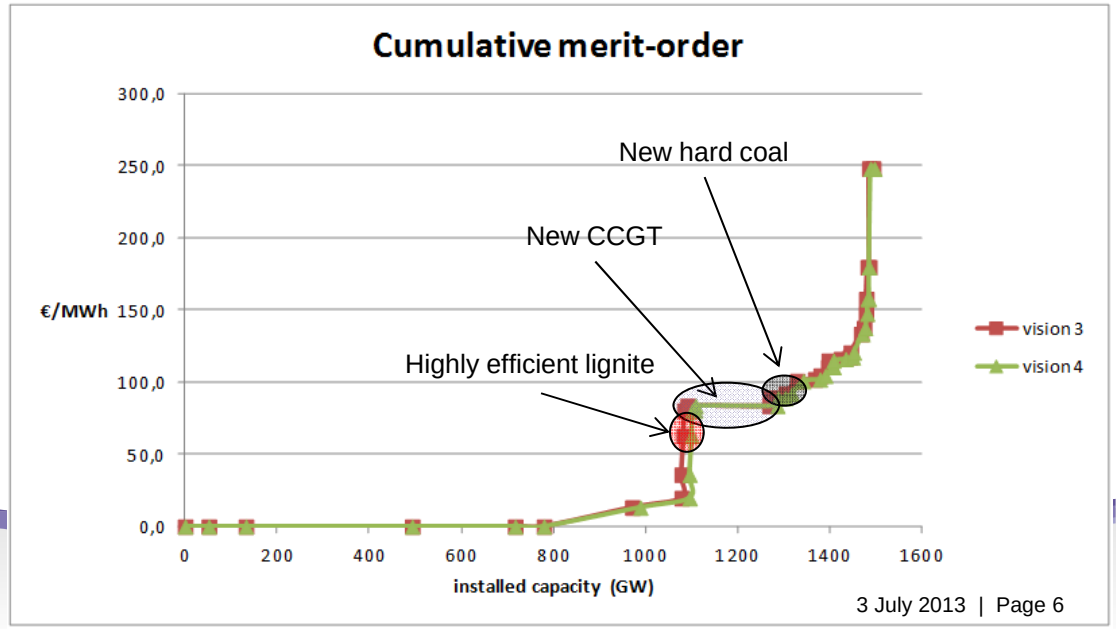
Basic Assumptions on Visions 2 & 4: Merit Order Curve

Sources for fuel and CO2 prices:

- Visions 1 & 2:
  - Fuel & CO_2: IEA World Energy Outlook 2011, Current Policies, year 2030
- Visions 3 & 4:
  - Fuel: IEA World Energy Outlook 2011, 450 scenario, year 2030
  - CO_2: IEA World Energy Outlook 2011, 450 scenario, year 2035

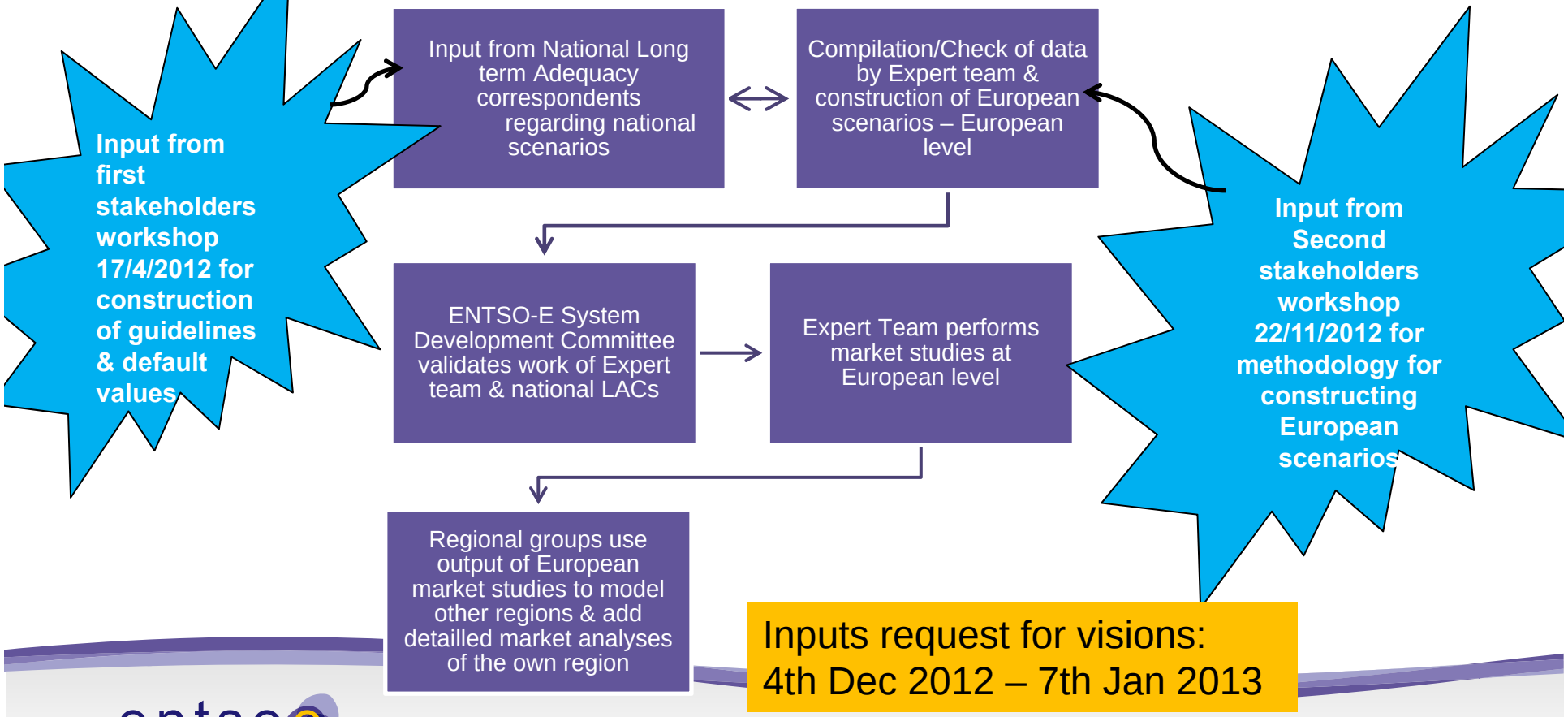


=> In order to enable the swap in the merit-order curve between gas and coal for Visions 3 and 4, data are taken from the greenest scenario of IEA (450 ppm)



Construction Process for 2030 visions

- a dedicated ENTSO-E TSO Expert Team
  - **Consistency checks of Visions 1 "Slow Progress" and 3 "Green Transition"**
  - **<u>Quantification of the two European top down 2030 Visions 2 "Money Rules" and 4 "Green Revolution"</u>**



Inputs request for visions:
4th Dec 2012 – 7th Jan 2013

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Construction of the Top-down Visions (“Money Rules” & “Green Revolution”)

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A Methodology built upon Bottom-up Data

- The top-down approach for visions 2 “Money Rules” & 4 “Green Revolution” requires that they are established at a centralized European level with visions 1 and 3 data as a starting point
- This is to ensure that we could start with a plausible and realistic dataset
- The derivation of the top-down scenarios was then based on the inputs provided by stakeholders (boundary conditions) within the framework (considered parameters: e.g. penetration of EV, heat-pump, additional storages, etc.) which has been presented to and acknowledged by stakeholders
- Inputs from stakeholders were integrated into our methodology as much as possible unless their opinions were divided (e.g. magnitude of GTC increase)
- Market simulation tools were required for the construction process
- In the construction process the ENTSO-E Expert Team also assessed whether there was any dump energy or if the system was adequate after thermal reduction

Philosophy: Construction of the European Top-Down visions 2 “Money Rules” & 4 “Green Revolution”

- From Vision 1 “Slow Progress” to Vision 2 “Money Rules” and from Vision 3 “Green Transition” to Vision 4 “Green Revolution” the objective is to reduce thermal generation capacities taking into account the probable increase of market-oriented transmission interconnection capacities (GTCs – Grid Transfer Capacities) all over Europe
- Reduction of expensive thermal generation units (economically unviable) is performed in a iterative (in case of danger on security of supply) and systematic way

Step-by-step Construction & Outcome

- Step 1: Hydro & Load Modification
  - Methodology: Vision 2
  - Methodology: Vision 4
  - Outcome
- Step 2: One step GTC Increase
  - Methodology
  - Outcome
- Step 3: On step Thermal Capacity Reduction
  - Methodology
  - Outcome

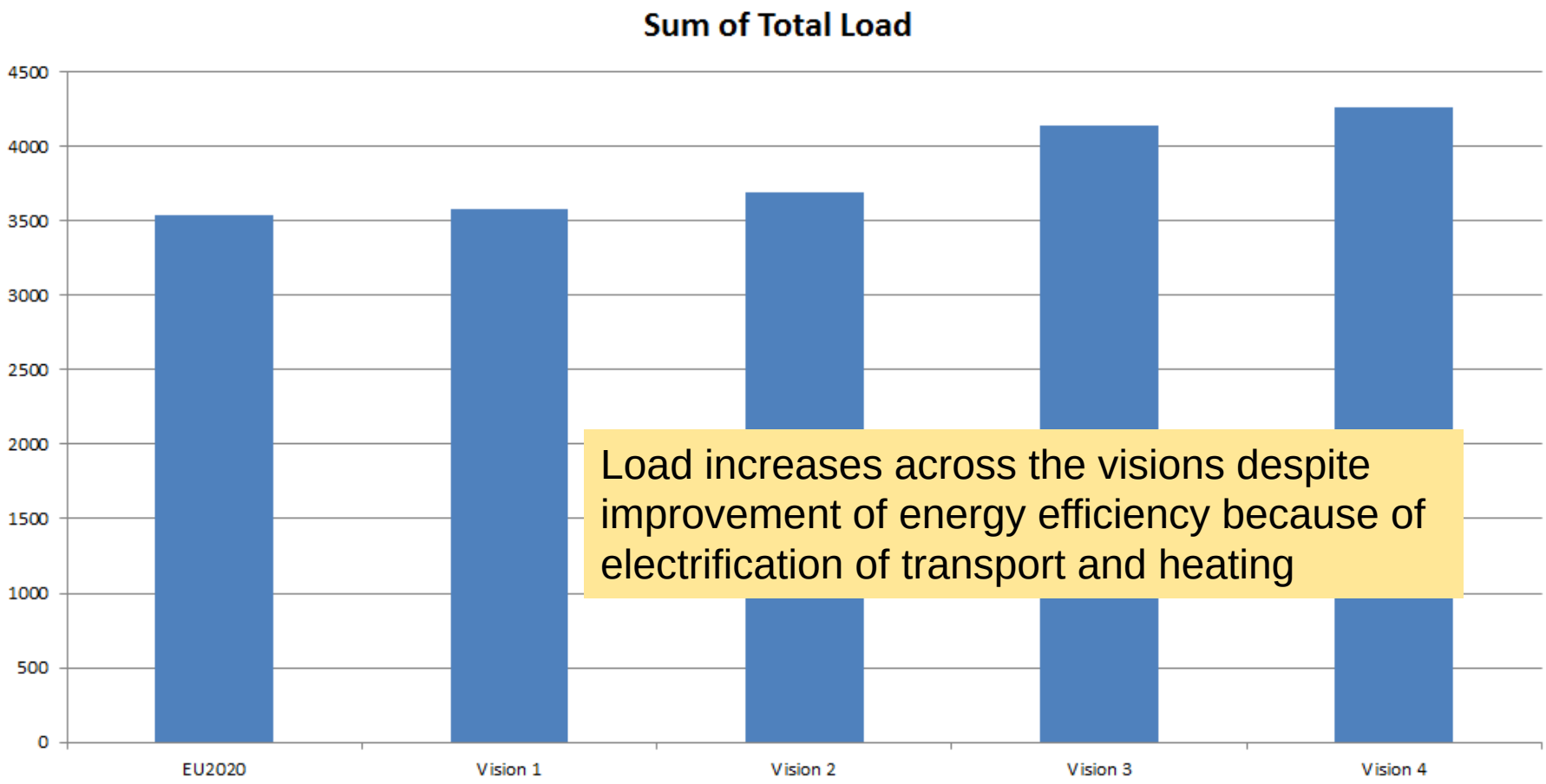
Step 1: Hydro and Load Data Modification (Vision 2)

- Load data: necessary default addition of profiles for peak shaving (2.5% vs. Vision 1), EV (10%) and heat pumps (5%) specific for Vision 2 (if justified by TSO's LAC other values were also possible) was integrated into the load profiles from Vision 1; the default values were those for Vision 3
- Hydro data: same as Vision 1
- For adequacy analysis: a week in the load curve derived as stated above is modified to reflect 1 in 20 worst case (high demand); for hydro the hydro curve derived above was modified to reflect a dry year condition

Step 1: Hydro and Load Data Modification (Vision 4)

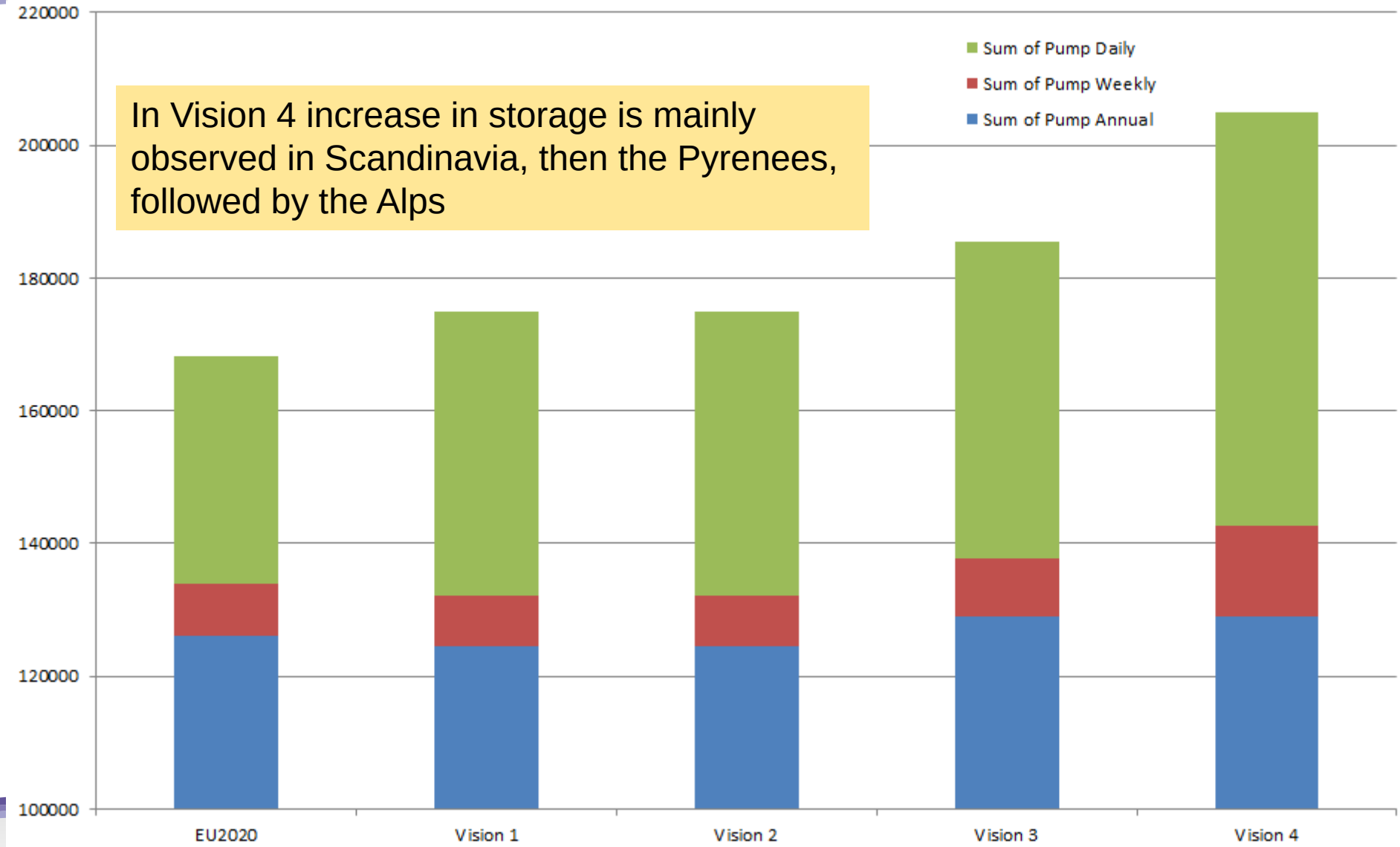
- Load data: structural growth rate for Vision 3 was taken into account to construct the base profile for Vision 4 + the necessary addition of profiles for peak shaving (5% vs Vision 1), EV (15%) and heat pumps (9%) specific for Vision 4 (if justified by TSOs other values were used)
- Hydro data: for hydro countries (total installed hydro > 15% of NGC – National Generation Capacity) additional information provided by LACs was taken into account when deriving their hydro capacities for Vision 4 (centralized storage added); for non-hydro countries decentralized storage capacity in Vision 3 is reduced or eliminated according to its relationship with the total amount of additional centralized storage; overall there was more centralized storage added than decentralized storage being eliminated
- For adequacy analysis: same procedure as for Vision 2

Outcome: Load (TWh)



Load increases across the visions despite improvement of energy efficiency because of electrification of transport and heating

Outcome: Hydro (GW)



In Vision 4 increase in storage is mainly observed in Scandinavia, then the Pyrenees, followed by the Alps

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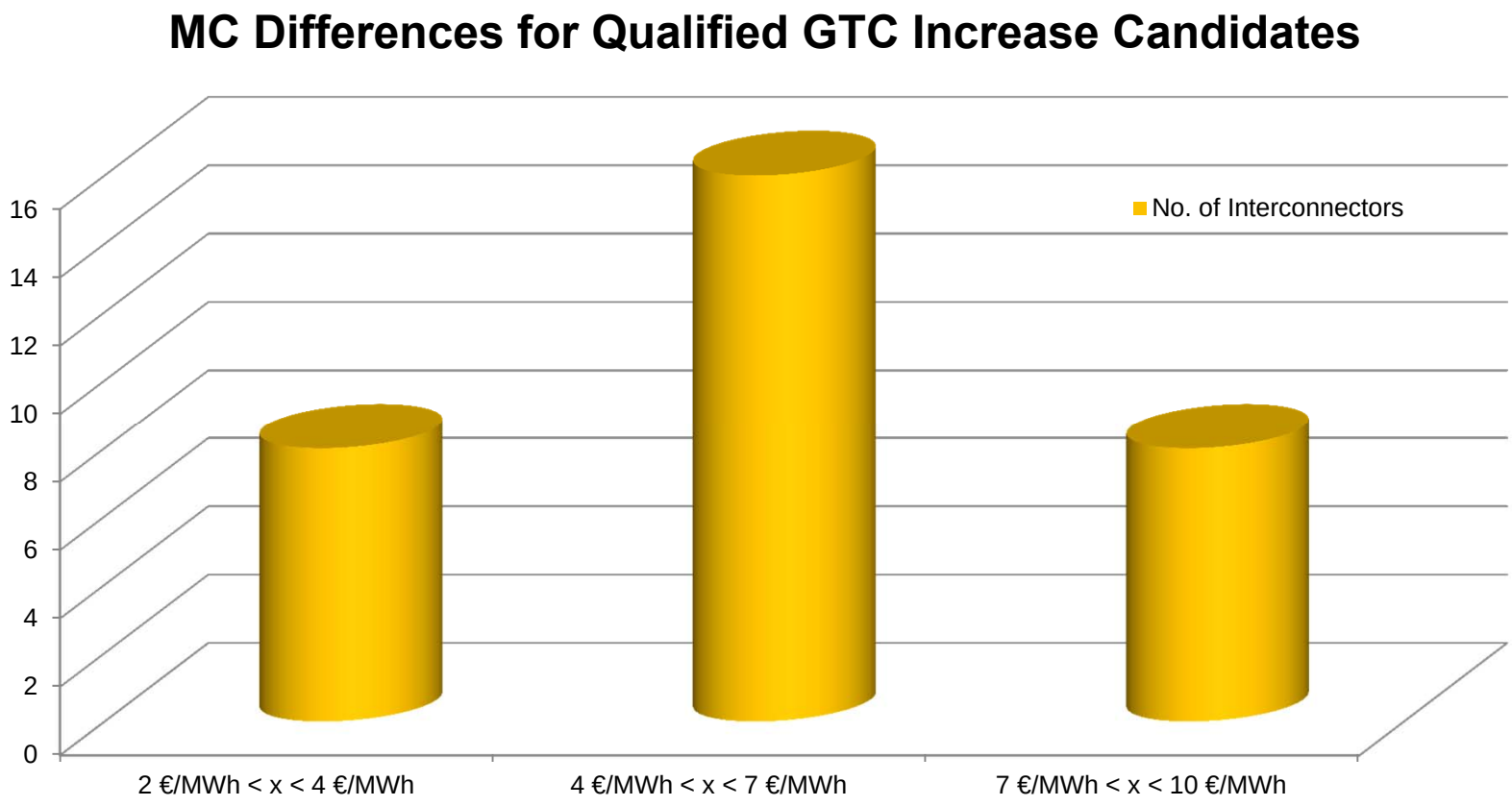
Step 2: One-step GTC Increase

- Goal: to allow for possible thermal capacity reduction in the next step with possible GTC increases based on market signals
- GTC indicators are calculated independently: marginal costs differences between market nodes (criterion: > 2 €/MWh)
- The default increase of GTC in MW are 0.7 and 1.4 GW for small and big countries respectively (according to their annual demand)
- Besides market-oriented criteria the Barcelona rule is also considered (10% NGC requirement)
- Simple CBA was performed for offshore DC-interconnectors
- <u>For RG studies: the increases in their regions will be replaced by real projects based on more in-depth assessments including system security of supply indicators</u>

Stakeholders Inputs

Divided opinions from stakeholders => TSOs expertise

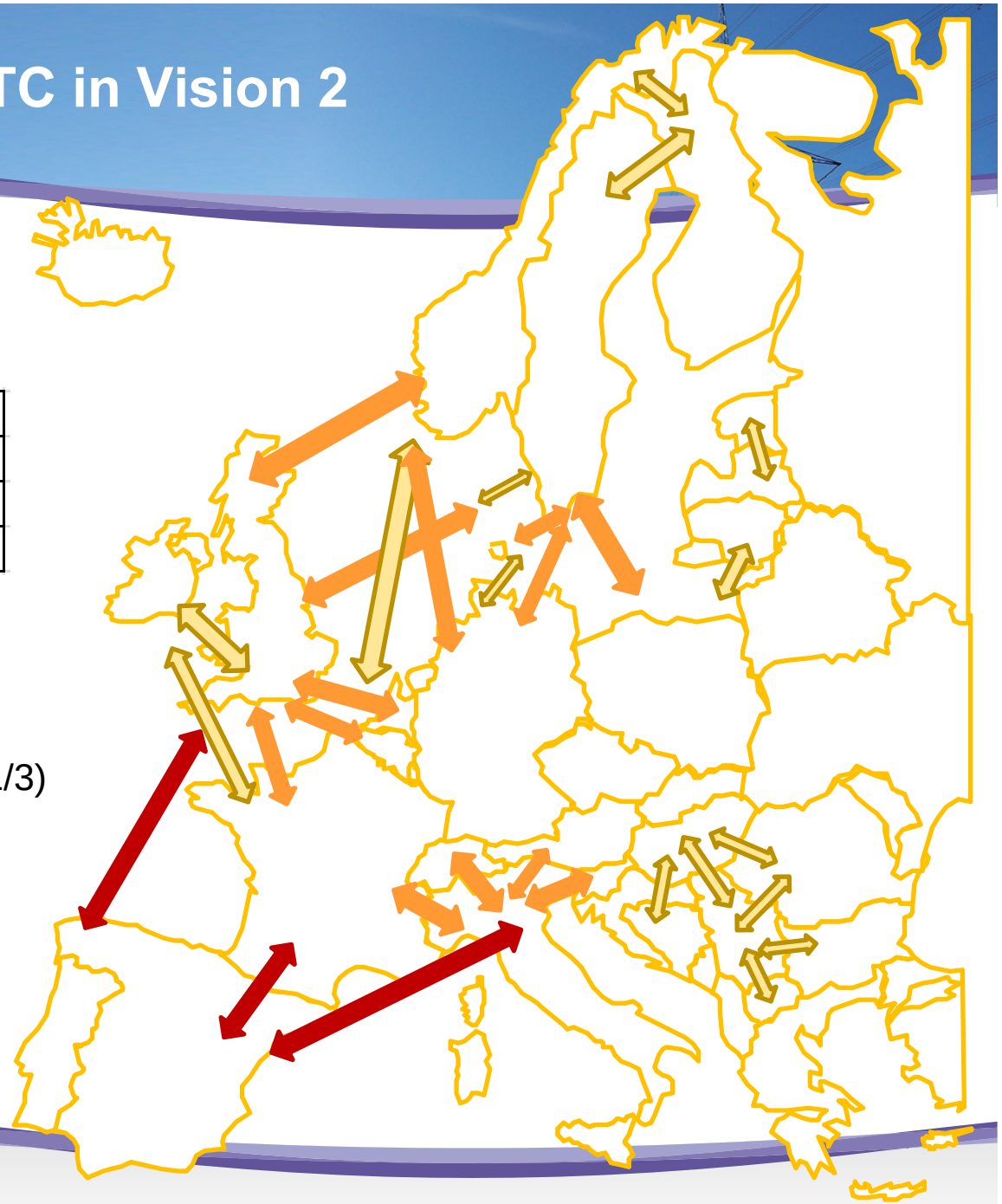
Outcome: MC Differences in Vision 2



Outcome: Additional GTC in Vision 2

GTC Increase
up to 3 GW
up to 1.4 GW
up to 0.7 GW

Total increase: 35.2 GW (vs. Vision 1/3)



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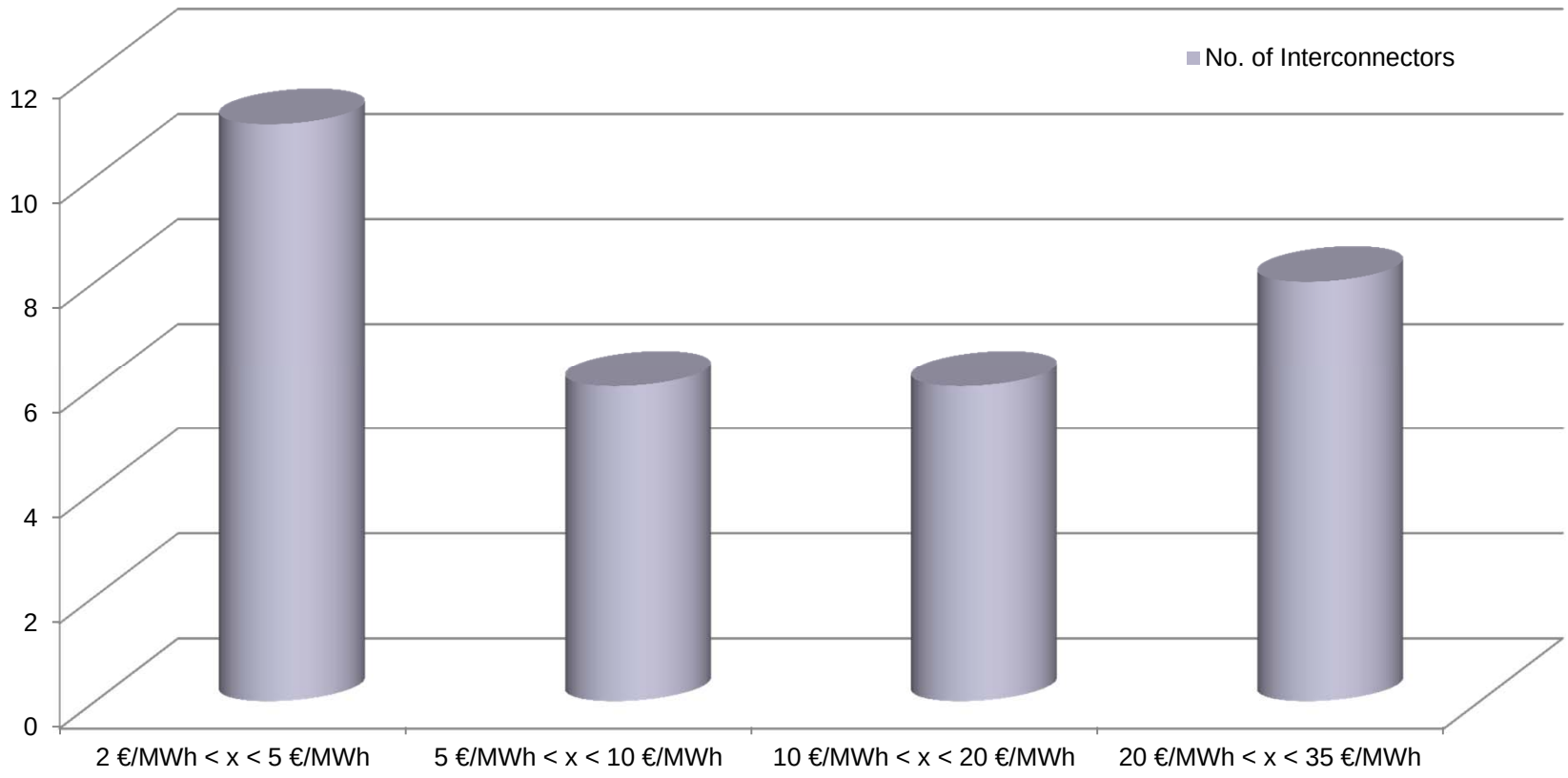
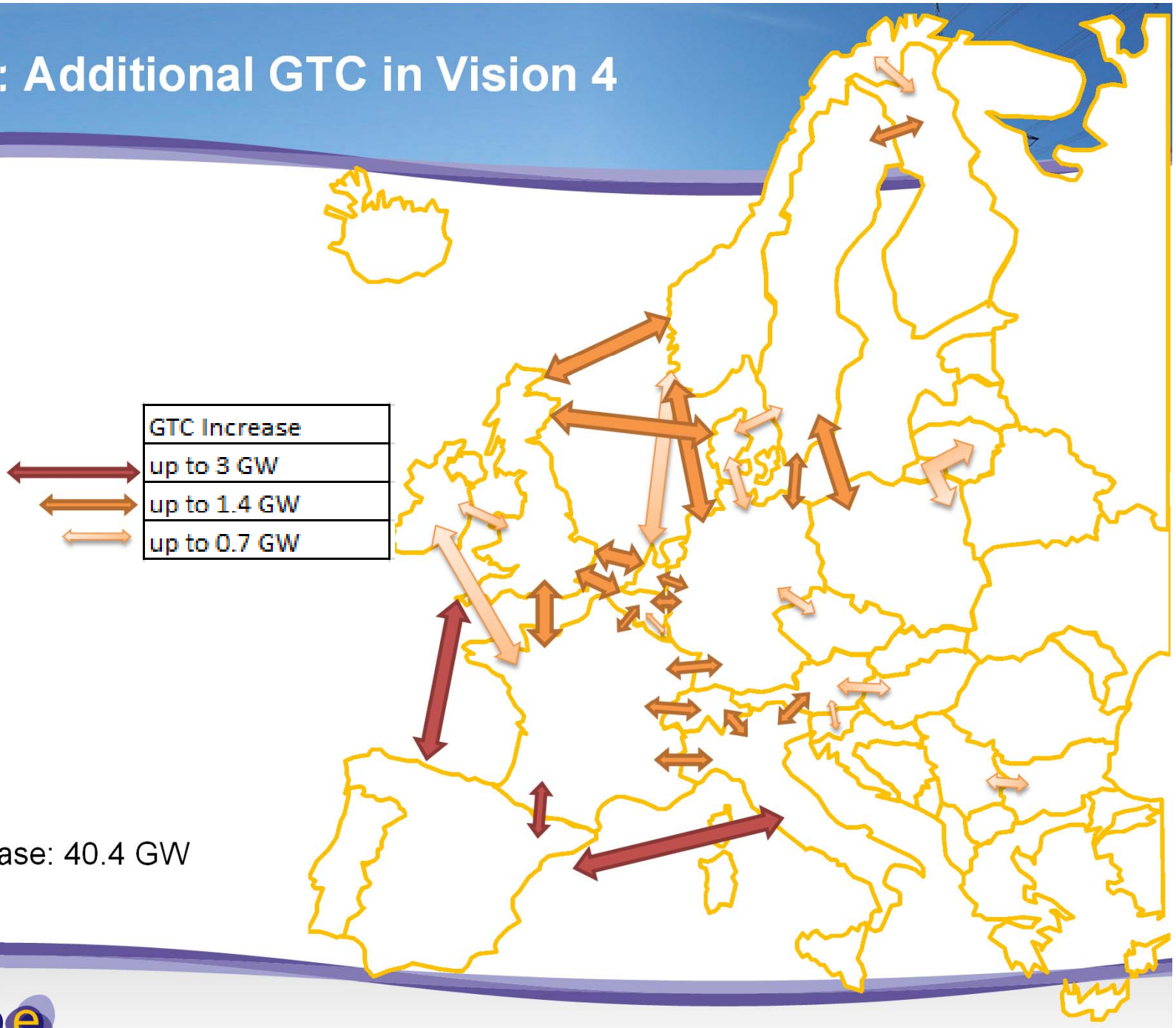
Outcome: MC Differences in Vision 4



Outcome: Additional GTC in Vision 4



Total increase: 40.4 GW

Step 3: One-step Thermal Capacity Reduction

- Goal: to propose a one step sensible reduction of less economic-viable thermal units after GTC increases
- Adequacy analyses are performed giving indicators LOLE and ENS
  - All countries with non-zero LOLE (respectively also ENS) values are exempted from reduction
- Other reduction indicators (EFPH and CBA indicator) are also provided through market simulations
  - The profitability of all new base-load and new mid-merit thermal units is assessed using the CBA indicators
  - The capacity of the new units with negative CBA indicators or insufficient EFPH (3000 hrs for hard coal, 2000 hrs for the rest) is reduced by a default value of 20%
- Vision 4: Other units hard coal (old) and gas (conventional, CCGT old) are also reduced in capacity according to the 20% default rule (for Vision 2, gas units are reduced first before hard coal because of the different merit-order curve)
- Another round of adequacy analyses is conducted to confirm that our one step reduction would not jeopardize the security of supply

Combined EFPH and CBA approach as proposed by stakeholders

Outcome: Thermal Capacity Reduction

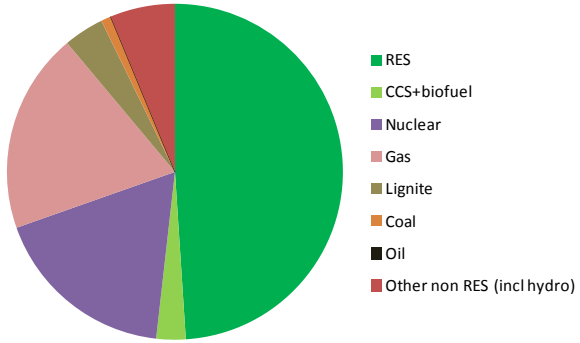
- Vision 2: total reduction (mainly gas) = 14 GW, mostly in GB, DE, ES and IT (out of the 485 GW installed thermal capacity in Vision 1)
- Vision 4: total reduction (both gas and hard coal) = 14.5 GW, mostly in DE, IT, NL and GR (out of 522 GW installed thermal capacity in Vision 3)

Market Simulation Results

On track for energy roadmap 2050

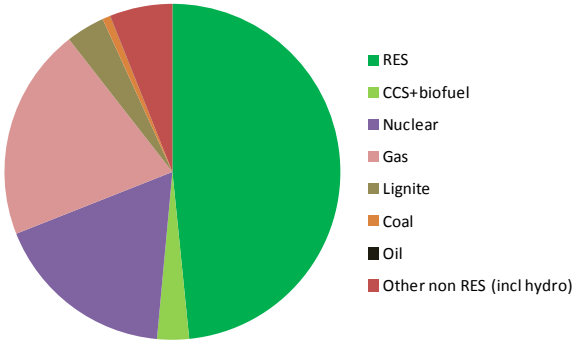
Gaz scenario

generation mix vision 3



- **Total cross-border exchanges in Europe ≈ 605 TWh**
- **Load including pumping 4167 TWh**

generation mix vision 4

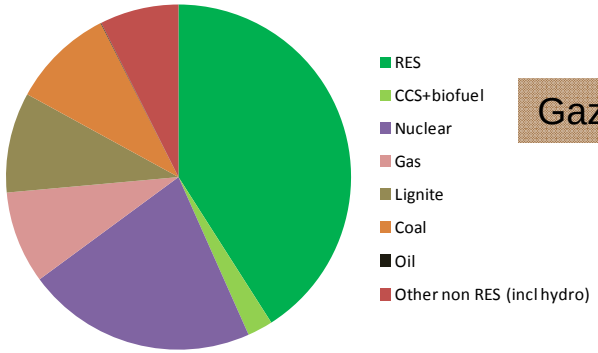


- **Total cross-border exchanges in Europe ≈ 735 TWh**
- **Load including pumping 4288 TWh**

High degree of integration
of the internal electricity market

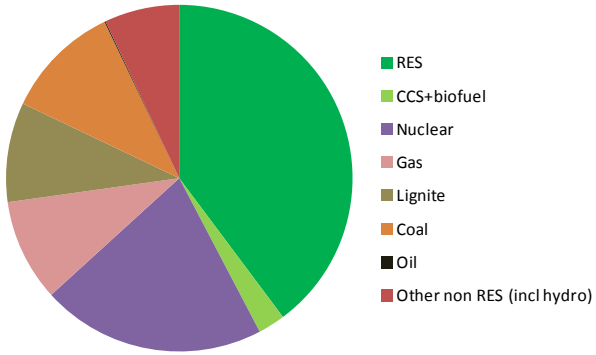
Gaz/Coal/Lignite scenario

generation mix vision 1



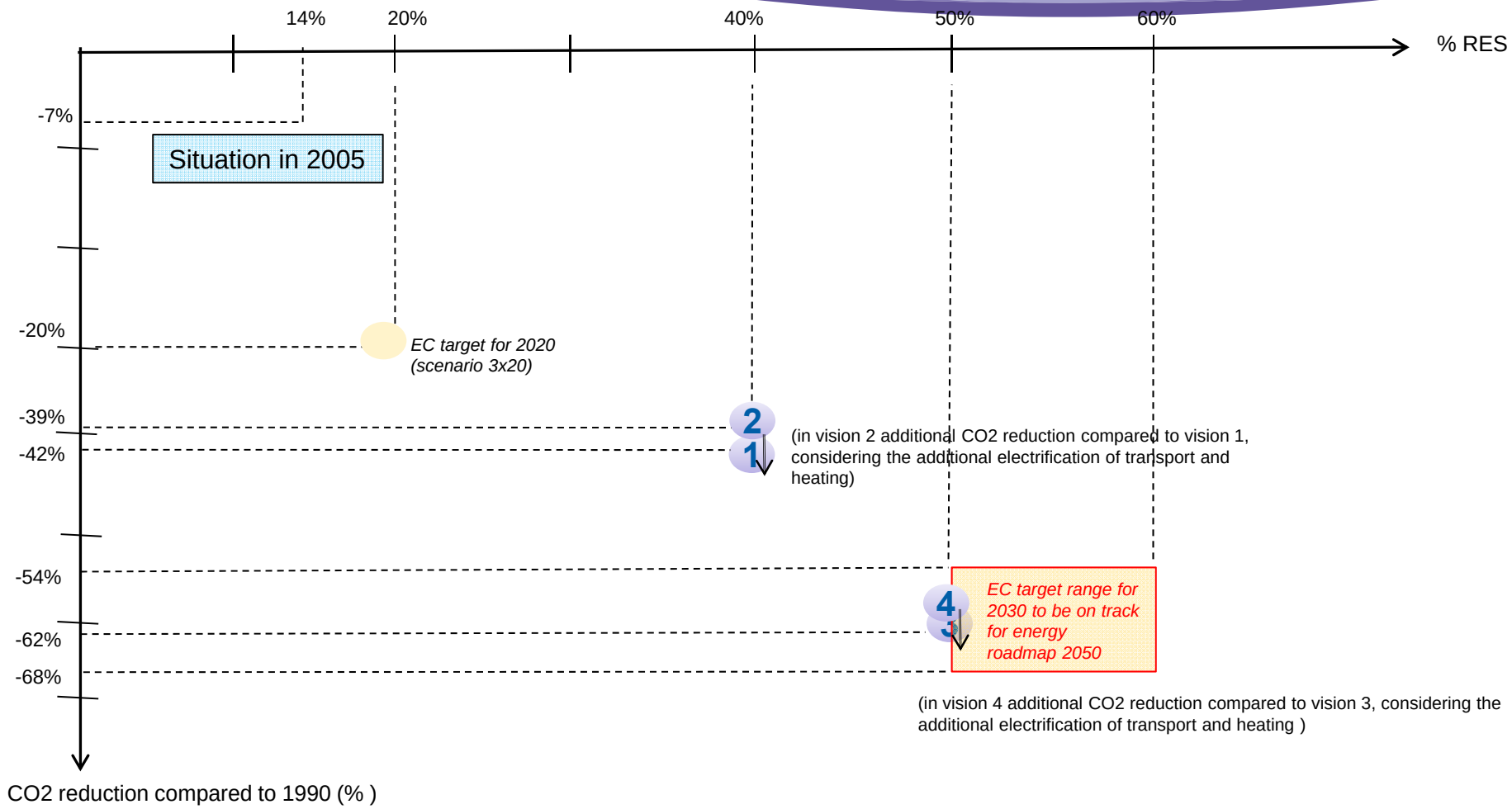
- **Total cross-border exchanges in Europe ≈ 660 TWh**
- **Load including pumping 3610TWh**

generation mix vision 2



- **Total cross-border exchanges in Europe ≈ 757 TWh**
- **Load including pumping 3712TWh**

A Bridge towards the Energy Roadmap for 2050



EC target range for 2030 to be on track for energy roadmap 2050:

•Visions 3 and 4 are in the range for CO2 reductions (-62%) / slightly inferior for RES integration (vs. Decarbonisation Scenarios)

•Visions 1 and 2 are not on track for both indicators (but ok against Current Trend Scenarios)

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Pros & Cons of the Current Methodology

Pros:

- First time that an overall assessment of the consistency of data is explicitly checked through a number of consistency checks
- Methodology (default values and common framework) consistent and compliant with discussions and inputs from previous stakeholders' workshops
- Methodology allows to take into account country specific characteristics that cannot be translated in optimization criteria
- Methodology allows to add an European layer on top of national specificities in a one step process
- Time and resource constraints from TSOs can be respected (few iterations)

Pros & Cons of the Current Methodology

Cons:

- A new process with one step to form the European layer is not enough:
  - Thermal capacity is reduced sensibly rather than “optimized”
  - Some bottom-up data get carried over to top-down scenarios, e.g. must-run obligations are kept from bottom-up scenarios
  - CCS restricted to limited number of countries even in Vision 4 (how commercialized can it be by 2030 in an optimistic scenario?)
  - Coal plants still dominate in “gas-scenarios” (Visions 3 & 4): unrealistic?
  - Conservative approach resulted in small differences between top-down and bottom-up scenarios
- Key parameters stemming from institutions (e.g. IEA), stakeholders’ feedback... But are they acknowledged?
- Limitation on the availability of resources and tools to perform very complex procedure

Identified Shortcomings (on Vision 4) & Improvement Suggestions

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Summary of collected Concerns for Vision 4 Results

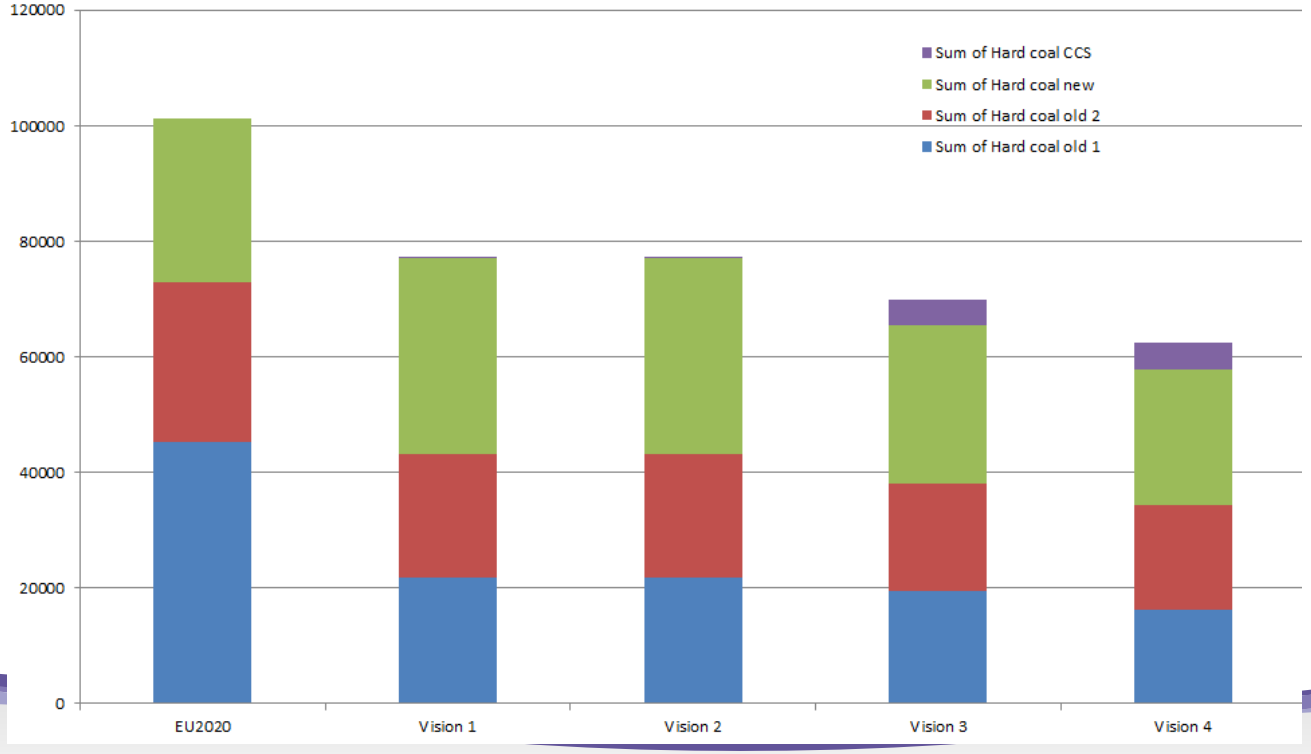
1. Lots of hard coal installed capacity despite high CO_2 price
2. Still unknown must-run obligations in a system with high RES penetration
3. RES installation not taking into account cost-effectiveness of national resources (climate conditions) & ambition for RES is not high enough
4. A top-down vision (V4) not much different from its bottom-up counterpart (V3)

Improvement Suggestions: Hard-coal Plants

- Concern #1: Lots of hard coal installed capacity in certain countries despite high CO_2 price

Proposed Solution: Consider that all new coal units can only be built when investors are confident they will be profitable, hence, in a context of high CO2 prices, that the units are CCS or have CCS-equivalent features to neutralise emissions

Installed hard-coal capacity in current dataset:



Improvement Suggestion: Must-run obligations

- Concern #2: Same amount of must-run obligations in V3 and V4
- In a scenario like V4 it is believed that the technical constraints imposed by the plants or the system will be circumvented by technological advancements and therefore should not be imposed on markets
- Vision 4 must-run: 49 GW out of total of 520 GW installed thermal capacity (~9.4%)
- Proposed Solutions:

a. Remove all must-run obligations in V4 except CHP

Improvement Suggestion: Cost-effectiveness & Ambition of RES Installation

- Concern #3: RES installation not taking into account cost-effectiveness of national resources (climate conditions) and RES ambition not high enough

- Possible Solutions:

a. Increase of RES penetration from the existing 49% to 60% (upper bound of the requirement to be on track for 2050 roadmap decarbonisation scenarios)

b. Distribution of additional RES installation according to local capacity factor of the different RES types (offshore & onshore wind, solar and other RES)

Expert Team Proposal on V4's Proximity to V3

•Concern #4: A top-down vision not much different from its bottom-up counterpart

•Expert Team:

- If all previous proposals implemented Vision 4 should become more distant from Vision 3, both on inputs and market simulation results

Stakeholders' Feedback

- General feedback on our proposals for improvement
- Specific request on RES increase:
  - Initial increase based on capacity factors alone resulted in some small countries having too much RES, additional parameters required, e.g. surface area; for offshore it is more tricky which parameters we can consider in addition to capacity factors
  - Studies with reliable maximum technical potential for all countries within the entso-e parameter

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