¿Qué aportan los 5GW de Termosolar en el PNIEC al sistema eléctrico español?

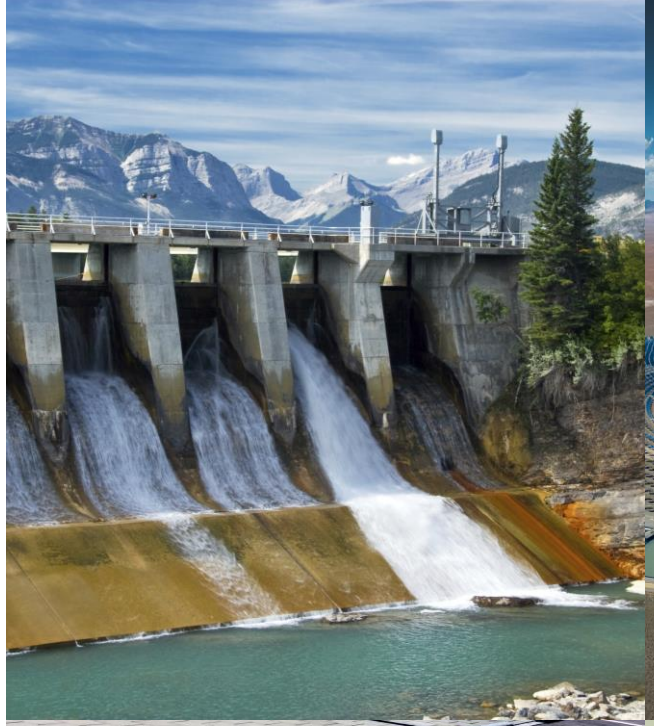
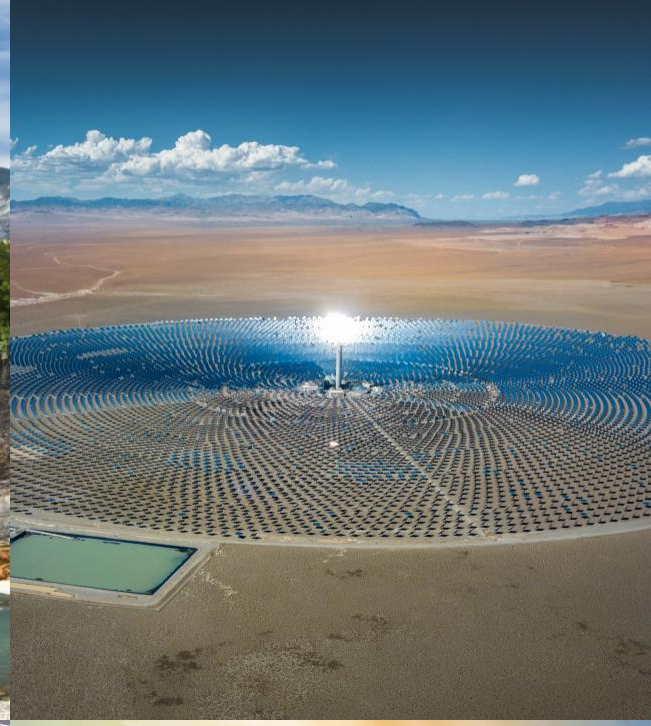
6 de octubre de 2020

JAVIER REVUELTA

AFRY
ÅF PÖYRY

Agenda

1. About AFRY
2. PNIEC challenges
3. Spanish market requirements
4. Impacts of CSP
5. Regulatory aspects
6. Takeaways

In 2019 ÅF and Pöyry became AFRY

- In February 2019 ÅF and Pöyry joined forces in order to become an international engineering, design and advisory company, driving digitalisation and sustainability for the energy, infrastructure and industrial sectors all over the world.
- In November 2019 ÅF Pöyry launched a new common brand, AFRY. The name is a combination of the letters in ÅF and Pöyry: AF+RY [eɪːfɹi]
- With a strong focus on sustainable solutions we bring the best from ÅF and Pöyry into the new brand AFRY.

Five divisions

INDUSTRIAL & DIGITAL SOLUTIONS

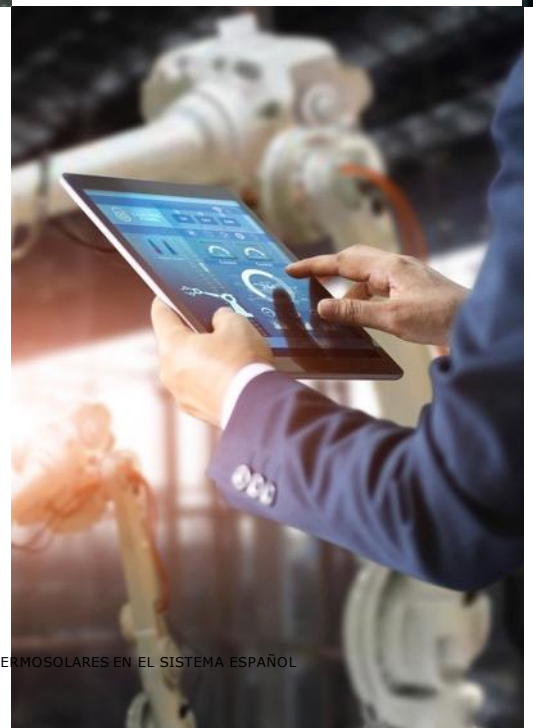
Advanced Automation
Automotive R&D
Connected Products
Experience Design
Food & Pharma
IT Solutions
Specialized Tech Services
Systems Management

ENERGY

Thermal Heat & Power, Renewables & Energy Markets
Hydro
T&D
Nuclear
Contracting

INFRASTRUCTURE

Transportation
Buildings
Project Management
Water
Environment
Architecture & Design



PROCESS INDUSTRIES

Bioindustries
Chemicals
Pulp, Board, paper & tissue
Metal & Mining
Smart solutions:
– Health & Safety
– Environment
– Smart Site TM & Digitalisation

MANAGEMENT CONSULTING

Energy Central & Northern Europe
Energy Western Europe & ROW
Capital
Operational Services
Industry
North America
Concept Development

Nordic base with strong global presence

No. of employees: 17,000

Approx. annual revenue: 1.9 bEUR

Industry
Infrastructure
Energy

Offices in countries: 50

Our presence

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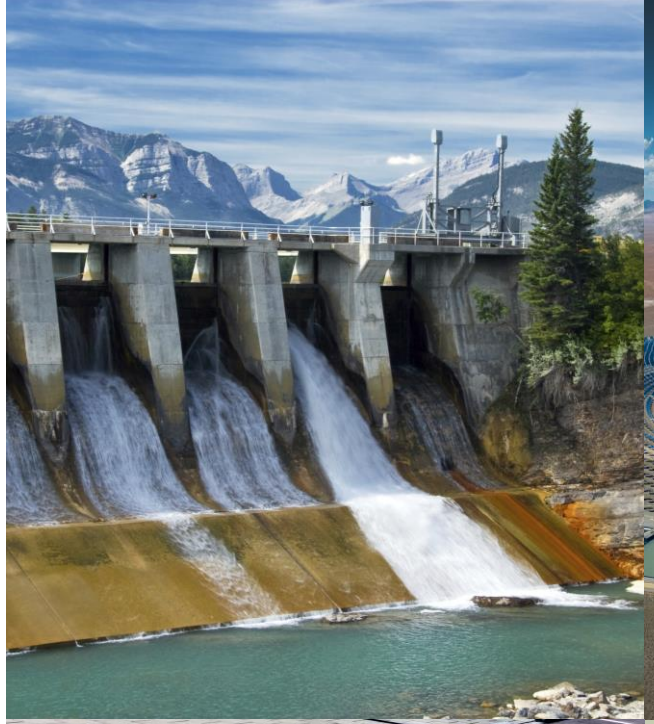
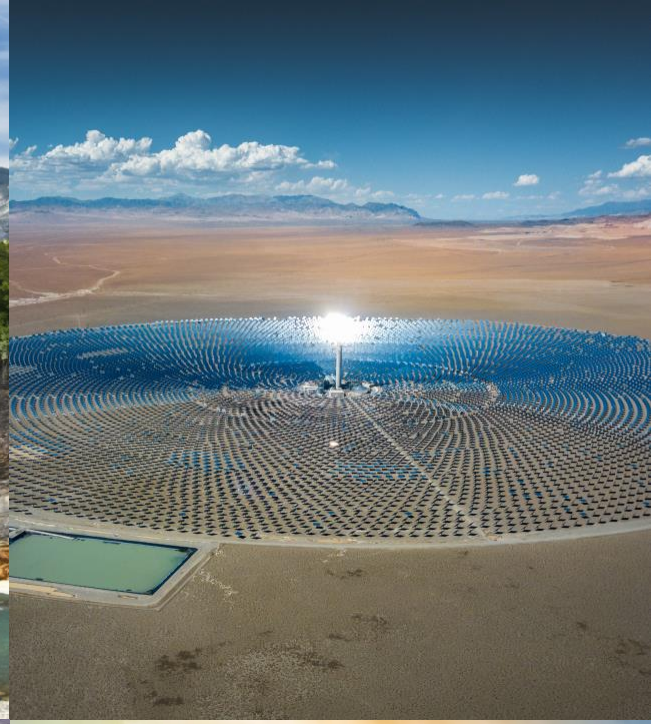
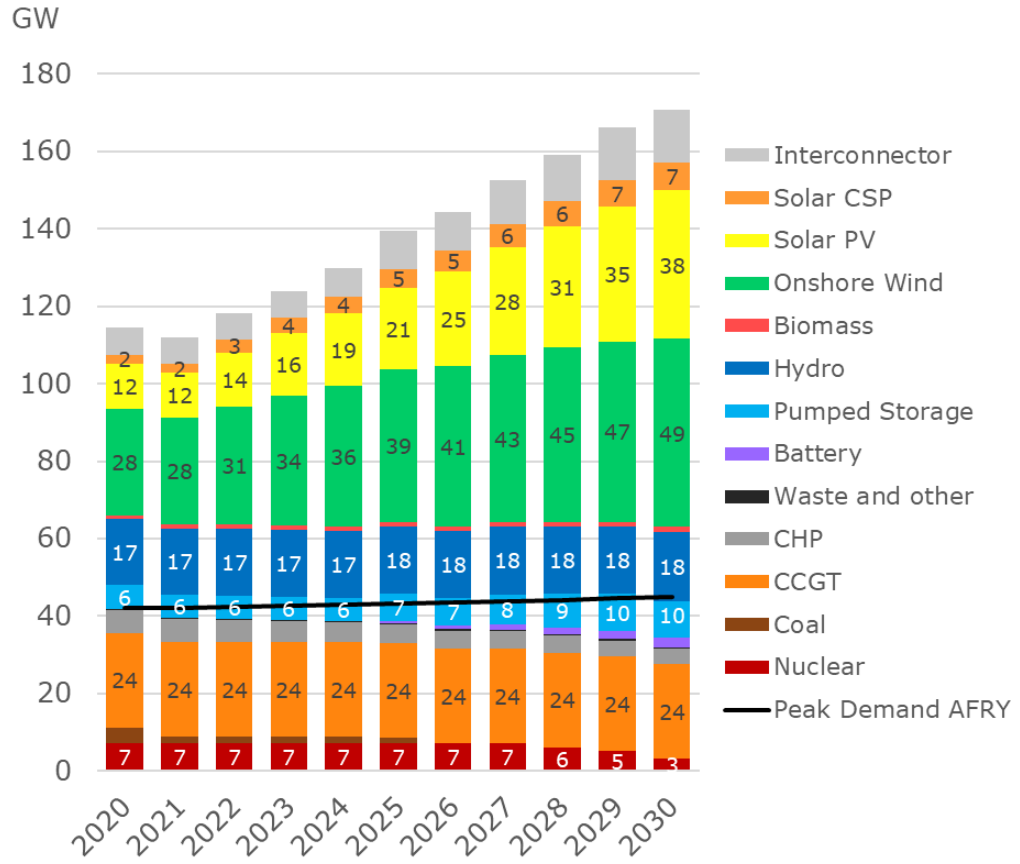



PNIEC targets raise technical, economic and regulatory challenges

- 42% RES-Final Energy, **78% RES-Electricity** by 2030 (74% national level) vs. c.38% by 2019
- **11GW of additional storage**
  - +3.5GW pumped storage hydro
  - +2.5GW batteries or other generic storage
  - +5GW in CSP plants with TES (>8 hours)
- Back-up capacity
  - **Closure of 3GW of nuclear**
  - **Closure of all 9GW of coal** (c.4GW after 2020)
- Interconnection capacity
  - **+3 interconnections** Spain-France in 2025-2030
- **5 million EVs**, 4GW of electrolysis

SPAIN'S NECP CAPACITY MIX



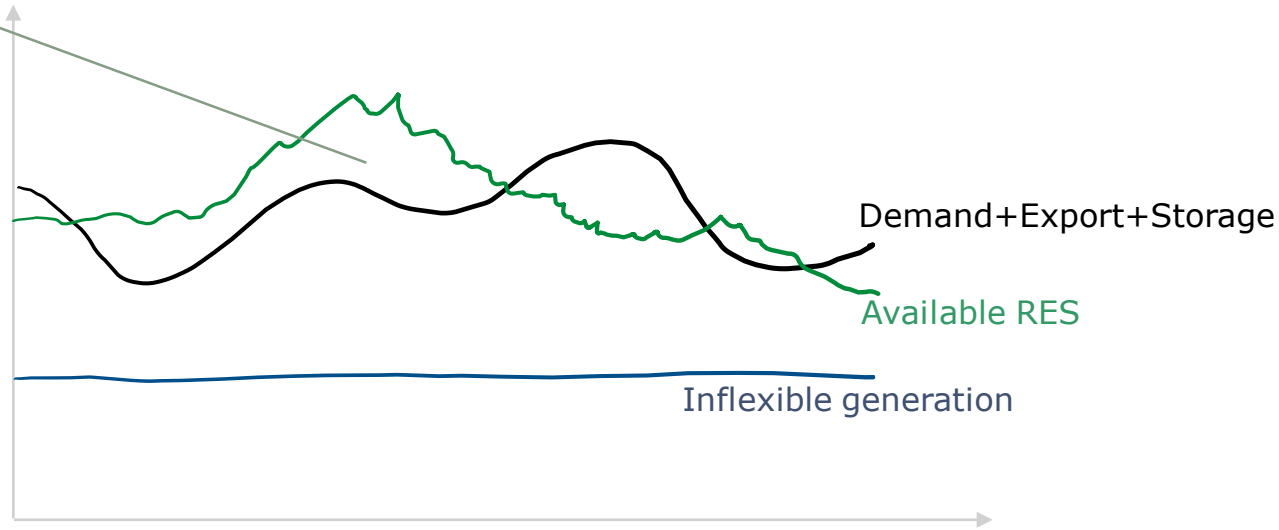
PNIEC CHALLENGES

Different types of RES curtailments to monitor

- **'Market' curtailments**
- 'Grid security' curtailments
  - market-wide
  - local

→ Marginal prices set by RES and 'cannibalised' close to €0/MWh

HOURLY SYSTEM LOAD AND GENERATION



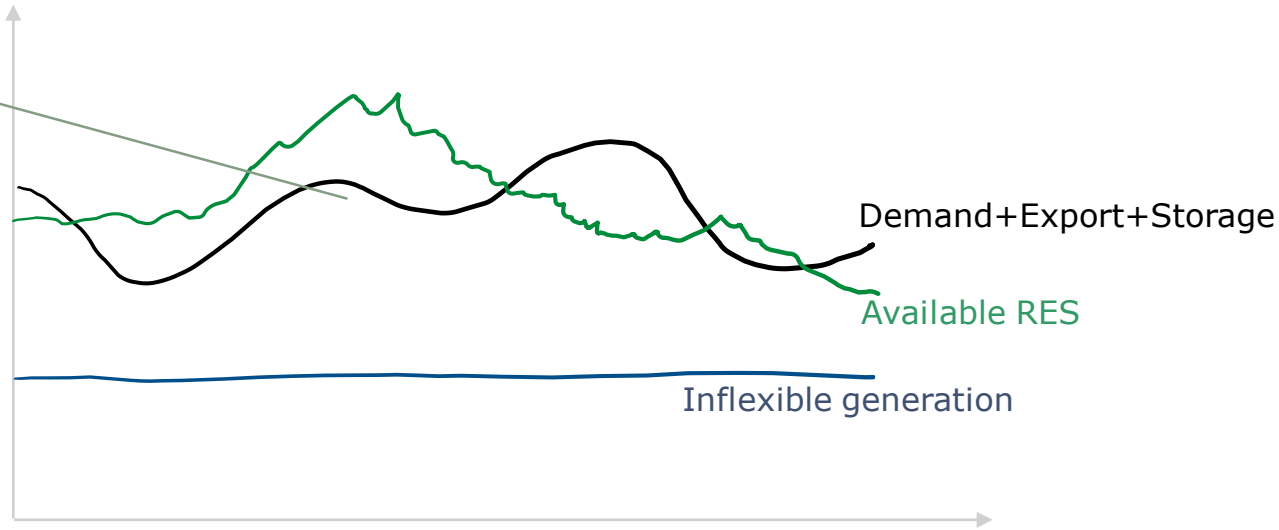
Different types of RES curtailments to monitor

- 'Market' curtailments
- 'Grid security' curtailments
  - **market-wide**
  - local

→ TSO adjustments after the market session do not alter wholesale prices (market driven)

→ Can receive economic compensation or not

HOURLY SYSTEM LOAD AND GENERATION



PNIEC CHALLENGES

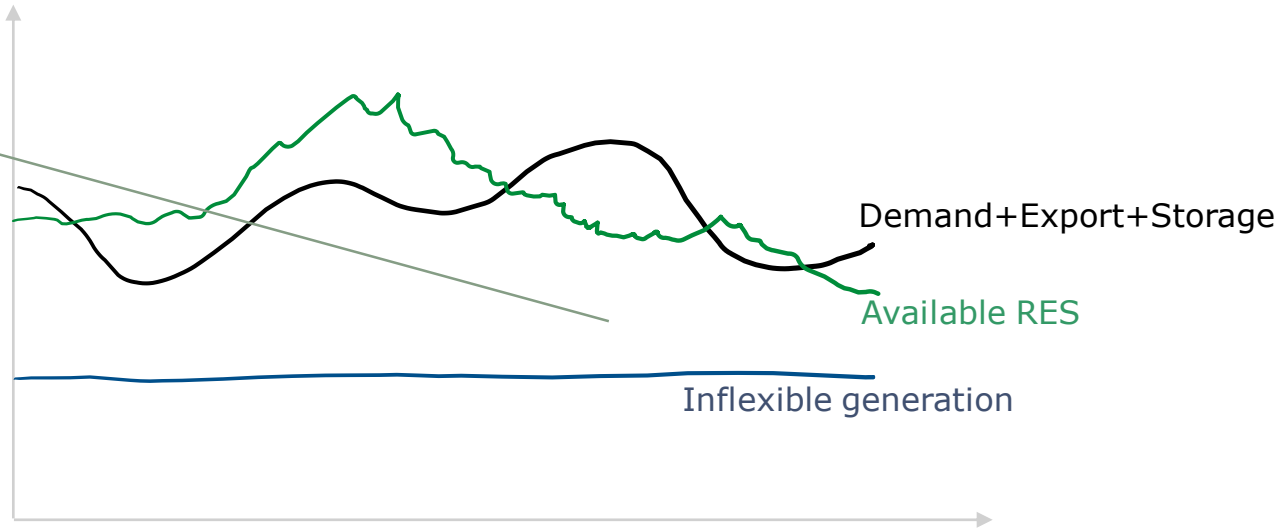
Different types of RES curtailments to monitor

- 'Market' curtailments
- 'Grid security' curtailments
  - market-wide
  - **local**

→ TSO/DSO adjustments anytime

→ Can receive economic compensation or not

HOURLY SYSTEM LOAD AND GENERATION

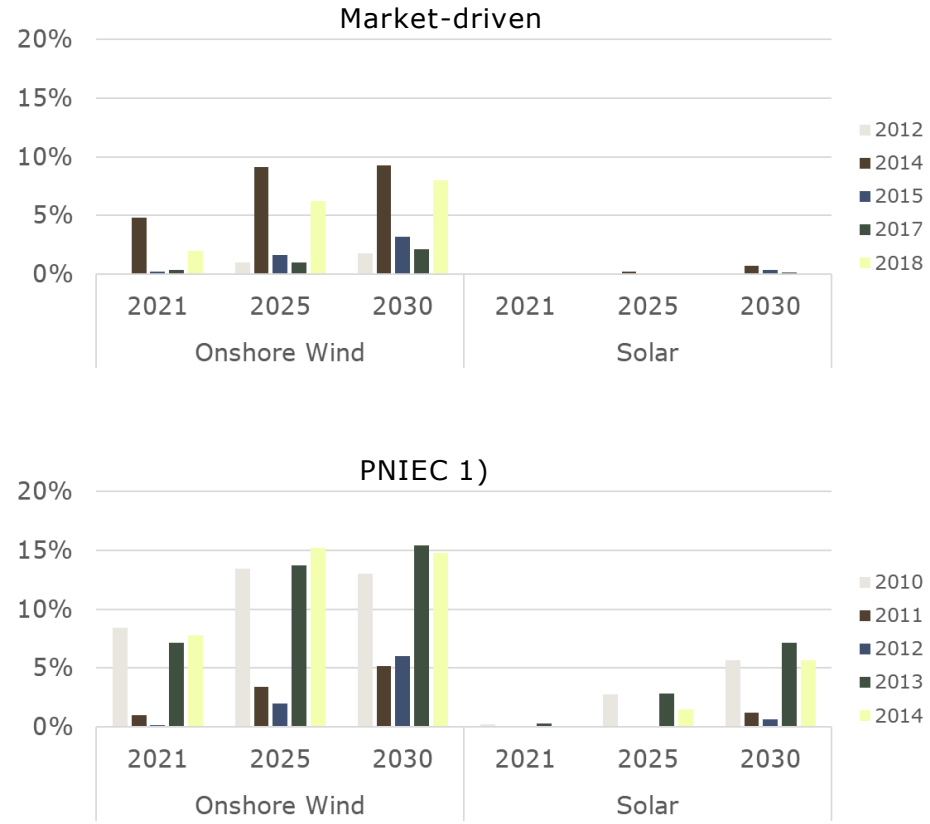


PNIEC CHALLENGES

Modelled evolution of RES curtailments

- Rising curtailment levels
- Rising frequency of curtailments
- High impact of weather patterns (not only hydro)

EVOLUTION OF ANNUAL RES CURTAILMENTS



PNIEC 1) is an AFRY sensitivity to the PNIEC scenario with less interconnection capacity

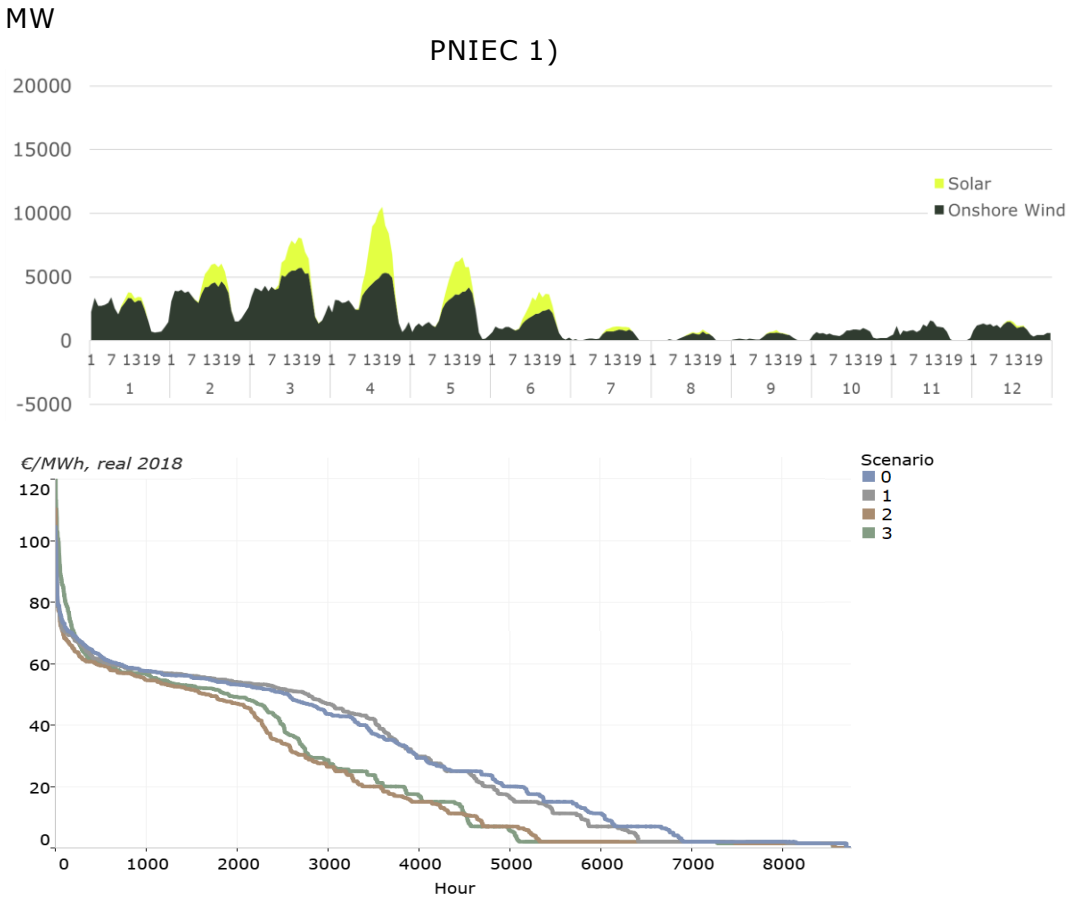
PNIEC CHALLENGES

Modelled evolution of RES curtailments

- Frequent periods of many consecutive hours with curtailments, and seasonal curtailments in Spring and wet/windy Winters
- Does the system need :
  - storage with high power? high energy? high efficiency?
  - reduce all curtailments?
- PNIEC considers 11GW of new storage:
  - 3.5GW pumped storage hydro
  - 2.5GW generic storage (batteries, thermal...)
  - 5GW thermal storage in CSP plants

→ low prices and probable insufficient revenues for:
  - new merchant RES
  - new storage
  - existing back-up capacity

SEASONALITY AND IMPACT OF CURTAILMENTS ON PRICES



PNIEC 1) is an AFRY sensitivity to the PNIEC scenario with less interconnection capacity

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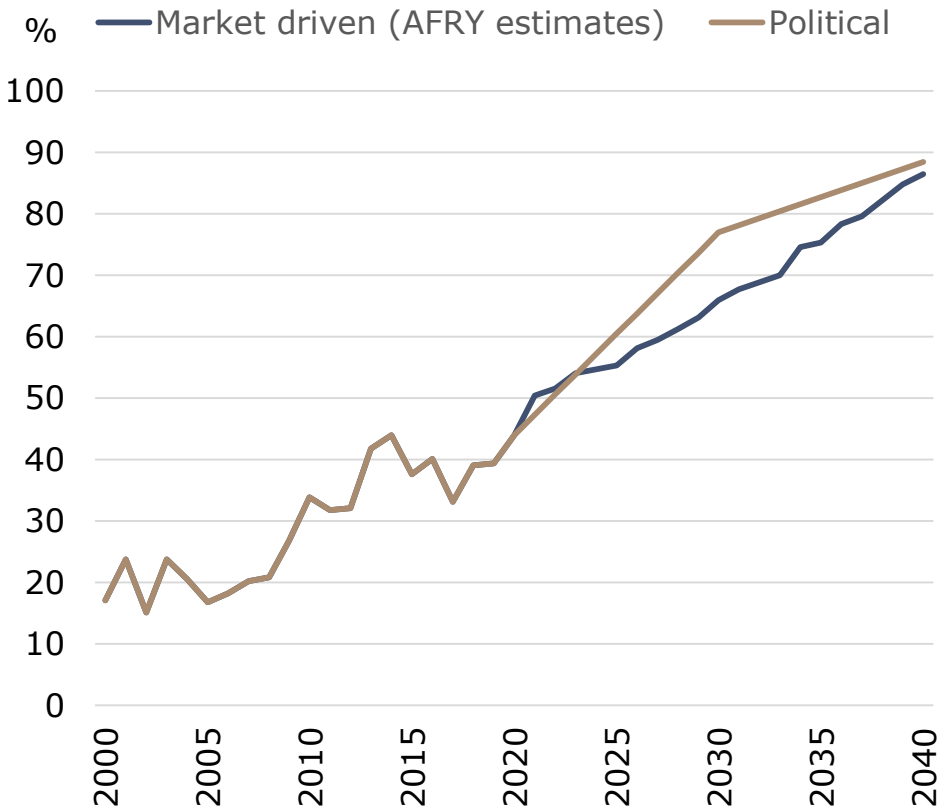
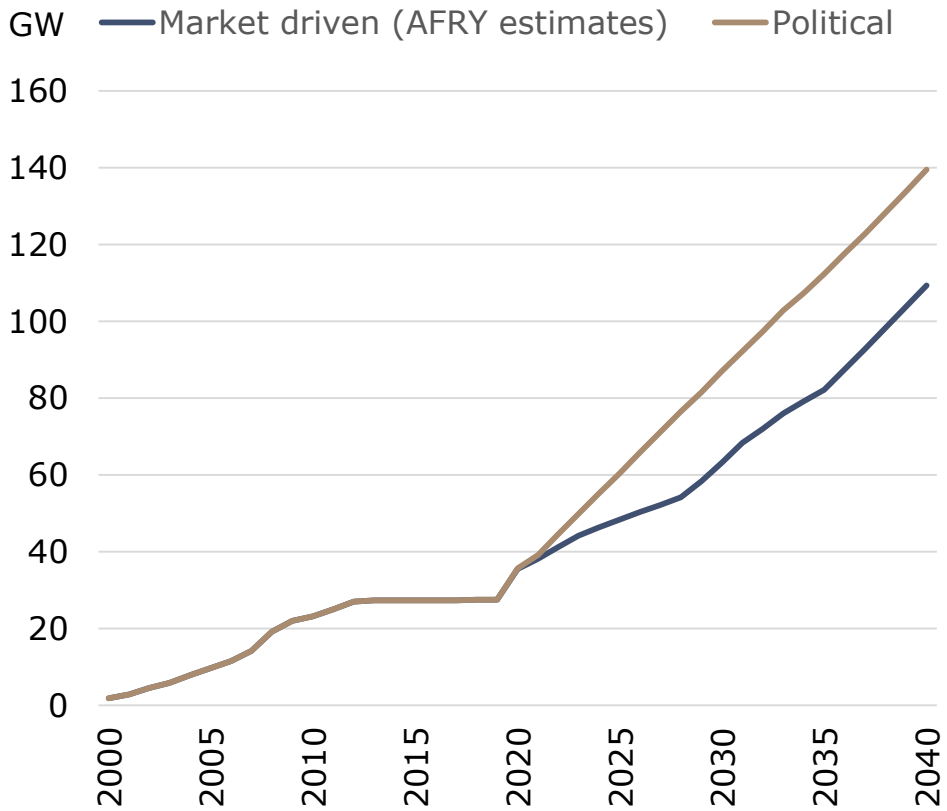
Renewable energies may be developed 'merchant' or from upcoming auctions

RES PENETRATION IN SPAIN (MAINLAND)



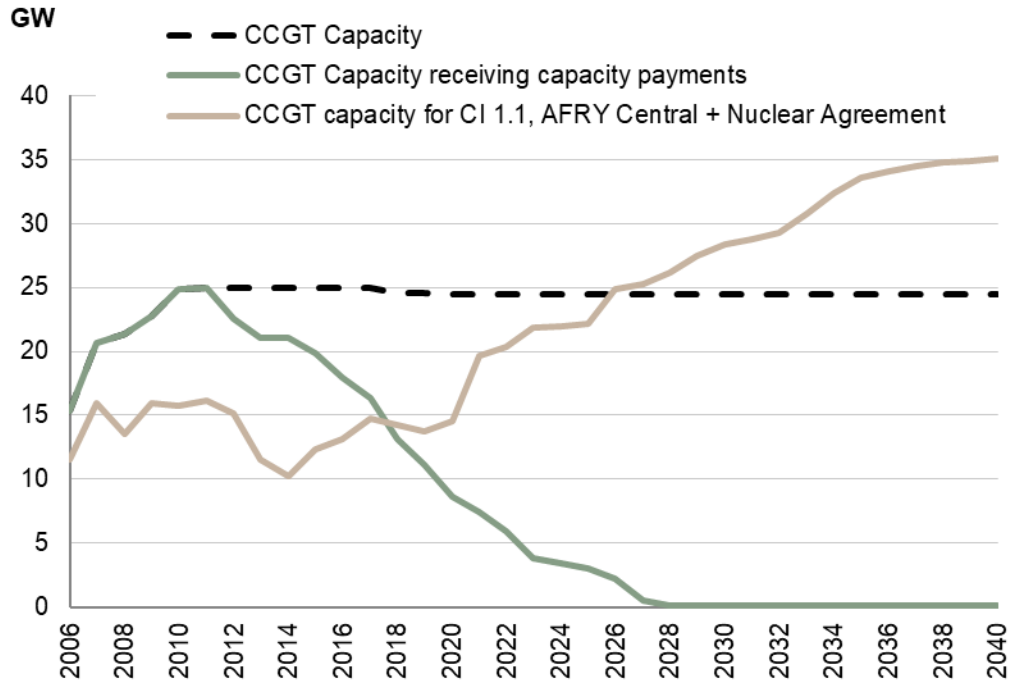
WIND + SOLAR PV CAPACITY IN SPAIN (MAINLAND)



How long can CCGTs hold with merchant revenues? How many are required?

- Most CCGTs at risk when they loose the Investment Incentive.
- Required capacity to be determined by Coverage Index or LOLE criteria, will depend on:
  - Evolution of critical demand (EVs)
  - Development of storage
  - Closure of nuclear capacity
- Probable development of CRM to prevent closures
- Probable development of framework for mothballing

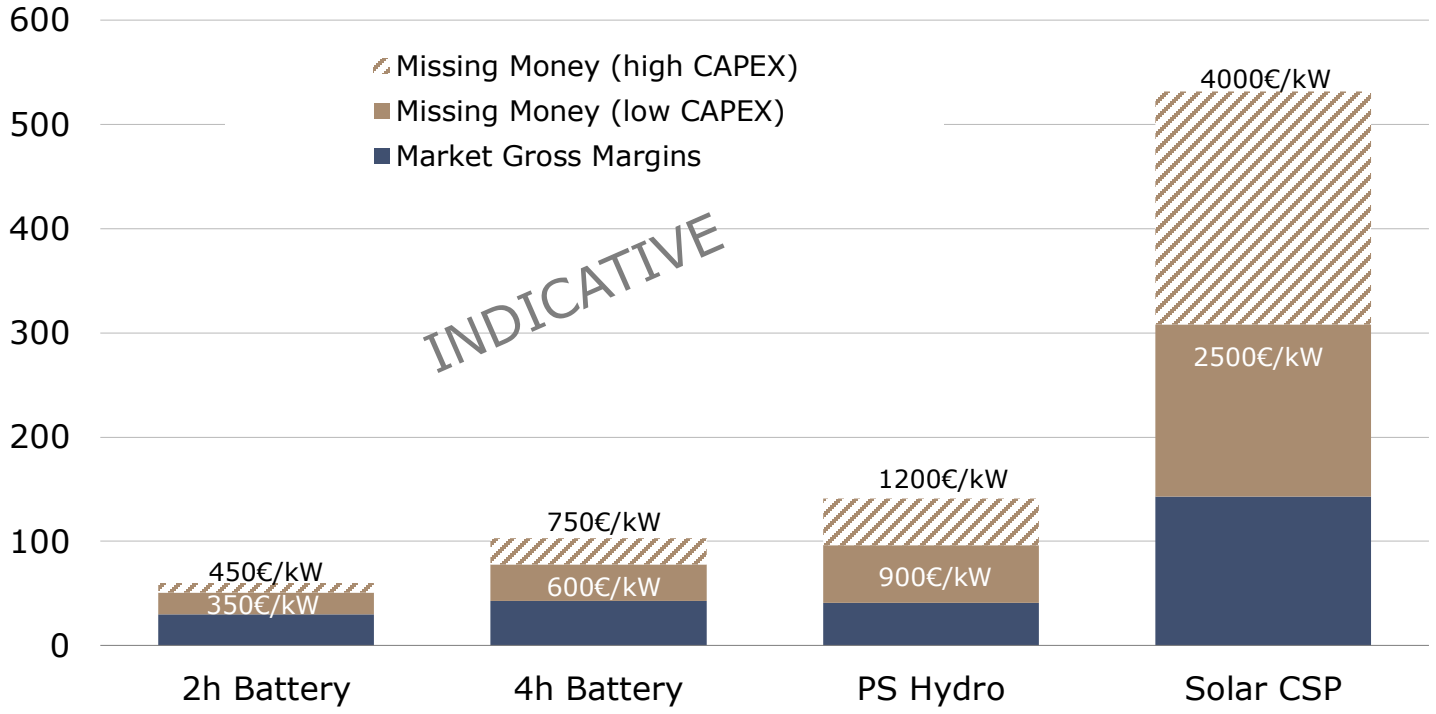
CCGT WITH CAPACITY PAYMENTS VS. SECURITY OF SUPPLY REQUIREMENTS



Revenues and missing money in the day-ahead market

GROSS MARGINS OF STORAGE TECHNOLOGIES IN 2030 [1]

(€/kW/year, real)



- Different 'missing money':
  - Capex at investment
  - Opex
  - Storage efficiency
  - Lifetime
  - Degradation
  - Market operations
  - Reference scenario

Market seems insufficient for any type of merchant storage by 2030

1 ILLUSTRATIVE FIGURES for 1GW in 2030 in scenario PNIEC 3), depending on technology evolutions and capex by 2030

Multicriteria optimisation

WHAT IS THE…

1) Fastest running animal?

Cheetah, 120km/h

2) Fastest swimming animal?

Black Marlin, 130 km/h

3) Fastest flying animal?

Peregrine falcon, 390km/h

And the fastest animal:
- running
- swimming
- flying

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Why storage? How much? Which type?

Technology	Pros	Cons	1GW	5GW	10GW
No storage	No incentive to storage	High curtailments, RES oversize			
Battery (2h)	Low Capex per MW	Low Security of Supply	**1**	**5**	**9**
Battery (4h)	Higher SoS	High Capex per MW	**2**	**6**	**10**
PSH (10h)	High SoS and known technology	Long development, EIA	**3**	**7**	**11**
CSP (with 9h)	RES + -cheap- storage	Very high Capex, few plants	**4**	**8**	**12**
Flywheels	Cheap frequency control	Little energy only for f control			
Compressed Air	Cheap storage and modular	Low efficiency			
Thermal storage	TBC	TBC			
Other	TBC	TBC			

- Over a 'base case' with no additional storage, we have modelled 12 scenarios with various types and capacities of storage, imposing a target 77% RES-Electricity
- Different storage options have offsetting impacts and costs on the wholesale market and the regulated system costs

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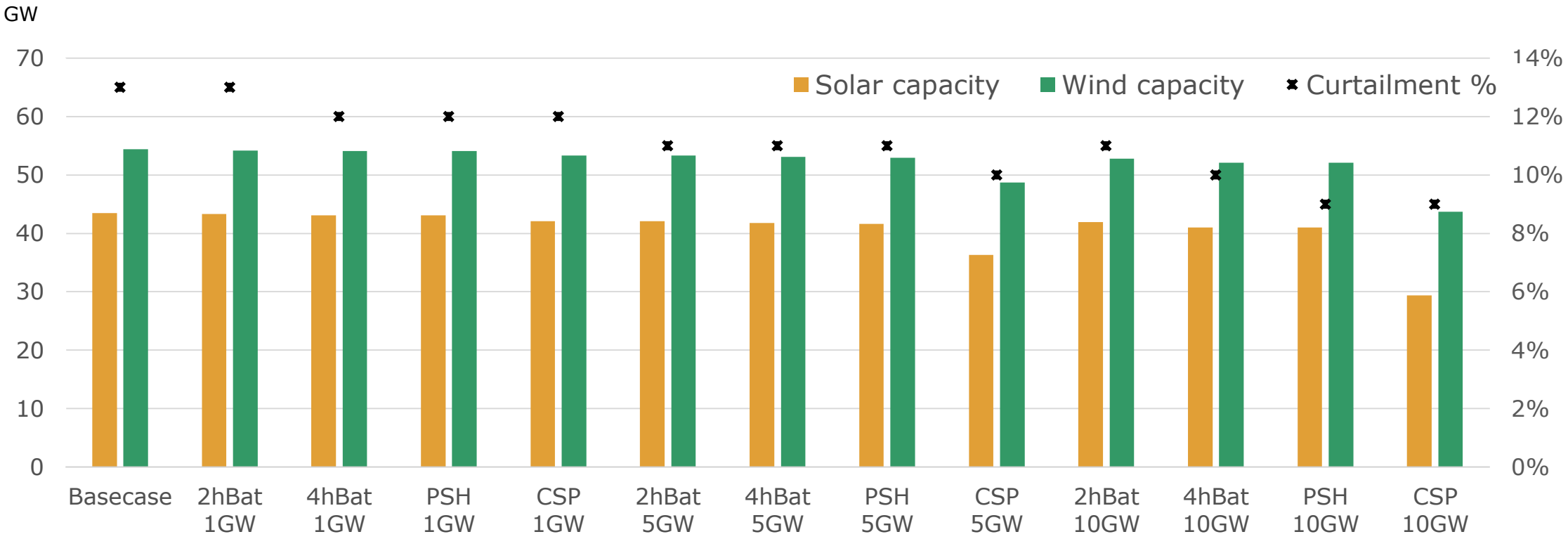
ECONOMICS OF STORAGE

Illustrative 77% scenarios – RES capacity and curtailment

INSTALLED CAPACITY AND CURTAILMENTS IN 2030



More and larger storage allows lower curtailments and lower oversizing of wind + PV capacity to reach 77% RES-E

Modelling on Scenario PNIEC 3) | Curtailment ratio over total wind and solar resource

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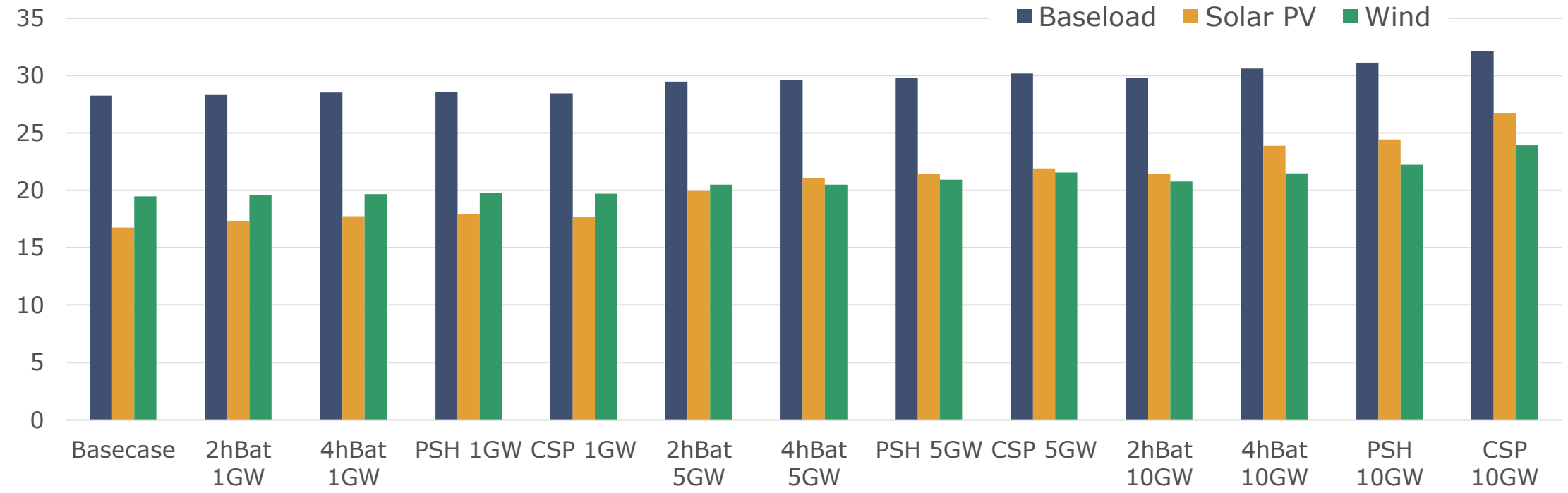
Illustrative 77% scenarios – Baseload and capture prices

BASELOAD AND CAPTURE PRICES IN 2030

€/MWh, Real



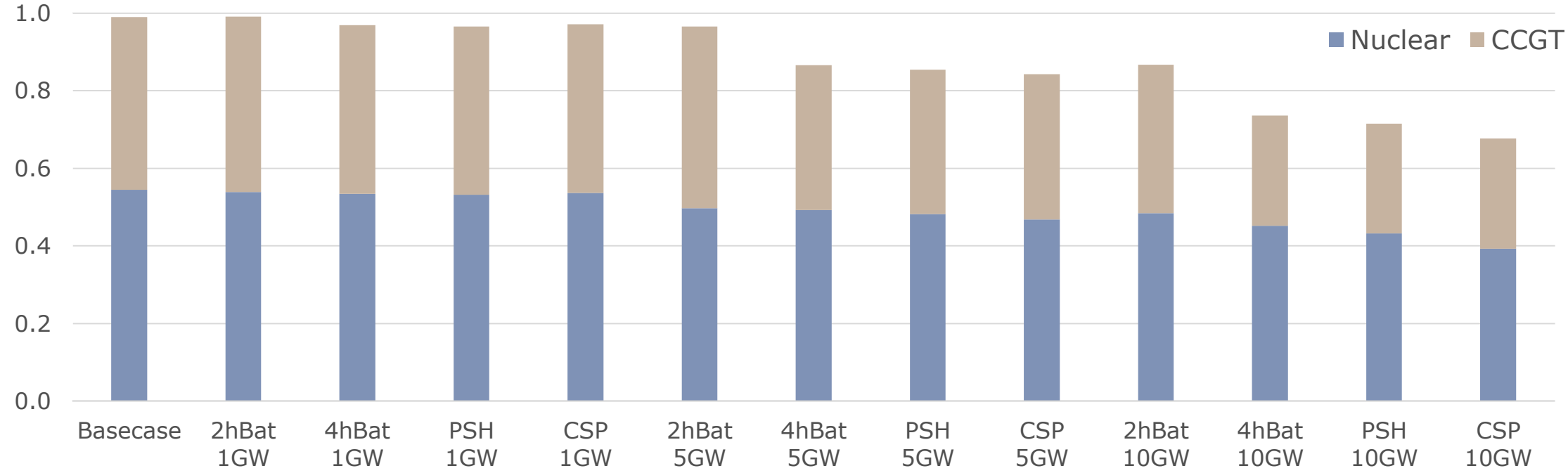
More and larger storage increase market prices and captured prices, hence reducing incentives

Modelling on Scenario PNIEC 3) | Captured prices per unit of resource

Illustrative 77% scenarios – Thermal back-up capacity

ANNUAL PAYMENTS TO THERMAL TECHNOLOGIES IN 2030

billion €, Real



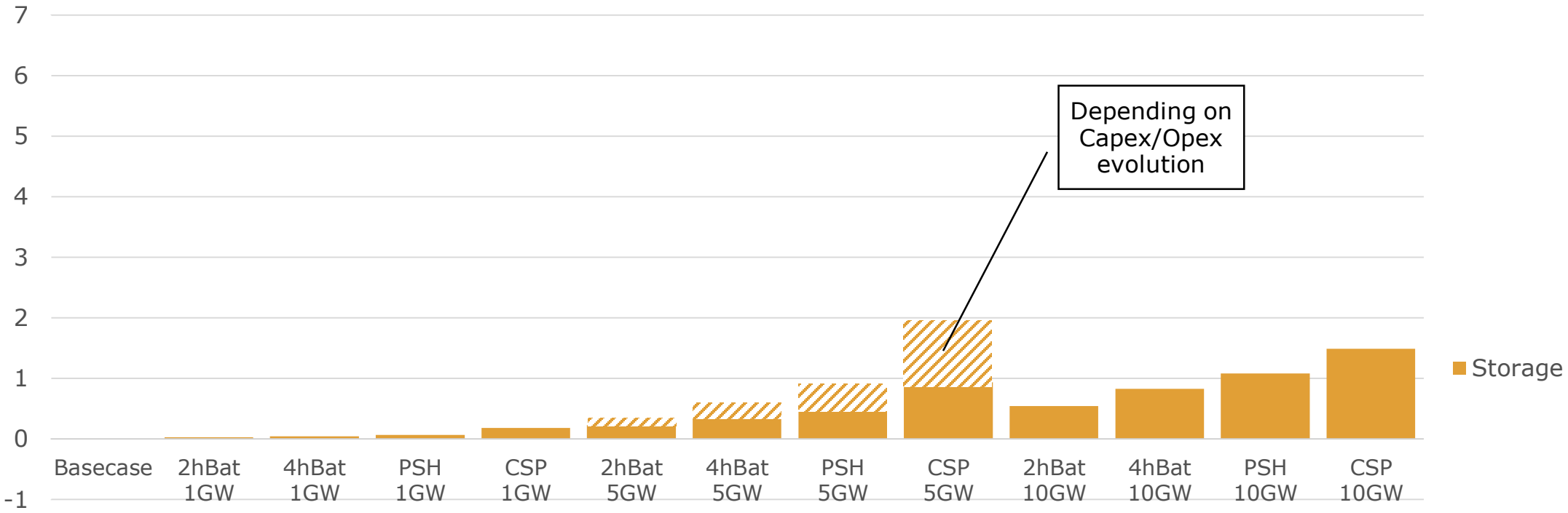
More and larger storage implies lower missing money to nuclear, and less capacity of CCGTs for back-up provided that storage has sufficient energy (>2h)

Modelling on Scenario PNIEC 3)

Illustrative 77% scenarios – Total system costs

TOTAL ANNUAL SYSTEM COSTS

billion €, Real



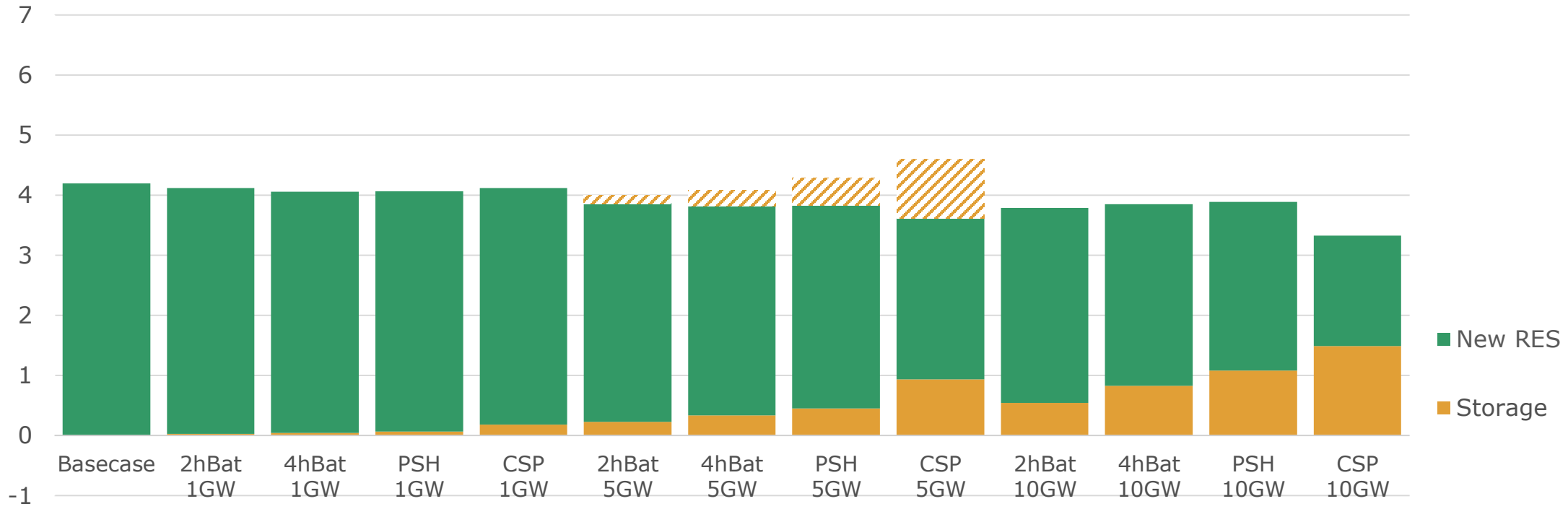
More and larger storage brings higher missing money to higher storage capacity, which increases total incentives

Figures are illustrative, assuming an incentive scheme period of 10 years

Illustrative 77% scenarios – Total system costs

TOTAL ANNUAL SYSTEM COSTS

billion €, Real



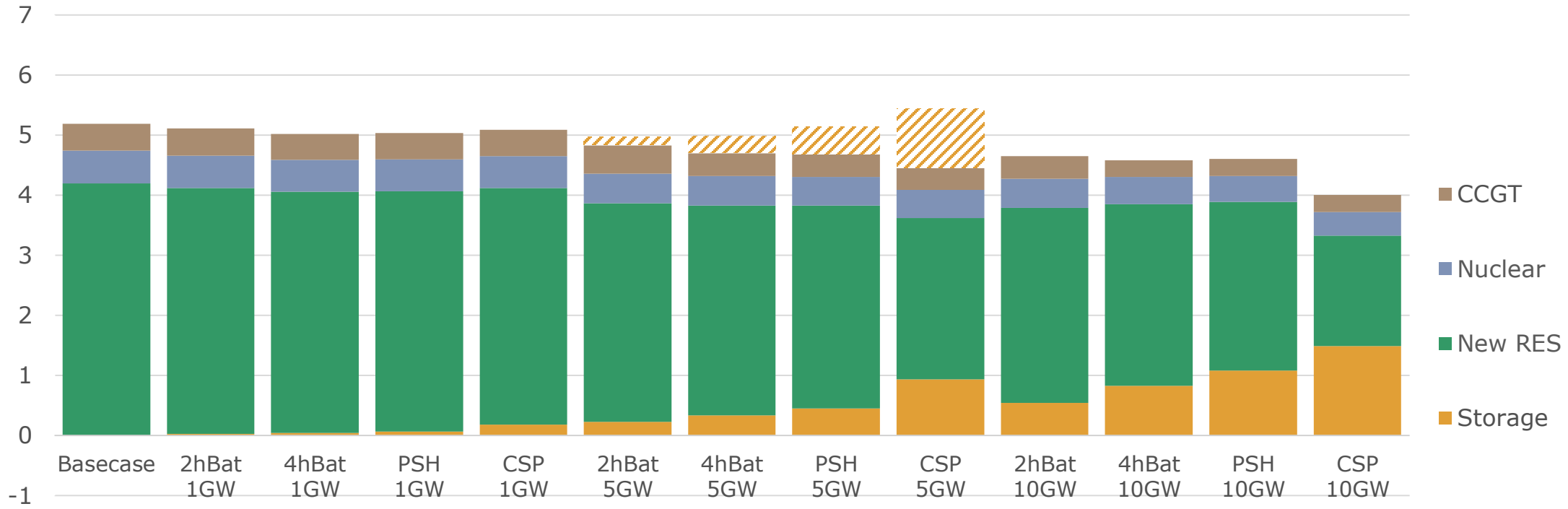
More and larger storage brings lower missing money to RES and less RES capacity, which decreases RES incentives

Figures are illustrative, assuming an incentive scheme period of 10 years

Illustrative 77% scenarios – Total system costs

TOTAL ANNUAL SYSTEM COSTS

billion €, Real



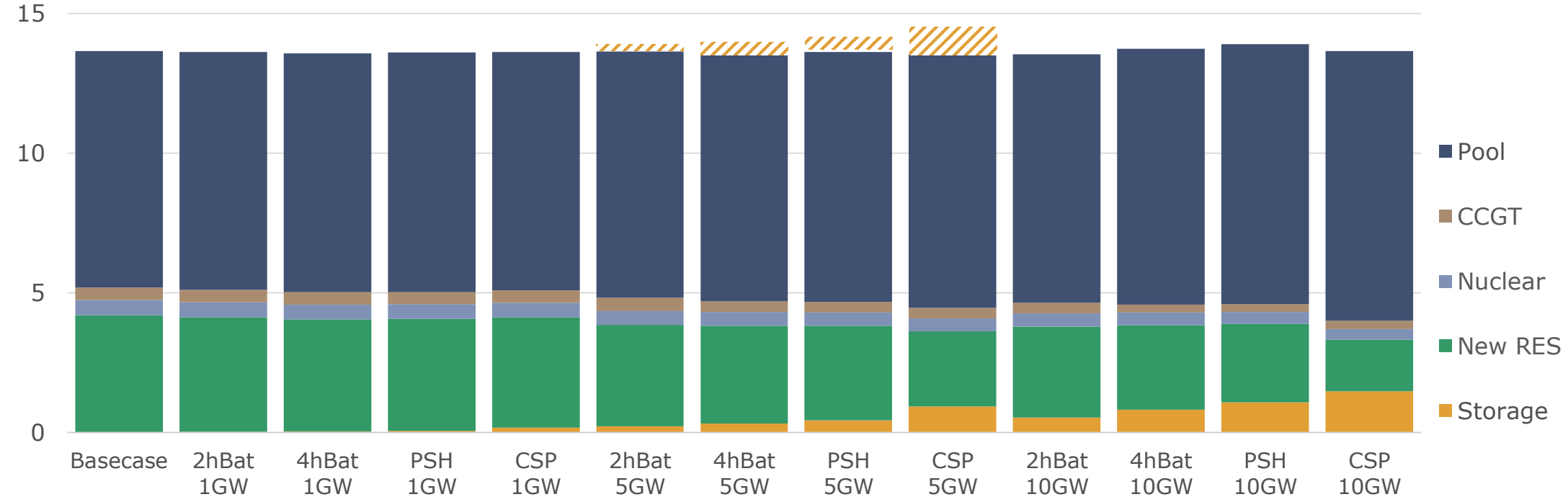
More and larger storage reduces total incentives to back-up capacity

Figures are illustrative, assuming an incentive scheme period of 10 years

Illustrative 77% scenarios – Total system costs

TOTAL ANNUAL SYSTEM COSTS

billion €, Real



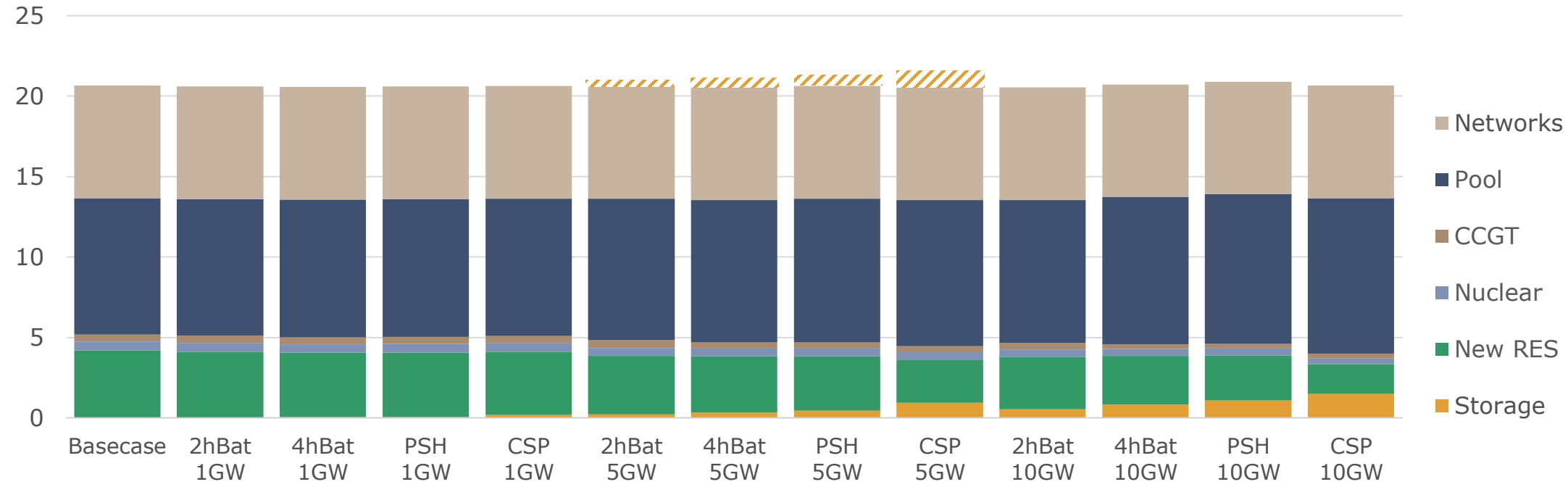
More and larger storage reduces frequency of curtailments and increases wholesale 'pool' prices to consumers

Figures are illustrative, assuming an incentive scheme period of 10 years

Illustrative 77% scenarios – Total system costs

TOTAL ANNUAL SYSTEM COSTS

billion €, Real



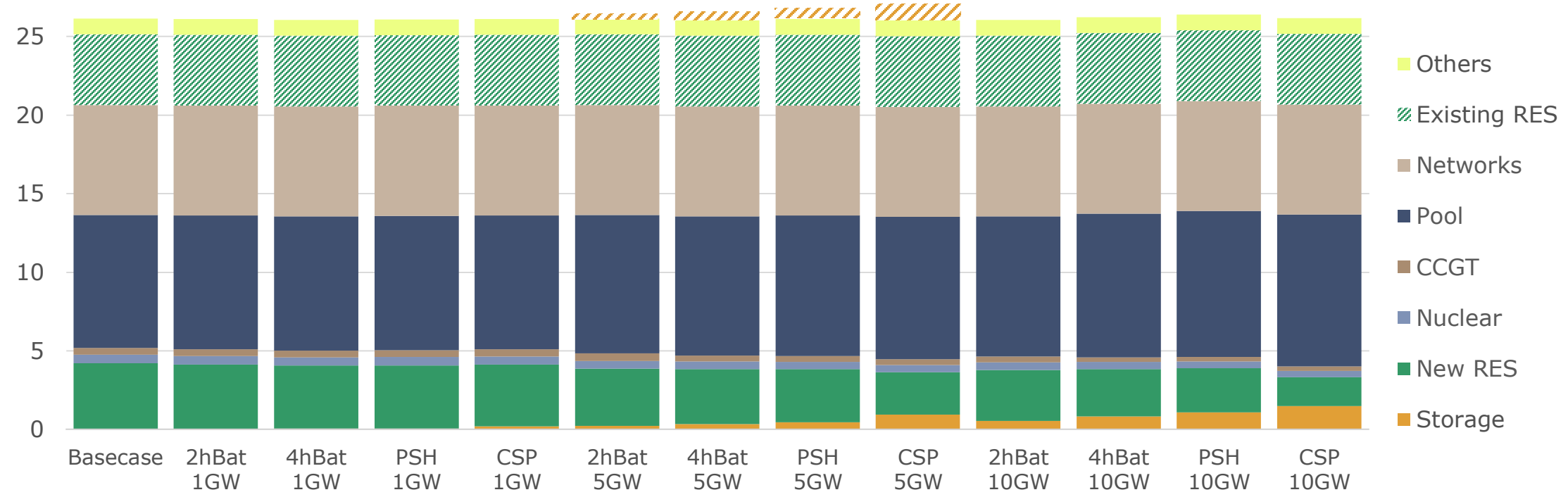
More and larger storage possibly reduces network costs given its impact on lower RES installed capacity required

Figures are illustrative, assuming an incentive scheme period of 10 years

Illustrative 77% scenarios – Total system costs

TOTAL ANNUAL SYSTEM COSTS

billion €, Real



More and larger storage brings down the costs of incentives to existing RES given its impact on RES captured prices

Figures are illustrative, assuming an incentive scheme period of 10 years

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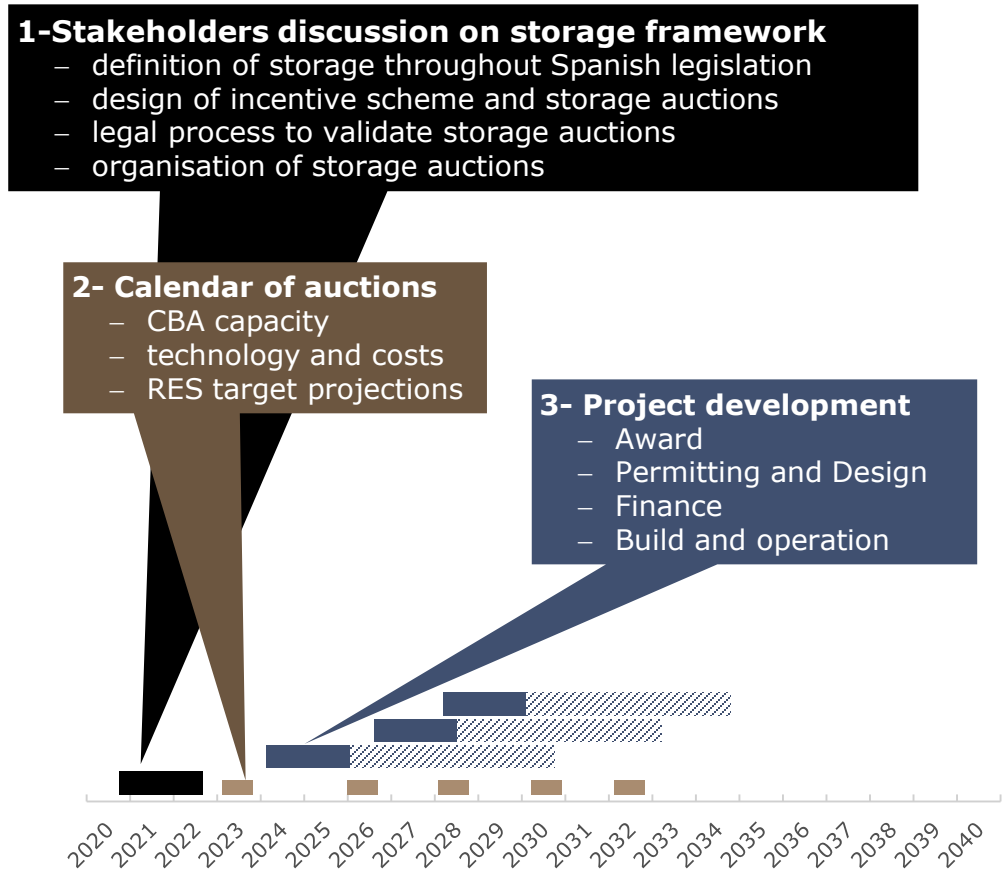
Other benefits of CSP in the Spanish market

BENEFITS OF CSP IN THE SPANISH SYSTEM

- **>3.500 hours, 8-10h storage at full load, 100% firm**
  - design with resistances can guarantee firm capacity
  - today much cheaper than equivalent PV + batteries
  - future Capex/Opex evolution of CSP and batteries?
- **Development timings**
  - Batteries: 1-2y since NTP
  - Pumped Storage: 6-10y since NTP
  - CSP? Design? Construction? Supply chain? Financing?
- **grid stability**
  - synchronous generation, 'grid forming' 50Hz, and voltage control
  - not problematic in 2020-2025, but >2030 and 2040?
- **Modular storage** design
  - future upgrades of cheap energy storage
- Contribution to **GDP, employment** and **technology exports**

IMPLEMENTATION PLAN FOR STORAGE



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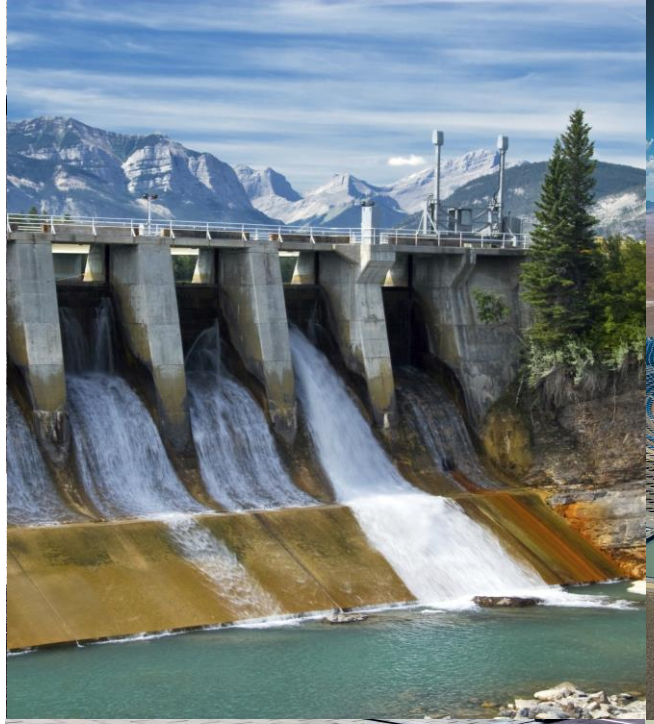
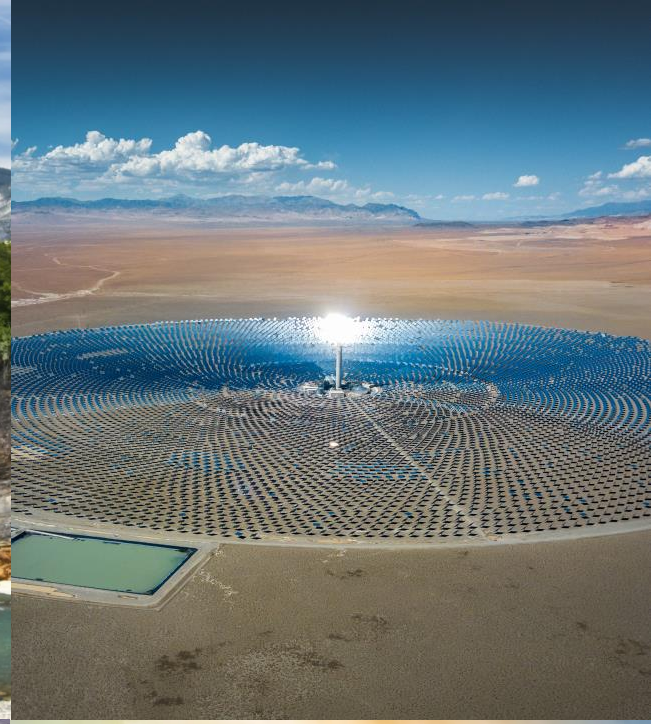
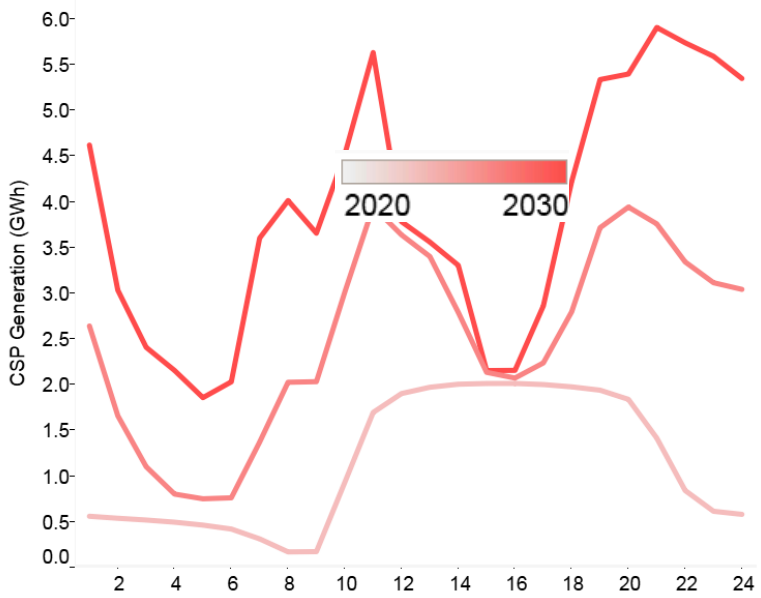



Regulatory options for incentivising CSP

- **New framework for RES, CRM and Storage** compliant with
  - Winter Package + State Aid Guidelines (minimise distortions, market exposure)
  - National regulation
  - Market optimisation, NO production in hours of sun!
- **Incentive options for CSP**:
  - **Specific incentive for CSP**, or for 'RES with e.g. 10 hours storage'. Critical auction definition
    - Option 1: **FiT CfD (€/MWh)** does NOT incentivise market optimisation
    - Option 2: **Premium (€/MW or €/MWh)** incentivises market optimisation
    - Option 3: **Stack of revenue streams** (RES incentive + CRM + storage incentive + DA market)
  - **Additional services**: storage, capacity, flexibility, inertia, voltage control
- Proposed 'Régimen Económico de Energías Renovables' (REER)?
- Competition vs. financeability to attract equity and lenders
- Economies of scale vs. 'one plant at a time'

CSP HOURLY PRODUCTION



CSP is likely to require a 'Pool + €/MWh' or '+ €/MW/year' resulting from specific auctions or RES with large storage

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Takeaways

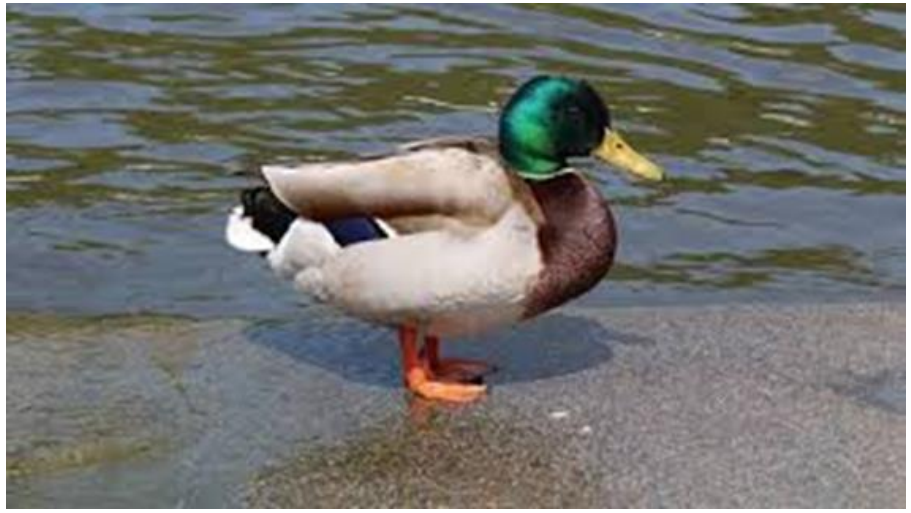
To meet Spain's NECP, the system needs:
- additional RES to exceed probably insufficient market-driven levels
- additional revenues to provide capacity (prevent some closures)
- additional storage to exceed probably insufficient market-driven levels

Scenarios with 5GW of CSP are economically competitive (depending on future Capex of CSP and other storage)
- reduces RES curtailments, enables a lower 'oversizing' of RES capacity, reduces RES incentives to reach the PNIEC
- provides (today) cheaper services than equivalent combination of PV+batteries → Capex evolution?
- provides additional services (intergia, 'grid forming' capability, 10h of firm capacity) that will be required after nuclear phase-out

New regulatory framework required to attract CSP
- incentive scheme from specific auction to be designed → key impact on design and operation of the plant
- recommended incentive based in 'pool + premium' in €/MWh or €/MW/year

CSP should
- optimise and standardise designs for Spain's need
- optimise costs to give visibility of future impacts vs. alternative options

Government should
- consider pros & cons of CSP (ducks) versus alternative scenarios (cheetahs + black marlins + falcons)
- design carefully regulatory frameworks that enable all NECP targets (devil is in the details...)



Bladerunner 2049 screenshot...


Making Future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