ESTELA WORKSHOP 2016

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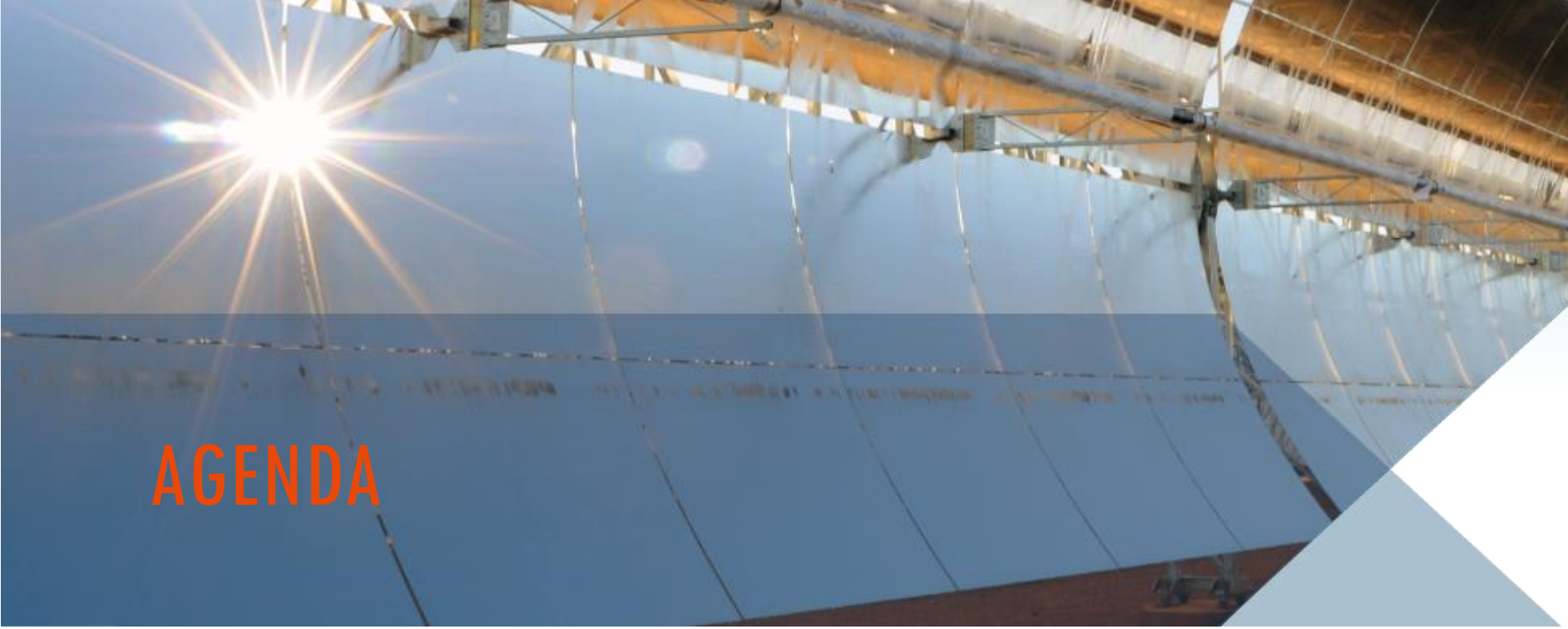

AGENDA

08:55	Opening
9:00-10:30	STE AND GROWTH
10:30-11:00	*Coffee break*
11:00-13:00	STE IN EUROPE
	Part I: The industry FOAK project(s)
	Part II and III: The R&D research proposals (STE & Turbines)
13:00-14:30	*Lunch Break*
14:00-16:30	STE ON WORLD MARKETS
16:30-17:00	Closing

PANEL 1: STE AND GROWTH

Speakers:

- Inmaculada Figueroa, *Ministry of Economy and Competitiveness, Spain*
- Agustín Escardino-Malva, *EC RTD*
- Michael Geyer, *Abengoa Solar*
- José Alfonso Nebrera, *ACS Cobra*
- Simon Benmarraze, *IRENA*
- Cedric Philibert, *IEA*

PANEL 2: STE IN EUROPE

Speakers:

- Inmaculada Figueroa, *Ministry of Economy and Competitiveness, Spain*
- Agustín Escardino-Malva, *EC RTD*
- Luis Crespo, *ESTELA/Protermosolar*

PANEL 2: STE IN EUROPE
PART I: THE INDUSTRY FOAK PROJECT(S)

Speakers:

- José Alfonso Nebrera, *ACS Cobra*
- Michael Geyer, *Abengoa Solar*
- James Gardiner, *ICF International*
- Jenny Chase, *Bloomberg*
- Natalia Caldes Gomez, *BETTER Project*

PANEL 2: STE IN EUROPE
PART II AND III: THE R&D RESEARCH PROPOSALS (STE & TURBINES)

Speakers:

- Eduardo Zarza, *CIEMAT-PSA*
- Mathias Deckers, *Siemens/EU Turbines*
- Robert Pitz-Paal, *DLR*

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PANEL 3: STE ON WORLD MARKETS

- Cedric Philibert, *IEA*
- Simon Benmarraze, *IRENA*
- Giuseppe Casubolo, *SQM*
- Jeroen Van Schijndel, *Rioglass*
- Luis Crespo, *ESTELA/Protermosolar*

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CLOSING

Thank you for your participation and see you soon!

Since some years we are hearing that batteries at utility scale will be soon available at competitive prices and then STE plants will not be further needed for dispatchability purpose

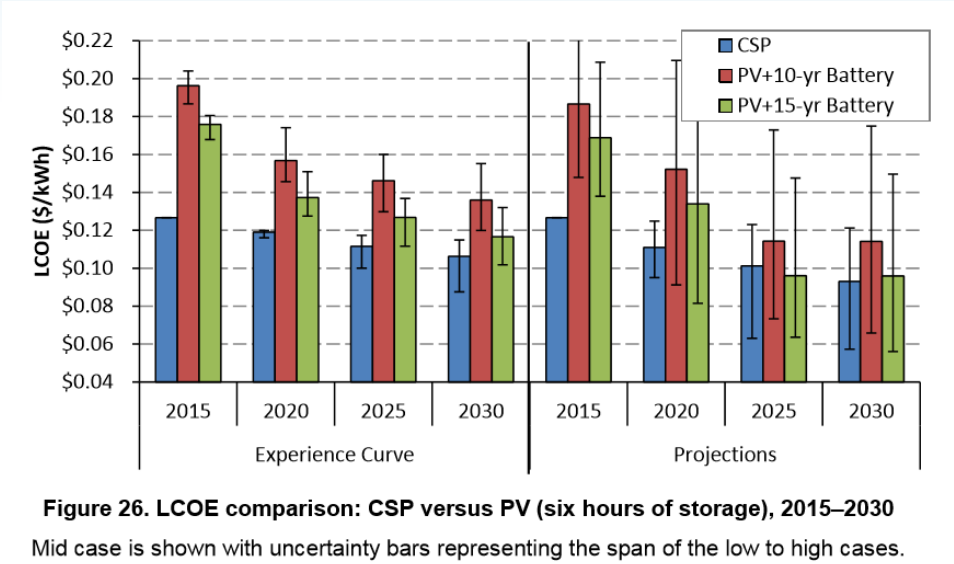


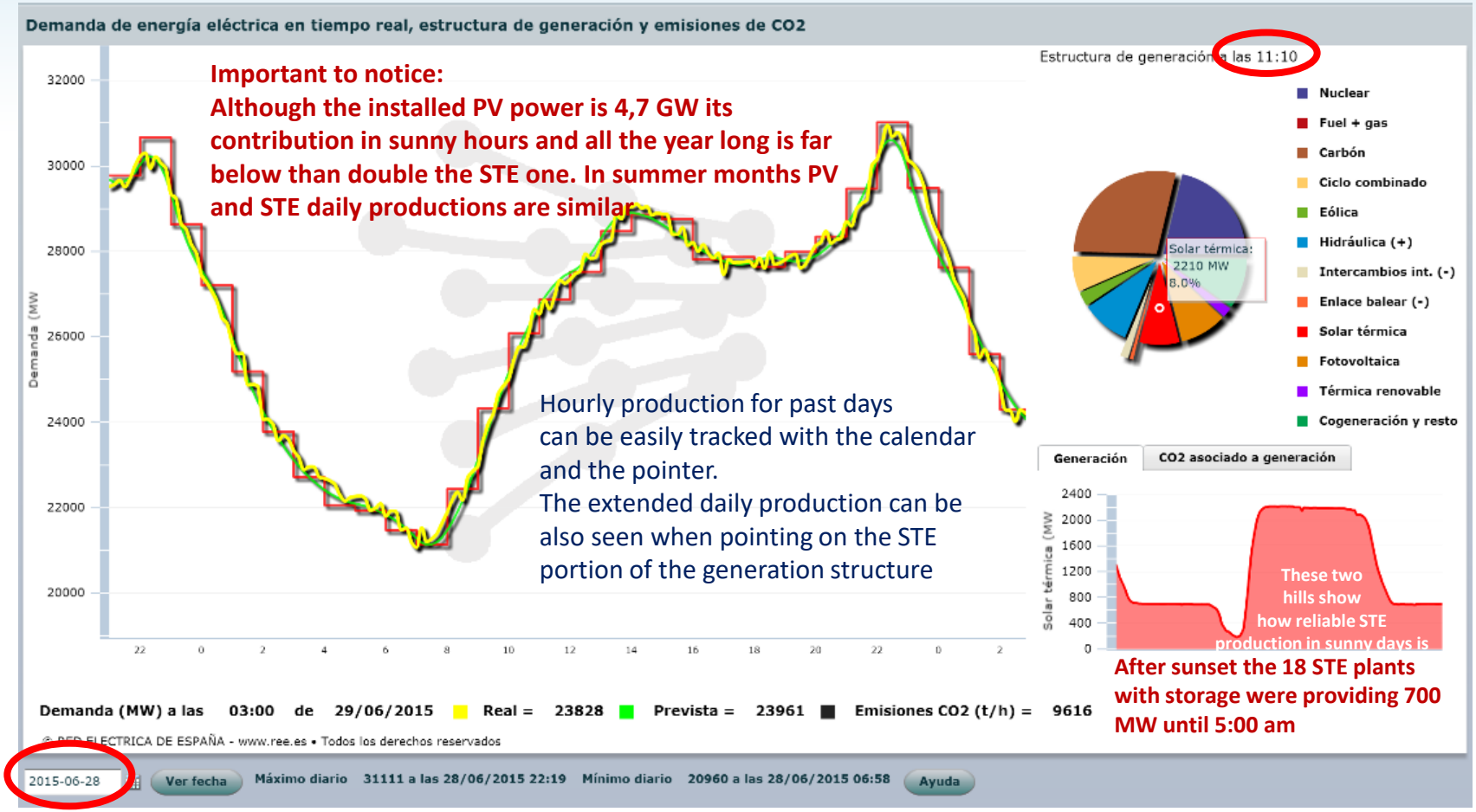
Figure 26. LCOE comparison: CSP versus PV (six hours of storage), 2015–2030

Mid case is shown with uncertainty bars representing the span of the low to high cases.

- Batteries will play an increasing role for distributed systems and for transportation but it doesn't seem to be the case for large utility Plants in the next decade
- **We don't have to forget that the generation fleet for 2030 must be planned and start implementation from TODAY**
- Download study: **http://www.nrel.gov/docs/fy16osti/66592.pdf**

Typical production in a summer day

https://demanda.ree.es/demanda.html



	Alemania	Belgica	Dinamarca	Chequia	España	Francia	Holanda	Italia	Portugal
Promotores	x				x	x		x	
Civil works					x			x	x
Campo Heliostatos	x				x				
Torre					x			x	x
Receptores	x		x		x		x		
Almacenamiento	x				x				
Control	x		x		x	x	x	x	x
Piping/Valves/Pumps	x	x			x			x	x
Steam Generator	x		x		x		x	x	
Turbine	x			x		x		x	
Cooling system					x			x	x
Electrical system	x		x	x	x	x	x	x	x
Auxiliary systems					x			x	x
Assembly					x			x	x

TWO STRATEGIC TARGETS (1/2)

Short-term: More than 40 % cost reduction by 2020 (from 2013) translating into a supply price* of < 10 c€ / kWh for a DNI level of 2050 kWh/m2/year (conditions in Southern Europe) by developing new schemes of plants and/or cycles, with a first demonstrator by 2020.

*** provided that 30 GW STE plants are installed at that time at world level**

Motivation:

- ✓ in the narrow context of electricity markets, significant narrowing of the cost gap between STE plans and gas combined-cycles;
- ✓ macro-economic benefits to EU economy not only in the countries hosting the STE plants.

TWO STRATEGIC TARGETS (2/2)

Longer-term: Develop the next generation of STE technology by 2025 via technological research and demonstration projects/ initiatives in order to raise current concepts covering key aspects of the STE technology linked to the achievement of higher temperatures at the receiver **from TRL 4/5 to 7/8.**

Motivation:

- ✓ An extended cooperation between EU research centers and industry is needed to accelerate the incremental and disruptive innovations and bring them to markets (higher TRLs).
- ✓ Most of research lines established in ESTELA's Strategic Research Agenda (2012) are fully compatible with this target and will also contribute to increasing efficiency and reducing costs.

NON-TECHNOLOGICAL PREREQUISITES TO MAJOR COST REDUCTIONS

- ✓ Economies of scale due to market volume
- ✓ Solid risk finance (investor protection)
- ✓ Fostering international cooperation

In practice, one or more Member States, supported by the EC services, should initiate a CSP *deployment* program (embedded in a **reliable investment environment**). **Motivation:**

- ✓ Adjusting the EU generation mix towards a CO_2 free power system in 2050 to a **better balance between non-dispatchable and dispatchable renewables** in the system (TSO needs!)
- ✓ Optimizing the use of renewables via the **cooperation mechanisms** (RES Dir 2009) across EU in order to reach the RES 2020 targets for Member States lacking abundant and/or flexible renewables resources.

Value component	33% renewables		40% renewables	
	STE with storage value (USD/MWh)	PV Value (USD/MWh)	STE with storage value (USD/MWh)	PV Value (USD/MWh)
Operational	46.6	31.9	46.2	29.8
Capacity	47.9-60.8	15.2-26.3	49.8-63.1	2.4-17.6
Total	94.6-107	47.1-58.2	96.0-109	32.2-47.4

What does operational value means:

Operational value represents the avoided costs of conventional generation at their respective dispatching times along with related ancillary services costs, such as operating reserve requirements. Savings on emission costs are also taken into account.

What does capacity value means:

Capacity value reflects the ability to avoid the costs of building new conventional generation in response to growing energy demands or plant retirements

"Flexible products" for different kind of network services - as requested by TSOs - need to be properly defined to reflect this added value and a market segment defined where RES would compete.

The diagram below shows the different approaches to produce dispatchable electricity from renewable energy technologies.

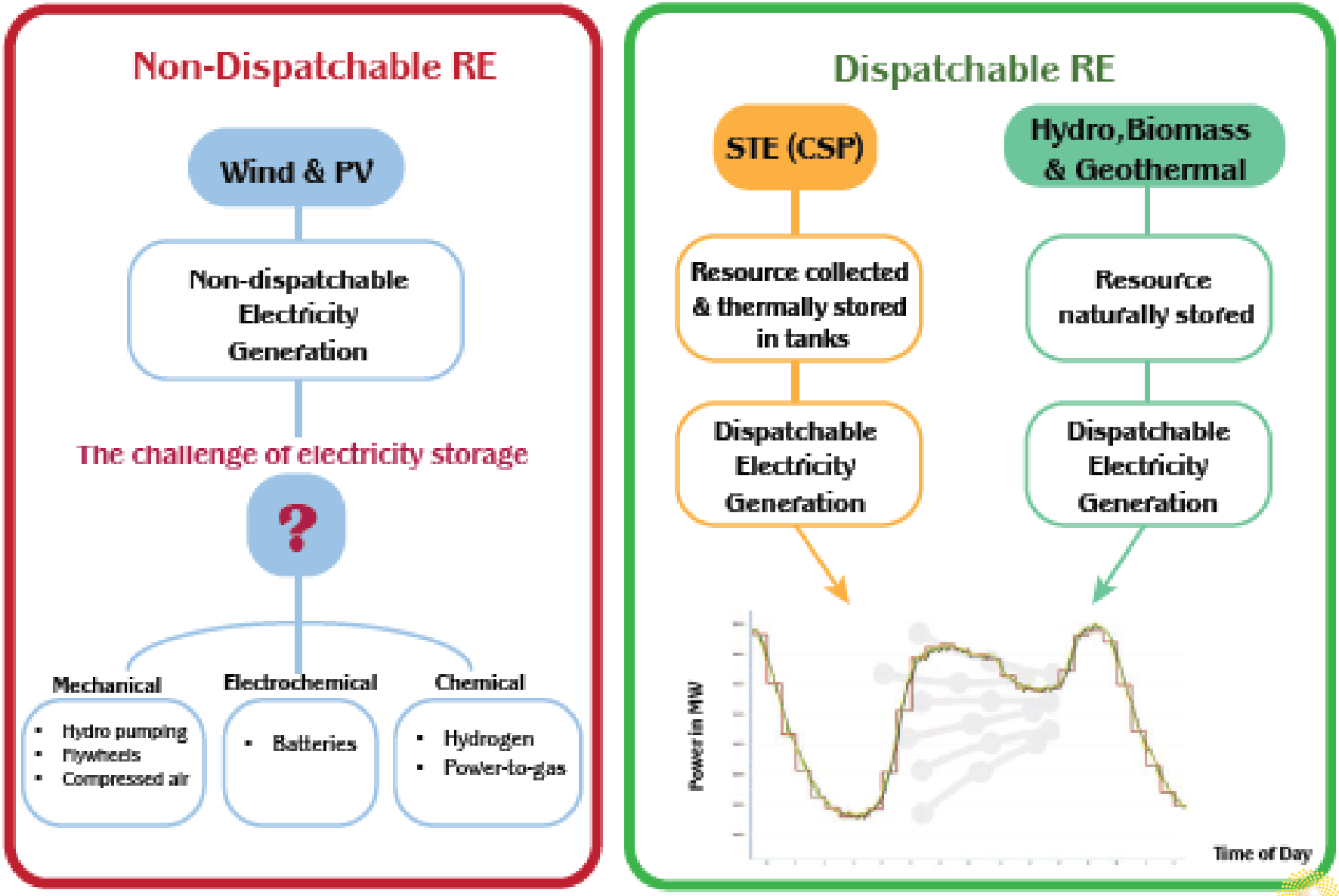


Figure 3: Different approaches to produce dispatchable electricity from renewable energy technologies.

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Joint Technology Initiatives (JTIs) Rationale

- Nature and size of the societal challenges
- Objectives cannot be achieved through regular H2020 instruments
- Need for long-term partnership between public and private side (PPP)
- Importance of leveraging private funds
- Need for a dedicated legal structure: JU (article 187 of TFEU)

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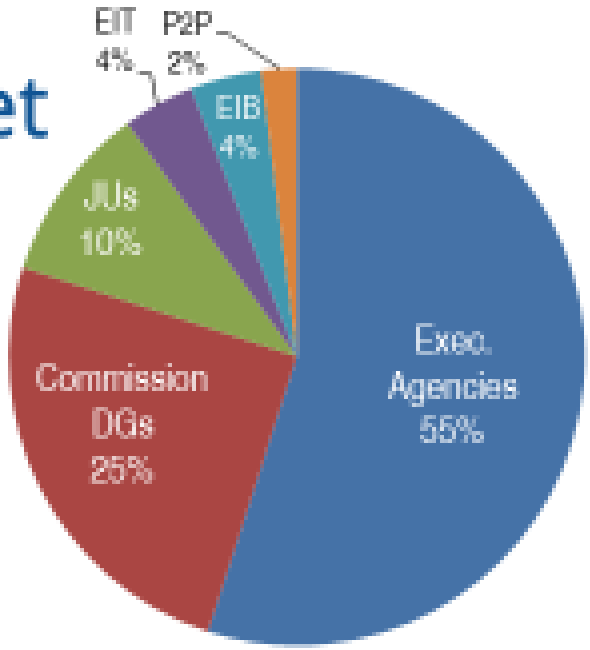
Joint Technology Initiatives (JTIs) Criteria

- **Strategic** importance of the sector
- Risk of **market failure**
- **Added value** at European level
- Scale of **impact** on industrial competitiveness and sustainable growth
- Strong and long-term financial and resource **commitment from industry**
- Capacity to attract additional national support and **leverage** current and future industry funding
- **Absent or not adequate** EU or national instruments

H2020 Budget

€ 72.451 billion



JTIs-JUs: Budget autonomy and direct discharge procedure

H2020 JUs	H2020 funding	Private funding	Member States	Eurocontrol	Total
Clean Sky 2	€ 1.755	€ 2.194			€ 3.945
IMI2	€ 1.638	€ 1.425			€ 3.063
FCH2	€ 665	€ 380			€ 1.045
BBI	€ 975	€ 2.730			€ 3.705
Shift2Rail	€ 450	€ 470			€ 920
ECSEL	€ 1.185	€ 1.657	€ 1.117		€ 4.012
SESAR	€ 585	€ 500		€ 500	€ 1.585
Total JUs	**€ 7.253**	**€ 9.356**	**€ 1.117**	**€ 500**	**€ 18.226**

JTIs – examples of successful projects

Fuel Cells and Hydrogen: Electric buses help to green transport

EU-funded CHIC project lays the groundwork for the widespread commercial deployment of fuel cell electric buses, providing cities with a solution to decarbonise their public transport fleet and reduce urban air pollution

The EU-funded CHIC project has demonstrated that fuel cell electric buses can deliver the same operational benefits as conventional diesel ones – with the big advantage of emitting just water vapour instead of CO_2 from the tailpipe.

Total cost: € 82 million
FCH funding: € 26 million
Private funding: € 56 million

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JTI-JUs in Horizon 2020:

What's new compared to FP7?

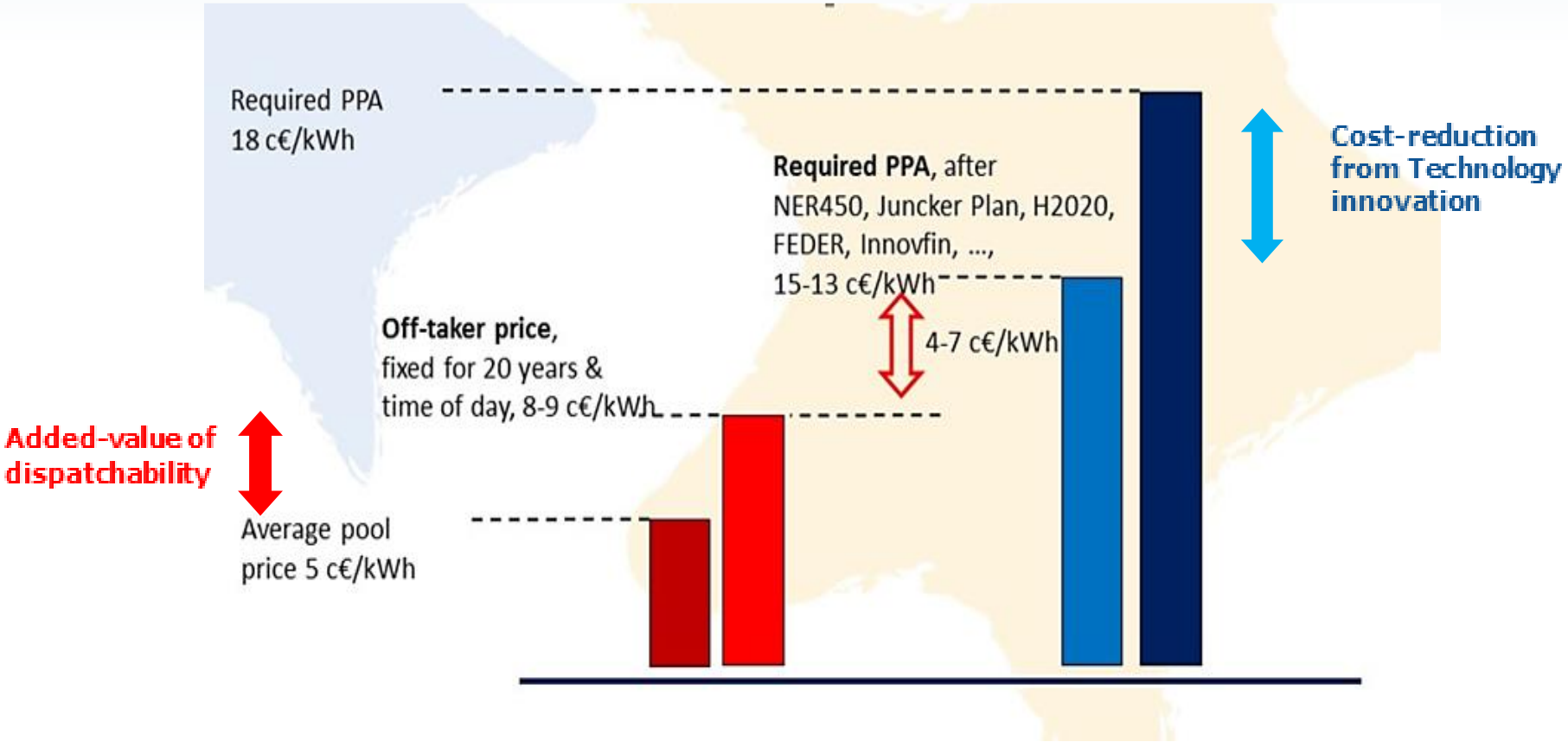
- **Simplified administration** through alignment with H2020 (common rules and funding rates)
- **Common Support Centre** for the JUs as well
- **Lighter financial rules** - Delegated regulations under Art. 209 of Financial Regulation
- Introduction of In-Kind contributions in **Additional Activities – commitment of industry** (to leverage more investment)
- Stronger **coordination with national/regional programmes** and possible synergies with other European funds (e.g. Structural Funds).

JTIs-JUs : openness and transparency

- The industrial partners in the JUs are **co-investing** with the EU to address major challenges at European level.
- H2020 JUs are **open to new members.**
- Projects are selected through **open and competitive calls for proposals** based on the Horizon 2020 rules of participation.
- **Strong participation** in the funded research projects by participants which are not members of the JU (**SMEs and higher education institutions**).
- **Industry** has committed to **fulfil the obligations** set out in the Council Regulations.
- The **Commission assesses the progress** of the initiatives on a regular basis.
- If industry does not live up to its commitments, the **Commission** may **reduce or even end its financial support for the JU.**

JTIs-JUs: accountability

- Governing Board: Commission holds 50% voting rights, plus a veto on key questions on finance and legality
- Annual work-plan approved by the Governing Board (Commission is a member) following advice by Member States and Stakeholders
- Annual Activity Report and Declaration of Assurance by the Director
- Ex-post audits, harmonised with the Commission
- Obligation to inform the Commission of any significant developments
- Internal Audit Service of the Commission as internal auditor
- European Court of Auditors as external auditor, producing an annual report
- Separate discharge given by the European Parliament
- Plus a range of informal contacts.


Required PPA
18 c€/kWh
Required PPA, after
NER450, Juncker Plan, H2020,
FEDER, Innovfin, ...,
15-13 c€/kWh
Cost-reduction
from Technology
innovation
4-7 c€/kWh
Off-taker price,
fixed for 20 years &
time of day, 8-9 c€/kWh
Added-value of
dispatchability
Average pool
price 5 c€/kWh

Investment needs for SET FOAK projects in the EU range from €4 billion to €28 billion

SET sector	Indicative project sizes (EUR M)		EU SET FOAK project deployment needs to 2020		Indicative investment needs to 2020 (EUR M)	Estimate of current unmet funding needs
	Min size of project	Max size of project	Min no of FOAK projects per sector	Max no of FOAK projects per sector		
Advanced Electricity Networks (Smart Grids)	10	50	14	28	140 - 1,400	Medium
Biomass (2nd gen biofuels)	150	600	5	10	750 - 6,000	High
Biomass (biomass to energy)	8	100	10	20	80 - 2,000	High
Carbon Capture & Storage	500	1400	1	2	500 - 2,800	High
Concentrating Solar Power	185	330	5	10	925 - 3,300	High
Geothermal	75	120	3	6	225 - 720	Low
Large-scale Energy Storage	15	350	5	10	75 - 3,500	Medium
Ocean	20	100	5	10	100 - 1000	High
Photovoltaic (generation)	35	50	5	10	175 - 500	Low
Photovoltaic (manufacturing)	45	250	3	5	135 - 1,250	Low
Wind (offshore fixed)	50	300	5	10	250 - 3,000	Low
Wind (floating array)	125	300	5	10	625 - 3,000	High
Total			75	149	3,980 - 28,470	

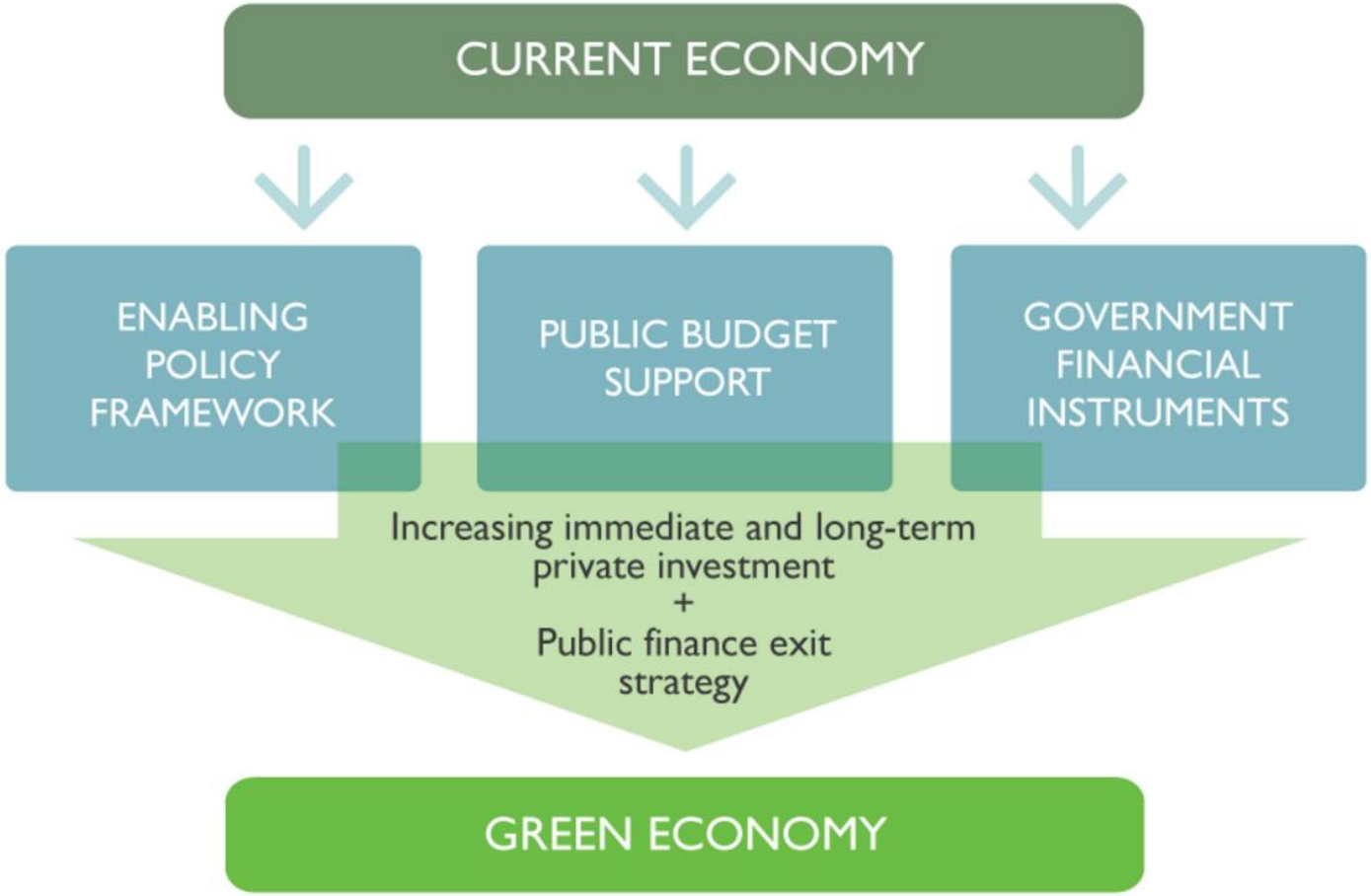
Unmet funding needs, i.e. where EC support most required

Around half of SET-Plan need

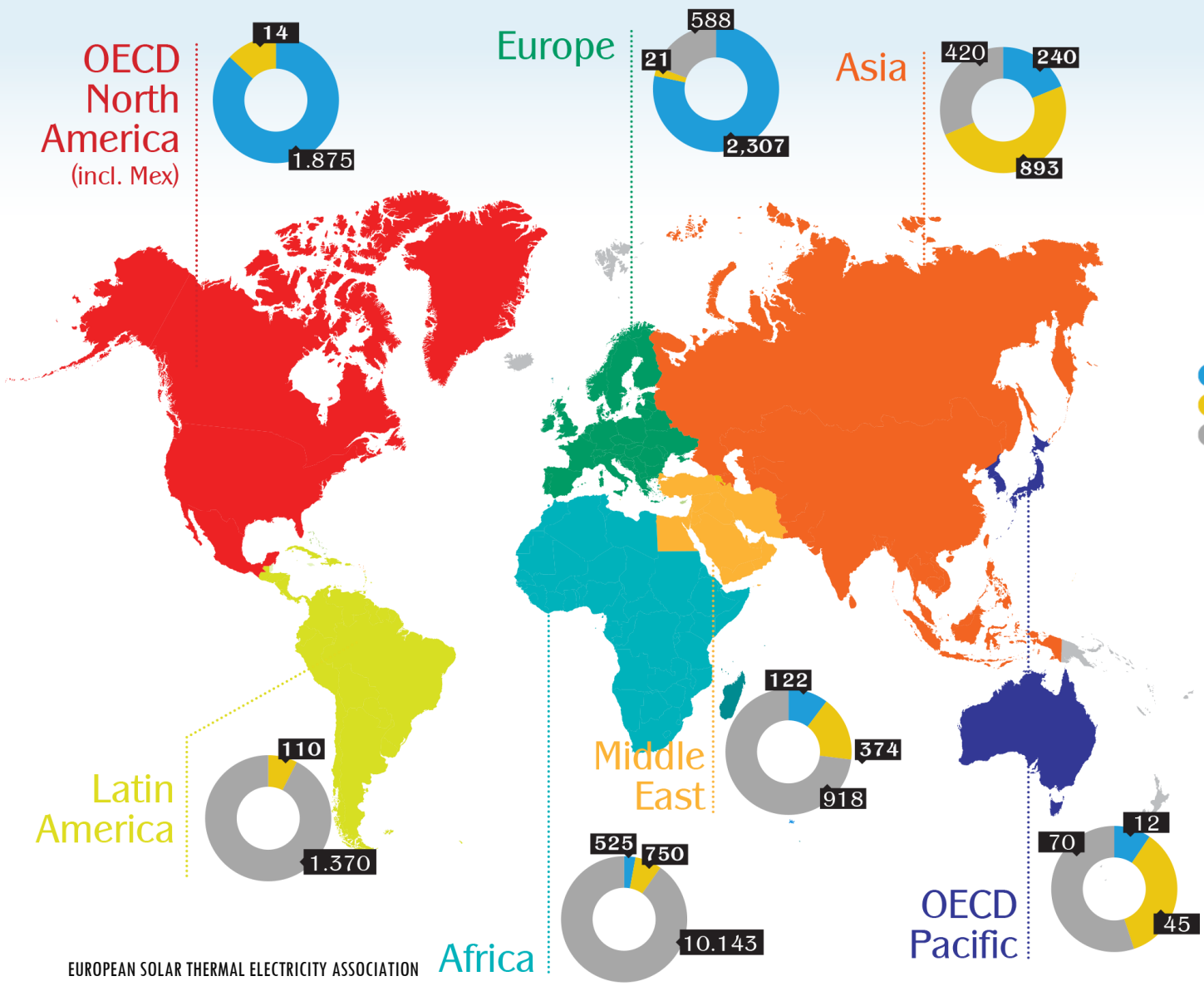
Grant funding is the most common support offered across EU and Member State mechanisms

GRANTS	LOANS	EQUITY
Most common support	Modest funds at MS level	Rarely used mechanism
Funding limits highly variable across schemes	More tailored provision at EC level	Mainly focused on innovative SMEs not projects *per se*
Max grant funding levels 50% of eligible costs	Max loan levels 50%	Good practice to not exceed max equity level (e.g. 33% France)
Key schemes: • Denmark, France, Sweden, UK (& Norway) • EU - NER 300	Key schemes: • Germany, France • EU - InnovFin Large Projects; InnovFin Energy Demo Projects (EDP); EFSI	Key schemes: • France, Sweden, UK • EU - InnovFin Energy Demo Projects (EDP); EFSI

EFSI = European Fund for Strategic Investments


CURRENT ECONOMY
ENABLING POLICY FRAMEWORK
PUBLIC BUDGET SUPPORT
GOVERNMENT FINANCIAL INSTRUMENTS
Increasing immediate and long-term private investment
+
Public finance exit strategy
GREEN ECONOMY

CURRENT MARKET SITUATION ACROSS THE WORLD



Source:

ESTELA Reference

(commercial plants < 5MW

ACTUAL INITIATIVES AROUND THE WORLD

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MIDDLE EAST

The Dubai Energy and Water Authority (DEWA) announced a CSP tender for a 200MW tower plant as part of a larger 1GW commitment.

Other countries in the Emirates, Iran Jordan, … have also announced plans

Saudi Arabia plans are still a big question mark

NORTHERN AFRICA

Morocco continues its deployment program. A new plant (hybrid STE/PV) is under expression of interest phase

SOUTH AFRICA

The "expedite round" award for 450 MW is still pending. New calls aren't clear at the moment

The Eskom plant will be awarded soon.

Namibia is in progress to announce the tender process for its first plant

CHILE

Intense promotion by developers looking for off-taking agreements. The current auction system is not appropriate for STE plants.

AUSTRALIA

Intense promotion by developers but still no appropriate support framework in place.

CHINA

20 plants (1,3 GW) have been awarded with a FiT of c$ 17 / kWh. (9 towers, 7 PT, and 4 Fresnel)

New plan for additional STE capacity is expected next year

EUROPE

There is a intense activity in Italy under the reviewed FiT system. The first commercial plants might be launched soon