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
PANEL 3: STE ON WORLD MARKETS

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

- 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.

Typical production in a summer day

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

After sunset the 18 STE plants with storage were providing 700 MW until 5:00 am.

Important to notice:
Although the installed PV power is 4,7 GW its contribution in sunny hours and all the year long is far below than double the STE one. In summer months PV and STE daily productions are similar.

Hourly production for past days can be easily tracked with the calendar and the pointer. The extended daily production can be also seen when pointing on the STE portion of the generation structure.

After sunset the 18 STE plants with storage were providing 700 MW until 5:00 am.
<table>
<thead>
<tr>
<th></th>
<th>Alemania</th>
<th>Belgica</th>
<th>Dinamarca</th>
<th>Chequia</th>
<th>España</th>
<th>Francia</th>
<th>Holanda</th>
<th>Italia</th>
<th>Portugal</th>
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<td>Campo Heliostatos</td>
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<td>Almacenamiento</td>
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<td>Piping/Valves/Pumps</td>
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<td>Steam Generator</td>
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<td>Cooling system</td>
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<td>Electrical system</td>
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<td>Auxiliary systems</td>
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<td>Assembly</td>
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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\textsubscript{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.
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.

```
| 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        |
```

“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.

**Non-Dispatchable RE**

- Wind & PV
- Non-dispatchable Electricity Generation

**Dispatchable RE**

- STE (CSP)
  - Resource collected & thermally stored in tanks
  - Dispatchable Electricity Generation

- Hydro, Biomass & Geothermal
  - Resource naturally stored
  - Dispatchable Electricity Generation

**The challenge of electricity storage**

- Mechanical
  - Hydro pumping
  - Flywheels
  - Compressed air
- Electrochemical
  - Batteries
- Chemical
  - Hydrogen
  - Power-to-gas

*Figure 3: Different approaches to produce dispatchable electricity from renewable energy technologies.*
Joint Technology Initiatives (JTI) 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)
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

<table>
<thead>
<tr>
<th>H2020 JUs</th>
<th>H2020 funding</th>
<th>Private funding</th>
<th>Member States</th>
<th>Eurocontrol</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean Sky 2</td>
<td>€ 1.755</td>
<td>€ 2.194</td>
<td></td>
<td></td>
<td>€ 3.945</td>
</tr>
<tr>
<td>IMI2</td>
<td>€ 1.638</td>
<td>€ 1.425</td>
<td></td>
<td></td>
<td>€ 3.063</td>
</tr>
<tr>
<td>FCH2</td>
<td>€ 665</td>
<td>€ 380</td>
<td></td>
<td></td>
<td>€ 1.045</td>
</tr>
<tr>
<td>BBI</td>
<td>€ 975</td>
<td>€ 2.730</td>
<td></td>
<td></td>
<td>€ 3.705</td>
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<tr>
<td>Shift2Rail</td>
<td>€ 450</td>
<td>€ 2.730</td>
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<td>€ 2.730</td>
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<tr>
<td>ECSEL</td>
<td>€ 1.185</td>
<td>€ 1.857</td>
<td>€ 1.117</td>
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<td>€ 4.012</td>
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<tr>
<td>SESAR</td>
<td>€ 585</td>
<td>€ 500</td>
<td>€ 1.117</td>
<td>€ 500</td>
<td>€ 1.585</td>
</tr>
<tr>
<td><strong>Total JUs</strong></td>
<td><strong>€ 7.253</strong></td>
<td><strong>€ 9.356</strong></td>
<td><strong>€ 1.117</strong></td>
<td><strong>€ 500</strong></td>
<td><strong>€ 18.226</strong></td>
</tr>
</tbody>
</table>
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 CO₂ from the tailpipe.

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

Off-taker price,
fixed for 20 years &
time of day, 8-9 c€/kWh

Added-value of
dispatchability
Average pool
price 5 c€/kWh

Required PPA, after
NER450, Juncker Plan, H2020,
FEDER, Innovfin, ...
15-13 c€/kWh

4-7 c€/kWh

Cost-reduction
from Technology
innovation
Investment needs for SET FOAK projects in the EU range from €4 billion to €28 billion

<table>
<thead>
<tr>
<th>SET sector</th>
<th>Indicative project sizes (EUR M)</th>
<th>EU SET FOAK project deployment needs to 2020</th>
<th>Indicative investment needs to 2020 (EUR M)</th>
<th>Estimate of current unmet funding needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Electricity Networks</td>
<td>10 - 50</td>
<td>14</td>
<td>140 - 1,400</td>
<td>Medium</td>
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<tr>
<td>(Smart Grids)</td>
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<tr>
<td>Biomass [2nd gen biofuels]</td>
<td>150 - 600</td>
<td>5</td>
<td>750 - 6,000</td>
<td>High</td>
</tr>
<tr>
<td>Biomass [biomass to energy]</td>
<td>8 - 100</td>
<td>10</td>
<td>80 - 2,000</td>
<td>High</td>
</tr>
<tr>
<td>Carbon Capture &amp; Storage</td>
<td>500 - 1,400</td>
<td>1</td>
<td>500 - 2,800</td>
<td>High</td>
</tr>
<tr>
<td>Concentrating Solar Power</td>
<td>185 - 330</td>
<td>5</td>
<td>925 - 3,300</td>
<td>High</td>
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<tr>
<td>Geothermal</td>
<td>75 - 120</td>
<td>3</td>
<td>225 - 720</td>
<td>Low</td>
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<tr>
<td>Large-scale Energy Storage</td>
<td>15 - 350</td>
<td>5</td>
<td>75 - 3,500</td>
<td>Medium</td>
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<tr>
<td>Ocean</td>
<td>20 - 100</td>
<td>3</td>
<td>100 - 1,000</td>
<td>High</td>
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<tr>
<td>Photovoltaic (generation)</td>
<td>35 - 50</td>
<td>5</td>
<td>175 - 500</td>
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<tr>
<td>Photovoltaic (manufacturing)</td>
<td>45 - 250</td>
<td>3</td>
<td>135 - 1,250</td>
<td>Low</td>
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<tr>
<td>Wind [offshore fixed]</td>
<td>50 - 300</td>
<td>5</td>
<td>250 - 3,000</td>
<td>Low</td>
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<tr>
<td>Wind [floating array]</td>
<td>125 - 300</td>
<td>5</td>
<td>625 - 3,000</td>
<td>High</td>
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<tr>
<td>Total</td>
<td>75 - 149</td>
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<td>3,980 - 28,470</td>
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</table>

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

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