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European Agenda on Research Infrastructure Needs

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1 Introduction

The Deliverable 3.2, which is the outcome of Subtask 3.2.4, is aiming to synthesize the information collected in the workshops that took place under Subtask 3.2.2 and the listing of Research Infrastructures (RIs) that was completed under Subtask 3.2.3. In addition to these, and in coordination with the EU-SOLARIS project, data from the work done in WP3 of that project will also be added to the above in order to propose a 'European Agenda' on RIs. The main goal of this document is to present a roadmap for action for the speeding up of cost reduction of STE systems and components, in line with the goals of the National and International Workshops that took place in the subtasks mentioned above.

The exact sources of information used to compile this report therefore are:

- STAGE-STE Task 3.2.2: A national Workshop in Spain, which took place in Seville in November 2015;
- STAGE-STE Task 3.2.2: An International Workshop, which took place in Abu Dhabi in October 2016 parallel to the SolarPACES conference;
- STAGE-STE Task 3.2.3: List of EU and non-EU RIs which was completed in November 2016;
- EU-SOLARIS MS19: Report on the viability of the new services to be offered based in users' demand. The final version of this report was submitted in January 2017;
- EU-SOLARIS MS27: Analysis of the results of the user questionnaire, completed in 2015;
- EU-SOLARIS D3.3: Services to be offered by EU-SOLARIS in the implementation phase, completed in 2017;
- EU-SOLARIS report for Task 5.2.2: Report (listing) of new potential users (EU and worldwide) completed in 2015.

2 Analysis of existing EU and international RIs

Under Task 3.2.2 a list of RIs in Europe and worldwide has been compiled. This list tried to

capture information on the technology of the RIs, but also the ownership, technical information on power and peak solar flux, the existence of storage etc. Table 1 below offers a summary of the findings:

Table 1: Summary of facilities identified in Europe and outside of Europe by facility type

Type of facility		**Solar furnace**	**Parabolic dish**	**Parabolic trough**	**Fresnel**	**Tower**	**Solar simulator**	**Total**
In Europe	# with facility type	4	2	3	3	5	7	
	# facilities in total	17	7	7	3	6	8	**48**
Outside Europe	# with facility type	5	6	13	8	13	8	
	# facilities in total	5	9	13	8	14	8	**57**
World	# with facility type	9	8	16	11	18	15	
	# facilities in total	22	16	20	11	20	16	**105**

The table lists the number of RIs that possess a certain facility type (solar furnace, dish, Fresnel etc. denoted by the symbol '#') and the total number of such types in all RIs (# facilities in total). It is apparent from these two listings that some RIs have more than one facility of the same type (e.g. CNRS has several solar furnaces, hence the higher number in the total row).

The Task authors point out that this list is not definitive and further facilities may have not been identified, especially outside Europe. The list points to the fact that Europe possess a large proportion of the RI overall, and the majority in some technological categories, such as Parabolic Troughs. In the rest of the World, there are facilities predominantly in the US, Australia, Israel and China, in line with the effort of their respective national governments for the advancement of STE technologies.

Further data for existing STE RIs can be found from the work done under WP3 of the EU-SOLARIS project, which had an explicit mandate to profile them, as this information is crucial for the creation of the entity. There have been some omissions from the list prepared

under task 3.2.3 (such as the solar furnaces at CNRS), but otherwise there is strong agreement between the databases.

3 Analysis of findings of workshops

Two workshops took place within WP3 of STAGE-STE: One in Spain in November 2015 and one in Abu Dhabi, parallel to the SolarPACES conference, in October 2016. The workshop in Spain had three sessions, in which there was a high level of debate among the participants, consisting about 100 people from the industrial and RTD sectors. The main conclusion drawn from these debates is the fact that Spain is falling behind other countries when it comes to governmental sustained commitment, and even though Spanish R&D centres and local industry have been long-standing leaders and innovators in the field, they find themselves surpassed by other countries that place a larger emphasis on state support of the sector. This lack of support from the Spanish central government is ostensibly leading research centres to lose their capacity for technological innovation and squander the advantage that they built in the last years.

The international workshop had a much narrower focus on the efforts to get a clear picture of the RIs needed by the STE sector to speed up the cost reduction trend required for a wide commercial deployment of concentrating solar thermal technologies. Some important conclusions were drawn from this workshop:

1. To accelerate the reduction of LCOE, the focus should not be on new R&D facilities (even though it is understandable for smaller countries to wish to develop their own RIs, but without replication) but to reduce the costs for *i)* Tower molten salt systems and *ii)* Parabolic troughs with thermal storage. For this purpose, **the RIs in existence today would be adequate**, which was also the main conclusion of the workshop.

2. Additional gains will be possible by focussing on cheaper heliostat concepts, new manufacturing techniques or materials for molten salt receivers, fast and accurate methods for heliostat calibration, new or improved working fluids and adequate software for solar towers design.

3. Confidentiality is a very important issue for private companies when they want to perform any R+D activity, and this is the main reason why they prefer to conduct their

research using their own RIs whenever possible.

4. The procedures to access existing public RIs are not clear enough and are not conducive to the collaboration between them and the industry.

5. The facilities that allow the testing of accelerated ageing of components are very important to the industry (e.g. receivers and mirrors).

6. The need for standardisation was highlighted, as this will ease the design convergence of R&D centres and the industry, and will reduce the costs for EPC contractors and clients.

7. Although the collaboration level between the industrial sector and the R+D centres is good, the collaboration between industries in the STE sector is still very poor and this is a barrier for a faster development of the learning curve.

It seems therefore that there are distinct opinions amongst the STE stakeholders of the way forward. On the one hand, the R&D centres and the universities feel that there is still room for developing new concepts for which they would prefer the continuing support from governments, policy makers etc. On the other, the industry believes that the current stock of RIs is enough for the tests required to lower the LCOE, the most crucial barrier in confidently entering the energy landscape.

It is interesting to discuss here these finding in the context of a number of reports on the existing and new services offered prepared under EU-SOLARIS, and on the existing and potential users of the facilities. The activities under WP5 of EU-SOLARIS have attempted to map the potential and existing users of the facilities, mostly by tapping into data provided by the operators of the two SFERA programmes. In those datasets, it became apparent that the main reason external entities ask for access to these facilities (see Figure 1) is to work on material sciences experiments (usually involving solar furnaces) or chemistry experiments, sometimes utilising low-temperature RIs. These results represent the requests mainly from other scientific institutions, since the sample contained only 17 industrial entities. Still, the requests have been for materials and chemistry experiments, and a few modelling & simulation requests.

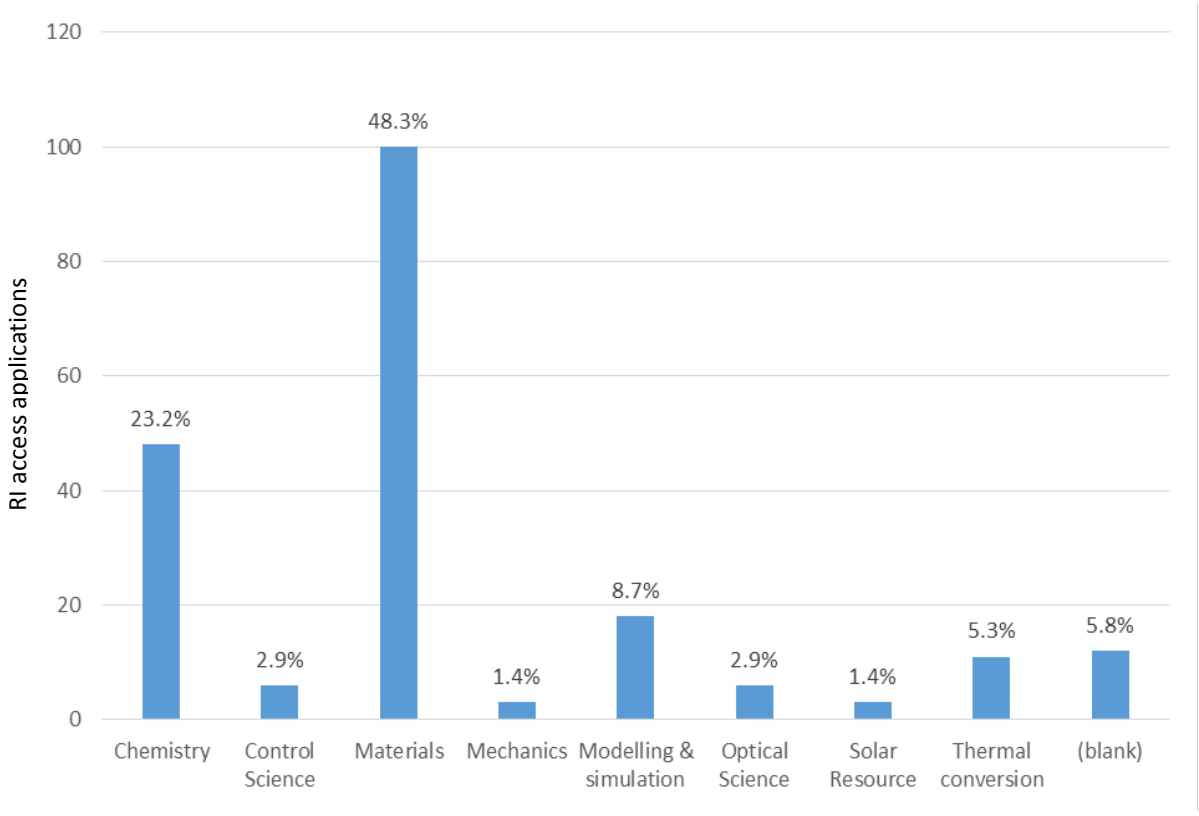

Figure 1: Frequency distribution of scientific fields request for access in various RIs. Source: EU-SOLARIS report for task 5.2.2. Data source: SFERA I and SFERA II access programmes

Better insight comes from the dedicated questionnaires distributed to various stakeholders for the needs of the project, recorded in MS27 and analysed in MS19. The responses in these questionnaires (from a sample of 186) are tabulated according to many parameters, including if the respondent is from the public or private sector. In regard to the needs for the infrastructures, the three main topics that were selected were:

- Testing of working fluids
- Testing of thermal storage
- Testing of solar reflectors

This corroborates the conclusion of the workshops (see section 3) when the industry suggested future actions for cost reduction. Furthermore, in regards to the services needed by the users, the three main topics ticked were

- Software for modelling (consistent integration of component's modelling) for

optimized system design and simulation

- Optical characterization
- Thermal properties measurement

The overarching conclusion from these reports is that all the RI and services needed by users are already available and therefore the implementation of new RIs would not be justified from this standpoint, similarly to what was found in the analysis of the workshops. Only new laboratories to measure the physical and thermal parameters of new working fluids at medium and high temperature (new thermal oils, new salt mixtures etc.) could be justified from an economic standpoint, because there is a lack of this type of laboratories at present, at least in the European RIs.

4 Proposals for the formulation of a European Agenda for RIs

Given the discussion in the previous sections, a more structured agenda for the European RIs can be recommended, split into five main pillars, as described in more detail below:

4.1 Pillar 1: Discourage duplication of large-scale RIs

This is a point that has been articulated during the international workshops. As already mentioned, countries with no significant STE RIs cannot be discouraged from building their own for teaching, testing and conducting experiments, given the fact that many countries in Europe enjoy very different climate conditions. What should be avoided is the construction of large, expensive RIs with overlapping qualities that can be found elsewhere. This is not trivial to manage, as it needs the coordination of national RI agendas and a centralised European node for overseeing RIs; this may very well be EU-SOLARIS, which is now in the process of formalising its existence.

4.2 Pillar 2: Promote IP protection and foster collaboration

Stemming from the discussion with the industry at the international workshop, the industry in the STE sector appears to resist collaboration between themselves mainly to protect their IP. The second pillar would therefore be to promote patenting in order to protect IP, but at the same time create an industrial forum to foster collaboration, perhaps under the coordination of

a network of RIs, e.g. EU-SOLARIS. The forum can be used as a venue for regular meetings with the academic nodes, general updating, collaboration on competitive research funding, etc.

4.3 Pillar 3: Focus funding on proven concepts

The track record of STE technologies in the last 20 years has seen some dramatic swings in technology choices, refinement and maturity of equipment, and general understanding of the place of the technology in the various markets. Since competition with other renewables and traditional generators is mostly – but not entirely – based on the Levelized Cost, it is proposed here to focus on reducing the costs of the technologies that have a proven record of accomplishments in the market. There needs to be careful consultation on what these may be, but early indications seem to point towards tower systems with molten salt-based storage and HTF, and parabolic troughs with storage and advanced silicon-based oils. Emphasis can be given in the main components of these systems, such as cheaper heliostats, new manufacturing techniques or materials for molten salt receivers, and new or improved working fluids among others.

4.4 Pillar 4: Converge on standards

The industry and the research institutions need to converge on standards of typical components, installation and integration procedures under an EU-wide standard. This will reduce the costs for everyone downstream from the research institutions and the private R&D centres, including EPC installers, plant designers and final clients.

4.5 Pillar 5: Re-engage national and regional governments

The STE sector in Europe has been through a period of enthusiastic support in the late 00s, to a period of sharp reductions in funding, and generally falling out of favour with policy makers in the years since. The period of support has managed to accelerate the development of the technologies to the point that entities from Spain, Germany, France and perhaps to a lesser extent Italy, Switzerland, Greece and Cyprus have managed to become international leaders. The U-turn in support leaves these entities unable to protect this lead from advances happening elsewhere, most notably in Australia, the US and China, undoing many of the investments made previously. The support needs to return in some form, perhaps addressing

the pillars outlined above.

5 Conclusions

The STE scene in Europe is going through a transitionary phase from the accelerated growth under strong governmental support that it used to enjoy, to an effort to carve out an important place in the future international energy mix. In the heart of this lie the efforts to reduce the costs of the technology, as also articulated by the main stakeholders and the European Commission in a recent issues paper[1], where the target has been set at less than 10 c€/kWh for southern European climates. The D3.2 report attempts to draft an agenda towards steps that will assist with the reduction of costs, through deliberation with the industry that took place in dedicated workshops, and from data collected on the users and prospective users of the RIs that were mapped under the EU-SOLARIS project. The workshops have revealed that the RIs of research institutions would like more governmental support, while the industry thinks that more and new RIs are not required, but efforts should be made to reduce the costs of core components and configurations that are already market proven. Hence, the steps proposed include the discouragement of building new and expensive duplicate RIs, and shifting the focus on reducing the costs of proven concepts. More collaboration is also key to the future, so industry-academia forums should be promoted, as well as converging on common STE standards. Finally, a re-invigorated support from governments would help the sector regain and protect the advantage it had built in Europe.

[1] See here for details: https://goo.gl/uD5sb3