Integrating CryoHub technology at the energy system level in Europe

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Analytical approach

Scenario analysis

Identify when and where LAES, combined with cold warehouse stores, should seek to be introduced to deliver maximum value to the operators and system. Analysis will represent diversity in energy systems, food distribution systems and geographic spread.

Policy assessment

Assess the policy and regulatory barriers that could prevent the technology from being deployed (at EU and national level) drawing on the work of WP8. We will also consider how the technology, if deployed at scale, could impact other energy/food policy decisions.

Stakeholder engagement and recommendations

A description of policy and market barriers will be put to the group, with the objective of agreeing a set of policy recommendations which would enable the effective deployment of the technology, to benefit the economy and meet wider energy system/food supply goals.

Journal paper published:
Murrant and Radcliffe (2018) https://doi.org/10.1016/j.egypro.2018.09.039

Selected countries

Renewable energy generation is expected to rise significantly in Europe, especially in the powers sector.

Five specific countries were selected to represent a range of cases for the scenarios:

- UK: High electricity demand and many refrigerated warehouses. Located in Western Europe.
- Belgium: Average electricity demand and a medium number of refrigerated warehouses, including the CryoHub demonstration site. Located in Western Europe.
- Spain: High/medium electricity demand and a relatively large number of refrigerated warehouses. Located in Southern Europe.
- Bulgaria: Low electricity demand and a comparatively small number of large refrigerated warehouses. Located in South-Eastern Europe.
- Germany: Highest electricity demand and many refrigerated warehouses. Located in central Europe.

Factors considered



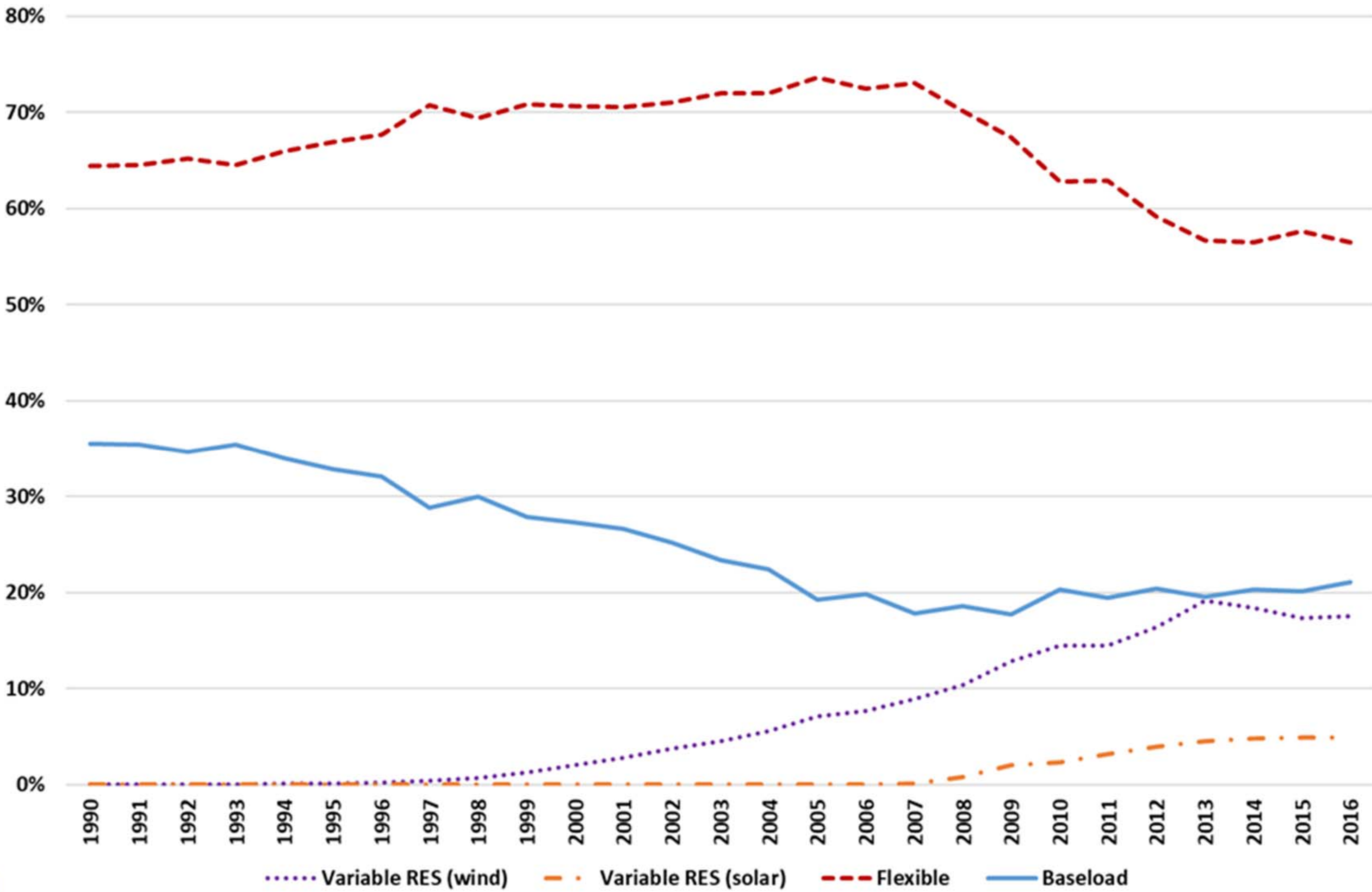

The food sector is of vital importance to the EU; and is the largest manufacturing sector and leading employer. Much of the food sector relies on refrigeration (approximately 40% of global food production requires refrigeration (Fikiin et al, 2017)).

Growth in EU refrigeration infrastructure for the food sector is expected to be low (approx. 0.24%/year), however globally it will be much higher (EU Commission Heating and Cooling Strategy working document 2016).

For each case study country the following factors were considered:

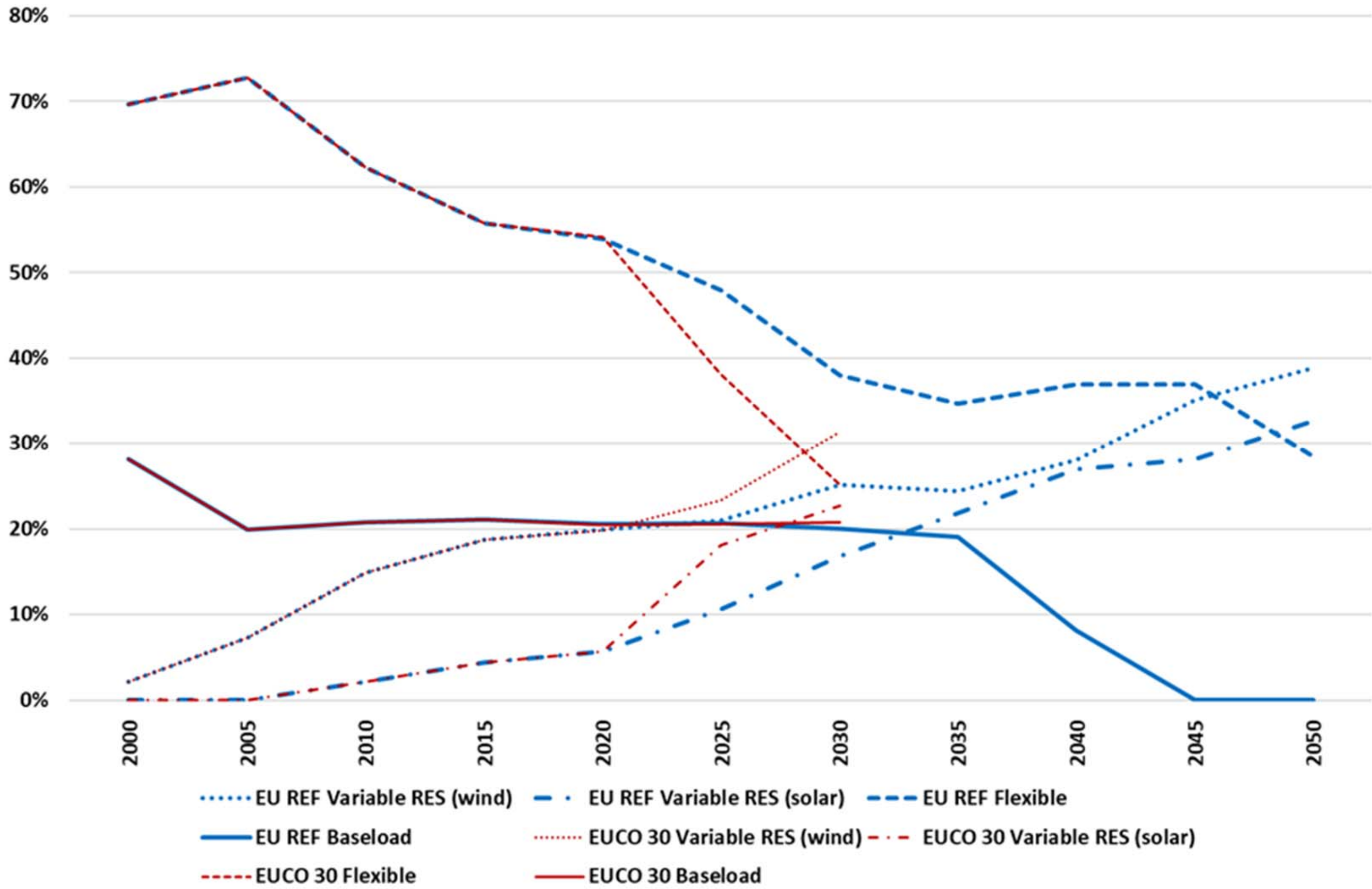
- Current and future electricity supply in terms of variable renewable, baseload and flexible generation (*taken from Eurostats and EU Commission energy scenarios*).
- Number and power consumption of refrigerated warehouses (*Report by CryoHub D2.1*).
- Future refrigeration demand (*taken from EU report 'Mapping and analyses of the current and future (2020 - 2030) heating/cooling fuel deployment (fossil/renewables)')*
- Total emissions from cooling sector (*taken from Greencoolingintiative.org*).

Spain Example, 1/3



Electricity Generation as Variable, Flexible or Baseload: 1990-2016

Spain Example, 2/3



Electricity Generation as Variable, Flexible or Baseload: 2000-2050 (EU Reference and EUCO30 Scenarios)

Spain Example, 3/3

24 large refrigerated warehouses identified in Spain with an estimated total power consumption of 56.33MW, an average of 2.35MW/warehouse (CryoHub Report D2.1).

By 2030 in Spain:

- The annual refrigeration demand is projected to be 1.44TWh, the 5th highest demand of the member states.
- Emissions from the cooling sector are expected to be up to 41.3Mt, representing 12% of total EU cooling emissions

In conclusion:

'The deployment of the technology would have most value in countries which have a large number of refrigerated warehouses and the highest levels of variable RES generation.

Of the selected case studies, the UK and Spain, which have high and growing levels of variable RES together with a significant number of refrigerated warehouses, would be the best candidates for deployment through the 2020s.'

Policies for energy storage

A wide range of mechanisms that can incentivise deployment of storage at different scales are being tested globally.

We reviewed policies relevant to energy storage in:

- Germany
- UK
- USA especially in California, New York, Hawaii
- Japan
- Australia
- South Korea

In general, approaches are context-dependent, varying according to national priorities (especially industrial strategy, also how market-driven the energy sector is) and energy system needs (scale and type of RES deployment, demand profiles).

Policies for energy storage

A range of mechanisms can incentivise deployment of storage at different scales, maybe specific to energy storage or other technologies which provide flexibility.

Technology specific

- Direct subsidies: Germany, for batteries alongside domestic PV; Calif. (small scale); Japan (for battery systems at multiple scales); many for EVs
- Mandated deployment: California, but not specifying the type of EST
- Infrastructure investments: Australia
- Innovation: all, to different degrees, very strong in S Korea & JP
- Regulation: many looking at definition of storage

Technology neutral

- Time of use tariffs: Germany, Calif., NY, Hawaii
- Ancillary service markets: UK, for freq response; NY
- Energy markets: UK, Capacity Market
- Demand reduction: NY

Policies that enable energy storage

Factors that enable the deployment of energy storage

- Scaling up the renewable energy generation which demands the need for the public investment in energy storage technologies – Germany and the UK
- Public investment in R&D of the new technologies – Germany and the UK
- Providing the favourable policy environment along with abundance of natural resources for renewable generation which attract the large-scale private sector investment – Australia and California/USA
- An innovation system that provides a level playing field for private sector actors from the early phase which in turn helps in commercialization of the new technologies – Japan and South Korea

Australia, California

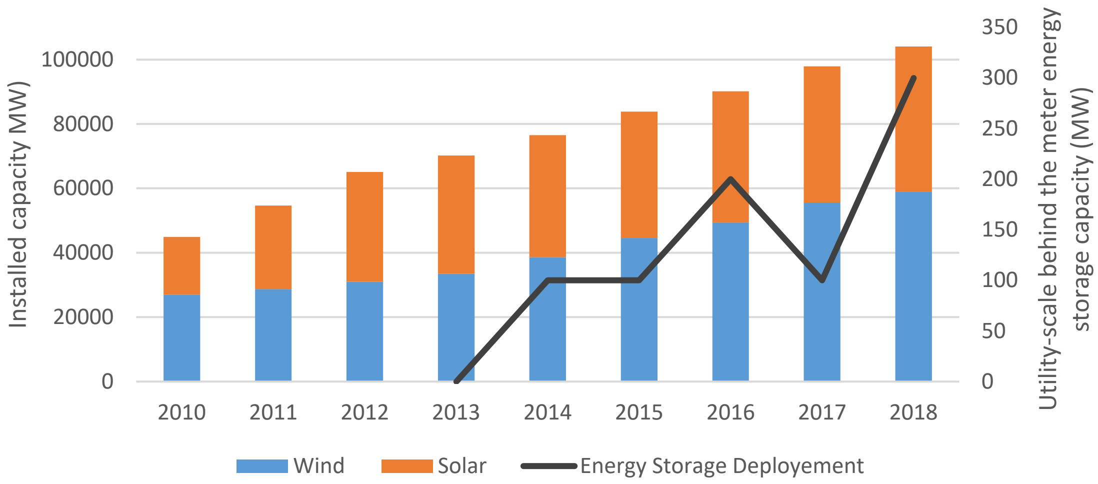
Germany, UK

High renewables generation	Favourable policy environment
Public R&D investment	Private Sector R&D investment

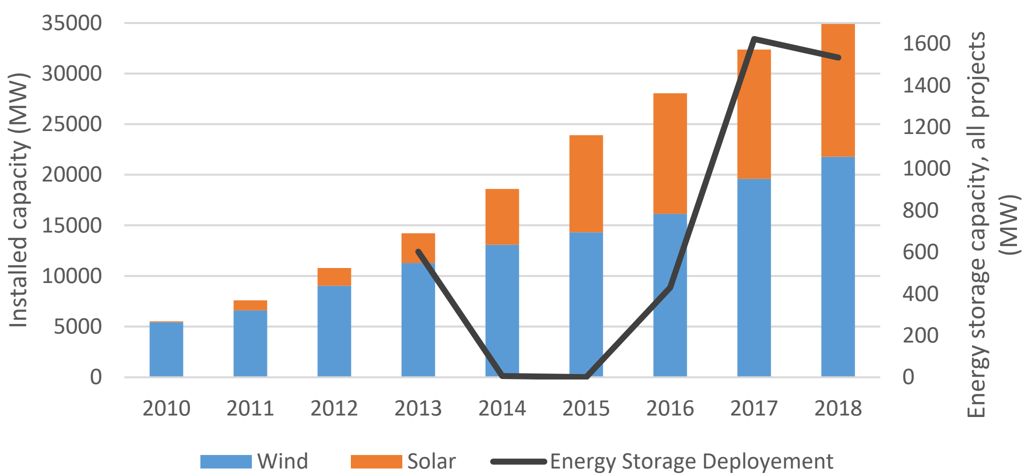
South Korea, Japan

Correlation between wind & solar energy generation and energy storage deployment

Wind, solar and energy storage deployment in Germany



Wind, solar and energy storage deployment in the UK



Source: (IRENA, 2020; DOE, 2020; BEIS, 2020)

https://www.irena.org/Statistics/View-Data-by-Topic/Capacity-and-Generation/Statistics-Time-Series
https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract
https://www.irena.org/Statistics/View-Data-by-Topic/Capacity-and-Generation/Statistics-Time-Series

Stakeholder engagement: barriers

Policy and market barriers for the development of new energy storage technologies in the EU

- **Capital expenditure/ Technology cost:** New technologies are likely to be expensive which discourages stakeholders to install such technologies.
- **Technology integration:** If the new technology cannot be integrated with the existing system/ process, this can discourage the businesses to install it.
- **Uncertainty in future value:** Energy storage technologies are still expensive and new more effective future technologies can risk investments.
- **Regulatory framework:** Existing regulatory framework was designed for a centralized energy system, which can become a barrier for the new, distributed energy systems.
- **Market structure:** Current electricity market and the heating market is too rigid and there is not enough freedom for new business models.
- **Market dependency outside EU:** Energy storage technologies such as batteries have market dependency outside Europe which can also be a barrier to the development of new technologies inside the EU.

Stakeholder Engagement: tackling barriers

The stakeholders suggested the following technology-related issues that need to be addressed in order to facilitate the development of new energy storage technology:

- Decrease the cost
- Improve cycle efficiency of an energy storage system
- Lower the logistical barriers to implementation
- Demonstrate the environmental efficacy of the technology (i.e., clear labelling) to allow front-runner businesses to promote their 'green branding'.
- More R&D should be carried out for system integration, demonstration and good programming for materials and component research

Key Messages

- Climate change and energy policies will drive an increase in renewable generation; first to 2030 an then onwards to 2050.
- This increase in renewable generation will be across energy sectors but especially for the power sector (particularly out to 2030). The food industry is an important economic contributor to the EU and refrigeration is a key element of this.
- This presents a ‘perfect storm’ for the development of LAES co-located with refrigeration.
    - To enable deployment at scale will require a number of non-technical barriers to be addressed – policy will be critical.
    - Different countries have adopted different approaches, based across driving public or private sector investment, regulation, and through markets when renewables penetration is high.
    - Cost and demonstrating the benefits of the technology are important to potential adopters.

Thank you

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