

Integrated **M**arket-fit **A**ffordable **G**rid-scale **E**nergy **S**torage

4-month progress meeting

29th June 2017 – University of Warwick

1) Summary of activities

Papers published or accepted:

1. Michael Waterson, "The characteristics of electricity storage, renewables and markets", *Energy Policy* 104, May 2017, pp. 466-473
2. J Wang, X Luo, M Dooner, C Krupke, "Compressed Air Energy Storage" in *Energy Storage*, One book chapter, World Scientific series in current energy issues, volume 4, to be published, 2017.
3. W He, Y Wang, J Wang, Pumped seawater combined with Compressed Air Energy Storage system: an integrated solution for storage/production of electricity and freshwater for offshore islands, OSES, 2017, USA
4. D Evans, F Crotogino G Schneider: Renewable energy storage in geological formations – chapter prepared for the *Journal of Power and Energy*
5. J Barton, E McKenna, M Thomson: Time-step analysis of the DECC 2050 Calculator pathways. First Published April 25, 2017
<http://journals.sagepub.com/doi/10.1177/0957650917704993>

Papers under revision:

1. X Luo, J Wang, L Shpanin, M Dooner, "A New Scroll-type Air Motor with Magnetic Spirals", *IEEE/ASME Transactions on Mechatronics*, completed the first round review, under modification.
2. W He, J Wang, Optimal Selection of air expansion machine in Compressed Air Energy Storage: a review, *Renewable and Sustainable Energy Review*

Submitted Papers:

1. W He, X Luo, D Evans, J Busby, S Garvey, D Parkes, J Wang, Exergy storage of compressed air in cavern and cavern volume estimation of the large-scale Compressed Air Energy Storage System, submitted to *Applied Energy*.
2. W He, J Wang, Y Wang, Y Ding, H Chen, Y Wu, S Garvey, Study of cycle-to-cycle Dynamic characteristics of adiabatic Compressed Air Energy Storage using packed bed Thermal Energy Storage, submitted to *Energy*
3. W He, J Wang, New radial turbine dynamic modelling in a low-temperature adiabatic Compressed Air Energy Storage system discharging process, submitted to *Energy Conversion and Management for consideration*

Manuscripts:

1. D Parkes: Physical cavern volumes - CAES potential for the UK.
2. J D Wojcik, J Wang: Technical feasibility study of Combined Cycle Gas Turbine (CCGT) integration with Adiabatic Compressed Air Energy Storage (ACAES) plant.
3. X Luo, J Wang, W He, M Dooner, YW Li, DC Li, O Kiselychnyk, "A Software Tool for Dynamic Modelling and Transient Control of Advanced Compressed Air Energy Storage with Thermal Energy Storage Systems", draft finish, aiming for *Energy* or *Applied Energy*
4. X Luo, J Wang, J D Wojcik, . M Draganescu. "Study of Power Network Grid Code Requirements for Electrical Energy Storage Applications", under writing, aiming for *Energies*
5. E Webborn, R MacKay: A Stability Analysis of Thermostatically-Controlled Loads for Electricity Frequency Response. special issue of "Complexity"

1) Summary of activities

Activities:

- D Evans: A database for incidents at gas and other fuel storage facilities - presentation at the ARMA Conference (San Francisco)
- Presentation of “Analysing the potential economic value of energy storage” by Waterson at a conference “The economics of energy and climate change” at the University of Toulouse, June 6-7, 2017
- J Wang, presentation at the EERA meeting for finalising European Energy Storage Roadmap document, Brussels, 15th March 2017.
- X Luo, visited HUST university at April 2017, international cooperation, dSPACE training & CAES laboratory at HUST.
- J Wang, M Dooner, attended Energy Storage Hub meeting, Oxford, 3rd May 2017. (given an overview about IMAGES project activities)
- J Wang, P Mawby, attended the sandpit workshop in Nanjing for potential joint grant application (smart grid and energy storage) with 14 partner universities, 26th May 2017.
- J Wang, UK-Guangdong joint workshop for potential Innovate UK Newton Fund project application (was selected to join the mission to China by KTN), 14th June 2017.

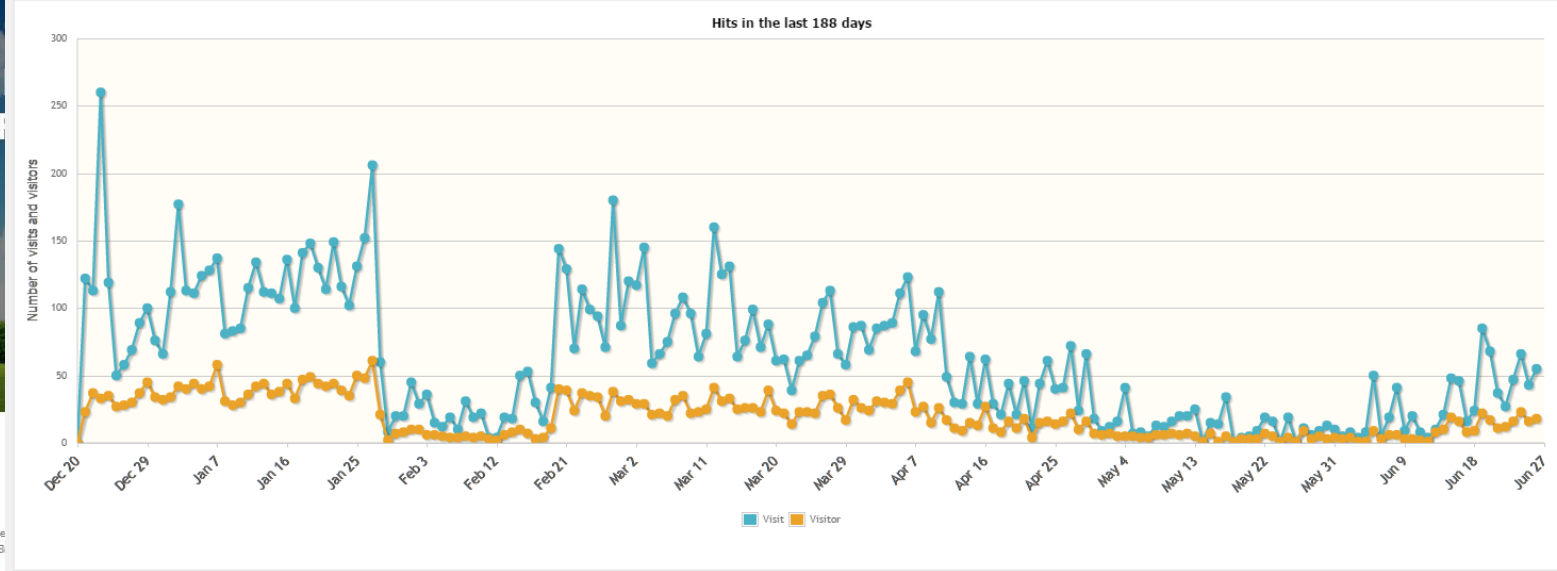
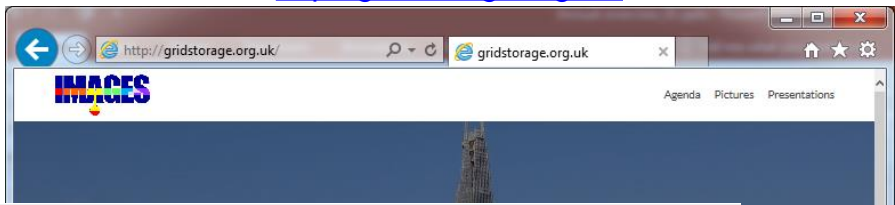
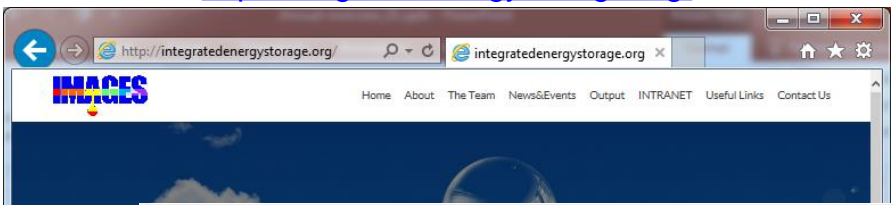
Staff changes:

1. Dr Romanos Panayiotis left the project
2. Mr James Lam, joined us in May 2017 (EPSRC CASE)
3. Dr Xing Luo and Dr Mark Dooner have been giving their support to the project

2) Website development

<http://integratedenergystorage.org/>

<http://gridstorage.org.uk/>



IMAGES is a rese
University and B

up to 2030. We are
pers into action.

Hits Statistics Summary

Chart Total:
All Time Total:

	Visit	Visitor
Chart Total:	11,651	3,716
All Time Total:	11,651	3,716

WHYDOW
STC

Short animation explaining why do we
actually need ES

Compressed Air Energy Storage (CAES) is
one type of commercialized multi-scale
electrical energy storage technology.

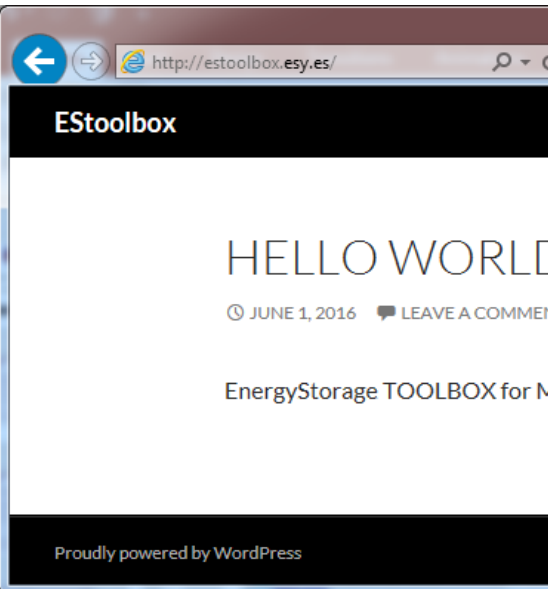
HTTS stands for High Temperature
Thermal Storage and is an innovative
technology currently undergoing a
feasibility study.

Information about other commercialized
Energy Storage Technologies

2) Website development

<http://estoolbox.org/>

<http://estoolbox.hqjt.co.uk/>



The screenshot shows the 'esToolBox' website. At the top, there is a navigation menu with 'Home', 'About', 'Software', 'Download', and 'Forum'. The main header features a large image of a turbine with the text 'Turbine Fluid Compression and Expansion Modelling'. To the right, there is a login section with fields for 'Username' and 'Password', a 'Remember Me' checkbox, and a 'Log in' button. Below the login section is a 'Site Search' box with a search input field and a 'Go' button. The main content area is divided into four columns: 'Background' (with an image of power lines), 'Compressed Air Energy Storage' (with a CAES schematic diagram), 'Thermal energy storage' (with a TES schematic diagram), and 'Software toolbox' (with a grid of software icons).

Background

In recent years the research in the field of energy storage and its applications has rapidly increased, including research in Compressed Air Energy Storage (CAES) and Thermal Energy Storage (TES). ...

Compressed Air Energy Storage

Compressed Air Energy Storage (CAES) works in the process: the ambient air is compressed via compressors into one or more storage reservoir(s) during the periods of low electricity demand (o...

Thermal energy storage

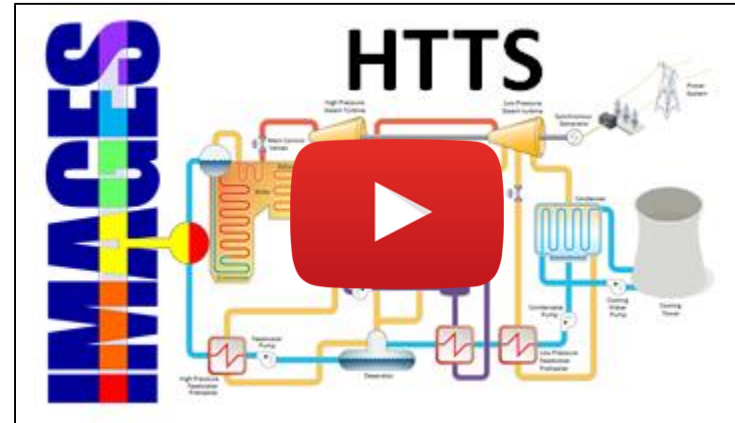
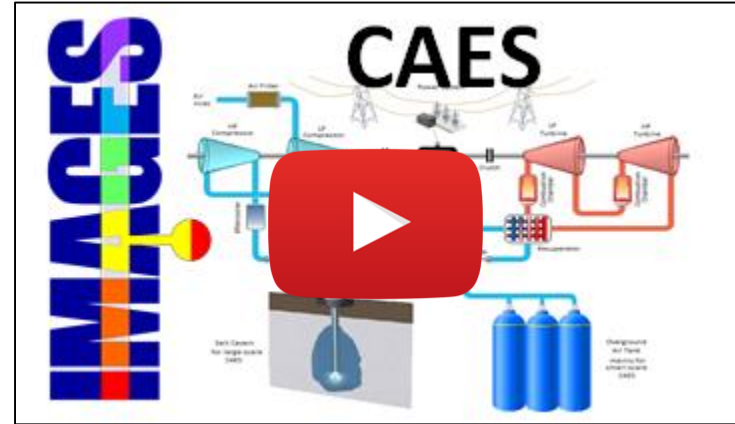
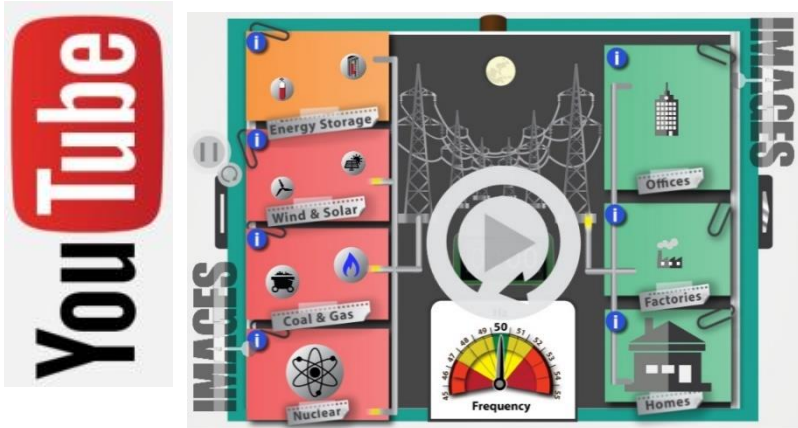
Thermal (TES) is a technology that stocks thermal energy by heating or cooling a storage medium so that the stored energy can be used at a later time for heating and cooling applications and power...



Software toolbox

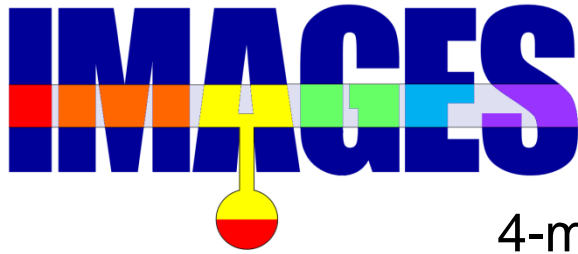
CAES-TES software toolbox introduction The structure of the library of the developed CAES-TES software toolbox is shown in the below chart. The multi-level classification method has been used. To...

2) Website development – YouTube

<https://www.youtube.com/channel/UCPnIFd0Itsce-BN3onm4LaA>



no	video	Visits
1	CAES new	5062
2	CAES old 	1119
3	HTTS new	940
4	HTTS old 	79
5	Why do we need energy storage	111
	TOTAL	7311



4-month Progress Meeting – Agenda

29th June 2017 – University of Warwick

10:00	Arrival/Registration + tea/coffee	(25 min)
10:25	Welcome , Prof J Wang	(05 min)
10:30	Project overview , Prof J Wang & Dr J Wojcik	(10 min)
10:40	Presentations by Warwick Economics	(20 min)
11:00	Presentations by Loughborough – Network and storage	(20 min)
11:20	Presentations by Loughborough – TES	(20 min)
11:40	Presentations by Nottingham	(20 min)
12:00	Presentations by Warwick Engineering	(20 min)
12:20	Lunch and Networking (Restaurant - Scarman House)	(60 min)

13:20	PMT meeting (for PMT board members only)	(60 min)