Introduction to the JP initiative on Energy System Integration

Mark O’Malley, UCD
13 October 2014
Purpose of JP ESI

- To bring together relevant existing work in Europe
- To coordinate ESI activities within EERA
- To define key research directions for ESI in EERA
- To coordinate with existing EERA JPs in areas of overlap
- To work closely with industry to develop joint initiatives in ESI
- To be a focal point for knowledge sharing and interaction of European researchers in ESI
- Draw attention to importance of increasingly integrated energy systems
- To develop ESI as an emerging interdisciplinary research area internationally

Enabling world class research in ESI within Europe
Context

- SET Plan
- $40 Trillion spend IEA
- EASAC statement
- iiESI
Scope of Energy Systems Integration (ESI)

Optimizes the integrated suite of electrical, thermal, and fuels pathways at all scales

Energy Source
- Fossil
- Nuclear
- Renewable

Single Technologies and Locations
- Campus, City Community
- Regional, National, Continental

Energy Use Sector
- Residential
- Commercial
- Industry
- Mobility

Electricity
- Thermal
- Fuels
- Data

“its scope is potentially vast but it is first and foremost focused on the interfaces where the coupling and interactions are strong and represent a challenge and/or an opportunity”
How can we make a difference
Examples of ESI

“Examples include integrated planning and operation of gas and electricity networks, and the increased coupling between electricity transmission grids and local heat networks via the concept of virtual storage”
Global generation units with water stress*

Medium to extremely-high stress

Today:

47% of Global Water-Reliant Power Production Resides in Areas of Significant Water Stress

Over 26,000 units are in areas of medium to extremely-high water stress

*Notes: Includes thermal and hydro plants. For visualization purposes, plants with design capacity less than 100 MW are not shown. Source: Platts UDI Database 2012 and WRI Aqueduct data

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ESI built on fundamental laws across may disciplines

Maxwell

$$\oint E \cdot dA = \frac{q_{enc}}{\varepsilon_0}$$
$$\oint B \cdot dA = 0$$
$$\oint E \cdot ds = -\frac{d\Phi_B}{dt}$$
$$\oint B \cdot ds = \mu_0 \varepsilon_0 \frac{d\Phi_E}{dt} + \mu_0 i_{enc}$$

Laws of Thermodynamics

Zeroth: "You must play the game."
First: "You can't win."
Second: "You can't break even."
Third: "You can't quit the game."

Kirchoff's Law

Apply

Newton's Laws

1st Law: Inertia

2nd Law: $F = ma$

3rd Law: Equal & Opposite

Supply and Demand

Demand

Surplus

Equilibrium

Shortage

Price

Quantity

0 10 20 30 40 50 60

0 1 2 3 4 5 6

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Policy Failures Because they are not Holistic

Borggrefe, F. and Neuhoff K. ”Balancing and Intraday Market Design: Options for Wind Integration” Deutsches Institut für Wirtschaftsforschung October 2011

Potential sub-programmes (SPs)
Coordination so far with other JPs

• Calls with
  - JP Wind
  - JP Smart Cities
  - JP Smart Grids

• Written comments from
  - JP Smart Cities
  - JP E3S
## Other engagements with wider community

<table>
<thead>
<tr>
<th>Lunch Break</th>
<th>13:00-14:30</th>
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</thead>
</table>
| 14:30-18:30 | A new vision of the retail energy market – the consumer at the centre  
**European Commission, DG Energy** |
| 14:30-16:15 | Towards a pragmatic energy (and resource) efficiency policy for buildings along the supply chain  
**EAACA, UFEMAT** |
| 14:30-16:15 | Pan-EU conformity assessment of energy related products: The key role of European Commission co-funded projects  
**CECED, ATLETE II Project, Market Watch, Complian TV** |
| Coffee Break | 16:15-16:45 |
| 16:45-18:30 | Energy systems integration – a global innovation challenge  
**European Commission, DG Research and Innovation** |
| 16:45-18:30 | Europe’s energy label: Modernising the success story  
**EEE, Coolproducts for a cool planet campaign, ECOS and Client Earth** |
**Vision:** A global community of scholars and practitioners from leading institutes engaged in efforts to enable highly integrated, flexible, clean, and efficient energy systems

**Objectives:** Share ESI knowledge and Experience: Coordination of R&D activities: Education and Training Resources

**Activities 2014**
- Feb 18-19 Workshop (Washington)
- May 28-29 Workshop (Copenhagen)
- July 21 – 25, ESI 101 (Denver)
- Nov 17th Workshop (Kyoto)

**Activities 2015**
- Dublin, Hawaii, Brussels, Australia

Addressing energy challenges through global collaboration [www.iiESI.org](http://www.iiESI.org)
Lessons learnt so far & observations

• Overlaps are inevitable
  – Mechanisms to manage overlaps and maximise synergy very important
  – Similar to other joint programmes

• JP ESI scope may be horizontal

• JP ESI overlaps can scientifically strengthen other JPs

• Researchers within EERA will find the JP that best suits scientific endeavours
Thank you for your attention
Any question?
Discussion on definition and potential sub-programmes of the JP initiative on Energy Systems Integration

William D’haeseleer, KU Leuven
13 October 2014
Potential sub-programmes (SPs)
Mathematical based models of the energy system have been developed over many years and are used regularly within industry, academia and policy domains. As the energy system gets more integrated the need for models that capture the coupling across pathways, scales and temporally increases. The current practice is to “soft” couple these models via data but this fails to fully capture the synergies and results in sub optimal solutions. The fully integrated model of the energy system (all pathways, scales and time resolutions) is not pragmatic and the data requirements are challenging, however there are opportunities to develop fully integrated models in niche areas that have the required data sets and can be valuable for analysis and optimization purposes. The proposed sub-programme on energy system modelling is focused on integrated energy system models that capture the strong physical, economic and regulatory coupling and interactions that exist within the energy system and that leverages the increasing volumes of data.
Forecasting is common place in electricity for the loads and for wind/solar energy, for heat and gas but rarely is it integrated. To leverage the synergies within the energy system integrated forecasting of heat, gas, electricity and wind/solar is necessary to optimally control and plan the system. The proposed energy system forecasting and control sub programme is focused on forecasting and control paradigms that leverage the coupling and interactions within the energy system.
There are emerging technologies that can allow the potential synergies that exist to be exploited. A good example of this is waste water systems that also produce energy and potentially could be net positive in energy. Other technologies are also being developed e.g. multi-fuel technologies etc. The research questions to be addressed include the validation of the integration benefits of these technologies via experiments, demonstrations and hardware in the loop.
The energy system is there to deliver energy services to the consumers and far too often they are ignored to the detriment of the development of the energy system in an optimal manner. The consumer for example is choosing to invest substantially in distributed generation in many parts of the world and this is having, technical, economic and regulatory challenges for the energy system operators and planners. This sub programme will focus on technology adoption, consumer preferences and behaviour and broader societal issues such as cyber security and privacy in the context of integrated energy solutions.
One of the biggest barriers to the implementation of many potentially impactful energy system ideas is finance and regulation. If nobody invests then nothing will happen and nobody will invest if the regulatory environment is not well designed. The system type solutions being proposed in ESI do not naturally lend themselves to simple financing and/or regulatory products. For example the current problems that exist within the European Electricity market with regard to low marginal cost energy process and a glut of gas generation capacity, increasing CO\textsubscript{2} emissions in power generation due to increased coal use are a classic example of regulatory crisis. There is a need for innovative financing and regulatory models that will enable efficient system solutions.
Next Steps

Guillaume milot, CEA
13 October 2014
Timeline

- Questionnaire circulated today – response by Oct 20th

- Core group formed by Oct 27th with the identification of the lead writers and potential JP and SPs coordinators

- Further consultations round with the interested participants in JP ESI

- Outline of description of work (DOW) by Nov 18th – for consideration by EERA EXCO on Dec 9th

- Further consultations round with the interested participants in JP ESI

- Full DOW by February 15th 2015 – to be accepted by EERA EXCO and General Assembly in Spring 2015

- Official launch and start of scientific activities in Spring 2015
Questionnaire for the EERA JP on ESI

The scope of the questionnaire:

• Identification of the relevant SPs **in which you wish to participate**

• Evaluation of your **potential contribution** (existing critical mass on ESI of your institution)

• Suggestion of **additional research areas**

• Declaration of **your availability** (in terms of time and responsibility) in the **drafting phase** and/or in **coordination activities** (Sub-programmes Coordinators or Tasks leaders)
## Information requested

For your organization, the following information are required:

<table>
<thead>
<tr>
<th>Name and address of your organisation</th>
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<tbody>
<tr>
<td>Contact person within your organisation (name, position and email)</td>
</tr>
<tr>
<td>Keywords for your research areas of interest for this EERA Joint Programme</td>
</tr>
<tr>
<td>The total py/y that your organisation wish to commit to this EERA Joint Programme (the sum of py/y committed to the proposed SPs and extra)</td>
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<tr>
<td>Your organisations profile (optional)</td>
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<td>[If you can provide a short standard description of your organisations profile (5-10 lines), it will assist the EERA secretariat in getting an overview of the participating organisations]</td>
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Information requested

For each Sub-Programme, the following information are required:

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<tr>
<th>Information</th>
<th>Requirement</th>
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<tbody>
<tr>
<td>Total staff in your organisation with substantial activities in this field</td>
<td>x (py/y)</td>
</tr>
<tr>
<td>Potential staff to participate in the SP</td>
<td>x (py/y)</td>
</tr>
<tr>
<td>Availability to actively contribute to the drafting of the activities of the SP</td>
<td>Yes (Name) / No</td>
</tr>
<tr>
<td>Availability to have a leading role in the management of SP activities (SP coordinator / task leader)</td>
<td>Yes (Name) / No</td>
</tr>
<tr>
<td>Recent and ongoing research projects in the field, and top three scientific publications</td>
<td></td>
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<tr>
<td>Other research areas that could potentially be addressed in this sub-programme which your institution would like to contribute with/to? Please outline briefly below (few sentences and/or keywords)</td>
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We are waiting for your inputs !!!

• The deadline for returning the questionnaire to the EERA secretariat is Monday October 20th, 2014.

• The completed questionnaire should be send to EERA secretariat members:
  - Guillaume Milot: guillaume.milot@cea.fr
  - Maria Holopainen: maria.holopainen@vtt.fi