

## **Plenary Keynote: Henrik Lund**

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### **New insights into Smart Energy Systems – Theory, Concepts and Applications**

#### **Abstract**

This presentation includes new insights into the concept, theory, and application of smart energy systems. The concept was introduced in 2012 and shortly after received a scientific definition. As opposed to, for instance, the smart grid concept, which puts a sole focus on the electricity sector, smart energy systems include the entire energy system in its approach to identifying suitable pathways to the green transition.

Based on the 3<sup>rd</sup> edition of “Renewable Energy Systems”, a theory of two smart energy systems hypotheses has been formulated. First, that one must take a holistic and cross-sectoral smart energy system’s approach to be able to identify the best solutions for an affordable and reliable transition of the energy system into a carbon neutral society. Second, that subsector studies (no matter if they consider the role of a specific technology or the role of a region or country) should aim at identifying the role to play in the context of the overall system transition rather than aim at decarbonising the sub-sector on its own.

The concept and theory have been applied to the analysis of the need for energy storage and electricity balancing in a future climate-neutral society. In five Smart Energy System Integration Levels (SESIL), progressing from a sole electricity sector focus to a fully

integrated system of electricity, heating, cooling, industry, transport, and materials, optimal investments in storage and resulting levels of curtailment are identified. It is illustrated how an overall least-cost solution is only identified in a fully integrated smart energy system, with affordable types of energy storage and little curtailment that cannot be found in a sole electricity sector approach.