

# Opportunities in future sustainable energy systems

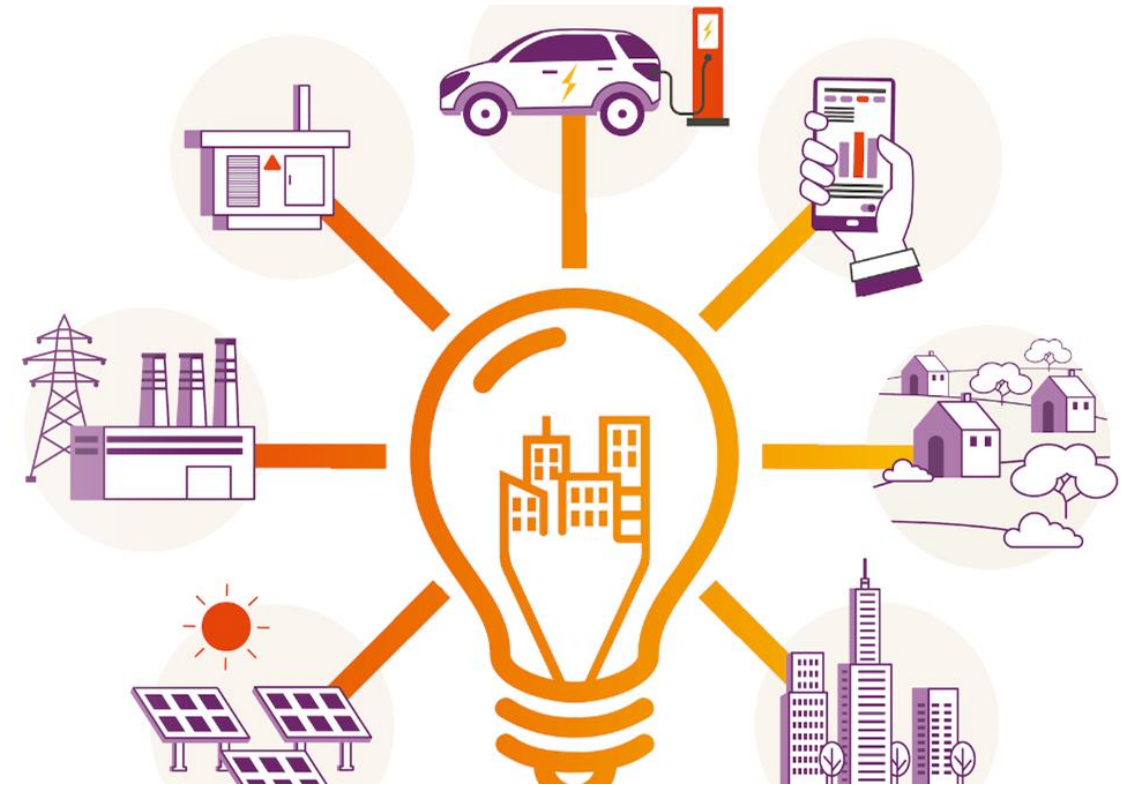
**Dr. habil. Gábor Pintér**

[pinter.gabor@pen.uni-pannon.hu](mailto:pinter.gabor@pen.uni-pannon.hu)

University of Pannonia Nagykanizsa  
University Center for Circular Economy  
Renewable Energy Research Group

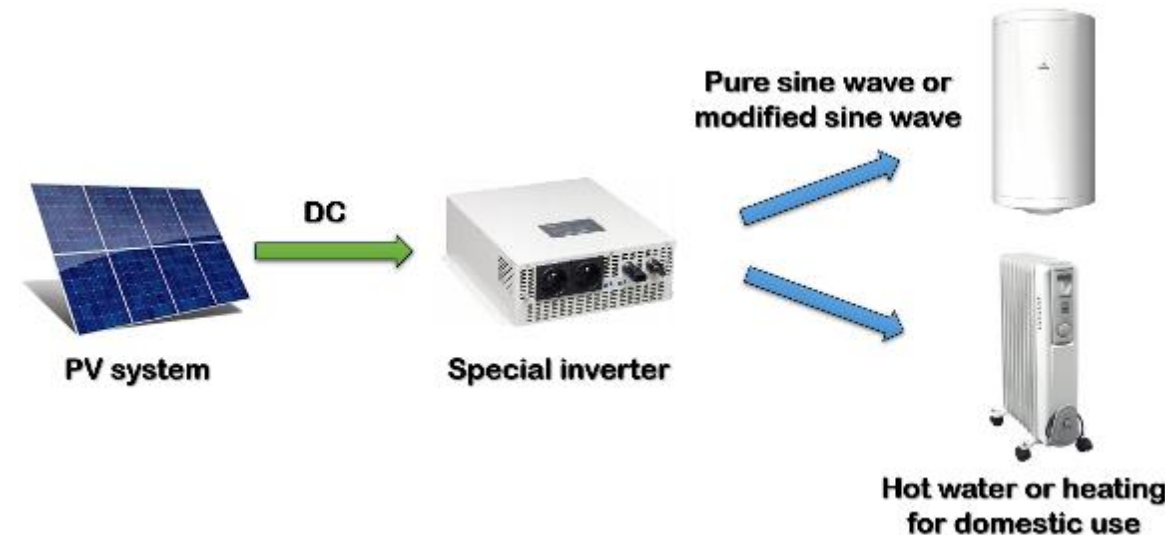
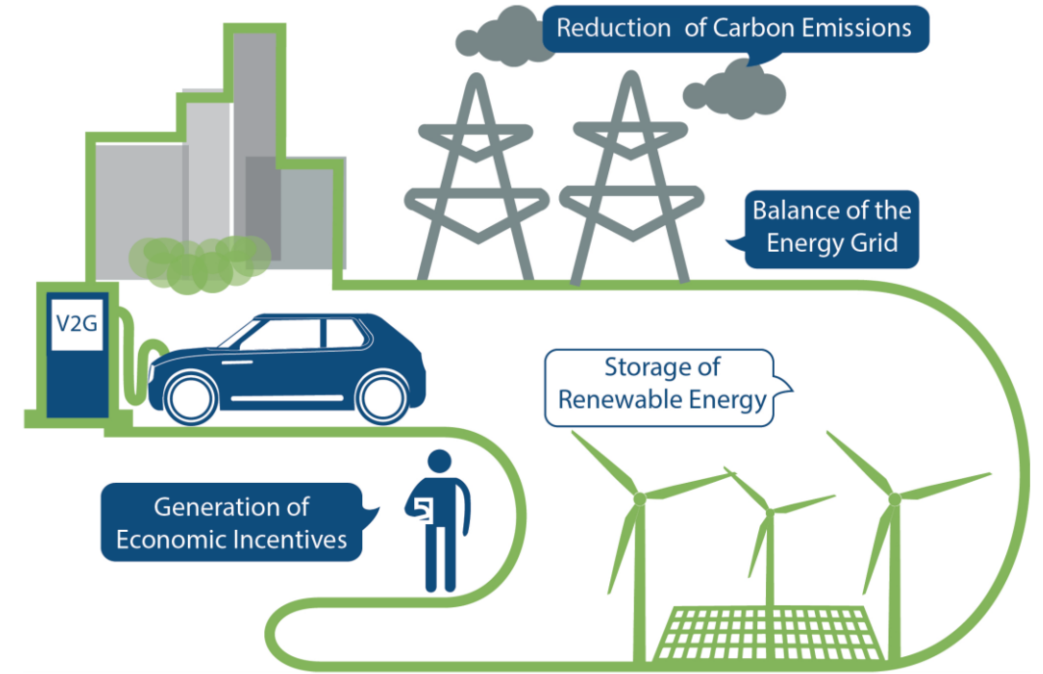
# Significance of the topic

- the increasingly important role of **citizens' active participation and energy communities** in the sustainable energy systems of the future
  - they are key to increasing the efficiency of energy regulation mechanisms
  - enable flexible management of energy demand
  - contribute to system stability



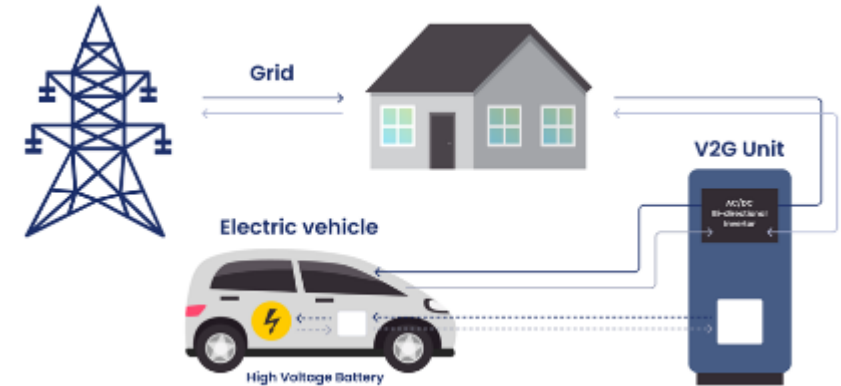
# Significance of the topic

- **the role of grid-connected electric vehicles** in balancing electricity production and consumption in sustainable energy systems of the future
  - **vehicle-to-grid (V2G)**
  - **boat-to-grid (B2G)** technologies
- **the role of domestic heat storage devices** (if appropriate monitoring and control systems are in place)
  - meeting downward regulation needs
  - efficient utilization of excess energy
  - storage of excess energy
- **All the above reduce load on the network.**



# Potential areas of project cooperation

- **V2G energy storage options** and utilization potential
- **V2G residents' potential** to increase the efficiency of energy regulation mechanisms
- **B2G energy storage options** and utilization potential
- **optimization possibilities of VRE energy production** using B2G concept
- development of **patents**



# Potential areas of project cooperation



- ***Vehicle-chargers combined with storage facilities (flywheel + battery)***
- **PV-based residential thermal energy storage**
- **optimization of PV power generation by power-to-hydrogen process**
- **VRE integration: the role of green hydrogen in ensuring grid stability and flexibility**
- **grid electricity savings using hybrid photovoltaic systems with energy storage**
- **reliability of PV power generation scheduling: regulation challenges and responses**
- **research into energy storage options by hydrogen methanisation**
- **potential energy solutions by sector coupling for and/or by residents and energy communities**

# Optimization of dual-axis solar tracking agrivoltaic systems for crop production



# Agrivoltaic systems

- **solar energy**
    - renewable energy production
  - +
  - **agriculture**
    - shading crops
    - reducing water use
    - increasing the stress tolerance of plants
- ↓
- **more than 100% land use!**



# The importance and potential of solar tracking in agrivoltaic systems

- **more efficient use of solar energy** (especially for dual-axis versions)
  - optimization of solar radiation utilization
  - significant increase in the efficiency of electricity generation
- **creating ideal conditions for plants**
  - considering developmental stages
    - e.g. maximum sunlight in germination and early growth phases
    - later also need for shading
- for all the above, **the following are essential**
  - careful planning of agrivoltaic systems
  - flexible application of sun tracking systems





# Identifying the challenges

- **shortcomings of the control procedures of solar tracking systems** currently on the market
  - continuous solar tracking from dawn to dusk
  - not taking into account the needs of plants at different stages of development
- the need for the **development of new intelligent control systems**
  - efficient operation of solar tracking systems
  - ensuring maximum yield from crop production
    - dynamic adaptation to plants' need for sunlight
    - reducing the negative effects of shading in critical growth phases
    - shading in case of excessively solar radiation



# Development project proposal

- **development of an innovative, hitherto non-existent control procedure and mobile demonstration solution** that
  - is able to dynamically adapt the operation of biaxial (and/or uniaxial) solar tracking photovoltaic systems to the development stages of different plants
    - takes into account the need to provide maximum sunlight during the germination and early growth phases of plants
    - provides optimal shading in later stages of development, which reduces water use and increases the stress tolerance of plants
- **innovative, proof of concept demonstration solution**
  - a practical example of the integration of agrivoltaic systems and advanced dual-axis solar tracking control technologies in crop production



# And several other areas of research

Integrating variable renewable energy into electricity systems: grid balancing, power generation scheduling, energy storage integration

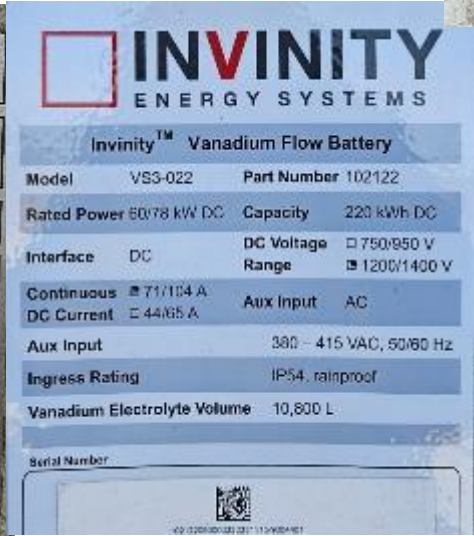
Design, establishing and operation of photovoltaic (PV) power plants with energy storage technologies

Complex energy analysis of different types of battery energy storage and variable renewable energy systems

Economic analyses of the spread of renewable energy and energy storage technologies

Energy policies, communicating energy policies

# Our existing infrastructure



## Our pilot batteries:

- VRFB (250kW / 1,5MWh)
- NaS (250kW / 1,5MWh)





**Thank you for your attention!**