SPECIAL TRACK
SEA: Smart Energy Applications

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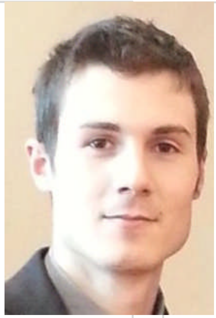
Proposers

- **Prof. Daniele Jahier Pagliari**



  - Assistant Professor of Computer Eng. at Politecnico di Torino
  - Research Interests:
    - Electronic Design Automation
    - Digital Systems
    - Efficient Machine Learning
  - Author of ≈ 40 papers on these subjects

Prof. Massimo Poncino

  - Full Professor of Computer Eng. at Politecnico di Torino
  - Research Interests:
    - Digital systems
    - Energy systems
    - Electronic Design Automation
  - Author of 400+ papers on these subjects
  - Fellow of the IEEE

SEA: Smart Energy Applications

- Adding smartness to energy systems relies on a set of enabling technologies to achieve an intelligent and efficient use of energy that enable a set of smart "services".
  - New materials and devicesfor efficient generation, transportation and storage of energy
  - fast and reliable connectivity to enable interaction among different parts of a grid, possibly using an Internet-of-things(IoT) paradigm
  - efficient and accurate simulation models and engines to allow early prototyping of these systems,
    - Possibly allowing the concurrent simulation of devices, connectivity and software within the same framework.

SEA: Smart Energy Applications

- Services enabled by these enabling technologies include, just to name a few:
  - real-time monitoring of energy consumption (e.g., through smart meters)
  - energy balancing and management in the grid at the building- or district-level
  - predictive identification of faults due to aging components
  - efficient integration of (possibly distributed) renewable sources
  - …

Smart Energy is *hot*

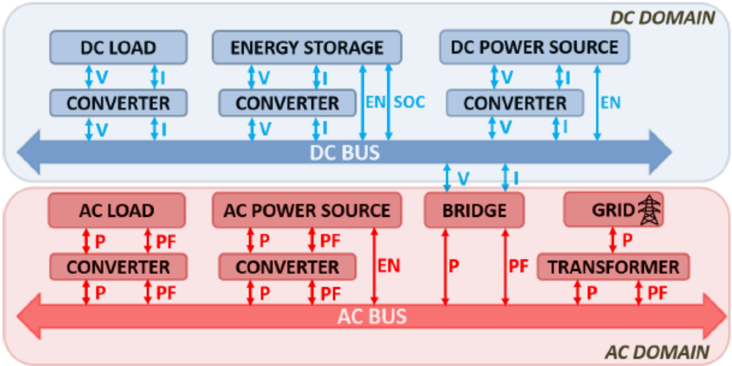
- Top priority in several research programs in the EuropeanUnion (Horizon2020, ECSEL, EPoSS),
  - A natural follow-up ofthe 2015 Paris Agreement, which set an ambitious direction forinvestment into low-carbon innovation.
- A number of measures have been proposed to achieve this goal, mostly with an emphasis on the “green” perspective of energy,
  - E.g., the ’Clean Energy for all Europeans’ package of measures of 2016 which pursues three main goals:
    - energy efficiency
    - leadership of Europe in renewables,
    - a fair deal to consumers

SEA Special Track: contents

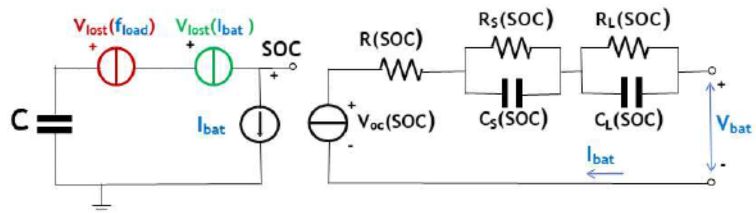
1. **Yukai Chen, Sara Vinco**
   Politecnico di Torino, Italy
   "The importance of Accurate Battery Models for the Power Assessment in Smart Energy System"
2. **Donkyu Baek**
   Chungbuk National University, Korea,
   "Powertrain Modeling and Range Estimation of The Electric Bus"
3. **Sangyoung Park, Andrea Cominola**
   TU Berlin, Germany
   "When Privacy Protection Meets Non-Intrusive Load Monitoring: Trade-off Analysis and Privacy Schemes via Residential Energy Storage"

Paper #1

- This work generalizes a smart energy system as the interaction of four main general modules:
power sources, energy storage, loads, converters.



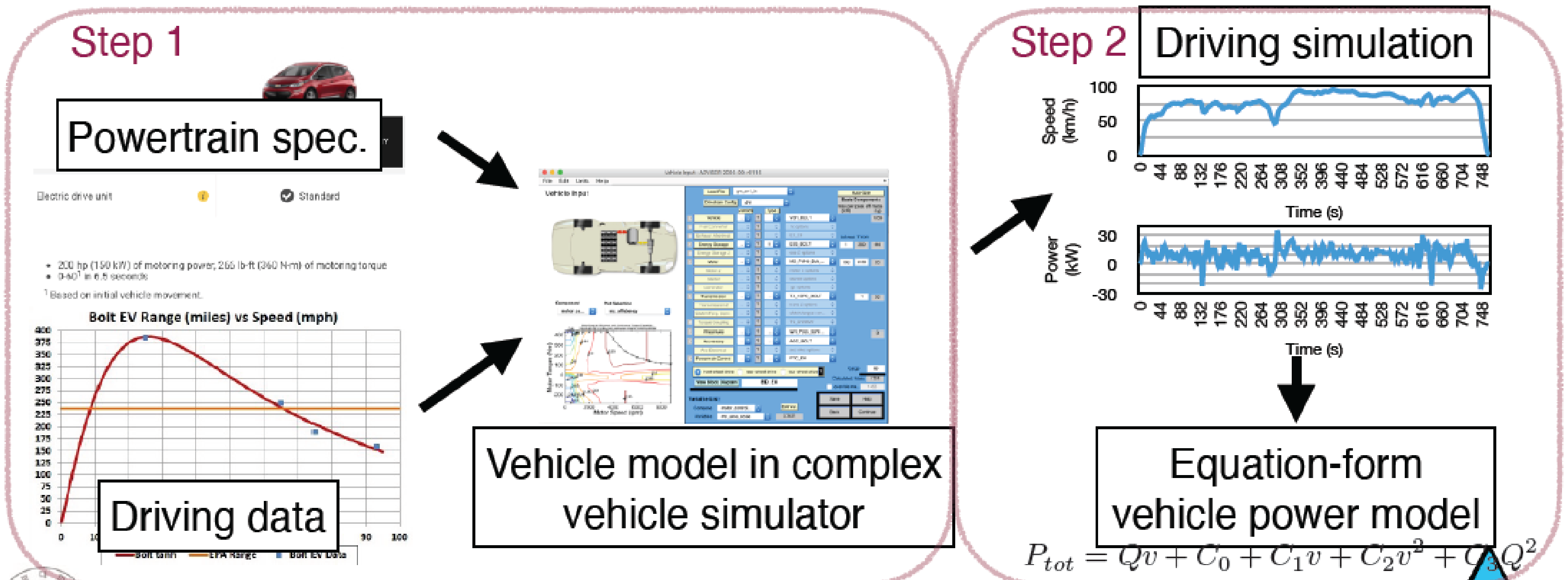
- When the battery acts as the main source of power , there is not a perfect 1:1 match between battery power and load power
- This work adopts an accurate circuit equivalent battery model to achieve a more accurate power assessment.



- Two different scales energy systems are presented:
  - An IoT multi-sensor node (mW scale)
  - A smart house applications (kW scale)

Paper #2

- Fast but accurate electric bus powertrain modeling
  - Step 1: implement vehicle model in complex vehicle simulator
  - Step 2: implement equation-form power model
- Case study 1: power estimation in online
- Case study 2: energy efficiency analysis by battery size



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Paper #3

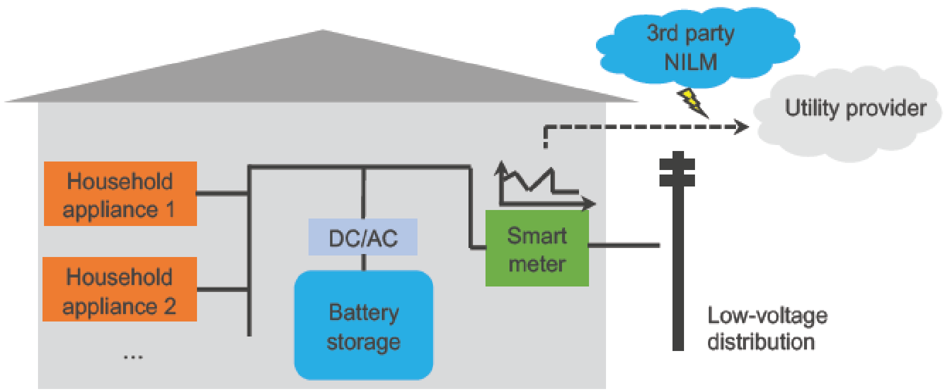
RESEARCH CHALLENGE

Smart meters coupled with **Non-Intrusive Load Monitoring (NILM)** allow to cost-effectively disaggregate household electricity usage in individual appliance usages. But this generate **privacy concerns**: how much control will one have over what is being analyzed (electricity usage behavior)?

RESEARCH CONTRIBUTION

We investigate the cost-effectiveness of the potential usage of a **residential energy storage for privacy protection** against Non-Intrusive Load Monitoring (NILM) algorithms:

- Battery storage can hide the true usage profile. Water-filling hides all privacy information
- Completely flat profile is incompatible with smart grid and requires an excessively large battery size



KEY RESULTS

- Larger number of appliances → slightly less accurate NILM.
- Appl. flattening or water-filling → do not necessarily reduce NILM accuracy and requires big battery capacity.
- Further analysis is required to leverage the trade-off and include variable costs and battery aging.

Perspectives

- Smart Energy encompasses a number of technologies that enable various smart services.
- By optimizing energy **management** (*generation, storage, distribution, consumption*) at different scales, these services can contribute to the objectives of clean energy and sustainability.
- Papers in this Special Track have featured both with technologies and services as a sample of the wide scope of the research topics under the “smart energy” umbrella