# The RAMP project for demand simulation.

## From remote villages to mobility and charging time series of electric vehicles across European countries

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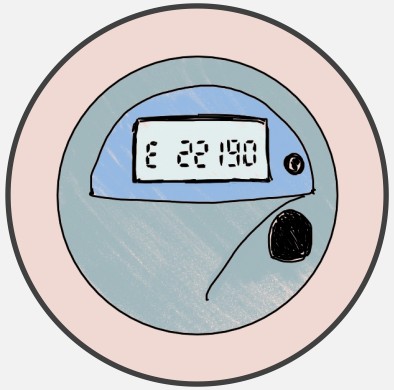
# Part A.

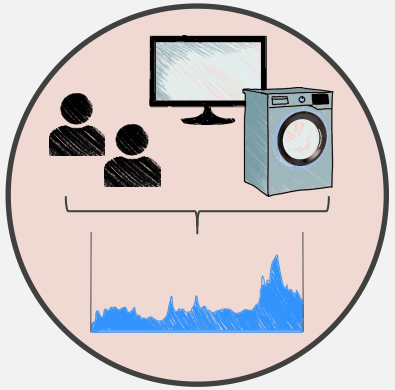
Simulating demand based on partial, uncertain data

# The origins.
## Energy access in off-grid areas

Knowledge of the **energy demand** is critical to design any energy system.

- Often, demand information simply exists in the form of **metered data**



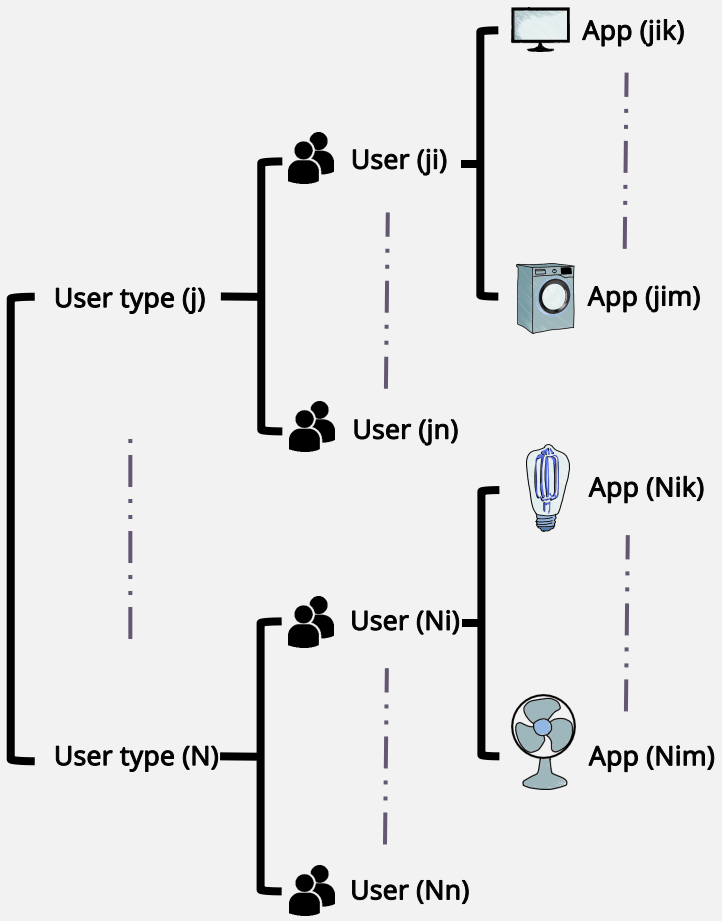


- If not, it can be **simulated** based on user activity and appliances data

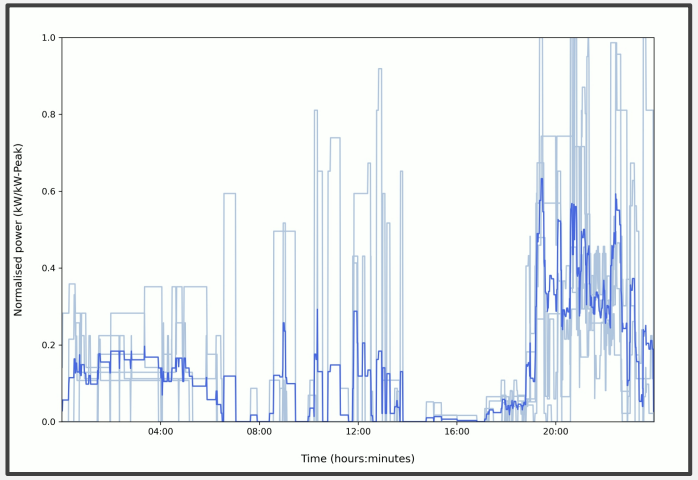
But what if a community **has never had (proper) access to energy** ?

A purely **stochastic approach** allows handling partial, uncertain data

# The origins.
## Energy access in off-grid areas




RAMP
Stochastic multi-energy load profiles

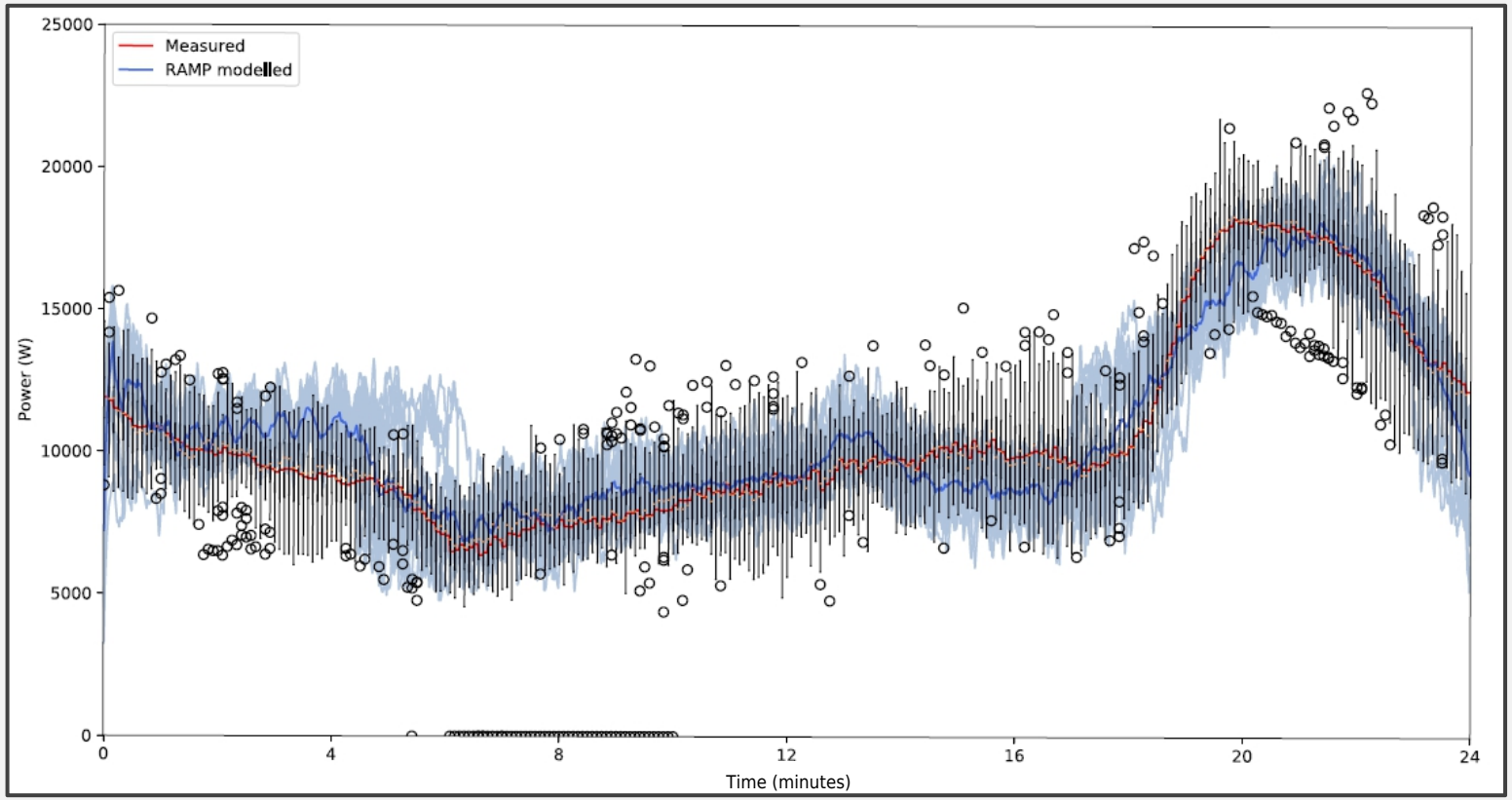



Lombardi, Balderrama, Quoilin, Colombo. *Energy.* 2019. 10.1016/j.energy.2019.04.097

# The origins.

## Energy access in off-grid areas

Solid results from the **validation** against data from a **microgrid in Bolivia**




Lombardi, Balderrama, Quoilin, Colombo. *Energy.* 2019. 10.1016/j.energy.2019.04.097

# The evolution.

Cooking, heating, mobility and more

Jun 2019

Feb 2020

Jul 2020

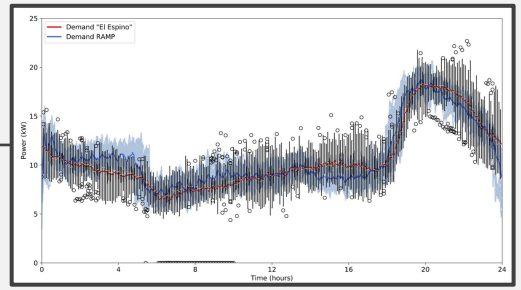
Feb 2021

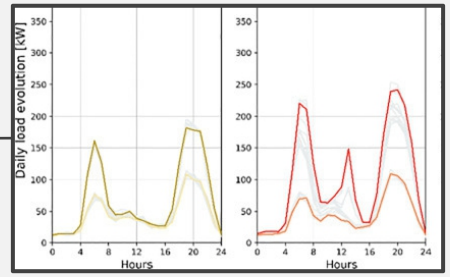
Oct 2021

UNIVERSIDAD MAYOR DE SAN SIMÓN

POLITECNICO MILANO 1863

LIÈGE université




KTH VETENSKAP OCH KONST

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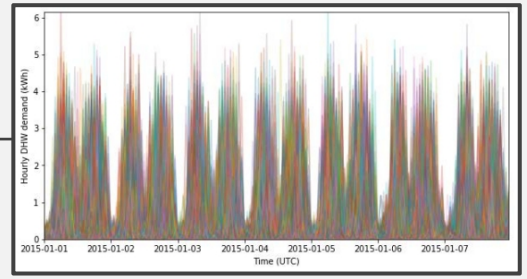
UNIVERSITÀ DEGLI STUDI FIRENZE

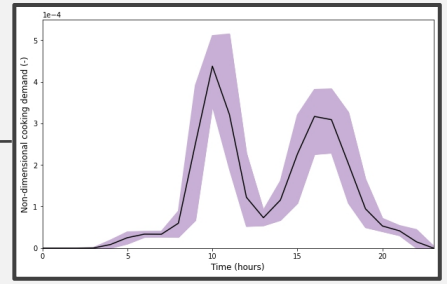
REINER LEMOINE INSTITUT

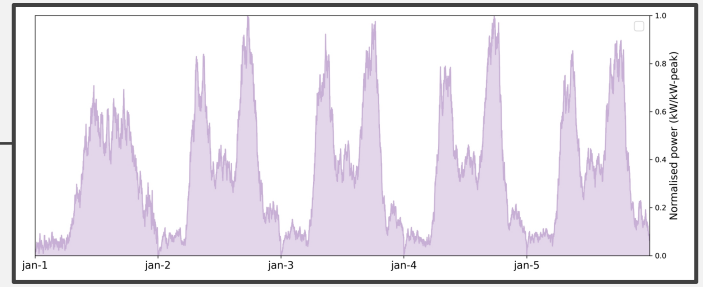
ETH zürich

University of BRISTOL




KU LEUVEN

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# Part B.
Mobility and charging time series of electric vehicles

# RAMP-mobility.
## Do we even need it?

With application to Europe, **why not** using **data-intensive approaches**?

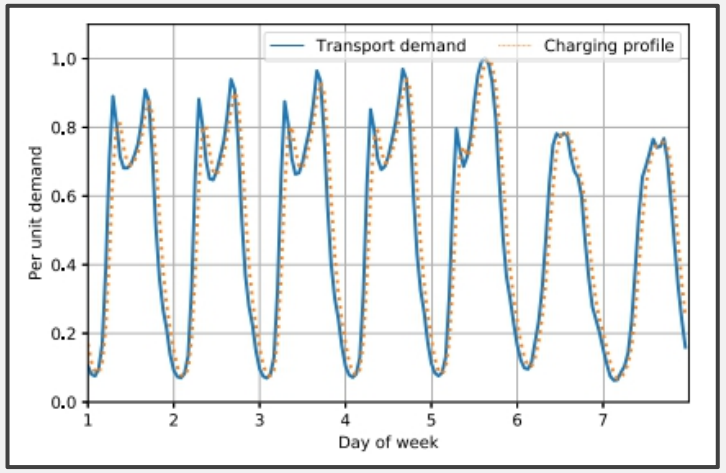



Figure:
Brown et al., 2018.10.1016/j.energy.2018.06.222

- **German higway mobility data** applied uniformly to all of Europe.
- Charging assumed as load-following with a lag

- **Extremely detailed** user-behaviour **data for Germany**
- For most countries, not repeatable

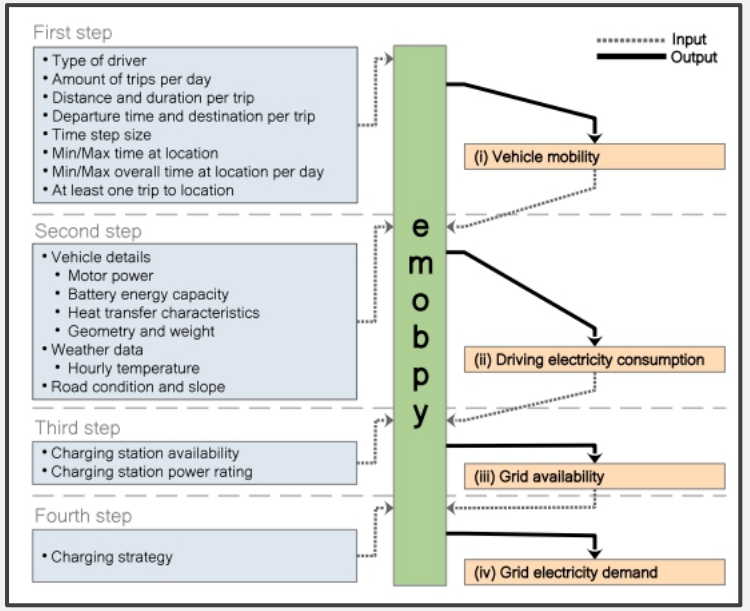
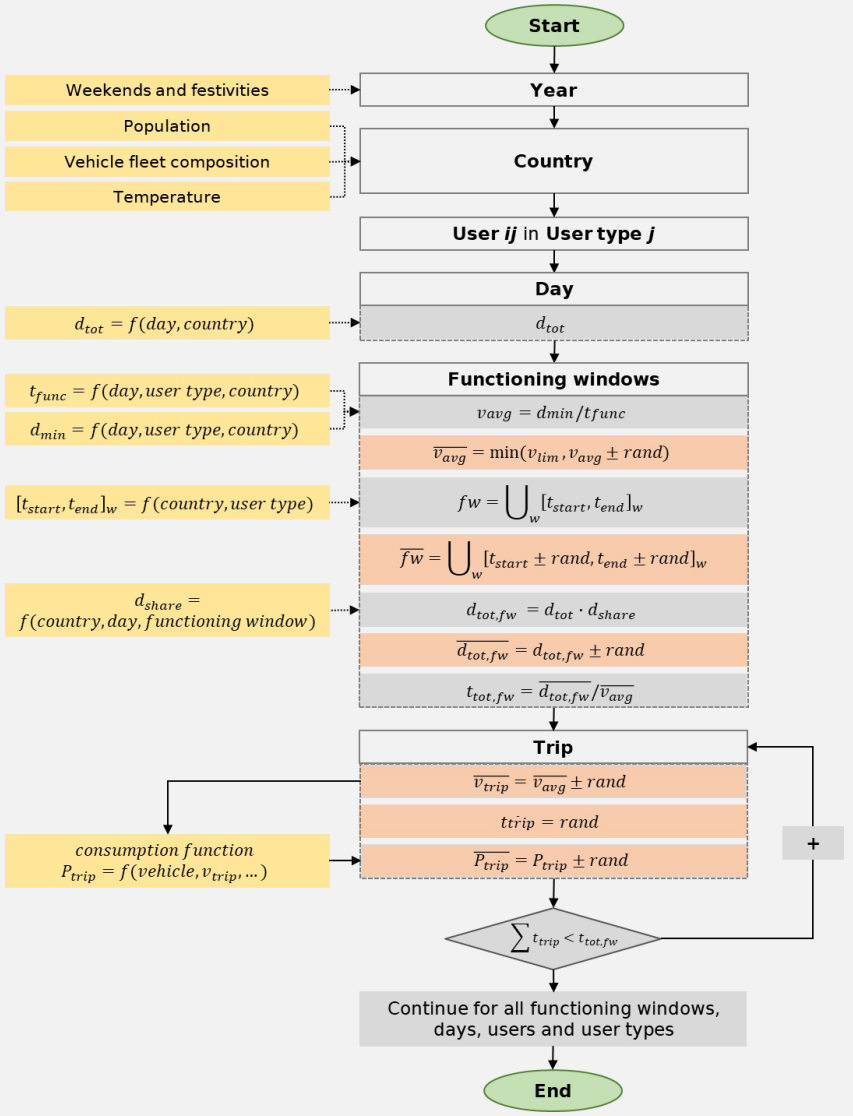
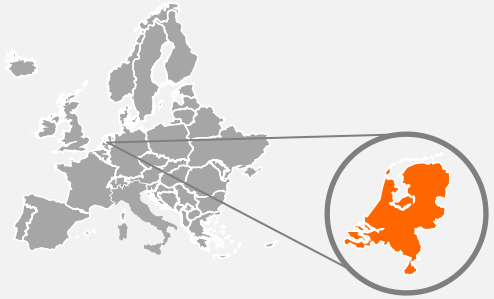


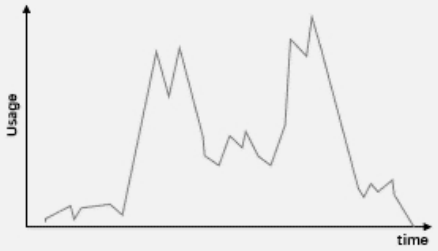

Figure:
Gaete-Morales et al., 2021. 10.1038/s41597-021-00932-9

The **original RAMP software engine** with the addition of mobility features

# RAMP-mobility.
## Mobility module



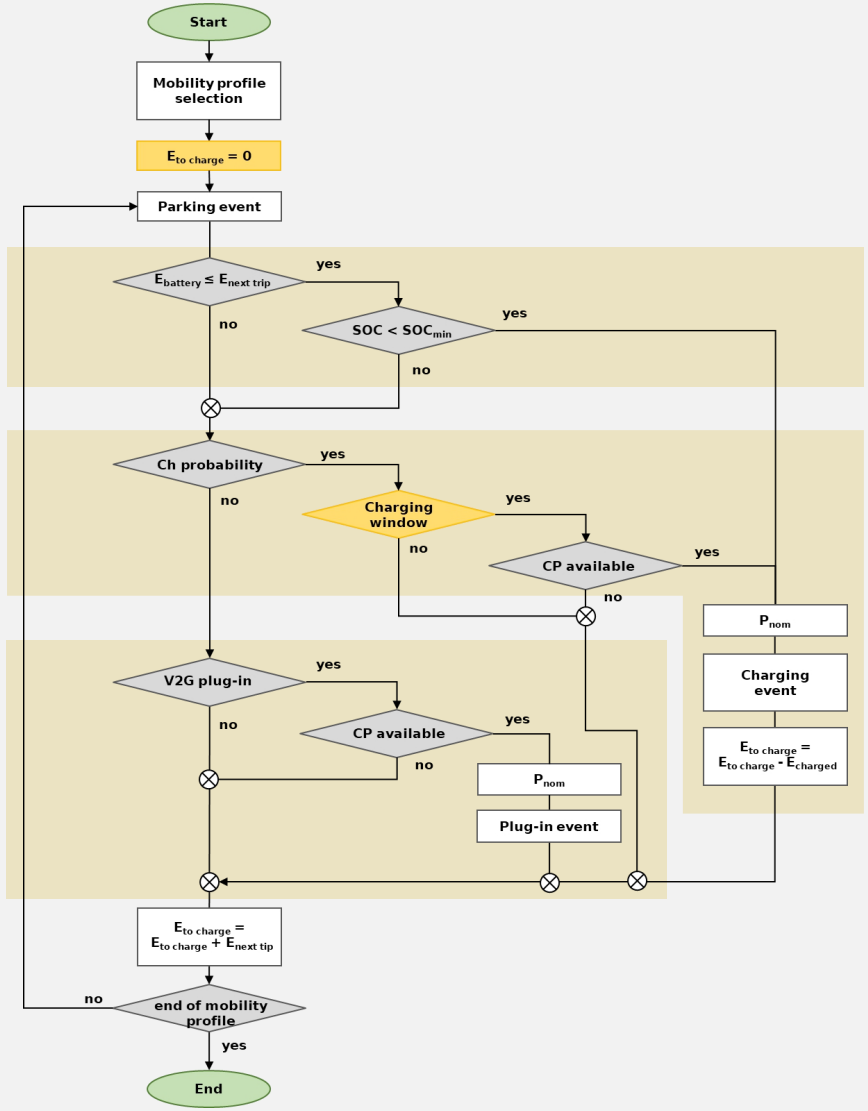



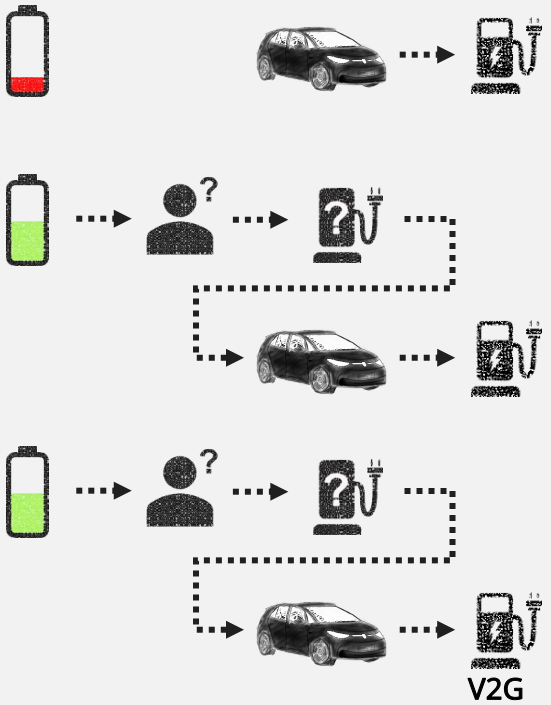


Mangipinto, Lombardi[CA], Sanvito, Pavicevic, Quoilin, Colombo. *App. En.*. 2022. 10.1016/j.apenergy.2022.118676

An **entirely new** stochastic simulation **on top of the mobility patterns**

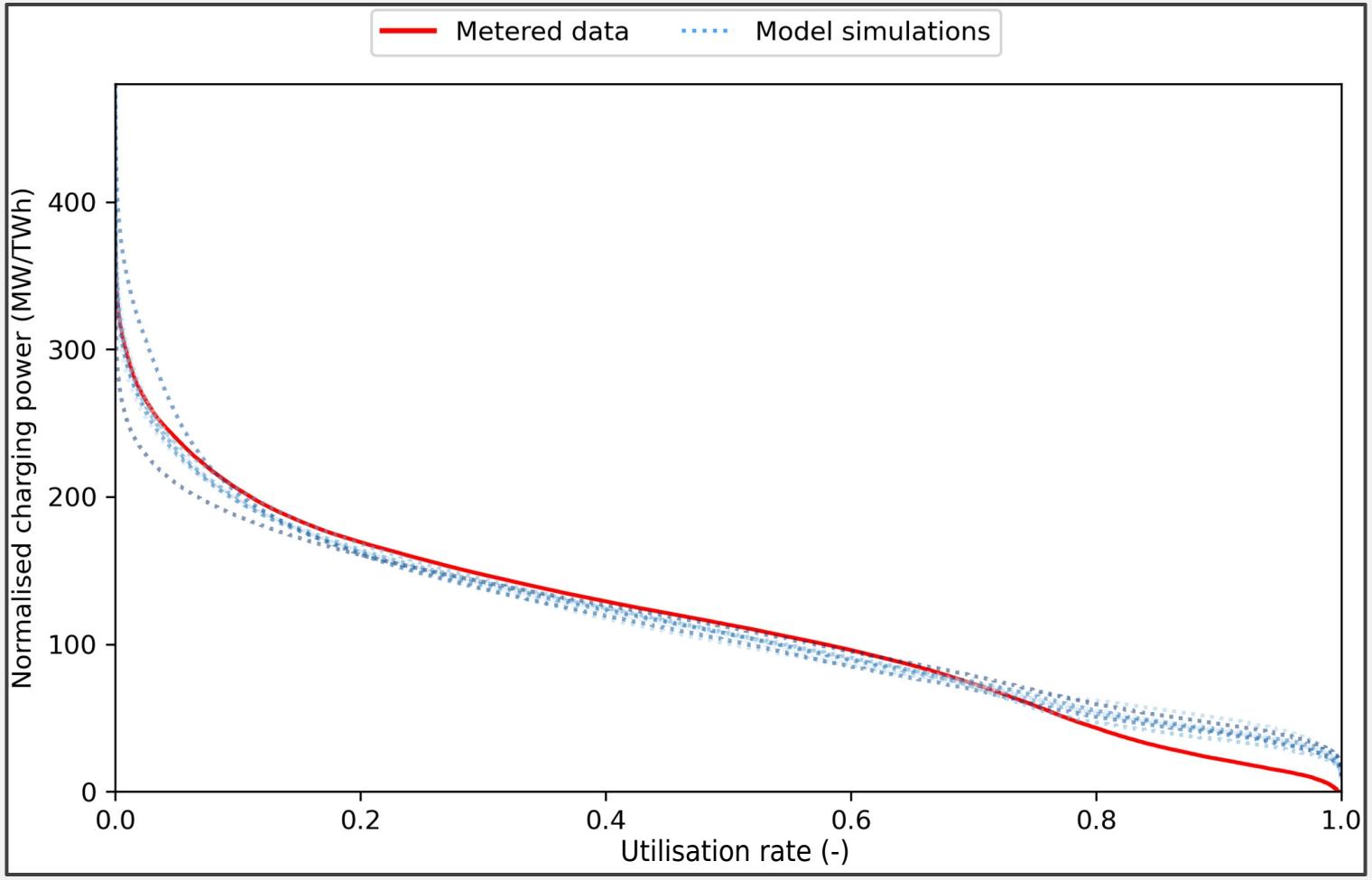
# RAMP-mobility.
## Charging module




Mangipinto, Lombardi[CA], Sanvito, Pavicevic, Quoilin, Colombo. *App. En.*. 2022. 10.1016/j.apenergy.2022.118676

# RAMP-mobility.
## Validation against data from ElaadNL

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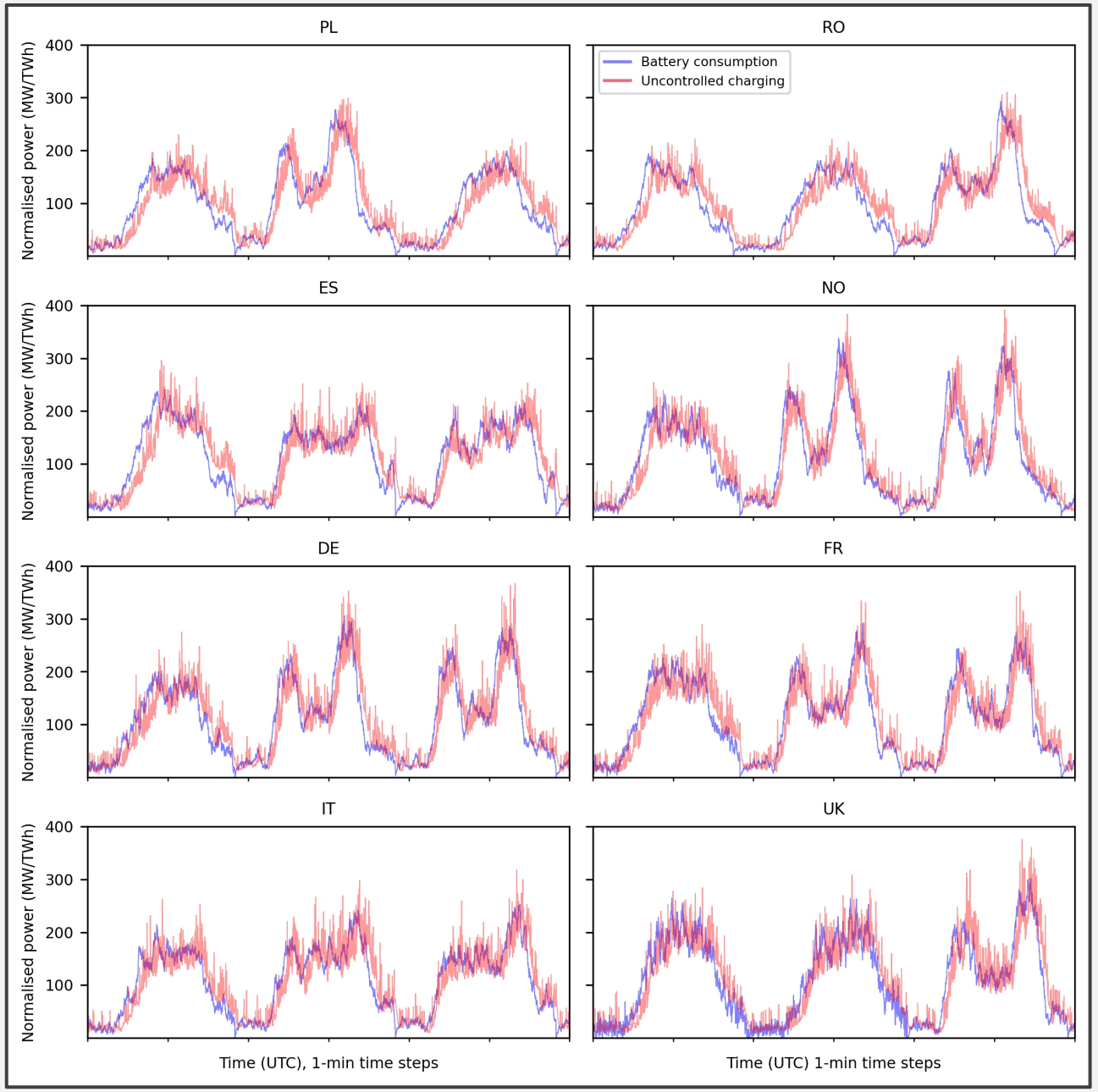
# EVs in Europe.
## Uncontrolled deployment

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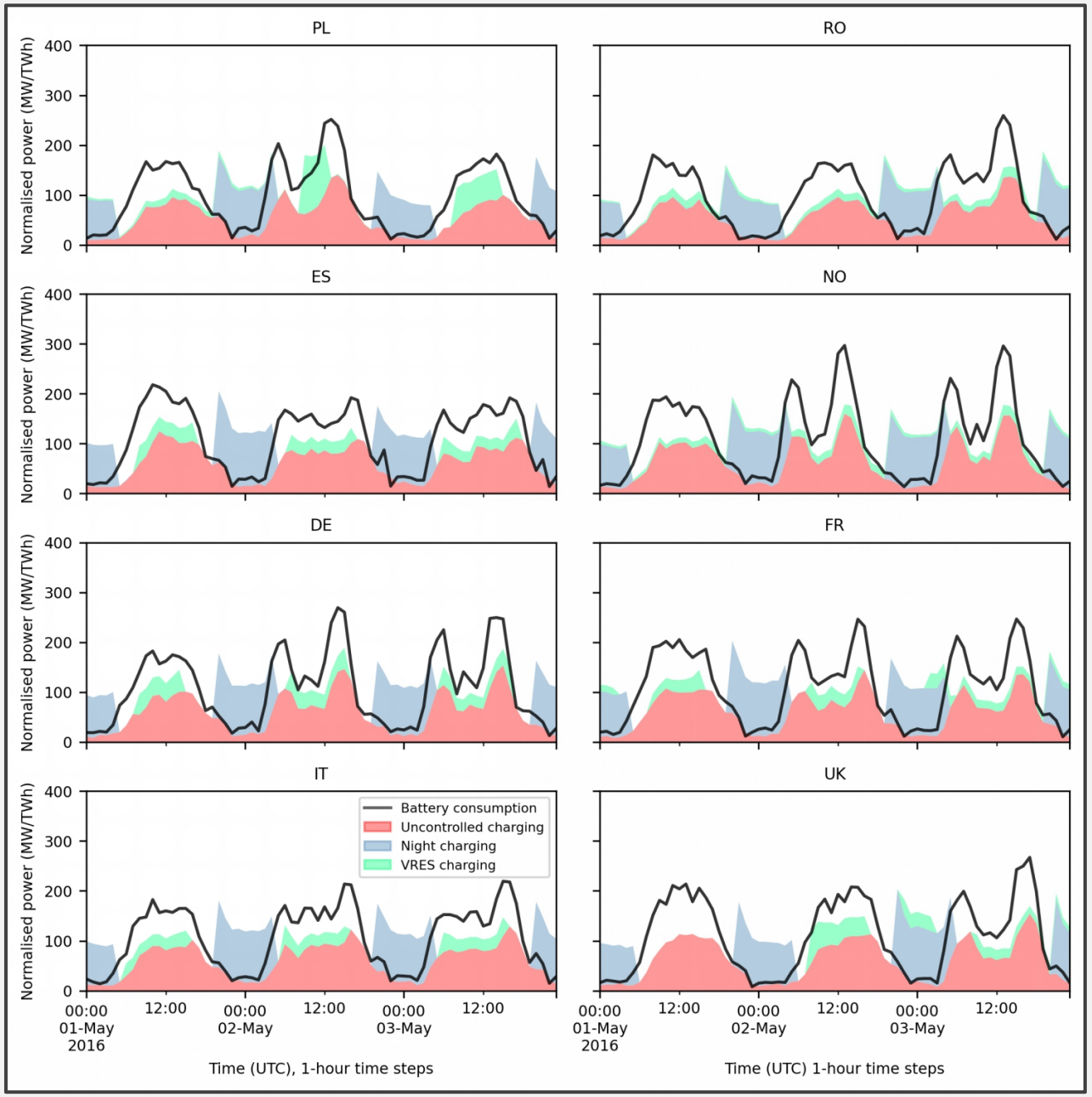
# EVs in Europe.

## Partial uptake of smart charging

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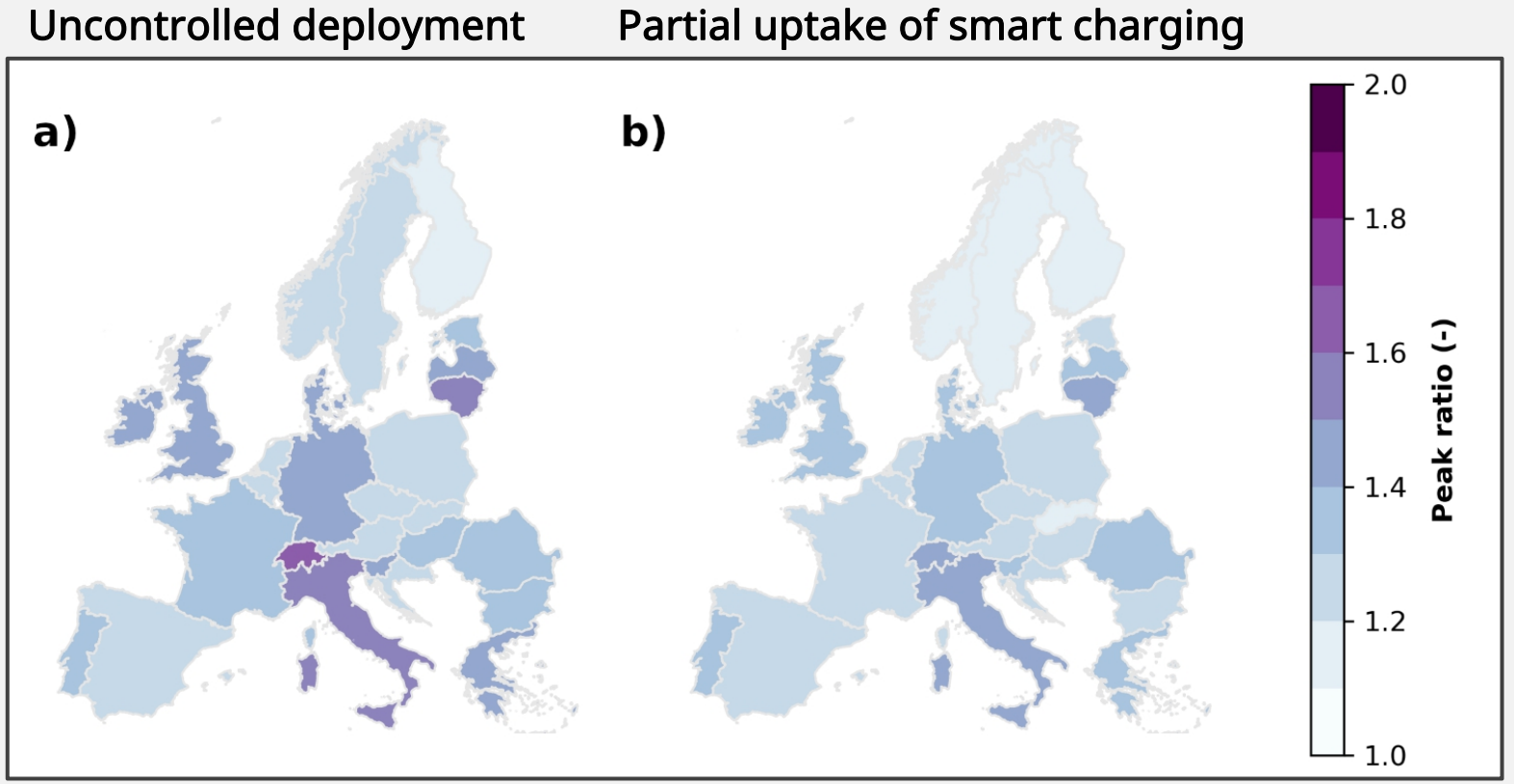
# EVs in Europe.

## Impact on peak electricity demand

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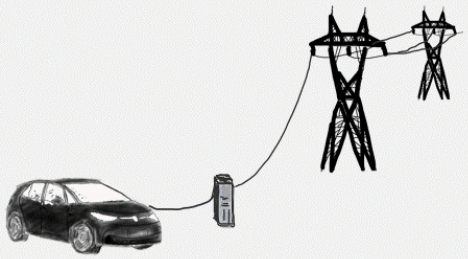
# EVs in Europe.
## Conclusions

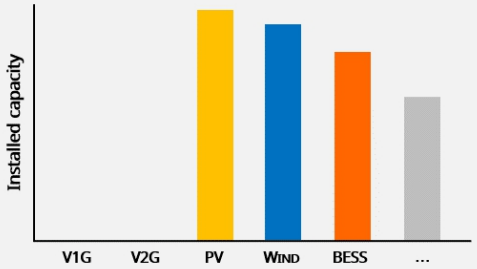
- Mobility and charging time series **differ substantially across countries**
- Energy system **optimisation models need** country-specific, weather-explicit mobility and charging input time series
- An **uncontrolled deployment** of electric vehicles would have a **significant impact** on power systems' peak load (36-51%)
- Plausible adoption of **smart charging** would **limit the impact** on peak load to the range 30-41% across countries - for Germany, this means 6 GW less of additional peak load
- **Stronger benefits** expected with **wider adoption of smart charging** and with the even-smarter management of vehicles by **aggregators**

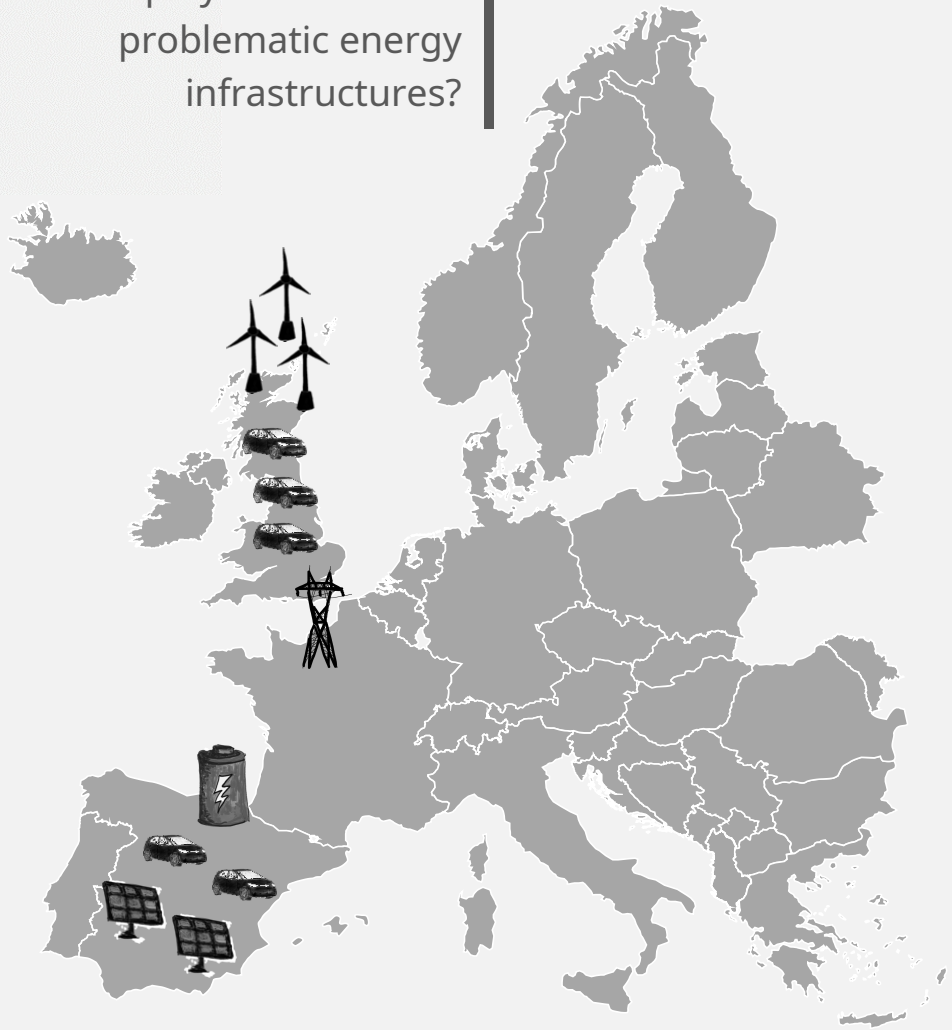
# EVs in Europe.
## Upcoming developments



Are EVs and smart charging mechanisms able to displace the deployment of other problematic energy infrastructures?

V1G and V2G could unleash many alternative energy system configurations



Calliope

# Part C.

Next-gen and multi-institution software development

# How it started.

# How it’s going.

# **Next-gen RAMP.**
## Professional software, website and more

1. Complete **restyling** of the **original RAMP** software
   - clearer, more efficient code structure
   - user-friendly (tabular) input files
   - tests and checks for internal code reliability

2. Dedicated **website** for the RAMP project and for its key sectoral applications (mobility, heat, cooking)

3. Publication of the joint software upgrade in the **Journal of Open Source Software** (JOSS)

# Thank you.
# Questions?

RAMP
Stochastic multi-energy load profiles

- Download, **reuse** and **contribute**! github.com/RAMP-project
- Need **technical support**? Join our Gitter chat: gitter.im/RAMP-project
- Access the **slides** anytime at www.flombardi.org
- Find here all the **methodology details**


F. Lombardi, S. Balderrama, S. Quoilin, E. Colombo, (2019). Generating high-resolution multi-energy load profiles for remote areas with an open-source stochastic model. Energy, 177, 433-444. DOI: 10.1016/j.energy.2019.04.097

A. Mangipinto, F. Lombardi[(CA)], F. D. Sanvito, M. Pavičević, S. Quoilin, E. Colombo, (2022). Impact of mass-scale deployment of electric vehicles and benefits of smart charging across all European countries. Applied Energy, 312, 118676. DOI: 10.1016/j.apenergy.2022.118676

F.D. Sanvito, M. Petris, Villa, E. Colombo, (2022). Improvements of RAMP-mobility framework: Generation of flexibility constraints in EVs and power sector integration applications. 40th International Energy Workshop. URL: tinyurl.com/2p8ep3b8



Thanks to: all RAMP developers and contributors as listed on GitHub