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ENERGY TRANSITION DIALOGUE IN LUXEMBOURG

- LIST's focus on **Sustainable Energy Systems** to Accelerate Energy Transition in Luxembourg

Daniel Koster
Florin Capitanescu
Phuong Nguyen, Phuong.nguyen@list.lu

WHAT POWERS THE WORLD?

How much of the world's electricity is still reliant on coal, oil and gas? Flick the switches to see where the world would go dark without fossil fuels, which countries rely the most on nuclear, and who is using entirely renewable power to keep the lights on.

Fossil Fuels Nuclear Renewables

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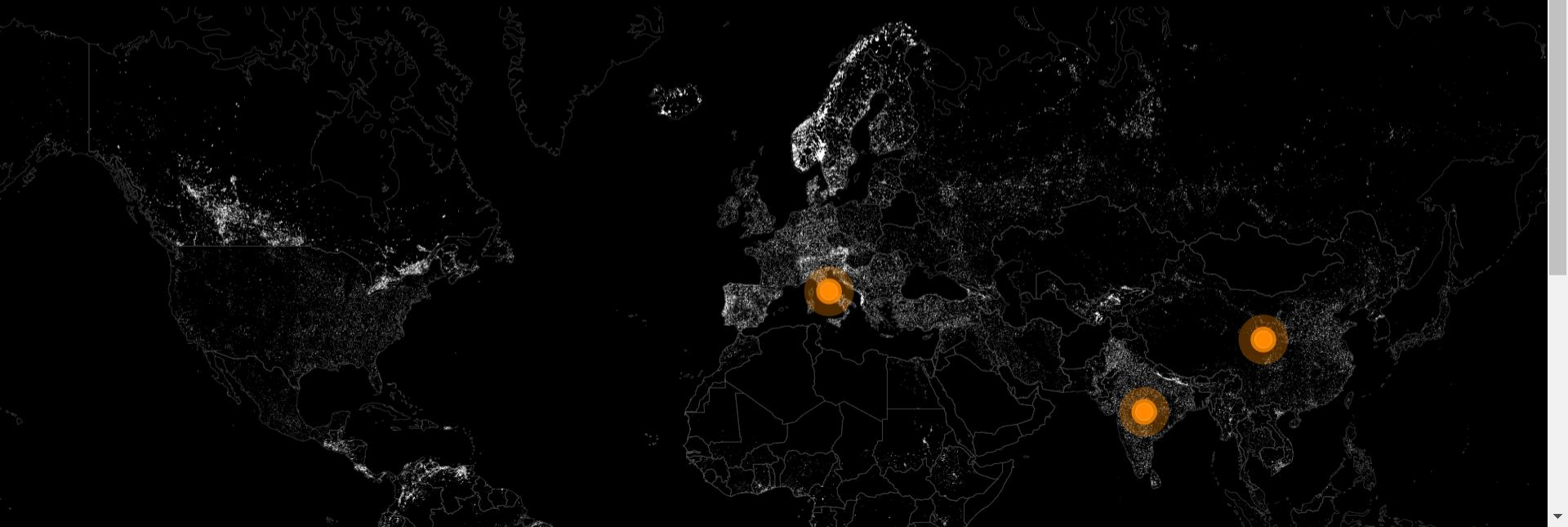
Fossil Fuels Nuclear **Renewables**



SUSTAINABLE ENERGY SYSTEMS

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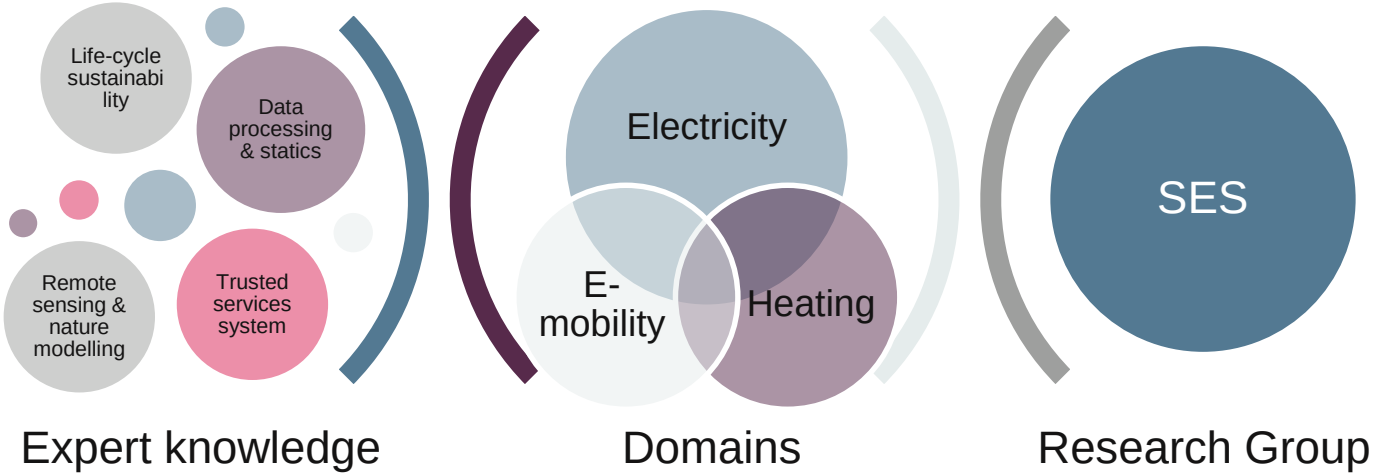
- A newly established group



SUSTAINABLE ENERGY SYSTEMS

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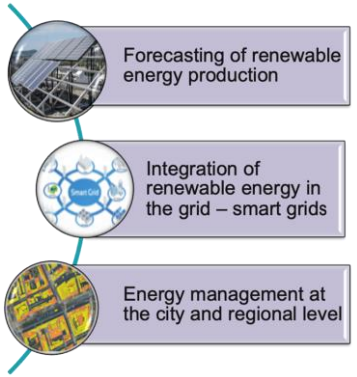
- Mission

Providing **know-how and tools** to support the optimal design and operation of energy systems, with a specific focus on renewable energy, digital and smart grid solutions.

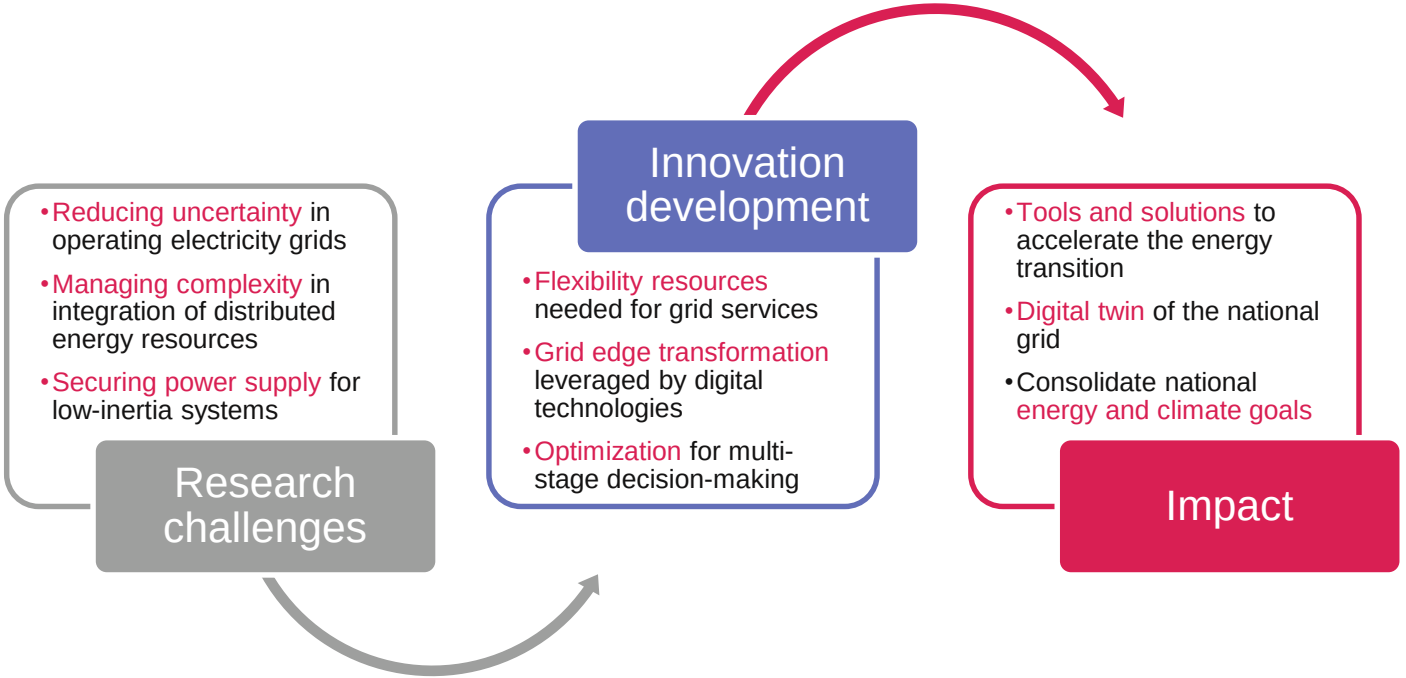


4 FTEs
- 3 PIs
- 1 eng.

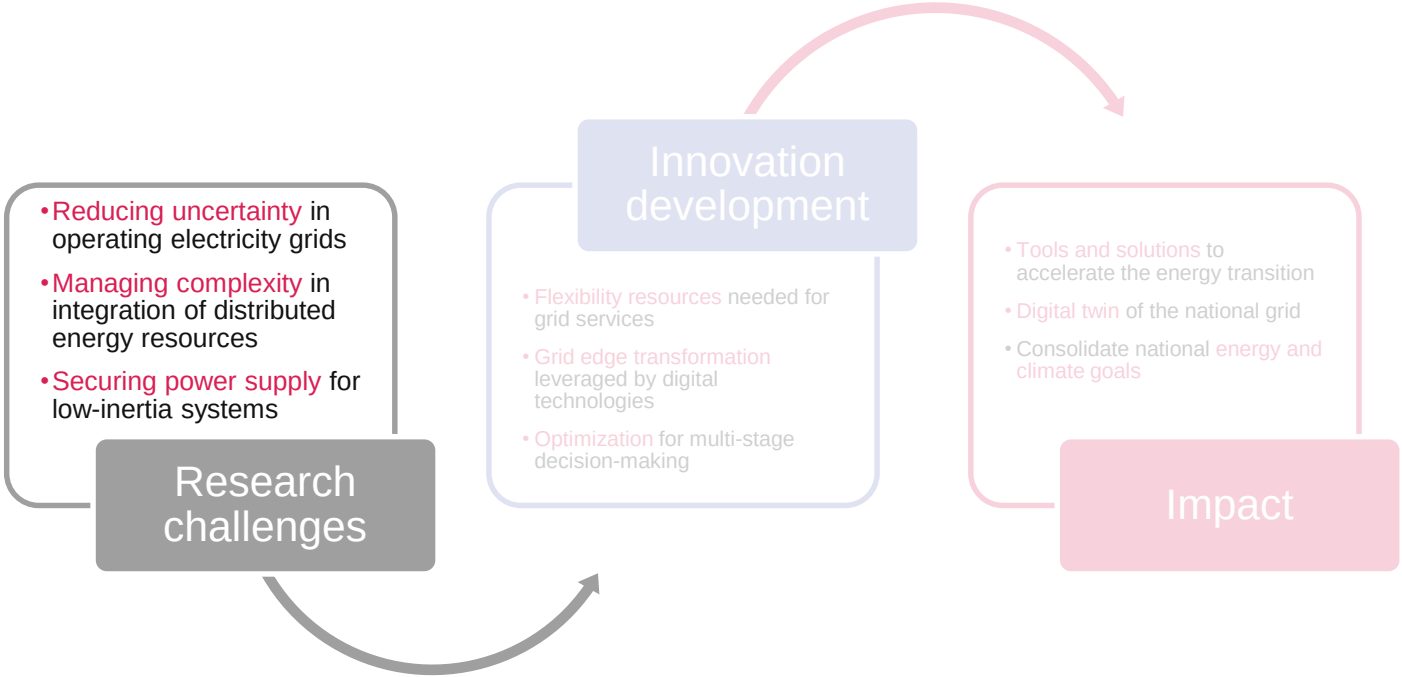
6 FTEs
- 3 PIs
- 1 eng.
- 1 postdoc
- 1PhD

9 FTEs
- 3PIs
- 1 eng.
- 4 postdocs
- 1 PhD

INNOVATION CHAIN



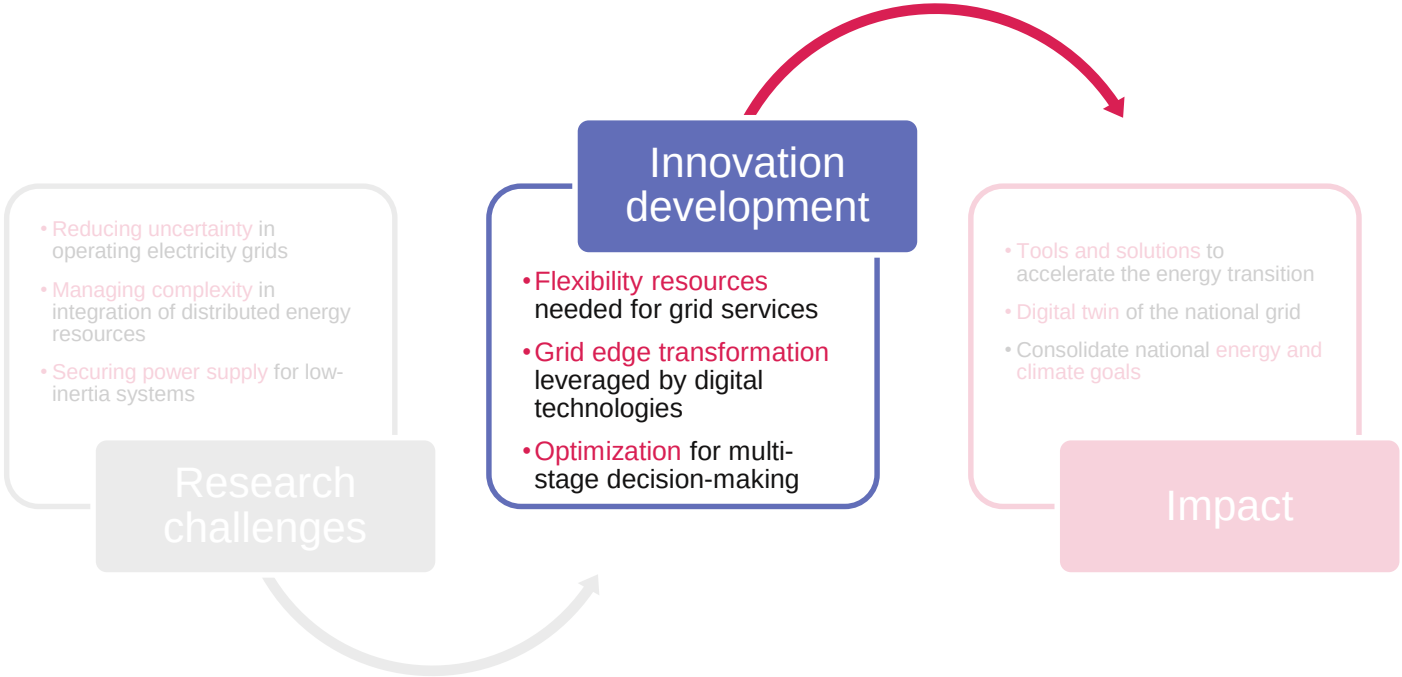
INNOVATION CHAIN



INNOVATION CHAIN

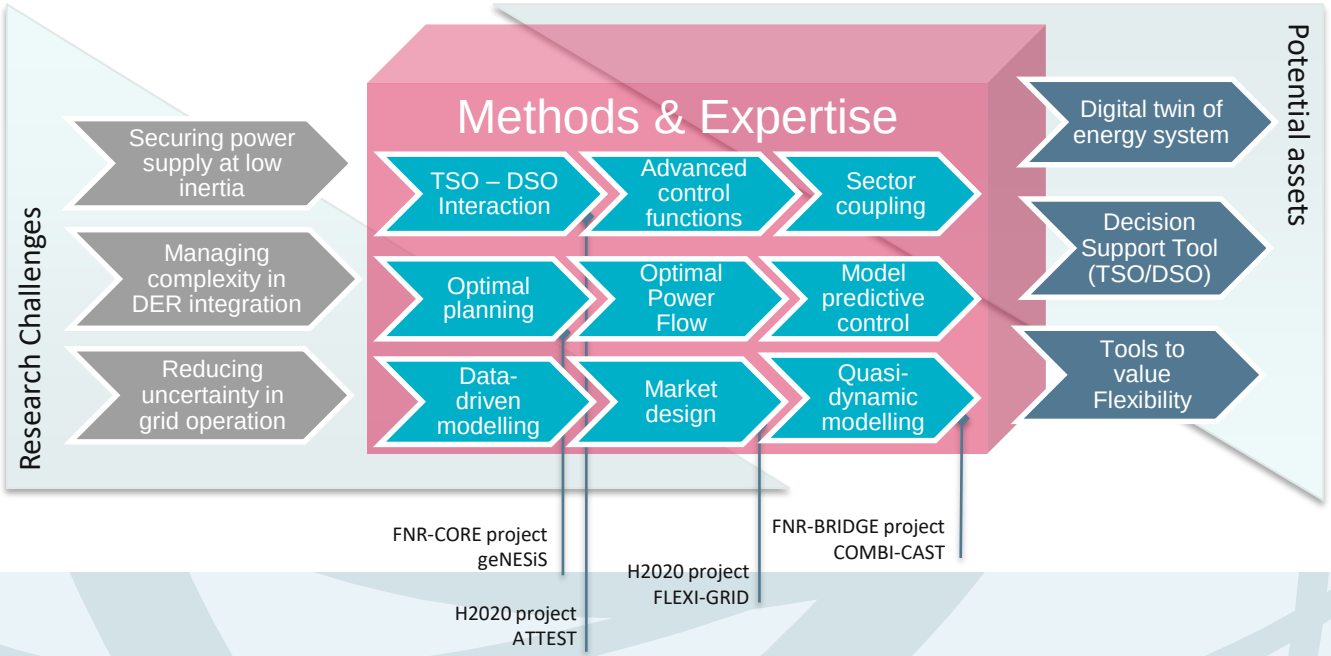
- Research challenges
  - Reducing uncertainty
  - Managing complexity
  - Securing power supply

INNOVATION CHAIN

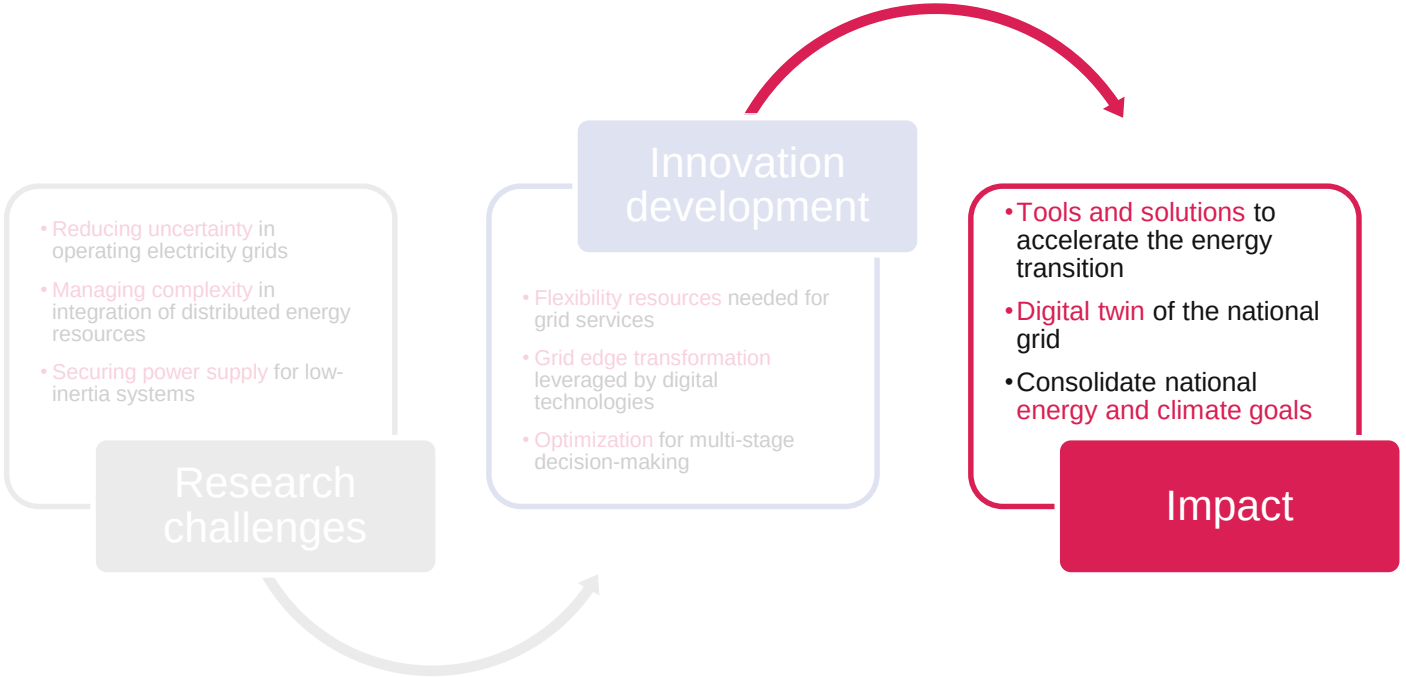


INNOVATION CHAIN

- Impact-driven innovation roadmap



INNOVATION CHAIN



COMPETENCES & ASSETS

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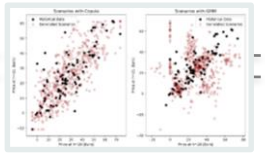
Cyber-physical ecosystem

Advanced data analytics

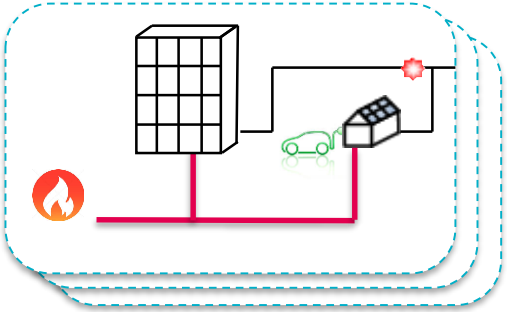


HPC

Forecasting tools

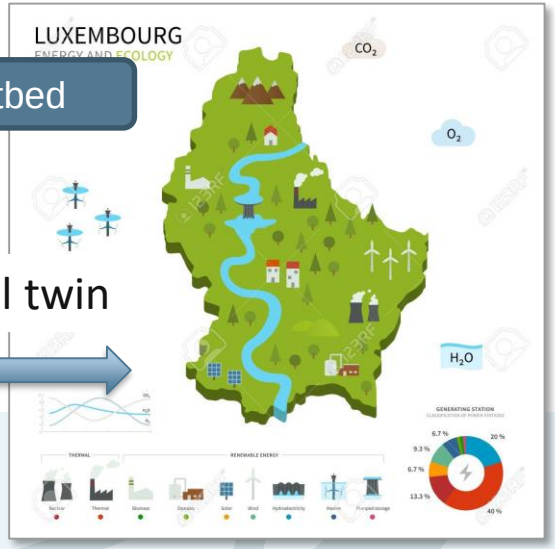
TSO/DSO solutions

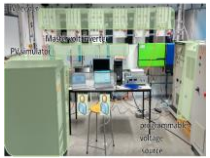
Tool to value flexibility



National testbed

Digital twin





Hardware components

Amplifier

Real-time digital simulator

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LIST's focus on **Sustainable Energy Systems** to Accelerate Energy Transition in Luxembourg

Examples on **PLANNING, FORECASTING** and **GRID-INTEGRATION** of PV-Systems for future smart grid applications

Daniel Koster
Florin Capitanescu
Phuong Nguyen, Phuong.nguyen@list.lu

PHOTOVOLTAIC POTENTIALS BEYOND ROOF-TOPS (SECuRe Project)

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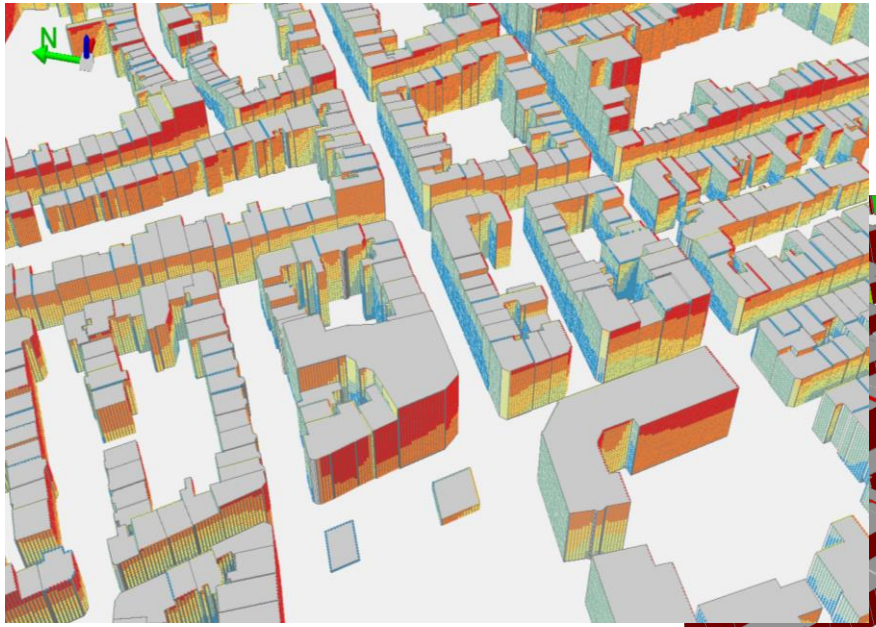
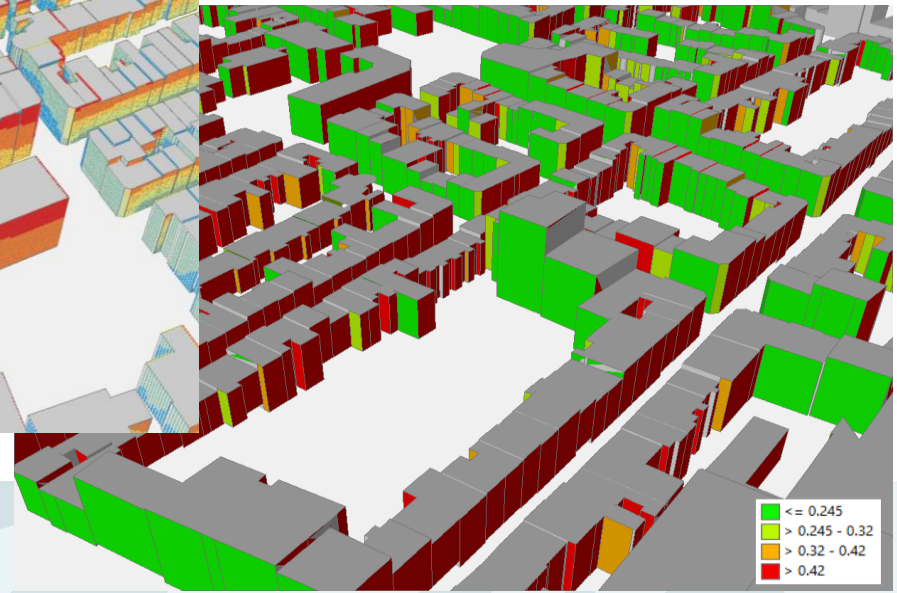
LISTs SES-Group – embedded in multi-disciplinary unit and department



Global Irradiation [kWh/a]

Electricity costs [€/kWh]



FONDATION ENOVOS

sous l'égide de la Fondation de Luxembourg

SECuRe has received funding from the Fondation ENOVOS Luxembourg .

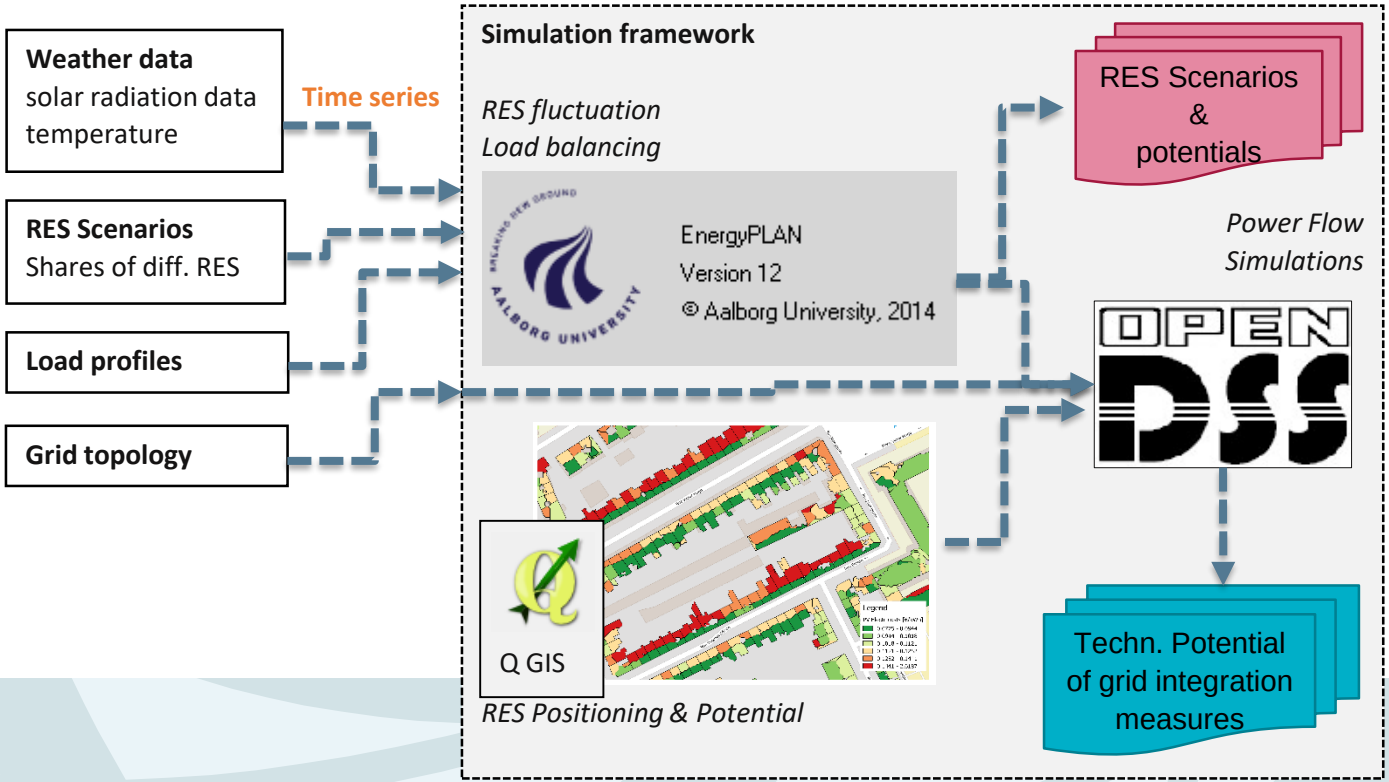
Contact: Ulrich Leopold

Partner & co-funding:

Project Partner:

ma ville, ma vie

TOWARDS ENERGY SCENARIOS AND GRID INTEGRATION STRATEGIES (REInGrid Project)



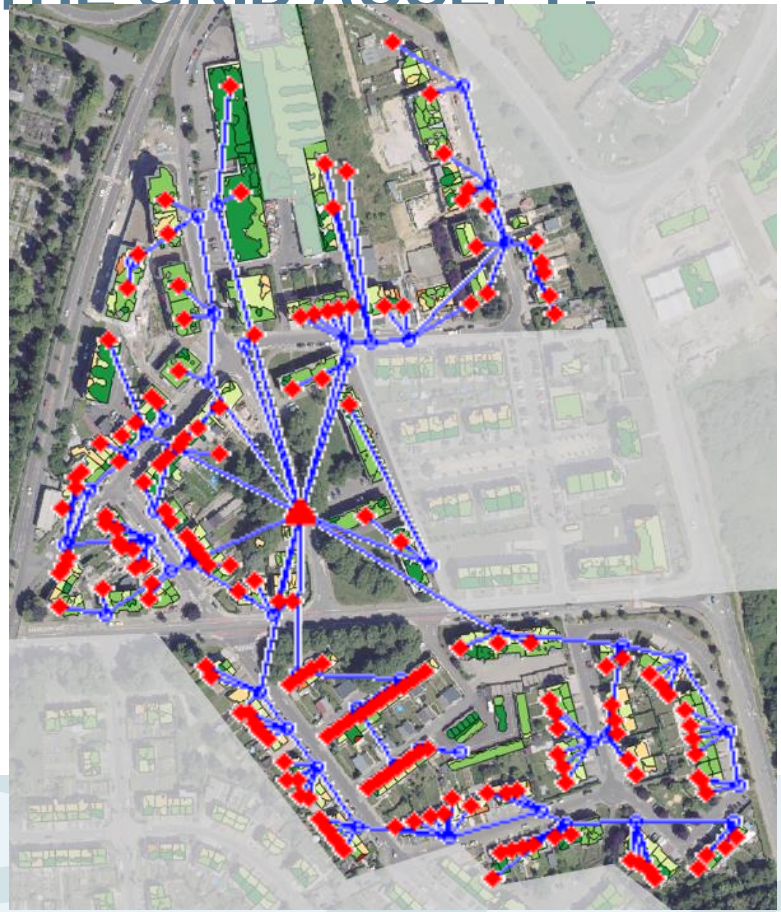
HOW MUCH DISTRIBUTED RENEWABLE SOURCES COULD THE GRID ACCEPT?

Partner & co-funding:

SUD STROUM

Project Partner:

ESCH
ma ville, ma vie



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Partner &
co-funding:

HOW MUCH DISTRIBUTED RENEWABLE SOURCES COULD THE GRID ACCEPT?

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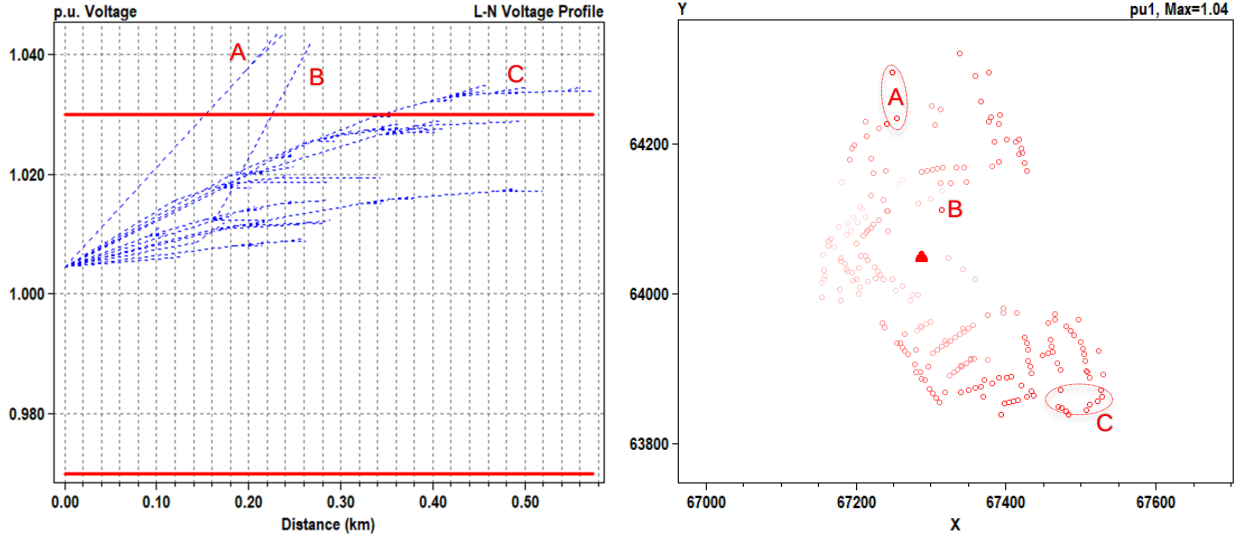
- …l undesired effects of high fluctuating renewables penetration
  - **…oltage band violations** & component overloads on medium- and low voltage level; Frequency stability on high voltage level
- Hosting capacity evaluated under static “worst case” conditions

Project Partner:

ESCH
ma ville, ma vie



voltage profile (left) & circuit plot (right) visualizing the p.u. voltage of the 66% scenario snapshot simulation

HOW MUCH DISTRIBUTED RENEWABLE SOURCES COULD THE GRID ACCEPT?

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SUD STROUM

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Project Partner:

ESCH ma ville, ma vie

Hosting capacity evaluated under static “worst case” conditions

Share of PODs using PV	15%	25%	33%	50%	66%	75%	80%	90%	100%
Nominal power [kWp]	247	296	418	602	790	944	995	1068	1248
Overvoltage [# of nodes]	0	1	1	8	27	79	86	111	134
PV penetration [%]	15,9%	19,1%	26,9%	38,8%	50,9%	60,8%	64,0%	68,8%	80,4%

Hosting capacity evaluated under more realistic conditions

- Using load profiles (minutes resolution / single day)
- Using weather data for a sunny day (minutes resolution / single day)

Share of PODs using PV	15%	25%	33%	50%	66%	75%	80%	90%	100%
Nominal power [kWp]	247	296	418	602	790	944	995	1068	1248
Overvoltage [# of timesteps]	0	172	172	5	188	340	343	265	362
Max # of nodes	0	1	1	2	4	23	28	42	103

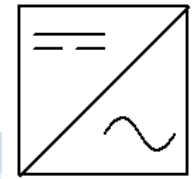
HOW COULD THE HOSTING CAPACITY BE INCREASED?

Partner & co-funding:

Project Partner:

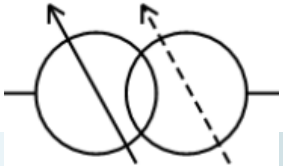
Share of PODs using PV	15%	25%	33%	50%	66%	75%	80%	90%	100%
PV nominal power [kWp]	247	296	418	602	790	944	995	1068	1248
PV penetration [%]	15,9%	19,1%	26,9%	38,8%	50,9%	60,8%	64,0%	68,8%	80,4%
Real. Hosting Capacity (Max # nodes)	0	1	1	2	4	23	28	42	103
Adapting orientation #1	0	1	1	0	4	23	27	42	103
Adapting orientation #2	0	1	1	0	4	21	26	41	96
Smart-Curtailment	0	0	0	0	0	1	1	2	23
Decentral. Storage (25% stor. pen.)						> 25 %			
Decentral. Storage (100% stor. pen.)								100%	
Smart Transformer Station (OLTC)	0	0	0	0	0	0	0	0	0

Adapting orientation of PV



Smart curtailment

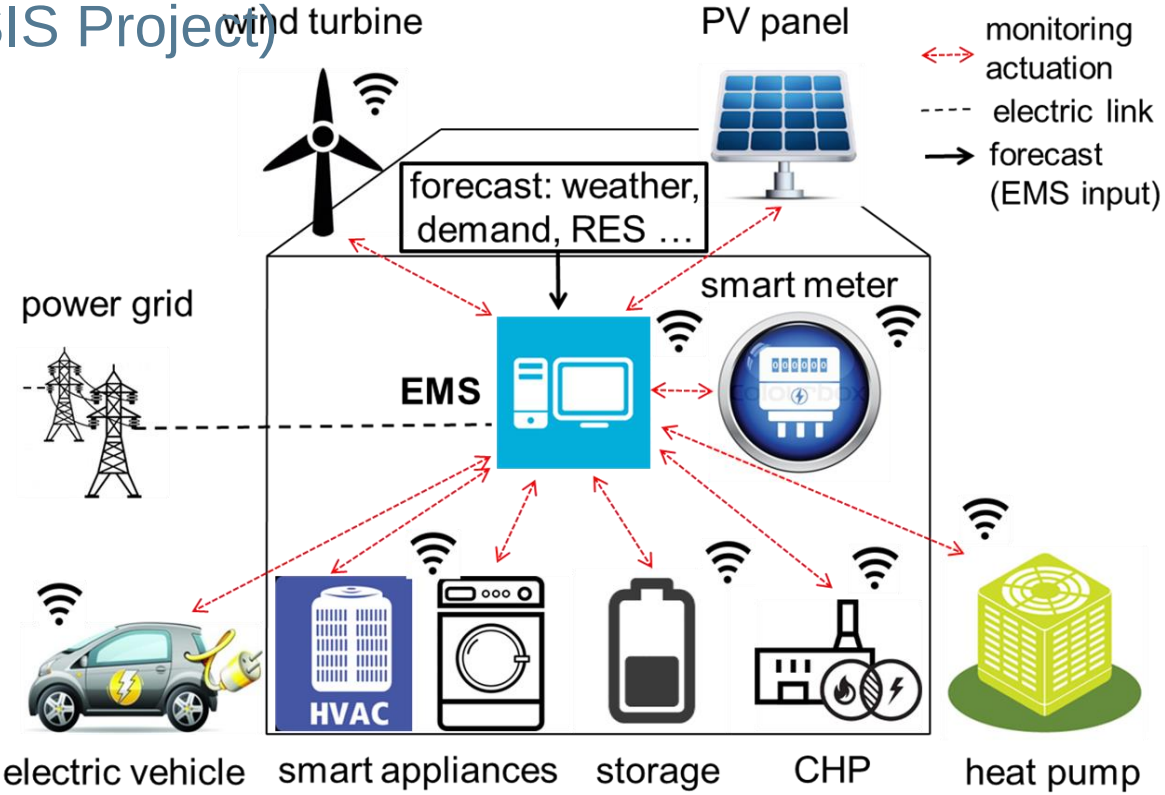
Decentralized storage



Smart Transformer (on-load tap-changing)

Partners:

HOW COULD SMART, NET ZERO ENERGY BUILDINGS FACILITATE GRID INTEGRATION (gENESIS Project)



Luxembourg National Research Fund

Supported by the Luxembourg National Research Fund (C18/SR/12676686)

Duration: 09/2019 - 09/2022

Contact:
Florin Capitanescu
florin.capitanescu@list.lu

FORECASTING OF PV SYSTEMS, BASED ON WEATHER PREDICTIONS

(PV-Forecast Project)

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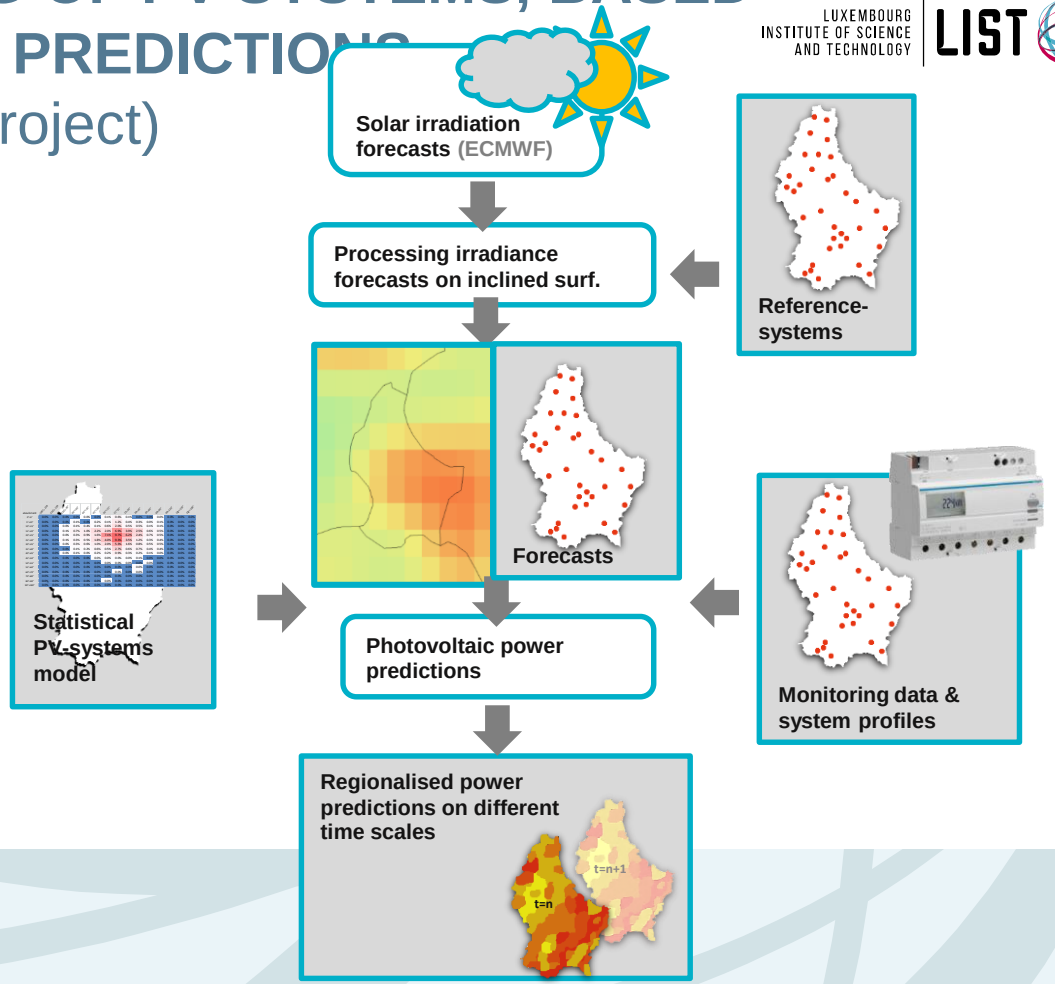

Co-financed by

FONDATION ENOVOS

FORECASTING OF PV SYSTEMS, BASED ON WEATHER PREDICTION (PV-Forecast Project)

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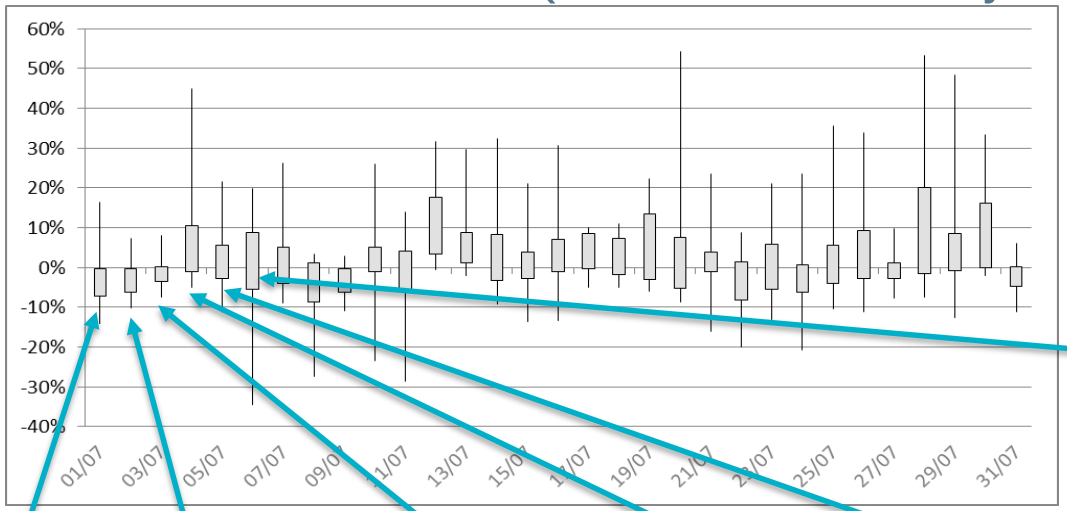
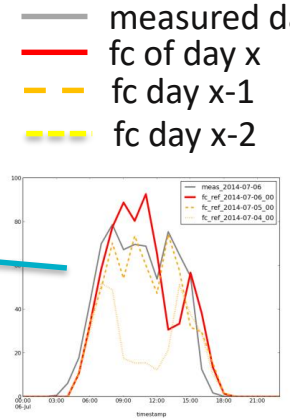
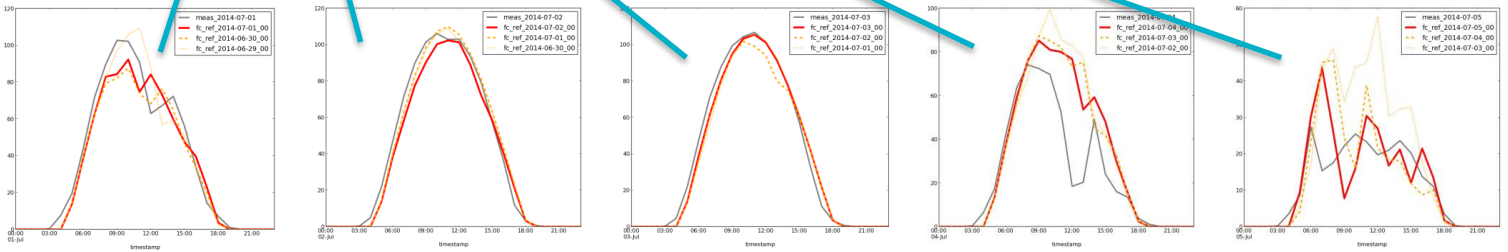
Forecast accuracy:
(Mean daily values)

- RMSE= 7.4%
- $RMSE_{dt}$= 10%
- bias= 1.1%
- $bias_{dt}$= 2.2%







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Boxplot of the normalized error ε of the hourly forecast for one reference system for July '14

Example: six days in July 2014, showing the correlation of the three forecast horizons (0-24h in red line / 24-48h in orange, dashed line / 48-72h in yellow, dotted line) and the measured values (grey line)

FORECASTING OF PV SYSTEMS, BASED COMBINED APPROACH (Combi-Cast Project)

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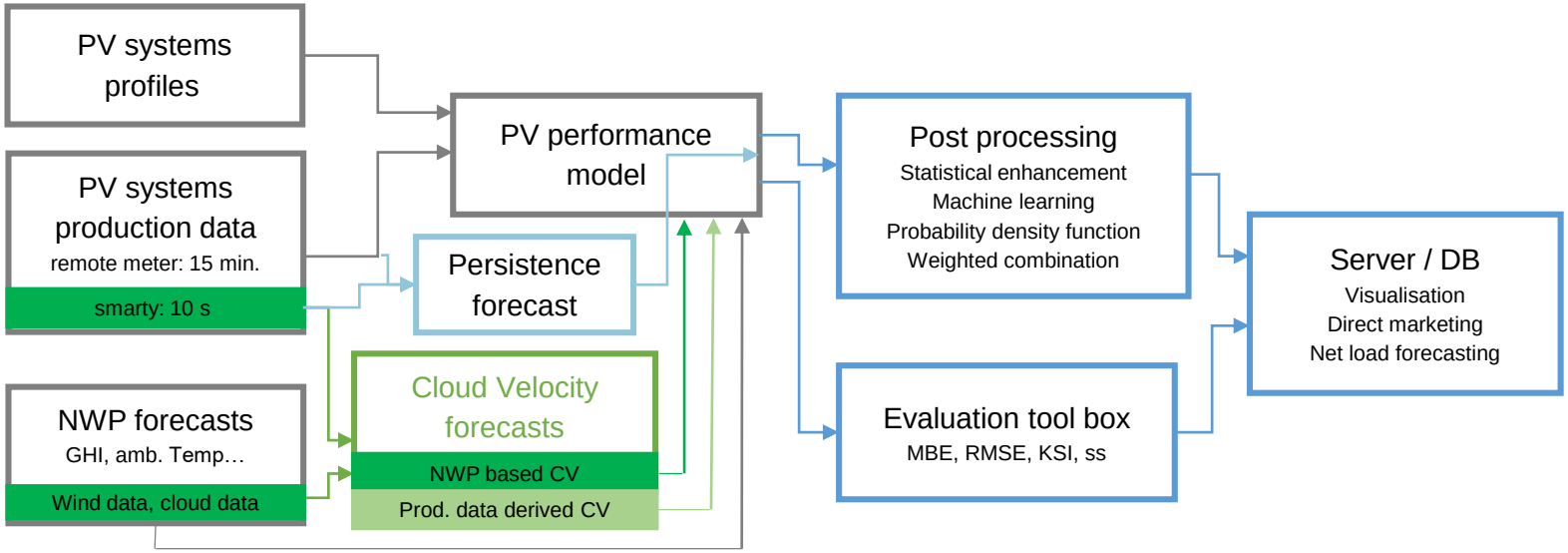
Partner & co-funding

Electris



- Combining the benefits of three forecasting approaches at different forecast horizons
- Use of high resolution smart meter data for CMV identification
- Introducing uncertainty intervals

Supported by the Luxembourg National Research Fund (BRIDGES18/IS/12705349)

Luxembourg National Research Fund

Thank you very much for your attention!

Phuong Nguyen
Daniel Koster
Florin Capitanescu

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