Describing transport for energy system modelling
Input for an openmod do-a-thon

Open Energy Modelling Workshop, Aarhus

2019/05/24

Niklas Wulff

DLR

Motivation – REMix, Assessing flexibility for future power systems

Conventional generation

DSM of Industry and Households

Battery storage

Heat technologies

RE Curtailment

Heat and synfuel Grids

Flexible RE

REMix

Transport sector

Motivation – REMix, Assessing flexibility for future power systems

Transport sector

Mobility demand

Vehicle fleet

Hourly profiles

REMix

Overview on tools, methods and scopes

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Forschungsstelle für Energiewirtschaft e.V.

Fraunhofer IEE

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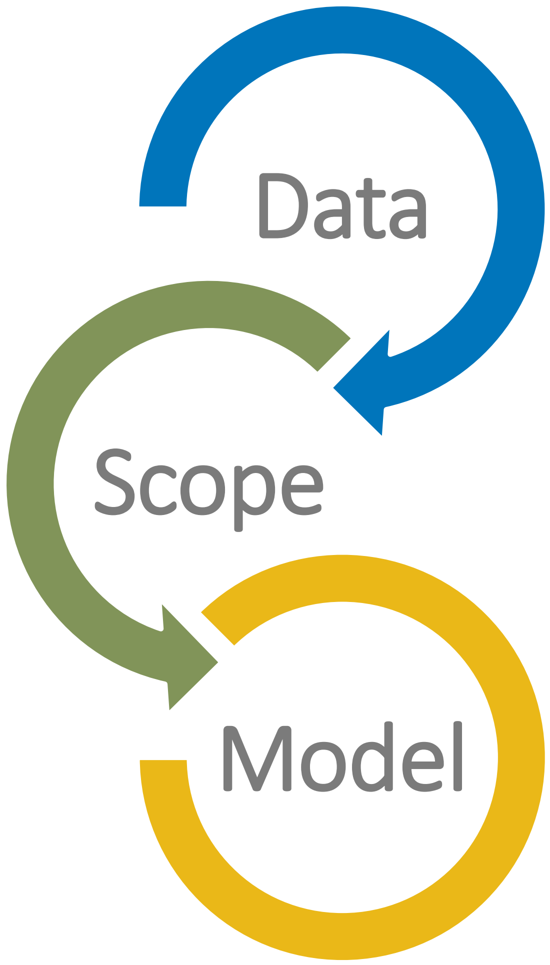

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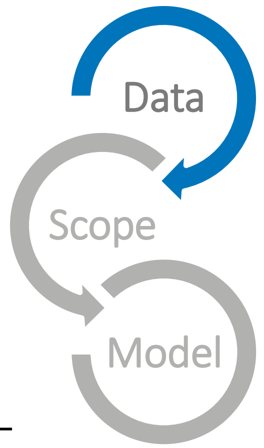
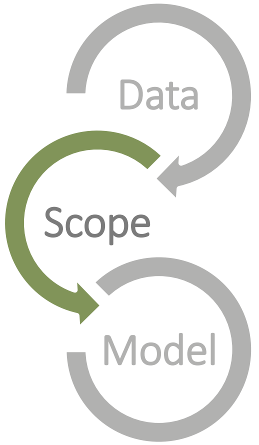
Overview on tools, methods and scopes

Data



	Mobility Demand	Fleet	Profiles
RLI	Literature (IP)	?	MiD
F-ISI	Literature	Stock and flow model (Aladin)	MoP
F-IEE	Literature (IP)	Stock and flow model	MiD, KiD
FfE	Literature	Stock and flow model	MiD, MoP

Abbreviations: MiD: Mobilität in Deutschland, KiD: Kraftfahrzeugverkehr in Deutschland, MoP: Mobilitätspanel, IP: Interdependence prognosis



Overview on tools, methods and scopes

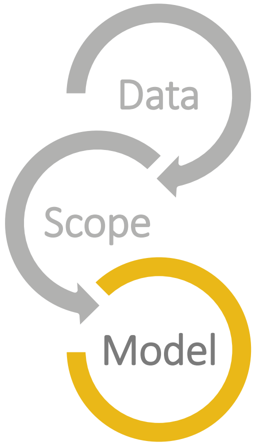
Scope

	Infrastr. Resolution	Technological	Vehicle Sizes	Modi
RLI	H, W, S, O	BEV, FCEV	-	Street (passenger)
F-ISI	H, W, P (slow), P (fast)	BEV, PHEV, FCEV, HDV	-	Street (passenger + goods)
F-IEE	H, W, O	BEV, ?, LDV	S, M, L, 3 HDV categories	Street (passenger + goods)
FfE	H, W, O	BEV, LDV, HDV	M	All modi

Abbreviations: GER: Germany, BEV: Battery electric vehicle, FCEV: Fuel cell electric vehicle, PHEV: Plug-in hybrid electric vehicle, HDV: Heavy duty vehicles, LDV: Light duty vehicles, S: Small, M: Medium, L: Large, HDT: Heavy duty transport

Overview on tools, methods and scopes

Methods

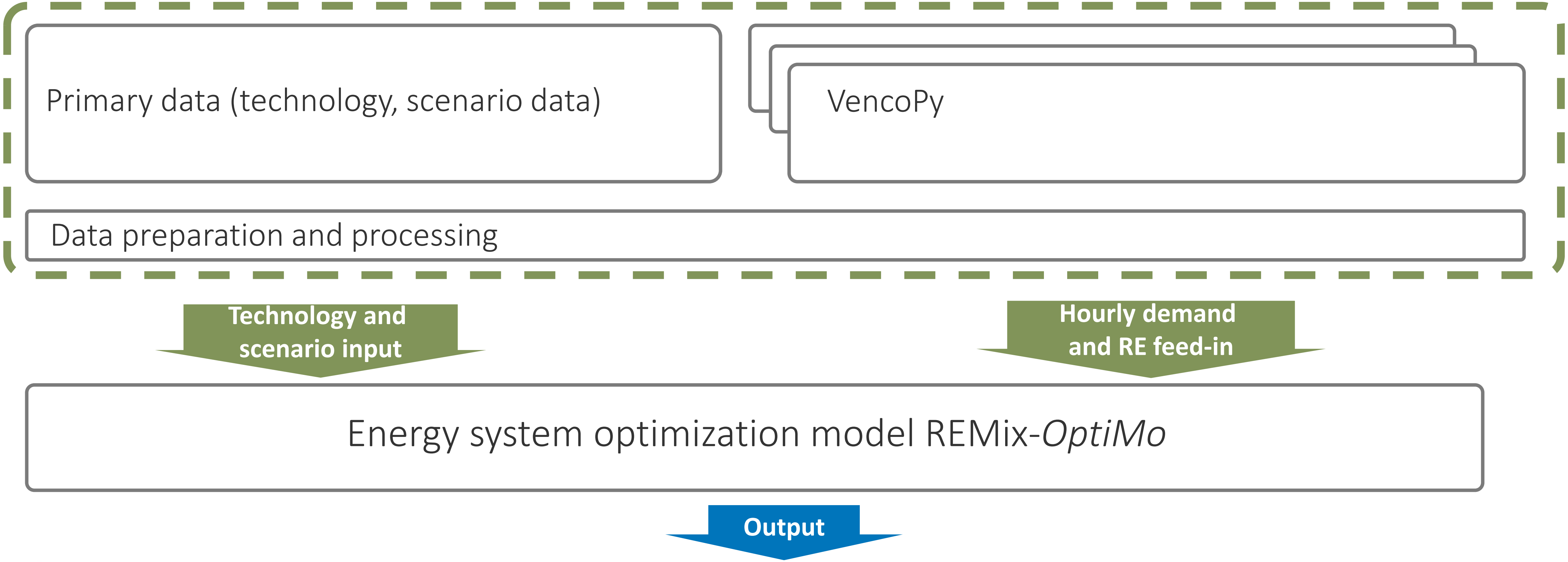


	Infrastructure modelling	Behaviour modelling	Language
RLI	Probabilistic in space	Risk factors assumed	Matlab, in future: Python
F-ISI	Deterministic	For stocks (Aladin)	?
F-IEE	Probabilistic infra types	-	Currently Matlab, in future: Python
FfE	Probabilistic infra types	-	PostgreSQL database / Matlab, in future: Python

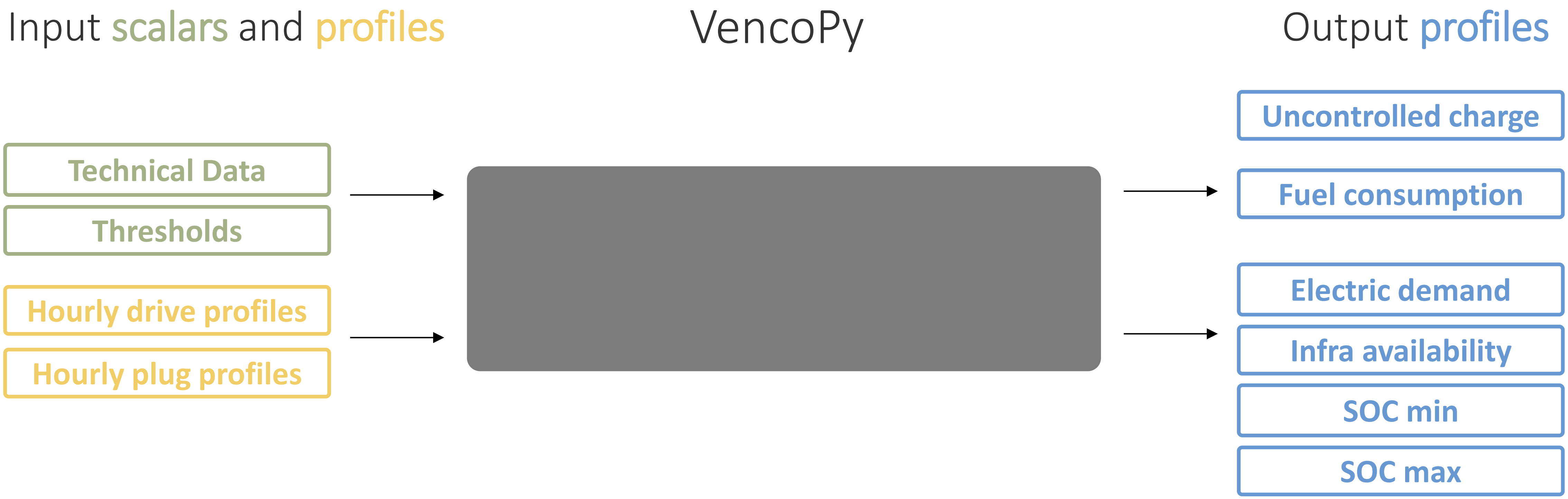
DLR

Vehicle Energy Consumption in Python - VencoPy

VencoPy – application context



VencoPy – opening the black box

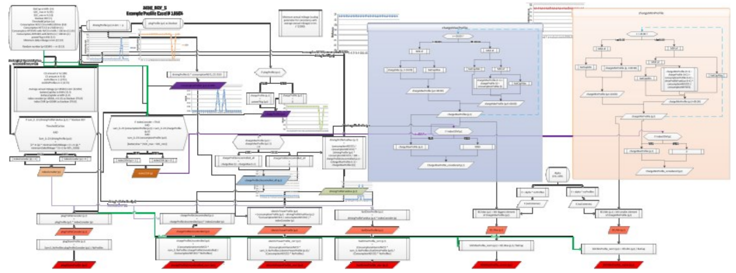


VencoPy – opening the black box

Input scalars and profiles

- Technical Data
- Thresholds
- Hourly drive profiles
- Hourly plug profiles

VencoPy

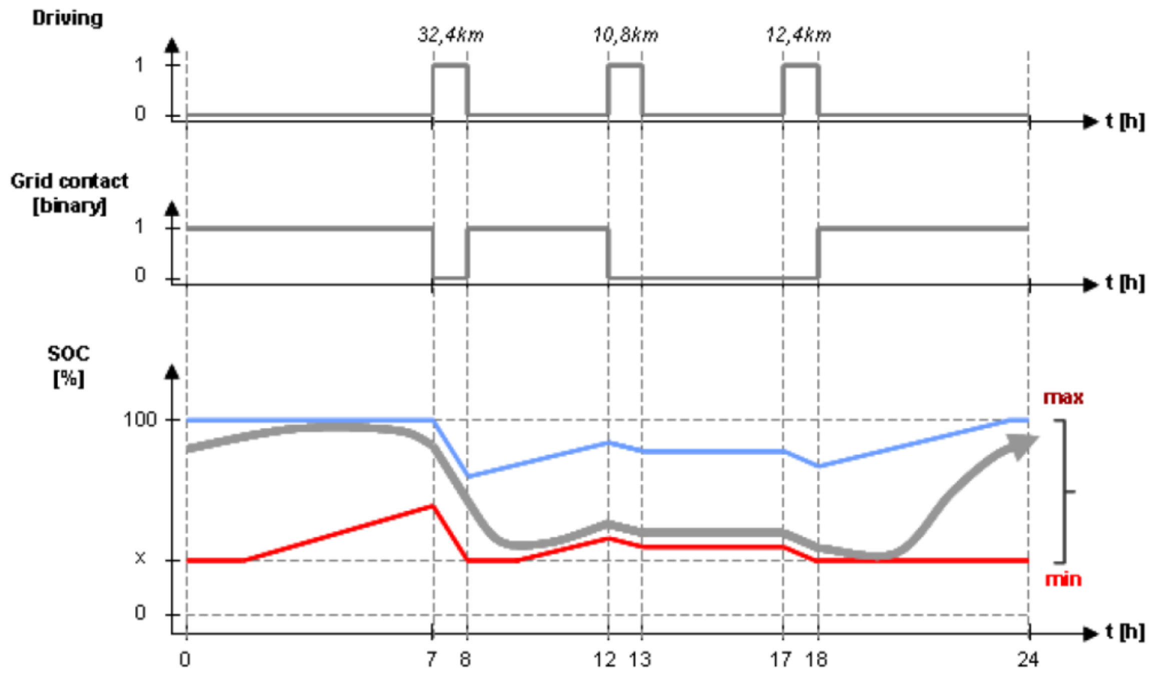


Output profiles

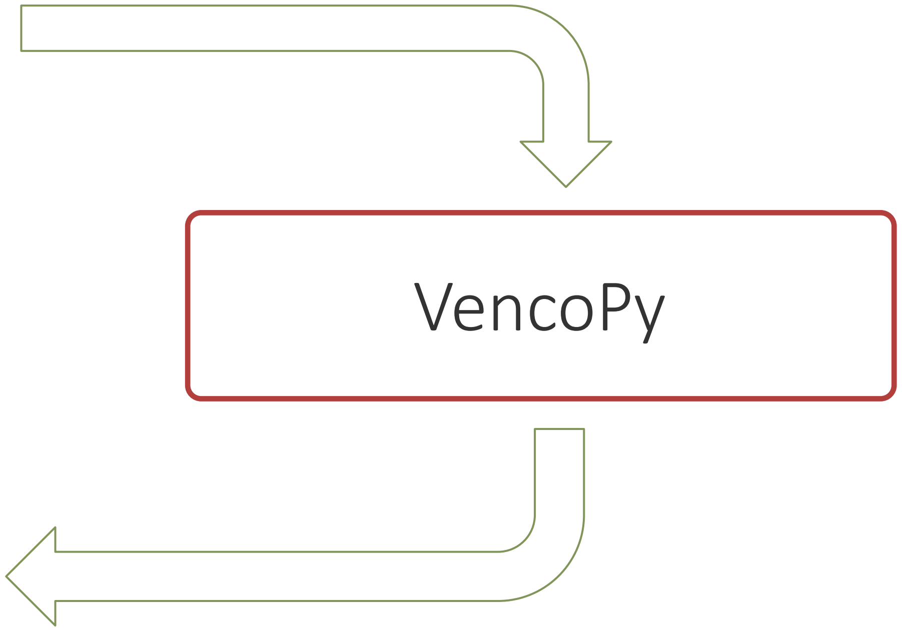
- Uncontrolled charge
- Fuel consumption
- Electric demand
- Infra availability
- SOC min
- SOC max

Five profiles for REMix

Luca de Tena & Pregger (2018)

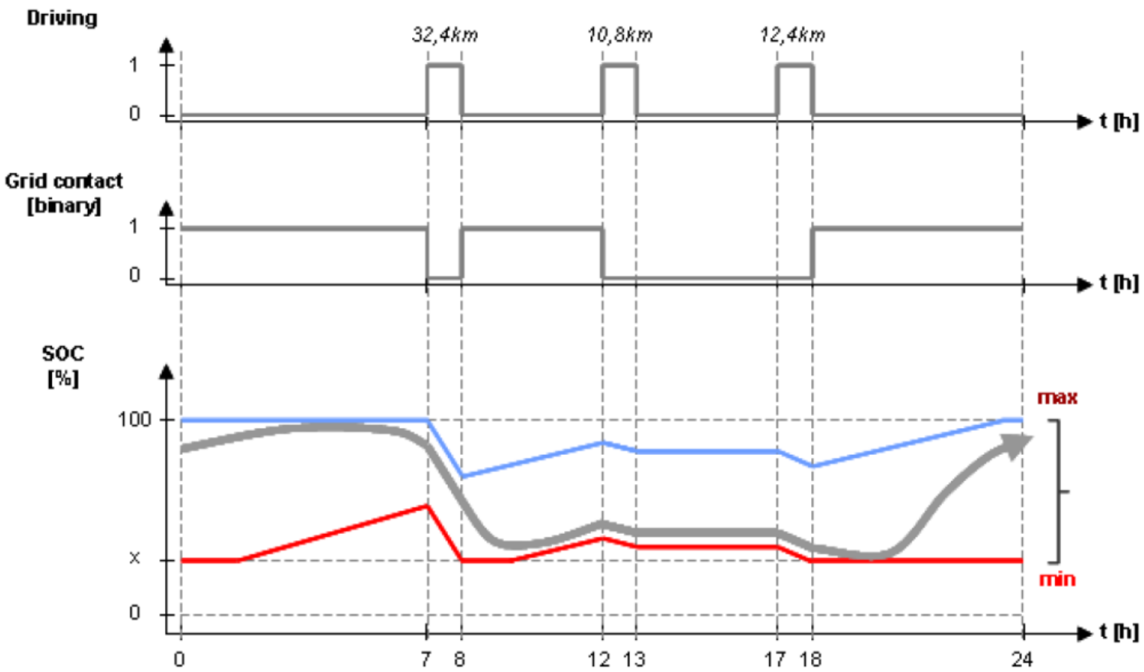


Source: DLR/IFHT/ISE, 2012



Five profiles for REMix

Luca de Tena & Pregger (2018)



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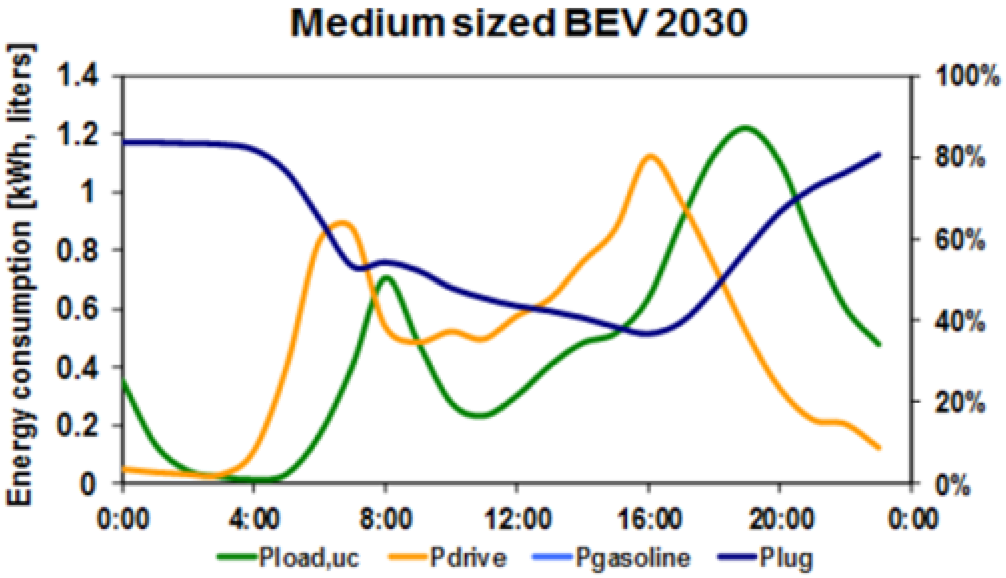
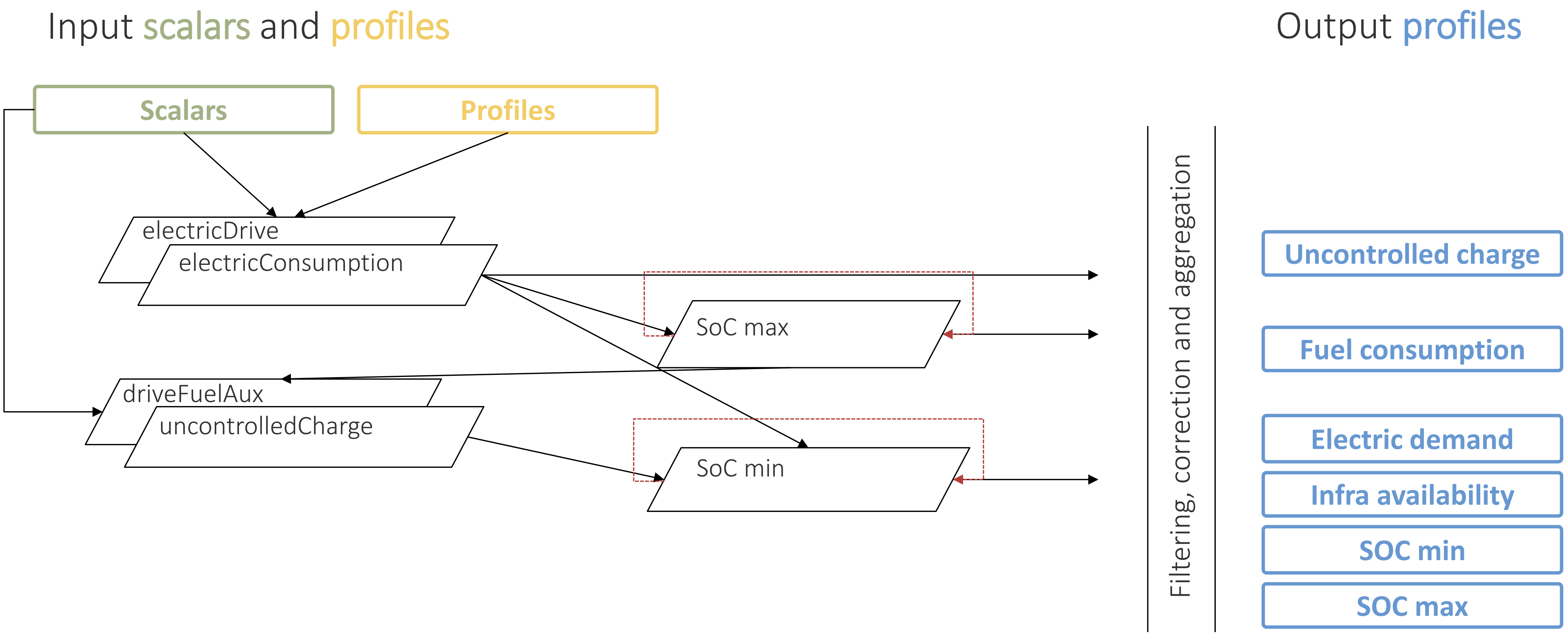
VencoPy

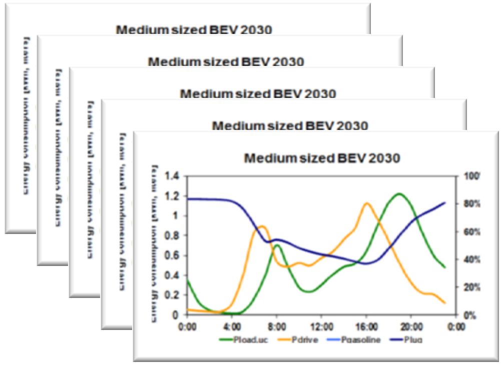


VencoPy – flow sheet



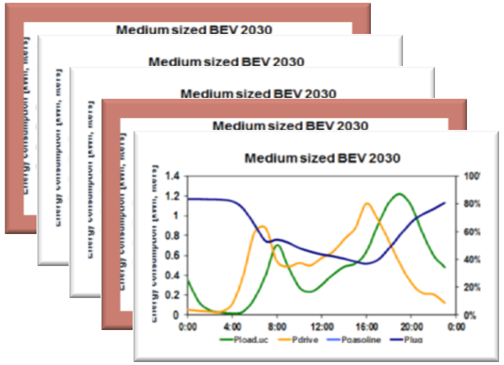
VencoPy – Filtering

Profiles



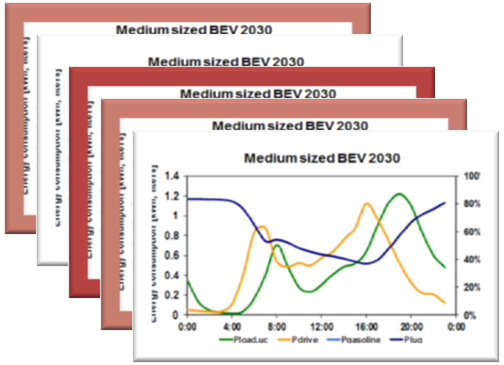
~18000 * 6 profiles

Two filters



Considered in general
- No fuel needed
- Minimum daily mileage

~10000 * 6 profiles



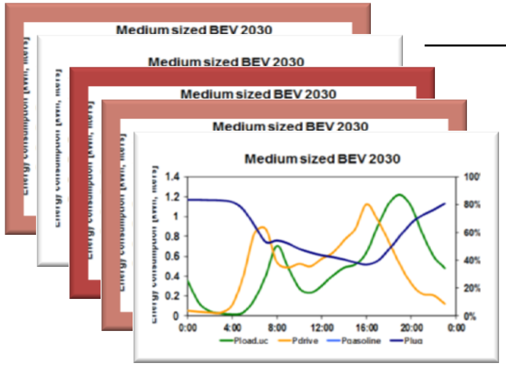
Considered for load shifting
- Consumption <= charge
- Consumption <= battery size

~5000 * 6 profiles

DLR

VencoPy – Aggregation to fleet profiles

Filtered Profiles



~5000 * 6 profiles

Aggregation

Averaged

- Exclusion of extreme profiles (1-10%)
- The next extreme profile is taken

6 profiles

Output profiles

Uncontrolled charge

Fuel consumption

Electric demand

Infra availability

SOC min

SOC max

Features to come

Content

- Temperature adjusted demand profiles
- Profile synthesis from daily to annual profiles
- Multiple values for rated power of charge columns

Community

- Regular TelCos
- Shared code basis
- Validation data sets and methodology?

Code integration

- Multiple config files
- Multiple input data formats
- More sophisticated reporting
- …

Backup slides

Motivations Open Source ESMs

Education:

How can we expect someone to master electrical engineering if they do not know the models that are used in real life software (the dummy Newton-Raphson example from the books doesn't count)

It is all right to teach the program X at university, but how many great contributions are we missing because people just don't know how it works internally?

Knowledge preservation:

The energy sector the base of the society. Do we want to plan for it using methods that we do not understand? made by corporations for their benefit? can we trust closed software models? I want none of that.

Ethics:

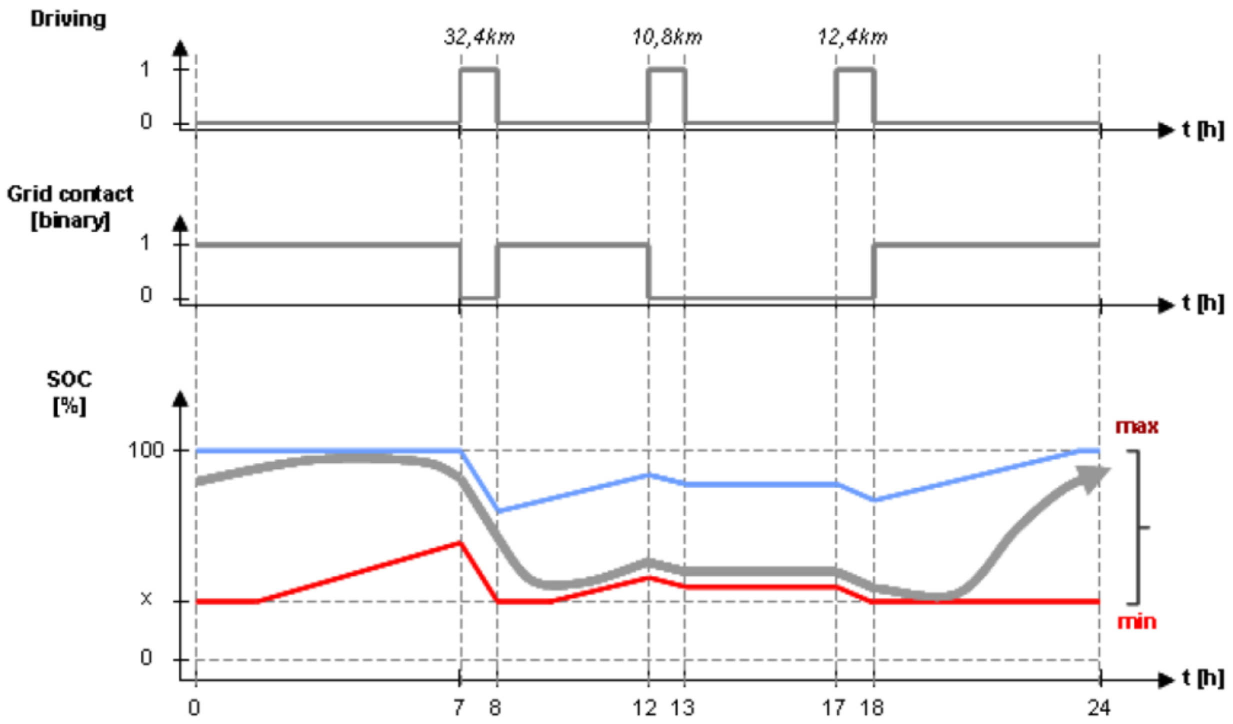
As an open modeller, there is nothing to hide. Both the method and the code are up to the public scrutiny.

We are certain that the code is right, and if not, anyone can correct it,. That leads to improving the quality of what we know as as a society. We are brave enough to open our thoughts to criticism. That leads to learn about what we do wrong; That is science.

The basic idea behind Venco

Luca de Tena & Pregger (2018)

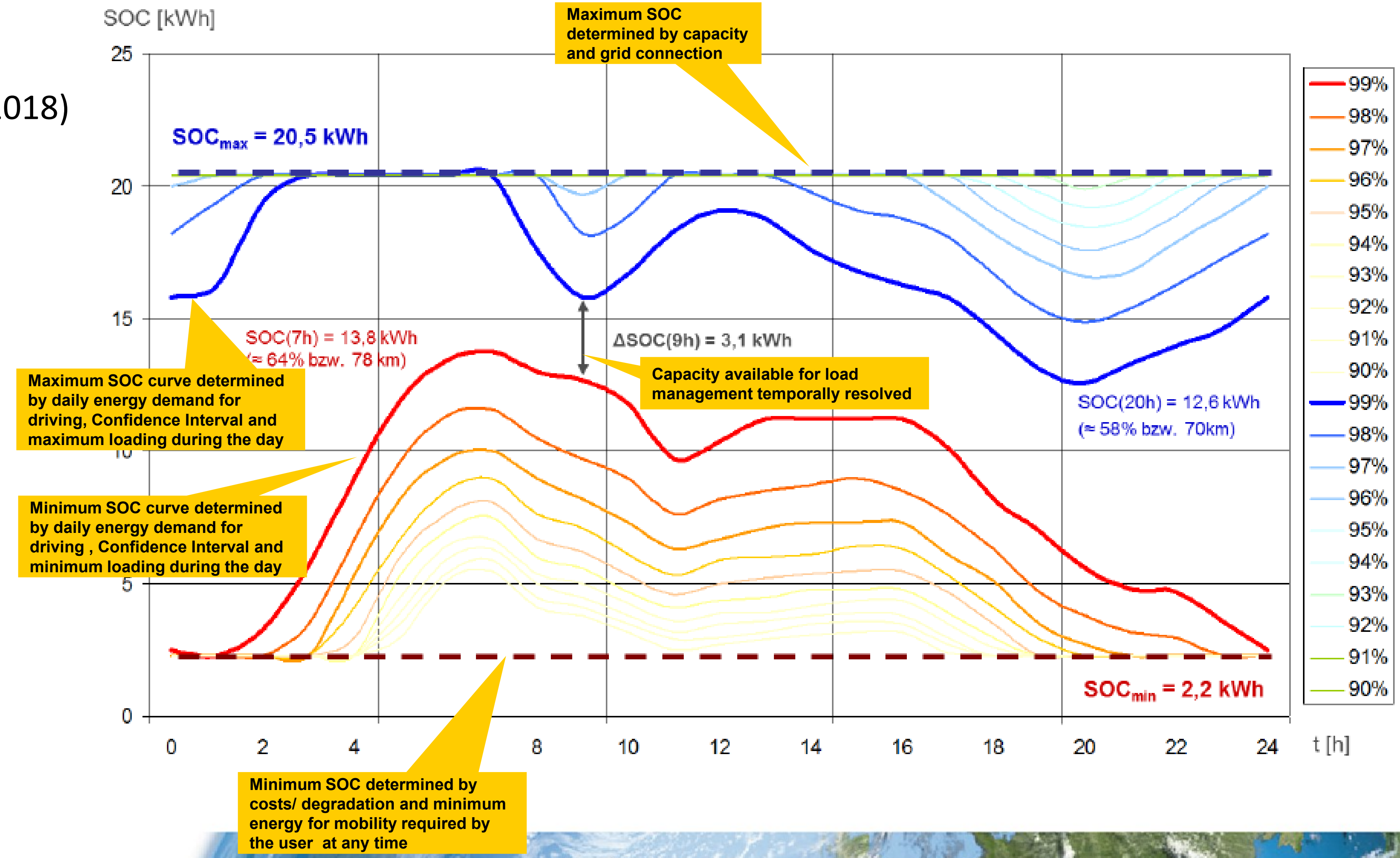
1) Improve the representation of electric vehicles (EVs) in energy system modeling as **flexible consumers** considering **real driving patterns**
2) Quantify the **impact of increasing EV** fleets on “energy system modeling results”
   - Residual peak demand
   - Electricity losses
   - Transmission system expansion
   - System costs



Source: DLR/IFHT/ISE, 2012

The basic idea behind Venco

Luca de Tena & Pregger (2018)



Motivation(s)

Automatization of models
Sensitivity analyses
Sector coupling
Load shifting potential
Infrastructure (all electric vs. green gas)
Reproducibility crisis
Model transparency
Slow administrative processes
Legal issues (licensing)
Technical issues (mainly hosting repos)
Saving time
Getting feedback and debugging
Data availability
Data heterogenity
Process of opening up models and tools

Categories

Methodological
Quality of research
Content-related
Administrative
Work-related

Critical review – filtering of profiles

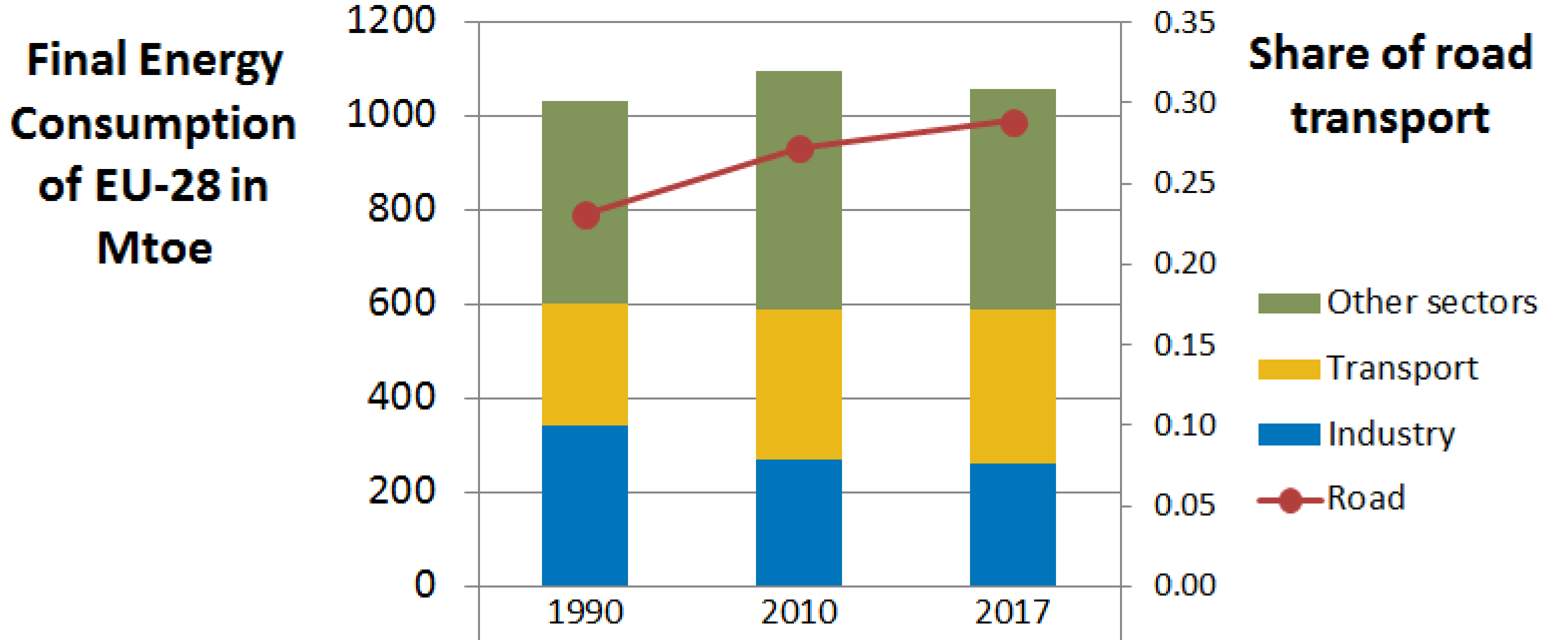
Index considered

- driveProfileFuelAux < Threshold?
- driveProfile

Index DSM

- Multiple config files
- Multiple input data formats
- More sophisticated reporting
- …

Motivation(s)



	1990	2010	2017
Other sectors	431	510	472
Transport	260	320	327
Industry	341	268	261
Road	0.23	0.27	0.29

Some Literature

Agora Verkehrswende, Agora Energiewende & Frontier Economics (2018): *Die zukünftigen Kosten strombasierter synthetischer Brennstoffe.* Online: https://www.agora-energiewende.de/fileadmin2/Projekte/2017/SynKost_2050/Agora_SynCost-Studie_WEB.pdf [accessed 2019/04/04].

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