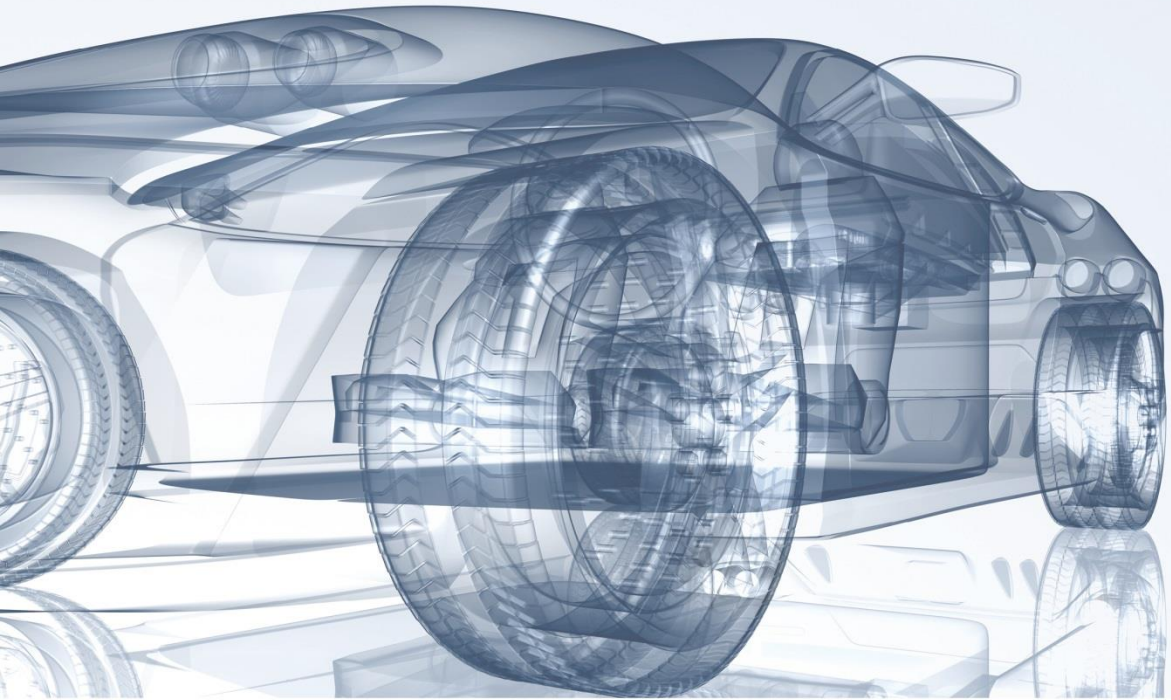
evs 30



The 30th International
Electric Vehicle
Symposium & Exhibition

October 9–11, 2017

Messe Stuttgart, Germany

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Life Cycle Assessment of Electric Vehicles – The Influence of Regional Aspects and Future Renewable Energy Targets

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Life Cycle Assessment of Electric Vehicles – The Influence of Regional Aspects and Future Renewable Energy Targets

AGENDA

- ❑ LCA of EV and interdependencies between different information levels
- ❑ Regional Dependencies in LCA modeling of EV
- ❑ Concept for Environmental Assessment of EV
  - Methodology
  - Integration of Renewable Energy Targets
  - Visualization
- ❑ Results
- ❑ Conclusion

Motivation | E-Mobility as a mitigation option

Global Warming

Greenland; Source: D. Egede, 2015

Local air pollution

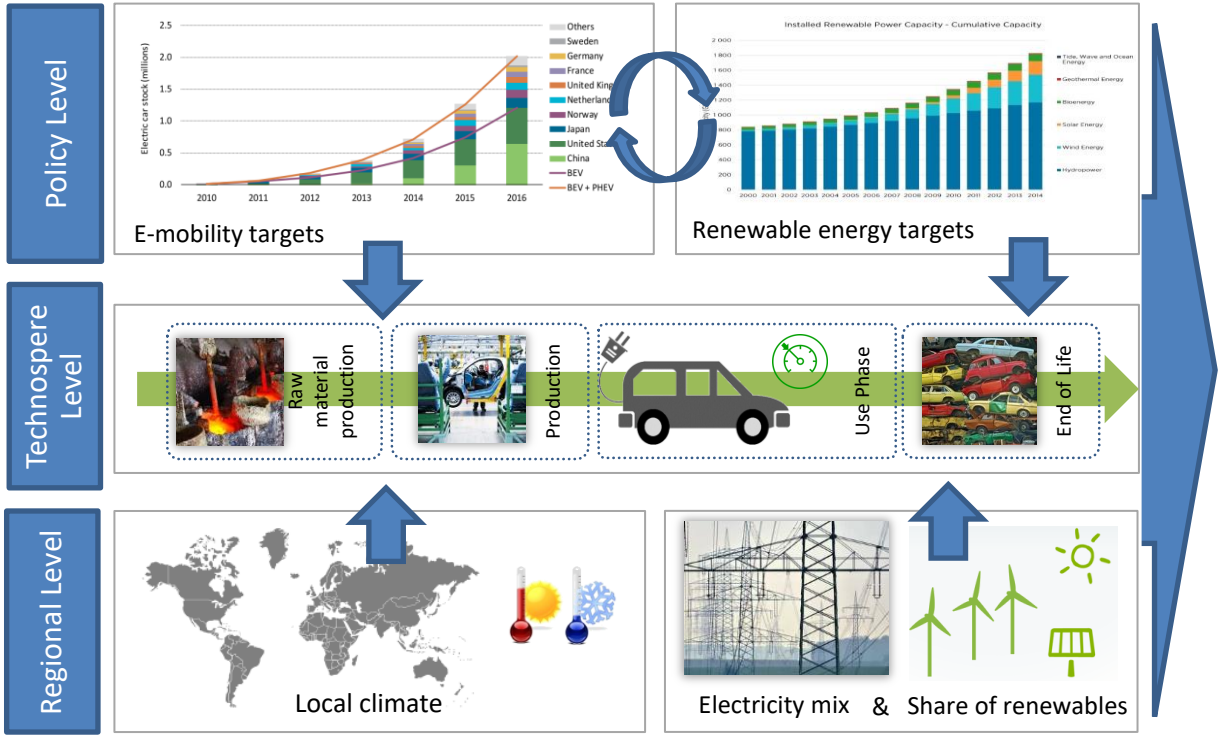
India; Source: P. Egede, 2010

→ *E-mobility as a mitigation option*

Source: ae kaufmann, naturenergie

What is the real environmental impact of e-mobility?

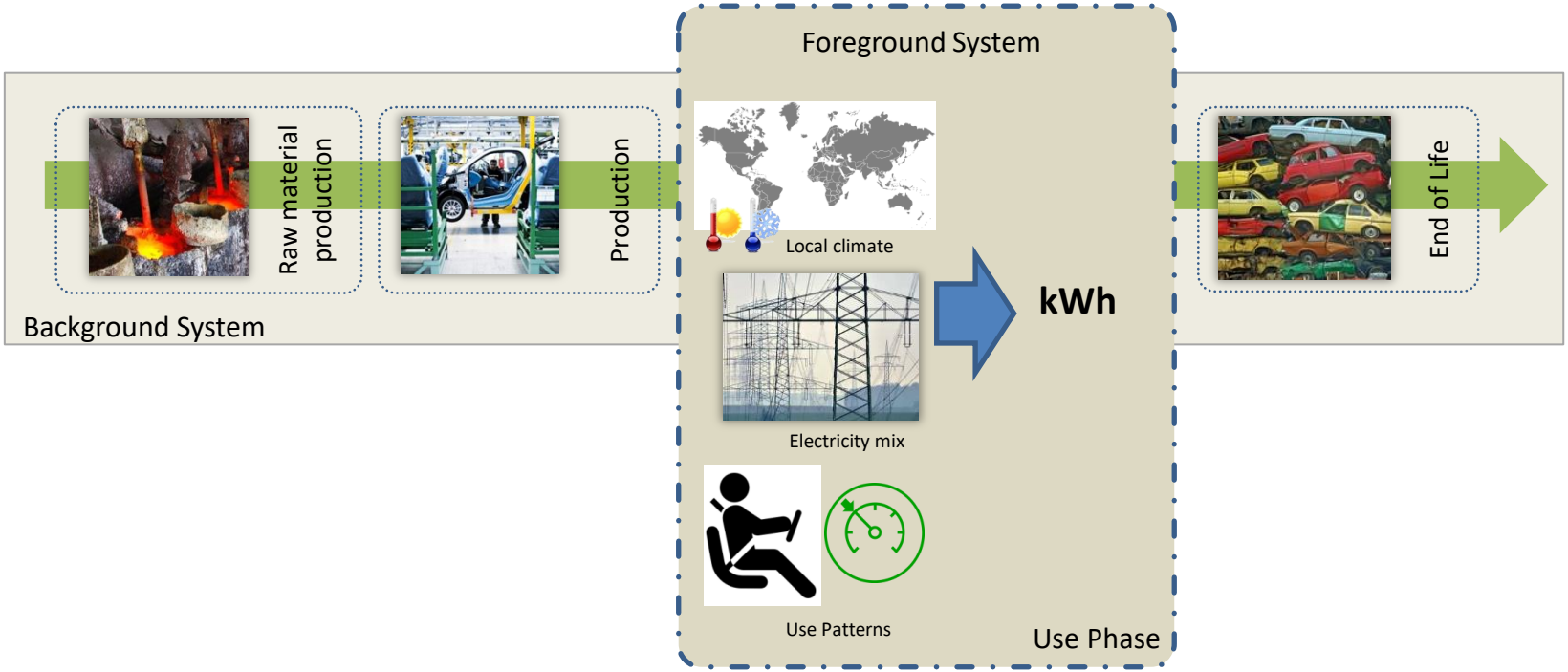
Motivation | LCA of EV and interdependencies between different information levels



- Do EV perform **environmentally better** than ICEV under each regional context?
- Are the future renewable energy targets **realistic enough** to make EV advantageous all over the world?
- How can the environmental trade-offs be **visualized**, so that the decision makers **perceive the correct messages**?

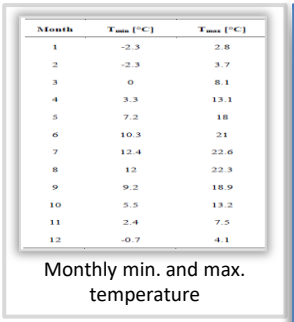
Source: International Energy Agency, 2017
International Renewable Energy Agency, 2015

Concept | Influencing Factors in LCA modeling of EV



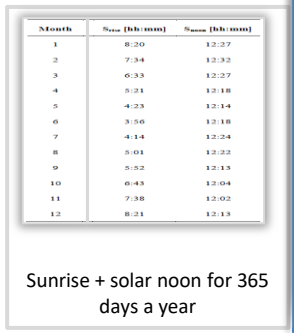
Source: Erkisi-Arici et.al., 2017

Concept | Methodology to Consider Influencing Factors



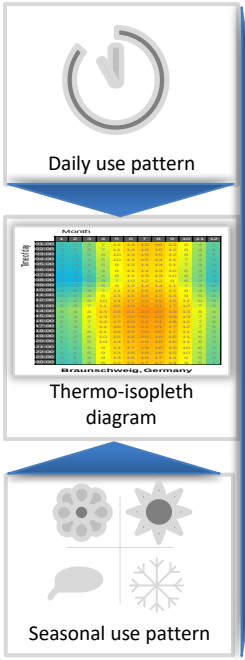
Month	T_{min} [°C]	T_{max} [°C]
1	-2.3	2.8
2	-2.3	3.7
3	0	8.1
4	3.3	13.1
5	7.2	18
6	10.3	21
7	12.4	22.6
8	12	22.3
9	9.2	18.9
10	5.5	13.2
11	2.4	7.5
12	-0.7	4.1

Monthly min. and max. temperature



Month	S_{rise} [hh:mm]	S_{noon} [hh:mm]
1	8:20	12:27
2	7:34	12:32
3	6:33	12:27
4	5:21	12:18
5	4:23	12:14
6	3:56	12:18
7	4:14	12:24
8	5:01	12:22
9	5:52	12:13
10	6:43	12:04
11	7:38	12:02
12	8:21	12:13

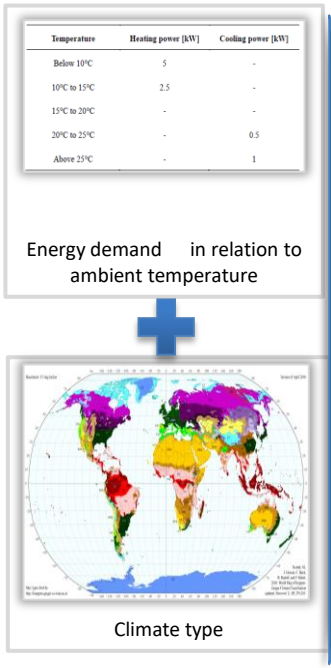
Sunrise + solar noon for 365 days a year



Daily use pattern

Thermo-isopleth diagram

Seasonal use pattern



Temperature	Heating power [kW]	Cooling power [kW]
Below 10°C	5	-
10°C to 15°C	2.5	-
15°C to 20°C	-	-
20°C to 25°C	-	0.5
Above 25°C	-	1

Energy demand in relation to ambient temperature

Climate type

#	Climate group	Climate	Heating [kWh/km]	Cooling [kWh/km]
1	Af	Af, North	0,000	0,051
2	Af	Af, South	0,000	0,039
3	Am	Am, North	0,000	0,037
4	Am	Am, South	0,000	0,045
5	As	As, North	0,000	0,045
6	As	As, South	0,000	0,045
7	Aw	Aw, North	0,005	0,031
8	Aw	Aw, South	0,000	0,040
9	BWk	BWk, North	0,227	0,000
10	BWk	BWk, South	0,103	0,002
11	BWh	BWh, North	0,041	0,028
12	BWh	BWh, South	0,078	0,008

Energy demand depending on ambient temperature and use pattern for entire world

Source: Egede, 2017

Concept | Integration of Future Renewable Energy Targets

Share of electricity generation from renewable sources data based on REN21

Renewable energy targets for forthcoming years?

NO

YES

Accepted as "no change in renewable energy share in future".

Does country have a target for year 2030?

NO

YES

A target for 2030 calculated by adopting a linear increase from the latest target.

Target accepted as it actualized.

Does country data exist in World Bank database?

NO

YES

GWP value for "Electricity mix, Rest of World" adopted. (from Database)

GWP is calculated. (based on World Bank share and datasets from Database)

Does country data exist in World Bank database?

NO

YES

GWP is calculated. (based on world average source distribution and datasets from Database)

Concept | Methodology to Consider Influencing Factors

Future renewable energy targets of countries

Actual electricity mix data of countries

Compilation of data for estimation of country specific future electricity mixes

Month	T_{min} [°C]	T_{max} [°C]
1	-2.3	2.8
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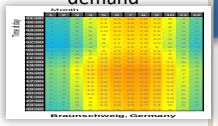
Monthly min. and max. temperature

Utilization of thermo-isopleth diagrams to calculate heating/air conditioning energy demand



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10°C to 15°C	2.5	-
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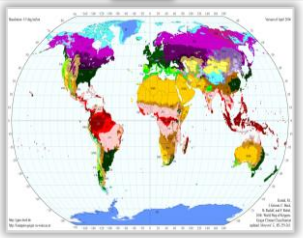
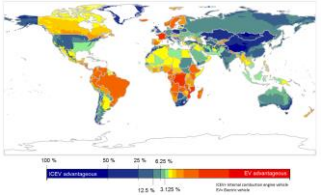
Energy demand in relation to ambient temperature with different time spans



Climate type

Integration in LCA methodology

Visualization



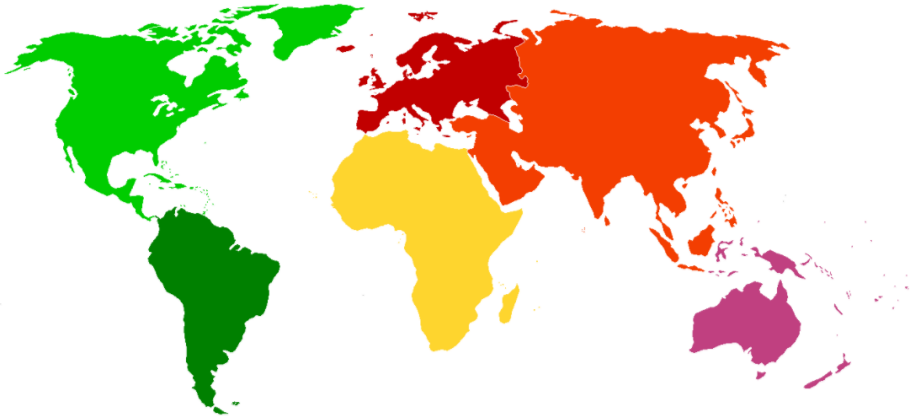
Source: koeppen-geiger.vu-wien.ac.at

Concept | Visualization

- LCA results deliver information for different interest groups, however LCA results are not always easy to interpret.

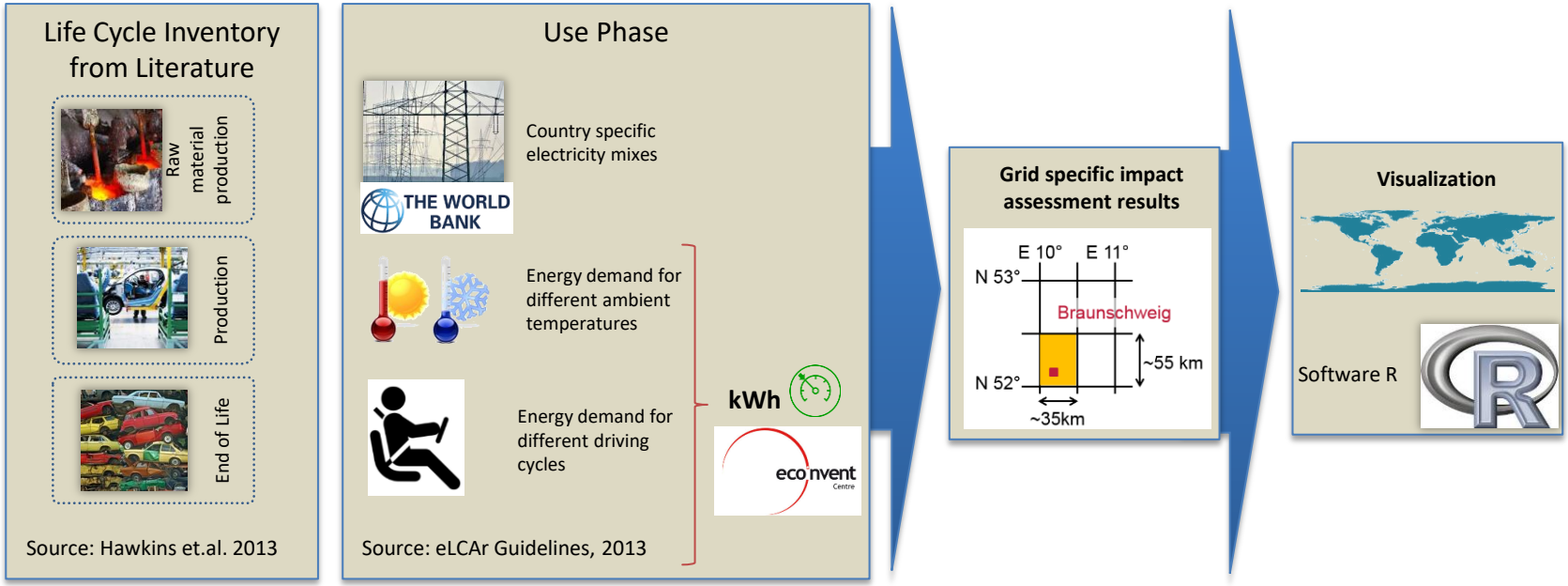
Role	Tasks	Requirements for Visualization
LCA practitioner	• Handling of large LCA models • Processing of results for other target groups	• Deep understanding of study details: multiple impact categories, contribution analysis, spatial effects, uncertainties • Transferability to decision-maker
Non-LCA expert	• Interpretation of received results • Derivation of decisions	• Decision implication • Depiction of tradeoffs
Marketing departments	• Interpretation of received results • Processing for communication	• Easy interpretable information
Policy makers	• Interpretation of received results • Derivation of decisions	• Comprehensive presentation of detail information • Decision implication

- An enhanced visualization technique should be applied to make the results easily interpretable to each interest groups.
- The visualization technique should also be suitable to stress the regional dependencies.



Source: Cerdas et.al., 2017

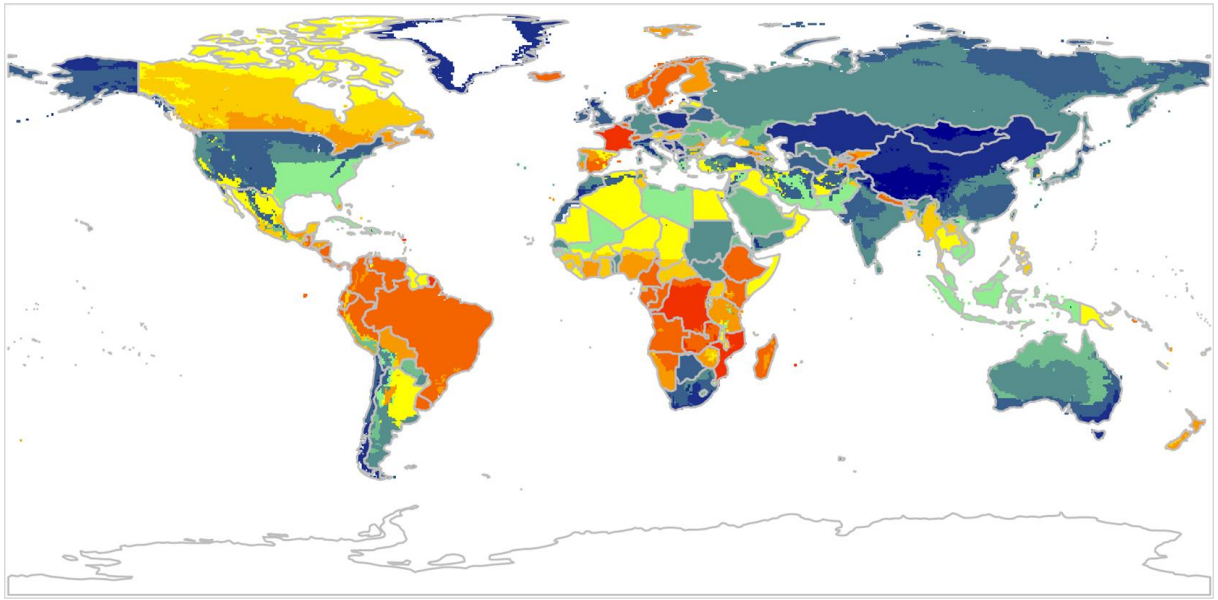
Case Study | Environmental impacts of EV compared to ICEV



Results | ICEV vs. EV comparison map for year 2015

Scenario description

ICE vehicle:	Gasoline	**EV battery:**	Li-FePO4	**Impact Category:**	Climate change	**Daily use:**	Commuter	**Seasonal use:**	Even



Results| Maps in Comparison – year of 2015 vs. 2030

Scenario description

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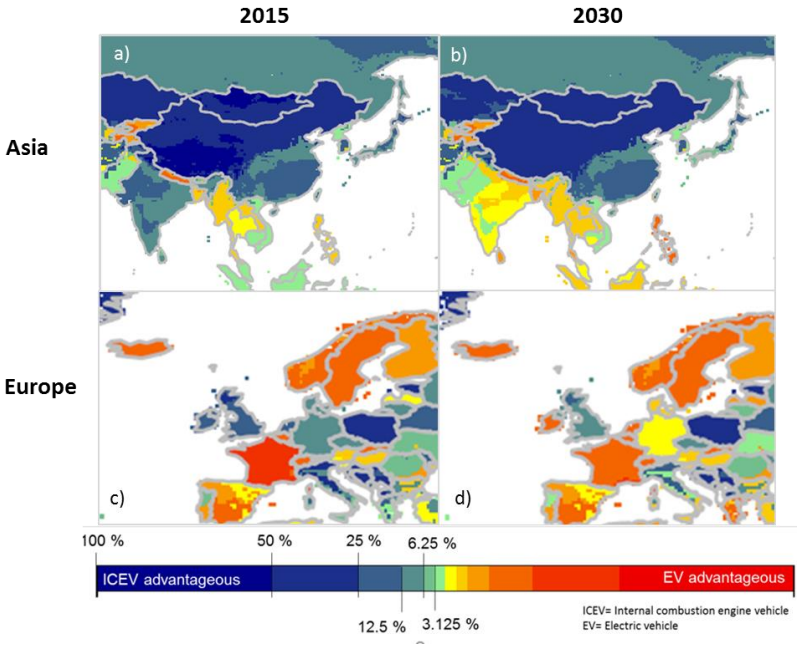
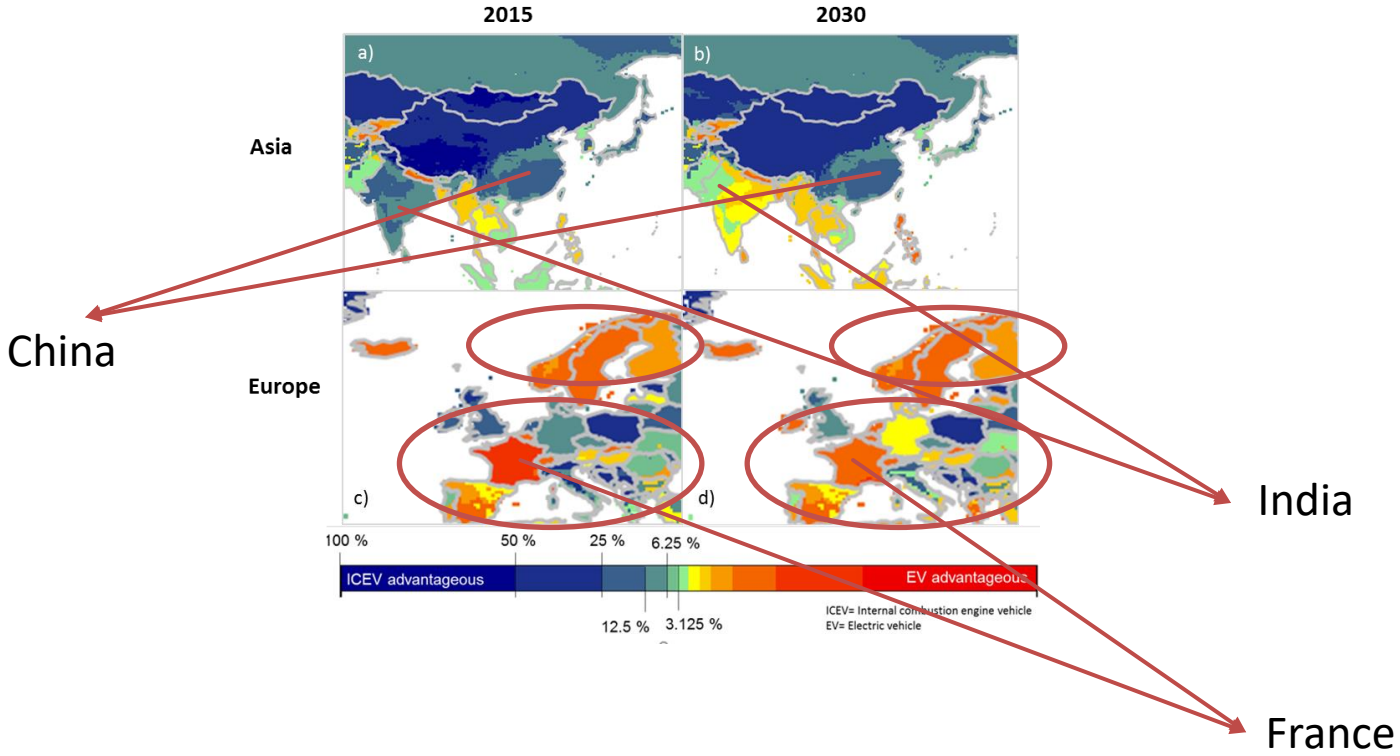


- ✓ The zoom maps let us comparing the ICEV vs. EV status for actual and future scenarios.
- ✓ A general shift towards an EV advantageous state can be observed.
- ✓ Policies of renewable energy generation contribute to lower the emissions from EV.

Results| Maps in Comparison – year of 2015 vs. 2030



Conclusion

- ✓The LCA world maps aim to deliver inputs in order to evaluate EV advantageous on a regional level.
- ✓The LCA world maps also reveal indications for the synchronization of energy and e-mobility policies.
- ✓The scenario for the year 2030 displays an improvement through EV advantageous states. However, for many countries (e.g. China), a dramatic change is not projected until 2030.
- ✓This means that the increasing market shares of EV will not lead to lower overall emissions resulting from vehicle use. A push for EV might not make sense at the moment and or new technologies, e.g. for HVAC of vehicles need to be developed.

Thank you for your attention!

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