FABRIC

Feasibility analysis and development of on-road charging solutions for future electric vehicles

# System-level assessment of electrified road solutions

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# If technology is ready…..

- The question becomes:

What are the system-level effects of large-scale deployment of on-the-road charging solutions?

- Multi-dimensional problem
  - Economy, Society, Ecology
- Spatiotemporal character
  - Where to start when, and how?
- With many stakeholders

# Stakeholders

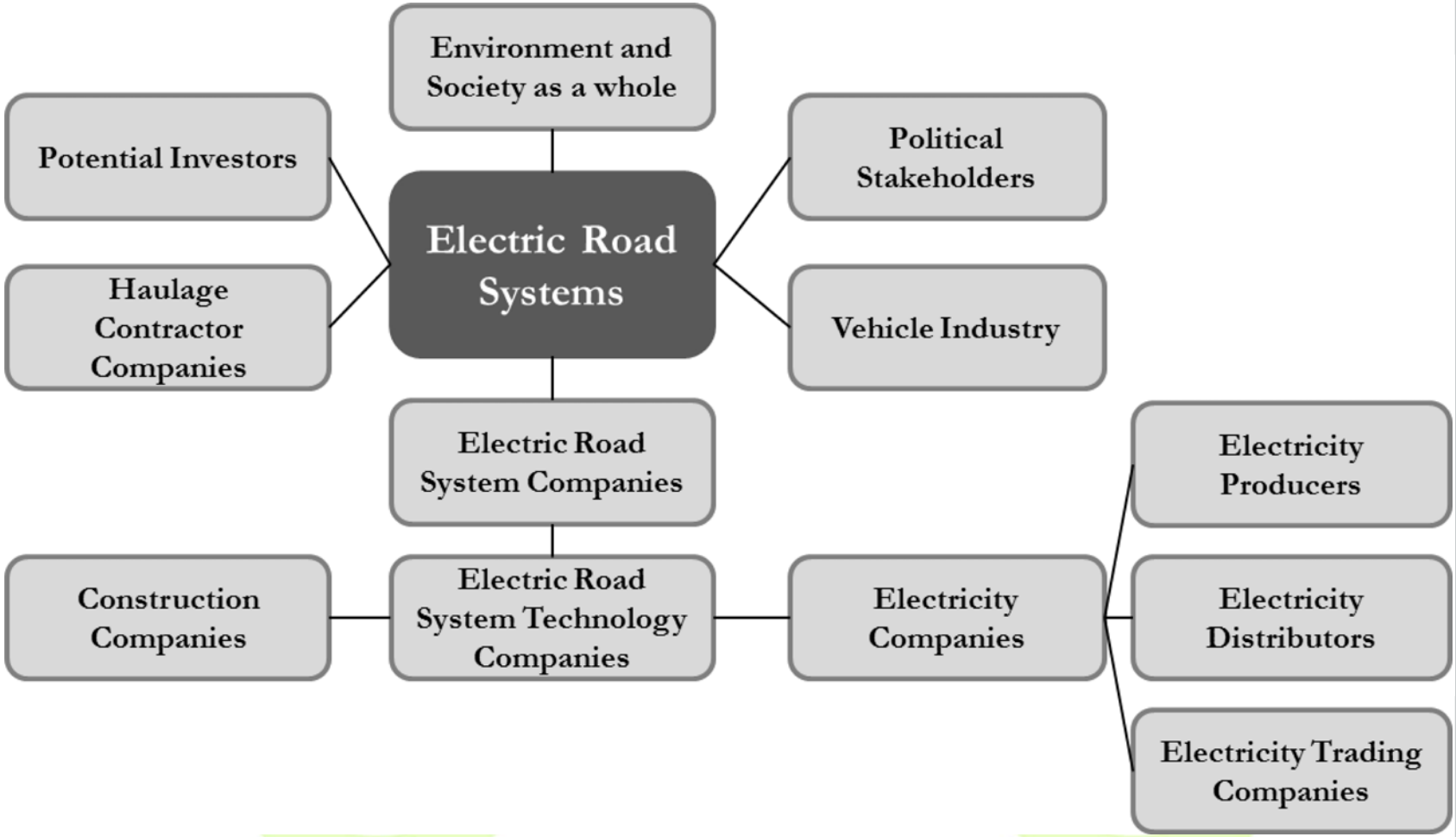



**Figure 12: Electric Road System stakeholders (Andersson & Edfeldt, 2013).**

# Feasibility Study and Assessment

- Both based on the same integrated framework

- Feasibility study: looks for blocking factors and uncertainties
- Assessment study: assesses the specific outcomes of FABRIC

- Risk of producing useless paperwork
  - Take point of view of (public) decision makers
  - Need to manage integrated approach
  - Experts are needed, but generalists need to connect

- FABRIC SP5: deadline Dec 2018 ☺

# Development of methodology

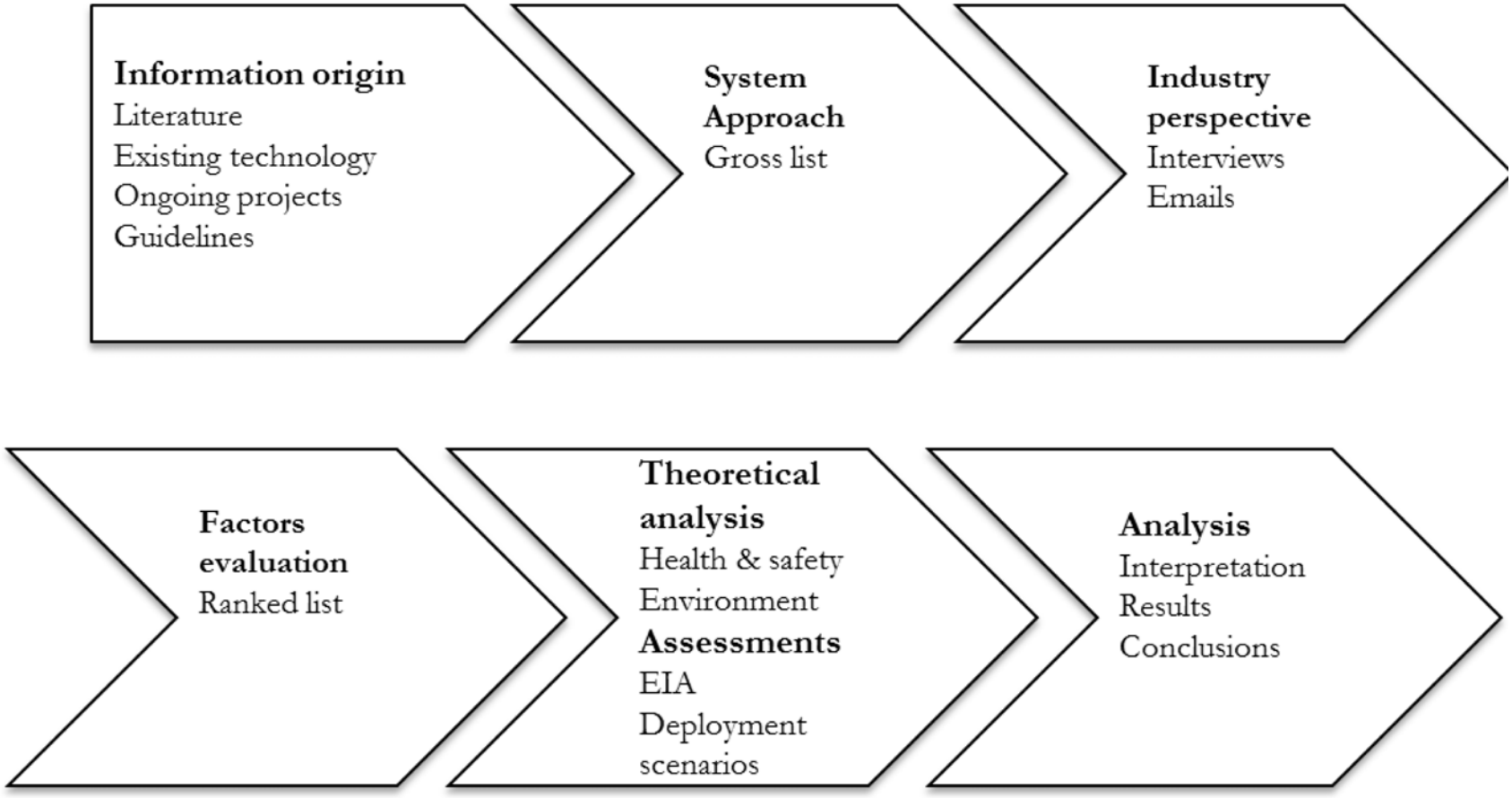


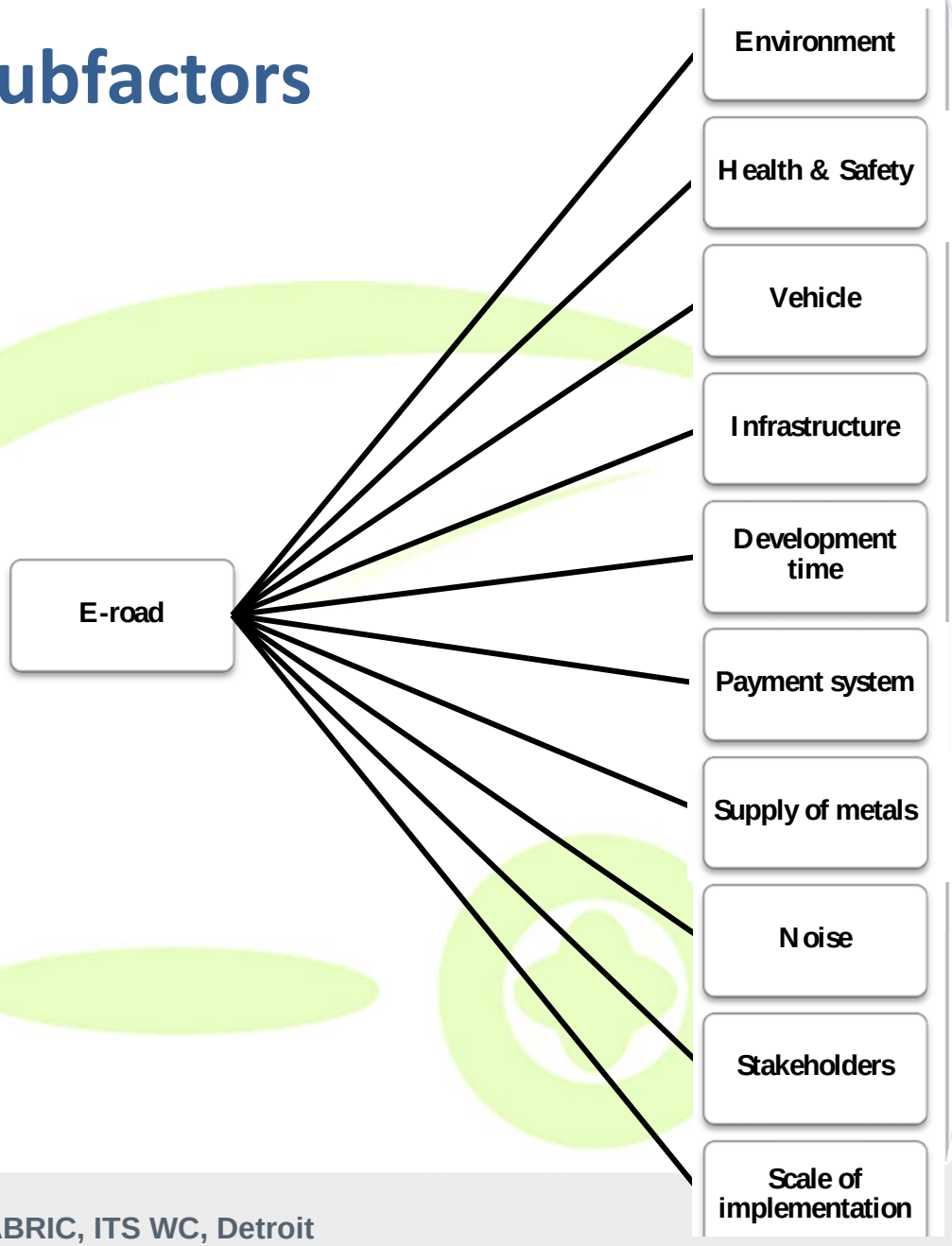

**Figure 1: Feasibility study procedure.**

# Hierarchie tree of subfactors

Hard to compare factors

Analysis of blocking factors

‘Is the risk on factor X so significant that this could block successful deployment?



# Quantitative and qualitative

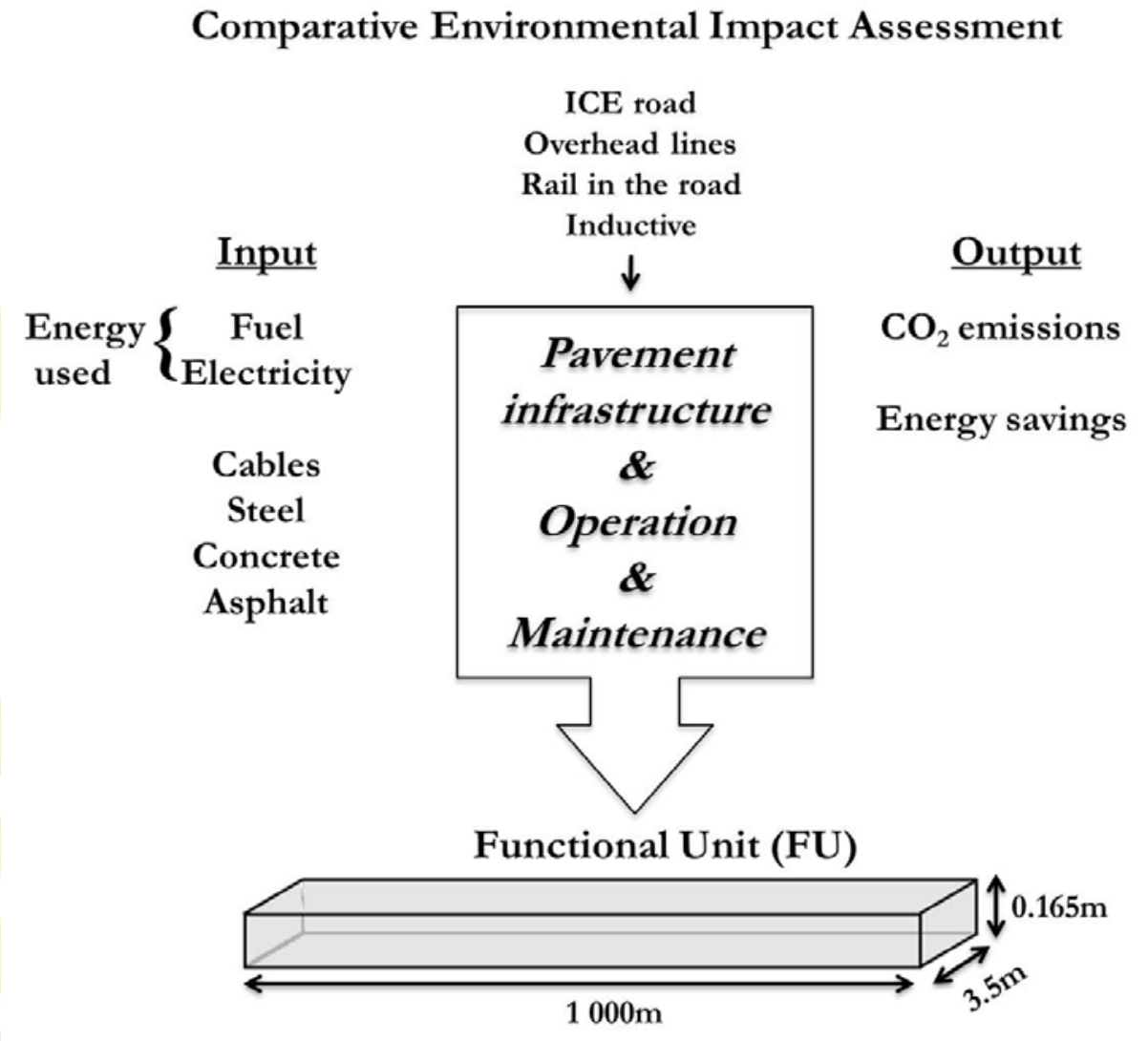
- Structural equations, each comprised of sub-calculation models
- Webs of relationships of variables

| Equations/Quantitative | |
|---|---|
| Energy Demand | E (kWh) = {Infrastructure phase}+{Operation phase}+{Maintenance phase}<br><br>E (kWh) = {Materials production}+{(Driven km)*(Energy consumption, kWh/km)*(1-Energy Losses %)}+{Maintenance procedures} |
| Particles & Pollutants | $CO_2$ (g) = {Infrastructure phase}+{Operation phase}+{Maintenance phase}<br><br>$CO_2$ (g) = {Materials production}+{Energy production}+{Maintenance procedures} |
| Vehicle cost | C (SEK) = {Battery (weight-capacity-price)}+{Electric motor}+{Shielding} |
| **Relations/Qualitative** | |
| Electro-Magnetic Fields (EMF) | EMF={(Exposure Time-sec),(Distance from source-m),(Frequency-Hz),(Strength-V),(Flux-T)} |
| Infrastructure equipment | I = {Topography, Grid voltages, Level of coverage} |

# Comparative approach

Dramatically reduces the uncertainty due to unknowns in input variables

Takes advantage of partial studies done elsewhere



# Some initial results

- Only done for freight vehicles in logistics in Sweden

- Technology: inductive and conductive
- Users: heavy trucks and distribution vehicles (<3500kg)
- Deployment: Long-haul transport and city distribution

- Constraints on battery weight / capacity
- All based on public numbers and industry contacts

- …strong technology push

# Inductive and conductive solution compared

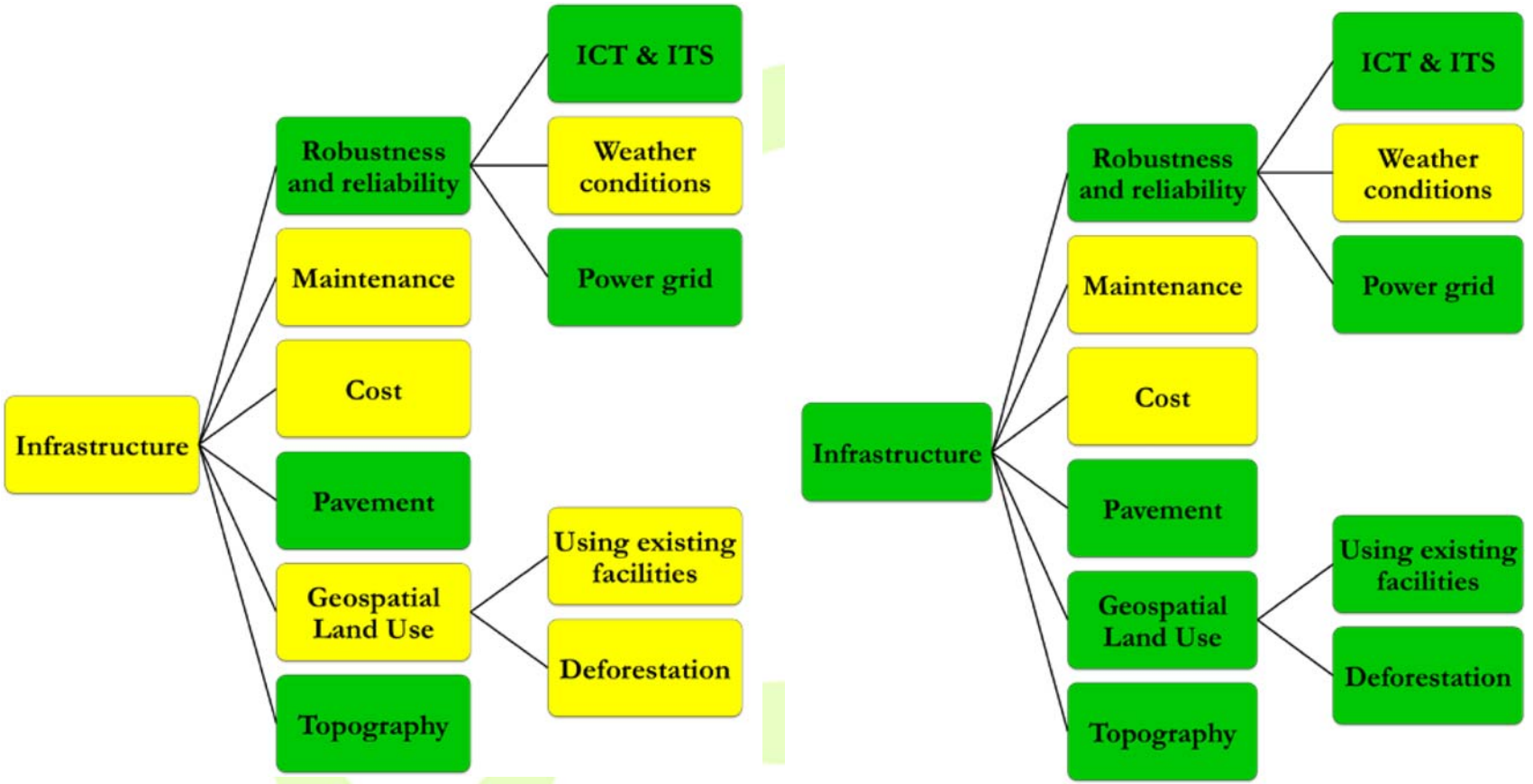


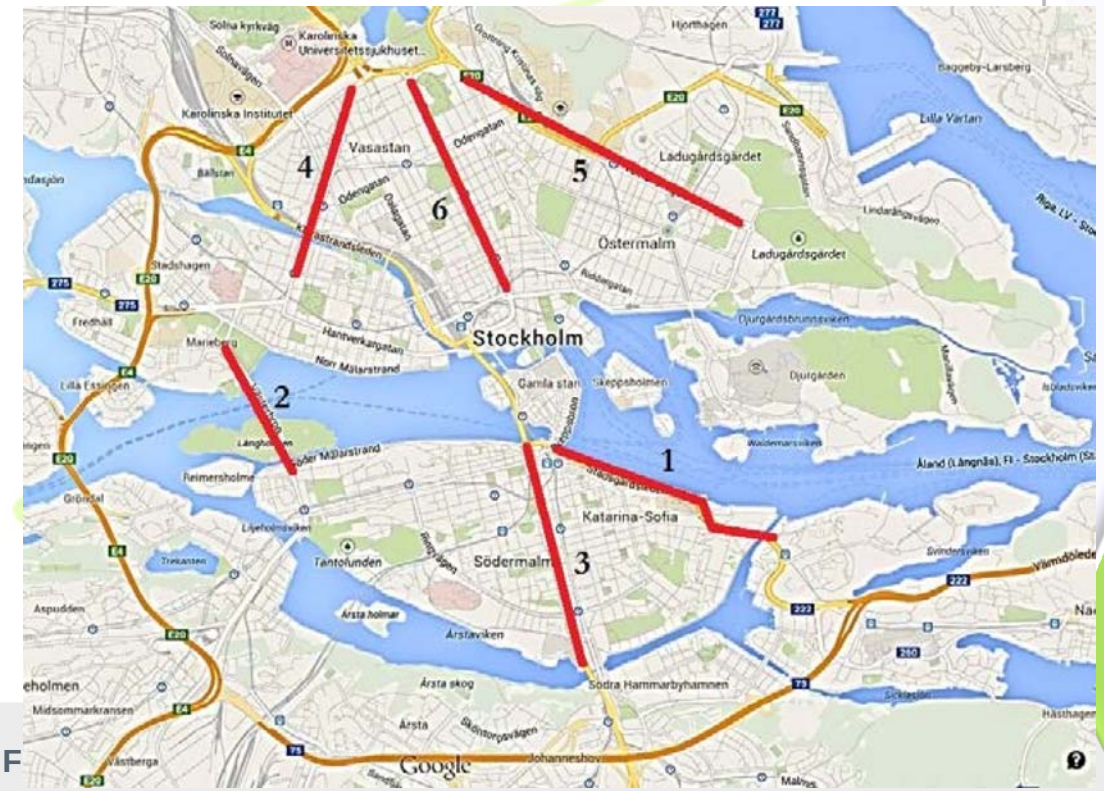

**Figure 34: Infrastructure subfactors for inductive (left) and conductive (right) ERS.**

# More initial results

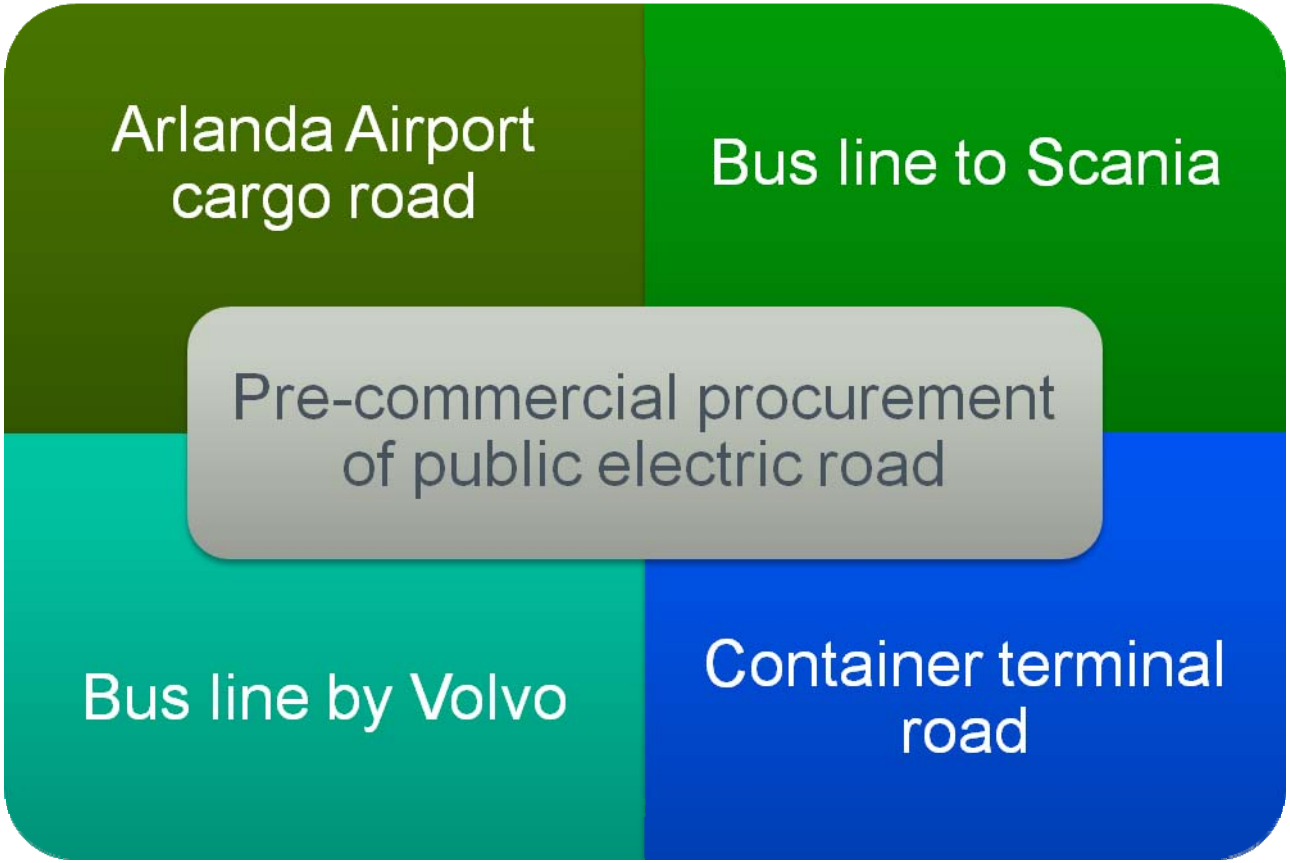
- Feasible: city distribution with partial coverage

- Difficult: long haul trucks – conductive
- Very difficult: long haul trucks – conductive

- Large uncertainties
  - EMF (inductive)
  - Certification
  - Business model
  - Dangerous goods
  - Battery production
  - Infrastructure life



# Swedish developments: happening now!



# Concluding

- Complexity of decision-making on ERS > ITS
  - Many stakeholders, large uncertainties
- Overhead lines appear most feasible
  - Limiting to freight / buss
  - Acceptance in landscape / city?
- EMF is major uncertainty for inductive charging
- Further study with simulations, scenario studies, and more
  - Electric grid, ICT, road infrastructure, business aspects

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# Thank you!


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