TAMPERE UNIVERSITY OF TECHNOLOGY

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# Electric vehicles in electricity grids

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Picture: Georgia Power ET

An EV and a charging station in 1912

# Content of the presentation

1. Introduction
2. Threats and opportunities of EVs to the electricity system
3. Towards an effective and reasonable electricity system
4. Conclusions

# 1. Introduction

# EVs in electricity networks – should we care?

- If we have only small amounts of EVs, we don’t have to care…
- If we have large amount of EVs we should care.
- If we have large amount of EVs with high-power charging, we really should care!

# Will we soon have lots of EVs?

- The main barriers for electrification of road transportation…?
- EV prices and especially battery prices (especially for full EVs) are quite high
- How will the prices be in the future?
  - Global Lithium-ion battery market in 2015 was about 55 GWh.
  - Roughly 69 million cars were produced in 2015
  - 5% of full EVs with 60 kWh battery packs…
  - …207 GWh/a additional battery need!

# 2. Threats and opportunities of EVs to the electricity system

# EVs affect different actors of the electricity system

- EVs can have different roles in electricity system:
  - Load
  - Controllable load
  - Controllable electricity storage
- EVs are only one type resource among other distributed energy resources (DER)!
- DERs affect to different actors of the electricity system:
  - Energy companies/electricity retailers
  - Distribution system operators (DSO)
  - Transmission system operator (TSO)

# Threats and opportunities from different actors points-of-view

| Actor | Threat | Opportunity |
|---|---|---|
| **Electricity retailers** | Unpredictable variations in consumption which increases the financial risks in electricity market | Controllable DERs as resources for demand response in electricity market |
| **Distribution system operators** | Increased peak loads in the networks | Controllable DERs could offer new tools for network management |
| **Transmission system operator** | Increase (and especially unpredictable increase) in national electricity (peak) demand | Controllable DERs could offer new resources in power system reserves |

# 3. Towards an effective and reasonable electricity system

# Minimizing threats and maximizing opportunities

- There are some conflicts of interest between different actors

| Actors | Conflicts of interests |
|---|---|
| Electricity retailer/energy company + DSO | Controlling DERs in accordance of the spot price might increase the peak loads in the distribution network.<br><br>DSO could use DERs for the purposes of the distribution network operation, and this could cause financial risks to the retailer. |
| DSO + TSO | DSOs would like to have low peak powers in the distribution networks, but the use of the DERs' flexibility might increase the peak powers or pose other technical problems to the network. |
| TSO (via a possible "third party") + Electricity retailer | If DERs would be used into operation of the power system for example in form of reserves, this would pose financial risk to the retailer. |

# Solution possibilities to the conflicts of interest

- Power based (or capacity use intensive) distribution tariffs might help DSOs to restrict the increase of peak loads
- Rules for increasing the retailers' financial risks by the non-retailer actors should be agreed
  - Direct financial compensation to the retailers by the actor controlling DERs?

# 4. Conclusions

# Conclusions

- EVs (with other DERs) pose threats and opportunities to the electricity system
- Conflicts of interests should be managed and rules should be agreed in the electricity market

# Thank you for your attention!

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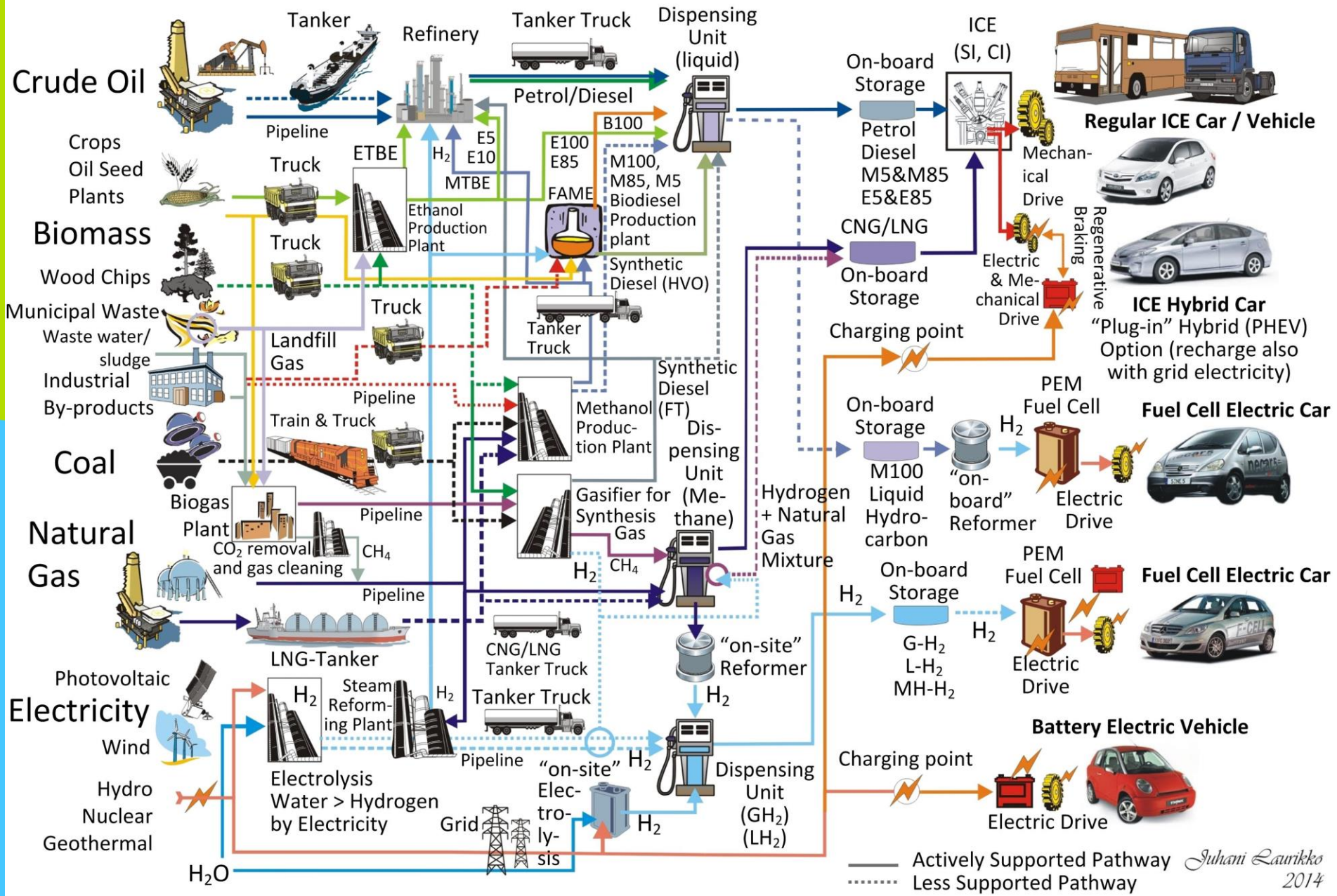
Source
Fuel Production
Distribution
End Use
Crude Oil
Biomass
Coal
Natural Gas
Electricity
Photovoltaic
Wind
Hydro
Nuclear
Geothermal
Crops
Oil Seed
Plants
Wood Chips
Municipal Waste
Waste water/ sludge
Industrial By-products
Biogas Plant
Tanker
Pipeline
Refinery
Tanker Truck
Petrol/Diesel
Dispensing Unit (liquid)
Truck
ETBE
E5
E10
MTBE
E100
E85
B100
M100, M85, M5 Biodiesel Production plant
FAME
Ethanol Production Plant
Synthetic Diesel (HVO)
Landfill Gas
Train & Truck
Methanol Production Plant
Synthetic Diesel (FT)
Dispensing Unit (Methane)
Gasifier for Synthesis Gas
$CO_2$ removal and gas cleaning
$CH_4$
LNG-Tanker
CNG/LNG Tanker Truck
Steam Reforming Plant
Electrolysis Water > Hydrogen by Electricity
$H_2O$
Grid
"on-site" Electrolysis
"on-site" Reformer
Dispensing Unit ($GH_2$) ($LH_2$)
Hydrogen + Natural Gas Mixture
ICE (SI, CI)
On-board Storage
Petrol
Diesel
M5&M85
E5&E85
CNG/LNG
Mechanical Drive
Regenerative Braking
Electric & Mechanical Drive
Charging point
Regular ICE Car / Vehicle
ICE Hybrid Car
"Plug-in" Hybrid (PHEV) Option (recharge also with grid electricity)
PEM Fuel Cell
M100 Liquid Hydrocarbon
"on-board" Reformer
Electric Drive
Fuel Cell Electric Car
G-$H_2$
L-$H_2$
MH-$H_2$
Battery Electric Vehicle
Actively Supported Pathway
Less Supported Pathway
Juhani Laurikko
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