FORMAT Case Study
A vehicle for everyday use in 2030

Stage T

Introduction

Agenda:

1. Introduction to methodology
2. Case study description
3. Overview on stages of forecasting
4. Forecast presentation
5. Summary

Marek Mysior eng.
Mechanical engineering
Mechanical engineering dept.
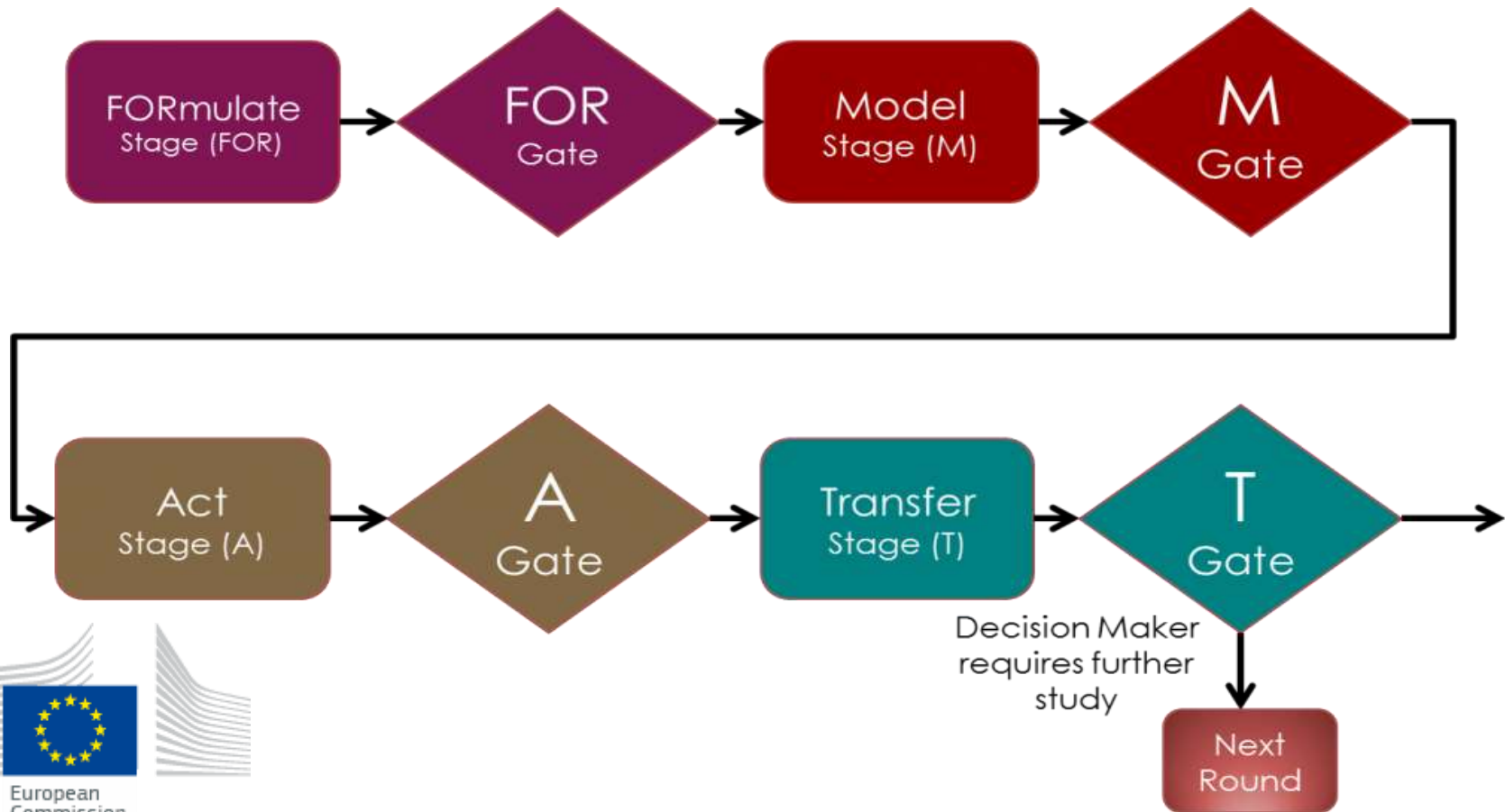Wrocław University of Technology

Bartosz Pryda eng.
Production management
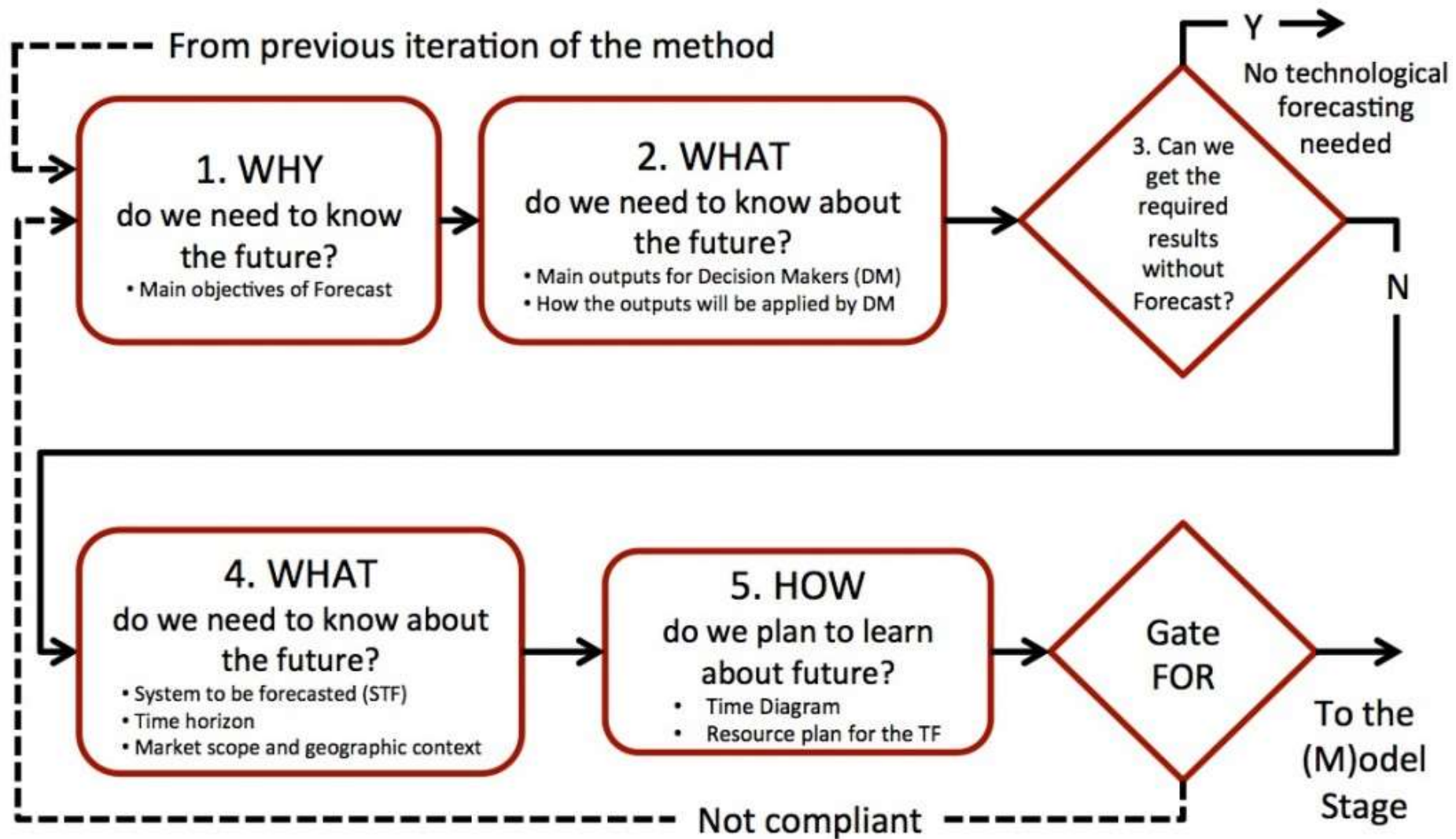Mechanical engineering dept.
Wrocław University of Technology

Sebastian Koziołek PhD
Meritorical suport
Wrocław University of Technology

Introduction do FORMAT methodology

Stage: FORmulate

Stage: FORmulate

FORMAT
Forecast and Roadmapping
for Manufacturing Technologies

1: WHY
Do we want to know the future?

- To design an innovative vehicle
- To suport strategic decisions on vehicle development
- To create a development plan

2 & 4: WHAT
Do we need to know about the future?

- Key function of the vehicle
- Key parameters of the vehicle
- Time horizon: year 2030

3: CAN WE
Get the required results without forecasting?

- No, we cannot
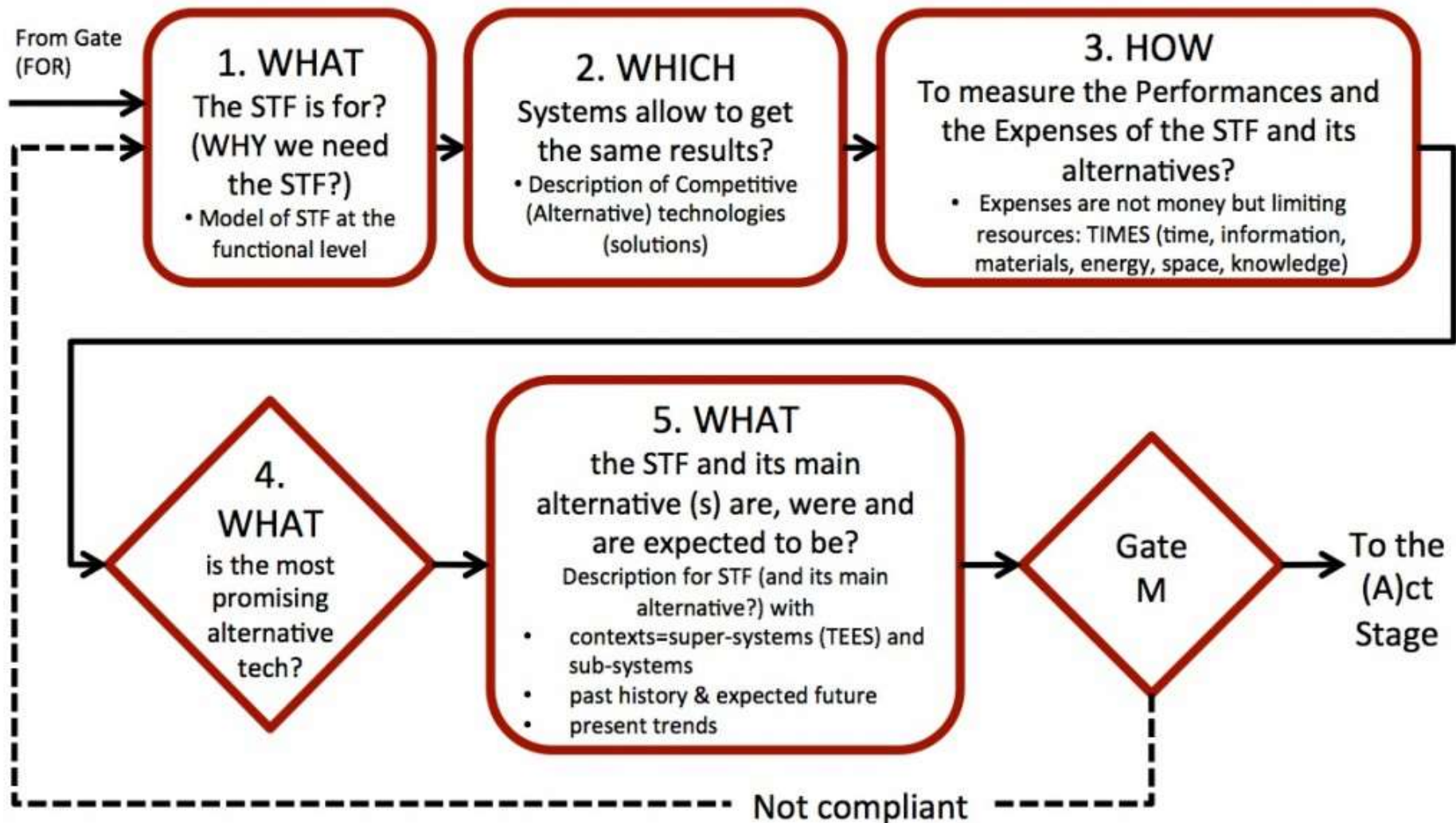
5: HOW
Do we plan to learn about the future?

Year 2030, Europe

Stage: Model

Stage: Model

1. WHAT
The STF is for?
(WHY we need
the STF?)
• Model of STF at the
functional level

2. WHICH
Systems allow to get
the same results?
• Description of Competitive
(Alternative) technologies
(solutions)

Energy

Human in point A

Transport of human
with his belongings
from point A to B

Human in point B

Stores
Protects
Gives pleasure

Accidents
Resource usage
Gas emission
Parking
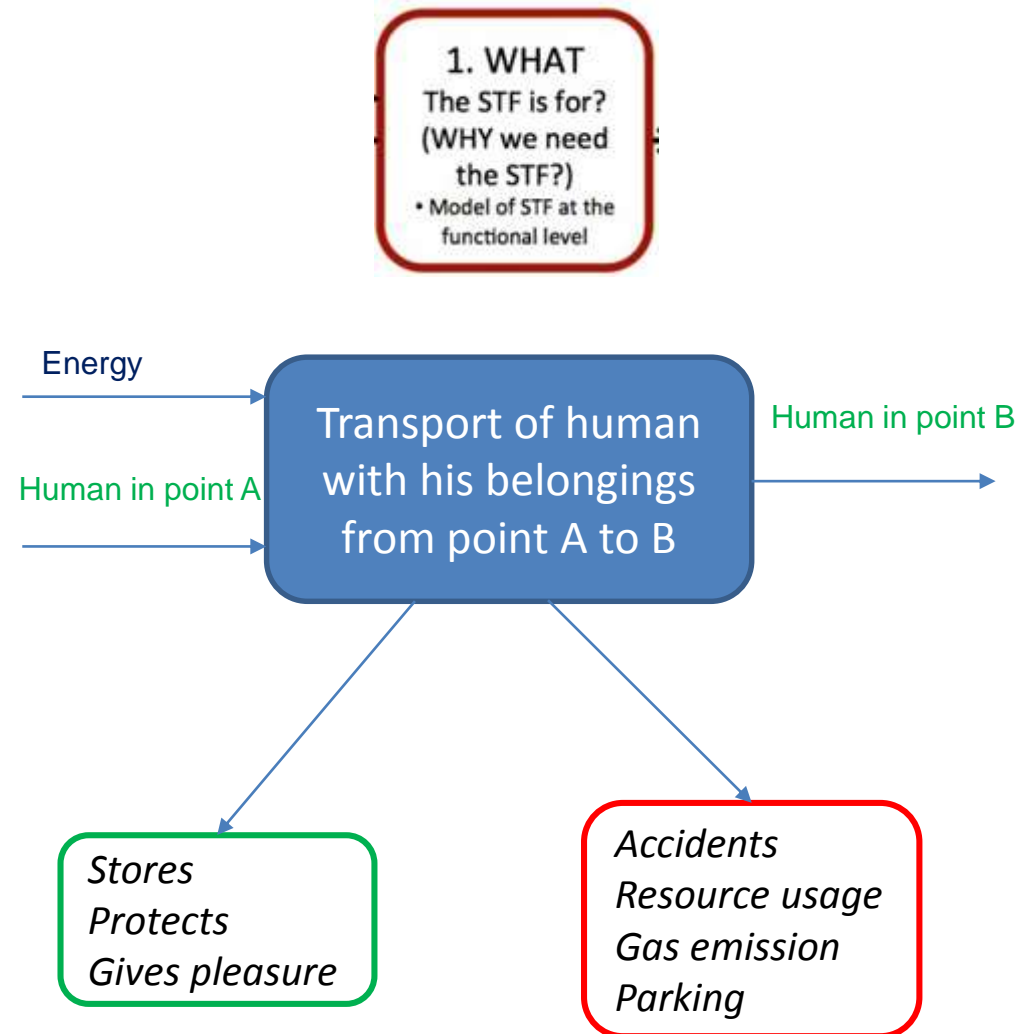
Stage: Model

3. HOW
To measure the Performances and the Expenses of the STF and its alternatives?
- Expenses are not money but limiting resources: TIMES (time, information, materials, energy, space, knowledge)

Transportation size [Gpkm]
No. of fatalities per 1000 inhabitants [#] — *Performance*

Time of travel [min]
Number of support systems [#]
Crude steel production [thous. tonnes] — *Expenses*
Fuel production [thous. barrels]
New roads length [km]

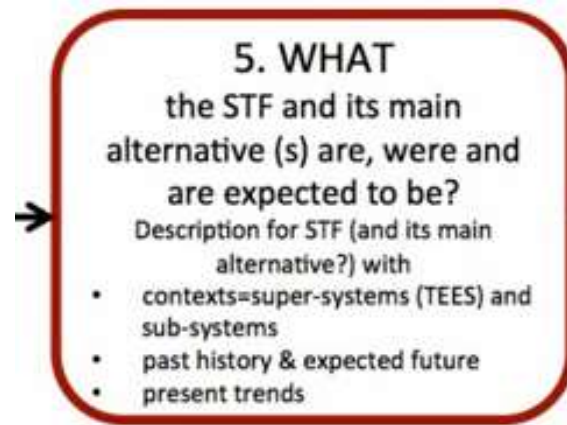**4. WHAT** is the most promising alternative tech?

Stage: Model
System operator

5. WHAT
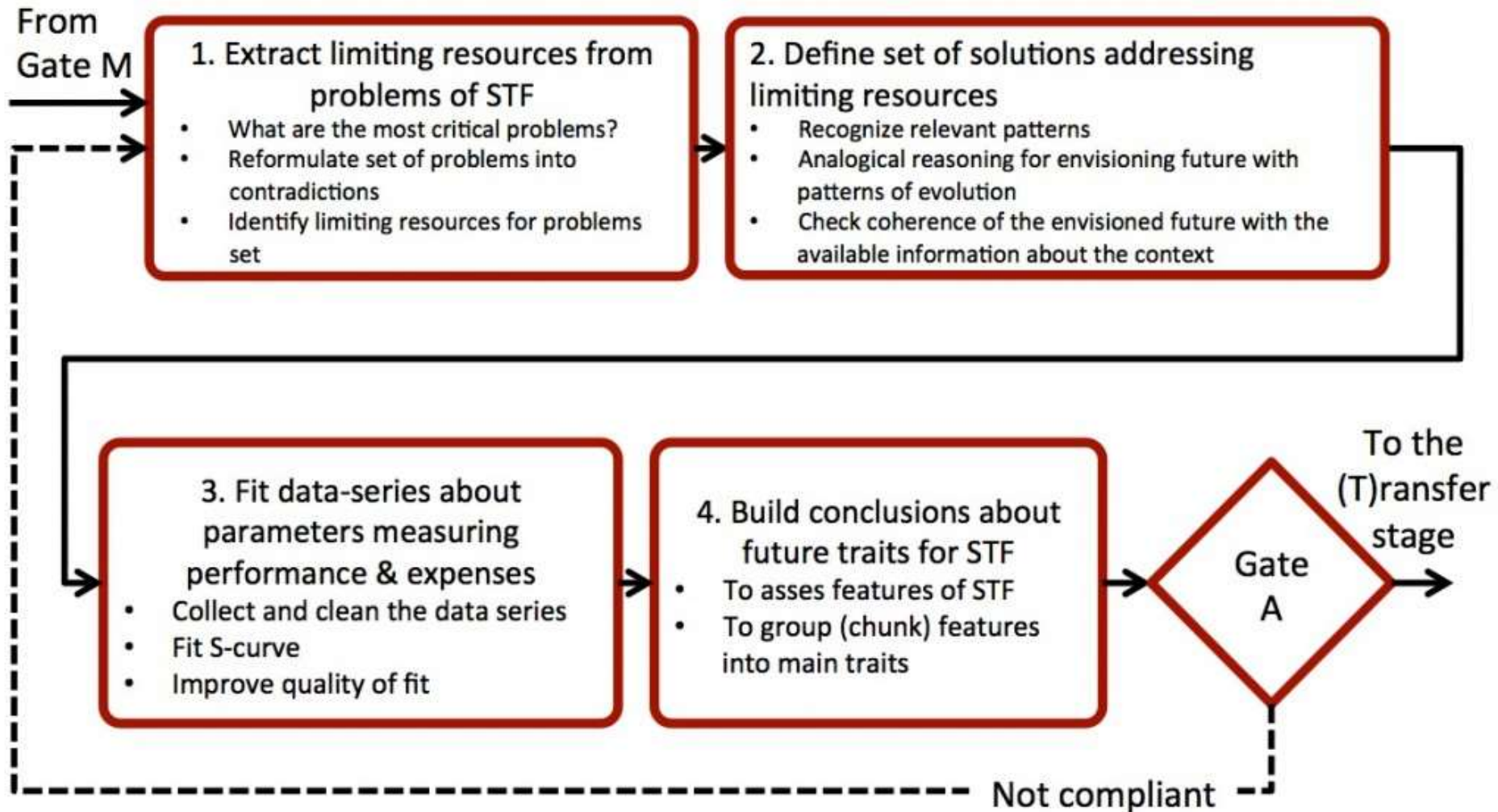the STF and its main alternative (s) are, were and are expected to be?
Description for STF (and its main alternative?) with
- contexts=super-systems (TEES) and sub-systems
- past history & expected future
- present trends

Supersystem: Transportation system (alternative technologies)		
Past: 2000	**Present: 2015**	**Future: 2030**
✓ Less people travelling by car ✓ Less cars on the roads ✓ Higher fuel consumption ✓ Higher car density on the roads ✓ Higher GHG emission	✓ More people travelling by car ✓ More cars on the roads ✓ Lower fuel consumption ✓ <u>Lower car density on the roads</u> ✓ Lower GHG emission	✓ More people travelling by cars ✓ Much more cars on the roads ✓ Much higher fuel consumption ✓ <u>Slightly lower car density on the roads</u> ✓ Slightly lower GHG emission

System: A vehicle for everyday use

Subsystem: expenses (TIMES: crude steel production, oil production, time of travel)

Stage: Act

FORMAT
Forecast and Roadmapping
for Manufacturing Technologies

From Gate M

1. Extract limiting resources from problems of STF
- What are the most critical problems?
- Reformulate set of problems into contradictions
- Identify limiting resources for problems set

2. Define set of solutions addressing limiting resources
- Recognize relevant patterns
- Analogical reasoning for envisioning future with patterns of evolution
- Check coherence of the envisioned future with the available information about the context

3. Fit data-series about parameters measuring performance & expenses
- Collect and clean the data series
- Fit S-curve
- Improve quality of fit

4. Build conclusions about future traits for STF
- To asses features of STF
- To group (chunk) features into main traits

Gate A

To the (T)ransfer stage

Not compliant

FORMAT
Forecast and Roadmapping
for Manufacturing Technologies

Stage: Act
System operator

1. Extract limiting resources from problems of STF
- What are the most critical problems?
- Reformulate set of problems into contradictions
- Identify limiting resources for problems set

| Parameters (specific values)	*2000*	*2015*	*2030*
Supersystem: Transportation system (alternative technologies)			
Transportation size [Gpkm]	4291,6	5024,9	More (6475,2)
No of cars per 1000 inhabitants [-]	250	500	Much more
No of cars per 1000 km of roads [thous.]	145	118	Slightly less
GHG emission [Mt CO2 eq.]	1800	1700	Slightly less
Electric vehicle range [km]	120	257	Much more
Time of electric vehicle charging [h]	8	5	Much less
Subsystem: expenses (TIMES: crude steel production, oil production, time of travel)			

(Row group label, rotated: System: A vehicle for everyday use)

Stage: Act
Representative technologies

2. Define set of solutions addressing limiting resources
- Recognize relevant patterns
- Analogical reasoning for envisioning future with patterns of evolution
- Check coherence of the envisioned future with the available information about the context

Representative car in year:		
2000	**2015**	**2030**
VW Golf IV • 1.9 TDI, 90 HP • Diesel • 5 l/100 km • Hatchback • ABS, ESP, cruise control	Nissan Qashqai • DOHC 1.6, 117 KM • Benzyna • 6,7 l/100 km • Crossover • Parking assist, braking assist, active cruise control	• Electric drive • Environmentally friendly • Developed communication

FORMAT
Forecast and Roadmapping
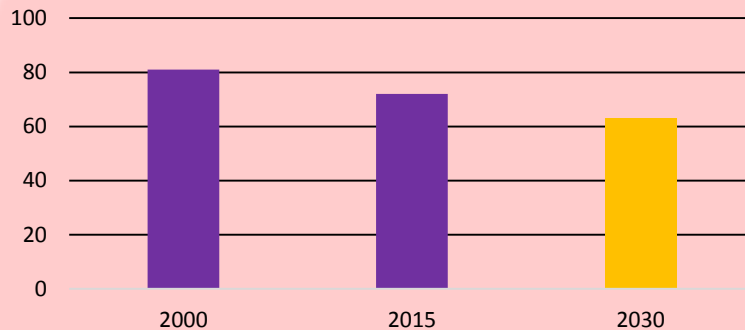for Manufacturing Technologies

Stage: Act
Parameter evolution

3. Fit data-series about parameters measuring performance & expenses
- Collect and clean the data series
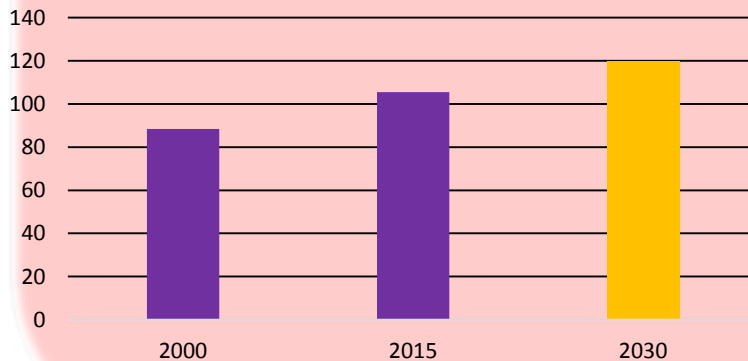- Fit S-curve
- Improve quality of fit

Transportation size [Gpkm]
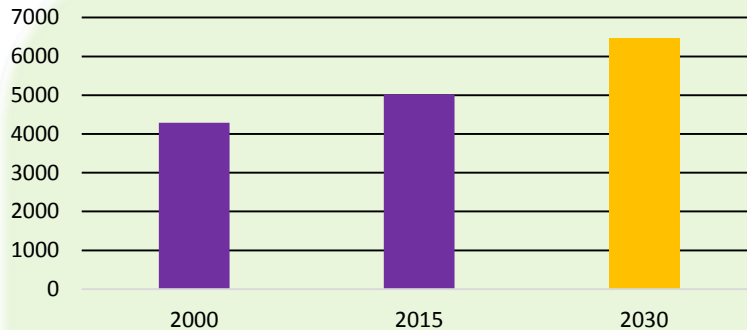
http://ec.europa.eu/dgs/energy_transport/figures/trends_2030/appendix2_en.pdf

GHG emission [mln tonnes CO2]

http://www.epa.gov/climatechange/ghgemissions/sources/transportation.html
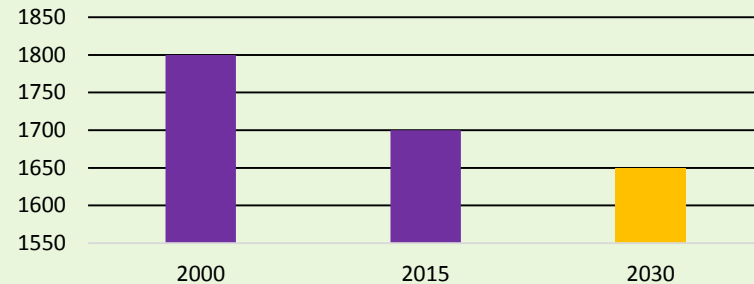
Diesel consumption [l/100km]
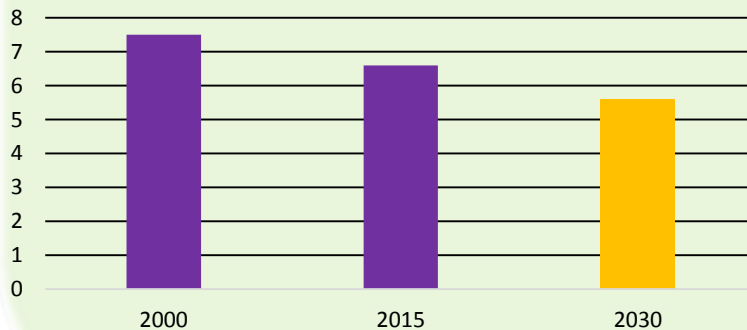
http://www.c2es.org/docUploads/Fuel%20Economy%20and%20GHG%20Standards_010605_110719.pdf

Fatalities [per million of inhabitants]
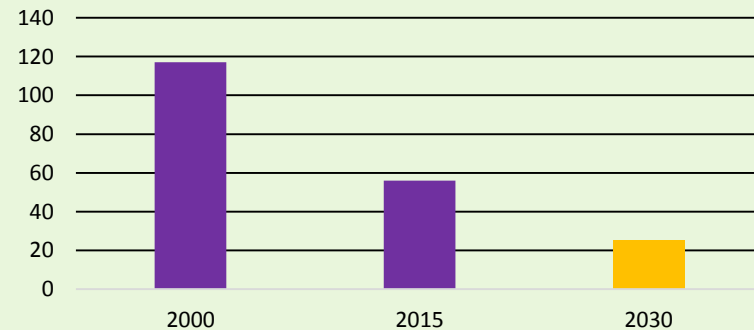
http://ec.europa.eu/transport/road_safety/

Stage: Act
Parameter evolution

3. Fit data-series about parameters measuring performance & expenses
- Collect and clean the data series
- Fit S-curve
- Improve quality of fit

Average daily distance per person [km]

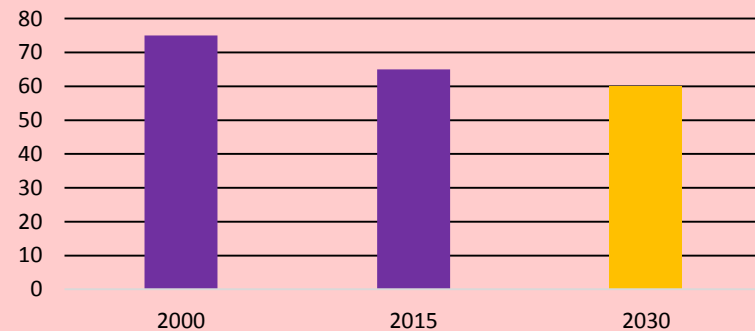http://data.worldbank.org/indicator/

LPG production [thous. tonnes]

https://www.quandl.com/c/energy/liquefied-petroleum-gas-net-inland-availability-by-country

Road density [km/100km^2]
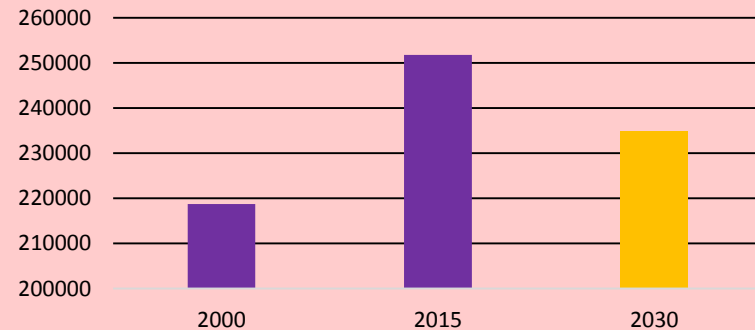
http://data.worldbank.org/indicator/IS.ROD.DNST.K2/countr

Time spent in a vehicle [min/day]

http://data.worldbank.org/indicator/

Stage: Act
Electric vehicles

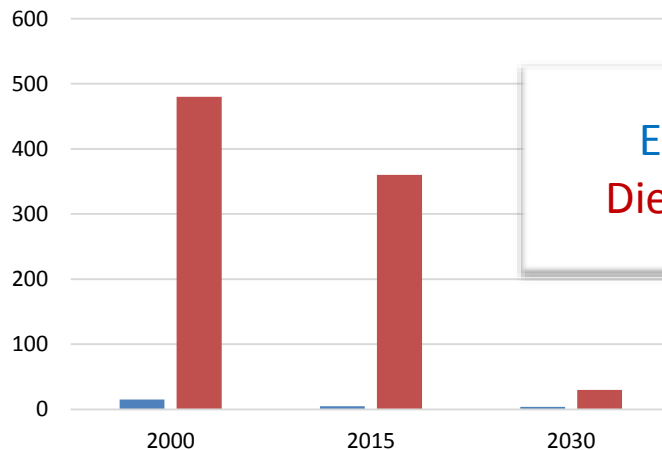4. Build conclusions about future traits for STF
- To asses features of STF
- To group (chunk) features into main traits
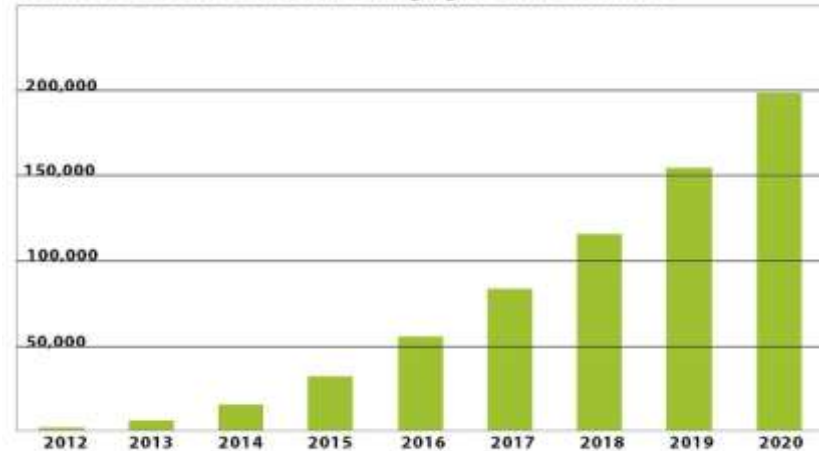
Vehicle range [km]
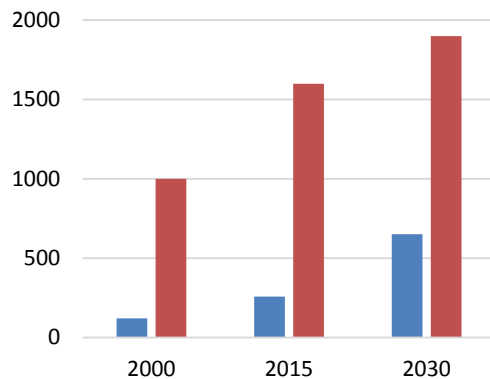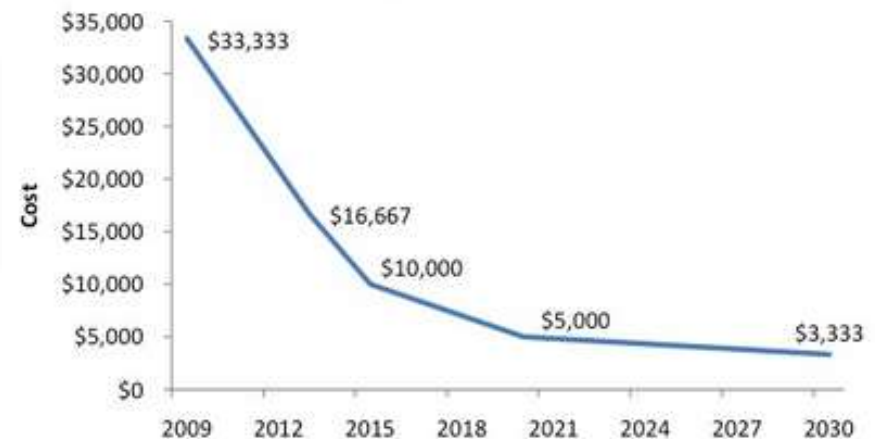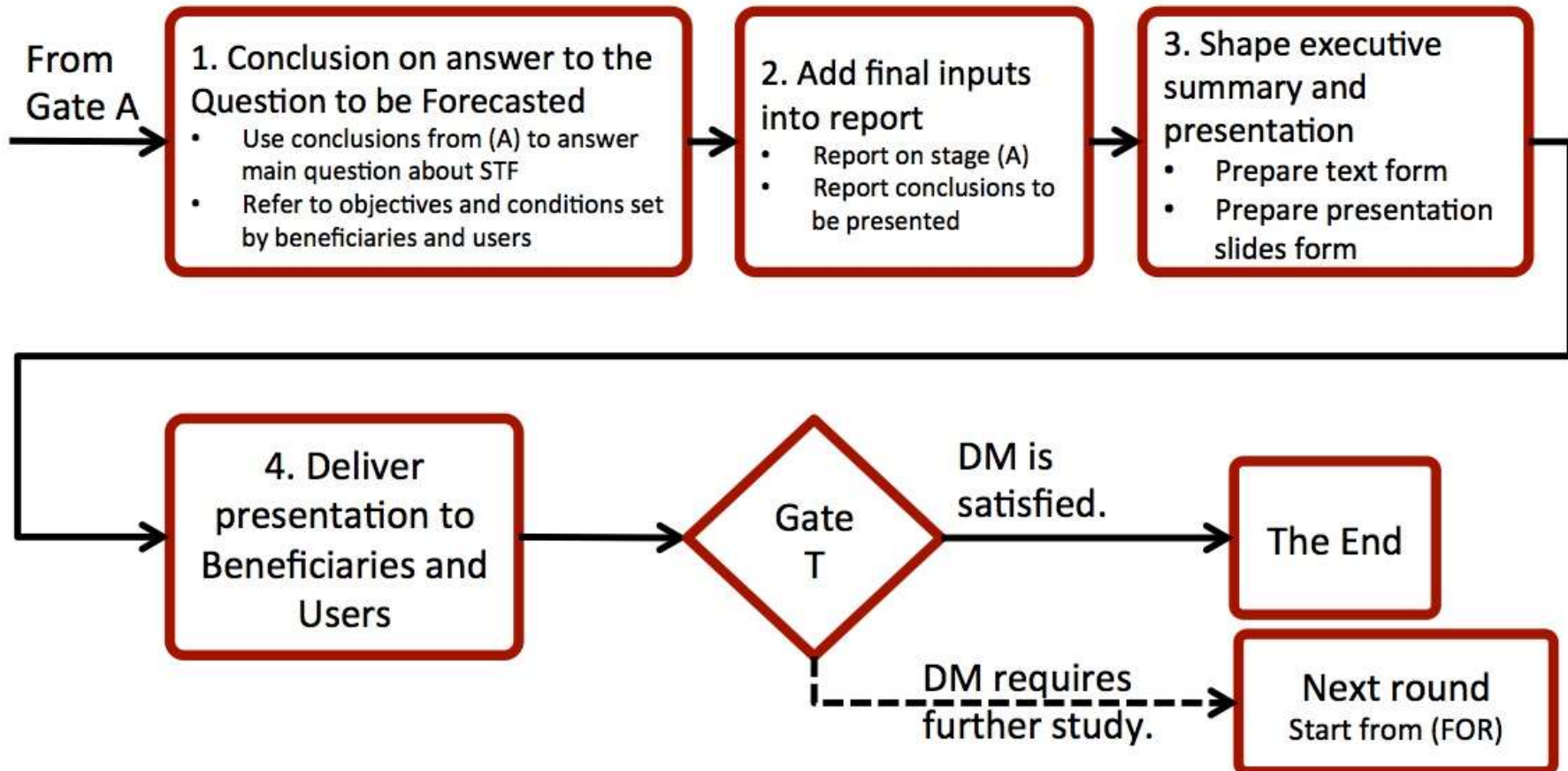
EV
Diesel

Charging time [min]

EV
Diesel

Number of electric vehicle fast-charging stations worldwide

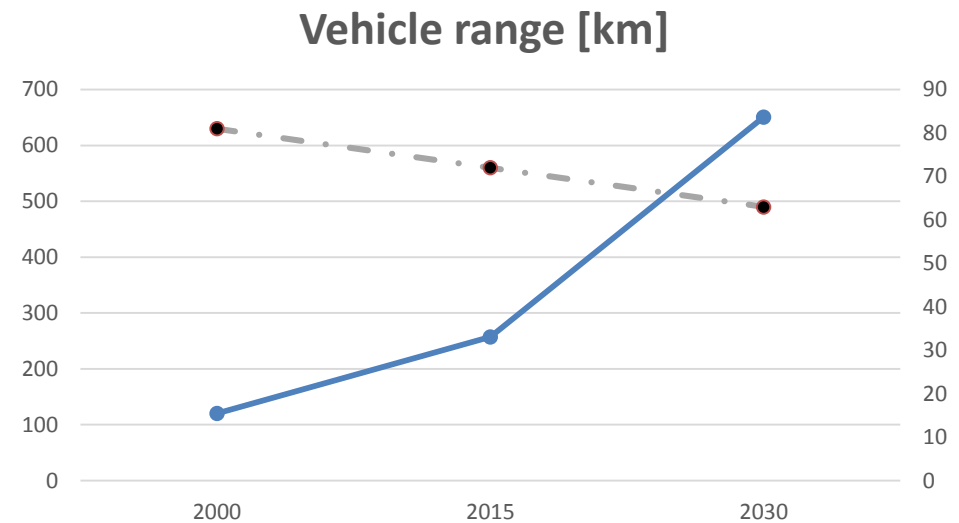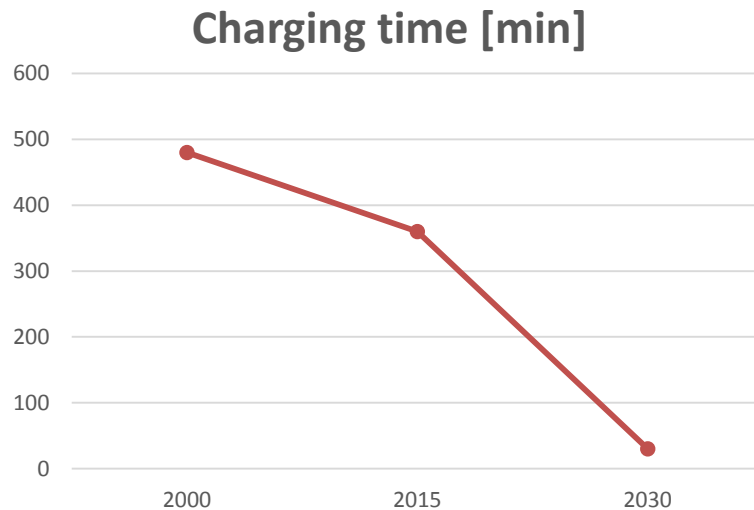### Forecasted Cost of a Typical Electric-Vehicle Battery

Stage: Transfer
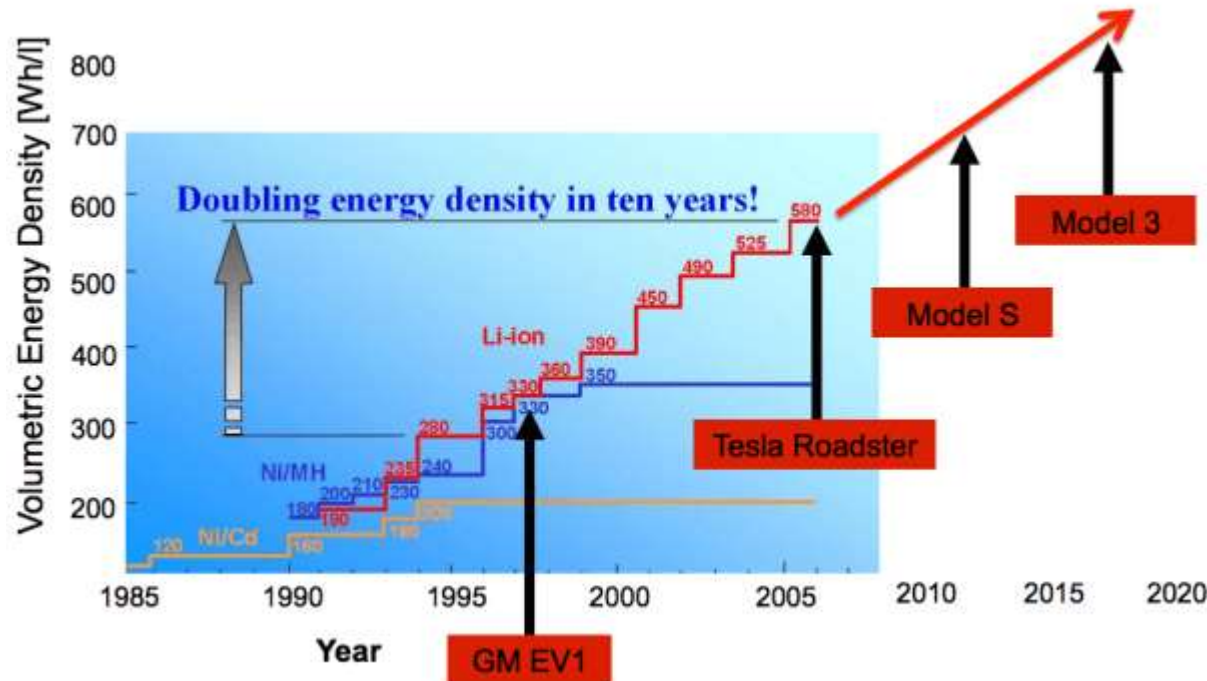
Stage: Transfer

Component: ***Energy source***

Key parameters:

🚗 **Long charging time**

🚗 Short distance

Charging time [min]

Vehicle range [km]

Summary

- ✓ Future automotive industry problems identified
- ✓ Similar solutions in the development stage

Development directions

– Examining the method on other examples

– Verification of its effectiveness with probability