CIR-dagen 2015

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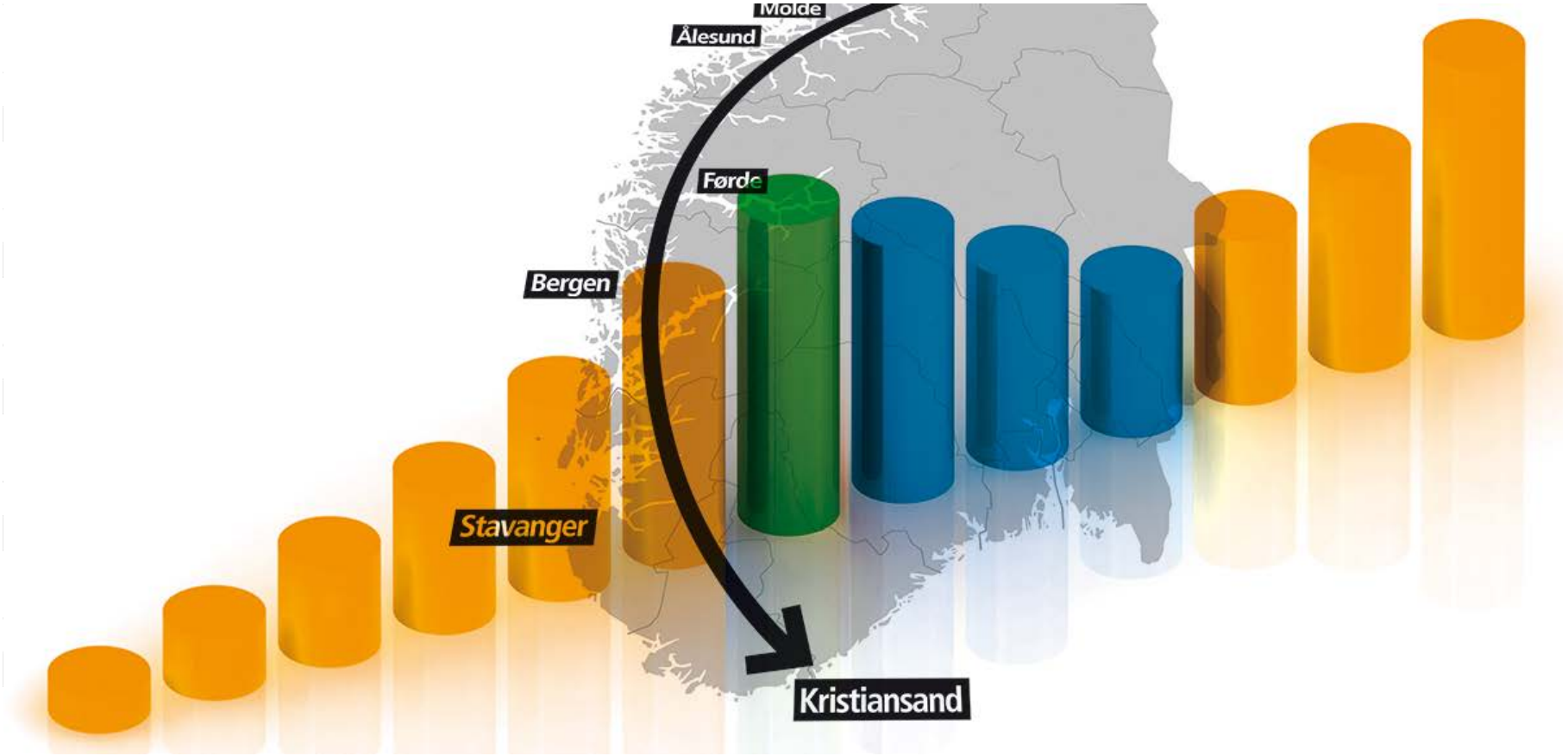
Ferjefri E39-Forskningsutmaningar vid Norges genom tiderna största infrastruktursatsning

30/01/2015

Prosjektleder Ferjefri E39, Energi Mohammed Hoseini, Statens vegvesen Vegdirektoratet



E39 Kristiansand - Trondheim

Approx 1100 km

8 Ferry links Remaining

Approx 150 bn NOK

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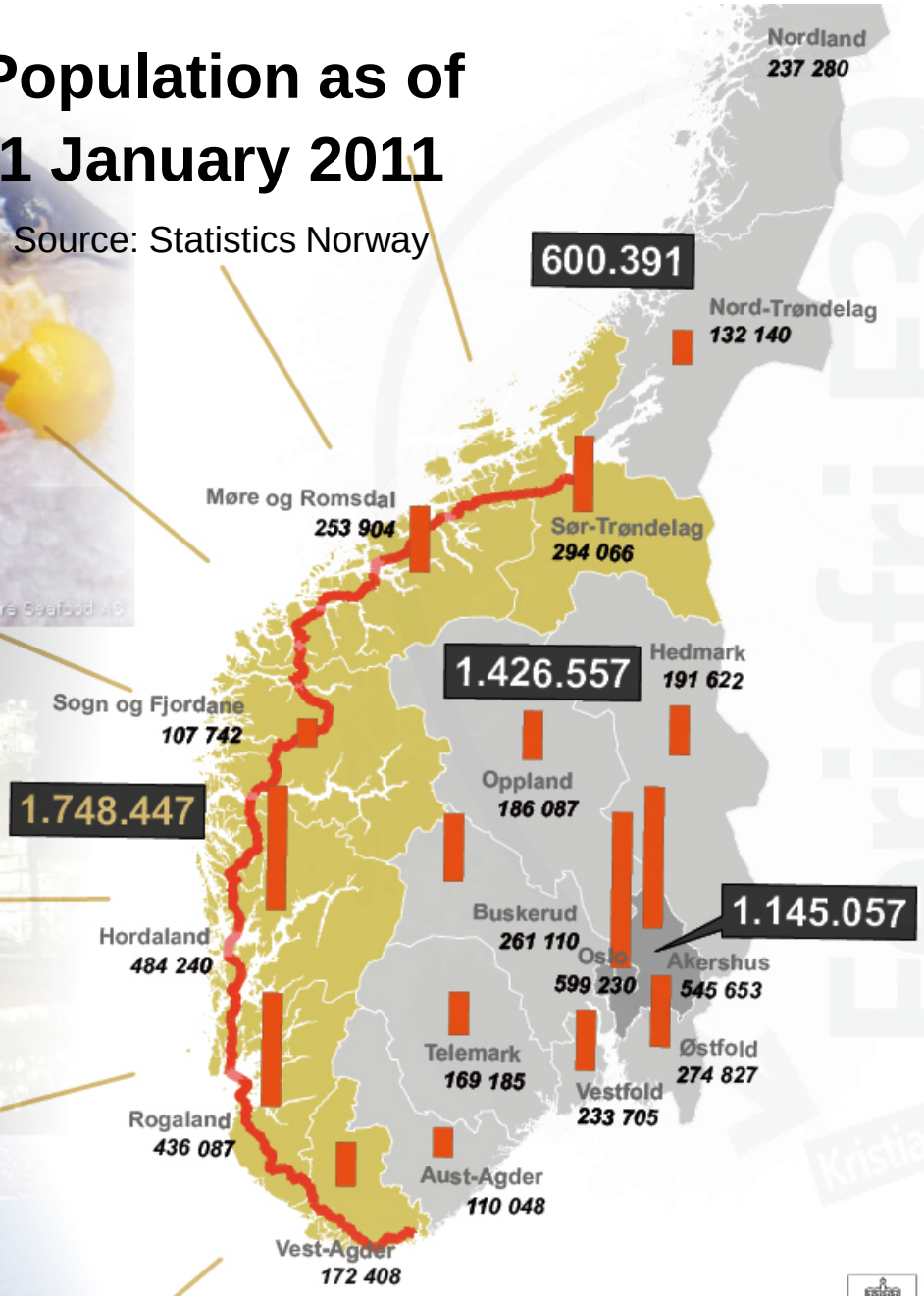
Population as of 1 January 2011

Source: Statistics Norway

50% of Norwegian Traditional Export Value from this area (2010)



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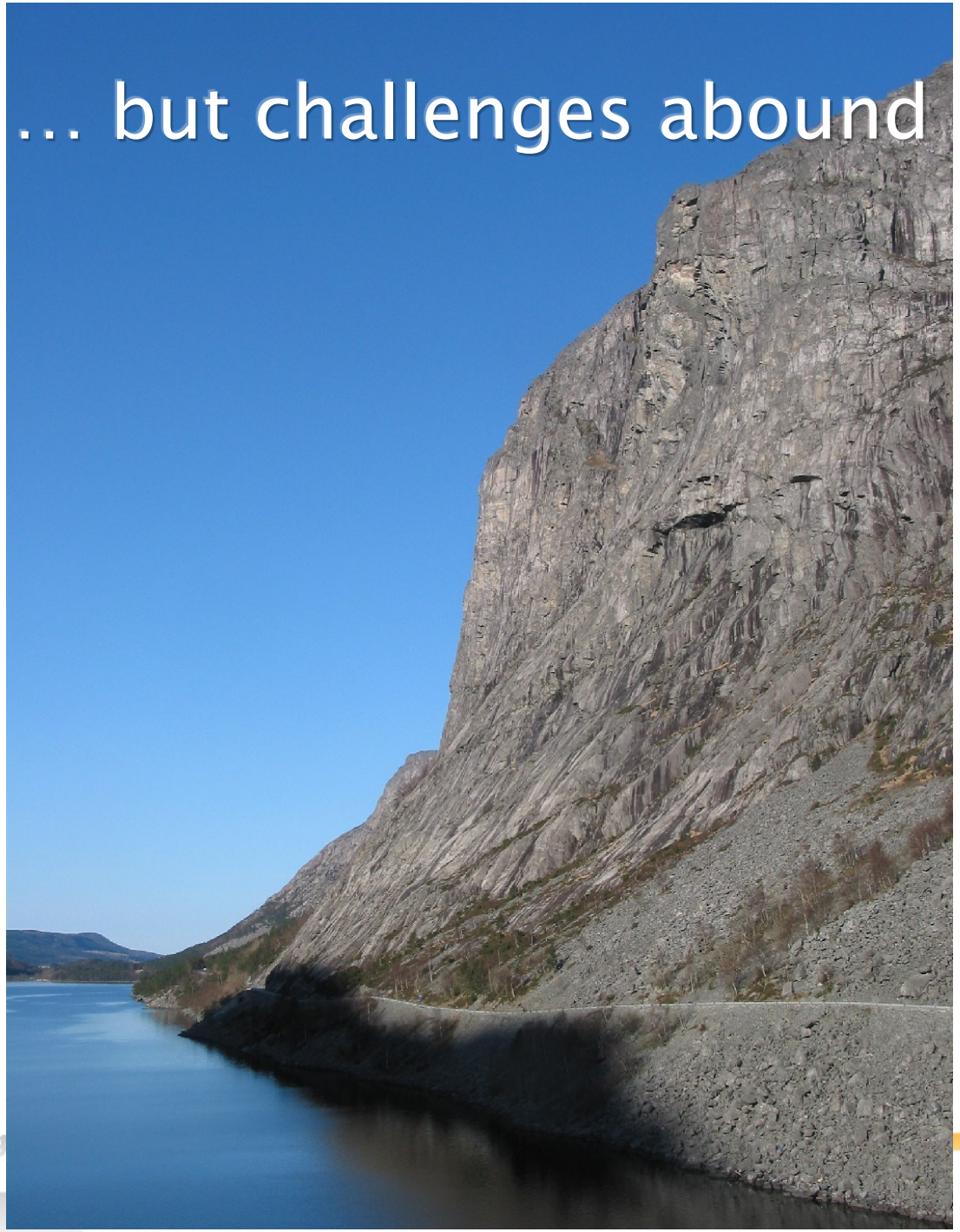
Magnificent Landscapes

… but challenges abound



Topographic challenges require untraditional thinking

Forskningsutfordringene

- De er mange
  - virkninger på samfunn
  - levetid – materialer og bestandighet
  - trafikksikkerhet, drift og vedlikehold
  - miljøsystemanalysene
  - mfl
- **Fjordkryssingene, dvs bruteknologien**
- **«Plussveger»**

Investeringer i teknologisk utvikling

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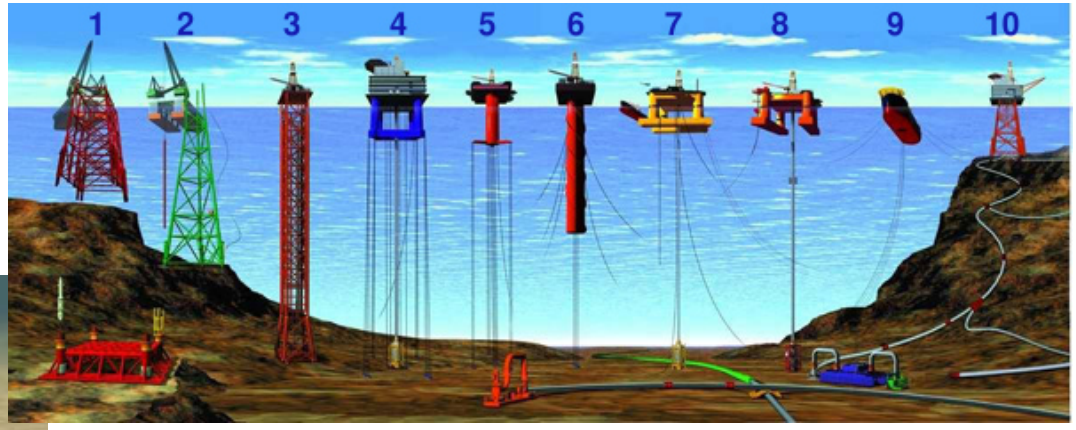
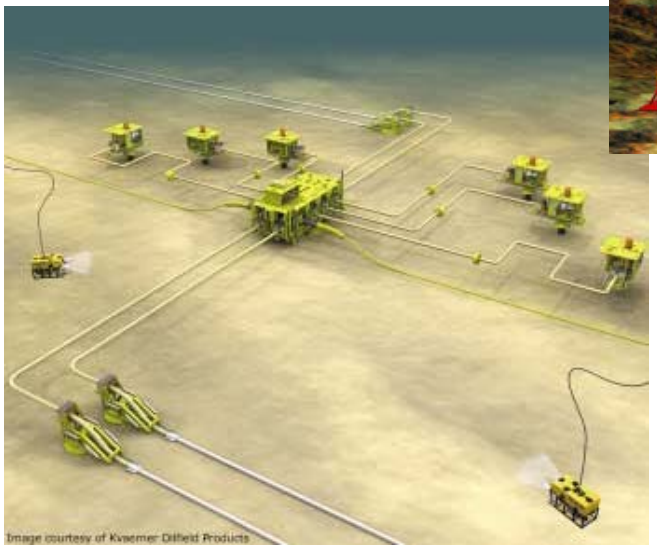
- Ekofisktanken:
  70 m dybde (1973)
- Troll platformen:
  303 m dybde (1995)
- Flytende plattformer forankret på dybder av mer enn 1500 m

Har krevd meget stor forskningsinnsats





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Norge bruker relativt lite på FOU

Andel til forskning og utvikling i 2011 (FOU) av Brutto nasjonalprodukt (BNP):

– Israel	4,39 %	
– Finland	3,78 %	
– Sverige	3,37 %	
– Danmark	3,09 %	
– Tyskland	2,84 %	
– USA	2,77 %	
– Østerrike	2,75 %	
– Slovenia	2,51 %	
– Gjennomsnitt	ca 2 %	av de ca 60 land med oppgitte data
– **Norge**	**1,66 %**	

Utdrag fra: United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics, Catalog Sources World Development Indicators

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Bjørnafjorden

Behovet for FOU er åpenbart

Hengebru med to brutårn på flytende fundament/TLP

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Forskningsutfordringene

Fjordkryssingene

- Hittil hovedsakelig på «rene» konstruksjoner, dvs
  - Flytebruer
  - Rørbruer
  - Hengebruer

- Det neste er kombinasjonene
  - Overgangsmodul fra flytebru til rørbru
  - Fra rørbru til undersjøisk fjelltunnel eller senketunnel
  - Stivhet i forankring og fortøyning ulike steder og elementer

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Fjordkryssinger

Flytebru og rørbru forankra i kunstig sjøbunn

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Fjordkryssingene

Teknisk optimalisering

- Vi er sikre på at det er teknisk mulig, men hvordan gjøre det smartest mulig?

  – Byggemetodene
  – Utnytte nye og «gamle» materialer best mulig
  – Automatisering og robotassistert framstilling

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E39 R&D Program NTNU

WP 1 Fjord Crossings – Identified Projects

- 1.1 Computer simulation of coupled vehicle-bridge systems under severe environmental conditions
- 1.2 Dynamic response of cable-supported bridges with floating towers
- 1.3 Critical load combinations with focus on cable-supported bridges with floating towers
- 1.4 Combined computational fluid structure interaction and wind tunnel studies of bridge deck sections for ultra-long suspension bridges
- 1.5 Hydroelastic stability of submerged floating tunnels
- 1.6 Moored floating bridges and submerged floating tunnels subjected to parametric excitation
- 1.7 Risk assessment for marine bridges with focus on ship collision and fire/explosion
- 1.8 Vortex induced behavior of cable supported bridges
- 1.9 Modelling and analysis of damping in structural systems
- 1.10 Reliability analysis of marine bridges including system effects
- 1.11 Anchoring for fjord crossings at E39
- 1.12 Dynamic modelling and analysis of long span cable-supported bridges subjected to wind loading with emphasis on field measurements
- 1.13 Dynamic modelling and analysis of long span cable-supported bridges subjected to wind loading with emphasis on wind tunnel measurements
- 1.14 Advanced Numerical Modeling of Floating Structures for the E39 Crossings
- 1.15 Force identification using measured dynamic response *)
- 1. 16 Experimental investigation of hydrodynamic behavior of slender submerged bodies *
- 1.17 Ship collisions
- 1.18 Explosion loads and load effects on submerged floating tunnels
- 1.19 Deep foundations

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WP 2 Traffic management

- 2.1 Developing a Transport Model for ferry replacement projects
- 2.2 Traffic modelling and highway design
- 2.3 Weigh in Motion
- 2.4 Section data and travel time
- 2.5 Space (Satellite) Technologies in the Coastal Highway Route E39– Smart Traffic monitoring/management, Traffic safety and Route planning

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WP 3 Road Planning and Pavement technology

- 3.1 Smart use of heated bridge decks
- 3.2 Use of Ground Penetrating Radar (GPR) for quality control
- 3.3 Use of local materials for road construction
- 3.4 Frost protection
- 3.5 Roadway design to reduce emissions and facilitate efficient mobility
- 3.6 Life-like visualization of prospective solutions for E39

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WP 4 Project management

- 4.1 Health, Environment and Safety (HES) – Importance for and learnings from E39-project
- 4.2 Speed-up – Consequences for and learning from E39-project
- 4.3 Uncertainty Management in infrastructure projects – Consequences for and learning from E39-project
- 4.4 Cost development and Cost estimation of Road projects – Consequences for and learning from E39-project
- **4.5 Implementation strategies and types of contracts**

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WP 5 Tunnels

- 5.1 Improved methods for control of large water inflow in deep sub-sea tunnels
- 5.2 Safe use of TBM for long and deep sub-sea tunnels
- 5.3 Identification of geological conditions in road tunnels

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WP 6 Geohazards

- 6.1 Natural hazards: Debris/mud flows
- 6.2 E39 Geotechnical challenge "Protection structures for landslides and rock fall, lighter solutions – flexible culverts"
- 6.3 Space (Satellite) Technologies in the Coastal Highway Route E39– Ground displacement on roads, fjord crossings and surrounding embankments
- **6.4 Effective Countermeasures for the debris & mud flow hazards along the E39 highway**

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WP 7 Materials/Concrete

- 7.1 Improved background for selection of crack width requirements for different types of structural elements and exposure classes
- 7.2 Improved background and materials data for the design basis and calculations methods & Improved background for planning of the construction process

- 7.3 Verification of current design basis for large scale reinforced concrete structures

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WP 8 LCA

- 8.1 Life Cycle Analyses, 2 PhDs

Status November/2014

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8 PhDs Founded by NPRA
2 PhDs and 1 post doc founded by Chalmers

Totally: 10 PhD students and one Post doc

Furthermore: 8 pre-studies were founded by NPRA

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Research activities with Chalmers in 2014

1. Pre-study in assessing the sustainability around the E39 infrastructure corridor
2. Pre-study in the role of microbiological biofilm communities for degradation of sprayed concrete in subsea tunnels
3. Pre-study in induced urban and regional development from a ferry-free E39
4. Graphene feasibility and foresight study for road infrastructure
5. Pre- study in Constructed stormwater management systems extended to provide biodiversity-neutral roads
6. Pre-study, Laser welded sandwich steel elements
7. Pre-study, Corrosion free reinforced concrete
8. Pre-study, Graphene enhanced cementitious materials

R&D Projects, Chalmers

- Pilot study in assessing the sustainability around the E39 infrastructure corridor
- Pilot study in the role of microbiological biofilm communities for degradation of sprayed concrete in subsea tunnels
- Pilot study in induced urban and regional development from a ferry-free E39
- Graphene feasibility and foresight study for road infrastructure
- Pilot study in Constructed stormwater management systems extended to provide biodiversity-neutral roads
- Infrastructure performance viewer (PhD)
- The E39 as a renewable European electricity hub (PHD)
- Safe and ice-free bridges using renewable energy sources (PhD)

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PhD projects in 2014/2015

1. Infrastructure performance viewer
2. The E39 as a renewable European electricity hub
3. Safe and ice-free bridges using renewable energy sources (2 PhDs, 1PhD is founded by Chalmers, cooperation with Trafikverket)
4. Assessing the sustainability around the E39 infrastructure corridor (in cooperation with Chalmers & NTNU)
5. The role of microbiological biofilm communities for degradation of sprayed concrete in subsea tunnels
6. Induced urban and regional development from a ferry-free E39
7. Constructed stormwater management systems extended to provide biodiversity-neutral roads
8. Competence center: Materials in Infrastructure (1 Post doc & 4 PhDs, the post doc & 2 PhDs are founded by Chalmers)

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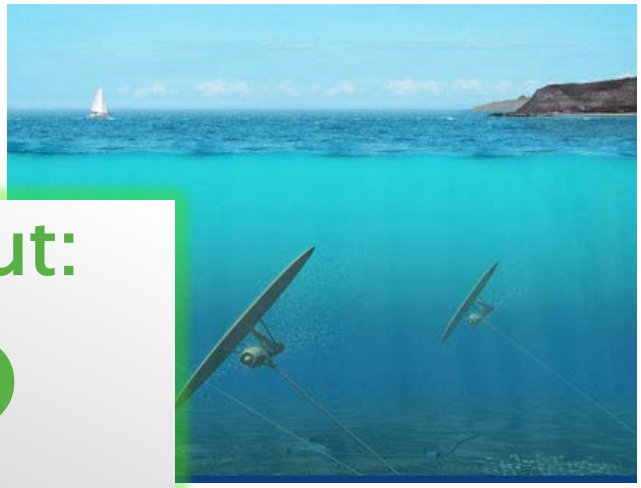
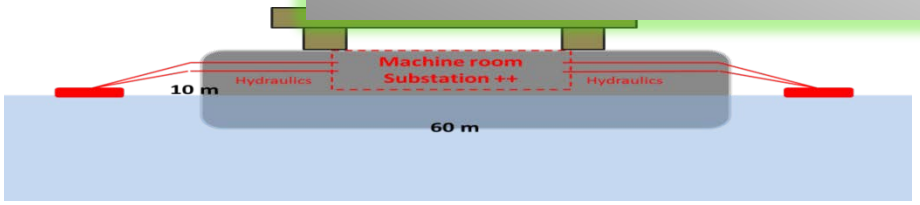
E39 Energy Component
Contributing to Meeting Climate Goals ?

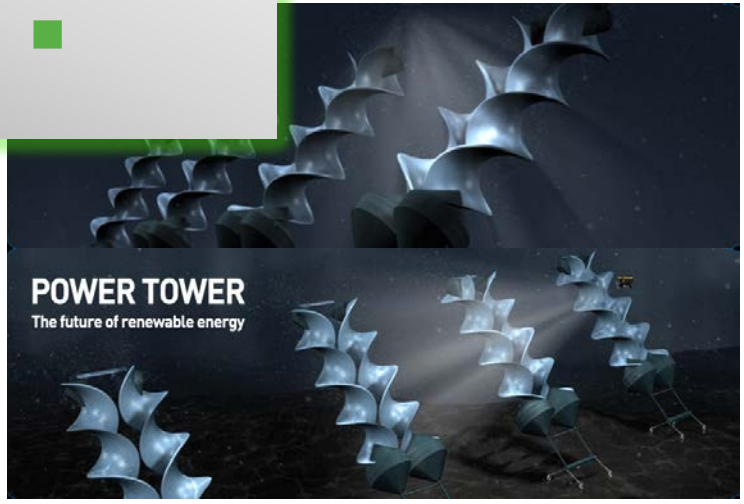


May start talking about:

- Passive Roads
- Plus Roads, or
- Power Roads

?





Potentials look larger than previously anticipated !

Infrastructure performance viewer

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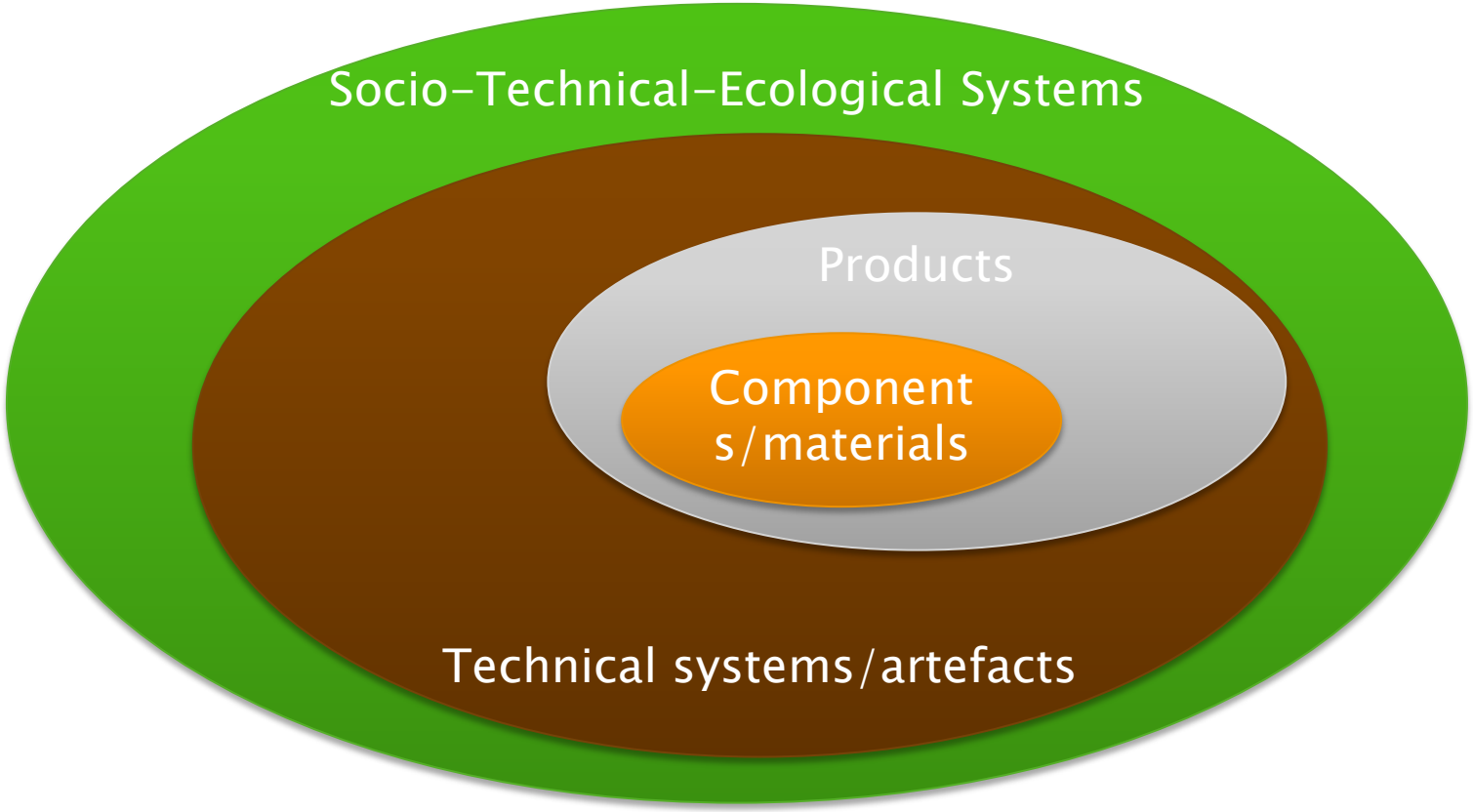

The E39 as a renewable European electricity hub

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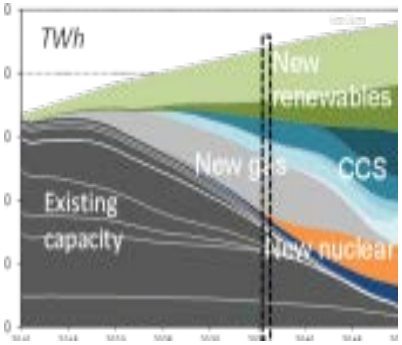
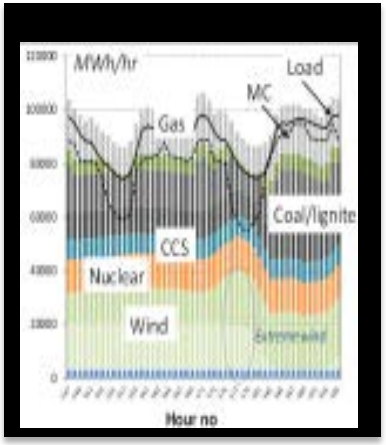
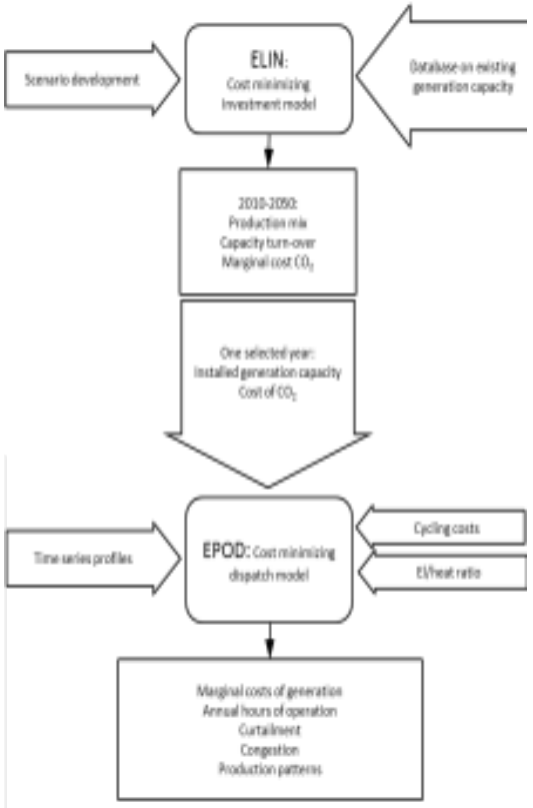
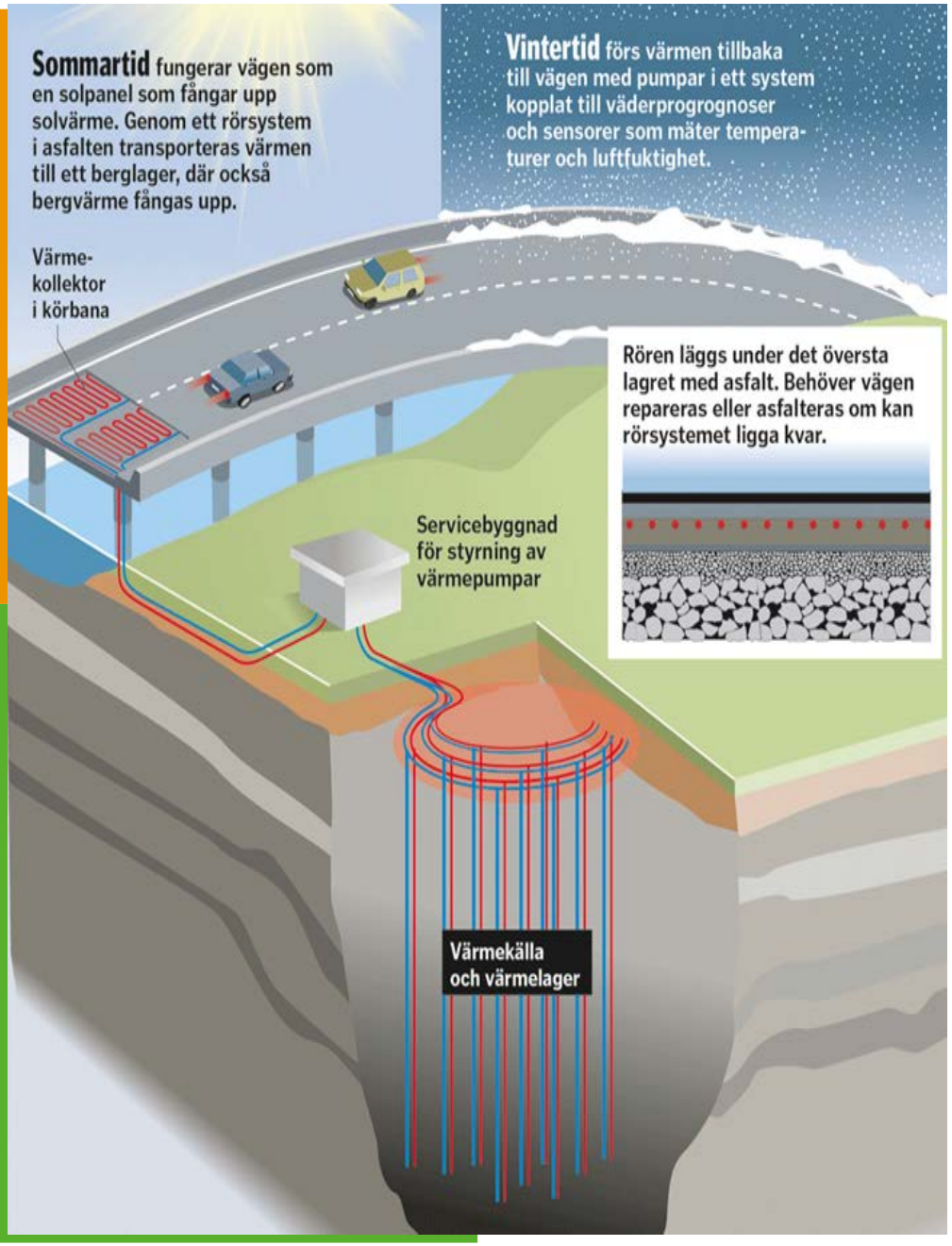
ELIN – long-term investments







Safe and ice-free bridges using renewable thermal energy sources



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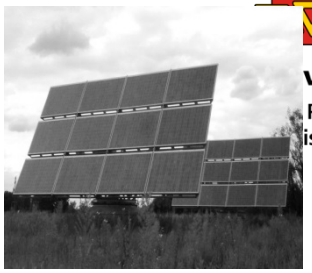
Project overview "nextgen ice-free roads"

Macro/ distant weather data

Tide power

Wind power



Solar power

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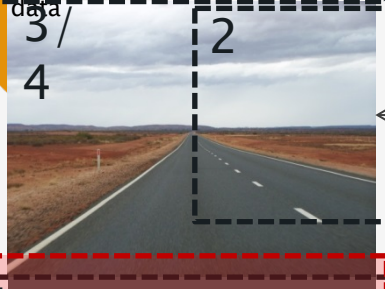
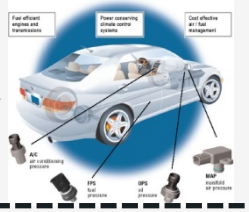
1) Generating local weather data via meteorological algorytms

Micro climate/ on site weather data

3) Modelling the road surface in regards to hygrothermal issues
4) Modelling the interchange of the road and cars



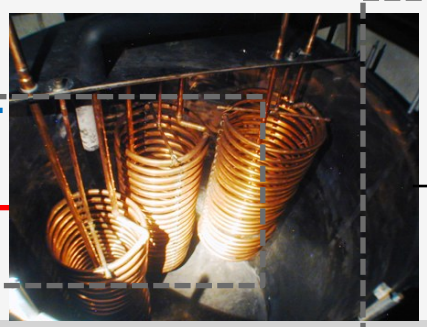


2) Generating local weather data via sensors in cars

1) Cretaing a Model for large scale ground storage (PCM?)

Next generation road

5 OVERLAP BEWTEEN PHD 1 and PHD 2



Thermal (ground) storage

4) Developing energy distribution solutions for heat in roads

3) Modelling the energy output of the groud storage

2) Modelling the energy input sensitivity into the groud storage

AoA Enery??

The (regional) grid

PROJECT BORDER ICE-FREE ROADS

Assessing the sustainability around the E39 infrastructure corridor

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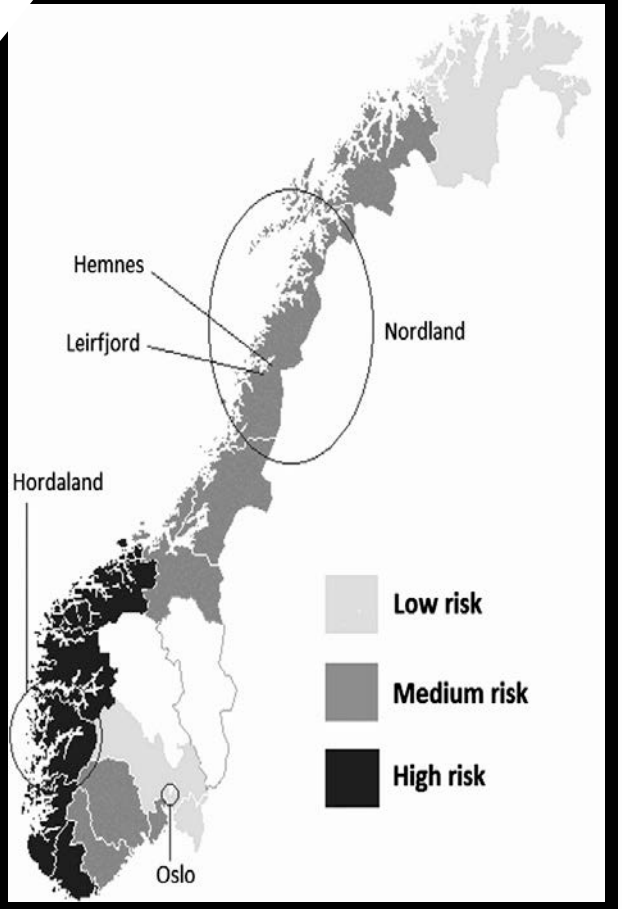

County	# buildings (< 1m)	Average sea level rise [m] (Vasskog et al 2009)
Hordaland	19490	1.10
Rogaland	7897	1.15
Møre og Romsdal	12147	1.05
Sogn og Fjordane	6119	1.05
Vest-Agder	5563	1.15
Nordland	16718	0.90
Troms	8607	0.90
Aust-Agder	5593	1.00
Telemark	3619	0.95
Sør-Trøndelag	5823	0.85
Nord-Trøndelag	5698	0.80
Vestfold	4102	0.90
Østfold	4140	0.85
Finnmark	1495	1.00
Akershus	1436	0.80
Oslo	892	0.80
Buskerud	646	0.80

Norge är viktigast i Europa – för Tesla

Erik Söderholm 2013-03-13 10:30

Senast uppdaterad: 2013-03-14 15:47

Tvärt emot vad man kan tro är det inte Tyskland eller Frankrike som är viktigast för Tesla – utan ett litet land som ligger mycket närmare oss. Galna skatteregler gör att många skippar en dyr BMW och istället köper en eldriven Tesla.

Tesla prioriterar den norska marknaden högt – nätverket med superladdare ska snart börja byggas.

The role of microbiological biofilm communities for degradation of sprayed concrete in subsea tunnels

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Induced urban and regional spatial development from a “ferry-free E39” A state of the art review

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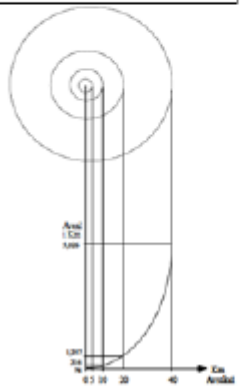
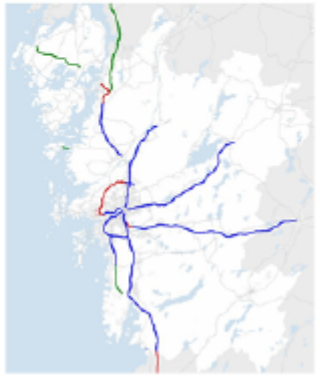
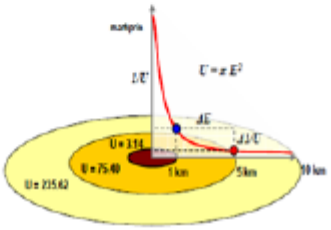
The accessible area for urban development within the same travel time grows with the square of the radius



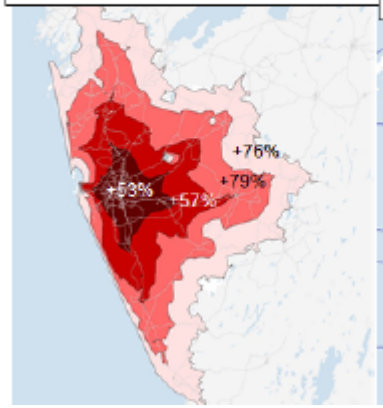
So, major road investments in the Gothenburg metropolitan area 1970- .....



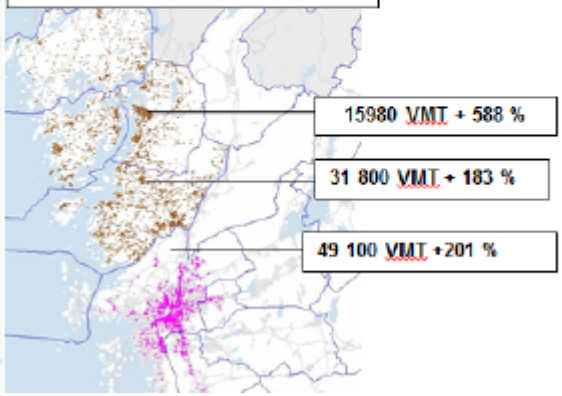
.... will give rise to huge amounts of cheap land in the periphery i.e. a strong stimulus for building single family homes



Growth in areas within 15, 30, 45 and 60 min car trip from CBD 1970 -



Commuting from single family home in the North West sector to work place in the city of Gothenburg



A review of the factors affecting the biodiversity of Constructed Stormwater Management Systems along roads

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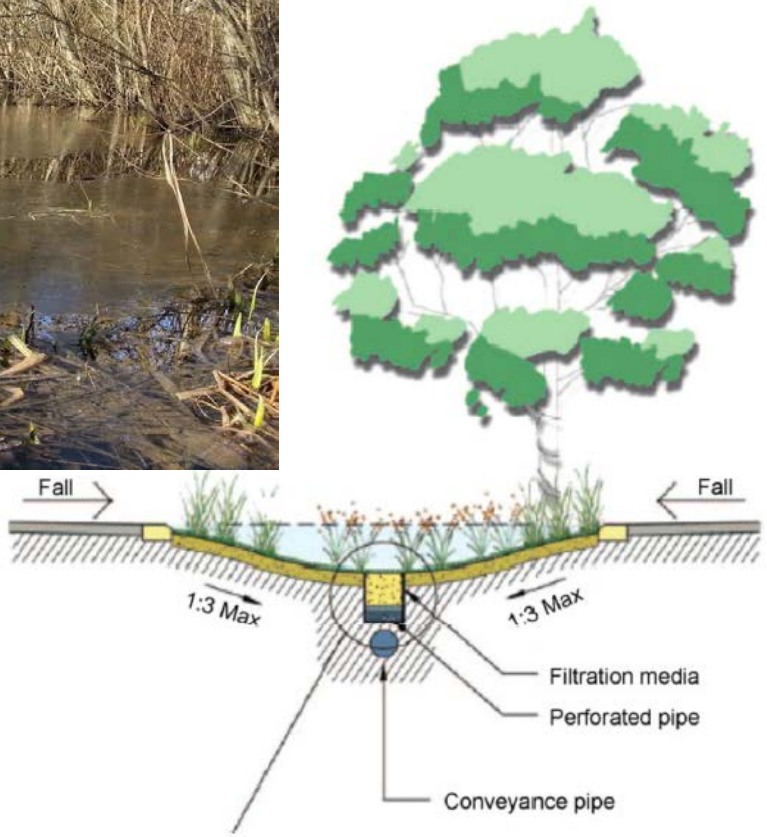

Greener and smarter roads

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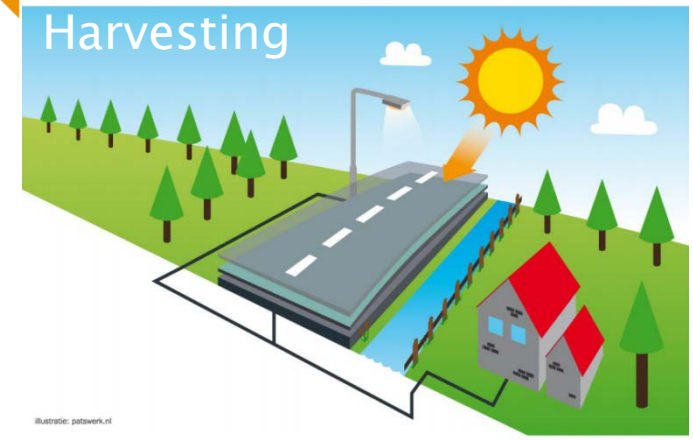

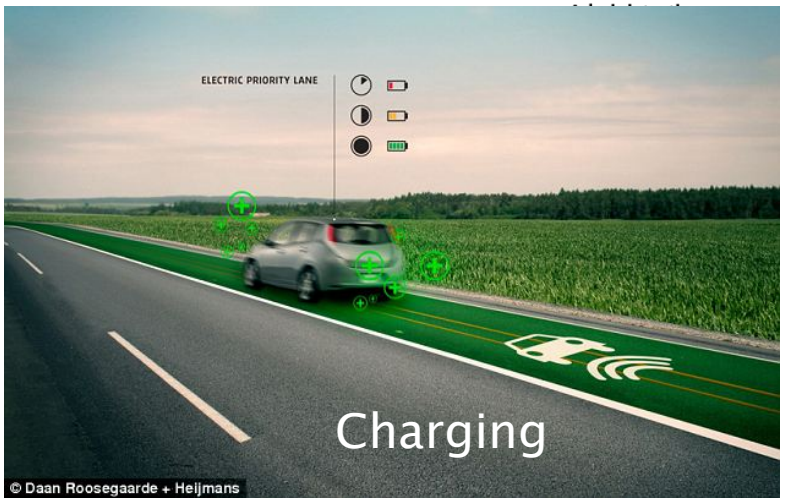

Components available in 5 years