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Group 6

Sustainable Energy Futures Annual Conference 2016

Low Carbon Technologies and Transport

Cloître Vincent
Langiewicz Filip
Skevi Kyriaki
Tongmark Napat
Tzimplakis Vasileios
Van de Kerckhove Simon

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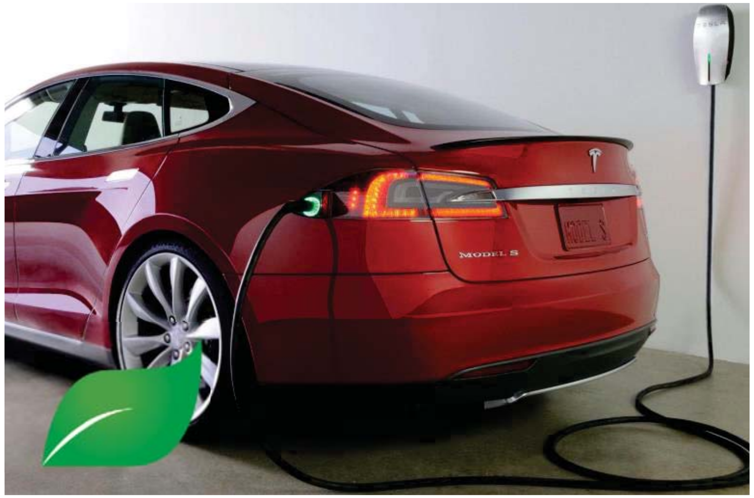
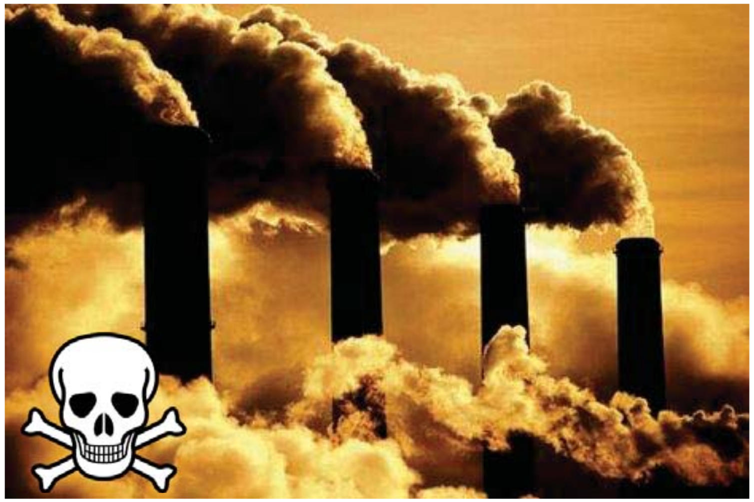
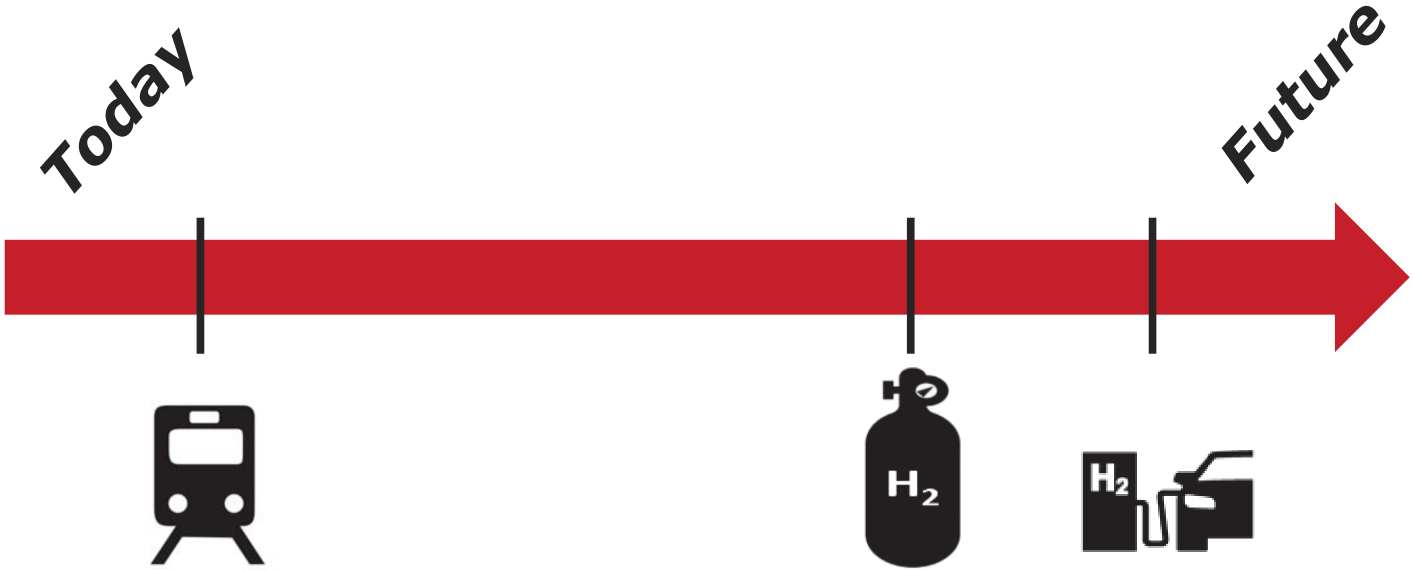
Motivations





The Transport Journey



Regenerative braking in urban rail

Filip Langiewicz
Poster 41

Supervisor: Dr. Marc Stettler

Urban rail

Trams

Underground

Light rail

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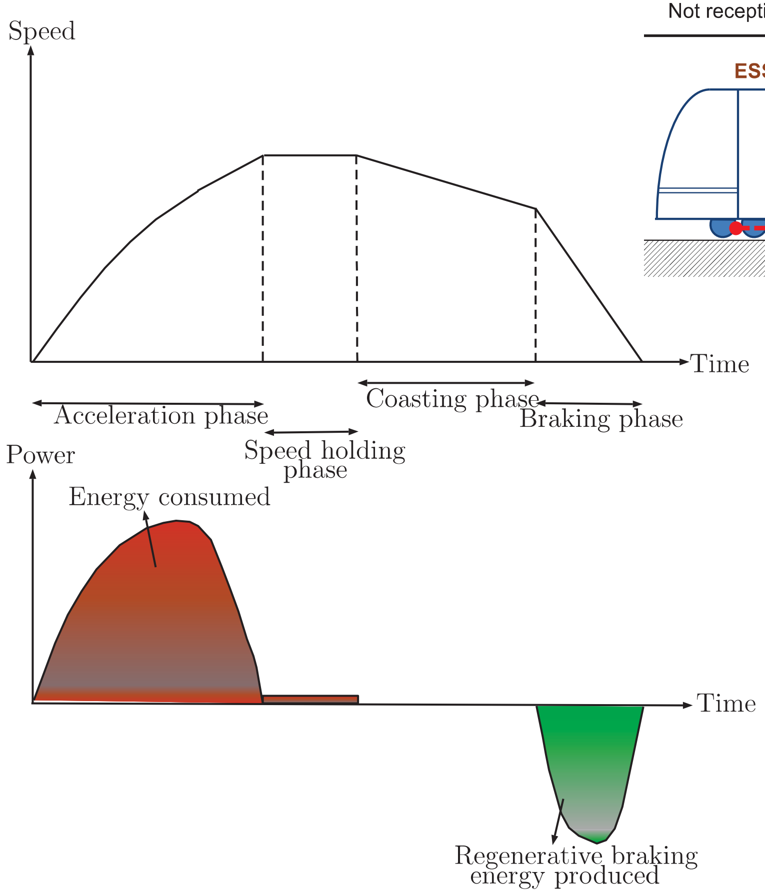
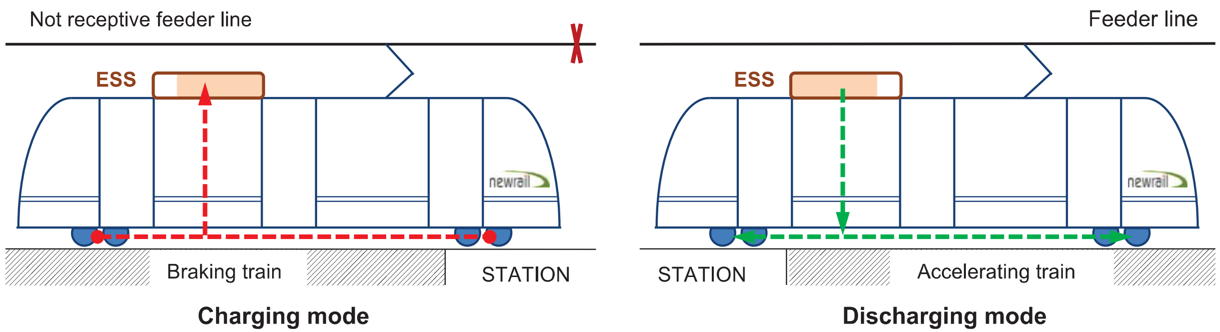
Filip Langiewicz

Regenerative braking and on-board supercapacitor storage





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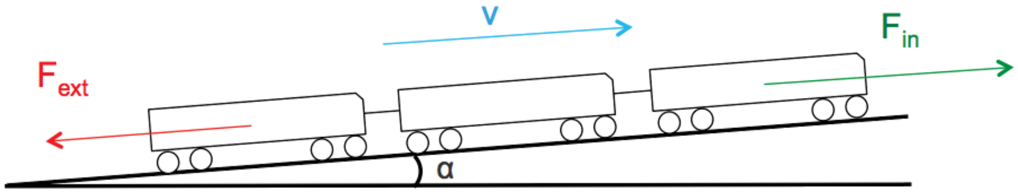
Filip Langiewicz

Method

Inputs

Distance
Running Time

Mechanical model



Speed profile
F_{in}

Electrical model

Outputs

Electrical energy consumed by the train and stored in the supercapacitors

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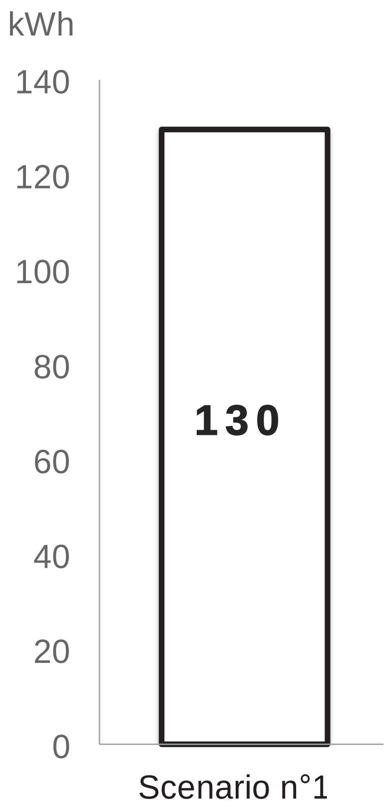
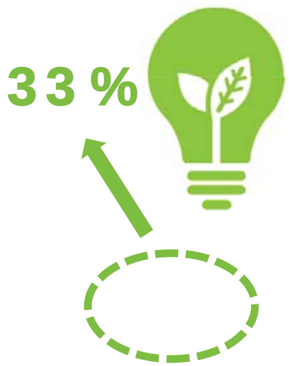
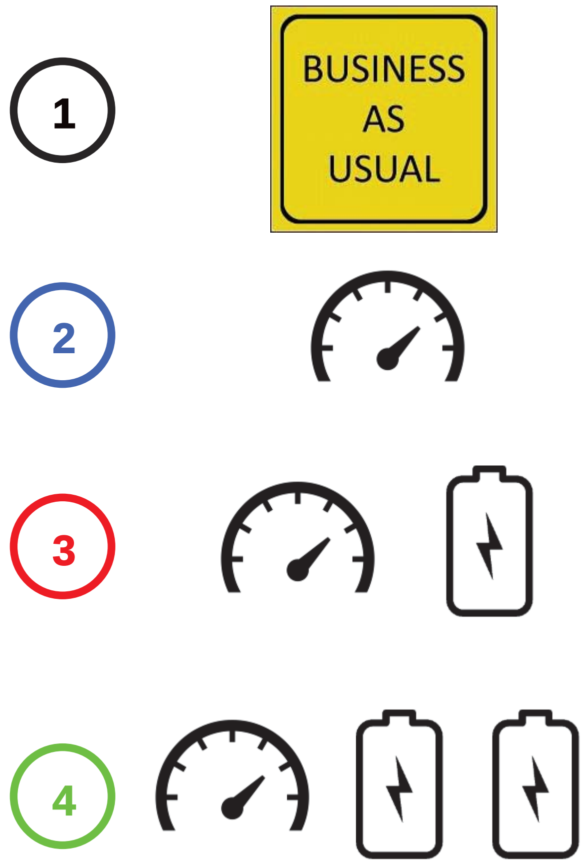
Results

UNDERGROUND







Victoria

Design and Operation of Integrated Wind-Hydrogen-Electricity Networks under Uncertainty

Vasileios Tzimplakis
Poster 44

Supervisors: Dr. Sheila (Ang) Samsatli

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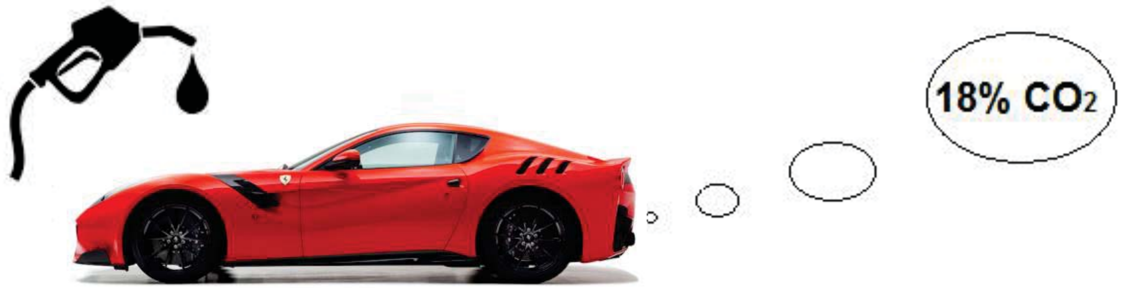
Vasileios Tzimplakis

Background

+

=

28% Energy



Solution

Gasoline & petrol combustion for the propulsion of vehicles is the cause of a polluting transport sector.

Substitution of gasoline & petrol with an eco-friendly fuel, which:

- *Is efficient, as far as energy-movement conversion is concerned*
- *Can be obtained by various sources*
- *Can be stored in large amounts*
- *Can offer reasonable refueling time and high driving range*

HYDROGEN

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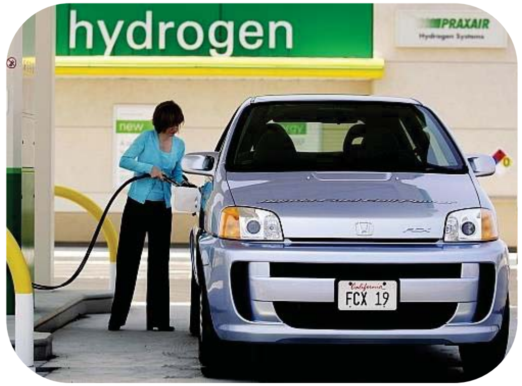
Barriers

Why is the adoption of hydrogen as a primary fuel difficult?

Lack of Fuelling Infrastructure

Sustainable Hydrogen Supply Chain (HSC) Network



Existing HSC Optimization Models

Are their advanced quality sufficient for the accurate design of a real HSC?
Unknown future status of uncertain factors

Wind Speed | **Hydrogen Demand** | **Cost of Technologies**

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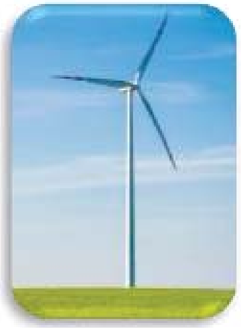
Aim

Examine how much the annual cost of a HSC network is affected by the variability of wind speed, hydrogen demand and cost of technologies involved in the network.

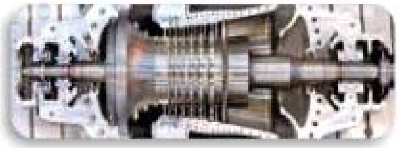
STeMES Model


Wind Turbines


Electrolysers

Fuel Cells


Hydrogen Storage


Expanders


Compressors


Electricity Lines


Hydrogen Pipelines

Input data

- *Hourly wind speed*
- *Hourly hydrogen demand*
- *Characteristics of the technologies*

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Vasileios Tzimplakis

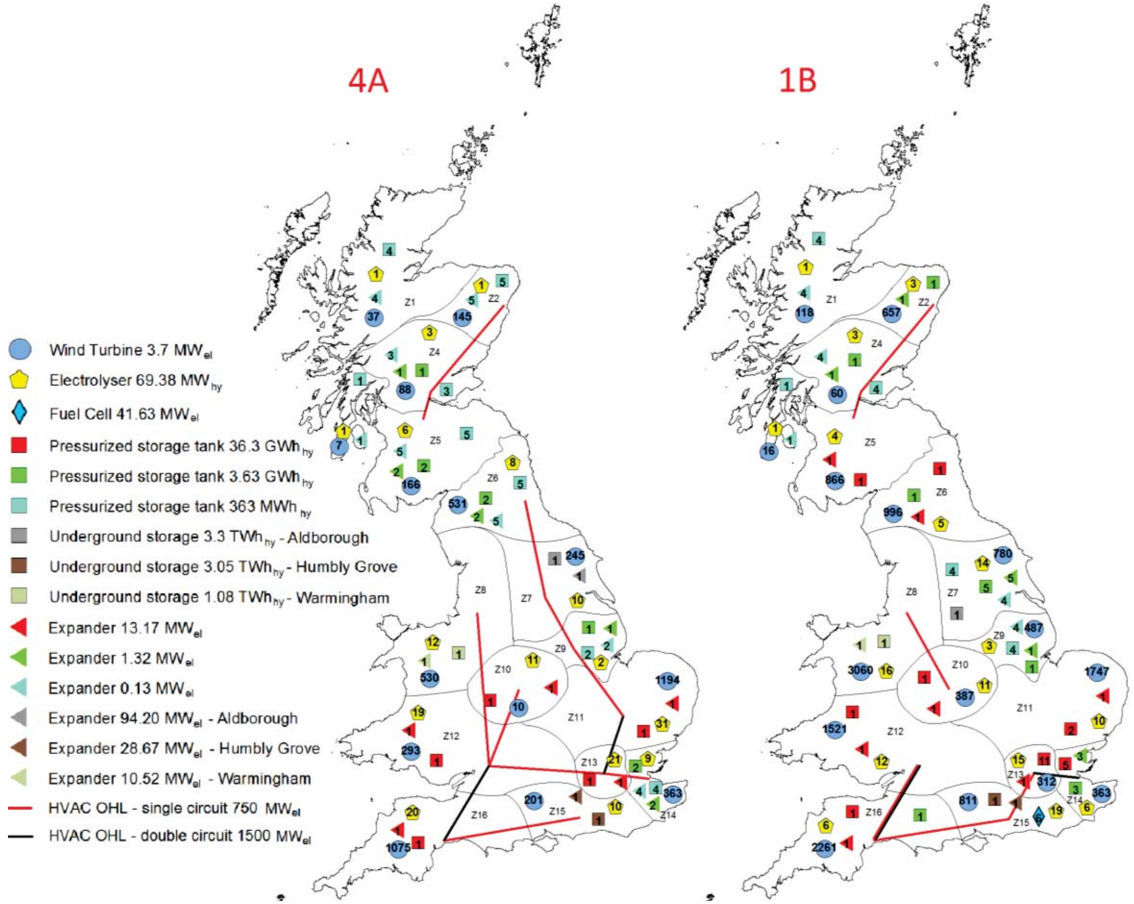
Wind Speed & Hydrogen Demand

Wind Speed Profiles — 1, 2, 3, 4

Hydrogen Demand Profiles — A, B

8 CASES

(1A, 2A, 3A, 4A, 1B, 2B, 3B, 4B)



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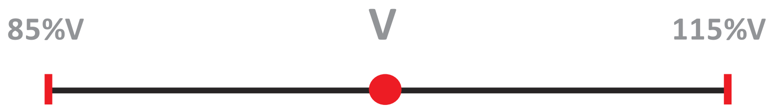
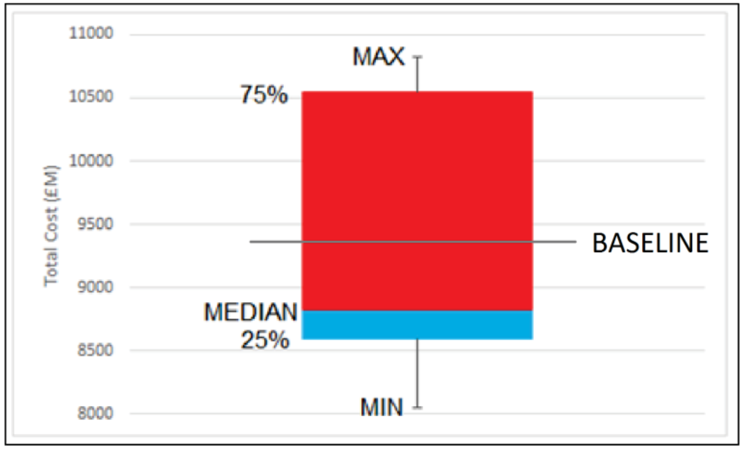
Cost of Technologies



Range of values for the cost of each technology

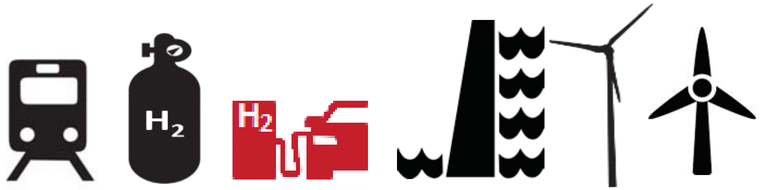
20 random values for the cost of each technology

20 cases with variable cost for each technology and identical wind speed and hydrogen demand profiles



CONCLUSION

The variability of uncertain factors has great influence on the cost of the network. HSC optimization for the creation of real networks is inaccurate without taking into account important uncertain factors.



Modelling Alternatives for Future Domestic Transport

Kyriaki Skevi
Poster 42

Supervisors: Dr. Sheila (Ang) Samsatli

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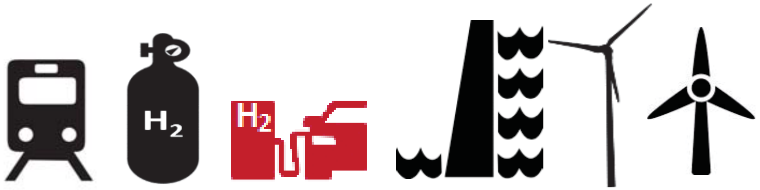
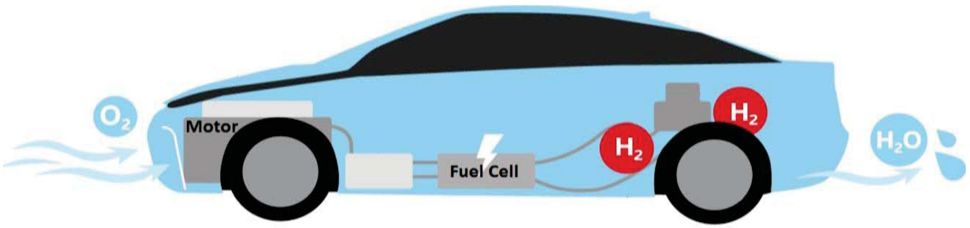
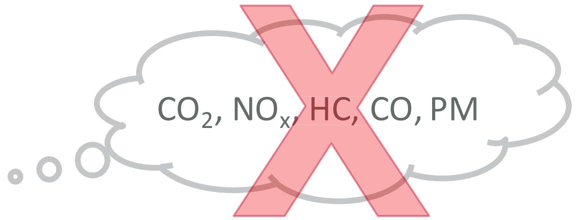
Kyriaki Skevi



Hydrogen Refuelling Infrastructure and Fuel Cell Vehicles

- Fuel Cell (FC) vehicles can contribute to the decarbonisation of transportation.





- However, an extended hydrogen refueling stations' (HRS) network is required.

Source: Air Products hydrogen fueling pump

13 HRSs in the UK

Europe	95
N. America	50
Asia	67
RoW	2
Total	**214**

Source: Hydrogen Filling Stations Worldwide-H2-Stations, 2015

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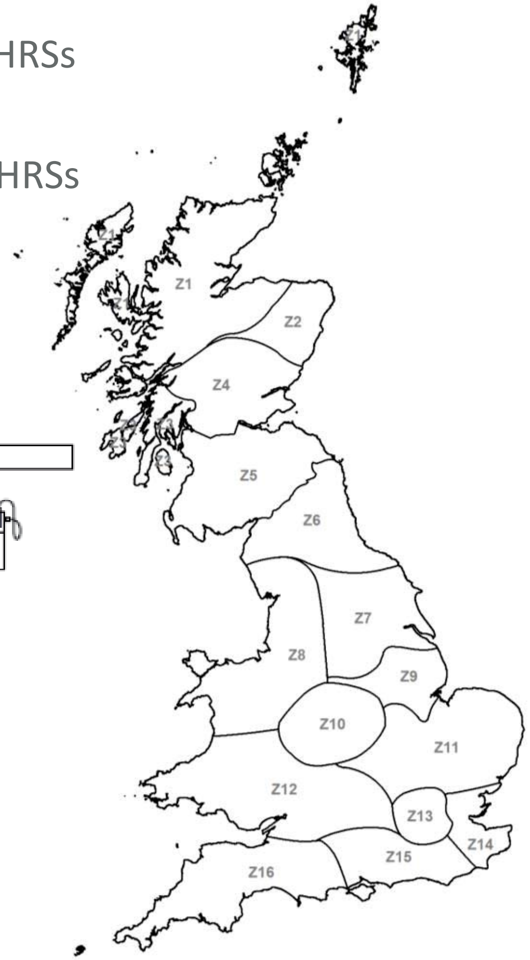
Kyriaki Skevi

Aim of the Project

Model → Optimal Structure of a HRSs network → Number of HRSs + Location of HRSs



so that:

- Hydrogen transport demand is satisfied and
- Total Annual Cost of the HRSs network is minimized

Suitability Analysis

- 4 criteria were considered:

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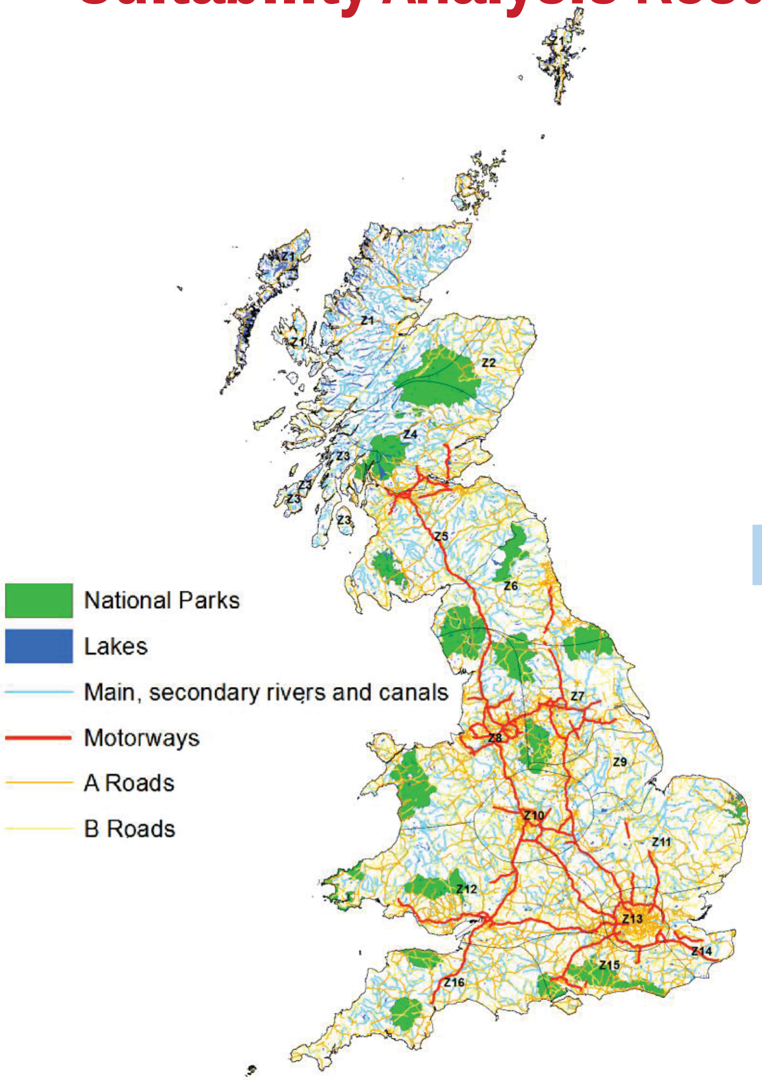
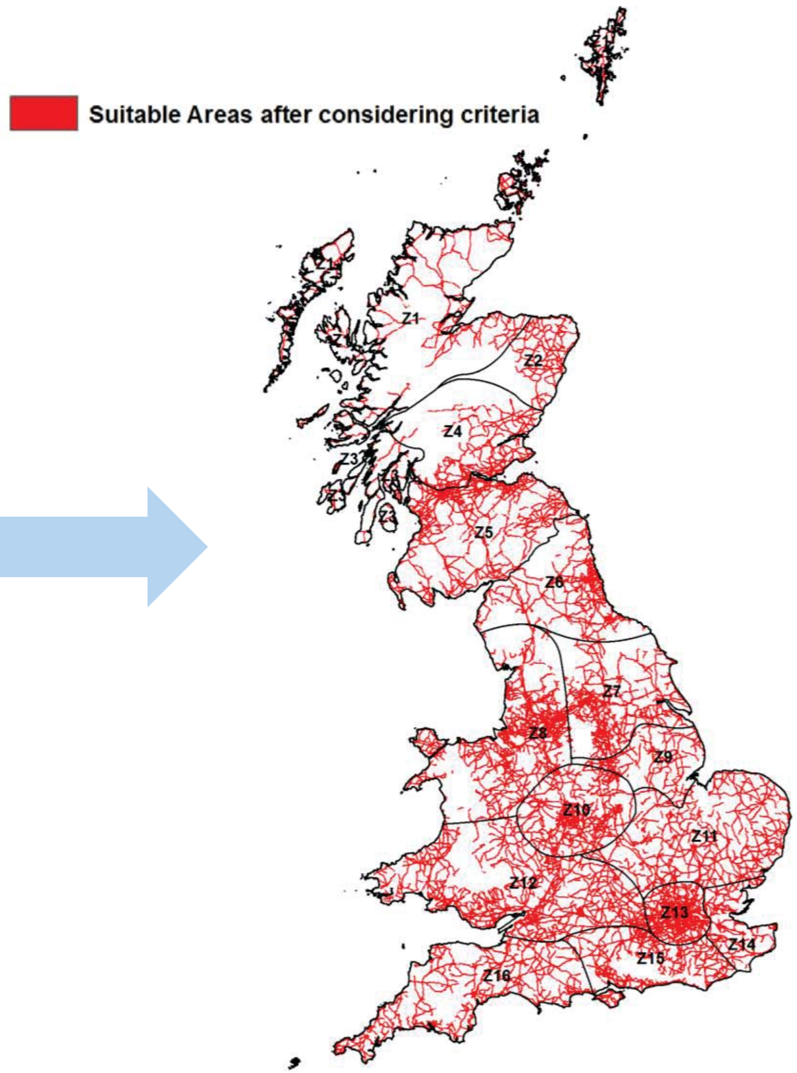
Suitability Analysis Results





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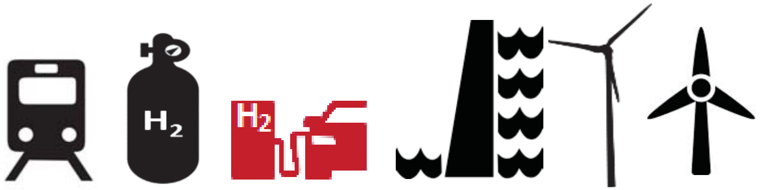
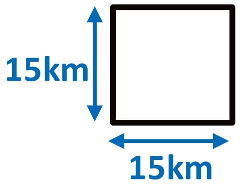
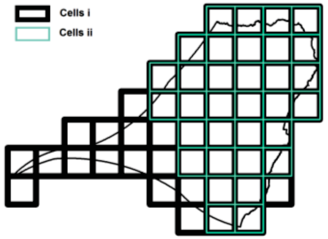


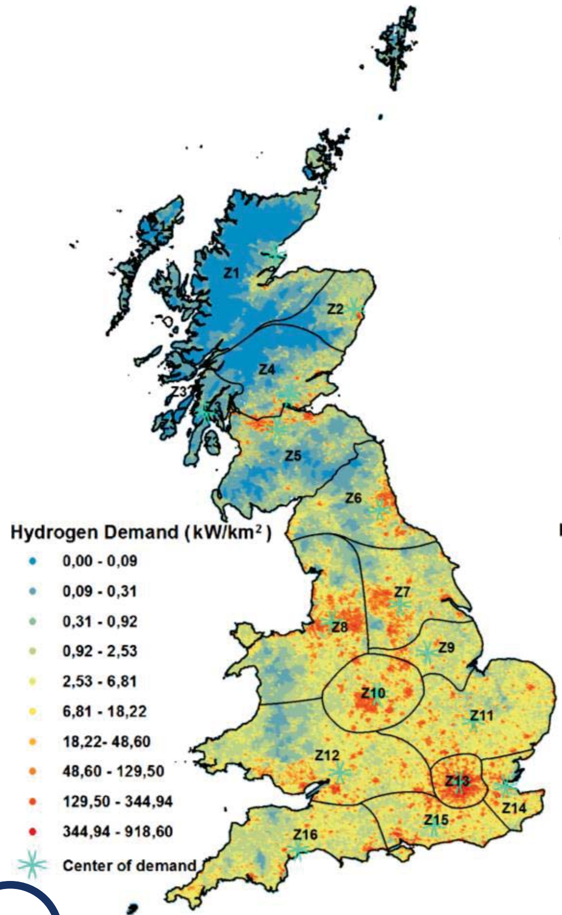
Case Studies & Results

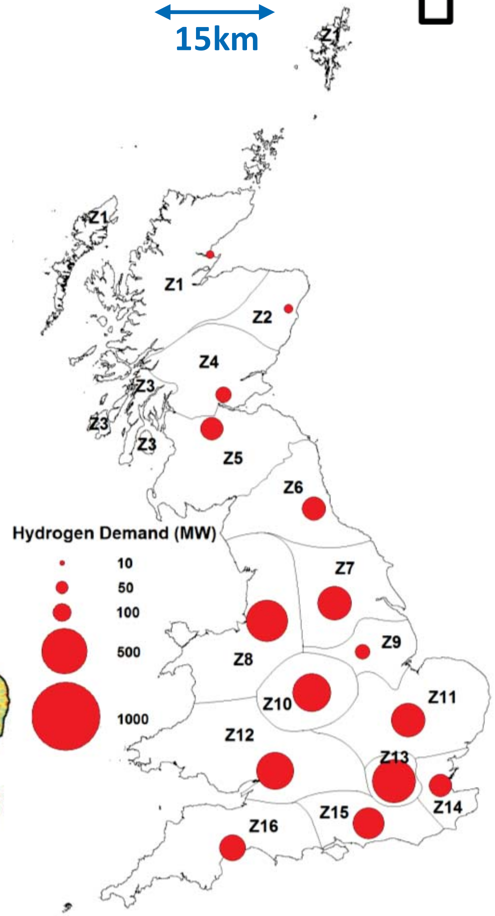
2 Case Studies:

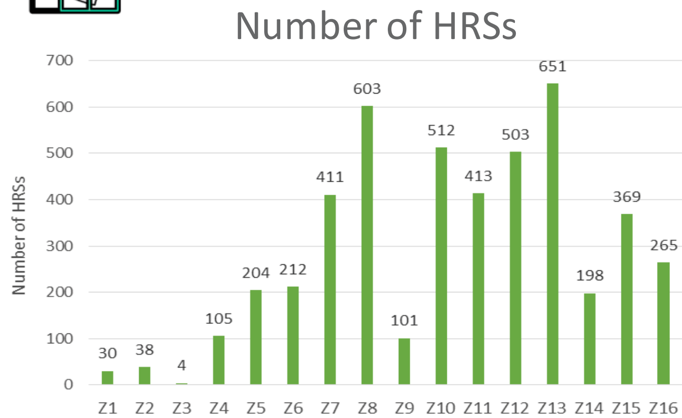
(a) Each of the 16 UK zones

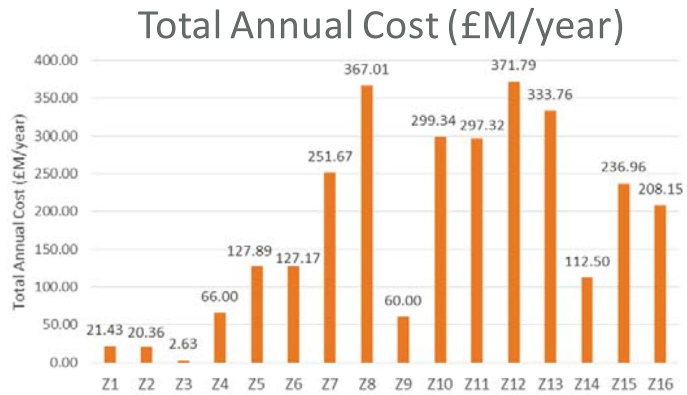












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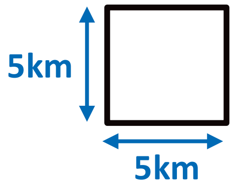
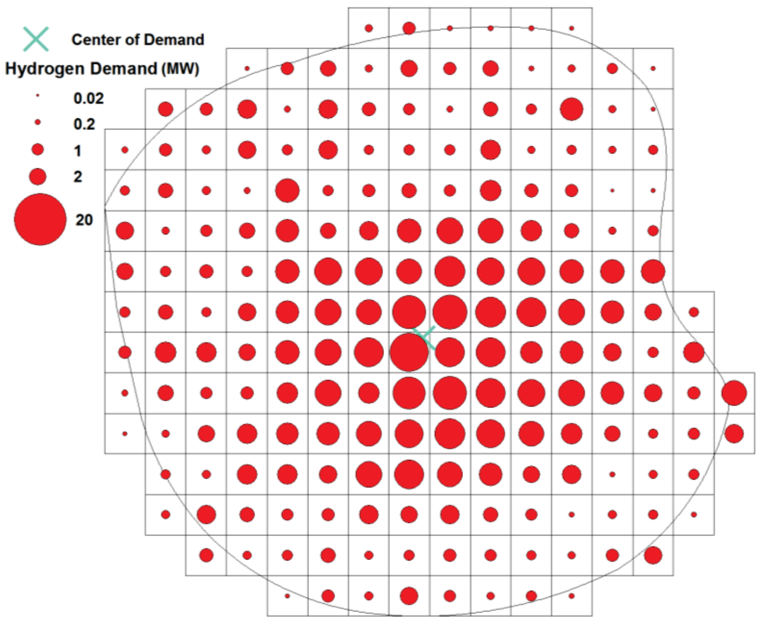
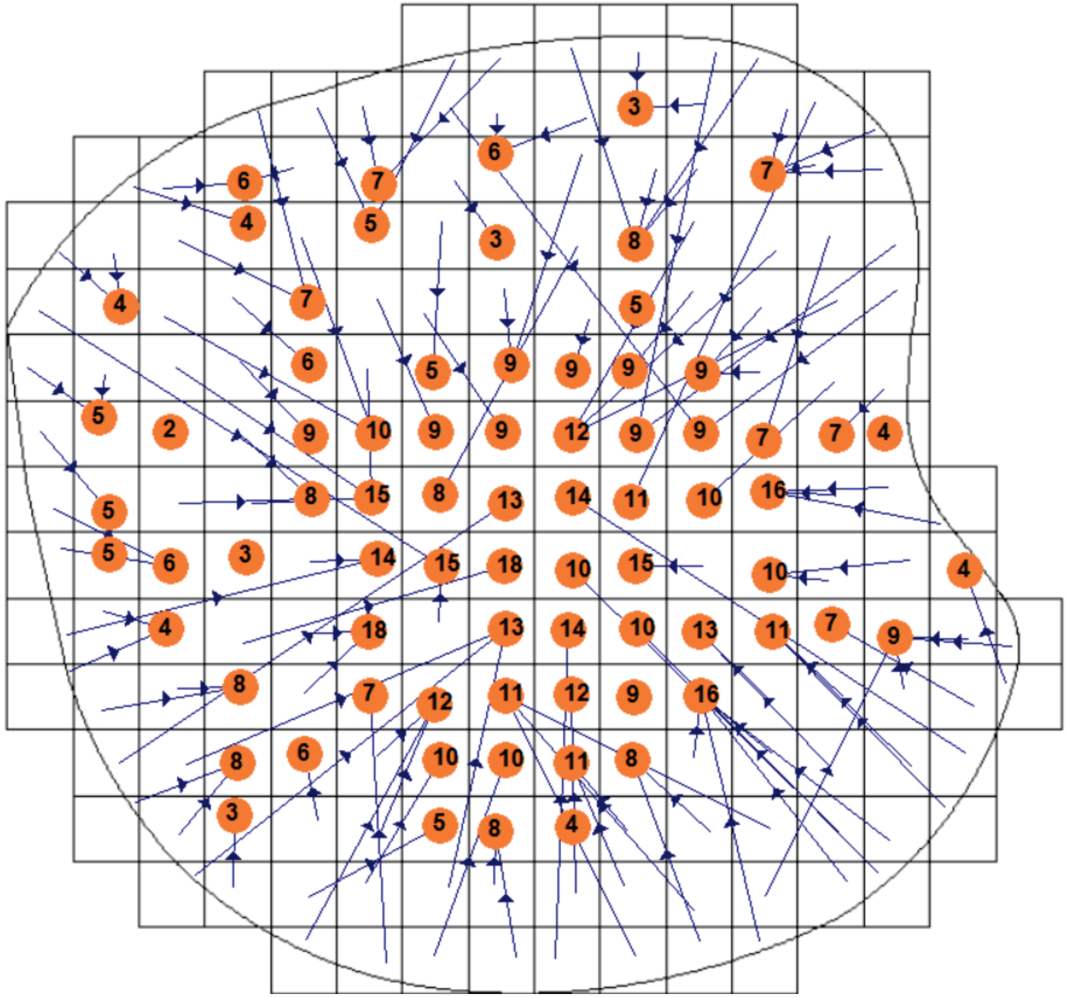
Case Studies & Results (cont.)

(b) Zone 13 (comprises London)







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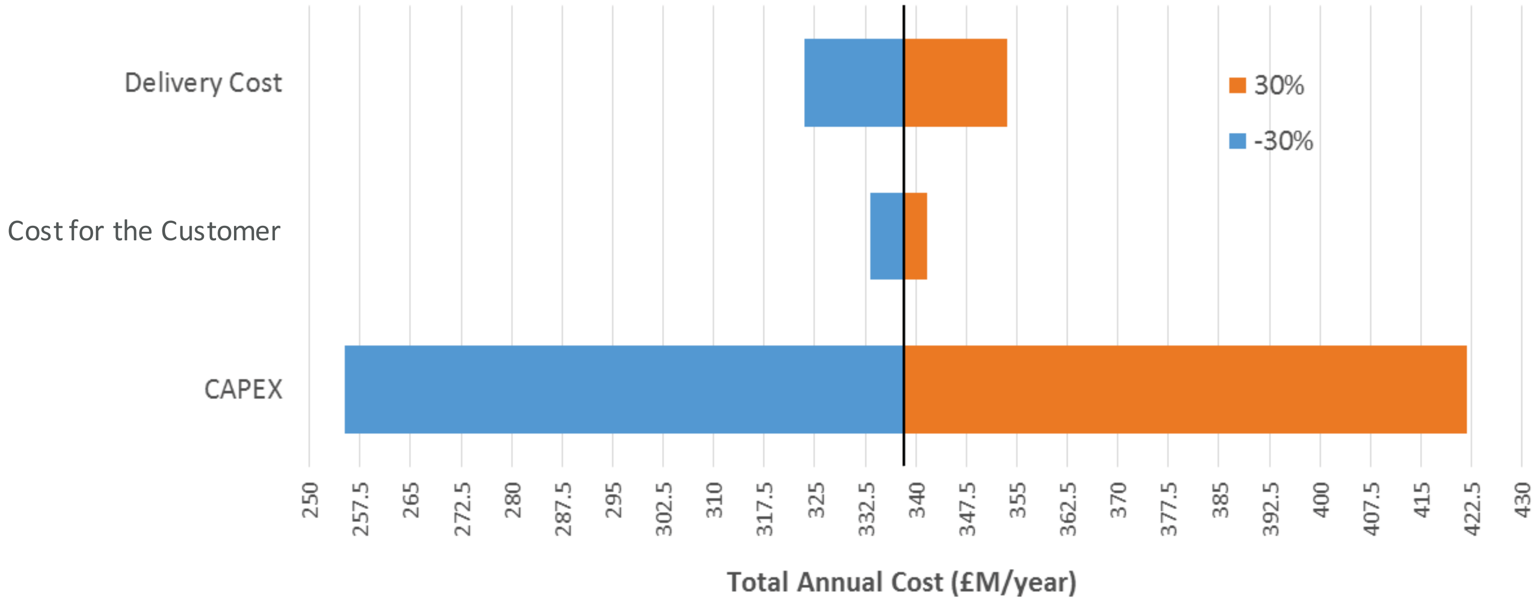
Sensitivity Analysis & Results

One type of cost is varied at a time:

- Cost for the customer
- Delivery cost
- CAPEX of HRS

Variations: $\pm$10%, $\pm$20%, $\pm$30%, $\pm$40% and $\pm$50% from their nominal values.



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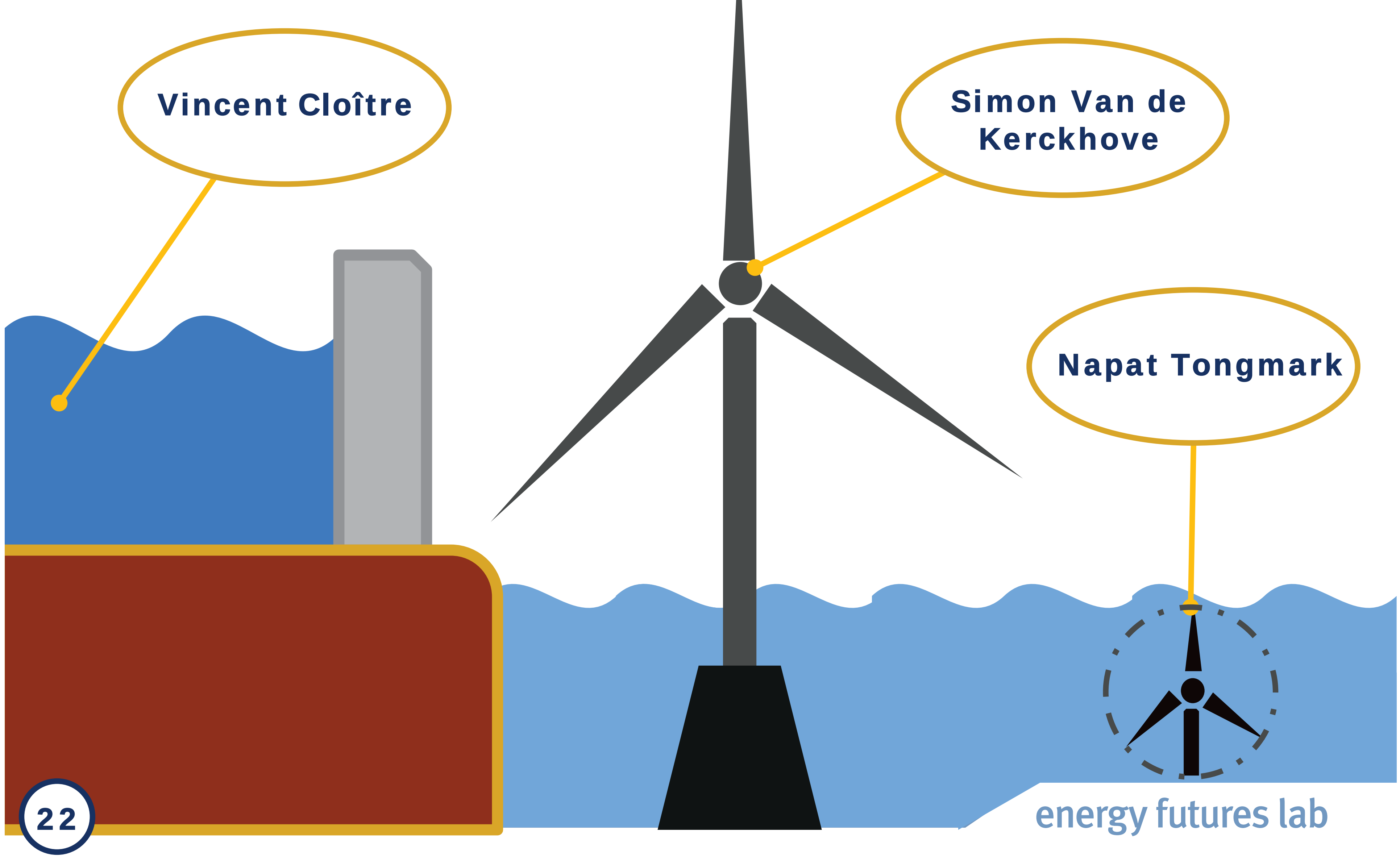
Low Carbon Story



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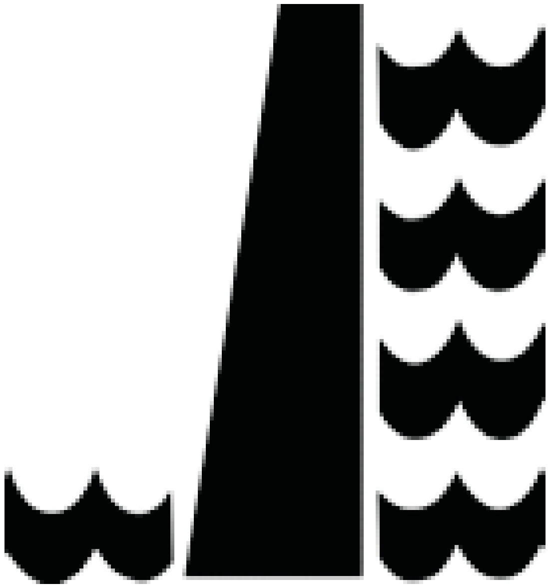

Evaluating electricity markets performance

Vincent Cloître
Poster 40

Supervisors: Dr. Kaveh Madani
Dr. Mark Workman

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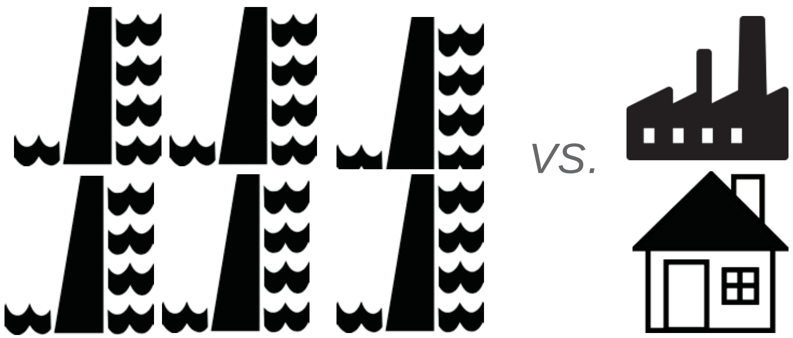
Vincent Cloître

A new power market in Yunnan



Yunnan selected to be a piloting province to introduce a competitive market

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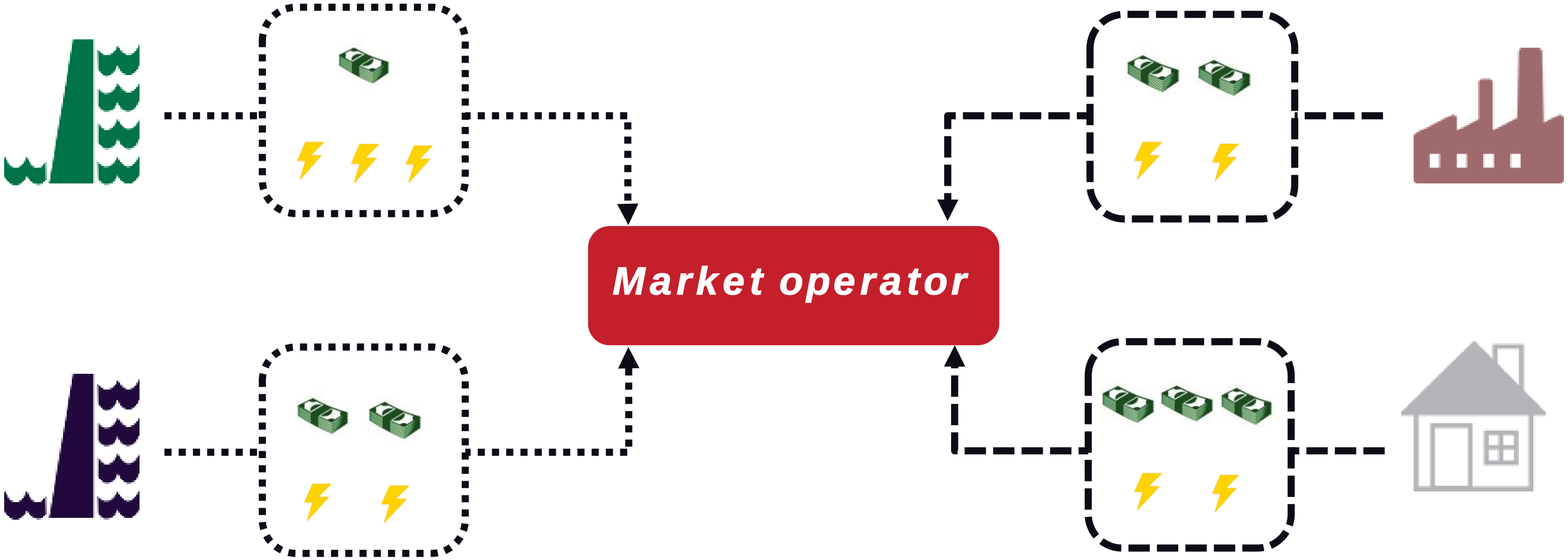
Importance of market rules

Phase 1: bid submission

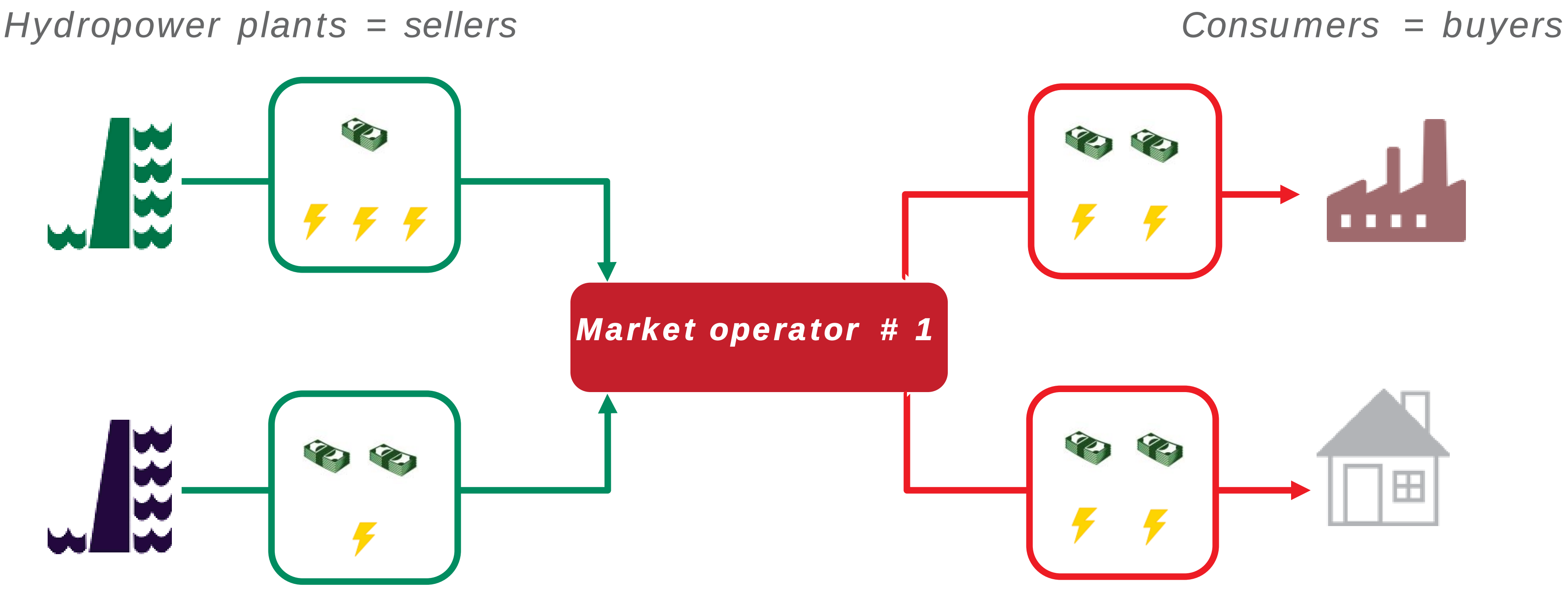
Hydropower plants = sellers

Consumers = buyers



Importance of market rules

Phase 2: market outcome ***with market rules #1***



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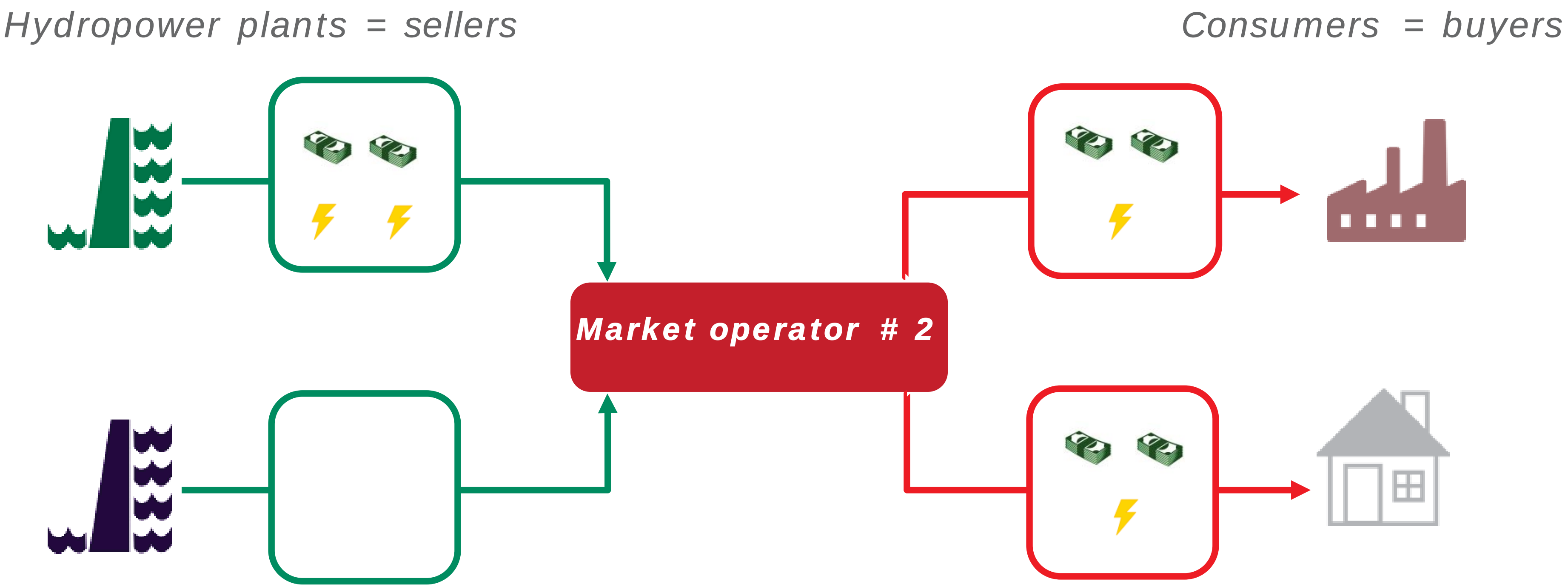
Importance of market rules

***Phase 2: market outcome* with market rules #2**



Different *market rules lead to* ***different*** *prices and power quantities traded*

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Modeling agents behaviours in power markets

Q-learning:

learning technique for each agent to optimise individually its action selection policy

Agents learning process

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Vincent Cloître

Results

- *Comparison of the Yunnan market with two other market mechanisms*

- **Affordable power for consumers**

- **Low income for power plants**
- **Grid instability**
- **Small consumers struggle to satisfy their demand on the market**

This kind of results are interesting for policy makers to anticipate prices and quantities traded, for power plants to anticipate their competitors behaviours

Frequency domain optimisation tool for offshore wind turbine substructures

Simon Van de Kerckhove
Poster 45

Supervisors: Dr.Johannes Spinneken
Mr. Pierre Bousseau

Offshore wind energy

(+) Better social acceptance, more stable resource

(−) Cost of energy: 2-3x higher than onshore wind

Substructures

- **10 %** of the LCOE
- **2nd potential** of cost reduction

→ **Optimisation under 3 constraints:**

Resonance frequency

Ultimate load

Lifetime fatigue

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Simon Van de Kerckhove

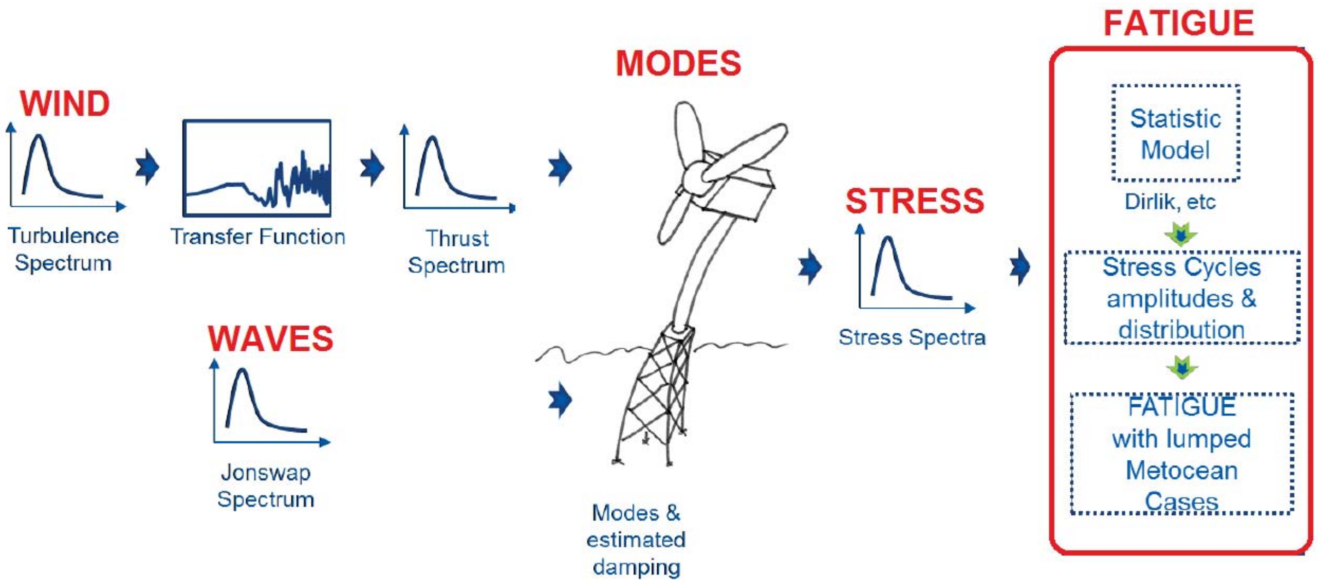
Fatigue evaluation methods

Standard method: Multiple temporal simulations of thousands of load cases, slower than real time

→ Computational time of several days

For optimisation, development of a ***frequency methodology:***

→ Computational time of 2 minutes



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Benchmarking study

Benchmarked against **Bladed**, a software product from the certifier DNV

→ The frequency method is found **representative** enough to conduct optimisation for a preliminary design

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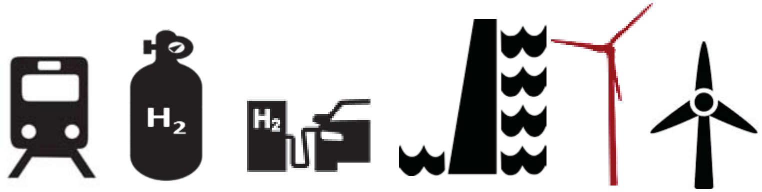
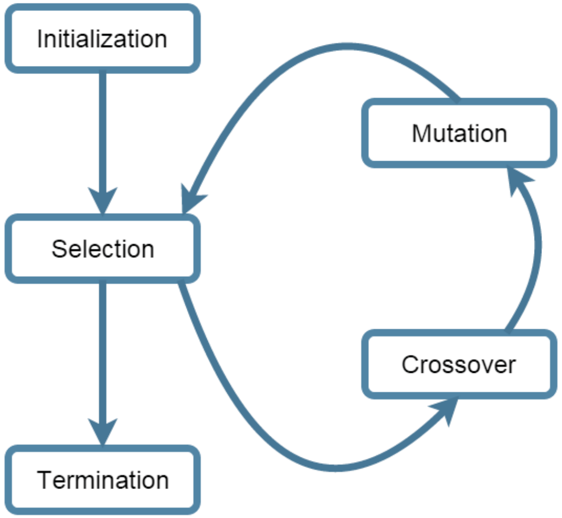
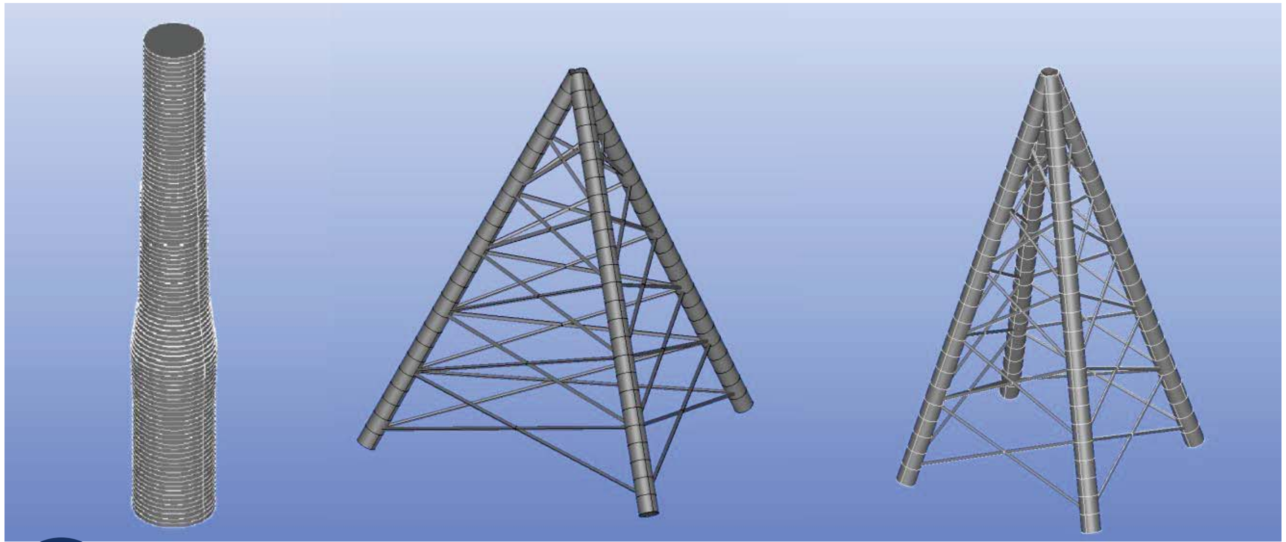


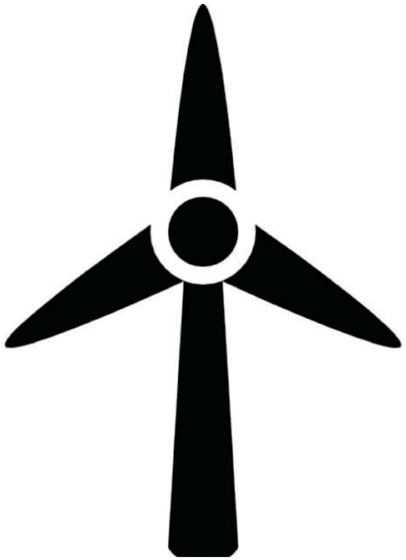
Optimisation

Genetic algorithms method





Results



Unsteady Loading of Tidal Turbine Blades

Napat Tongmark
Poster 43

Supervisors: Mr. Georgios Deskos
Dr. Johannes Spinneken

Wind Turbine to Tidal Stream Turbine

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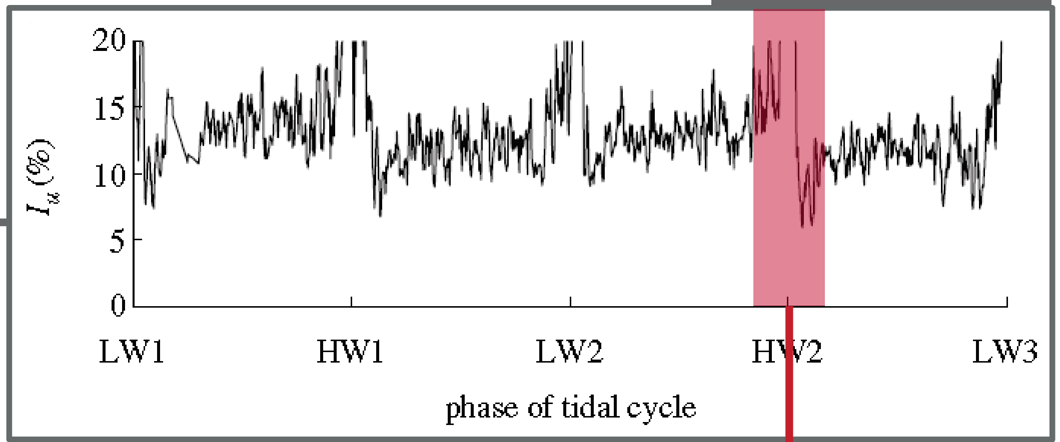
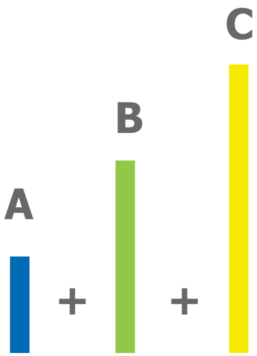
Napat Tongmark

Tidal Stream

Turbulence



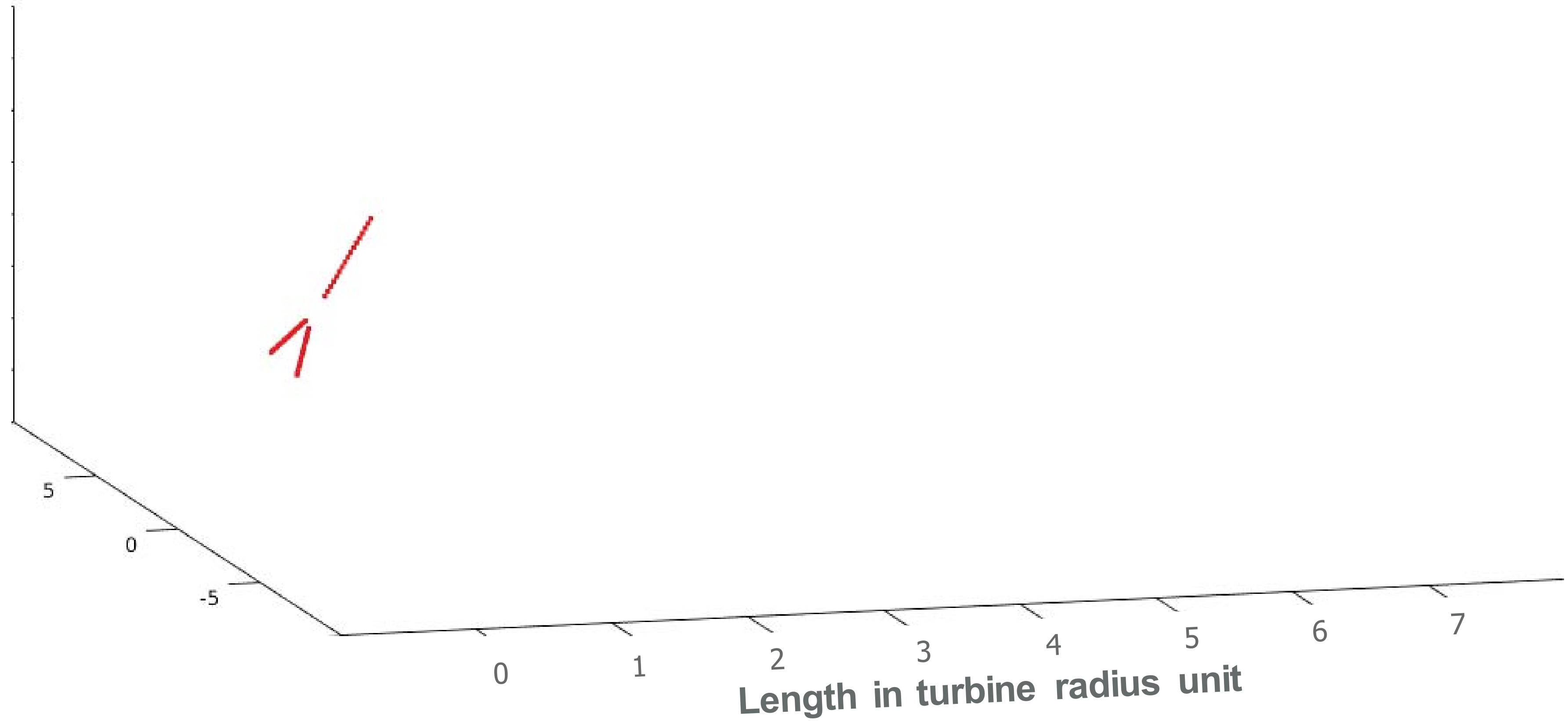
CACTUS



Impulses

Downstream Flow (Wake)

Steady Impulse



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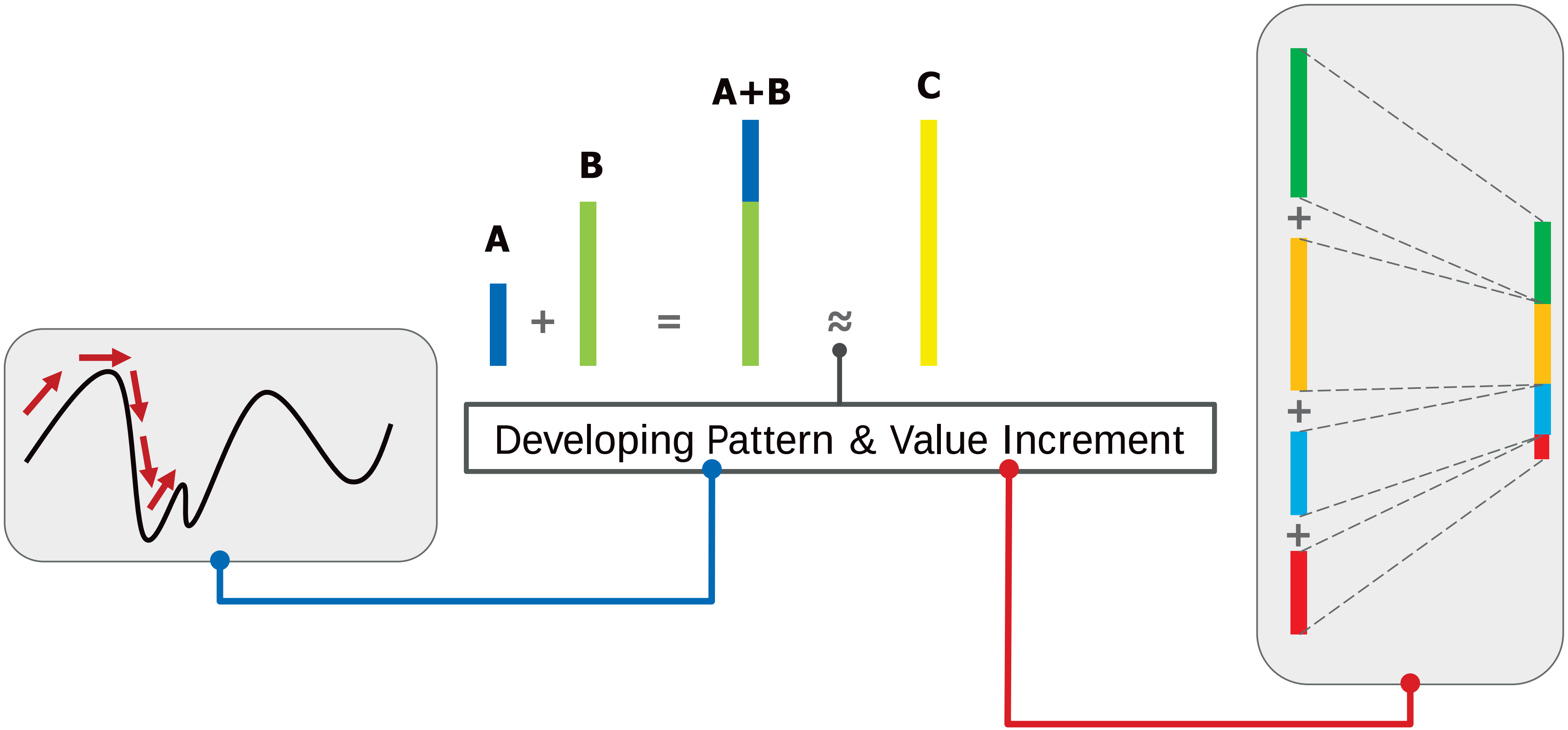
Napat Tongmark

Prediction



Future:


Diolch
Kiitos
Sheun
umesc
Dekuju/Dekujeme
Kasih
Mamnoon
Todah
Shnorhakalutiun
Te^o ekkür
Hvala
Shokriya
Dziękuję
Shokran
Spaas
Mul
Ači
Gamsahapnida
Ngiyabonga
Dank
Takk
Cam
Gra
or
Xie
Dhanyavaad
al
Kop
Salamat
Merci
Dankie
Go
Grazie
Faleminderit
Dakujem
Waad
Dhanyavaadaalu
Daw
Dhanyavad
Khopjai
Kruthagnathalu
ThankYou
kun
Arigatou
krap
Or
Dhonnobaad
Tack
Shukriya
ederim
Asante
Grazzi
raibh
Gracias
Nandree
Blagodariya
Gomapsupnida
Euxaristo
Kun
Hain
Dhan
Fyrir
Terima
Enkosi
Danke
dank
daa


ANY
QUESTIONS ?

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Appendix

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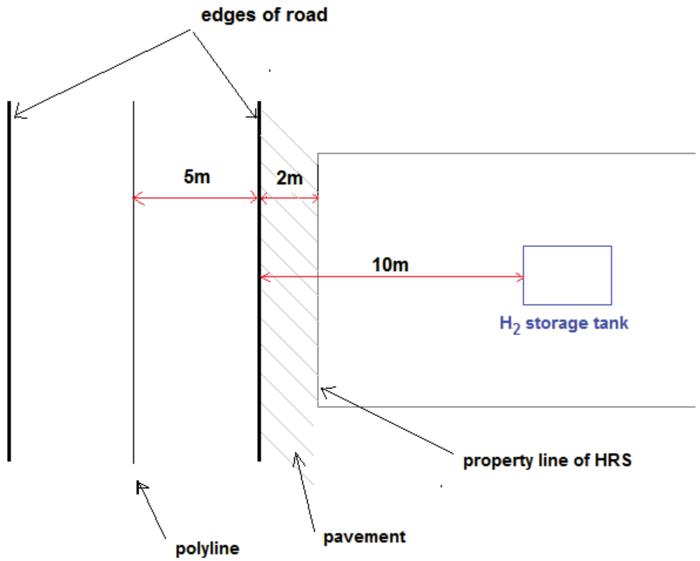
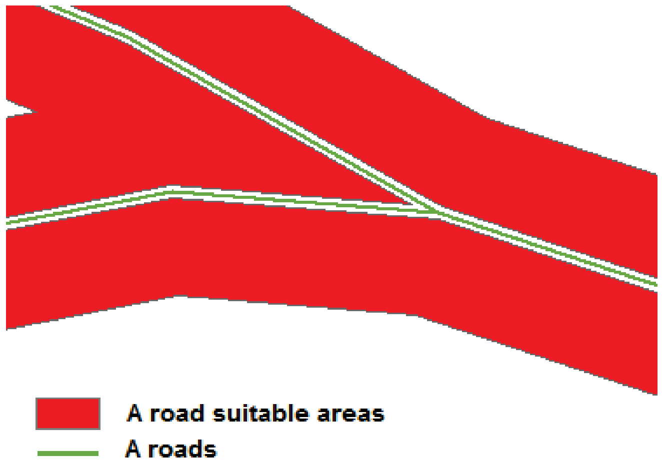
Kyriaki Skevi

Suitability Analysis

A Roads (width~10m)	2 (minimum distance)
	100 (maximum distance)
B Roads (width~7m)	2 (minimum distance)
	100 (maximum distance)
Motorways (width~30m)	10 (minimum distance)
	100 (maximum distance)
Rivers	10 (minimum distance)
Lakes	10 (minimum distance)
Nat. Parks	Just excluded





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Model

Objective function:

$$TotalCost = \sum_{i}\sum_{ii}\left(Alloc(i,ii)\cdot DFTP(ii)\cdot\frac{D(i)}{TCap}\cdot TCap\cdot DC\right) +$$

$$+\sum_{i}\sum_{ii}\left(Alloc(i,ii)\cdot 2\cdot d(i,ii)\cdot\frac{D(i)}{VTCap}\cdot C\right)+\sum_{ii}\left(NFS(ii)\cdot\left(OPEX+\frac{CAPEX}{CCF}\right)\right)$$

Hydrogen demand data:

$$Hydrogen\ demand\left[\frac{kWh}{(km^2\cdot year)}\right] = Petrol\ demand\left[\frac{kWh}{(km^2\cdot year)}\right]\cdot\frac{49}{79}$$

Average fuel economy of petrol and FC vehicles

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Input Data

FC Vehicle Tank Capacity	0.155 MWh or 5 kg
Truck Capacity	40.59 MWh or 1100 kg
HRS Capacity	7,213.3 MWh (annual) or 750 kg/day
Cost for the Customer	0.07 £/km
Delivery Cost	0.66 £/MWh/km
HRS Capex	1,705,756.9 £
HRS Opex (=5% of Capex)	85,287.8 £
Capital Charge Factor	5 years

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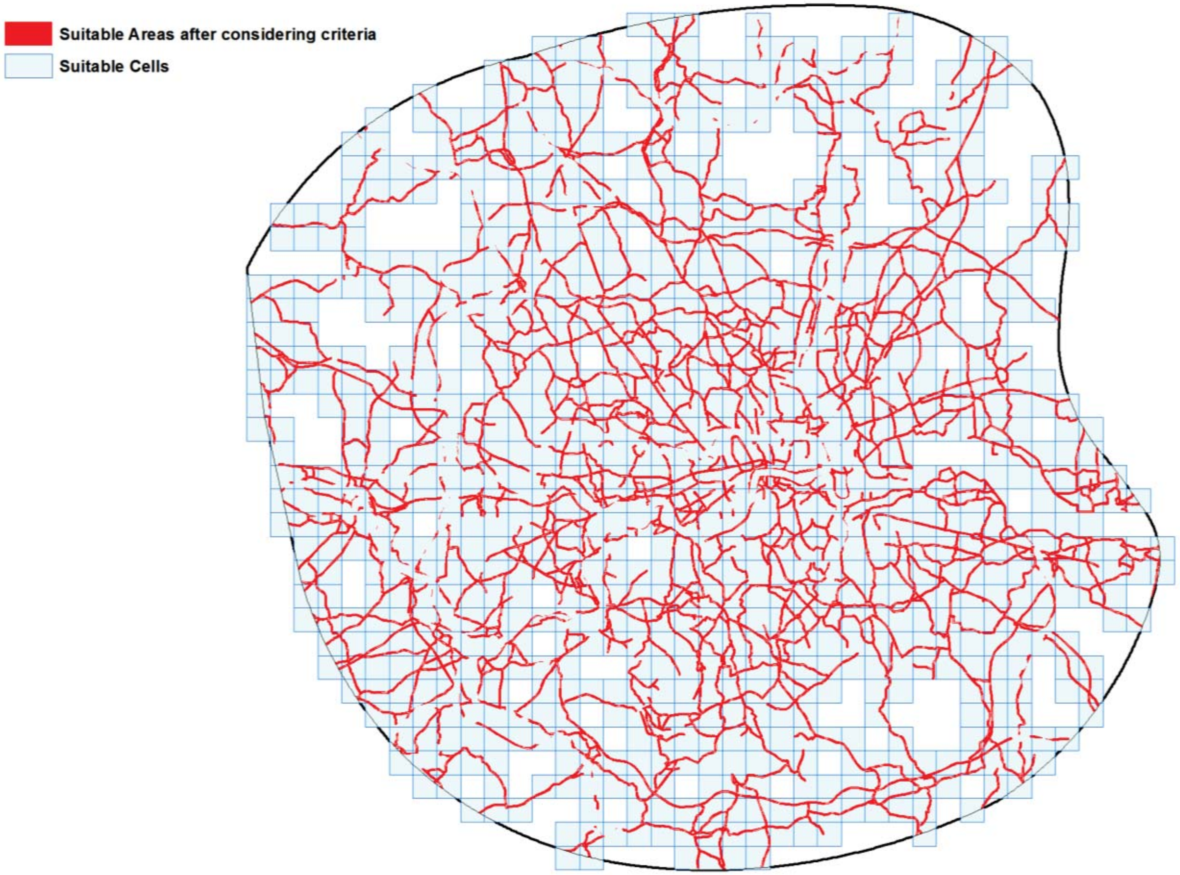
Suitable areas and suitable cells of zone 13



2x2 km

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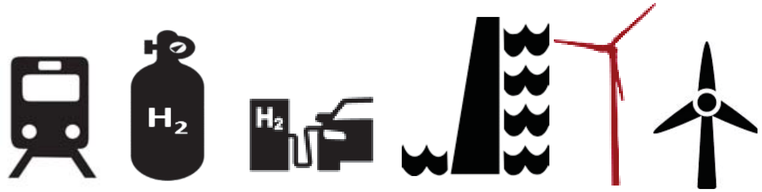
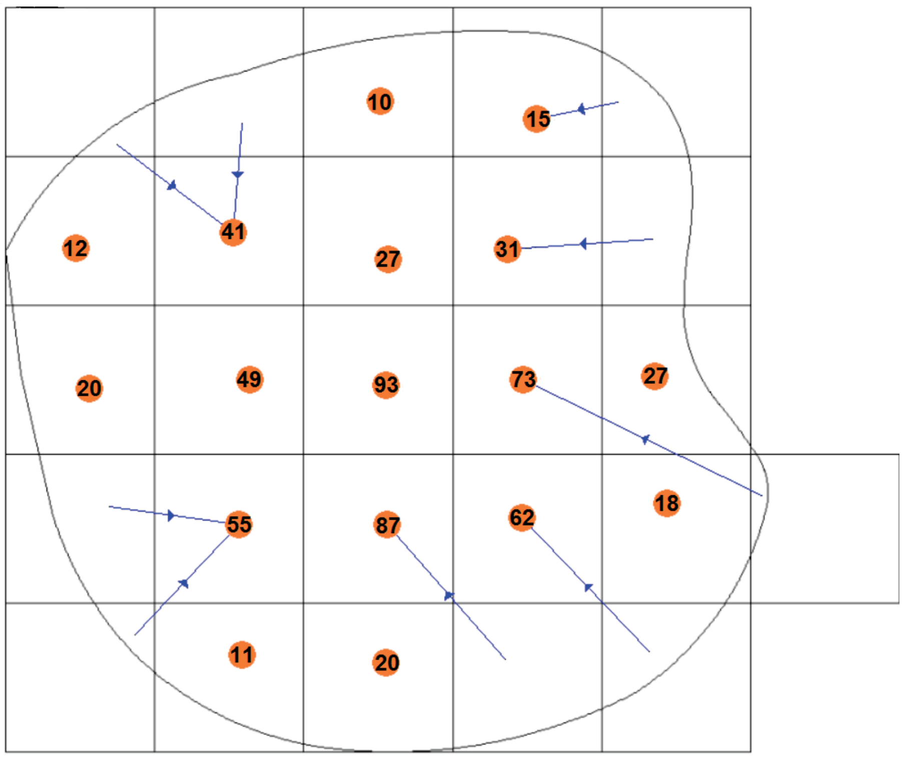
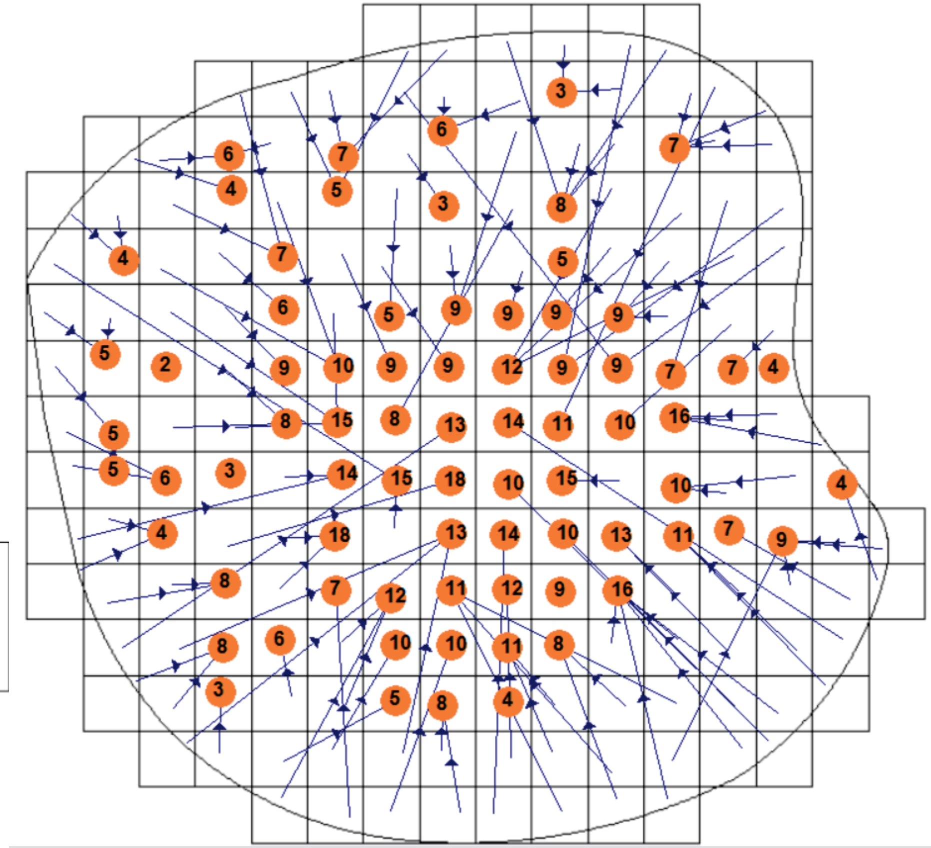


Spatial Resolutions for Zone 13



15x15 km



5x5 km

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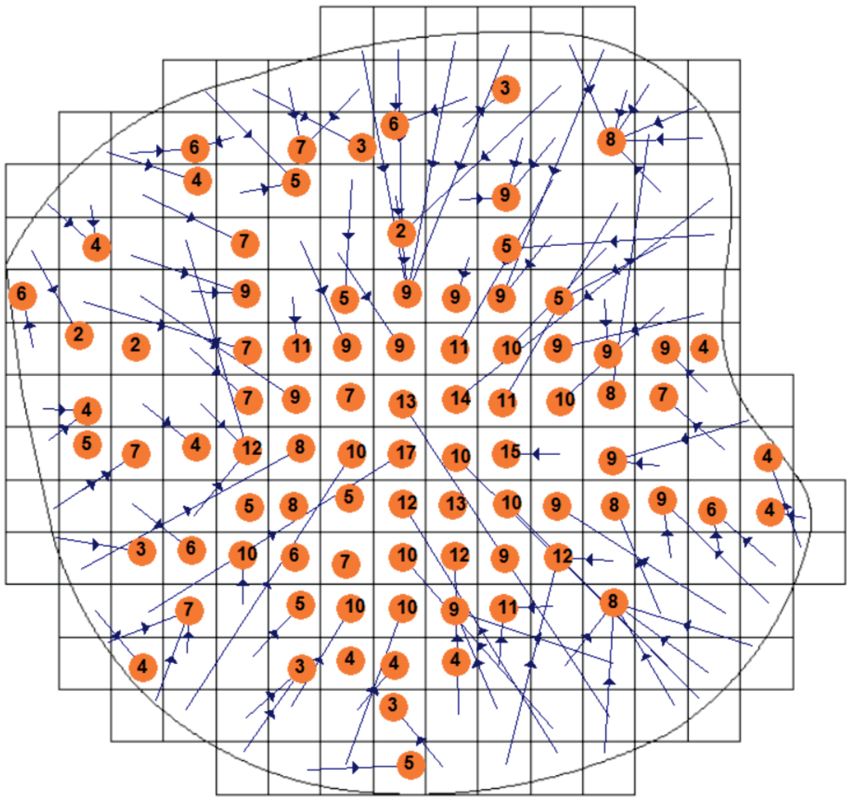
Sensitivity Analysis & Results

Delivery cost: −**50%** from nominal value



Delivery cost: +**50%** from the nominal value