

Estimating the Economic Impacts of Offshore Wind Farms and Fisheries Using a CGE Model

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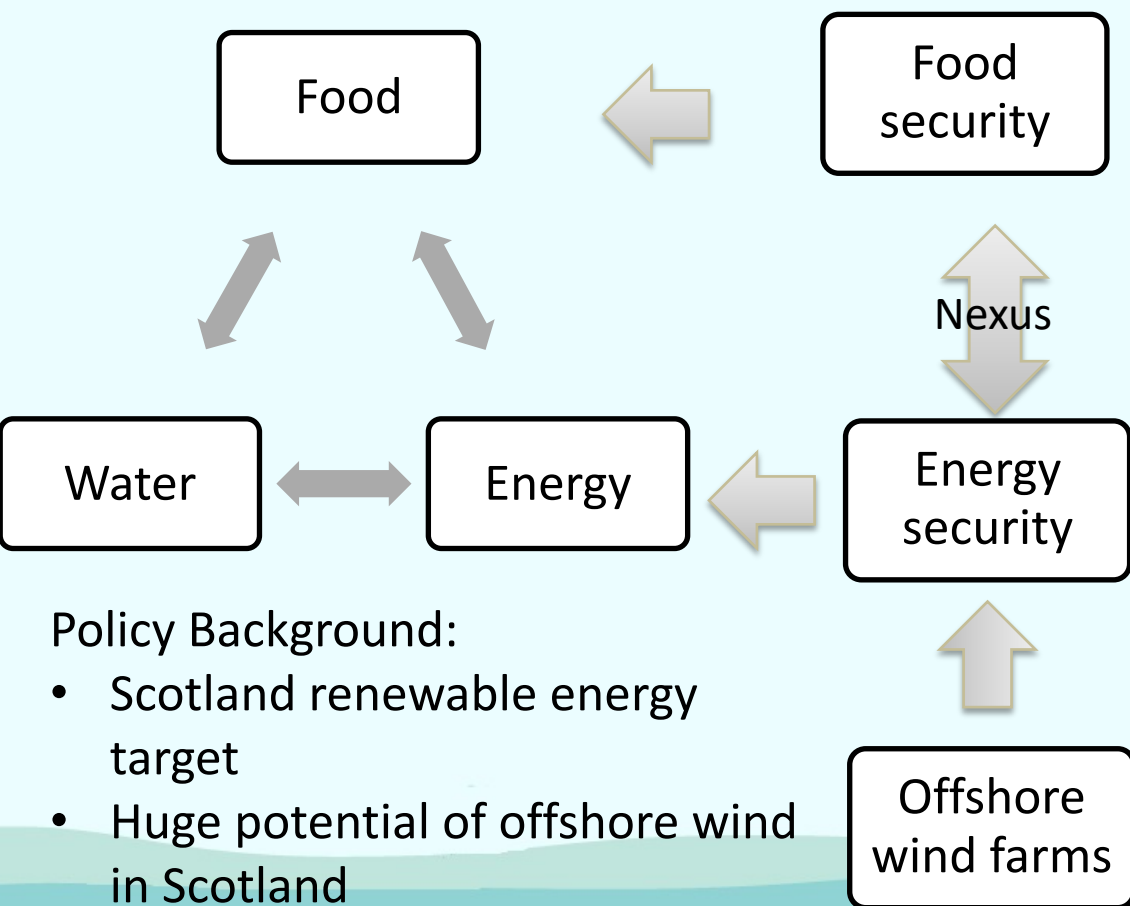
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PhD project overview



- Negative if marine area is taken away from fishery production: lower food availability
- Positive if fisherman can benefit from the artificial reef effect and the spillover effect
- Positive regarding improved energy security
- Negative if higher levelised cost

Policy Background:

- Scotland renewable energy target
- Huge potential of offshore wind in Scotland

- Need policy approach to minimize trade-offs in resource use and to build synergies
- Need for economy-wide integrated framework to determine impact of different scenarios

Economic impact

Electricity impact

- **Intermittent supply** – renewable energy
- **Higher levelised cost**

Fish affordability

Potential economic impact

- **Food processing** (change in electricity prices)
- **Change in consumer budget** (mix of basket of goods)
- **Change in welfare**

Fishery impact

- **Physical impacts**
- **Closed areas:** increase in biomass, abundance of species
- **Artificial reef effects:** creation of new habitats and shelters for certain fish species
- **Spillover effects:** increased egg output

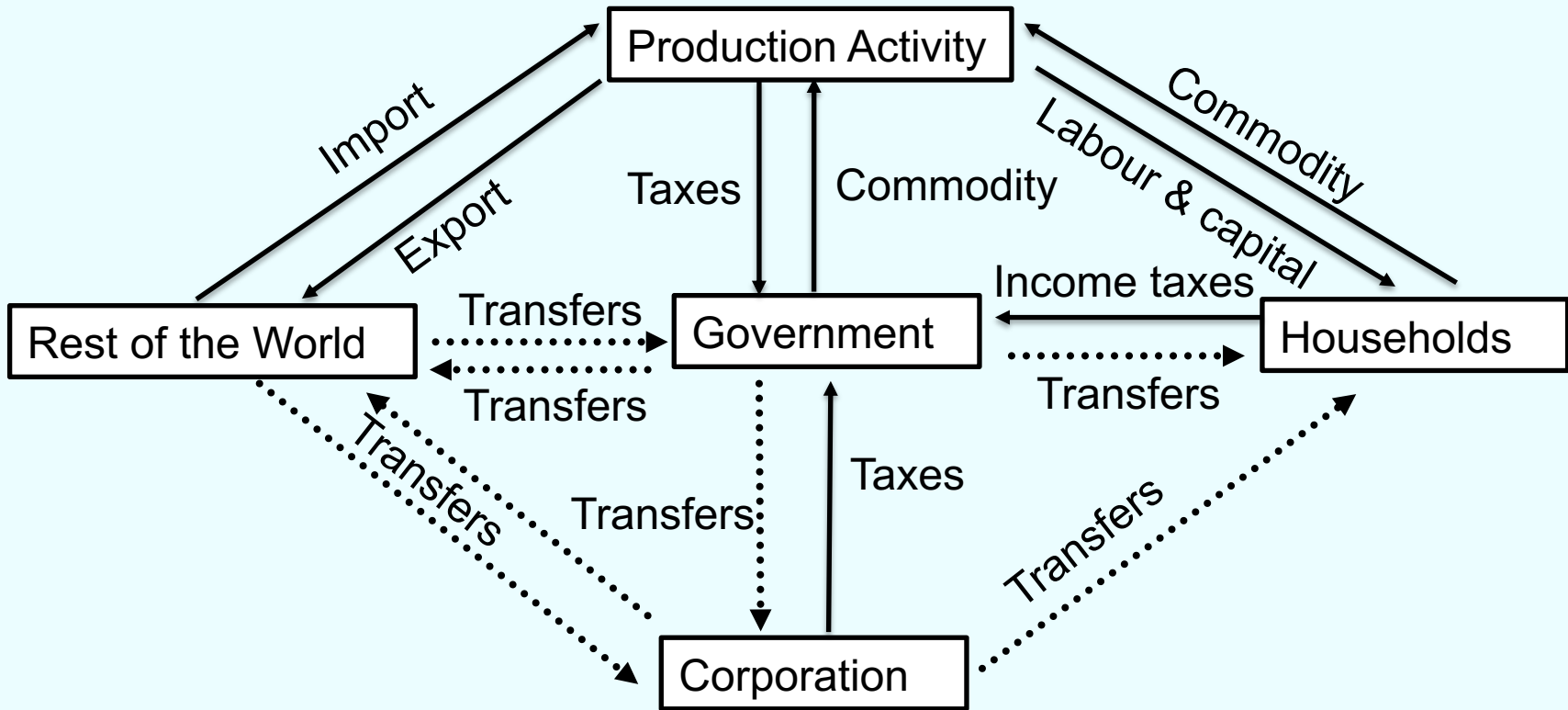
Fish availability

- **Change in fishing grounds** (species, distance)
- **Change in operating costs** (fuel costs)
- **Change in catch** (fishing unfamiliar grounds; not accessible to all gear types)

Computable General Equilibrium Model

- Function a market economy
- Inter-linkages across all markets – better for nexus assessment
- Consists of two parts:
 - Theoretical model: explains the behaviour of production sectors, households and other economic agents through mathematical equations
 - The social accounting matrix (SAM): economy-wide representation of a country's economic structure
- Output: price and quantity change, household behaviour, GDP, welfare distribution, etc.
- Model results: improve policy making

Circular Flow in CGE Model



- Five types of economic agents: production activities, households, government, corporation and the rest of world
- Solid lines: endogenous variables in the model
- Dash lines: constant in the model

Data: Scottish SAM

- Productive and diverse marine resources in Scotland
- Fishery:
 - 65% of total fish landing of UK in 2016
 - 0.37% of Scotland GDP (compared to 0.07% UK GDP)
- Offshore wind:
 - 25% of the whole European offshore wind resources.
 - 4 GW granted to take into plans

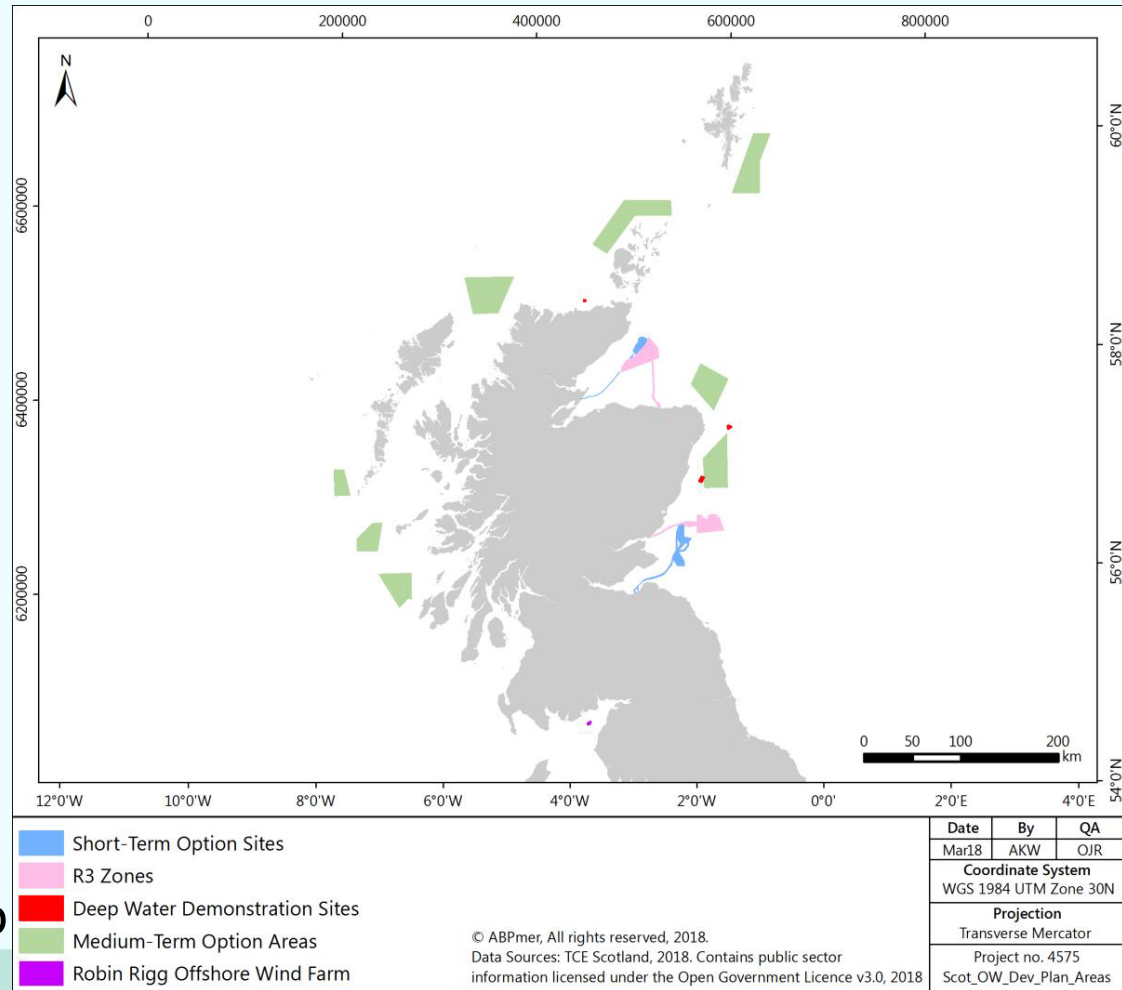



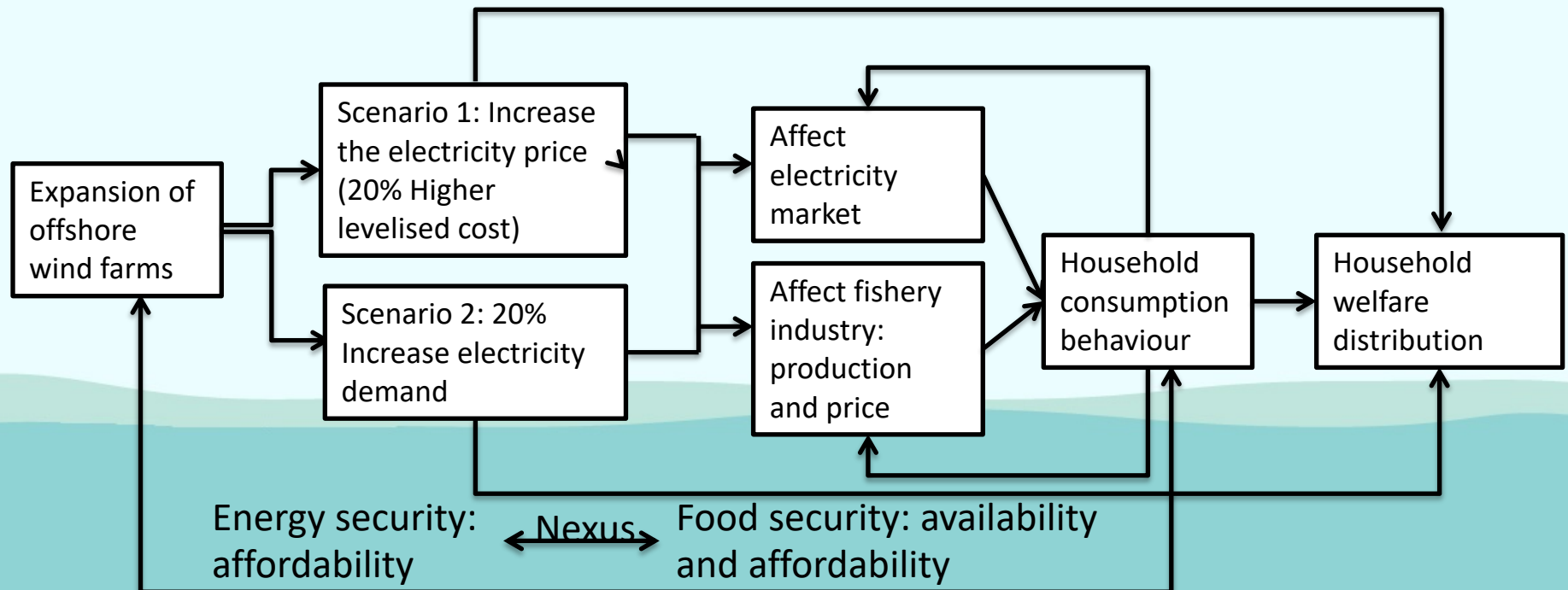
Figure 1. Existing and Planned Offshore Wind Development in Scottish Waters (Scottish Government, 2018)

Application to Scotland

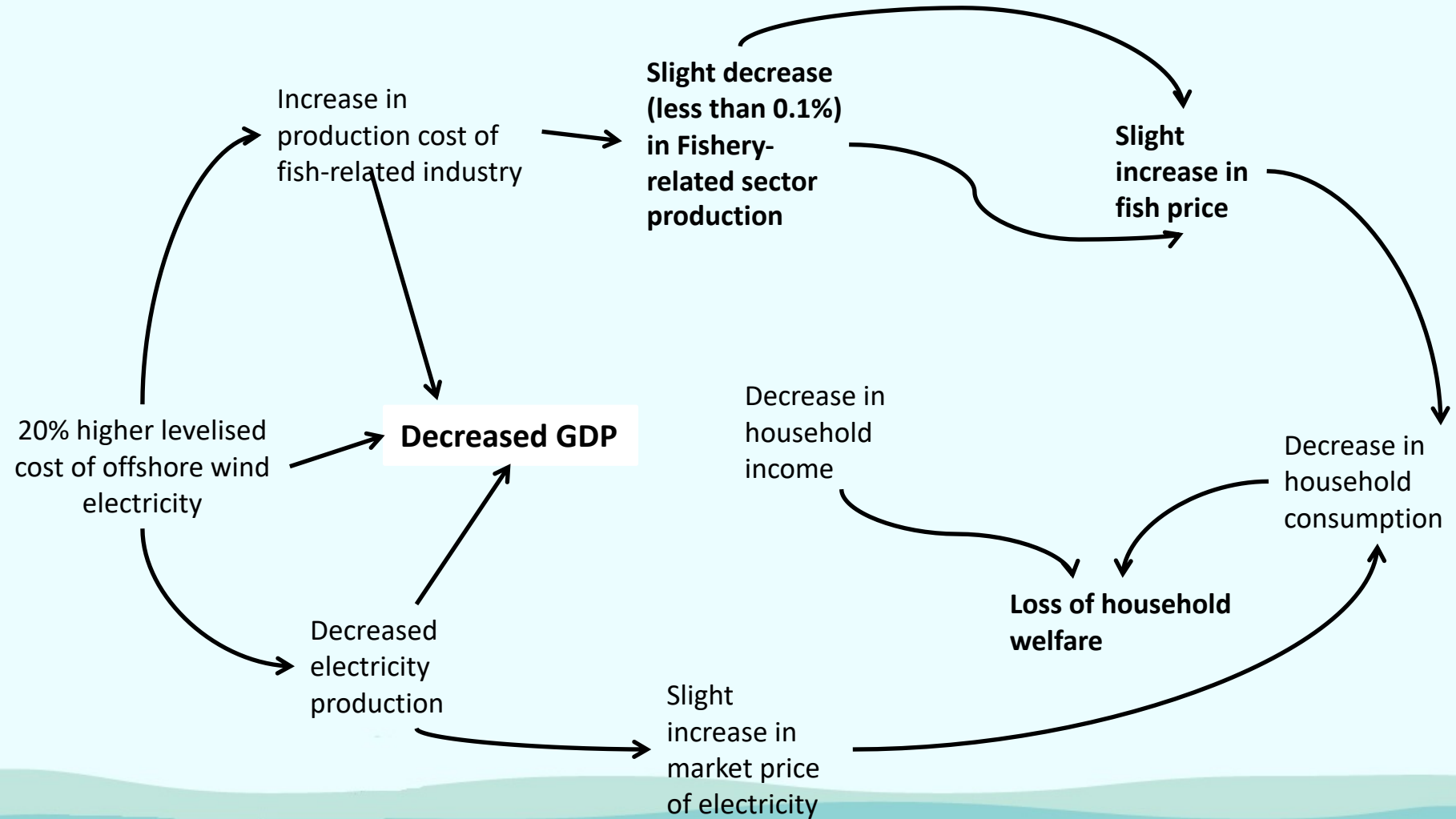
- Published Scottish SAM (University of Strathclyde, 2016): 104-activity aggregation table
 - Aggregation into 8 production activities
 - Disaggregation into 5 households based on different income levels: average income increase from HH1 to HH5
 - Rest of UK and Rest of the World as one sector
 - Provide benchmark and calibration of parameters in the CGE model
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Application 1 – Economy Level

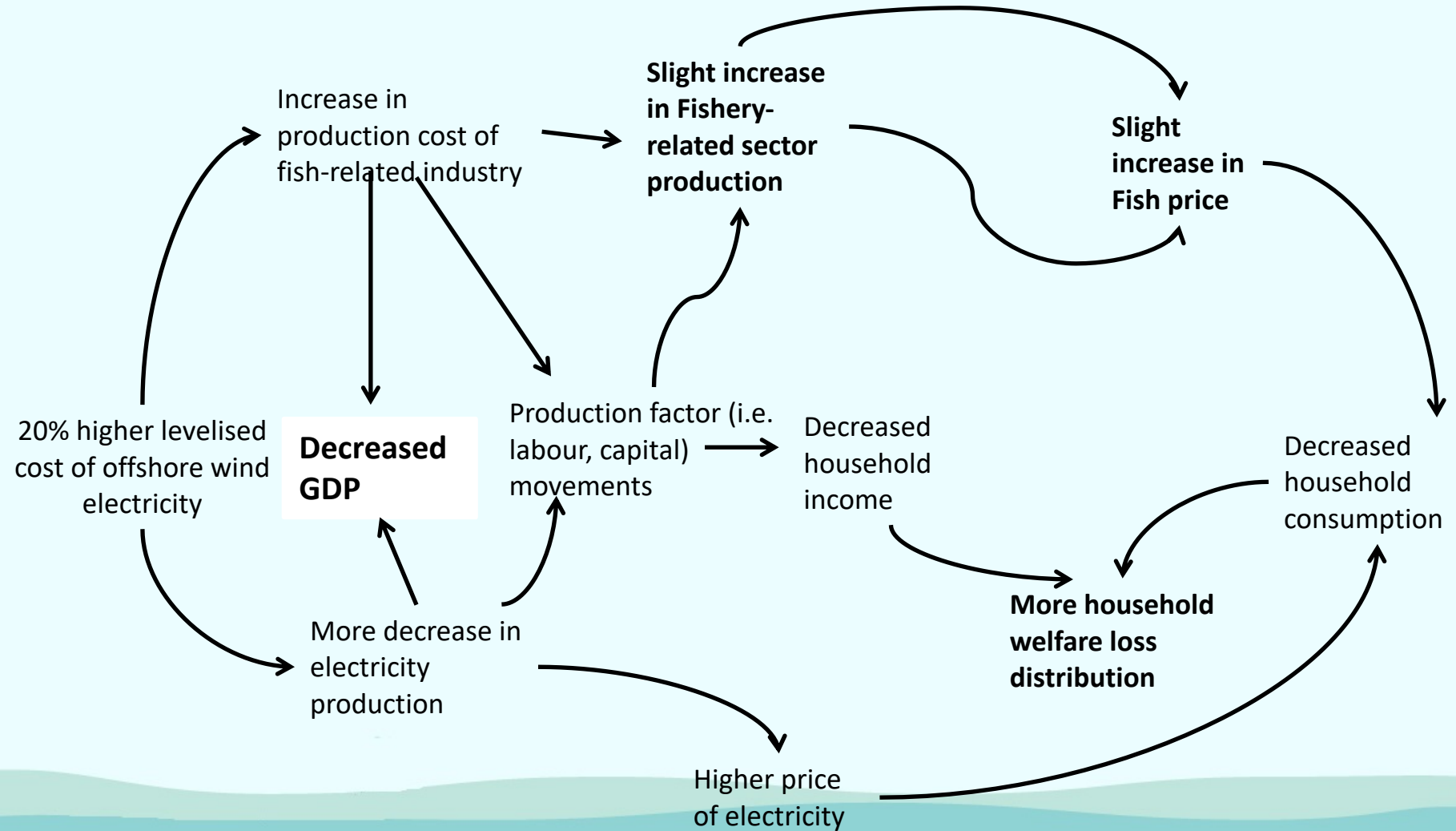
- How does the offshore wind energy expansion affect fish availability and prices?
 - Expansion: price, quantity
- How does the expansion change the fish affordability from household consumption behaviour changes?
- Who would benefit or suffer loss from potentially changed commodity and food prices? (welfare change)



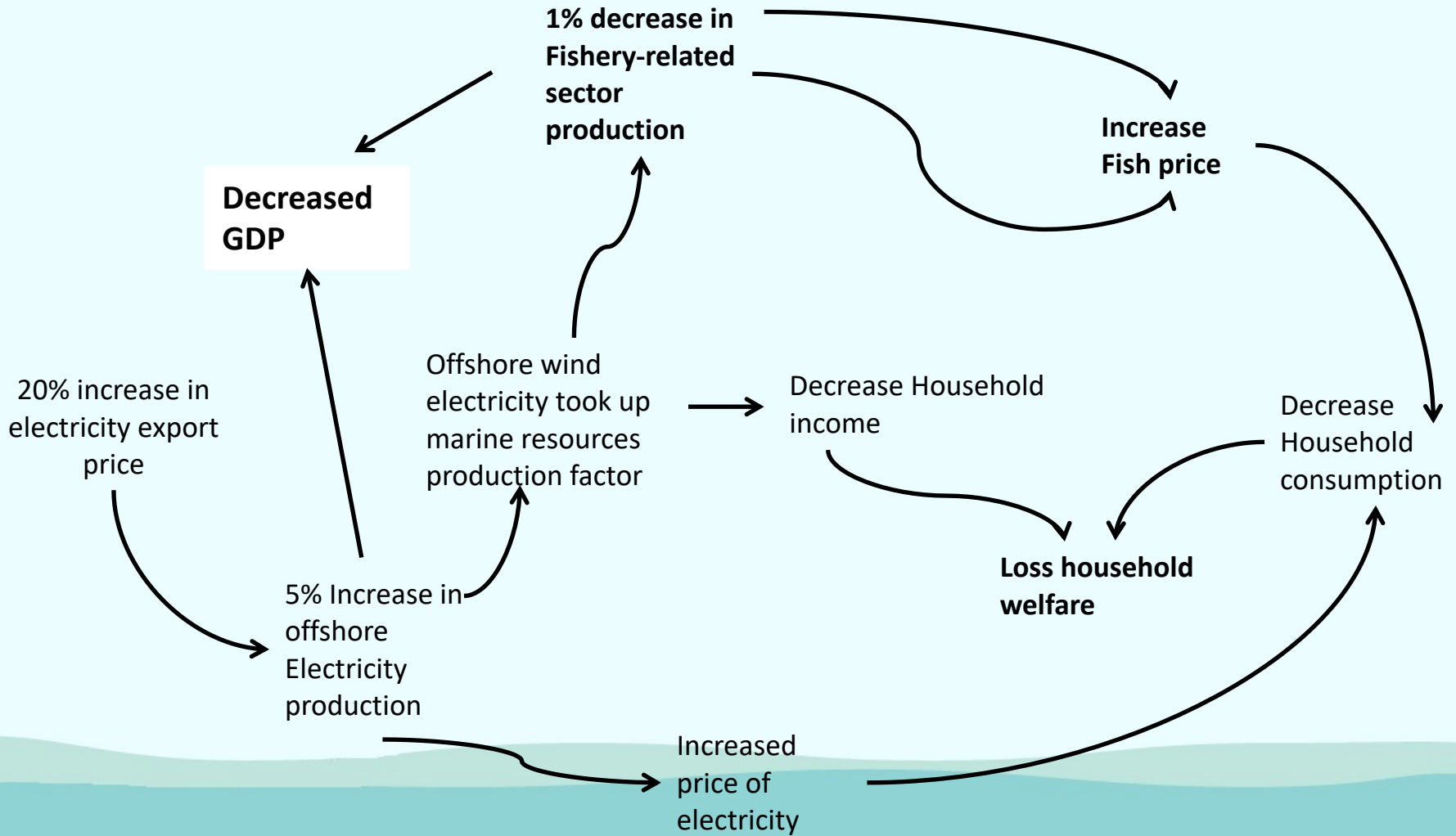
Scenario 1 – short run



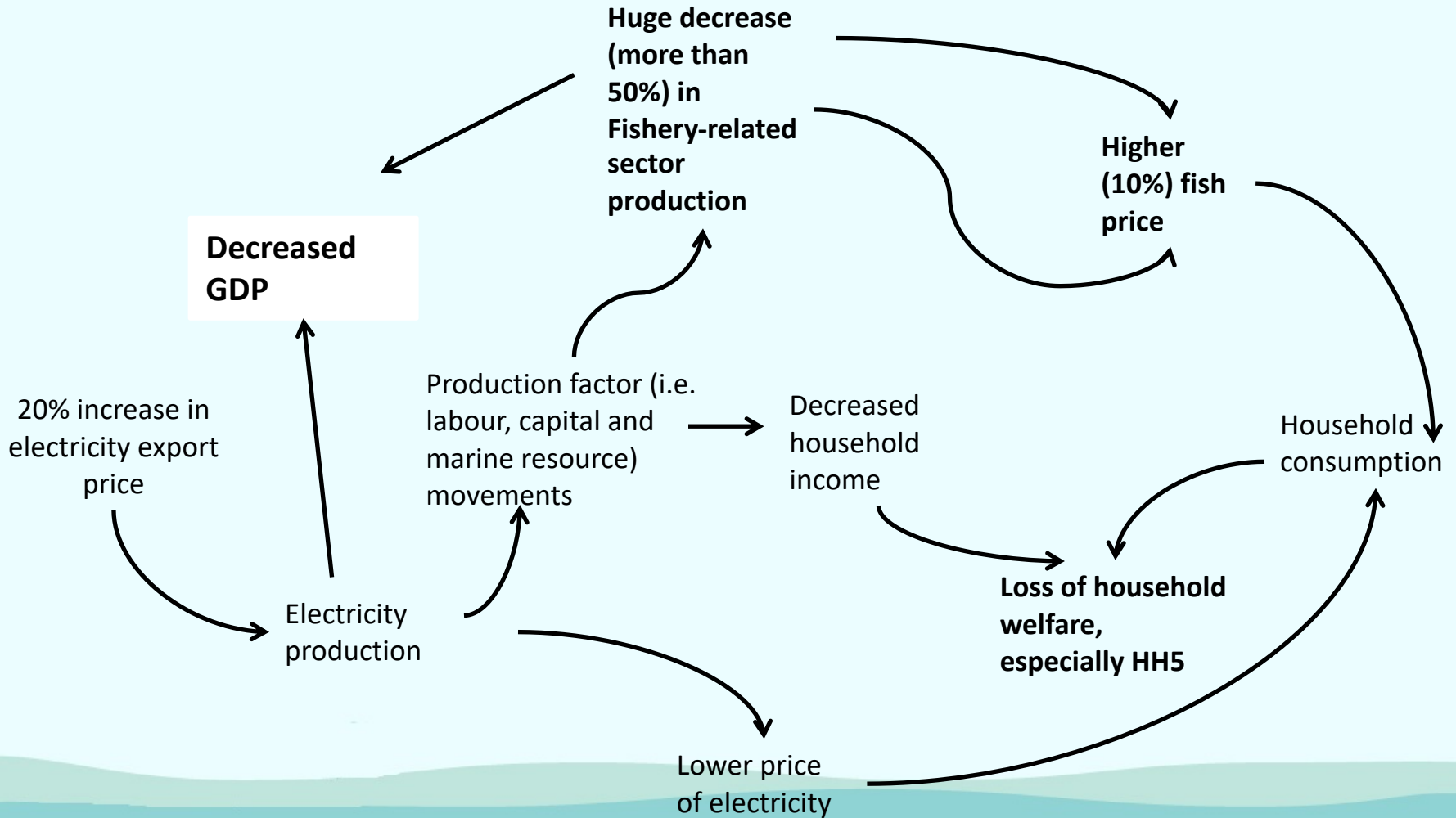
Scenario 1 – long run



Scenario 2 – short run



Scenario 2 – long run



Application 2 – Environment Level

- Introducing environment as a new sector in CGE model
 - A source of natural capital
 - A sink of by-products
- Track the two-way interrelationships between the economy and the environment:
 - The impacts of changes in natural capital on economic performance
 - The impact of economic changes on the use of natural capital
 - The feedbacks between these

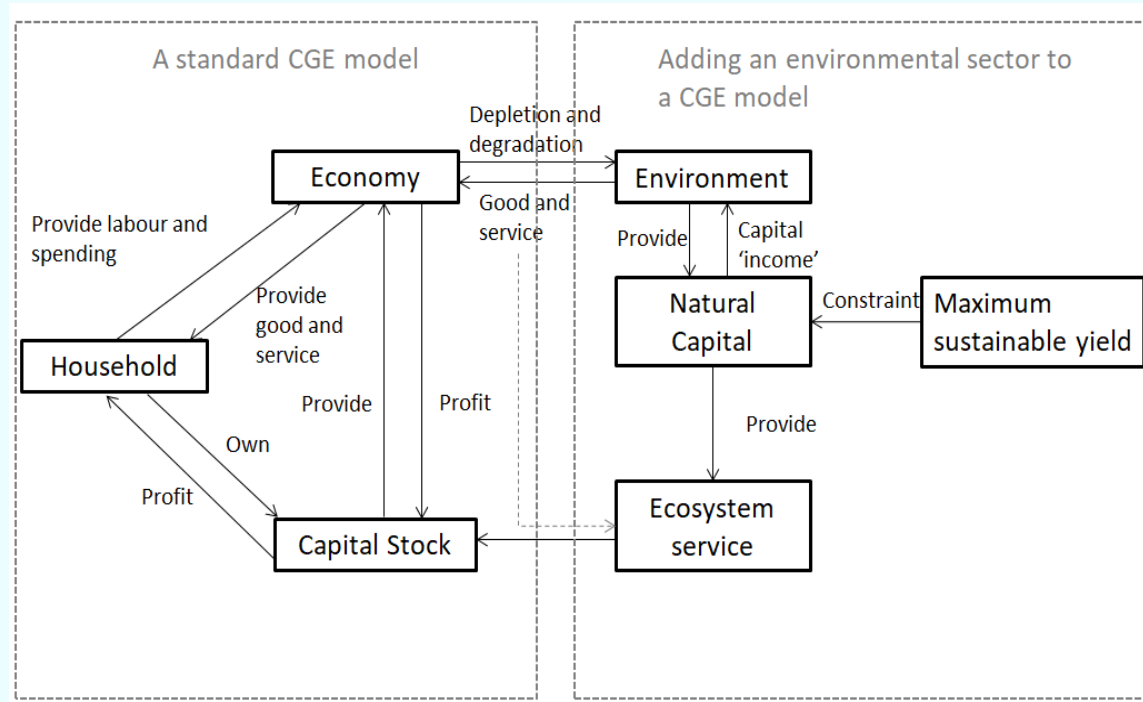


Figure 2 Flow chart of the structure of CGE model with environment as a new sector (Adapted from Allan et al., 2018)



Preliminary Results – Scenario 1

- Scenario 1: 10% increase in electricity demand
- From economic side:
 - Fishing sector domestic output decreased by 4.3% due to loss of labour and capital
- From environment side:
 - Loss of labour capital reduced fishing effort 4.3% and harvested fish 4.3%
 - Fish stock increased slightly by 0.28%



Preliminary Results – Scenario 2

- Scenario 2: 5% increase in fish stock due to artificial reef effect of offshore wind farms
- From environmental side:
 - Decreased fishing effort by 3.5%
 - Increased fish harvested by 6.2%
- From economic side:
 - Increased fishing domestic production by 2.9%
 - Slightly impacts on other sectors (less than 0.1%)

Conclusion

- CGE model is capable of assessing the economic impacts of food-energy nexus
 - Higher levelised cost has small impact on electricity price and slightly impact on fishery industry
 - Displacement of marine resources caused significant negative impacts on fishery industry
- Linking natural capital with CGE model is useful to assess the economic impacts on environment resources, and the other way around.

Questions?
Thanks for listening!

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