

## 2R UK MARKAL Model: development and results

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### Content

- The UK and Scottish policies
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- Scenarios
- Results

## Climate and renewable policies

- The UK Government has set the target of 80% CO<sub>2</sub> reduction at 1990 level by 2050 and 34% of GHG (29% CO<sub>2</sub>) by 2020
- EU renewable directive:
  - The UK's contribution to this should be to increase the **share of renewables to 15% by 2020**
  - Renewable Energy Strategy (RES) for UK
    - Renewable Obligations (RO)--30% from 2020
    - Renewable Transport Fuel Obligations (RTFO)--10%
    - Renewable heat (RH): 12% from 2020
- Scottish Government targets
  - 42% GHG by 2020 and 80% by 2050
  - Renewable 80% by 2020

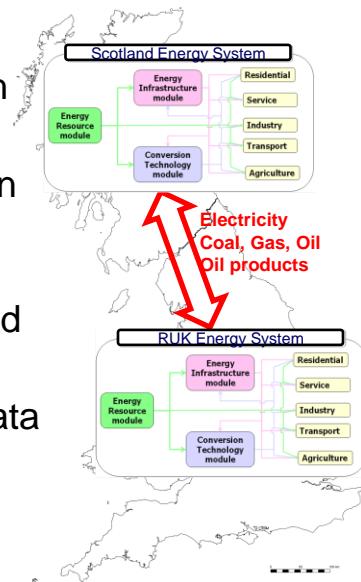
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## Research Question

- Meeting the UK climate and renewable policies under the objective of maximising social welfare--  
**would it meet regional (Scottish) policies?**
- Since a considerable amount of renewable resources especially wind, **what is the net flow of electricity (renewable) from Scotland to England?**
- 2R UK MARKAL model, where Scotland (SCT) and rest of the UK (RUK) are the two regions, has been developed to do the analysis

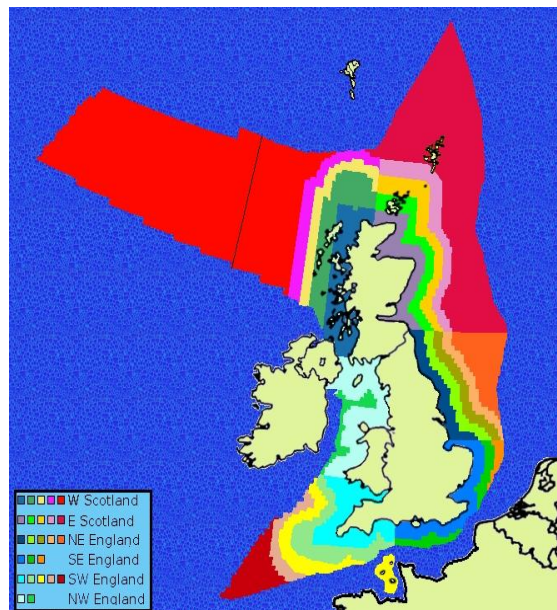
## 2 R UK MARKAL Model

- Each region can trade energy with rest of the world
- Inter-region energy trade (between Scotland and Rest of the UK regions) is allowed for fossil fuels (coal, oil and gas, oil products) and electricity
- Spatial off-shore wind resource data for each region



## Wind Resource Data

Annual capacity factor is calculated for each zone using mean wind velocity (power density).  
Grid interconnection cost is added to the investment cost

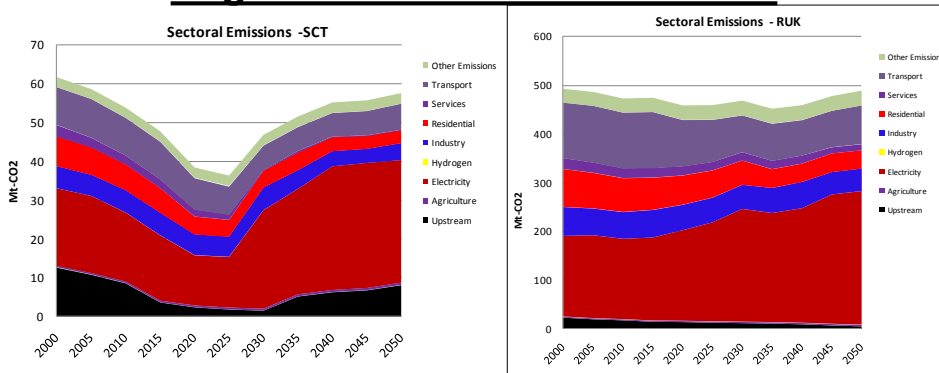


## Scenarios

- Reference Scenario (REF): No climate policy is applied. RO 15% and RTFO 5%
- Low Carbon Scenario (LCS): Global emission constraint is applied to the UK. CO<sub>2</sub> emission mitigation target is 29% in 2020 and 80% in 2050.
- Renewable Energy Strategy Scenario (RES): RO 30%, RTFO15% and RH12%

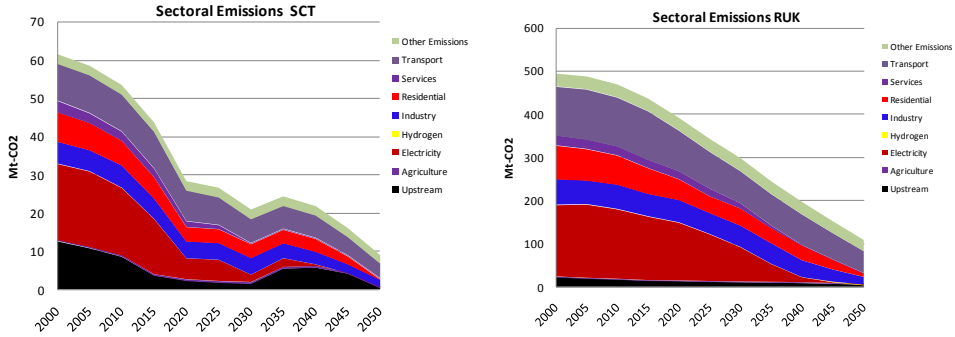
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## Regional CO2 emissions in REF



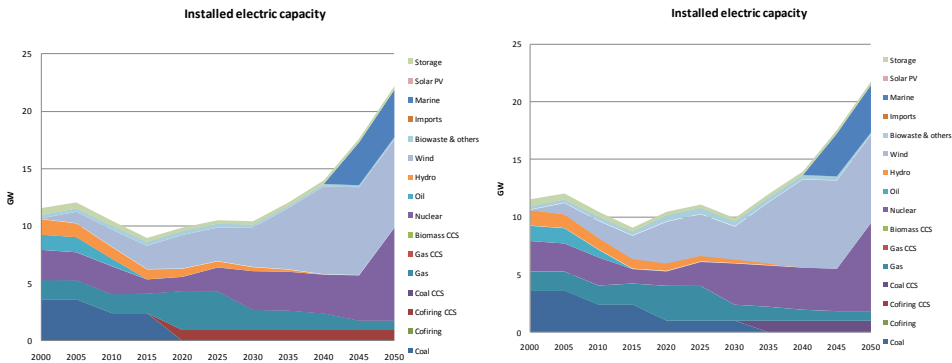
- Scottish share in the UK emissions is in the range of 7-11%
- Scottish emissions depend on export of electricity and fossil fuels to rest of the UK

## CO2 emissions in LCS



- Reduction in Scotland is slightly higher than that in the RUK

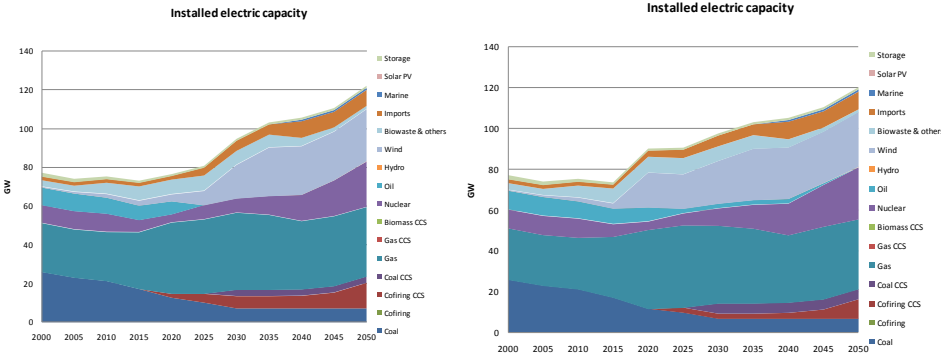
## Installed capacity in LCS and RES--SCT



- Wind and gas capacity is increased to meet RES



# Installed capacity in LCS and RES--RUK



- Wind capacity is increased in 2020 to meet RES



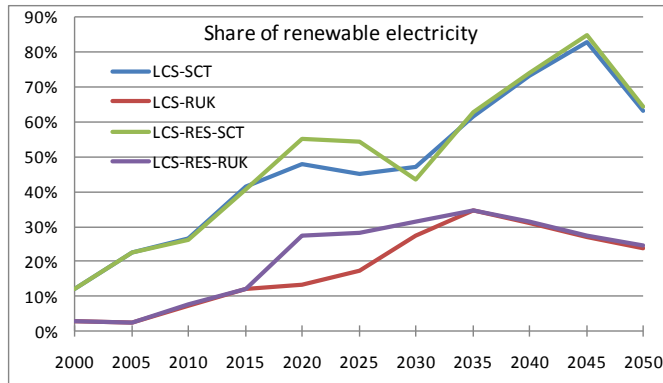
## Climate policies

Table 1. Results against targets for the Low Carbon Scenario

	Target in 2020	Reduction in 2020	Target in 2050	Reduction in 2050
Scotland	42%	53%	80%	85%
UK as a whole	29%	29%	80%	80%

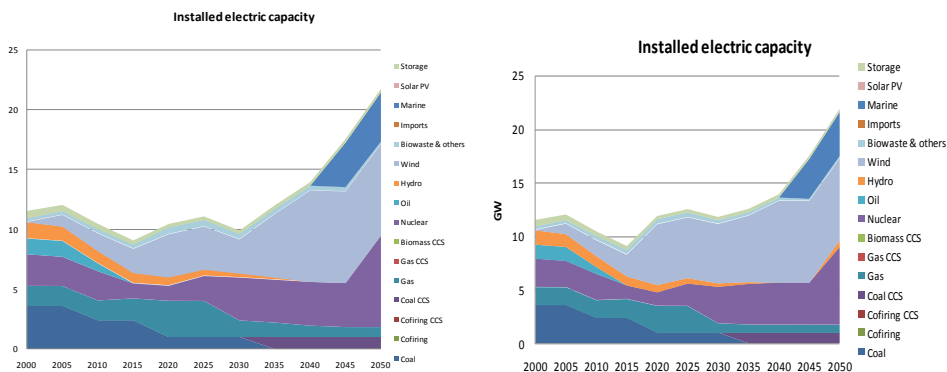
- Meeting national target (UK wide) satisfies the regional target (Scottish target)

## Renewable electricity policy



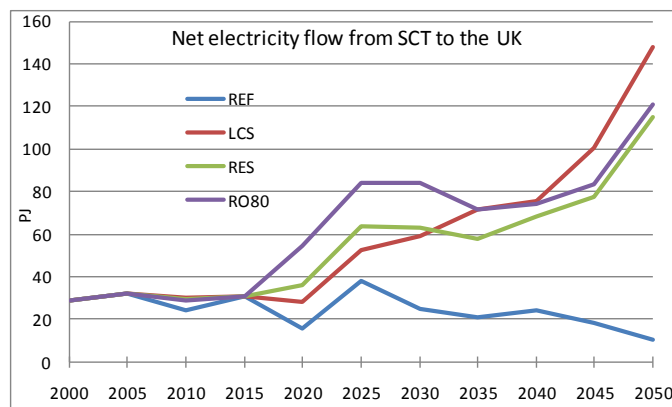
- Though share of renewable electricity is relatively high in Scotland, regional target has not been met when the national target is met.

## Scottish RO80 with RES



- Wind generation in 2020 is increased to meet Scottish renewable obligation

## Electricity flow



- Net electricity flow is significant in the future under climate policies
- Scottish RO 80 requires early investment in transmission capacity

## Conclusion

- Meeting national climate policy under the objective of social welfare maximisation requires more reduction in Scotland than the Scottish climate target in 2020
- Scottish renewable electricity policy (RO80) is not met when the UK renewable energy strategy is met
  - Scottish renewable electricity target is too optimistic?
- Net electricity flow is significant in the future under low carbon and renewable scenarios
- Meeting Scottish 80% renewable electricity target increases energy system cost and requires early investment in transmission capacity