

FLEXIBLE STRATEGIC FOREST MANAGEMENT IN LONG-TERM ENERGY PLANNING

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Outline of the presentation

- ❑ Forestry and bio-energy sectors
- ❑ Project objectives
- ❑ Forestry and energy planning model
- ❑ Preliminary results
- ❑ Conclusions

Forestry and bioenergy sectors

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Forestry and bioenergy

Project objectives

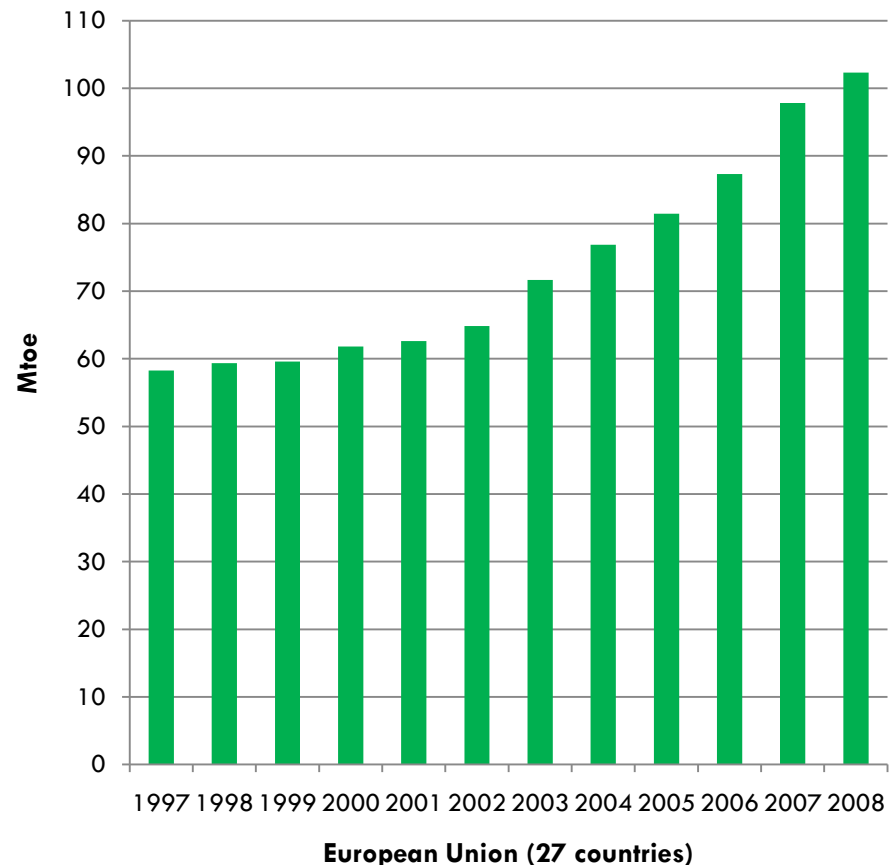
TIMES model

Preliminary results

Conclusions

- Biomass is a vital source of renewable energy
- Worldwide, biomass provides 10% of Total Primary Energy Supply (TPES):
 - Heat
 - Electricity
 - Biofuels
- Numerous biomass sources may be used for energy purposes

Primary energy production Biomass & Renewables (EUROSTAT)



Forestry and bioenergy sectors

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Forestry and bioenergy

Project objectives

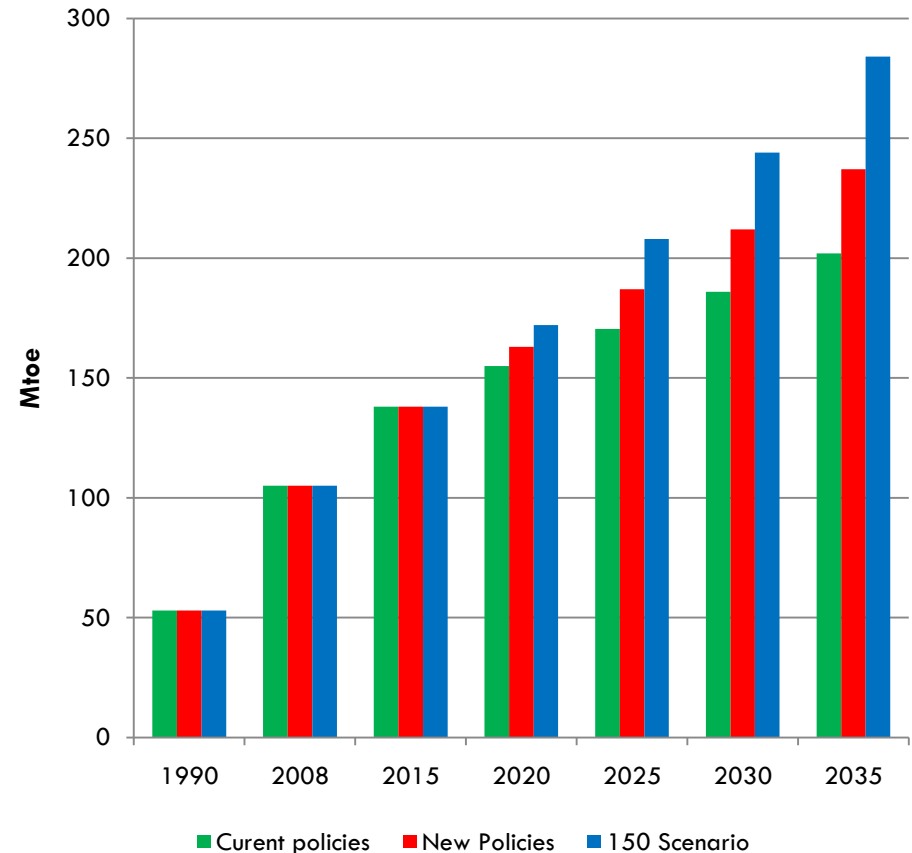
TIMES model

Preliminary results

Conclusions

- Energy production from biomass is cost-efficient, particularly in countries with abundant biomass sources
- Relays on well known and mature technologies
- To mitigate climate change, modern use of biomass should provide 17% of TPES by 2035

Primary energy production Biomass & Renewables (WEO 2010)



Forestry and bioenergy sectors

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Forestry and bioenergy

Project objectives

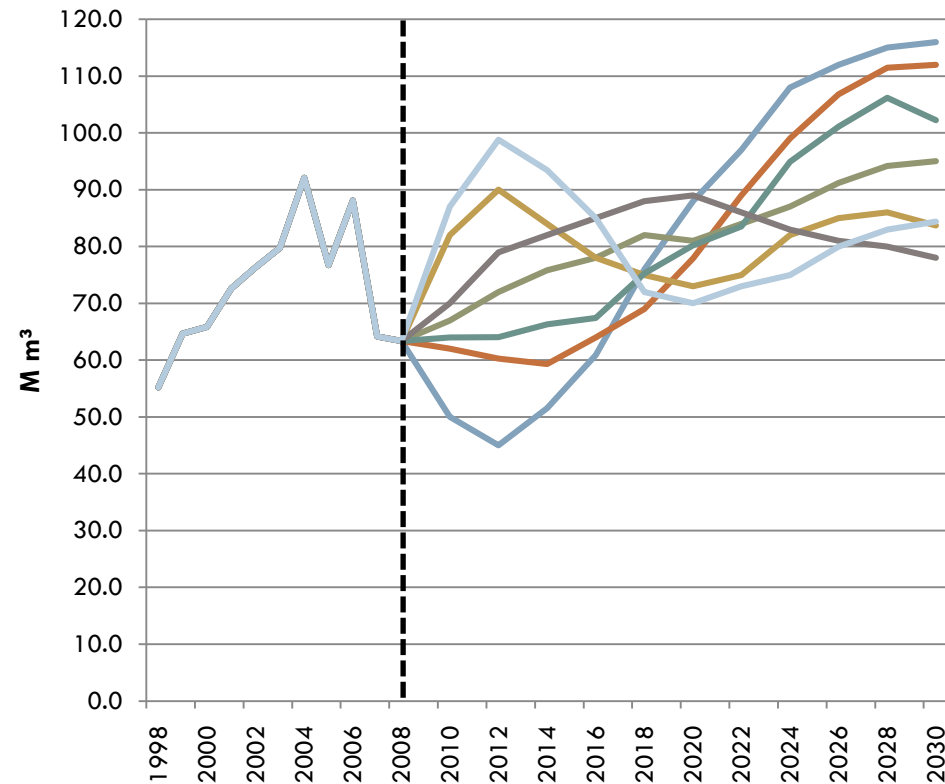
TIMES model

Preliminary results

Conclusions

- Wood is the main source of biomass being used for energy purposes
- Demand for bio-energy is affecting the forestry sector:
 - ▣ Cutting of tree top
 - ▣ Utilization of Wood chips, Sawdust, Pulpwood
- From a bio-energy point of view:
 - ▣ What is the optimal forestry management?
 - ▣ What is the optimal long-term forest harvesting level?

**Forestry harvest in Sweden
(Swedish National Forest Inventory)**



- Main aim of project:
 - Analyze the link between the forestry and bio-energy sectors
 - Analyze a long-term forest harvesting level that is optimal from a bioenergy point of view
- Create a prospective model that considers:
 - Development of the forestry and energy sectors
 - Biomass sources from forestry and agricultural sectors
 - Sub-national resource specification
 - Detailed cost-supply curves of biomass sources
- Case study of Sweden, assessing the development of the forestry and bio-energy sectors

TIMES forestry and energy planning model

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Forestry and bioenergy

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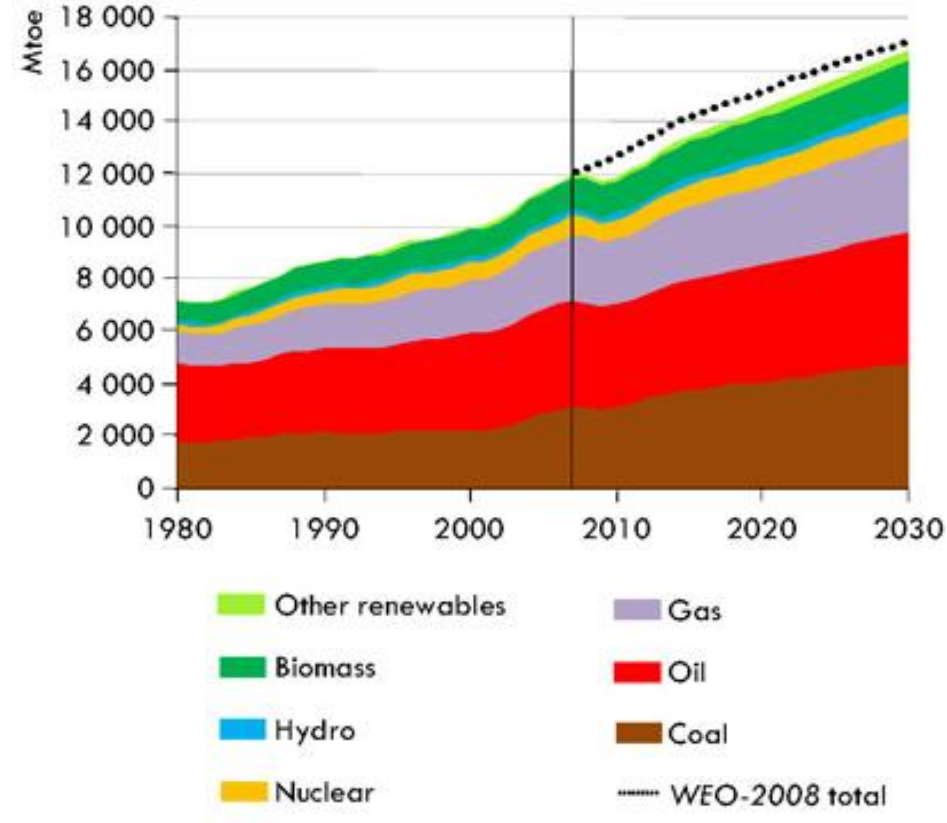
TIMES model

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Conclusions

- Prospective models is a family of models, specifically developed for analyzing development of energy systems
- Can be used to estimate:
 - ▣ Future energy mix & utilization of technologies
 - ▣ Future integration of developing technologies
 - ▣ “Least cost” solutions for reaching climate targets

World Energy Outlook - 2008 (IEA)



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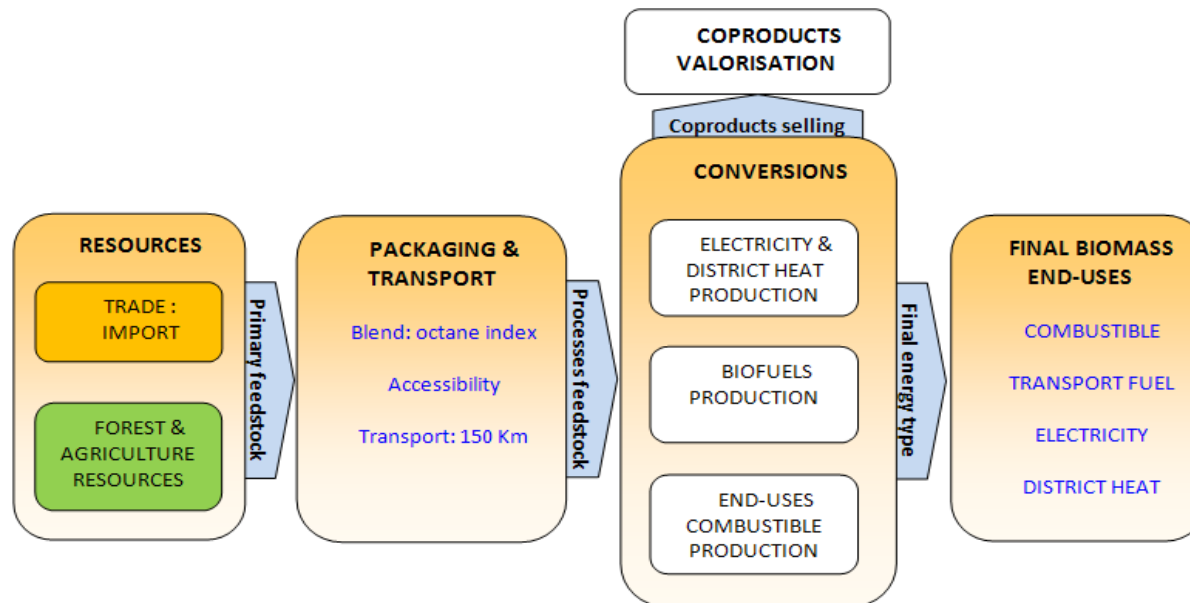
Project objectives

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Conclusions

- TIMES/MARKAL is a family of prospective models developed by the ETSAP organization



TIMES-MARKAL models

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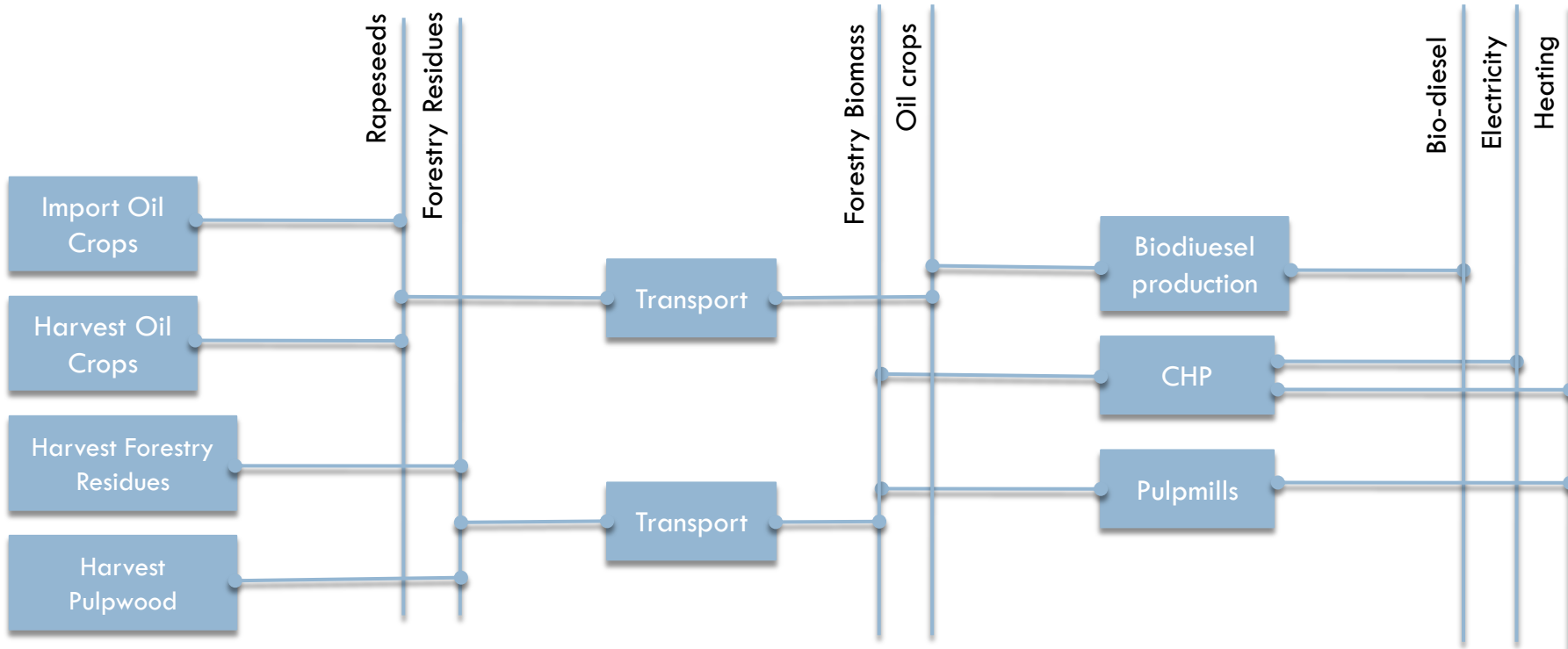
Project objectives

TIMES model

Preliminary results

Conclusions

- A model is defined by commodities and technologies



TIMES forestry and energy planning model

- The TIMES biomass-forestry model being developed considers a planning horizon of 2005 - 2100
- Numerous agricultural & forestry biomass sources are considered in the model:
 - ▣ Starch, Sugar, Oil, Woody, and Grassy crops
 - ▣ Forestry residues, Sawlogs, Pulpwood, Refined woody products
- Only unutilized biomass sources are available for energy purposes
 - ▣ No competition with food and feed sectors
 - ▣ No competition with forestry industries

TIMES forestry and energy planning model

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Forestry and bioenergy

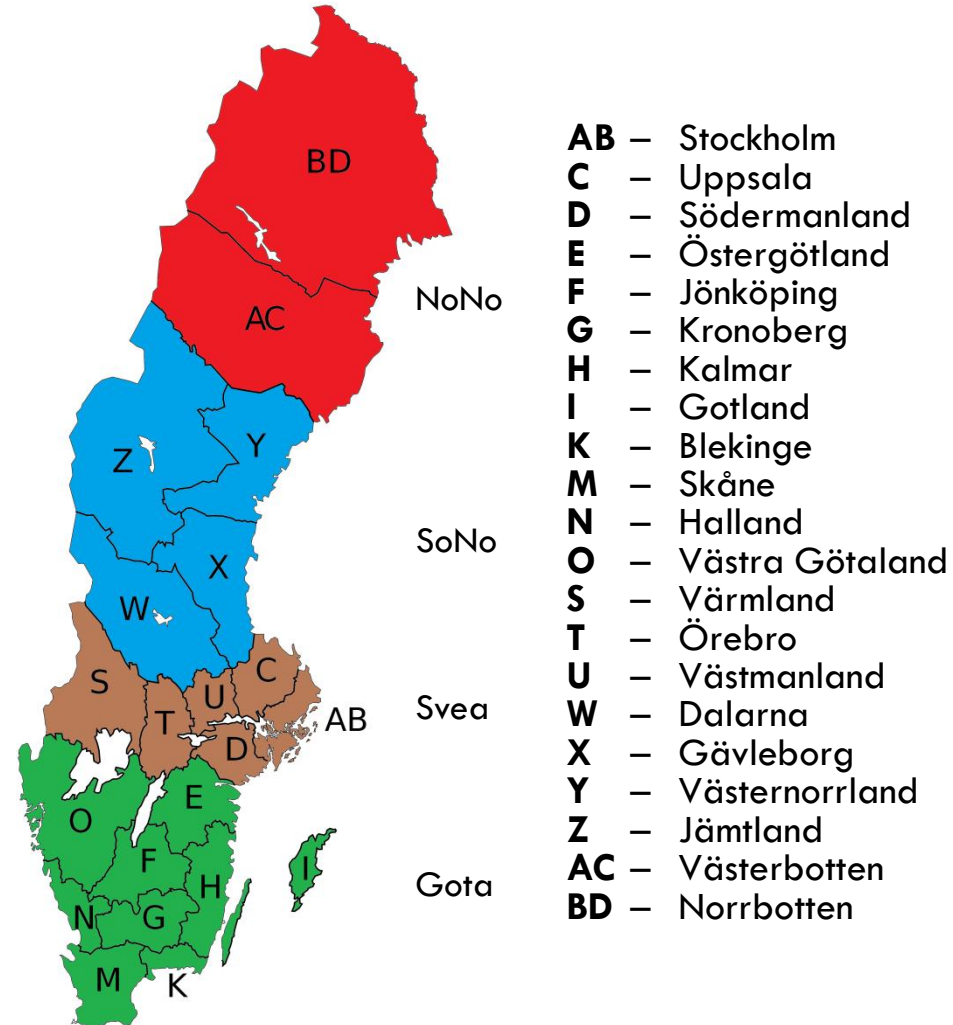
Project objectives

TIMES model

Preliminary results

Conclusions

- Sweden is divided into four regions: NoNo, SoNo, Svea, and Gota
- Highly detailed cost-supply curves of forestry biomass sources for each region
- Cost-supply of agricultural biomass sources expressed on an aggregated national level



TIMES forestry and energy planning model

- Detailed technology database including the most promising 2nd generation biofuel production methods
- End-use demand of bio-energy in terms of:
 - ▣ Biofuels for road transport, private heating, district heating, and electricity

	Starch crops		Sugar crops	Oil crops	Woody crops	Grassy crops	Wood
Generation	1 st	2 nd	1 st	1 st , 2 nd	2 nd	2 nd	2 nd
Bio-diesel				X			
Bio-ethanol	X		X		X	X	X
FT-diesel		X			X	X	X
Bio-HVO				X			

TIMES forestry and energy planning model

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Forestry and bioenergy

Project objectives

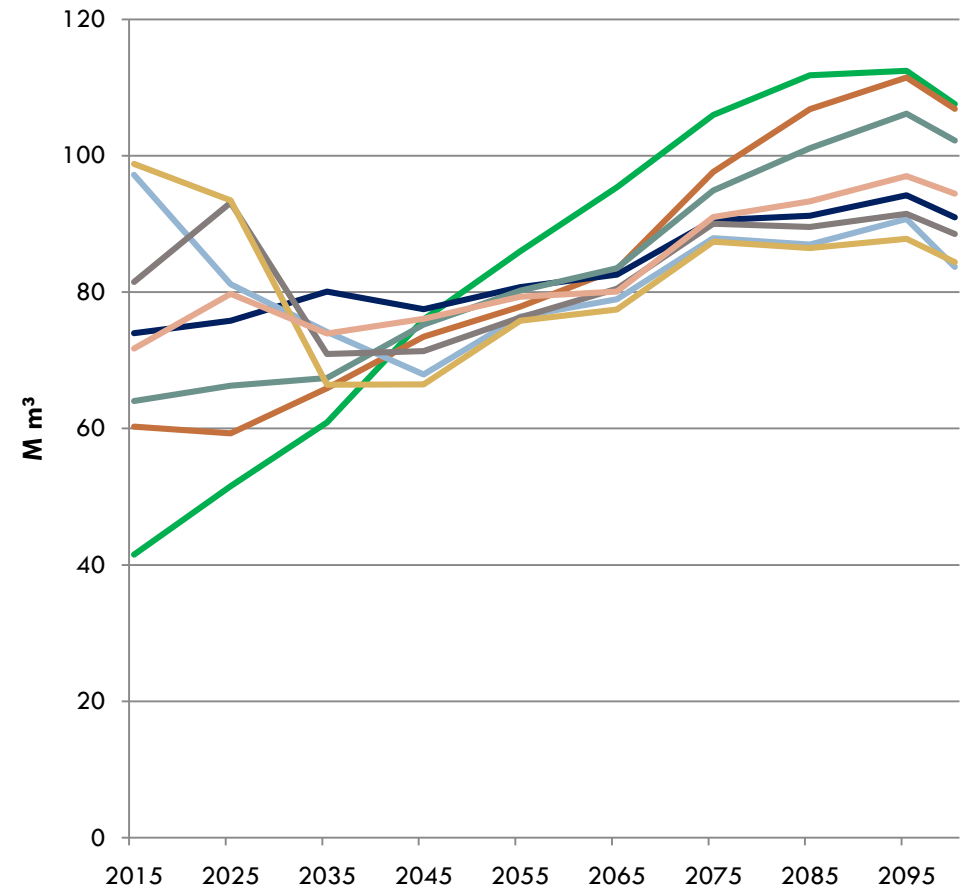
TIMES model

Preliminary results

Conclusions

- A number of applicable harvesting scenarios are considered:
 - ▣ Specifies the harvest levels during the time periods
 - ▣ Affects supply of forestry residues, pulpwood, sawlogs
- An optimal harvesting level is computed by the model as a linear combination of the harvesting scenarios

National harvest potential



Preliminary results

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Forestry and bioenergy

Project objectives

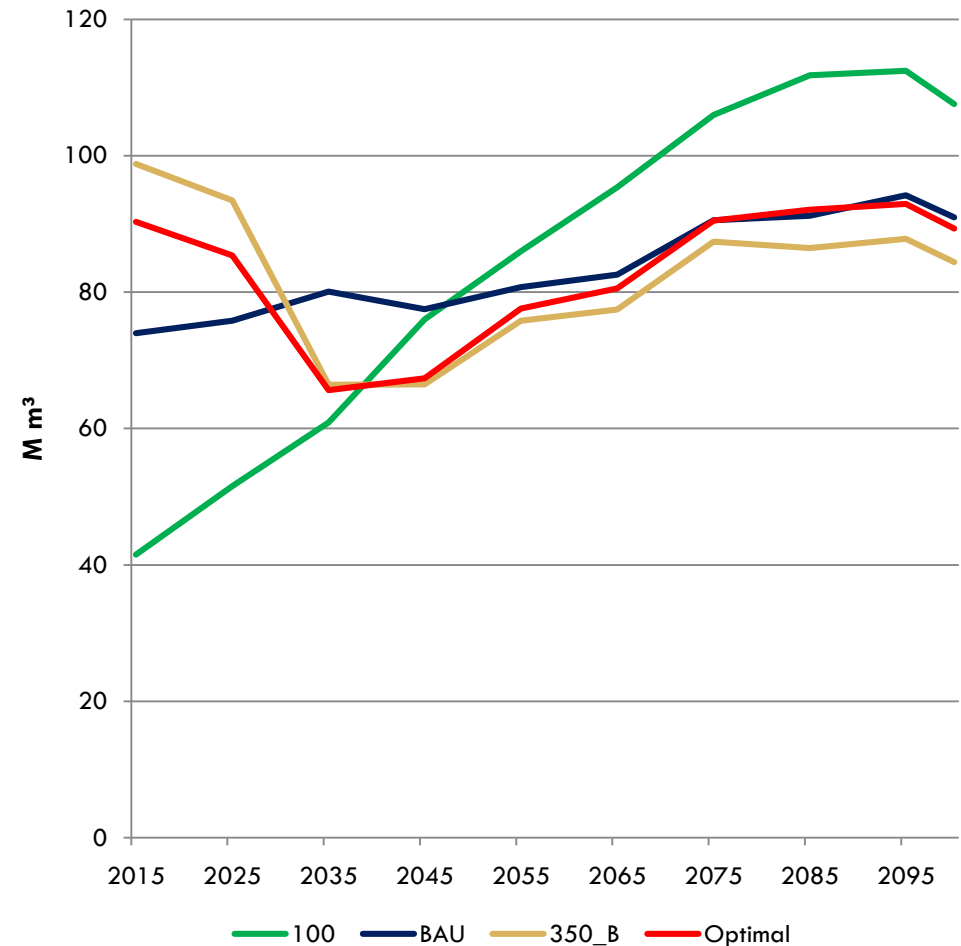
TIMES model

Preliminary results

Conclusions

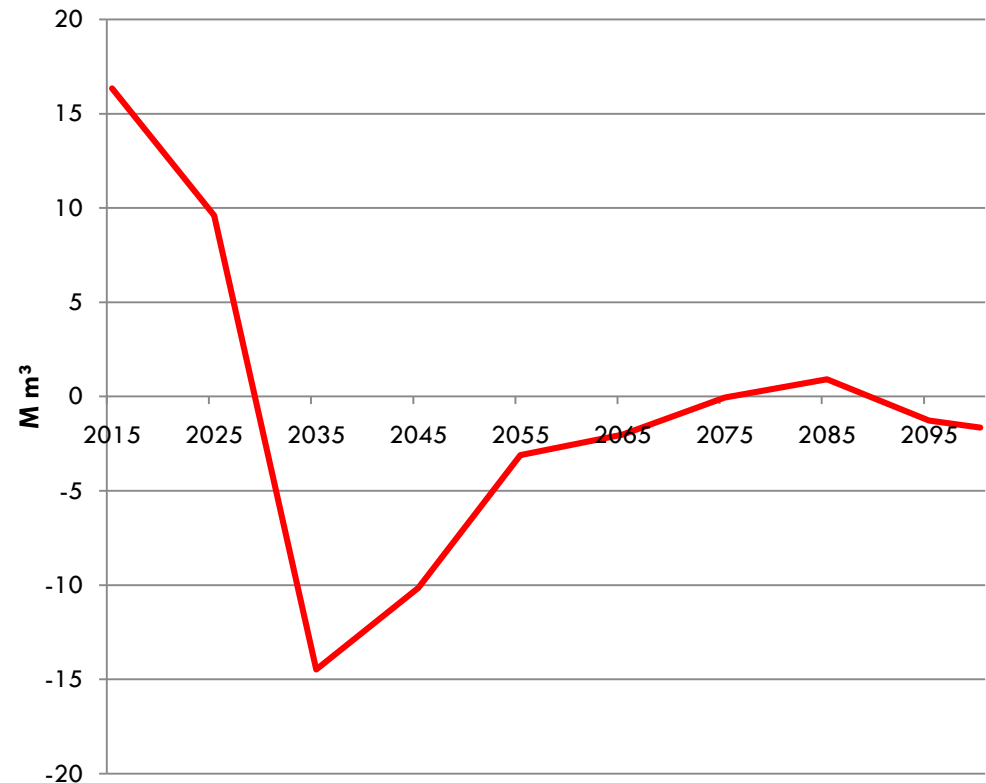
- Final tuning of model is ongoing
- Optimal forest harvest level is found to promote:
 - ▣ High short-term harvest
 - ▣ Low mid-term harvest
 - ▣ BAU end-term harvest

National harvest potential



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Difference in harvest between BAU and optimal bio-energy harvest level



Preliminary results

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Forestry and bioenergy

Project objectives

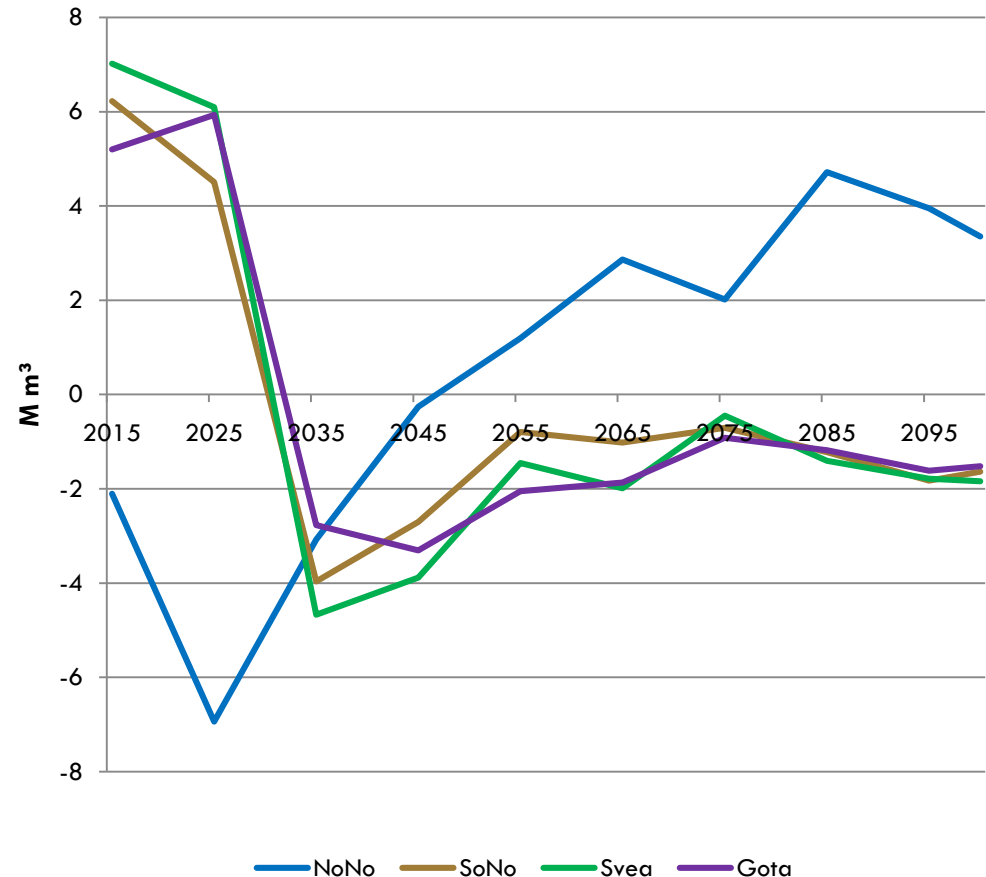
TIMES model

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- Final tuning of model is ongoing
- Optimal forest harvest level is found to promote:
 - ▣ High short-term harvest
 - ▣ Low mid-term harvest
 - ▣ BAU end-term harvest
- High regional differences in harvest levels

Difference in harvest between BAU and optimal bio-energy harvest level



- We are developing a TIMES forest energy-system model
- Model can be used to:
 - ▣ Analyze the link and dependencies between the bio-energy and forestry sectors
 - ▣ Analyze optimal long-term forest harvest level from a bio-energy point of view
 - ▣ Analyze regional differences in biomass utilization
 - ▣ Analyze value and impact of adapting forest harvest levels to bio-energy demand



Conclusions



Preliminary results

- Changes in utilization of other biomass sources?

TIMES forestry and energy planning model

- TIMES/MARKAL is a family of prospective models developed by the ETSAP organization
- The models are based on:
 - Considers the whole energy production chain
 - Supply-demand model
 - Deterministic future development
 - Multiperiod with variable periodic length
 - Technology rich
 - Bottom-up approach
 - Partial-equilibrium setting
 - Perfect foresight and no conflicts of interest
 - Linear-Programming

Forestry and bioenergy sectors

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Forestry and bioenergy

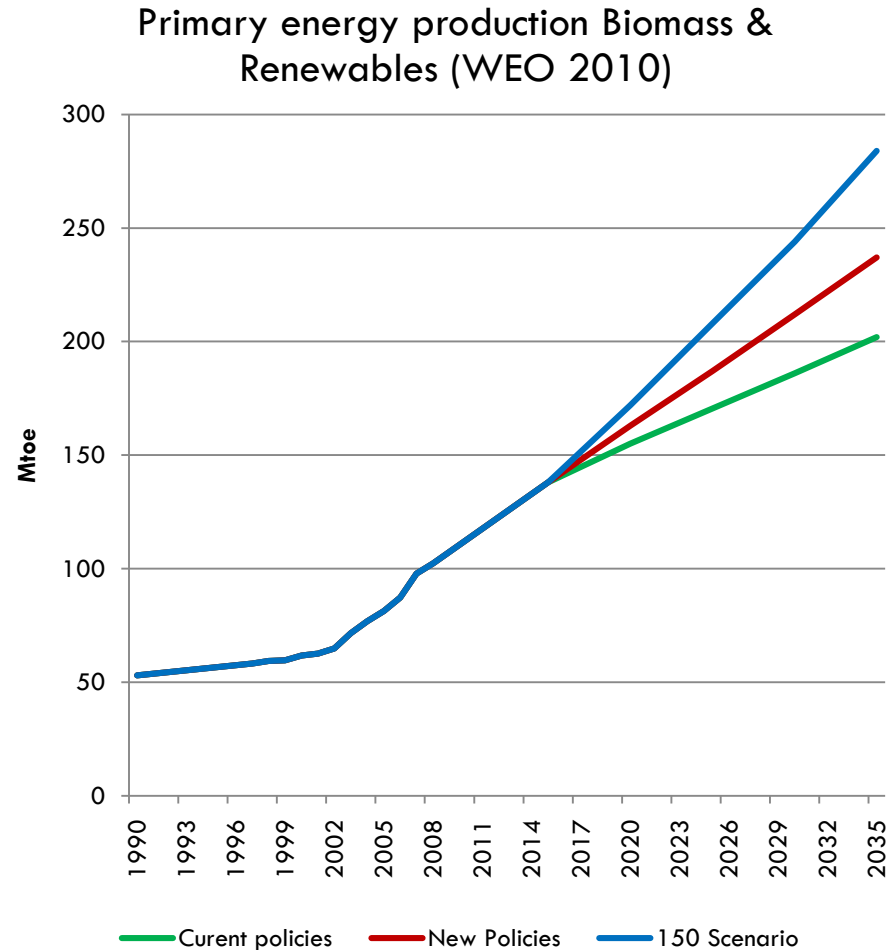
Project objectives

TIMES model

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- Energy production from biomass is cost-efficient, particularly in countries with abundant biomass sources
- Relays on well known and mature technologies
- To mitigate climate change, modern use of biomass has to expand rapidly



TIMES forestry and energy planning model

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 - ▣ No competition with forestry industries
- No land change between agricultural and forestry sectors

TIMES forestry and energy planning model

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Forestry and bioenergy

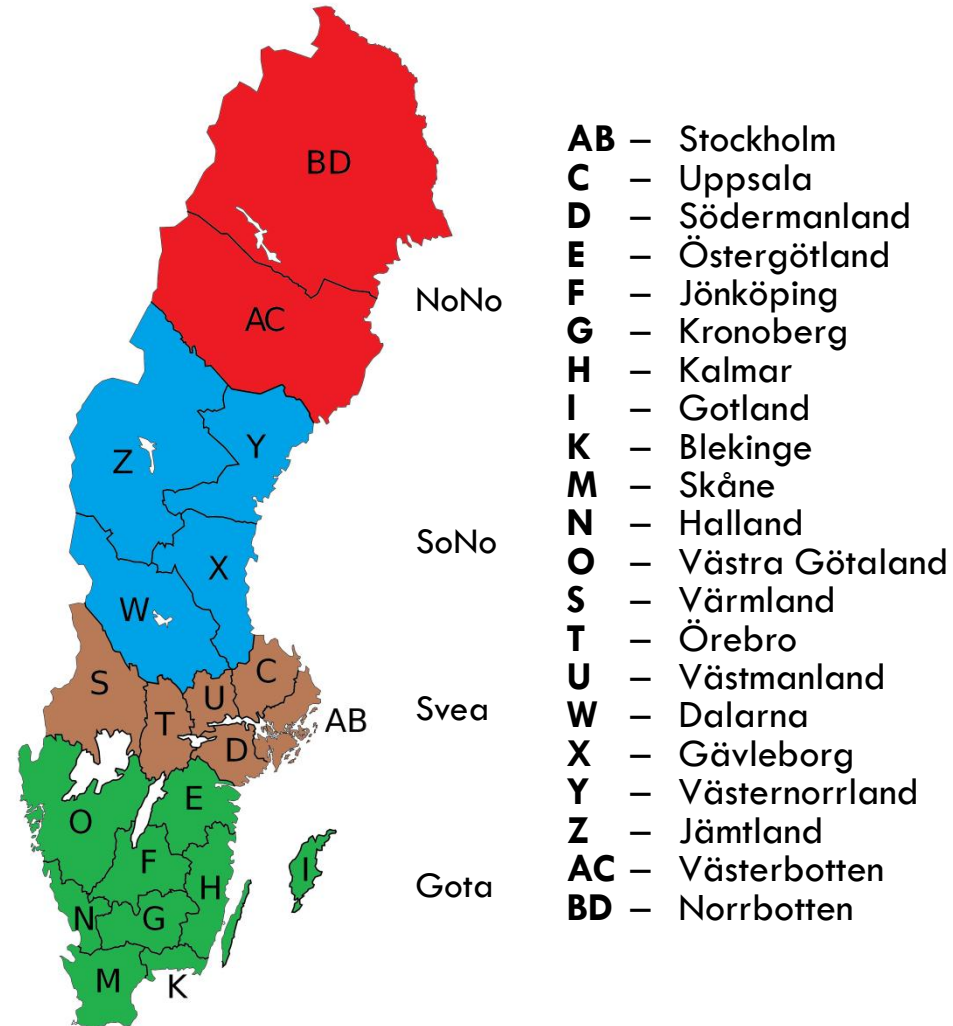
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TIMES forestry and energy planning model



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