Biomass role in achieving the Climate Change & Renewables EU policy targets. Demand and Supply dynamics under the perspective of stakeholders . **IEE 08 653 SI2. 529 241**

Report on the interactions with the Green-X modelling team

Deliverable D5.8

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March 2012
ECN-12—022

Preface

This publication is part of the BIOMASS FUTURES project (Biomass role in achieving the Climate Change & Renewables EU policy targets. Demand and Supply dynamics under the perspective of stakeholders - IEE 08 653 SI2. 529 241, www.biomassfutures.eu) funded by the European Union's Intelligent Energy Programme.
This report presents the interactions with the Green-X model that took place in the course of the project.

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1

Introduction

Within the modelling activity interactions with the Green-X modelling team has been deemed useful as Green-X has been involved in a number of projects such as Re-shaping, FORRES2020, Futures-e, REPAP 2020. Early in the process we contacted the Green-X modelling team and organised a workshop on 27 January 2009 to discuss the similarities and the differences of the two models Green-X and RESolve model set. The agenda of this workshop is presented in Annex 1. As a next step, Green-X colleagues were invited to give a presentation on 29 June 2011 at the Biomass Futures dissemination activity within the AEBIOM conference. In general, a fruitful knowledge and data exchange was established, facilitating a mutual learning process among all involved parties. Green-X colleagues contributed also to the stakeholder dialogue, acting as reviewer throughout various stakeholder and project meetings.
A dedicated meeting also took place in Vienna (early December 2011) between the project coordinator, Dr C. Panoutsou and the coordinator of the Green X model, Dr Gustav Resch to discuss in detail all the scenarios that Green X has run for biomass in the BioBench project and the ones that Biomass Futures has been taking into account in order to minimise duplication, ensure complementarity and comparability and increase the added value of the project outputs.
At last, they participated to the stakeholder workshop on demand analysis organised by ECN on 7 March 2012 in Amsterdam. In this workshop RESolve modelling activity and the final results of the scenarios were discussed.

The following chapter will briefly introduce the Green-X model and the RESolve Model Set and present the comparison of the results. The comparison however should be read with cautious as a full comparison of the two models and their outcomes, respectively, is beyond the scope of this activity.

2

Introduction to the models

2.1 Green-X

The model Green-X has been developed by the Energy Economics Group (EEG) at Vienna University of Technology in the research project "Green-X – Deriving optimal promotion strategies for increasing the share of RES-E in a dynamic European electricity market", funded within the 5th framework program of the European Commission, DG Research (Contract No. ENG2-CT-2002-00607). Initially focussed on the electricity sector, this tool and its database on RES potentials and costs have been extended within follow-up activities to incorporate renewable energy technologies within all energy sectors.

Green-X covers the EU-27, and can be extended to other countries, such as Turkey, Croatia and Norway. It allows the investigation of the future deployment of RES as well as the accompanying cost (including capital expenditures, additional generation cost of RES compared to conventional options, consumer expenditures due to applied supporting policies) and benefits (for instance, avoidance of fossil fuels and corresponding carbon emission savings). Results are calculated at both a country- and technology-level on a yearly basis. The time-horizon allows for in-depth assessments up to 2020, accompanied by concise outlooks for the period beyond 2020 (up to 2030).

The Green-X model develops nationally specific dynamic cost-resource curves for all key RES technologies, including for renewable electricity, biogas, biomass, biowaste, wind on- and offshore, hydropower large- and small-scale, solar thermal electricity, photovoltaic, tidal stream and wave power, geothermal electricity; for renewable heat, biomass, sub-divided into log wood, wood chips, pellets, grid-connected heat, geothermal grid-connected heat, heat pumps and solar thermal heat; and, for renewable transport fuels, first generation biofuels (biodiesel and bioethanol), second generation biofuels (lignocellulosic bioethanol, biomass to liquid), as well as the impact of biofuel imports. Besides the formal description of RES potentials and costs, Green-X provides a detailed representation of dynamic aspects such as technological learning and technology diffusion.

Through its in-depth energy policy representation, the Green-X model allows an assessment of the impact of applying (combinations of) different energy policy instruments (for instance, quota obligations based on tradable green certificates / guarantees of origin, (premium) feed-in tariffs, tax incentives, investment incentives, impact of emission trading on reference energy prices) at both country or European level in a dynamic framework. Sensitivity investigations on key input parameters such as non-economic barriers (influencing the technology diffusion), conventional energy prices, energy demand developments or technological progress (technological learning) typically complement a policy assessment.

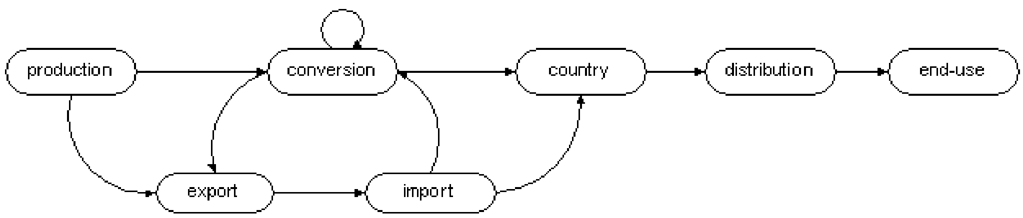
Within the Green-X model, the allocation of biomass feedstock to feasible technologies and sectors is fully internalised into the overall calculation procedure. For each feedstock category, technology options (and their corresponding demands) are ranked based on the feasible revenue streams as available to a possible investor under the conditioned, scenario-specific energy policy framework that may change on a yearly basis. Recently, a module for intra-European trade of biomass feedstock has been added to Green-X that operates on the same principle as outlined above but at a European rather than at a purely national level. Thus, associated transport costs and GHG emissions reflect the outcomes of a detailed logistic model. Consequently, competition on biomass supply and demand arising within a country from the conditioned support incentives for heat and electricity as well as between countries can be reflected. In other words, the supporting framework at MS level may have a significant impact on the resulting biomass allocation and use as well as associated trade.

Moreover, Green-X was recently extended to allow an endogenous modelling of sustainability regulations for the energetic use of biomass. This comprises specifically the application of GHG constraints that exclude technology/feedstock combinations not complying with conditioned thresholds. The model allows flexibility in applying such limitations, that is to say, the user can select which technology clusters and feedstock categories are affected by the regulation both at national and EU level, and, additionally, applied parameters may change over time.

2.2 Resolve model set

RESolve model set consists of three independent modes (RESolve-biomass, RESolve-E and RESolve-H models) working together in an iterative manner. RESolve-biomass determines the least-cost configuration of the entire bioenergy production chain through minimal additional generation cost[1] allocation, given demand projections for biofuels, bioelectricity and bioheat, biomass potentials and technological progress, see Figure 1 (Lensink et al, 2007; Lensink & Londo, 2010; Faaij & Londo, 2010). By doing so it mimics the competition among the three sectors for the same resources. The RESolve-biomass model includes raw feedstock production, processing, transport and distribution. Constraints on avoided emissions, over the entire chain, can be included in the model as well. One of the most important features of the RESolve-biomass model is the ability to link the national production chains allowing for international trade.

Figure 1: Supply chain in RESolve-biomass (Lensink et al, 2007)



The RESolve-biomass model includes:

- 31 crop/non-crop raw materials (primary feedstocks),
- 45 conversion steps with 10 intermediate products ,
- 1 auxiliary and 7 by-products

[1] The total costs of bioenergy generation minus the cost of reference conventional fossil fuel energy production.

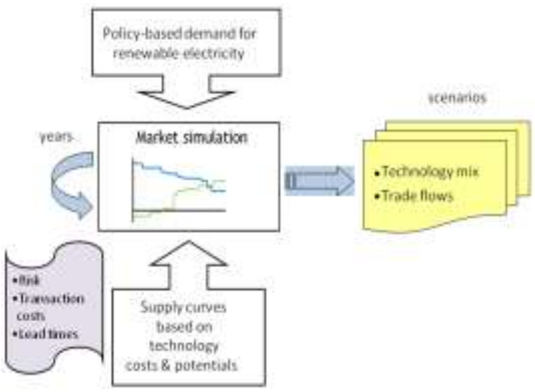
- 7 biofuels and associated distribution technologies, bioelectricity and bioheat as final products
- The biofuels included in the RESolve-biomass model are:
  - Bioethanol (1st and 2nd generation)
  - Biodiesel
  - Bio-FT-diesel
  - Bio-DME
  - Bio-SNG
  - Bio-ETBE

For the simulation of bio-electricity (including bio-CHP) within the renewable electricity (RES-E) in the EU RESolve-E model(Daniëls & Uyterlinde, 2005) is used. The RESolve-E model is based on a dynamic market simulation in which national RES-E supply curves are matched with policy-based demand curves.

The simulations can be done for several target years up to 2030, taking account of various other factors complicating investment in renewables, such as (political) risks, transaction costs and delays due to planning and permitting processes. These factors contribute to a realistic simulation of the effectiveness of different policy instruments.

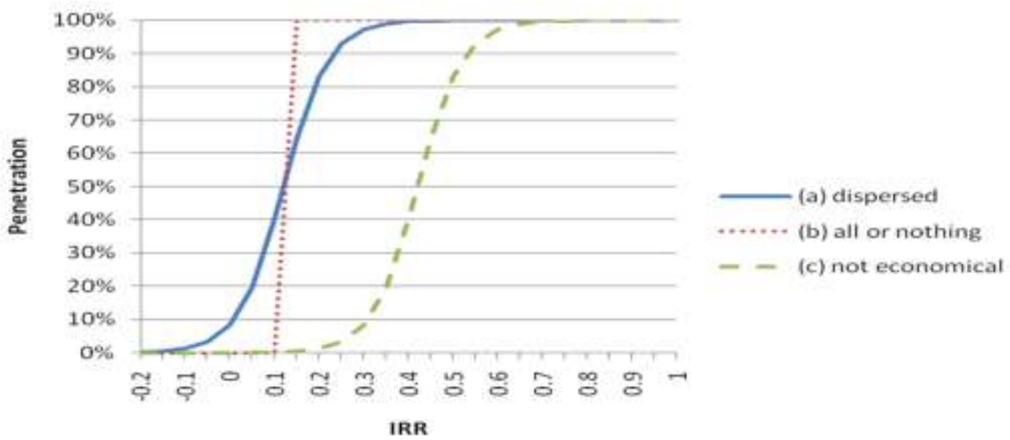
A schematic overview of the RESolve-E model is presented in Figure 2.

Figure 2: Schematic overview of the RESolve-E model



RESolve-H is a simulation model that calculates the penetration of RES-H options based on a *dispersed S-curve* description of consumer's behaviour, Figure 3(a).

Figure 3: Penetration vs. Internal Rate of Return (IRR) in RESolve-H



Each RES-H option has a cost to the consumer, but it also brings some benefits, namely the avoided costs of using non-RES fuels. When the benefits for a certain option are comparable to the costs, the option starts to become economically attractive for the consumer. This is modelled by considering the Internal Rate of Return (IRR) of a certain option, taking explicitly into account the avoided costs of not using fossil fuels. In the example of Figure 3 (b) all consumers immediately switch to RES-H as soon as the IRR is higher than 0.12. This *all or nothing* case is obviously not very realistic, and the real consumer behaviour is better modelled by a *dispersed* S-curve such as the one in Figure 3(a): early adopters would invest even at 'uneconomical' levels of the IRR (cf. the range below 0.12), whereas some players ('laggards') do not even invest as higher levels of the IRR (cf. the range above 0.12) because other, non-financial barriers prevent them from doing so.

3

Comparison of the results

3.1 Scenarios in Green-X[2]

Business as usual (BAU): RES policies are applied as currently implemented (without any adaptation) – until 2020. Under this variant a moderate RES deployment is projected for the future up to 2020.

BAU with barriers mitigated: This scenario builds also on currently implemented RES support but assumes a mitigation of *non-economic RES barriers* (i.e. administrative deficiencies, grid access, etc.) for the future[3]. More precisely, a gradual removal of these deployment constraints, which allows an accelerated RES technology diffusion, is conditioned on the assumption that this process will be launched in 2013.

Strengthened national policies (SNP): Within the Re-shaping project Green-X assumes a continuation of national RES policies until 2020 which will be further optimised in the future with regard to their effectiveness and efficiency. In particular the further fine-tuning of national support schemes will require in case of both (premium) feed-in tariff and quota systems a technology-specification of RES support. Similar to all other cases this scenario builds on the BAU-case for the near future. More precisely, it is assumed that policy changes as well as improvements with respect to non-economic barriers[4] will become effective by 2013. The fulfilment of the target of 20% RES by 2020 is preconditioned both at EU level and at national level. Further light has been shed on the need for and impact of RES cooperation between Member States. For this three different variants of RES cooperation have been conditioned that can be distinguished as follows:

- As default scenario, i.e. for the reference case of “strengthened national policies” an efficient and effective resource exploitation is assessed assuming a moderate level of cooperation between Member States. Thus, this reference case of “moderate (RES) cooperation” can be classified as compromise between both “extreme” options sketched below.

[2] For details on Green-X work, for example with respect to approach, assumptions, scenario definition or results, please see Resch et al. (2010).

[3] In general, it can be expected that a removal of non-economic RES barriers represents a necessity for meeting the 2020 RES commitment. Moreover, a mitigation of these constraints would also significantly increase the cost efficiency of RES support.

[4] Similar to above (i.e. BAU with barriers mitigated) a gradual removal of these deficits is assumed for the future.

- A “national perspective” is researched as sensitivity variant where Member States primarily aim for a pure domestic RES target fulfilment and, consequently, only “limited cooperation” [5] is expected to arise from that.
- A “European perspective” is taken in the third variant that can be classified as “strong cooperation” where an efficient and effective RES target achievement is envisaged rather at EU level than fulfilling each national RES target purely domestically. [6]

3.2 Scenarios in Biomass Futures (RESolve Model Analysis)

Within Biomass Futures three scenarios are developed and modelled. A brief description of the scenarios are as follows. Further details of the biomass Futures models can be found in D5.2. Biomass Futures scenario set-up and the methodology for analysis, (Uslu & van Stralen, 2012).

Reference scenario: Reference scenario presents a bioenergy future, where the implications of sustainability criteria for biofuels and their impacts on electricity and heat sector are illustrated. It not only presents the utilisation of biomass resources but also the respective costs and the greenhouse gas emissions. Moreover this scenario analysis the policy measures Member States proposed in their NREAPs in terms of whether they are ambitious enough to reach the targets set or not.

Sustainability scenario: Different than the reference, this storyline foresees higher GHG mitigation targets-increasing to 80% by 2030. Furthermore, it presents a future in which the indirect land use change implications of the biofuels are to some degree compensated through crop specific iLUC factors.

High biomass scenario: This scenario builds on the reference scenario bioenergy potentials and applies national policy measures that are stronger than the current ones. Thus, the sustainability criteria in line with the current RED directive is only applied to biofuels for transport.

3.3 Results

EU27 bioenergy demand figures from Green-X scenario modelling and the biomass futures-RESolve scenario modelling are illustrated per sector in comparison to the NREAP data in **Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.**, **Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.** and **Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.**. When comparing these projections it has to be taken into account that cumulatively at EU level the NREAPs assume a slightly

[5] Within the corresponding model-based assessment the assumption is taken that in the case of “limited cooperation / National perspective” the use of cooperation mechanisms as agreed in the RES Directive is reduced to necessary minimum: For the exceptional case that a Member State would not possess sufficient RES potentials, cooperation mechanisms would serve as a complementary option. Additionally, if a Member State possesses barely sufficient RES potentials, but their exploitation would cause significantly higher support expenditures compared to the EU average, cooperation would serve as complementary tool to assure target achievement.

[6] In the “strong cooperation / European perspective” case economic restrictions are applied to limit differences in applied financial RES support among Member States to an adequately low level – i.e. differences in country-specific support per MWh RES are limited to a maximum of 8 €/MWh_{RES}. while in the “limited cooperation / National perspective” variant this feasible bandwidth is set to 20 €/MWh_{RES}. Consequently, if support in a country with low RES potentials and / or an ambitious RES target exceeds the upper boundary, the remaining gap to its RES target would be covered in line with the flexibility regime as defined in the RES Directive through (virtual) imports from other countries.

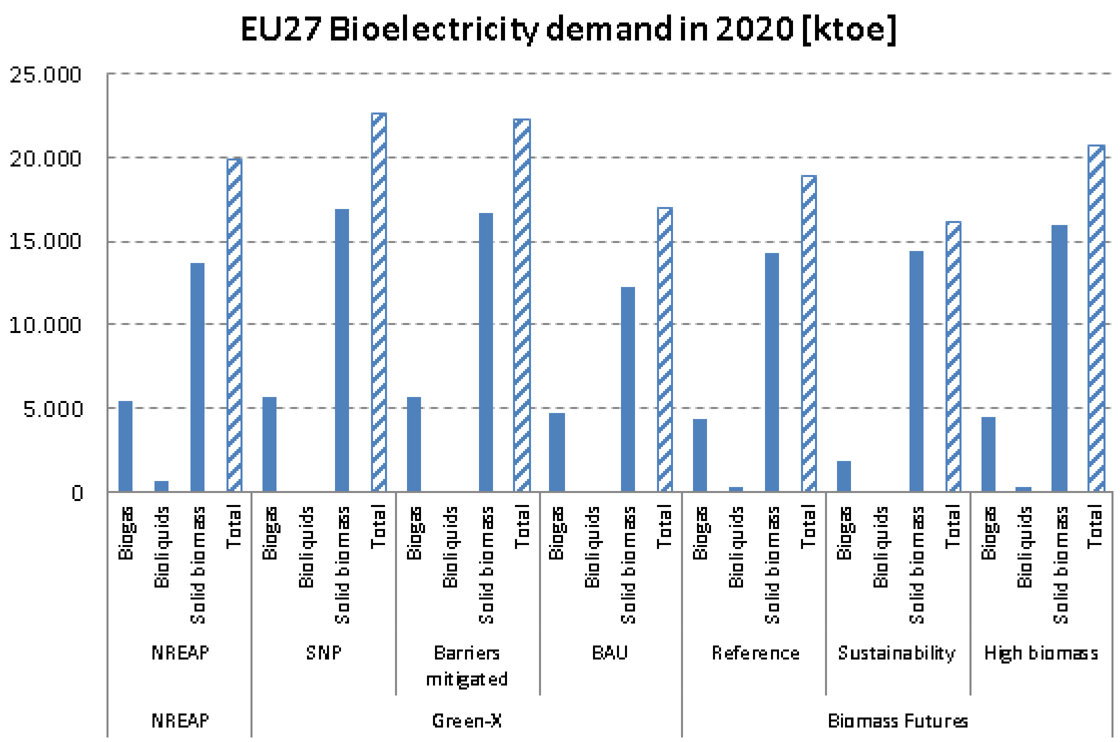
lower overall energy demand for 2020 than in the PRIMES reference case (NTUA, 2011) which is used as default reference for energy demand (and price) assumptions for Green-X scenarios.

Note that a comparison of results on bio-electricity and bio-heat per Member State is presented in Annex II.

Bio-electricity

While both the models and the input data as well as scenario constructions show some differences results are generally comparable. Biomass Futures reference scenario results for bio-electricity are in between the Green-X BAU and BAU barriers mitigated scenario results. On the other hand Green-X SNP figures are 9% higher than the RESolve high biomass scenario.

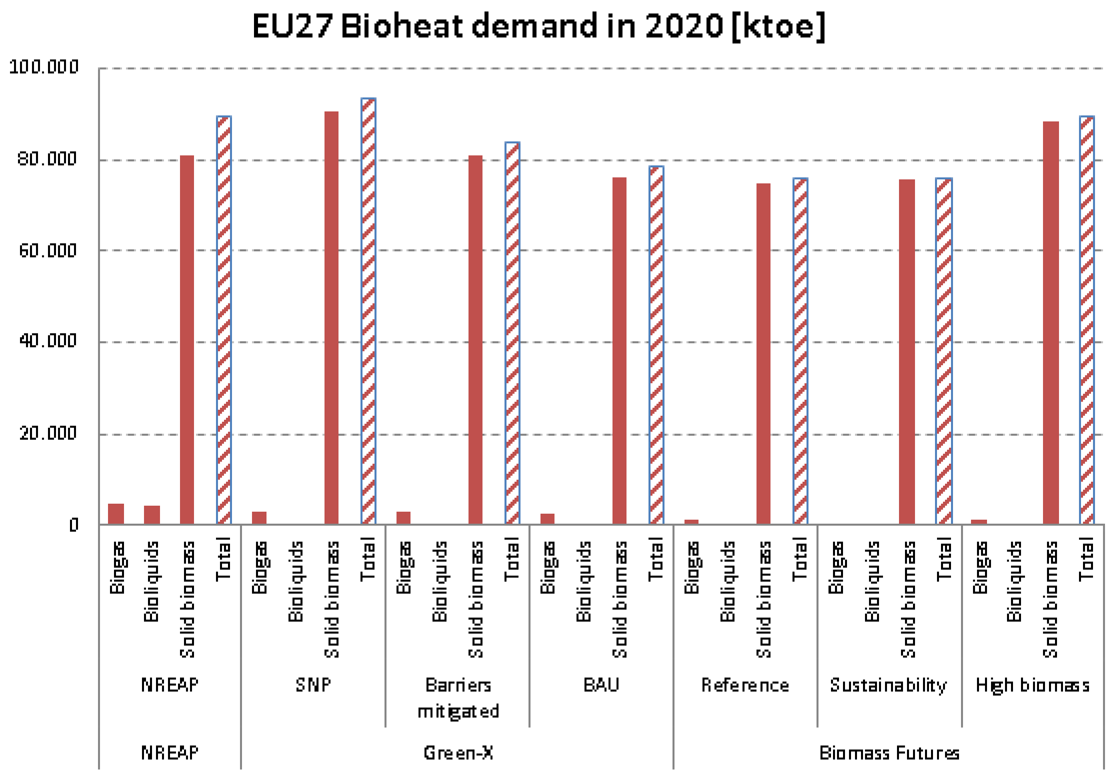
Figure 4: Bio-electricity demand in 2020 from Biomass Futures and Green-X scenarios in comparison to NREAPs.



Bio-heat

Biomass Futures bio-heat production figures for the reference and the sustainability scenario are lower than the Green-X scenario results. On the other hand SNP scenario of the Green-X produces higher figures than the RESolve high biomass scenario.

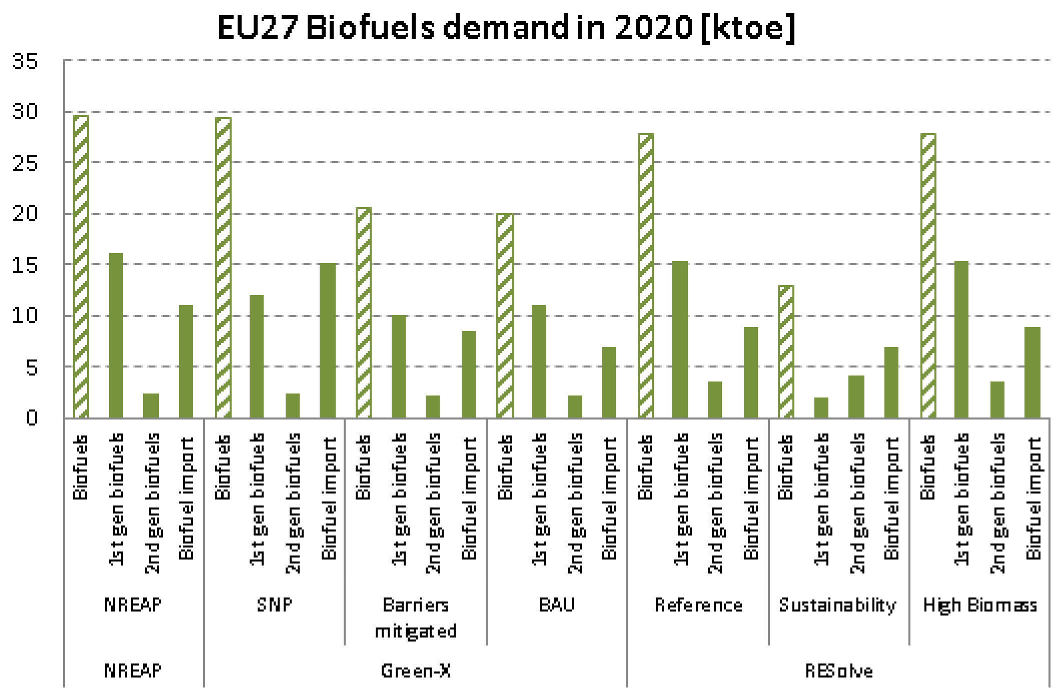
Figure 5: Bio-heat demand in 2020 from Biomass Futures and Green-X scenarios in comparison to NREAPs.



Biofuels

The modelling outcomes for this sector are also comparable. The main difference lies at the Biomass Futures sustainability scenario, which includes the iLUC effect through crops specific iLUC factors. In this scenario the contribution of 1st generation biofuels significantly lower than all of the scenario results. All of the Biomass Futures scenario results forsee higher contribution of 2nd generation biofuels in 2020 when compared with the results of Green-X scenario analysis and the NREAP figures.

Figure 6: Biofuels demand in 2020 from Biomass Futures and Green-X scenarios in comparison to NREAPs.



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Appendix A. Modelling workshop draft agenda

Modeling workshop- Draft agenda

Wednesday, 27 January 2010

Place: Radarweg 60, 1043 NT Amsterdam
Meeting room 01.17

Tel: 0031 (0)6 10955081

9:30-9:35	Welcome by the chair	Paul Oosterkamp
9:35-10:00	Introduction to the meeting	Ayla Uslu
10:00-11:00	Current state of the Green-X model and the bioenergy section of the '20% by 2020 balanced scenario' model run results	Gustav Resch
11:00-11:30	Questions and answers session 1	All
11:30-11:45	Coffee break	
11:45-12:15	Biomass Allocation	Jan Ros
12:15-13:00	Lunch break	
13:00-13:45	Presentation of the ECN models "RESsolve-T and –E"	Joost van Stralen
13:45-14:15	Renewable H/C model	Joost van Stralen
14:15-14:30	Coffee break	All
14:30-15:00	Question and answers session 2	
	End of the session	

Appendix B. Country results for bio-electricity and bio-heat

Bio-electricity(ktoe)			AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK	EU27
NREAP	NREAP	Biogas	50	124	31	12	247	2016	214	1	77	225	23	318	55	27	518	36	12	50	4	401	346	45	82	5	32	74	479	5503
		Bioliquids	3	2	0	0	0	125	1	1	0	0	0	0	0	0	418	0	0	1	0	0	0	131	0	6	0	0	0	687
		Solid biomass	390	823	44	0	283	2113	546	29	31	636	1087	1158	231	59	679	70	16	55	7	1030	877	126	168	1431	27	73	1771	13761
		Biomass (electricity)	***443***	***949***	***75***	***12***	***530***	***4.253***	***761***	***30***	***108***	***861***	***1.110***	***1.477***	***286***	***87***	***1.615***	***105***	***29***	***107***	***12***	***1.431***	***1.223***	***302***	***249***	***1.441***	***58***	***147***	***2.250***	19952
Green-X	SNP	Biogas	122	104	23	3	144	2.327	55	8	78	215	38	295	91	37	573	14	7	18	1	211	286	32	92	57	38	28	849	5747
		Bioliquids	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0
		Solid biomass	698	349	152	6	447	3.259	561	71	84	1.102	1.494	1.521	318	89	1.111	74	8	51	2	603	1.015	358	321	1.455	95	257	1.432	16934
		Biomass (electricity)	**821**	**453**	**175**	**9**	**591**	**5.585**	**616**	**79**	**162**	**1.318**	**1.532**	**1.816**	**409**	**126**	**1.684**	**88**	**14**	**69**	**3**	**814**	**1.300**	**390**	**413**	**1.513**	**134**	**285**	**2.282**	**22681**
	Barriers mitigated	Biogas	211	143	23	3	197	2.328	28	8	83	215	38	295	84	38	617	11	9	21	1	124	184	32	90	57	40	29	826	5738
		Bioliquids	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0
		Solid biomass	661	501	133	4	561	2.999	417	80	106	937	1.224	1.742	267	108	1.161	44	13	42	0	512	1.055	405	281	1.395	126	279	1.587	16641
		Biomass (electricity)	***872***	***645***	***156***	***8***	***758***	***5.327***	***446***	***88***	***189***	***1.153***	***1.262***	***2.037***	***351***	***146***	***1.778***	***54***	***22***	***63***	***1***	***637***	***1.239***	***437***	***371***	***1.452***	***166***	***308***	***2.414***	22379
	BAU	Biogas	236	98	6	3	198	2.328	28	3	39	91	21	122	35	19	327	4	8	10	0	124	81	19	15	22	28	10	875	4751
		Bioliquids	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0
		Solid biomass	545	482	71	5	261	2.580	392	53	50	508	1.164	589	230	41	728	21	8	9	0	442	924	356	92	1.545	71	204	875	12246
		Biomass (electricity)	***781***	***580***	***77***	***8***	***459***	***4.909***	***420***	***56***	***90***	***599***	***1.185***	***711***	***265***	***60***	***1.056***	***25***	***16***	***19***	***0***	***566***	***1.005***	***375***	***107***	***1.566***	***98***	***214***	***1.750***	16997
Biomass Futures	Reference	Biogas	72	35	16	8	50	2439	28	2	32	86	10	98	107	28	218	33	5	21	2	446	114	27	25	9	42	47	396	4396
		Bioliquids	3	0	0	0	0	0	0	0	0	0	0	0	0	0	285	0	0	0	0	0	43	0	13	0	0	0	0	343
		Solid biomass	585	780	3	0	235	1992	646	27	26	870	1403	1252	231	35	627	56	4	11	1	958	953	165	262	1590	8	71	1477	14268
		Biomass (electricity)	***660***	***815***	***19***	***8***	***286***	***4.431***	***673***	***29***	***58***	***956***	***1.412***	***1.349***	***338***	***63***	***1.129***	***89***	***8***	***32***	***3***	***1.404***	***1.110***	***192***	***300***	***1.599***	***51***	***118***	***1.874***	19007

Sustainability	Biogas		70	26	14	8	53	389	33	2	29	79	8	92	107	21	243	33	3	17	2	46	105	27	25	9	41	27	349	1859
	Bioliquids		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Solid biomass		585	783	4	0	278	2151	646	27	26	870	1403	1137	258	44	625	61	4	11	0	959	989	165	204	1591	8	72	1506	14408
	Biomass (electricity)		***655***	***809***	***18***	***8***	***331***	***2.541***	***678***	***29***	***55***	***949***	***1.411***	***1.229***	***365***	***66***	***869***	***94***	***6***	***28***	***2***	***1.005***	***1.094***	***192***	***229***	***1.600***	***48***	***100***	***1.855***	16267
High biomass	Biogas		72	24	16	7	50	2478	28	2	32	92	11	98	107	28	218	45	6	23	2	443	114	27	25	9	42	47	396	4443
	Bioliquids		3	0	0	0	0	0	0	0	0	0	0	0	0	0	285	0	0	0	0	0	43	0	13	0	0	0	0	344
	Solid biomass		588	807	5	0	269	2585	720	30	27	1007	1625	1222	299	38	663	68	4	11	1	951	1202	165	263	1612	9	74	1685	15929
	Biomass (electricity)		***663***	***830***	***21***	***7***	***319***	***5.064***	***748***	***32***	***59***	***1.099***	***1.636***	***1.320***	***406***	***66***	***1.165***	***114***	***10***	***35***	***3***	***1.394***	***1.358***	***192***	***300***	***1.622***	***51***	***121***	***2.082***	20716

Bio-heat(ktoe)			AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK	EU27
NREAP	NREAP	Biogas	16	55	20	6	167	1692	165			100	60	555	56	33	266	50	13	49	2	288	453	37	20	11	0	60	302	4476
		Bioliquids	0	32	0		0	711	8			0	2610	0		0	150							801	11	65	28			4416
		Solid biomass	3591	1947	1053	24	2350	8952	2470	607	1222	4850	3940	15900	1225	453	5254	973	70	1343	0	650	4636	1484	3845	9415	497	630	3612	80993
		Total	***3607***	***2034***	***1073***	***30***	***2517***	***11355***	***2643***	***607***	***1222***	***4950***	***6610***	***16455***	***1281***	***486***	***5670***	***1023***	***83***	***1392***	***2***	***938***	***5089***	***2322***	***3876***	***9491***	***525***	***690***	***3914***	89885
Green-X	SNP	Biogas	93	66	6	0	103	1394	135	4	24	61	50	156	18	22	211	8	6	15	0	185	138	5	22	35	9	16	303	3086
		Bioliquids	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0
		Solid biomass	4136	1374	1156	17	2059	13606	2614	876	1151	4441	7075	14256	1246	422	4107	1115	71	1384	0	1251	6964	2850	4693	9043	605	816	3162	90489
		Total	***4229***	***1440***	***1162***	***17***	***2162***	***15000***	***2748***	***880***	***1175***	***4502***	***7125***	***14411***	***1264***	***444***	***4318***	***1123***	***77***	***1399***	***0***	***1437***	***7102***	***2855***	***4715***	***9078***	***614***	***833***	***3465***	93575
	Barriers mitigated	Biogas	179	90	9	0	114	1375	113	3	28	61	50	156	13	21	245	4	9	15	0	128	60	5	15	32	12	15	267	3020
		Bioliquids	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0
		Solid biomass	4237	1366	879	15	1583	12917	2529	696	1151	3433	6715	13515	846	423	4307	933	50	1090	0	938	4652	1848	3862	8985	559	677	2862	81066
		Total	***4416***	***1456***	***888***	***15***	***1697***	***14293***	***2641***	***700***	***1180***	***3493***	***6765***	***13670***	***858***	***444***	***4552***	***937***	***58***	***1104***	***0***	***1066***	***4712***	***1853***	***3876***	***9017***	***571***	***692***	***3130***	84085
	BAU	Biogas	202	59	2	0	115	1375	113	2	13	39	42	103	5	10	96	2	8	7	0	128	41	3	2	24	11	6	293	2701
		Bioliquids	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	0
		Solid biomass	4794	1262	789	16	1278	12615	2511	646	1001	3285	7146	11841	695	265	3699	806	50	947	0	811	4147	1852	3501	9000	417	598	2049	76021
		Total	***4996***	***1321***	***791***	***16***	***1393***	***13990***	***2624***	***647***	***1014***	***3325***	***7188***	***11944***	***701***	***275***	***3795***	***809***	***58***	***954***	***0***	***939***	***4188***	***1855***	***3502***	***9023***	***427***	***603***	***2343***	78722
Biomass Futures	Reference	Total	19	15	4	2	12	603	54	0	9	18	2	23	24	5	51	7	1	5	0	121	38	6	6	2	20	12	127	1186
		Bioliquids	3	6	0	0	0	136	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	7	0	0	0	163
		Solid biomass	3579	1115	963	30	2418	6669	1818	205	575	5034	5922	16706	1131	110	4527	226	40	451	0	923	4065	1461	3111	8843	507	660	3539	74630

		Total	***3601***	***1136***	***967***	***32***	***2430***	***7408***	***1873***	***205***	***584***	***5052***	***5924***	***16729***	***1156***	***116***	***4578***	***234***	***41***	***457***	***1***	***1044***	***4103***	***1479***	***3116***	***8852***	***527***	***671***	***3666***	75979
	Sustainability	Biogas	19	3	3	2	13	97	2	0	8	19	2	21	24	5	46	7	1	4	0	88	25	6	6	2	10	9	82	504
		Bioliquids	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Solid biomass	3586	1131	961	30	2283	6745	1818	205	1176	4995	5924	16292	1132	434	4554	433	41	802	0	897	3968	1351	3113	8843	496	631	3726	75568
		Total	***3605***	***1134***	***964***	***32***	***2296***	***6843***	***1819***	***205***	***1184***	***5014***	***5926***	***16313***	***1157***	***439***	***4600***	***441***	***41***	***806***	***1***	***985***	***3992***	***1358***	***3118***	***8845***	***506***	***640***	***3808***	76072
	High biomass	Biogas	19	6	4	2	11	743	8	0	8	22	3	23	24	7	50	10	2	6	0	55	27	6	6	2	10	12	92	1158
		Bioliquids	4	0	0	0	0	0	0	0	0	0	0	0	0	0	260	0	0	0	0	0	50	0	15	0	0	0	0	328
		Solid biomass	4420	1316	1209	38	2946	8310	2211	257	668	5733	7070	18784	1295	528	5613	267	53	497	1	970	4907	1695	3670	10333	620	758	4047	88215
		Total	***4442***	***1322***	***1213***	***39***	***2957***	***9053***	***2219***	***257***	***677***	***5755***	***7073***	***18807***	***1320***	***535***	***5923***	***277***	***55***	***503***	***1***	***1025***	***4984***	***1701***	***3690***	***10335***	***630***	***770***	***4139***	89702