



IEPEC 2012

Long Term Market Transformation
from a Short Term Subsidy:

Energy Savings from Residential
Air□to□Air Heat Pumps in Norway

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- 1) Enova's role
- 2) Theoretical basis
- 3) The market transformation
- 4) The Household Subsidy Programs
- 5) Estimation of market transformation effects



1. Enova's role

- Norwegian national energy agency, est. 2002
- Mission: energy efficiency and use of renewables
- Owned by Ministry of Petroleum and Energy
- Financed by the Energy Fund
- Quantified energy targets
- Freedom in program design

60 employees, located in Trondheim



2. Theoretical basis

”Energy behavior” is the central concept

Household energy behavior defined:

“Any decision made by the household that affects its stationary energy use”

We must *understand* in order to *change*!

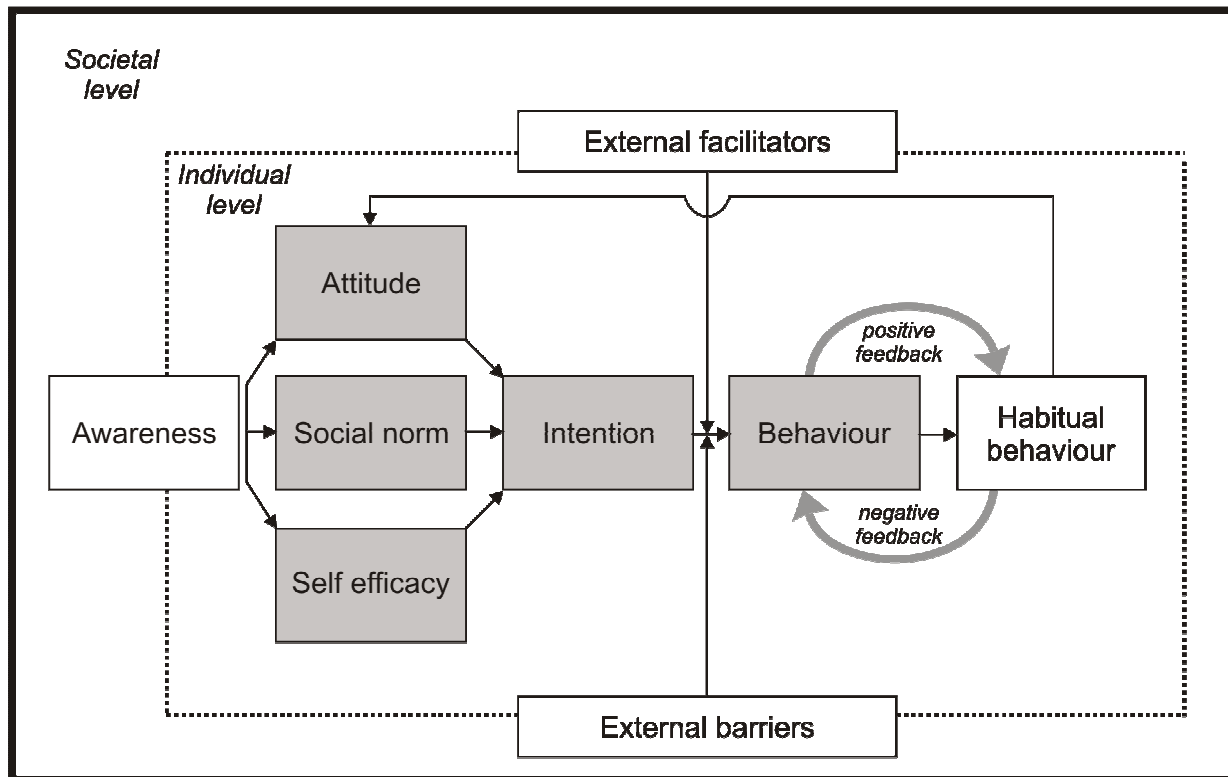
Typical energy behaviors:

- Investment behavior
- Purchasing behavior
- Habitual behavior



2. Theoretical basis

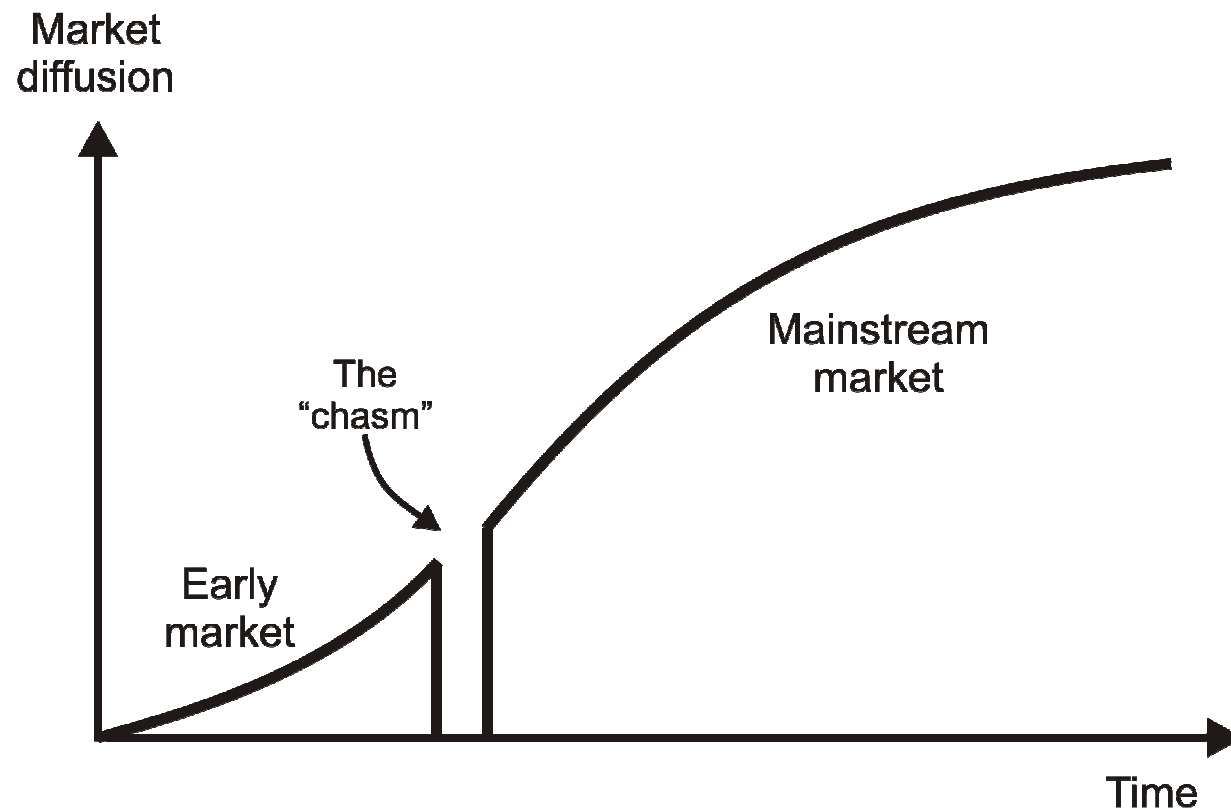
Model for micro-level energy behavior





2. Theoretical basis

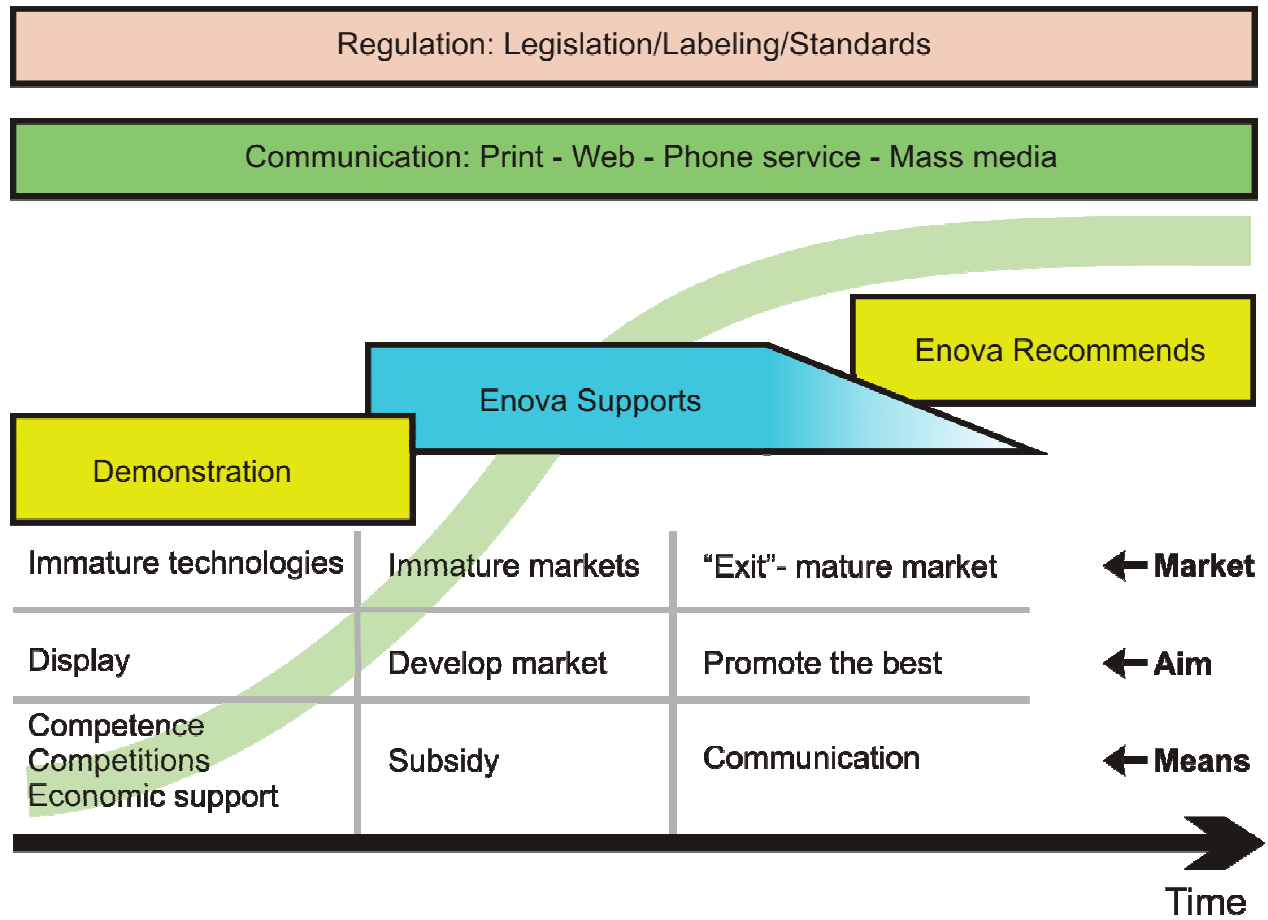
Decision makers respond differently!





3. The market transformation

The Enova Model:





3. The market transformation

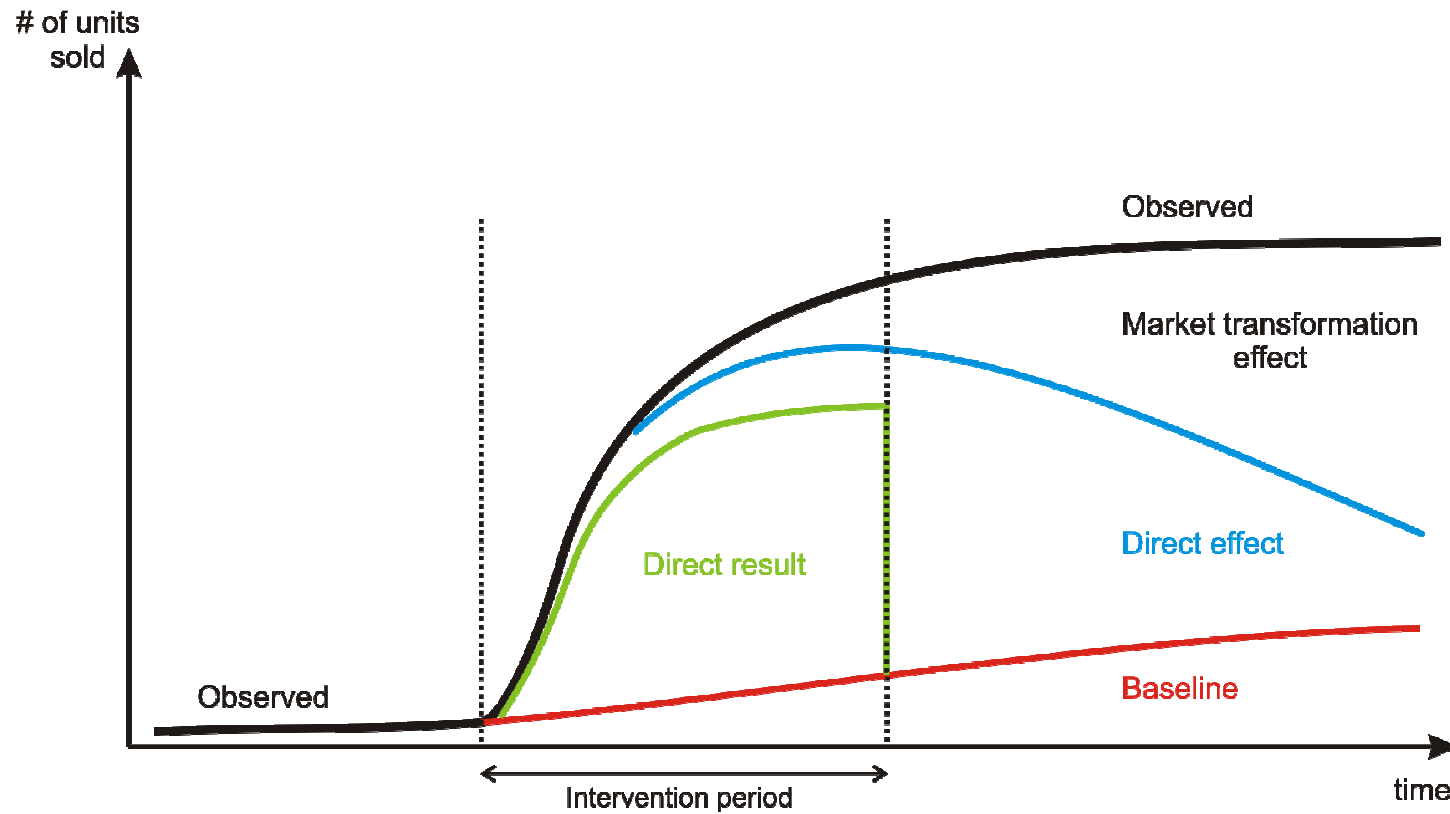
Program effects:

- Direct result
- Direct effect
- Changes in behavioral intentions
- Market transformation



3. The market transformation

Illustration of program effects:





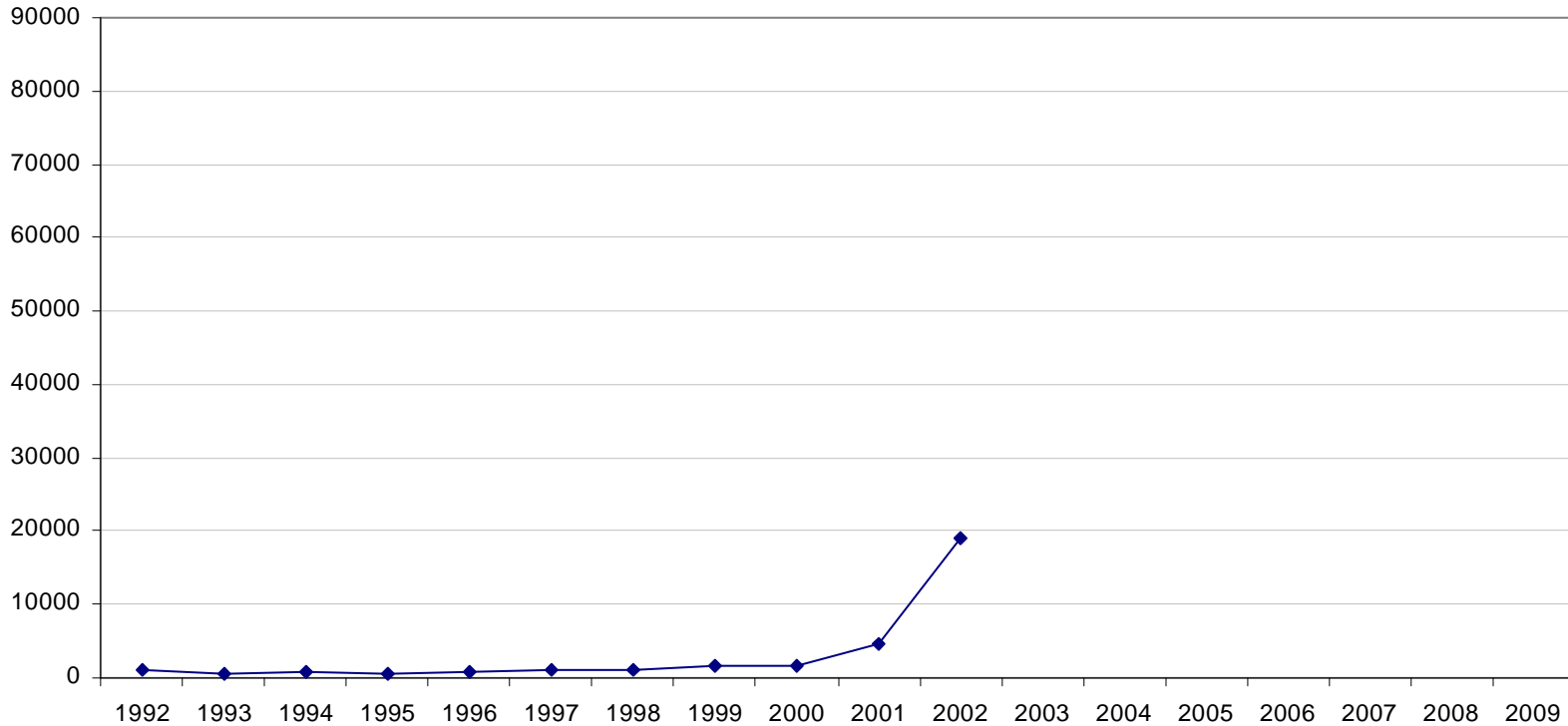
4. The 2003 Household Subsidy Program

- Response to "tight" electricity market w02/03
- Electricity saving technologies:
 - heat pumps
 - pellet stoves
 - heat control systems
- 20 % subsidy (w/limit)
- "One shot" (six weeks application period)
- 50 000 applications, mostly heat pumps

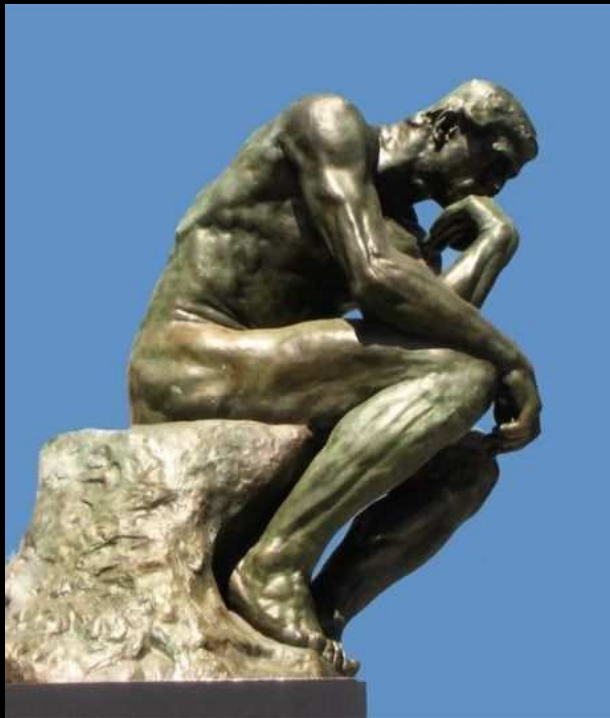
Similar program continued from 2006.



5. Estimation of market transformation effects

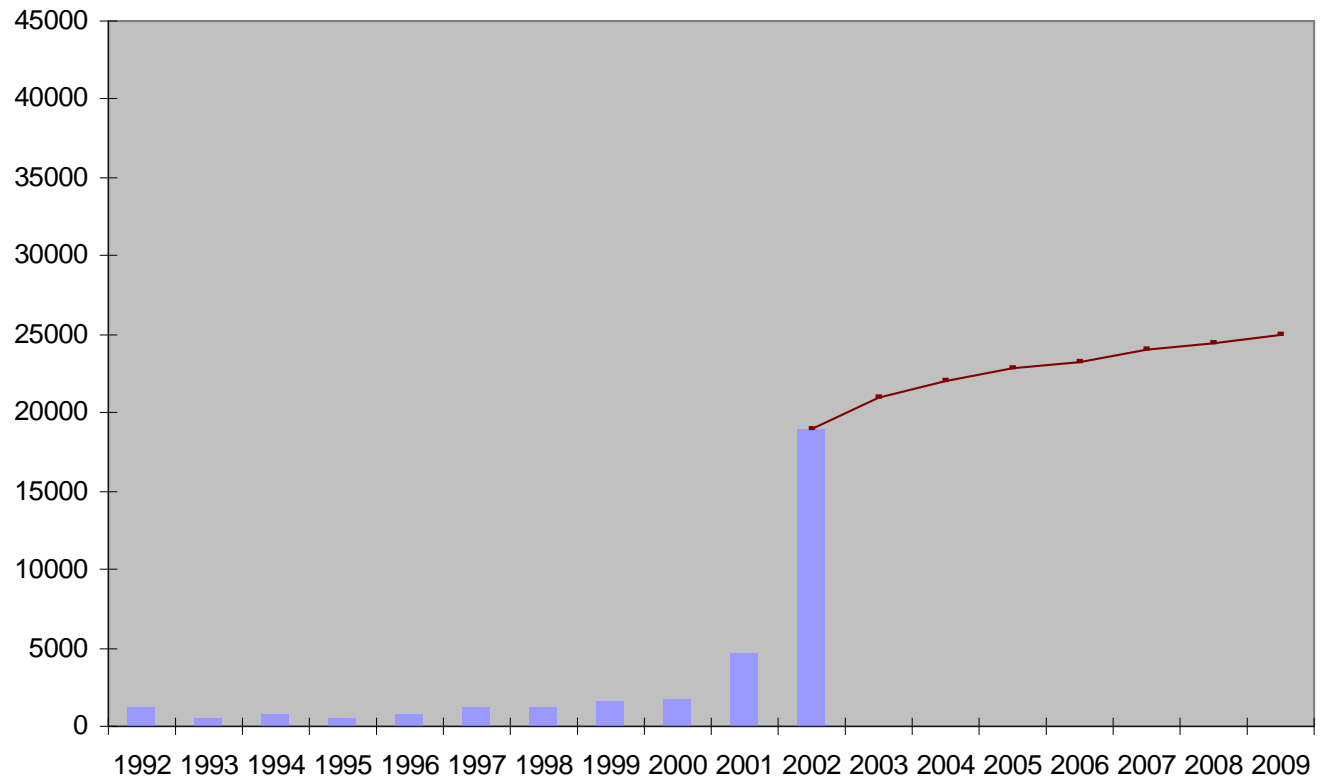
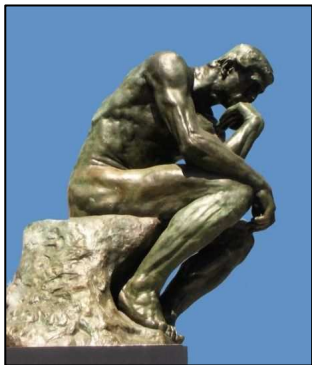


Baseline – different approaches



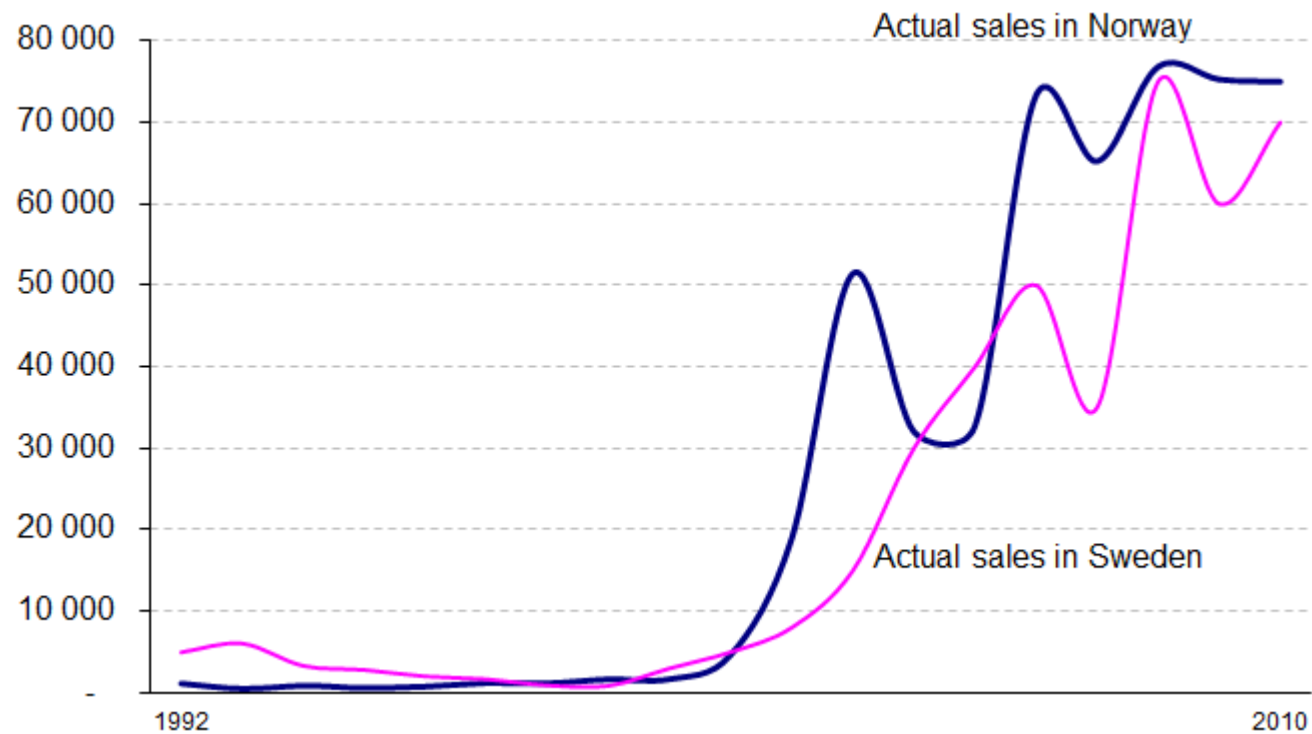


Expert assessment





Comparison between countries

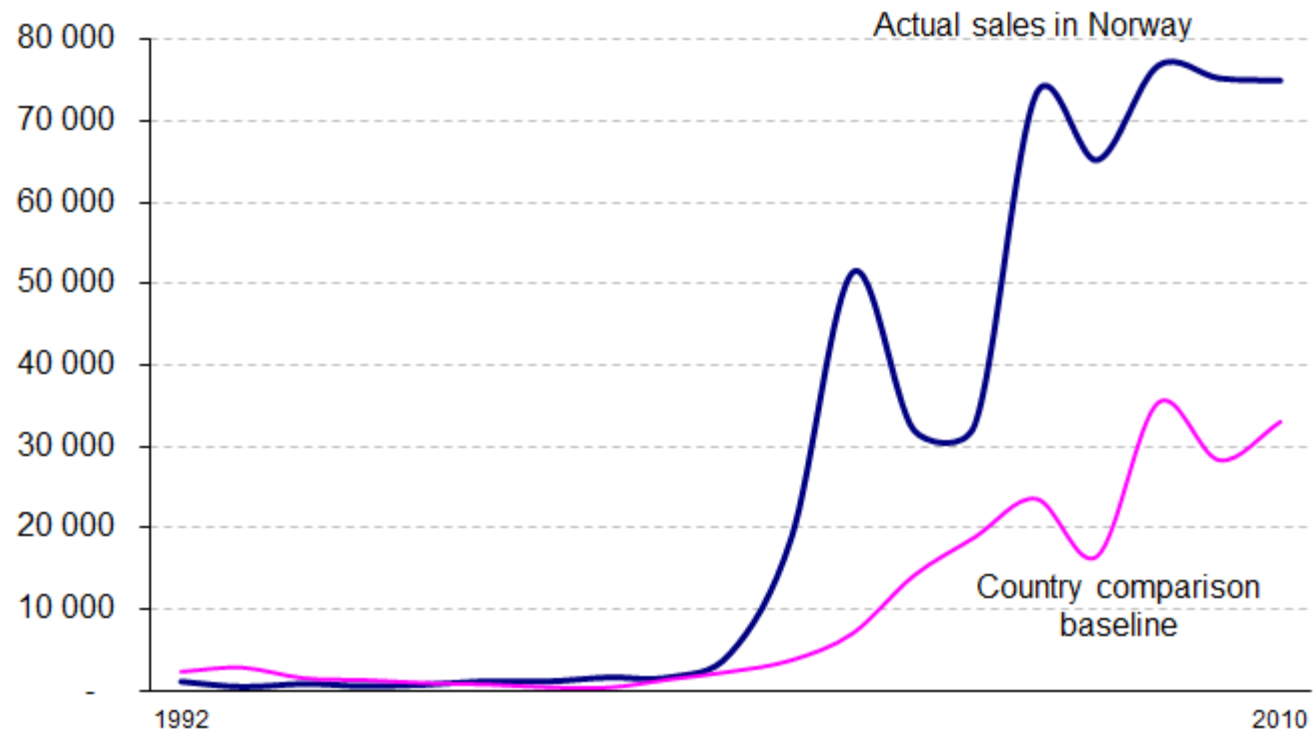


Sweden has

- twice the population
- twice as many households

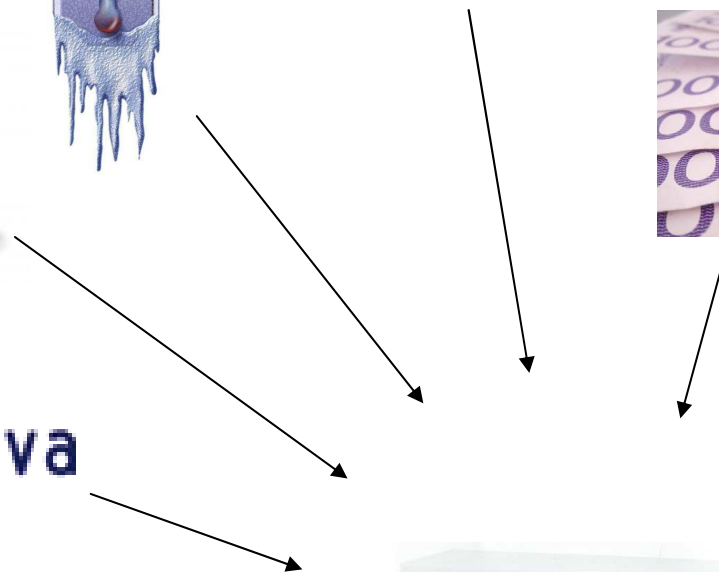
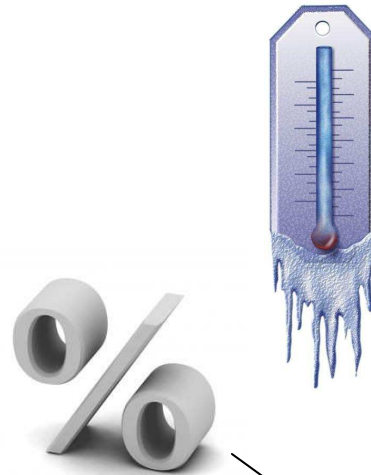


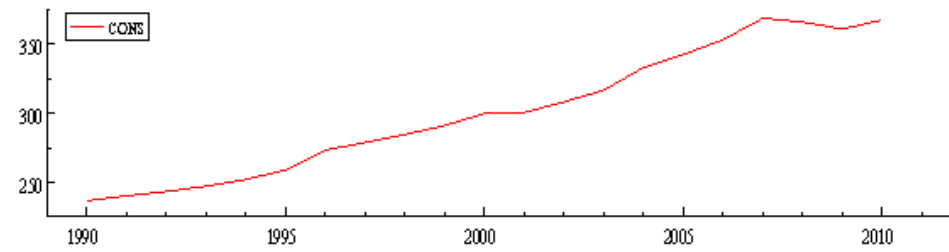
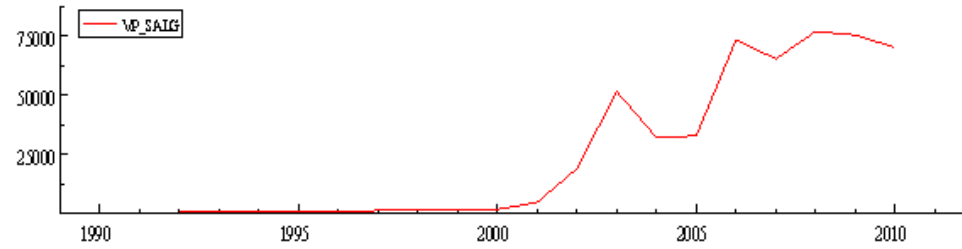
Comparison between countries





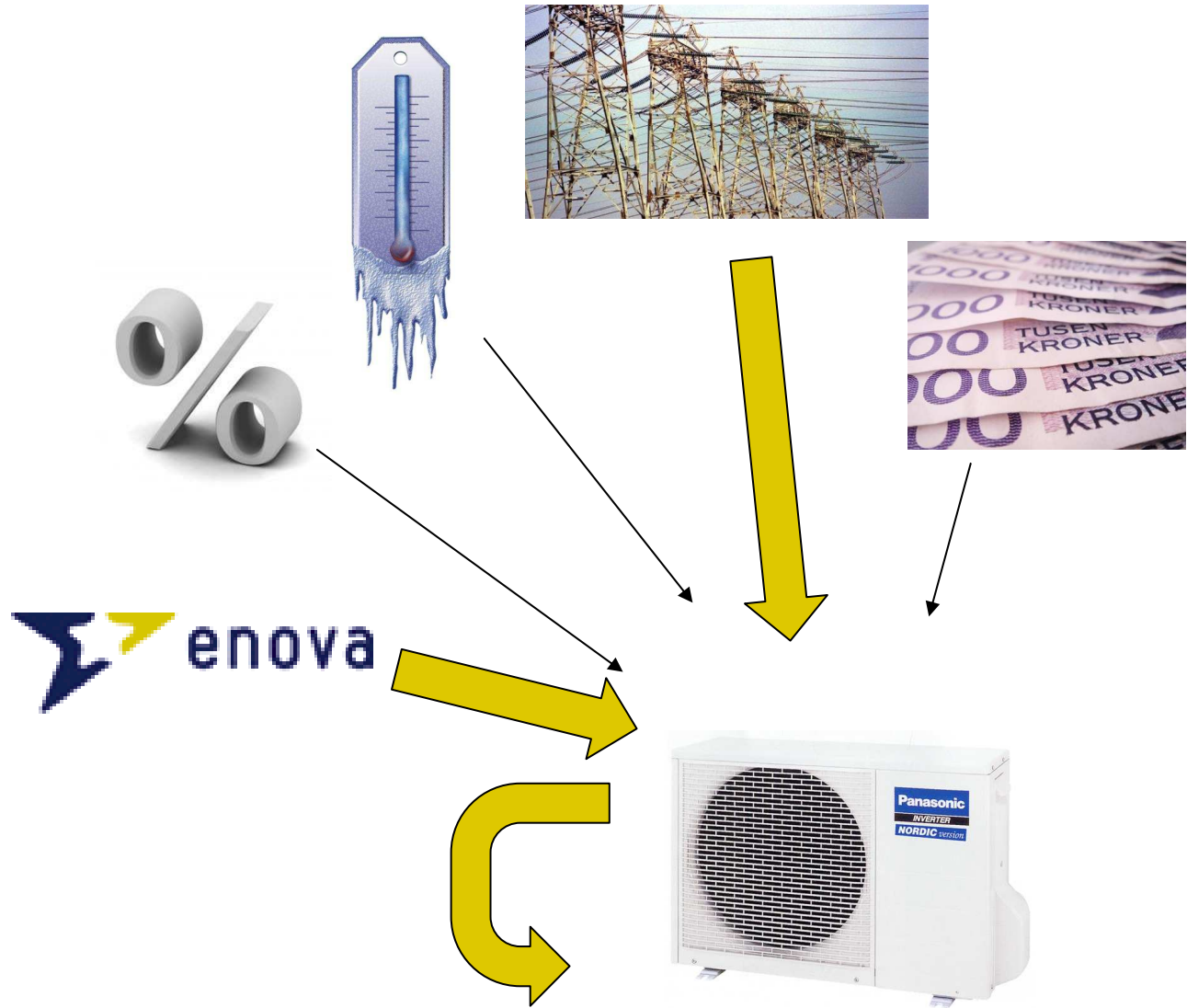
Regression model – explanatory variables







Results





Results



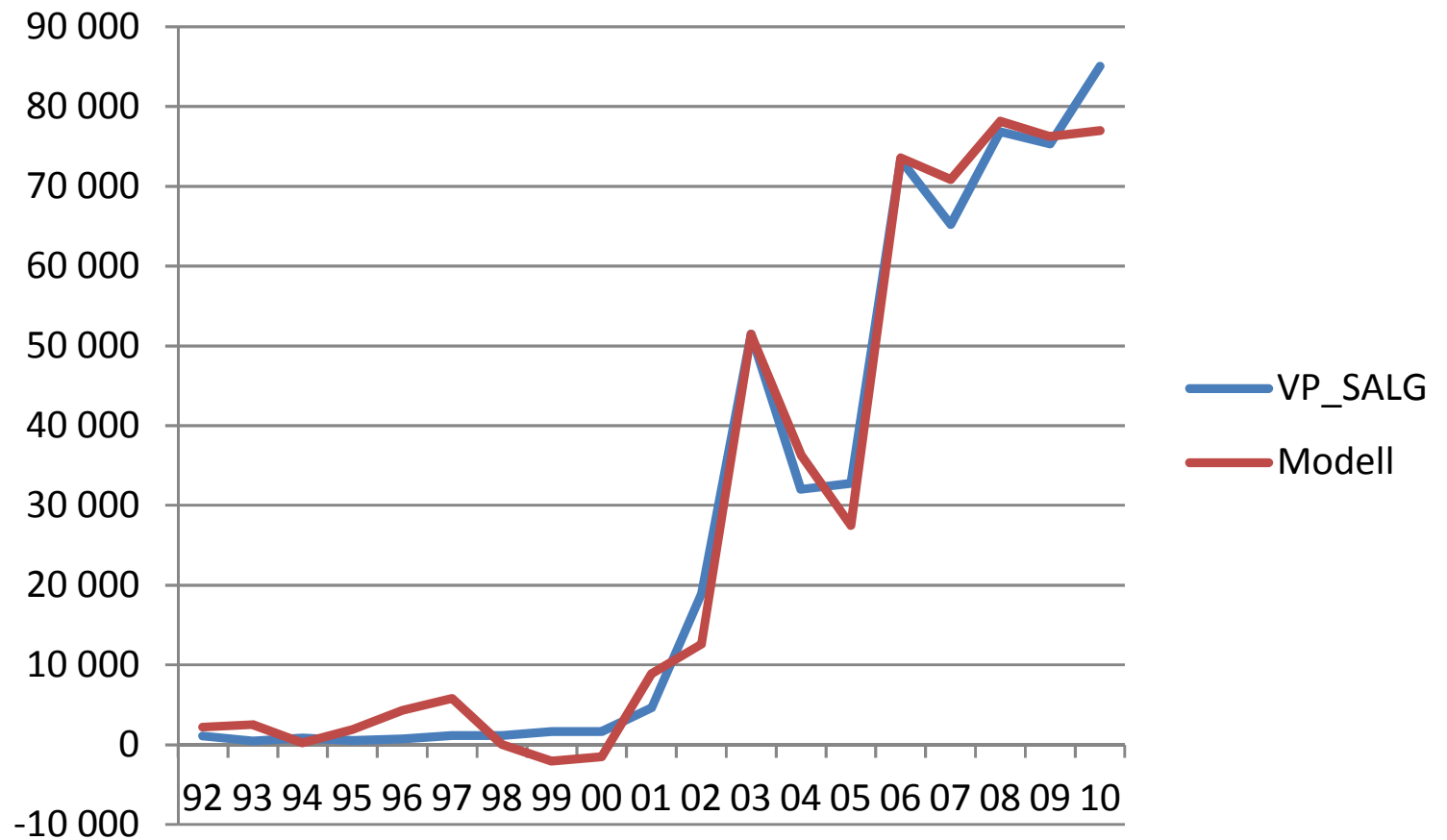
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig
	B	Std. Error	Beta		
7 (Constant)	-58 084	11 493		-5,054	0,000
ELPR	1 392	255	0,353	5,45	0,000
ENOVA03	15 353	6 353	0,110	2,417	0,031
ENOVA06	31 132	4 862	0,437	6,403	0,000
L_VP_SALG	0,312	0,077	0,288	4,055	0,001

Model Summary^h

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
7	,993 ^g	,985	,981	4550,136	1,986



Results





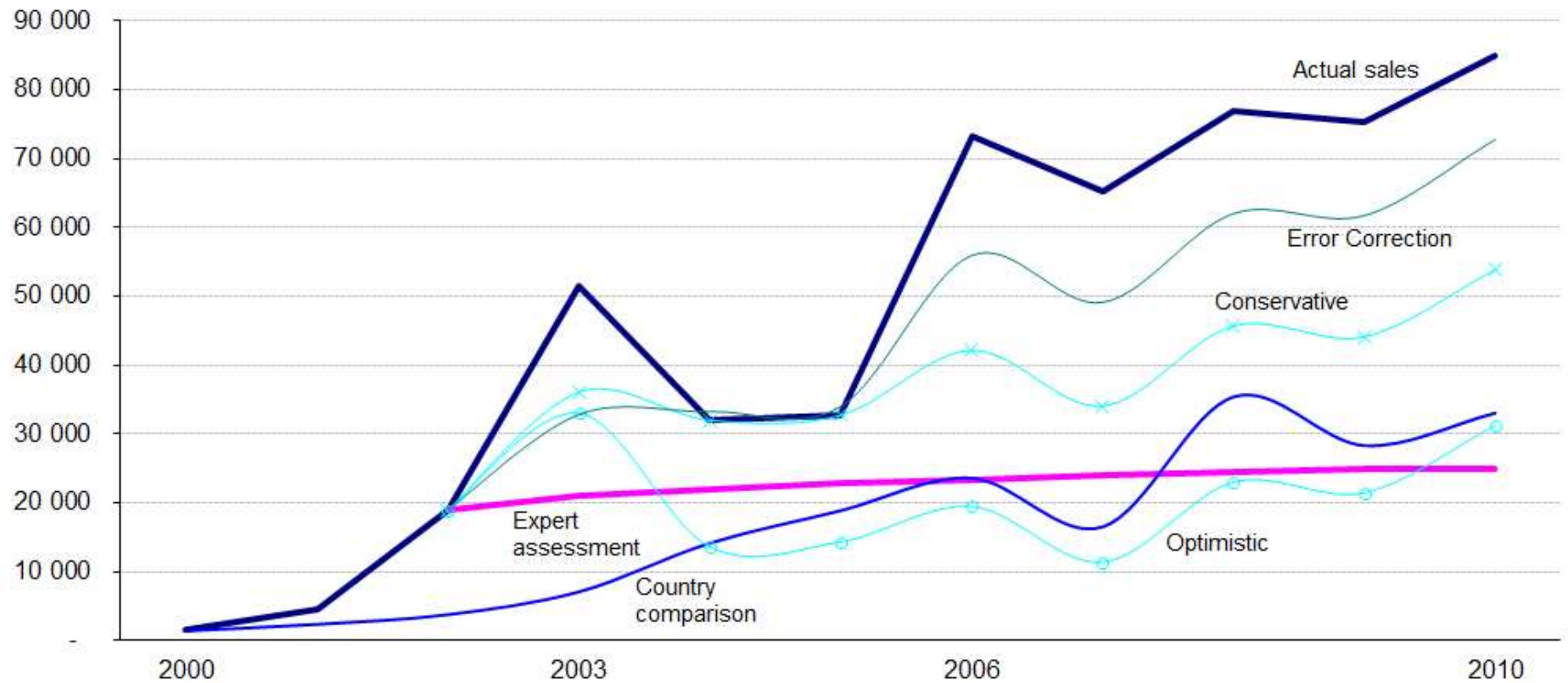
Sensitivity



Model	Predictors	Preliminary 2010 data 70 000	Preliminary 2010 data 81 000	Complete 2010 data 85 046	Experimental 2010 data 90 000
Optimistic	Price of electric energy	1 281	1 225	1 205	<i>model not selected in backward regression</i>
	HSP'03 (jump)	17 304	18 098	18 390	
	HSP'06	49 641	52 680	53 798	
	constant	-52 854	-50 414	-49 517	
	R ²	0,984	0,980	0,976	0,970
	Adjusted R ²	0,980	0,976	0,971	0,964
	Durbin Watson	1,740	1,338	1,240	1,169
	Reset23 significance	0,045*	0,047*	0,072	n.a.
	Enova result [GWh]	1 501	1 588	1 621	n.a.
	Conservative	Price of electric energy	1 507	1 423	1 392
HSP'03 (pulse)		13 886	14 959	15 353	15 836
HSP'06		29 564	30 710	31 132	31 648
Previous sales (lag 1)		0,260	0,298	0,312	0,329
constant		-62 906	-59 381	-58 085	-56 497
R ²		0,988	0,988	0,985	0,981
Adjusted R ²		0,985	0,984	0,981	0,975
Durbin Watson		2,265	2,137	1,986	1,830
Reset23 significance		0,755	0,639	0,565	0,499
Enova result [GWh]		809	843	855	870
Error Correction	Price of electr.(diff)	1 119	1 138	1 145	1 154
	Price of electr.(lag)	910	588	470	325
	HSP (diff)	21 015	19 254	18 606	17 813
	HSP (lag)	4 413	1 138	-1 271	-3 142
	Previous sales (lag 1)	-0,264	-0,092	-0,029	0,049
	constant	-38 054	-24 487	-19 496	-13 386
	R ²	0,929	0,934	0,925	0,907
	Adjusted R ²	0,899	0,906	0,894	0,868
	Durbin Watson	2,644	3,087	2,995	2,780
	Reset23 significance	0,121	0,258	0,395	0,559
Enova result [GWh]	1 006	674	450	267	

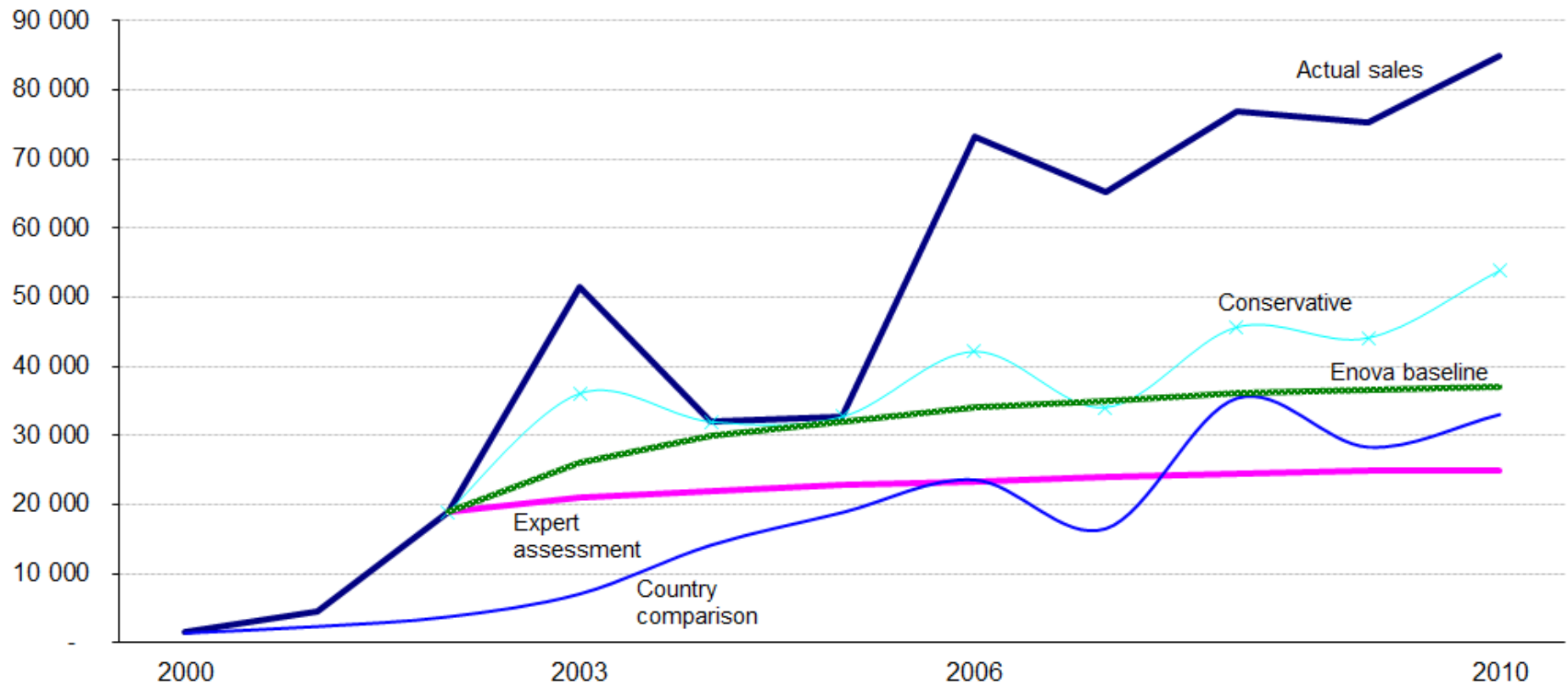


Results – baselines





Results – baselines



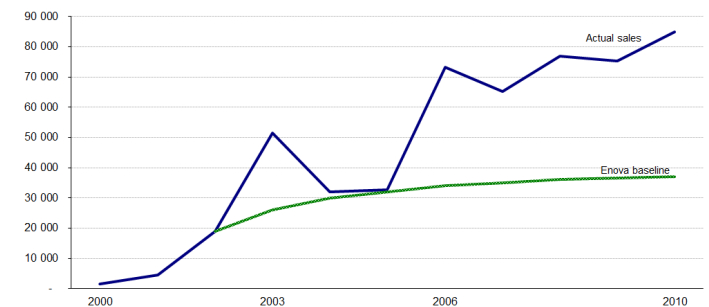


Results – energy saved

We estimate 225 000 additional units sold, due to the HSP

With annual saving per unit at 5 000 kWh,
this amounts to 1 125 GWh of electricity saved.

➔ 3% of annual household electricity use





Thank you for your attention!

