The PASHMINA scenarios: implications for policy makers
Introduction

- First stage: enhanced versions of models
- Second stage: translate the paradigm shifts of PASHMINA in long-term scenarios
- Main drivers as in PASHMINA database
- Presentation of policy relevant results from scenarios generated using WITCH, GLOBIOM, IMACLIM and FASTEST
- Illustrative worlds that reflect PASHMINA paradigms
- Scenarios not forecasts
WITCH
Transition to a low-carbon world
(FEEM)
WITCH - Overview

- Focus on transformational change needed to achieve a low-carbon economy
- Focus on challenges to achieve global cooperation

Further work has examined:
- Interaction between R&D and green policies
- Impact of paradigm shifts on adaptation capacity
- Beyond GDP (leisure, international cooperation)
Emissions in the apple world

Global CO₂ emissions

From Pear to Apple population

- New fertility assumptions in the PASHMINA APPLE scenario lead to moderate emission reductions
- Aggressive climate policy at global level is needed to achieve the long-term 2°C target.
Temperature increase
WITCH – Policy trade-off

• A complementary set of scenarios shows that ambitious climate policies are extremely costly for fast growing Asian Economies.
• Trade-off between political feasibility and environmental target
WITCH – Policy trade-off

China – Policy cost

GDP loss (% of cumulative GDP)

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<th>2010-2100</th>
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<td>2.77%</td>
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Innovative solutions

- Innovative paradigm shifts:
  - The role of the Green Fund for reducing emissions
  - Asia Emission Trading Scheme

Massetti and Tavoni (2012)
The pattern towards sustainability

GHG emissions in 2050

Societal change

- $74/tCO₂
- $118/tCO₂
- $237/tCO₂
- $422/tCO₂
GLOBIOM
Agriculture and Forests
(IIASA)
GLOBIOM - Overview

• GLOBIOM’s contribution:
  – Nutritional requirements
  – Agricultural productivity
  – Price signal on agricultural and LUC emissions

• Implications of PASHMINA worlds on:
  – Food security
  – Agriculture and land use emissions
  – Forests
Implications for agriculture

- Productivity growth in crop yields outweights growth of food demand
- Stronger impact of paradigm shift on livestock vs crops price
- Dietary change

Price indices

- APPLE crops
- APPLE Animal products
- PEAR Crops
- PEAR Animal products
- ORANGE crops
In the ORANGE world, nutritional requirement are met thanks to 2 mechanisms:

• Exogenous yield increases are high in Sub-Saharan Africa and in Latin-America

• GLOBIOM allows for shifts between production systems, which can lead to agricultural intensification
Implications for forests

- **PEAR:**
  - Large increase in ag land
  - Deforestation

- **APPLE and ORANGE:**
  - Forest area stable between 2000 and 2030
  - Increasing forest area 2030-2050 (due to the carbon tax)

*The “other natural vegetation” category is not shown in the graph, the changes represented are thus not balanced*
GHG emissions baselines

- GHG emissions from land use change very similar in APPLE and ORANGE - lower than in PEAR
- Carbon tax leads to emissions abatement, other input variables have little impact
Policy conclusions

- In both the APPLE and ORANGE scenarios emissions are not reduced by 50% in 2050 as ambitioned by the EC.
  - Increase in food production slightly reduced by the implementation of the carbon tax, but otherwise LUC emissions too high.

- Aim to halt global loss in forest areas by 2030 achieved in APPLE & ORANGE, but not in PEAR.
BAYESIAN NETWORKS
Assessing uncertainty (FEEM)
Bayesian networks in Pashmina

Analysis of paradigm shift processes + policy choices

Uncertainty (future trends; policy effectiveness; key dynamics…)

Complexity (interaction of factors from different disciplines)

Bayesian networks (BNs):
• Integrate in a synthetic model interdisciplinary outputs of complex models
• Incorporate the uncertainty of the issue into the analysis
• Inform policy makers and support a transparent decision process
WITCH – Uncertainty on future scenarios

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<th>Carbon tax</th>
<th>PEAR</th>
<th>APPLE</th>
<th>ORANGE</th>
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<td>0</td>
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<td>0.6</td>
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<tr>
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<td>0</td>
<td>0.6</td>
<td>0.2</td>
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<tr>
<td>T4</td>
<td>0</td>
<td>0.1</td>
<td>0.05</td>
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WITCH – Target setting
GLOBIOM - Uncertainty on tax and yields
GLOBIOM - Uncertainty on future scenarios

- GDP (USD); Population (bn); Caloric intake (Kcal/cap/day)
  - PEAR 40%
  - APPLE 33%
  - ORANGE 27%

- Exogenous Yield Increase
  - PEAR 35%
  - APPLE 37%
  - ORANGE 28%

- Carbon Tax (USD/t)
  - NoTax 42%
  - T2 58%

- Welfare (billion USD)
  - from_67700_to_67900 13%
  - from_67900_to_68000 1%
  - from_73600_to_73700 25%
  - from_73700_to_73800 8%
  - from_76100_to_76200 2%
  - from_76200_to_76300 30%
  - from_76300_to_76400 8%

- Emissions (MtCO2/year)
  - from_2400_to_2600 5%
  - from_2600_to_2800 43%
  - from_2800_to_3000 10%
  - from_4800_to_5000 1%
  - from_5000_to_5200 1%
  - from_5200_to_5400 1%
  - from_5400_to_5600 20%
  - from_5600_to_5800 18%

- Food Production (2000-2050, %)
  - from_72_to_74 19%
  - from_80_to_82 26%
  - from_86_to_88 3%
  - from_92_to_90 1%
  - from_94_to_96 2%
  - from_98_to_100 9%
  - from_100_to_102 11%
  - from_106_to_108 1%
  - from_114_to_110 18%

- Forests (% of tot area)
  - from_54_to_55 20%
  - from_55_to_56 22%
  - from_56_to_57 0%
  - from_57_to_58 0%
  - from_58_to_59 1%
  - from_59_to_60 52%
  - from_60_to_61 5%

- Cropland (% of tot area)
  - from_13_to_14 514%
  - from_14_to_15 4%
  - from_14_to_14 558%
  - from_15_to_15 4%

- Grassland (% of tot area)
  - from_26_to_26 540%
  - from_26_to_27 27%
  - from_28_to_28 3%
  - from_29_to_29 3%

- Price reduction (2000-2050, % negative N)
  - from_14_to_16 1%
  - from_16_to_20 23%
  - from_22_to_24 8%
  - from_24_to_26 37%
  - from_26_to_28 9%
  - from_28_to_30 19%
  - from_30_to_32 2%
  - from_32_to_34 2%
  - from_34_to_36 0%
GLOBIOM - Target setting
Q&A on global scenarios
IMACLIM-P
A focus on France
(SMASH-CIRED)
A French case study

- A 2035 snapshot of the French economy under the 3 paradigms
- Implementation of IMACLIM-P, a recursive CGE model with secondary income distribution among 5 household classes
- Macroeconomic results + focus on equity issues
- Insights on energy poverty through micro-simulation
Paradigm drivers 1

• From PASHMINA storylines
  • Total and active population
  • Labour productivity and annual working hours (Orange -28%)

• From model harmonization:
  • International energy prices (inc. WEURO elec)
  • Strong price signal (€122 per ton CO₂ in 2035)
Paradigm drivers 2

**Demand-side management assumptions**
- Specific electricity *per* head
- Oil in automotive fuels
- Transport intensity
- Housing tax to tackle urban sprawl

**Income distribution levers**
- Unemployment rate
- Wage inequalities
- Income tax reform
## Macro results

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<thead>
<tr>
<th></th>
<th>2006 to 2035</th>
<th>PEAR</th>
<th>APPLE</th>
<th>ORANGE</th>
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</thead>
<tbody>
<tr>
<td><strong>GDP</strong></td>
<td></td>
<td>+65%</td>
<td>+66%</td>
<td>+29%</td>
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<tr>
<td><strong>Final E consumption</strong></td>
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<td>+32%</td>
<td>+25%</td>
<td>-12%</td>
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<tr>
<td><strong>CO₂ emissions</strong></td>
<td></td>
<td>+26%</td>
<td>+14%</td>
<td>-25%</td>
</tr>
<tr>
<td><strong>Hh E consumption</strong></td>
<td></td>
<td>-6%</td>
<td>-18%</td>
<td>-32%</td>
</tr>
<tr>
<td><strong>Hh CO₂ emissions</strong></td>
<td></td>
<td>-12%</td>
<td>-49%</td>
<td>-73%</td>
</tr>
<tr>
<td><strong>Inequalities: Gini</strong></td>
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<td>+12%</td>
<td>-6%</td>
<td>-33%</td>
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<tr>
<td><strong>Inequalities: Q1 lag</strong></td>
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<td>9 pts</td>
<td>9 pts</td>
<td>-6 pts</td>
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Energy poverty

<table>
<thead>
<tr>
<th>Million households</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Σ</th>
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<tr>
<td>2006</td>
<td>1.59</td>
<td>0.86</td>
<td>0.52</td>
<td>2.97</td>
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<tr>
<td>PEAR</td>
<td>2.62</td>
<td>1.36</td>
<td>0.66</td>
<td>4.64</td>
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<td>2035</td>
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<tr>
<td>APPLE</td>
<td>1.60</td>
<td>0.57</td>
<td>0.19</td>
<td>2.35</td>
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<tr>
<td>ORANGE</td>
<td>1.06</td>
<td>0.41</td>
<td>0.14</td>
<td>1.60</td>
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Through micro-accounting with reweighting
Main findings

• Paradigms can be modelled... except energy efficiency gains?
• Paradigm shifts through «carbon pricing» and housing tax to get at transportation activities
• Paradigm shifts have regressive impacts
• These should be mitigated by fiscal reforms
• 1st income quintile cannot lose too much public support
FASTEST
A focus on energy
(WIFO)
Philosophy

“From energy services to energy flows”

- Energy services (e.g. well-tempered living space, mobility) and not energy flows are relevant for welfare
- Energy services are a combination of behaviour, technologies (stocks) and energy consumption (flows)
- For the analysis of a transformation of the energy system a focus on energy services hence is inevitable

- Problem: Data on energy services is not included in statistics – proxies for the different energy services need to be defined
The PASHMINA indicators for sustainable energy development

- Development, definition and collection of indicators that put more emphasis on stocks, flows and energy services and depict the interaction of stocks and flows
- Data coverage: EU 27
- Structure
  - 6 sectors
  - 6 thematic areas
  - 8 meta indicators (such as GDP, population, ..)

<table>
<thead>
<tr>
<th>Context</th>
<th>Households</th>
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<tr>
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<td>Households</td>
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<tr>
<td></td>
<td>Household size</td>
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<tr>
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<td>Stock of appliances</td>
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<td>Stock of heating systems</td>
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<td>Floor area p.c.</td>
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<td>Household income</td>
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<td>Income inequality</td>
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<td>Energy prices</td>
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| Energy services          | Space heating and lighting - proxy: floor area  |
|                          | Hot water - proxy: number of persons            |
|                          | Other (e.g. cooking) - proxy: number of appl.   |

| Energy productivity      | Energy services by service type per FEC         |

| Energy use and provision | FEC per household                              |
|                          | FEC by activity and energy source (percentage shares) |

| Environmental aspects    | Air pollutants                                 |
|                          | GHG emissions                                  |

| Social aspects           | Share of energy costs in average household income |
|                          | Share of energy costs in household income of lowest 20% |
The PA for sustainable energy development

- Development, definition and collection of indicators that put more emphasis on stocks, flows and energy services and depict the interaction of stocks and flows
- Data coverage: EU 27
- Structure
  - 6 sectors
  - 6 thematic areas
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Implications of “PEAR” and “ORANGE” on the energy indicators

- Structural energy model
- Coverage:
  - 19 EU Member States (reflecting the availability of service proxies)
  - Five sectors: Industry, Services, Households, Transport, Electricity and Heat Supply
- Input data:
  - Central drivers for energy system (GDP, population,...) according to PASHMINA database downscaled by FEEM on OMS and NMS level
- Outputs:
  - Estimated development of energy indicators (energy services, energy productivity, energy flows, energetic CO$_2$ emissions)
Differences in “PEAR” and “ORANGE” in NMS (1)

- **Pear**
  - Strongly rising energetic CO$_2$ emissions, particularly in the transport sector

- **Orange:**
  - Moderate increase in CO$_2$ emissions
Differences in “PEAR” and “ORANGE” in NMS (2)

Underlying developments

• Pear
  • Energy service demand grows strongly
  • Energy productivity cannot offset the increase in energy service demand
  • Both effects together with a shift towards renewables dampen increase in CO₂ emissions

• Orange:
  • Considerably lower income growth than in “PEAR” translates into moderate energy service demand increase
  • Energy productivity improvements are lower than in “PEAR” reflecting the influence of GDP growth on innovation that is more pronounced in "PEAR"
  • Smaller increase in service demand as dominant influence for almost constant CO₂ emissions, minor contribution of energy productivity and fuel shift
Conclusions from analysis of the energy system

• The estimation results of the structural energy model point out how the different drivers affect the different levels of the energy system, starting from energy services.
• This highlights potentials for the transformation of the energy system towards a low carbon society:
  • Life style and behavioural changes with a focus on energy services
  • Technological options with a focus on energy productivity
  • Fuel mix changes towards renewables
Implications for agriculture cont’d

- **Most crops:** highest supply increase for PEAR, medium for APPLE, lowest for ORANGE due to: difference in POP, yield increases & nutrition requirements

- **Some crops** (e.g. cassava, millet, sorghum): reversed order because yield increases higher in Africa and LAM for ORANGE and APPLE

<table>
<thead>
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<th>Crops</th>
<th>PEAR</th>
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<th>ORANGE</th>
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<td>51.4</td>
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<tr>
<td>Rape</td>
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<tr>
<td>Rice</td>
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