

## Azores Green Islands: Maximizing Renewable Electricity in São Miguel

A. Pina, IST  
E. Spang, MIT  
C. Silva, IST  
S. Connors, MIT

### MIT-Portugal Green Islands Project

#### Introduction

The Azores are highly dependent on fossil fuel imports, but the abundant natural resources they possess allow envisioning a more energy sustainable and independent system. The main goal of this work is to model and design scenarios that:

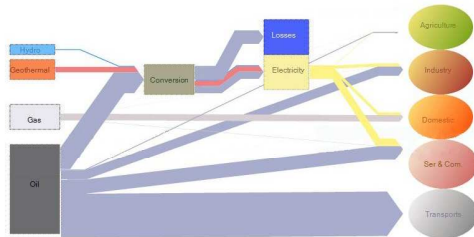
- Enable high penetrations of renewable energy in electricity production;
- Enable the increase the share of renewables in primary energy;
- Allow the decrease of overall fossil fuel consumption.

#### Electricity production

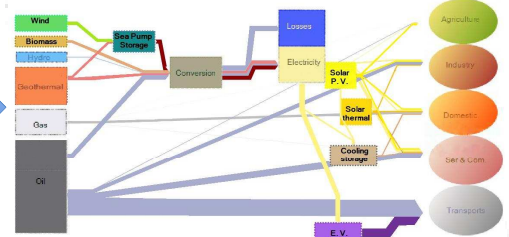
- 53.2% Fuel
- 41.4% Geothermal
- 5.4% Hydro

#### Primary energy consumption

- 86.6% Oil products
- 6.6% Butane
- 6.1% Renewables



HOW?



#### Methodology and Scenarios

The modeling was performed with TIMES, which is an optimization tool for the design of energy systems. The model being built aims to include:

High temporal resolution

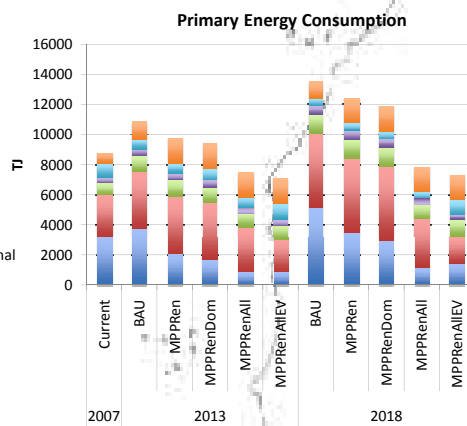
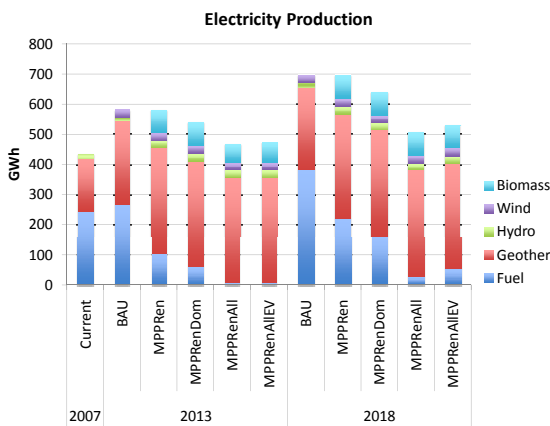
High detail on resource availability

High disaggregation of energy demand

High detail on demand dynamics and savings

	Geo (MW)	Hydro (MW)	Wind (MW)	Biomass (MW)	Storage (MW)	Elect. GR (%)	Energy GR (%)	Domestic Gains	EVs
BAU	37	5	9			4	5		
MPPRen	47	9	9	10	15	4	5		
MPPRenDom	47	9	9	10	15	4	5	✓	
MPPRenAll	47	9	9	10	15	2	1		✓
MPPRenAllEV	47	9	9	10	15	2	1		✓

#### Results and Conclusions



#### Azores Government targets (2018)

- 50% electricity in energy consumption ✓
- 75% renewable electricity ✓
- 40% renewable energy consumption (primary) ⚠

#### BAU

#### MPPRen

• These scenarios show that the introduction of renewables and storage systems can help increase renewable energy penetration in the short term. On the long term, however, the high consumption growth rates have a large impact and reduce the penetration of renewables.

#### MPPRenDom

#### MPPRenAll

• These scenarios incorporate energy efficiency measures, showing better results. It becomes clear that it is crucial to understand energy consumption and possible efficiency gains.

#### MPPRenAllEV

• The last scenario shows how the introduction of electric vehicles can help reduce primary energy consumption. While there is a shift from the consumption of regular transportation fuels to Fuel Oil consumption for electricity production, there is an increase in efficiency which allows a larger penetration of renewables in terms of primary energy consumption.

Although the scenarios developed show how renewable energy penetration can increase significantly, they do not meet the goals set by the Azores Government. Furthermore, future work will include broader economics and sustainability metrics to better determine the impact of the scenarios designed. This work will also expand to include more resource and demand dynamics.

References: 1. EDA Statistical Information Report, December 2007; 2. DGEG Fuel consumption statistics 2006; 3. R. Loulou, U. Remme, A. Kanudia, A. Lehtila, G. Goldstein, "ETSAP-TIAM: the TIMES integrated assessment model Part I: Model structure", Springer, February 2007; 4. F. Amorim, B. Palmintier, A. Pina, "Azores Green Islands: Looking at Demand", AGS 2009.