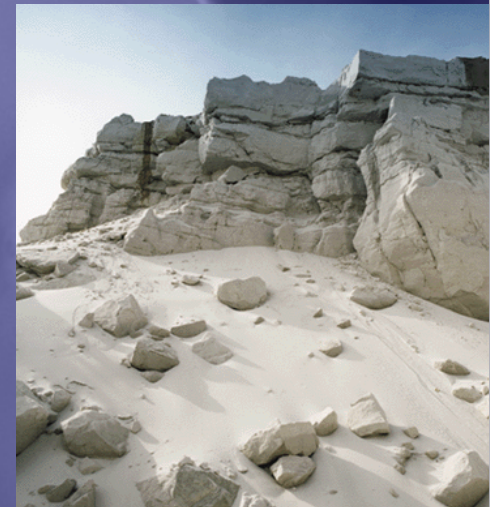


The influence of liberalization and Groningen depletion on UGS in the Netherlands

And possible consequences for the security of gas supply

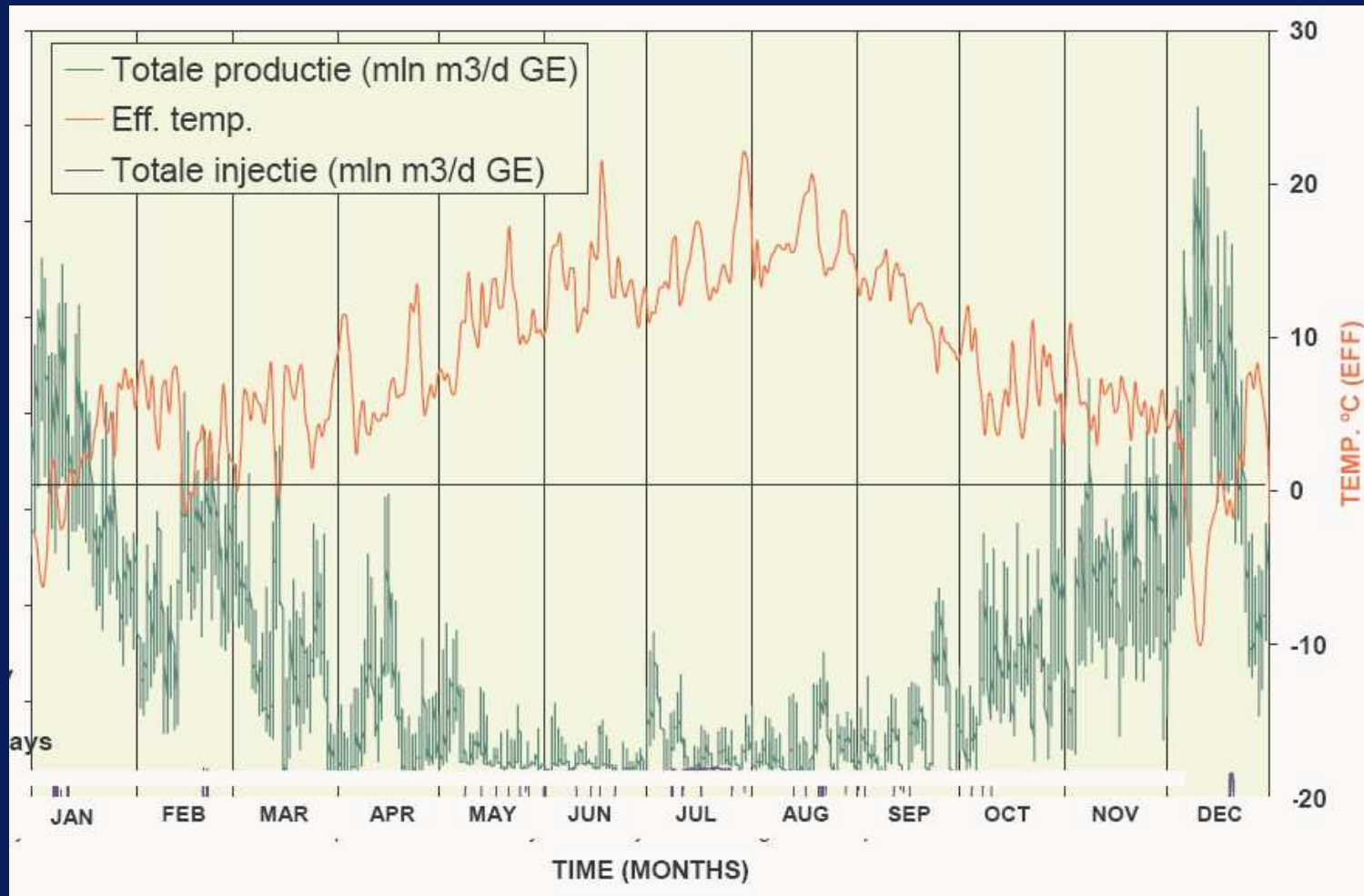
TNO Built Environment and Geosciences
- Department of Geo-Energy



An introduction to flexibility

- UGS as a form of flexibility
- **Definition: the ability to adjust supply to demand**
- **Aspect of security of supply**
- **Case study: the Netherlands**
- **Recent developments:**
 - Groningen depletion
 - Liberalization

Groningen flexibility



Source: NAM, 2002.

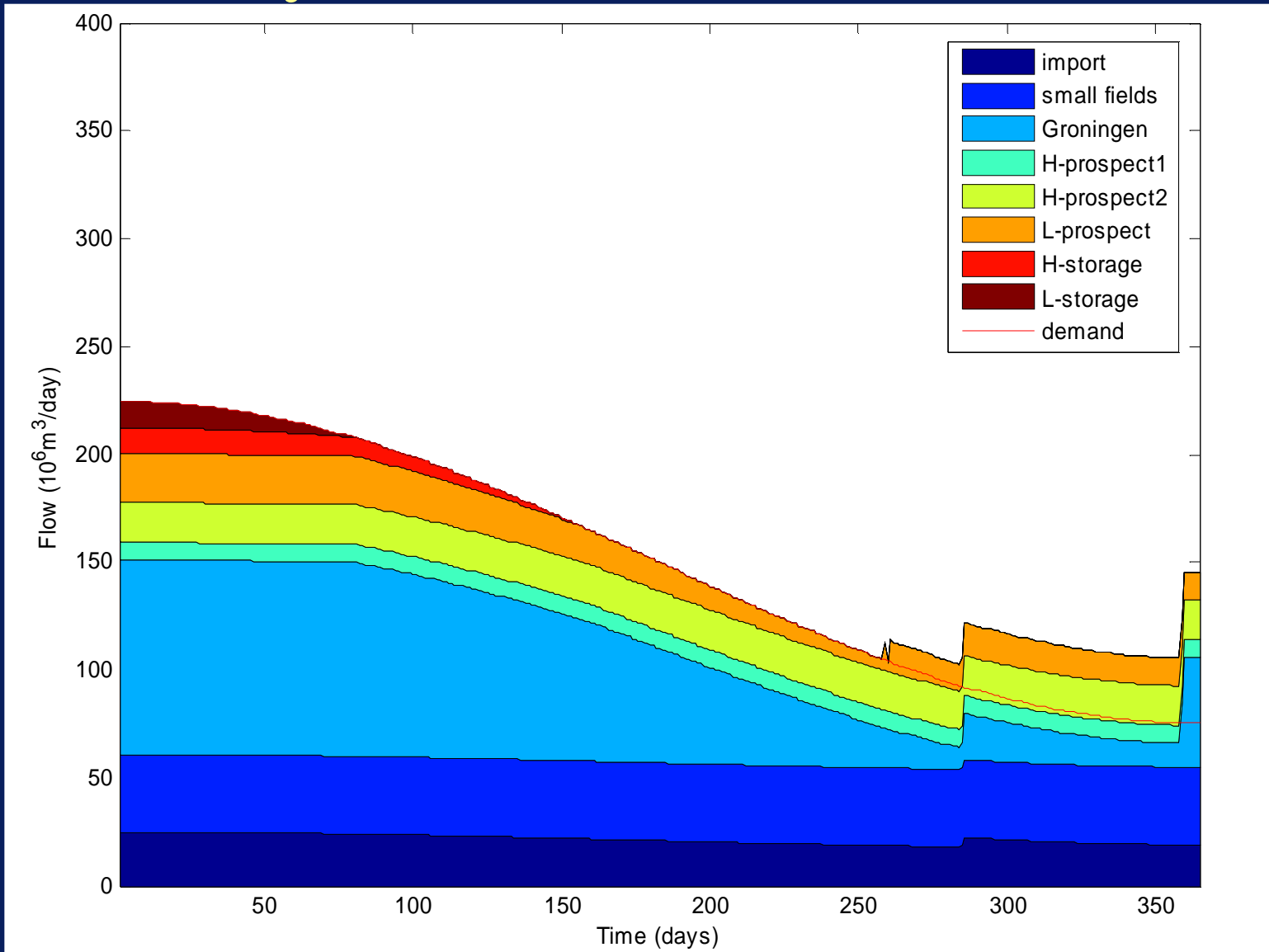
Liberalization: complexity increases



Sources of flexibility

- **Swing capacity**
- **Linepack**
- **(Underground) Storage facilities**
- **Interruptible customers**

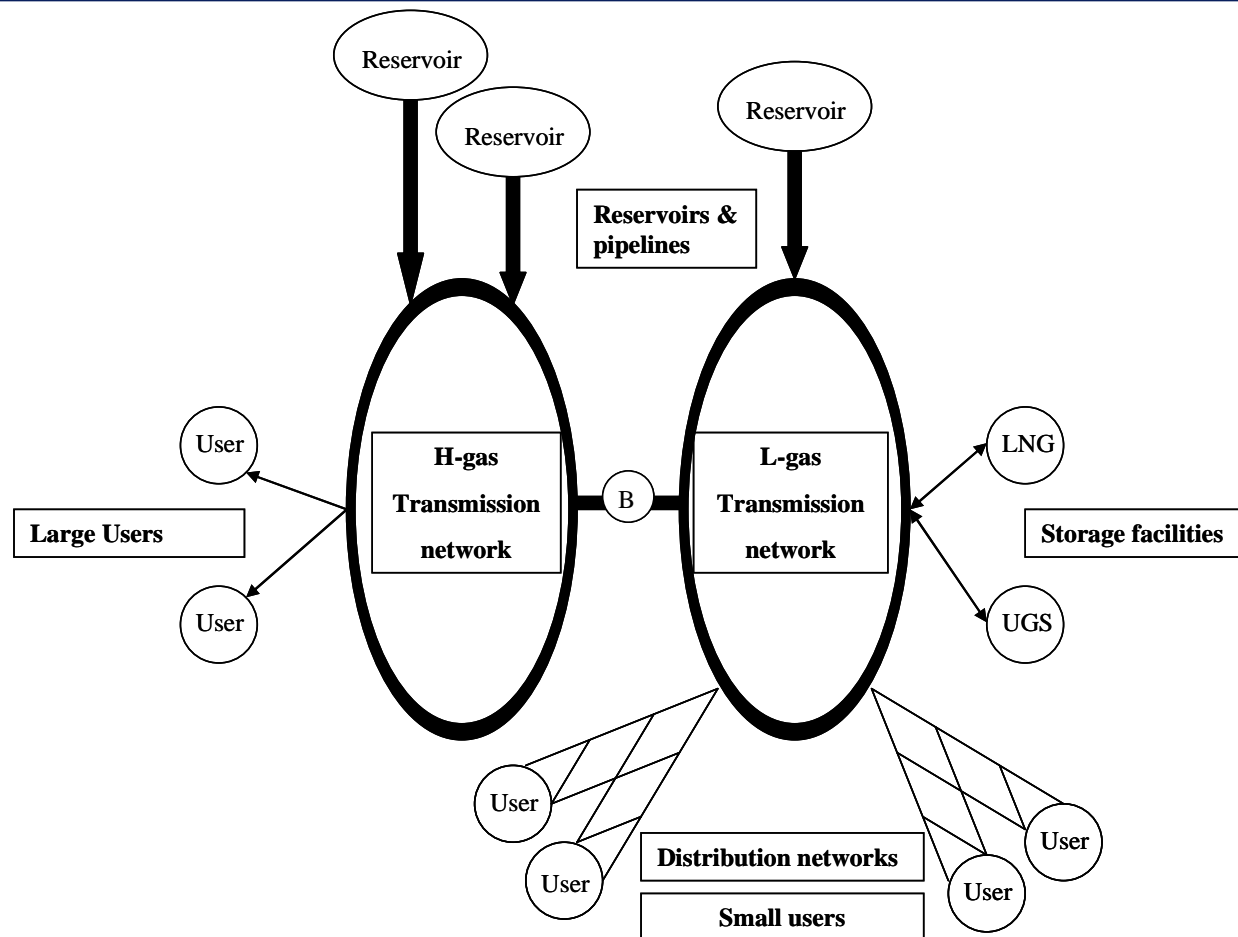
Flexibility in the Netherlands



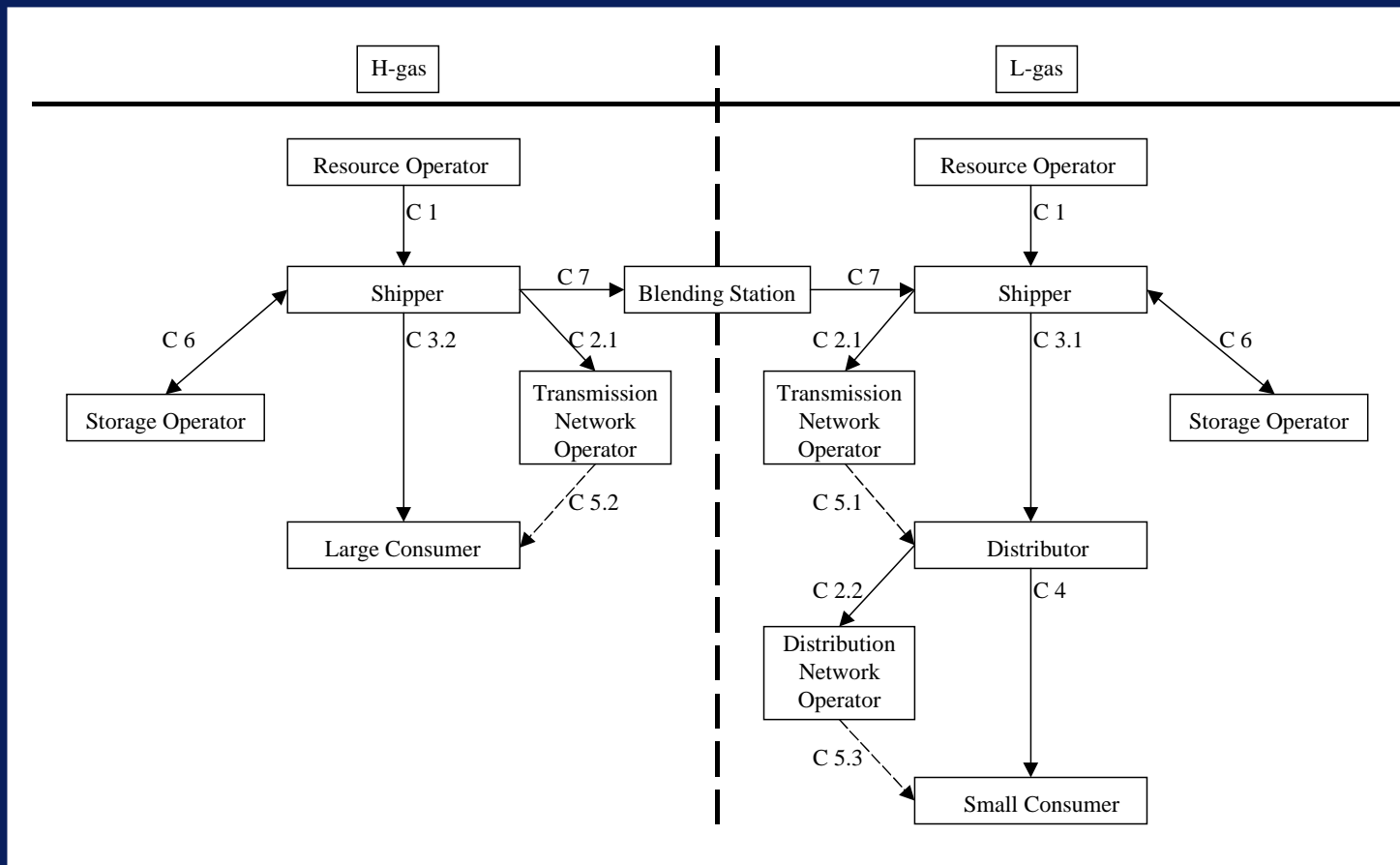
Modeling the flexibility of gas supply

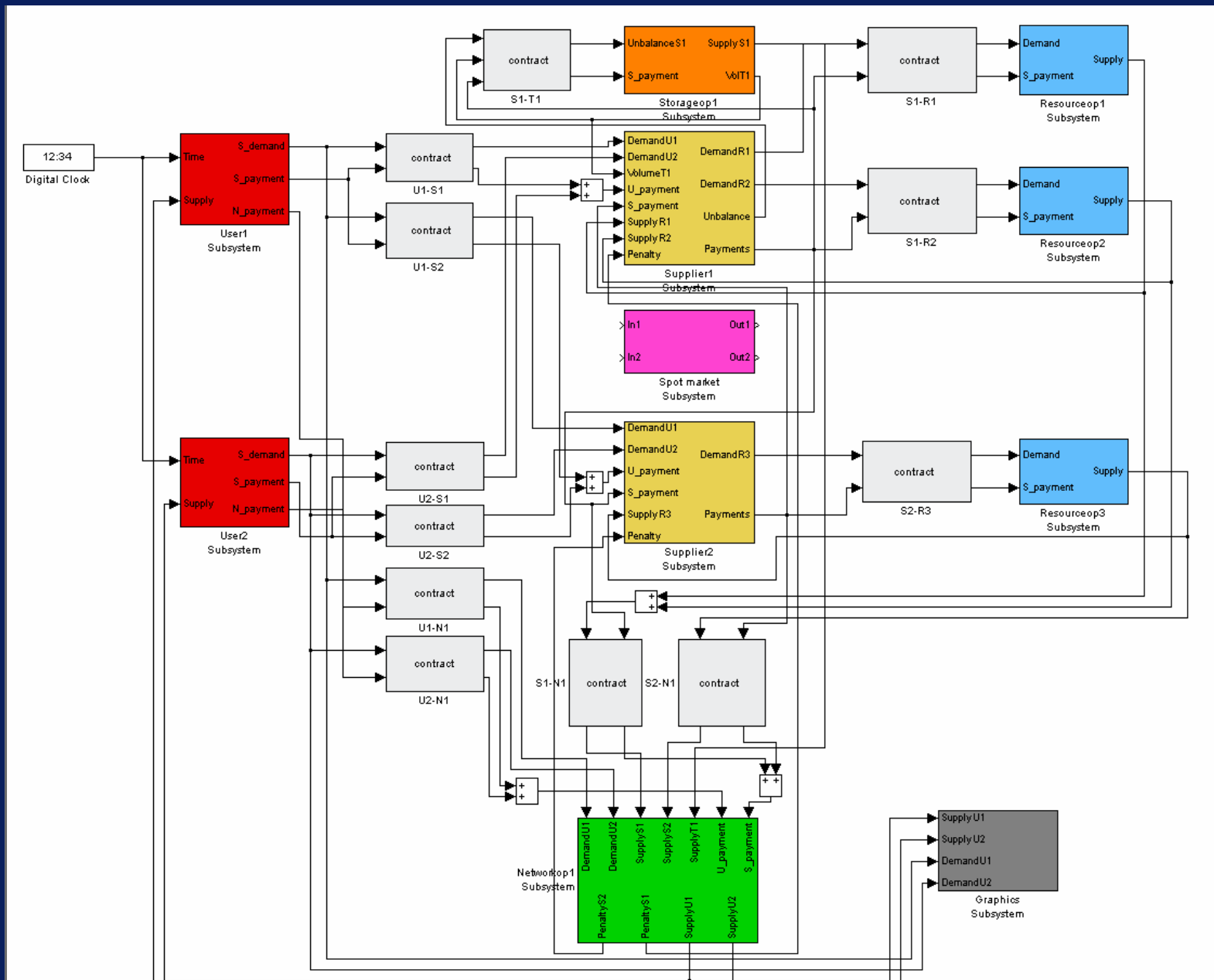
- **Inclusion of flexibility sources**
- **Agent-based approach**
- **Agents linked by: company, market, contract**
- **Decision algorithms**
- **Data set**
- **Investment**
- **Model scope and applicability**

Physical infrastructure



Contractual relations





Scenarios

- **The perfect market**
 - Access for all
- **High barriers**
 - Every man for himself
- **Uncertainty prevails**
 - Suppliers in the mist



Scenario results

Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>				
<i>High Barriers</i>				
<i>Uncertainty Prevails</i>				

Scenario results

Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>	National flexibility supplier			
<i>High Barriers</i>				
<i>Uncertainty Prevails</i>				

Scenario results

Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>	National flexibility supplier	Availability high, Investment low		
<i>High Barriers</i>				
<i>Uncertainty Prevails</i>				

Scenario results

Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>	National flexibility supplier	Availability high, Investment low	Many, Good resale opportunities	
<i>High Barriers</i>				
<i>Uncertainty Prevails</i>				

Scenario results

Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>	National flexibility supplier	Availability high, Investment low	Many, Good resale opportunities	Short term high, Long term cycle
<i>High Barriers</i>				
<i>Uncertainty Prevails</i>				

Scenario results

Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>	National flexibility supplier	Availability high, Investment low	Many, Good resale opportunities	Short term high, Long term cycle
<i>High Barriers</i>	Privately owned, No selling obligations			
<i>Uncertainty Prevails</i>				

Scenario results

Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>	National flexibility supplier	Availability high, Investment low	Many, Good resale opportunities	Short term high, Long term cycle
<i>High Barriers</i>	Privately owned, No selling obligations	Availability low, Investment fair		
<i>Uncertainty Prevails</i>				

Scenario results

Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>	National flexibility supplier	Availability high, Investment low	Many, Good resale opportunities	Short term high, Long term cycle
<i>High Barriers</i>	Privately owned, No selling obligations	Availability low, Investment fair	Average, Resale limited to own supplier	
<i>Uncertainty Prevails</i>				

Scenario results

Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>	National flexibility supplier	Availability high, Investment low	Many, Good resale opportunities	Short term high, Long term cycle
<i>High Barriers</i>	Privately owned, No selling obligations	Availability low, Investment fair	Average, Resale limited to own supplier	Short term medium, Long term high
<i>Uncertainty Prevails</i>				

Scenario results

Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>	National flexibility supplier	Availability high, Investment low	Many, Good resale opportunities	Short term high, Long term cycle
<i>High Barriers</i>	Privately owned, No selling obligations	Availability low, Investment fair	Average, Resale limited to own supplier	Short term medium, Long term high
<i>Uncertainty Prevails</i>	No decision made			

Scenario results

Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>	National flexibility supplier	Availability high, Investment low	Many, Good resale opportunities	Short term high, Long term cycle
<i>High Barriers</i>	Privately owned, No selling obligations	Availability low, Investment fair	Average, Resale limited to own supplier	Short term medium, Long term high
<i>Uncertainty Prevails</i>	No decision made	Availability low, Investment low		

Scenario results

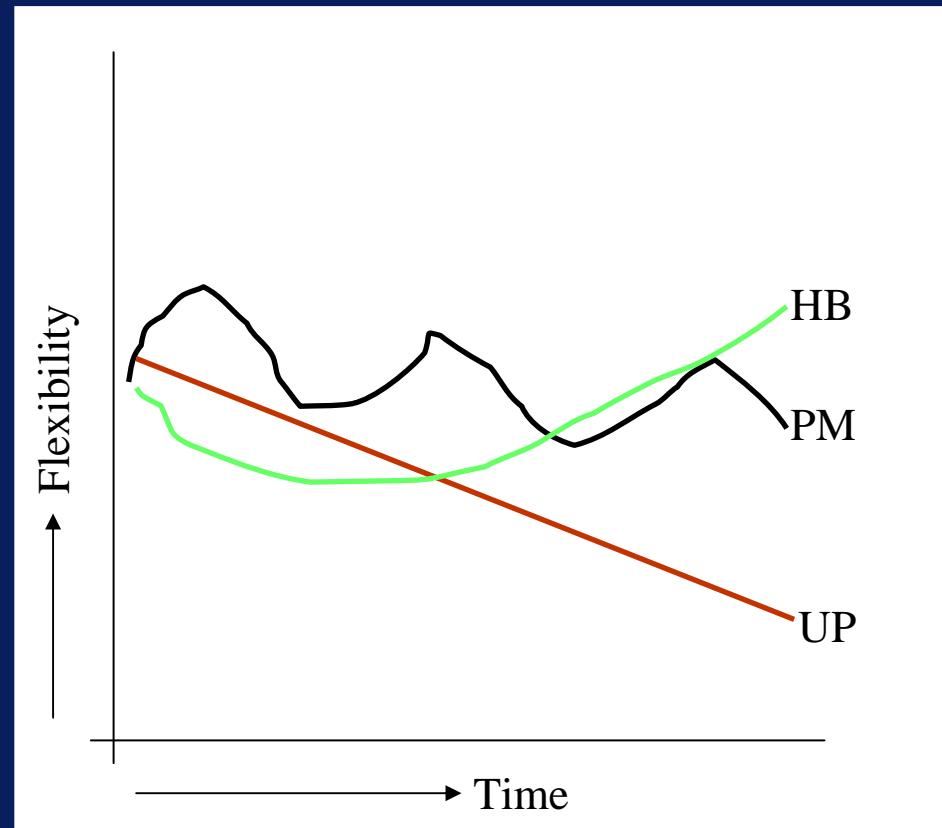
Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>	National flexibility supplier	Availability high, Investment low	Many, Good resale opportunities	Short term high, Long term cycle
<i>High Barriers</i>	Privately owned, No selling obligations	Availability low, Investment fair	Average, Resale limited to own supplier	Short term medium, Long term high
<i>Uncertainty Prevails</i>	No decision made	Availability low, Investment low	Few, Limited resale opportunities	

Scenario results

Scenario	Groningen	UGS	Interruptible Customers	Security of supply
<i>Perfect Market</i>	National flexibility supplier	Availability high, Investment low	Many, Good resale opportunities	Short term high, Long term cycle
<i>High Barriers</i>	Privately owned, No selling obligations	Availability low, Investment fair	Average, Resale limited to own supplier	Short term medium, Long term high
<i>Uncertainty Prevails</i>	No decision made	Availability low, Investment low	Few, Limited resale opportunities	Short term medium, Long term low

Scenarios

- **The perfect market**
 - Access for all
- **High barriers**
 - Every man for himself
- **Uncertainty prevails**
 - Suppliers in the mist



Implications

- **Market structure determines**
 - Amount of flexibility
 - Distribution of flexibility
- **New flexibility needed: UGS and interruptibility**
- **Policy shapes security of supply**
- **Recommendations**
 - Policy makers: provide clarity and stability
 - Companies: develop a robust flexibility strategy

Visit the TNO stand at the WGC!

Menno van Benthem
TNO geo-energy
Utrecht, the Netherlands
Menno.vanbenthem@tno.nl