A Methodology for Determining "FIT" to Promote RE Investment in Developing Countries.

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Contents

Some questions

A sound RES policy should be based on some evidences from technical and economic analysis

- Under a private cost analysis (natural penetration), are there economic signals that may foster the development of RE in the event that all other barriers are removed?
- How much conventional power could be displaced by cheaper RES generation, even without an specific RES policy, if regulatory and financial barriers are addressed?
- Which is the optimal quota of RES in the mid-term?
  - Is there an economic benefit for society in developing the optimal quota for RE, and if so, how much is the total surplus? (under a partial equilibrium analysis)
  - Which are the prices /tariffs for RES that maximized the benefit for the society?
  - How total surplus should be allocated between producers (of RES) and consumers and what does it imply for incentive mechanisms?
  - Which incentive mechanisms represent the best trade-off between effectiveness and fairness?

Methodology

Avoided social cost for conventional energy

- Prices/tariffs and quantities of RES should be based on an estimation of the social avoided cost of conventional energy under a partial-equilibrium analysis.
- The electricity market is severely distorted (external costs tend not to be internalized). Market failures (externalities) generate differences between social and private cost curves in conventional energy
- In equilibrium $MSC_{Conventional} = MSC_{RES.}$
- Requires to estimate social supply curves for RES and conventional energy. Rather difficult to estimate but provide reference for fine-tuning policy options

Model & assumptions

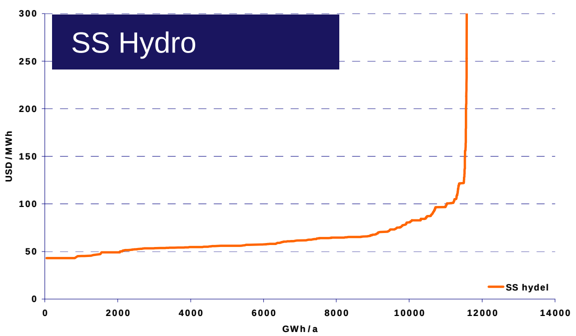
General assumptions of the model

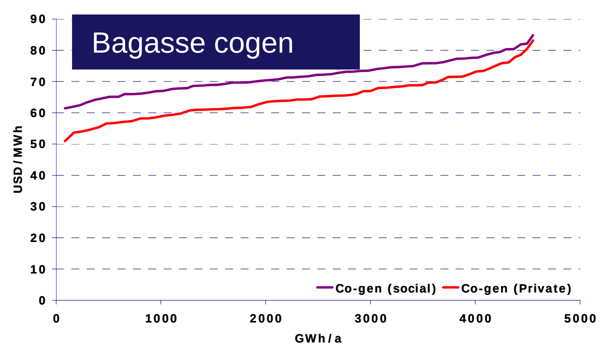
- **Target period:** medium to long term (10 to 20 years)
- **Incremental model approach:** the social and private supply curves for both RES and conventional energy are computed without considering the installed capacity in any particular type of energy. Incremental demand is considered.
- **Efficiency assessment:** Our model is mostly related to static efficiency assessment; therefore, we compute the supply curves employing current costs for different technologies. Can be extended to dynamic efficiency but increase uncertainty.
- **L**ong-term marginal costs assessment
- **Country's RES potential:** medium-term potential under the assumption that all existing barriers can be overcome and all driving forces are active
- **Monetization of externalities**: we considered (1) Global environmental costs, (2) Air quality, (3) Fuel dependency. RES externalities not considered
- **All matured RES technologies considered** (wind on-shore, biogases (most types), small hydro, solar PV and thermal, solid biomass, geothermal, WTE)

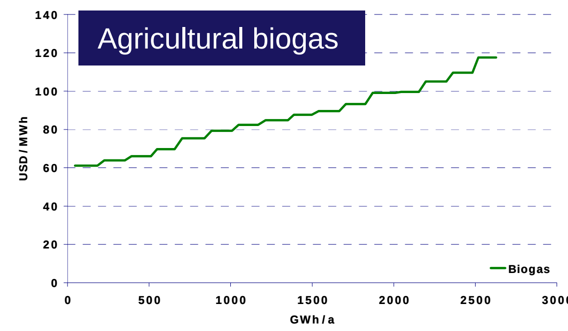
General assumptions of the model

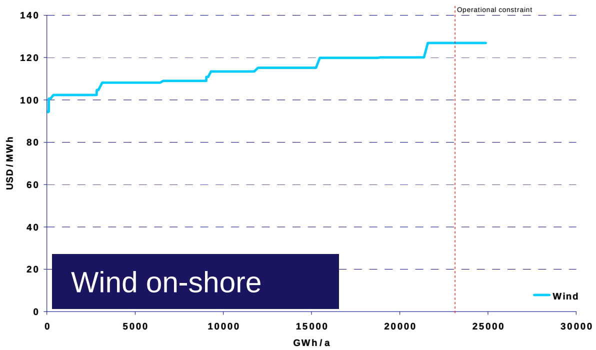
- **Supply curve assessment:** Two different approaches, depending on the quality of available information
  - Where information about potential and costs is good enough, curve based on detailed 'bottom-up' assessment
  - In all other cases, probabilistic cost approach by:
    - Simulating a large number of scenarios and combining values for different key parameters
    - Modelling each of the available technologies using different combination of values for key cost drivers: (1) investment costs; (2) fuel costs; (3) efficiency factors, and (4) load factors
    - O&M costs are assumed to be a fixed percentage of the investment costs
- **Grid and reserves costs:**
  - Grid investment costs are not included (installations less than 25 km from existing transmission lines)
  - The model does not consider the cost of backup reserves but constrain the amount of non-firm RES to install
- **Sensitivities to return on/of capital**

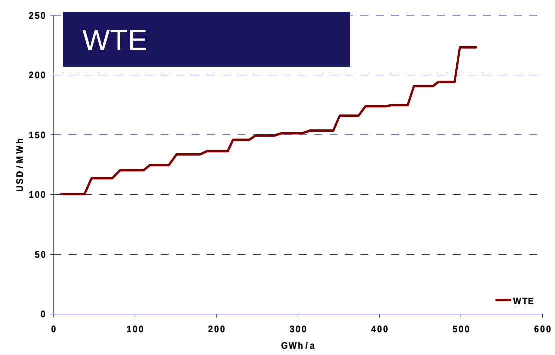
RES Supply curves simulation

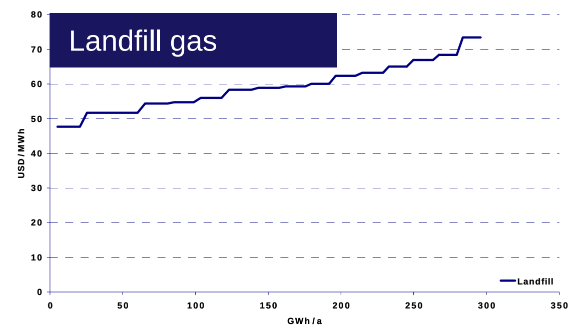


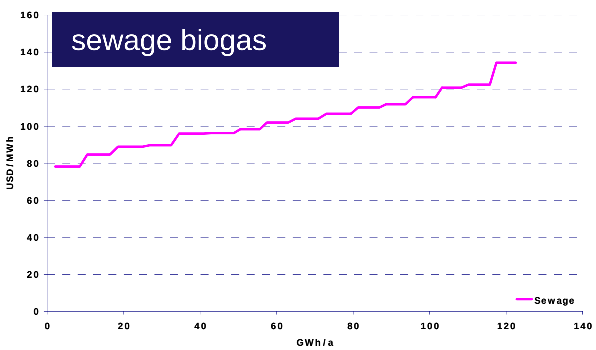


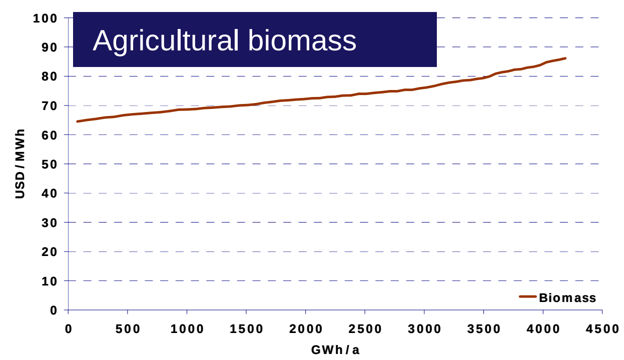


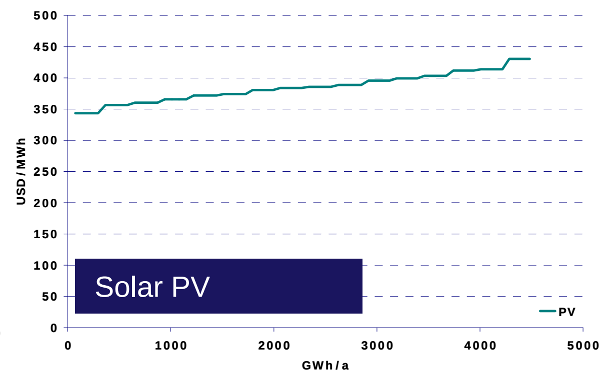




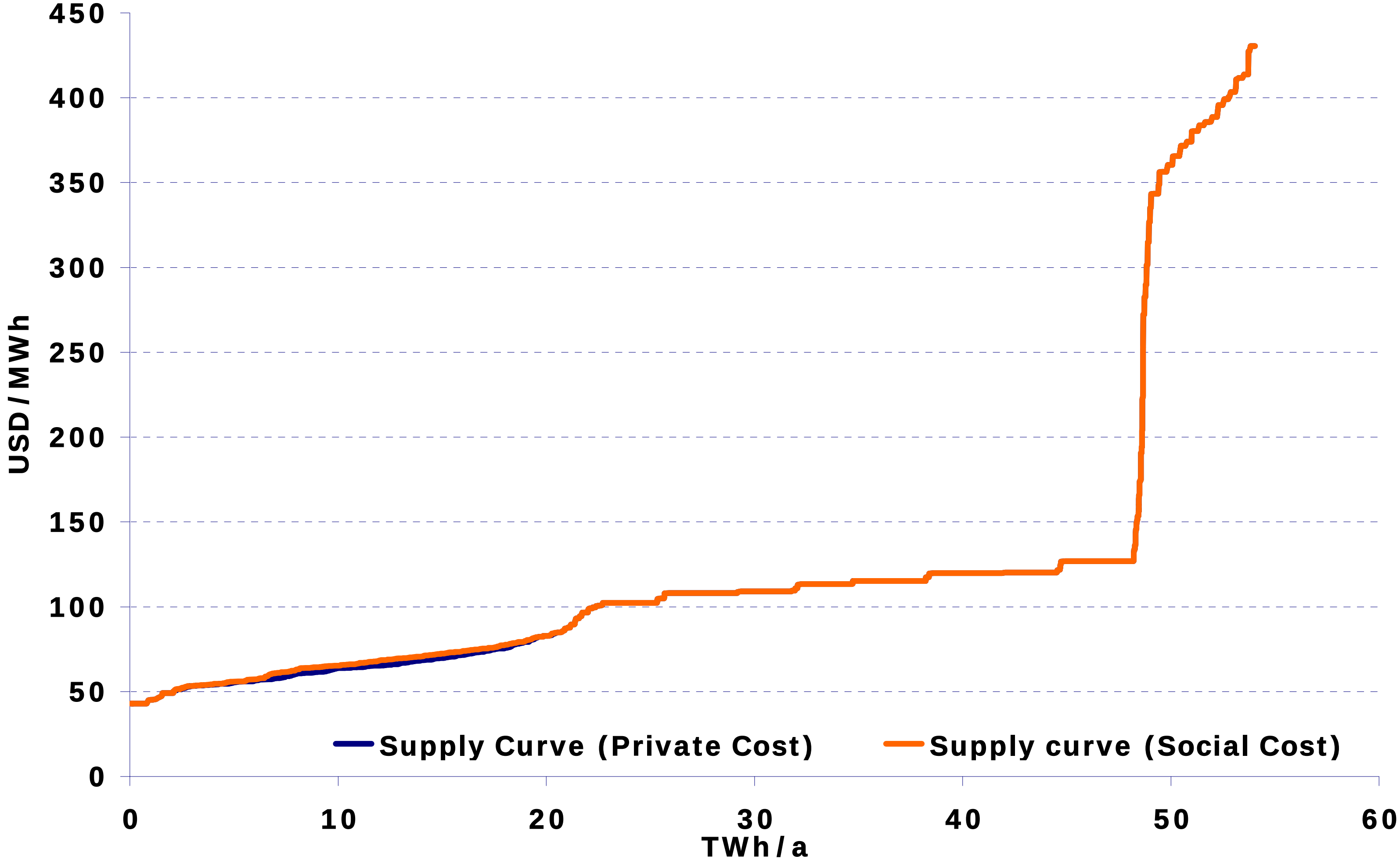








RES aggregated Supply curve simulation



Conventional energy Supply curve simulation

Technology-wise private cost of Conventional Generation - Expected Incremental generation 2008-2020

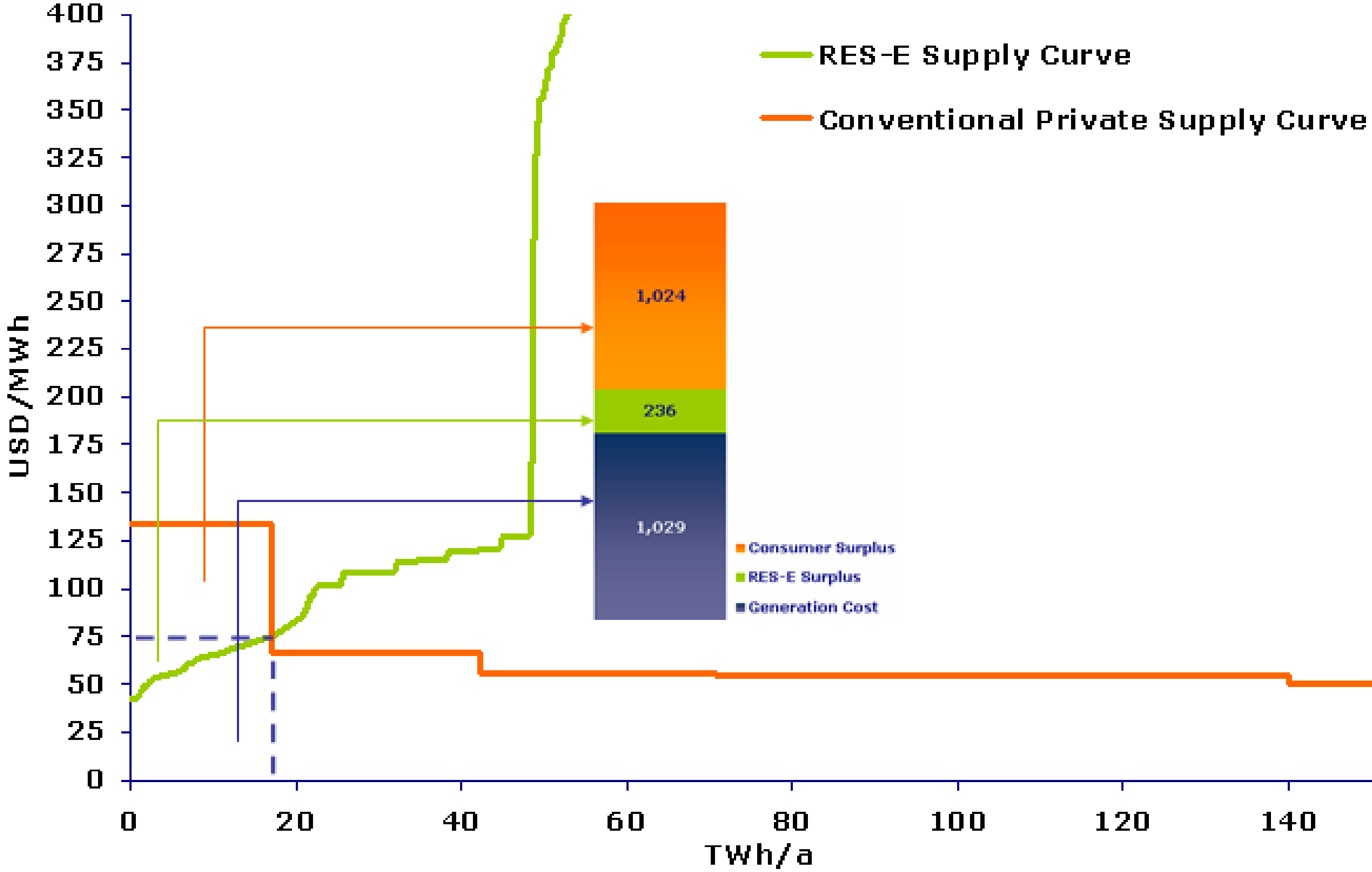
Generation Options	New CCGT Natural Gas	New CCGT Fuel Oil	Steam Turbine Local Coal	Large Hydel	Nuclear
Total Investment cost (USD/KW)	882	812	1,400	1,547	2,000
Thermal Efficiency (%)	50%	43%	38%		
Fuel Cost (USD/MMBtu)	6.29	13.77	2.75		
Capital Cost (USc/KWh)	1.79	1.64	2.48	5.01	3.33
O&M Cost (USc/KWh)	0.59	0.81	0.61	0.47	0.63
Fuel Cost (USc/KWh)	4.29	10.92	2.47	-	1.07
Total Generation Cost (USc/KWh) @12 %	**6.67**	**13.38**	**5.56**	**5.48**	**5.04**

Technology-wise Social Cost of conventional Generation

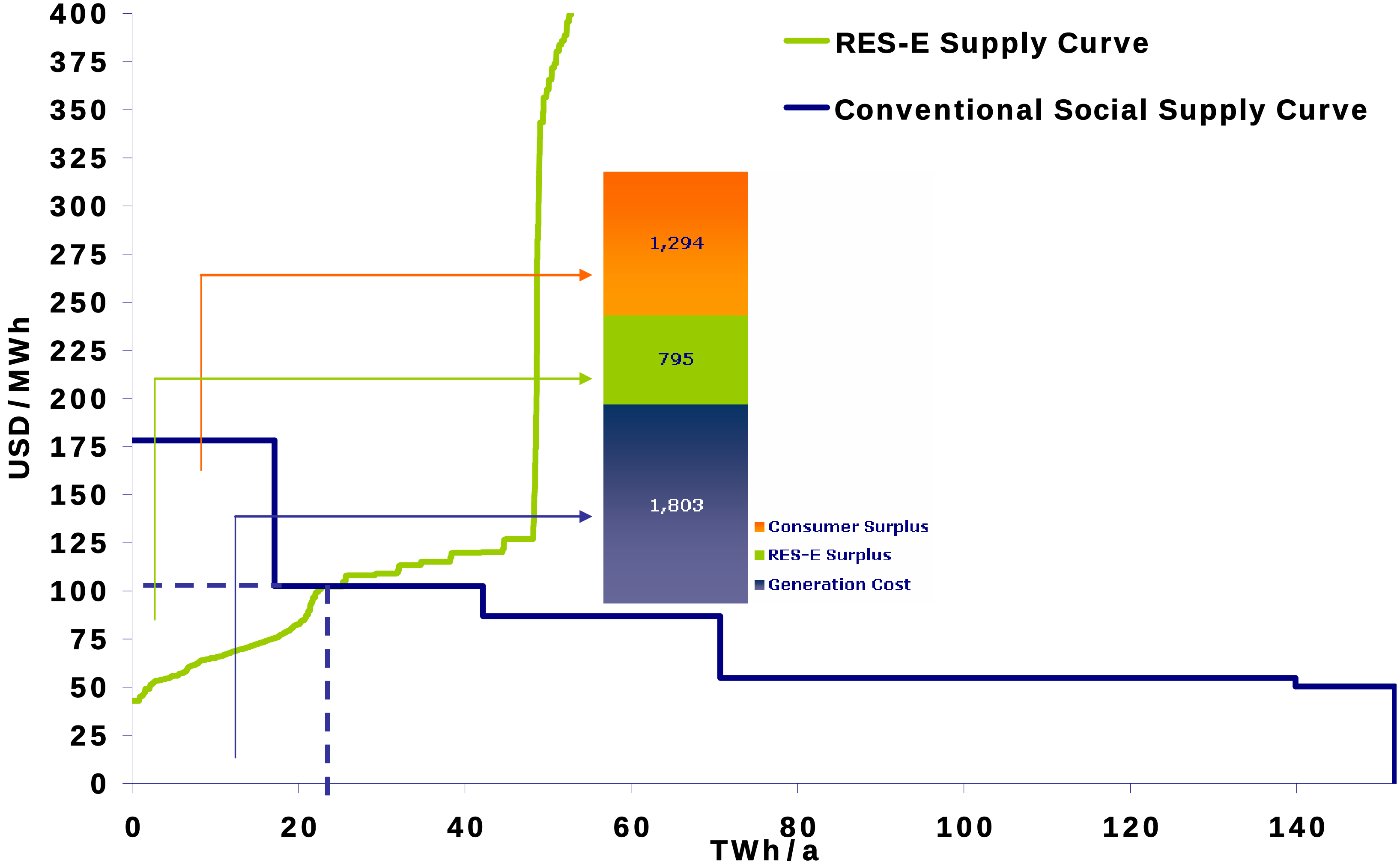
Generation Options	New CCGT Natural Gas	New CCGT Fuel Oil	Steam Turbine Local Coal	Large Hydel	Nuclear
Private generation cost (Usc/kWh)	6.67	13.38	5.56	5.48	5.04
C02 Ext. Cost (USc/kWh)	1.11	1.5	2.7		
Local Pollut. Ext. Cost (USc/kWh)	-	0.45	0.43		
Security of supply. Ext. Cost (Usc/kWh)	2.48	2.48			
Total Generation Cost (USc/KWh)	10.26	17.82	8.69	5.48	5.04

Oil price scenario: USD 90/bbl

Natural RES penetration by 2020

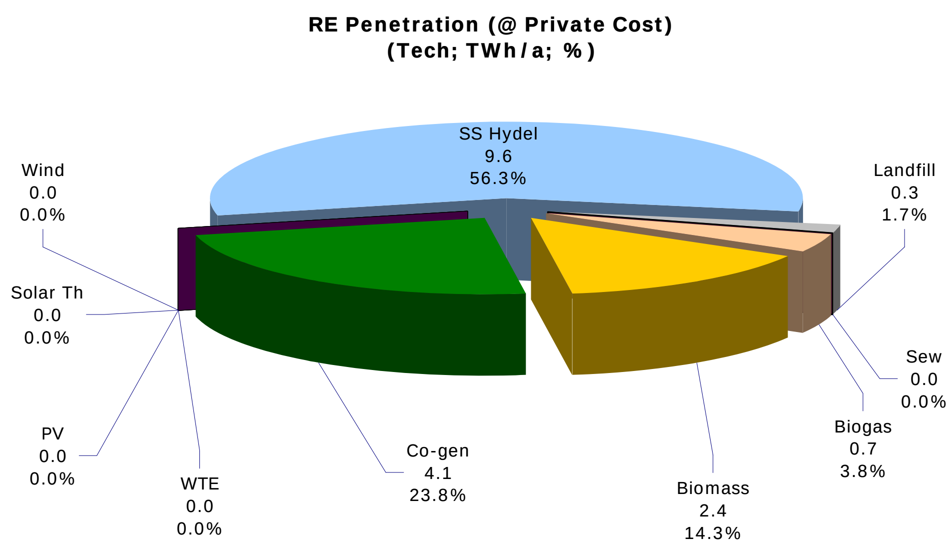


Optimal RES penetration by 2020

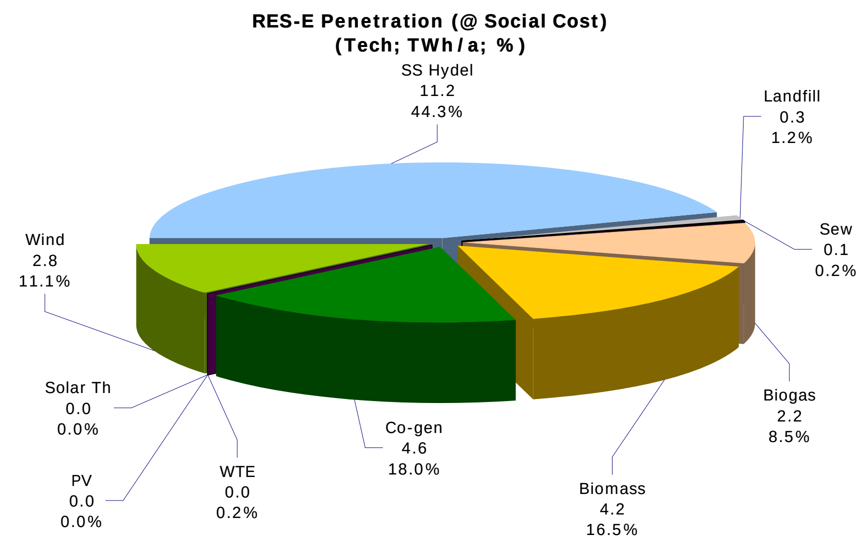


RES penetrations by type

Natural penetration



Optimal quota



The effects on Feed-in tariff mechanisms

Single feed-in tariffs:

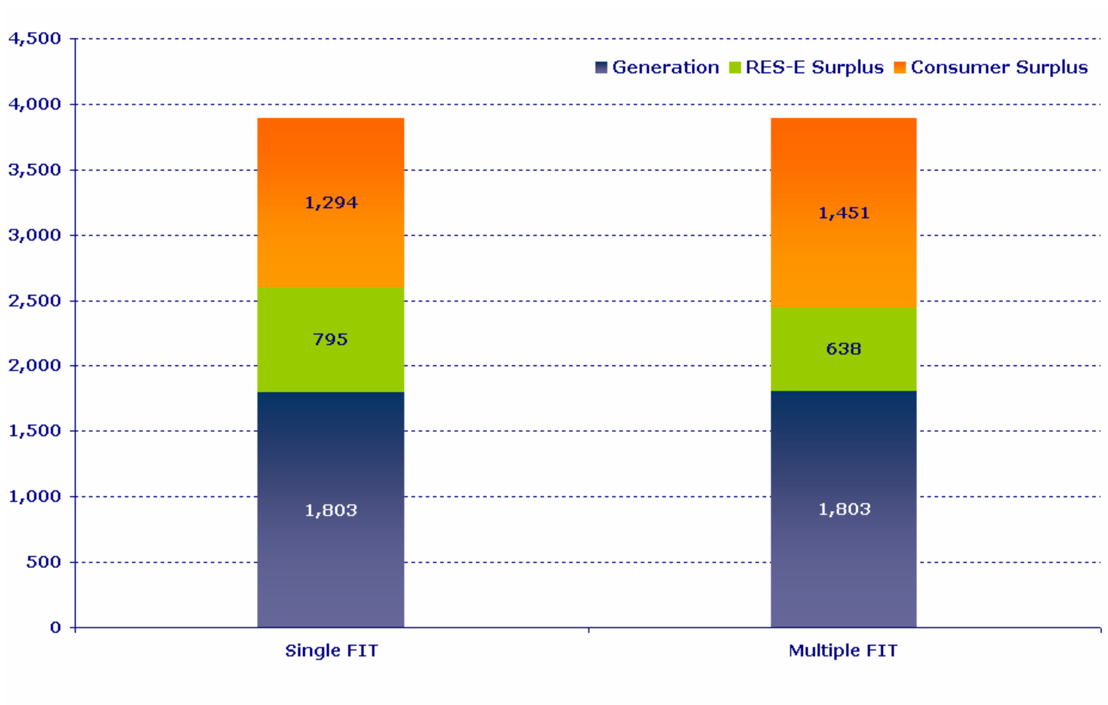
- Single FIT: USD 103/MWh
- RES-E quota: 10.3% of total generation in 2020
- Two mains drawbacks:
  - Single FIT does not foster the development of certain technologies (i.e., the more expensive ones)
  - Single FIT may generate high producers' surpluses
    - Multiple FITs tend to reduce the producers' surplus
    - A cost-plus approach maximizes the consumers' surplus (if no information asymmetries exist, which is unlikely)
    - Inframarginal rents exist in all markets (and are a natural incentive)

The effects on Feed-in tariff mechanisms

Multiple feed-in tariffs:

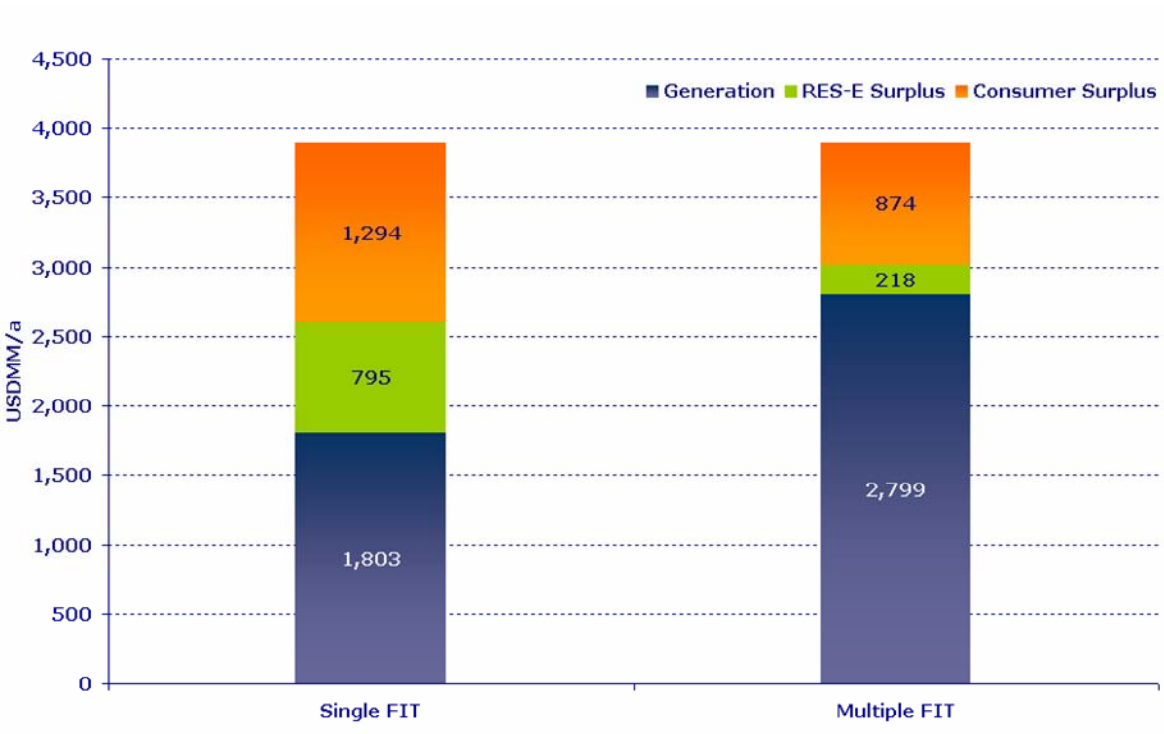
- Three different cases:
  - **Optimal quota-constrained analysis—cost-efficient case:** We assume the same technologies and penetration for each RES as under the optimal quota analysis
  - **Optimal quota-constrained analysis—industry policy-driven case:** Same penetration for RES-E, but all RES technologies are taken into account, including those that they do not qualify under the optimal quota analysis
  - **Exhausting the medium-term potential**
    - Except for the first case, the proposed alternatives are not cost-efficient and, hence, it can be expected that the total surplus will be lower in these cases

Optimal quota-constrained analysis—cost-efficient case:



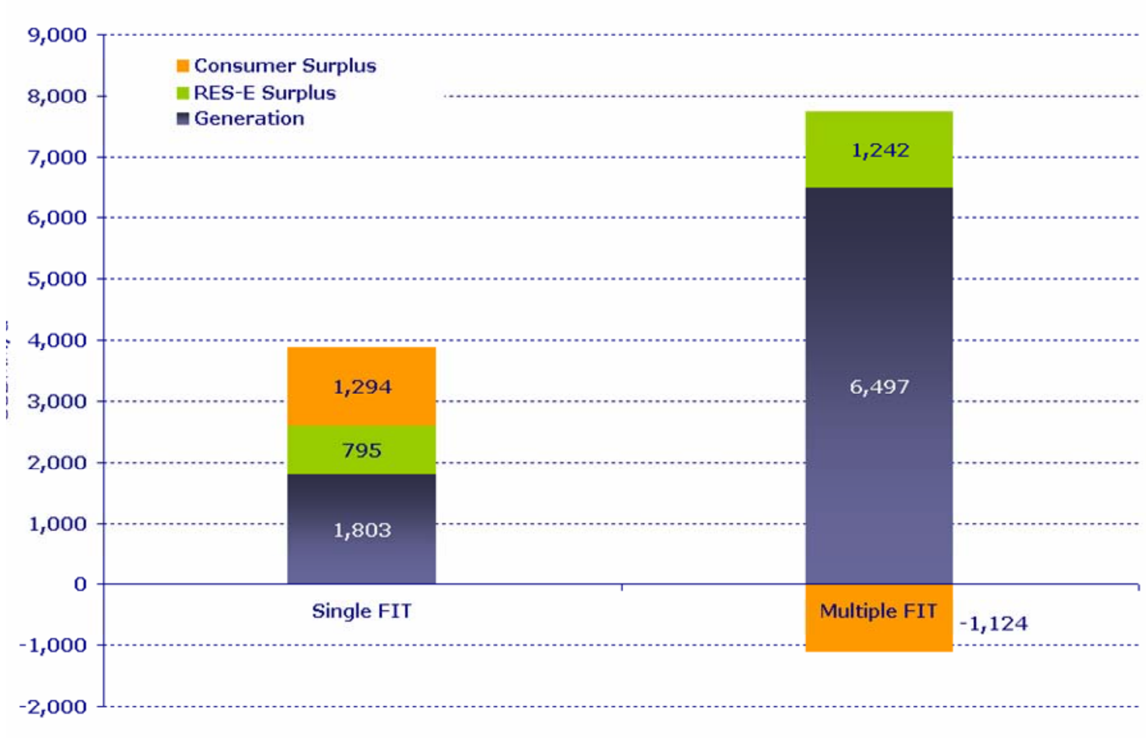
Feed-in Tariffs by RE technology (USD/MWh)	
FIT SSHydel	103.3
FIT Bagasse-based CHP	84.8
FIT Biomass	86.1
FIT Farm slurries biogas	99.6
FIT Sewage biogas	102
FIT Landfill Gas	73
FIT Waste-to-energy	100.3
FIT Wind energy	102.3

Optimal quota-constrained analysis—industry policy driven case:



Feed-in Tariffs by RE technology (USD/MWh)	
FIT SSHydel	54.1
FIT Bagasse-based CHP	68.8
FIT Biomass	69.7
FIT Farm slurries biogas	75.4
FIT Sewage biogas	96
FIT Landfill Gas	54.7
FIT Waste-to-energy	133.6
FIT Wind energy	109
FIT Solar thermal	371.7
FIT PV	326.8

Exhausting the medium-term potential



Feed-in Tariffs by RE technology (USD/MWh)	
FIT SSHydel	103.3
FIT Bagasse-based CHP	84.8
FIT Biomass	86.1
FIT Farm slurries biogas	117.5
FIT Sewage biogas	134.2
FIT Landfill Gas	73.4
FIT Waste-to-energy	223.2
FIT Wind energy	126.9
FIT Solar thermal	427.4
FIT PV	430.5

Final comments

Final Comments

- To perform this type of study, large amounts of data are needed, some of which is rather difficult to access and thus, results may be not extremely precise but help policymakers to ensure at least reaching the RES objective does not result in a waste of the society's resources
- In some cases analysed, we have seen that natural penetration of RES may be important. The fact that any capacity approaching this share is not currently being developed indicates that some strong barriers (administrative, regulatory, or financial) may exist, especially if we consider that the marginal cost of RES is cheaper than marginal conventional energy in many emerging countries.
- Policymaker should not only focus in new policies for providing more incentives for RES but also for addressing exiting barriers
- Optimal quota for RES uses to be higher than natural penetration because of the externalities. To develop that extra RES generation, an economic incentive mechanism needs to be put in place
- The benefit for society is maximized when the optimal quota is met and is supplied utilizing all RES generation cheaper than the avoided social cost of producing conventional energy.
- Some RES-E technologies, such as solar PV or solar thermal, are not as economically viable, given the current state of technology; therefore, in an optimal solution, they should be developed only for off-grid solutions.
- Multiple feed-in tariffs provide the optimal trade-off between allocation of surpluses and effectiveness

Thank you