Renewable Reserves Workshop

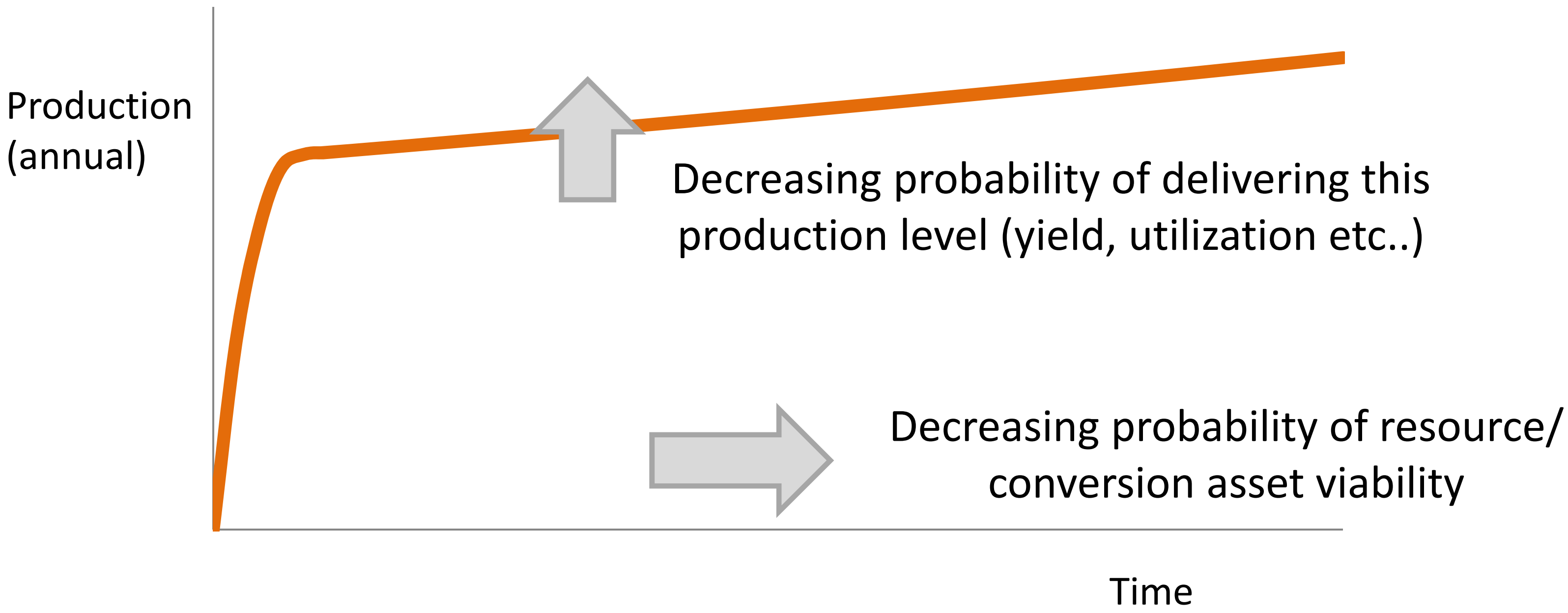
How could we apply a reserves methodology to Renewables ?

James Primrose

Session 6

October 31st 2012

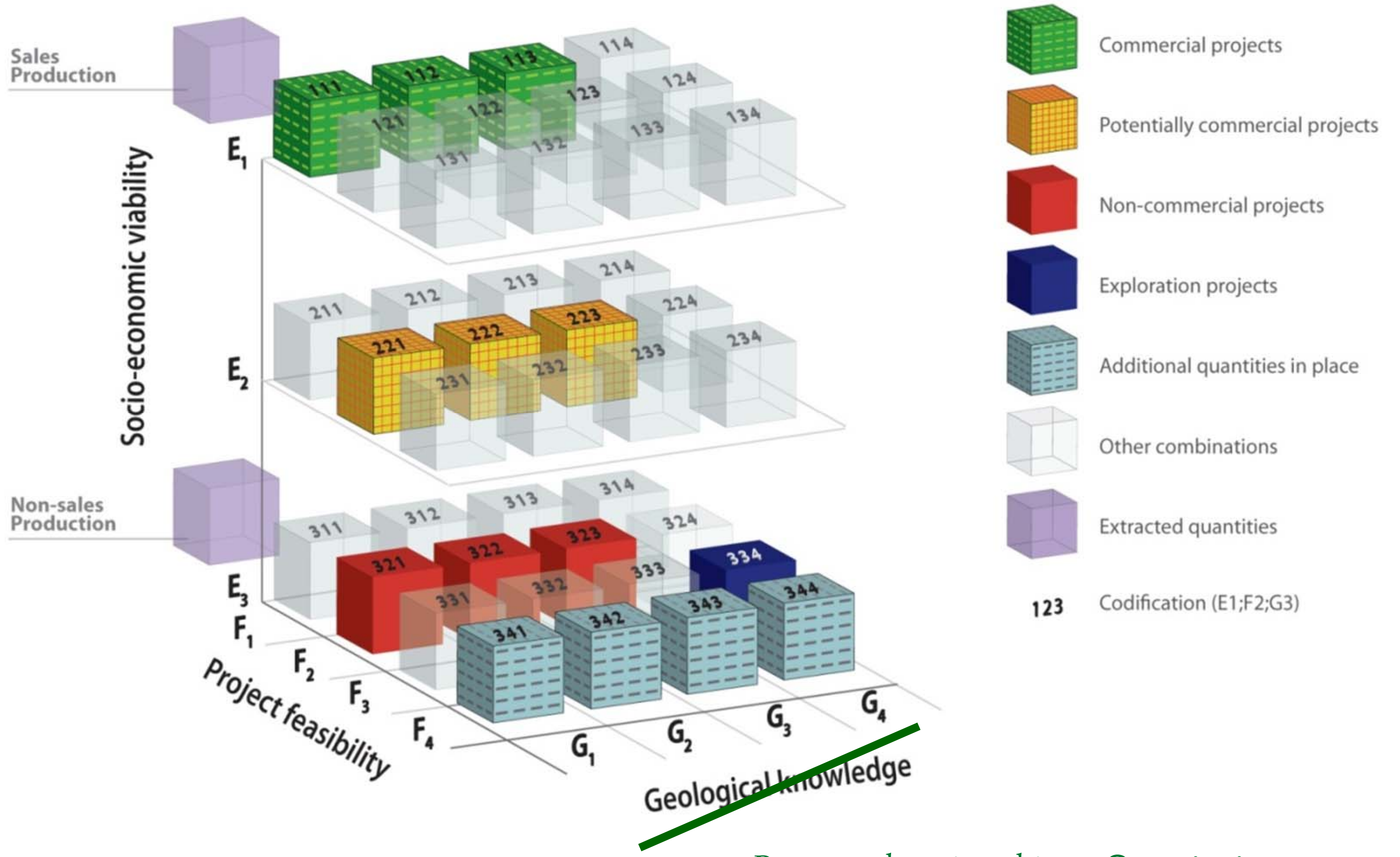
Renewable Projects <u>cannot</u> represent an expectation of infinite production potential – they must be bounded



- A renewable resource is almost wholly analogous to a conventional resource.
  - A conventional resource represents an expectation of ***energy in place*** that can be brought to market in the future.
  - A renewable energy resource represents an expectation of ***future energy production potential*** that can be brought to market.
- A renewable project's future production potential must be bounded by the same or similar constraints as an assessment of a conventional resource's energy in place.

How do we work with this ?

The UN reserve classification framework



Propose changing this to **Quantitative Uncertainty**

More simply, there are 3 main categories

- **Proved Reserves:** by analysis of technical and commercial data, can be estimated with reasonable certainty to be economically producible, from well understood resources, under existing economic conditions, operating methods, and government regulations.

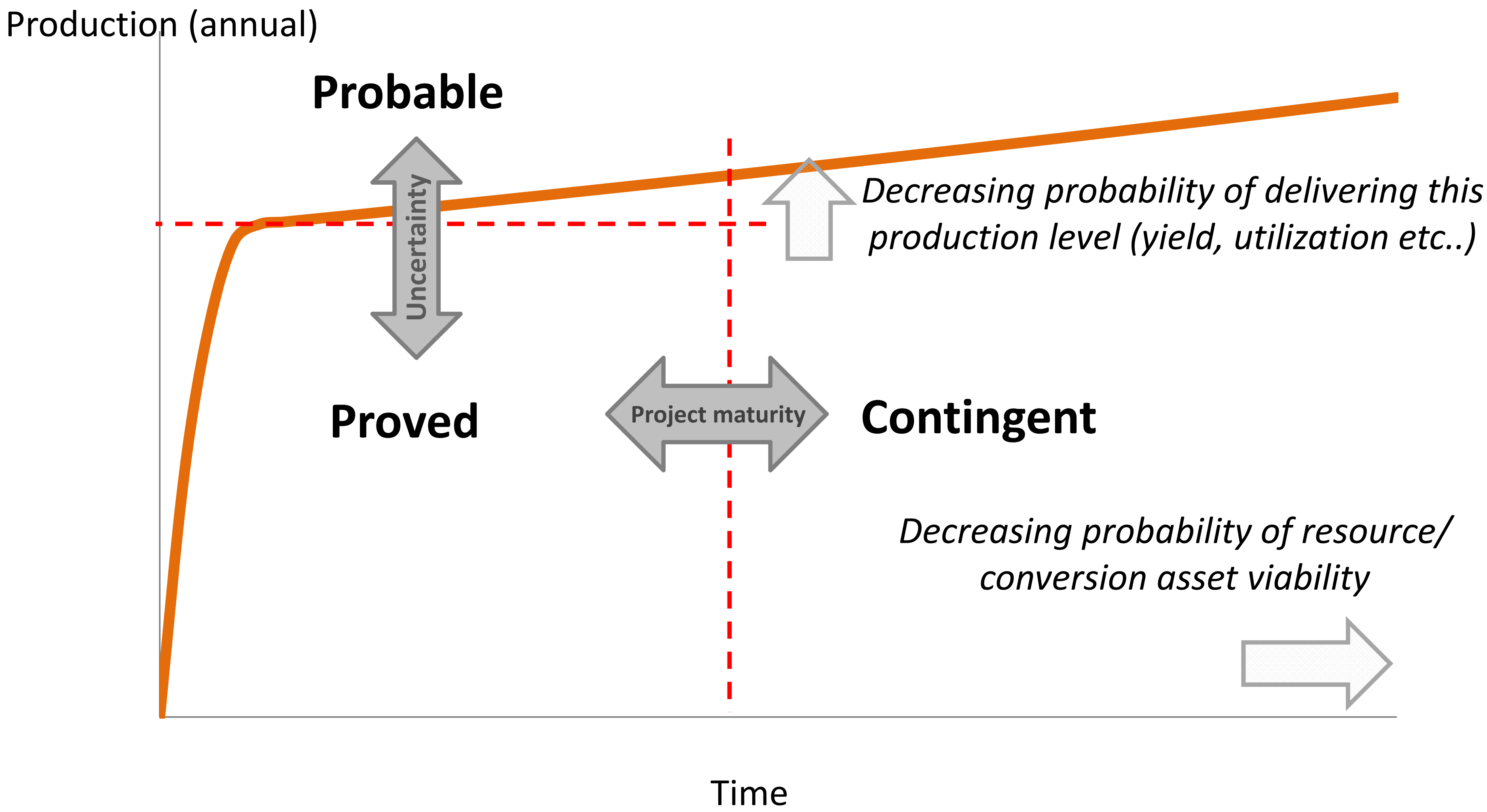
- **Probable Reserves:** incremental volumes which meet all criteria for classification as reserves, but less certain to be recovered than proved reserves.

- **Contingent:** remaining quantities anticipated to be exploitable, by application of development projects to discovered accumulations, but the development project does not have sufficient technical or commercial maturity to be considered as reserves.

Proved and Probable reserves are reported externally, and so are most important

Increasing **project maturity** moves projects from Contingent to Proved
Decreasing **uncertainty** moves projects from Probable to Proved

We can match these terms to a Renewable Project



- Clearly for credibility a Renewable Reserve Methodology must be as consistent as possible with the existing approach.

Project Maturity is defined by Technical and Commercial criteria

Technical maturity is a detailed set of requirements for each technical area, and is highly specific to the resource

	Proved Reserves	Reserves	Penetrated Resources	Unpenetrated Resources
Reservoir Container	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx
Hydro-carbon Column	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx
Reservoir Properties	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx
Reservoir Fluids	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx
Defined Reservoir Area	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx
Economic Produc-ibility	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx
Recovery Factor	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx
Wells & Facilities	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx	• Xxxxxxxxx • Xxxxxxxxx • xxxxxxxxx

Commercial maturity involves more generic factors, which are easier to translate to renewables

Access & Entitlement

- Right to exploit, entitlement & economic benefit
- Time period for concession / licence / PSC

Market & Sales Connectivity

- Physical capacity in infrastructure; export facilities
- Contractual agreements

Authorisation & Commitment

- Intent to develop / Management approval
- Government Intent

Economic Case Validation

- Economic model demonstrating commerciality
- Prod., capital and opex aligned; supportable trends

- The **Commercial Criteria** appear to be the key determining criteria for renewables

Uncertainty delineates between Proved and Probable Reserves

- Quantitative uncertainty typically covers uncertainty on the quantity of energy that a project will produce or be able to sell
- The level of uncertainty determines whether the reserve is **Proven** or **Probable**

	Biofuels	**Wind power**	**Solar power**
Uncertainty nature	• Biomass yield •Feedstock quality •Conversion yield •Product price	• Wind speed patterns • Power sold • Power Price/Market	• Sun irradiation • Cloud cover •Power Price/Market
Uncertainty range **(P90, P50, P10)**	Yield, e.g. sugarcane 75 (P90)–90 (P10) t/ha	Net capacity factor 25% (P90)–40% (P10)	Net capacity factor 10% (P90) –20% (P10)
Evidence for data used	• Historical yields • Crop proxies •Agronomic projections/modeling	Upfront on-site wind speed measurements Utilization factors	Upfront on-site solar irradiation measurements Utilization Factors

So what is the required evidence base ?

- The assessment is done at a **project** level, e.g.
  - A new wind farm, PV array, or biofuels plant
  - A change to an existing asset requiring major investment

- The assessment is done for a specific time-point e.g. at sanction or during operating life. Evidence must be consistent with that time-point.

- Evidence can either be **Deterministic** or **Probabilistic**.
  - Deterministic evidence are technical data/evidence that backs up forward assumptions.
  - Probabilistic evidence involves the use of various stochastic modelling techniques to support assumptions.

- An **Investment Case or Operating Plan** is a key element within the evidence base.

The Commercial Criteria in more detail (1)

- **Resource Access and Entitlement** - demonstration of exposure to the resource risk. The entity booking the reserves would need to
  1. **Own the relevant land /resource**, or
  2. **Lease the land/resource**. Proved reserves would initially be limited to the length of the lease. Renewals could be proved or probable depending on the strength of the evidence.

- **Market and Sales Connectivity** - conversion technology and infrastructure in place to produce the energy product. Demonstration of exposure to the conversion risk.

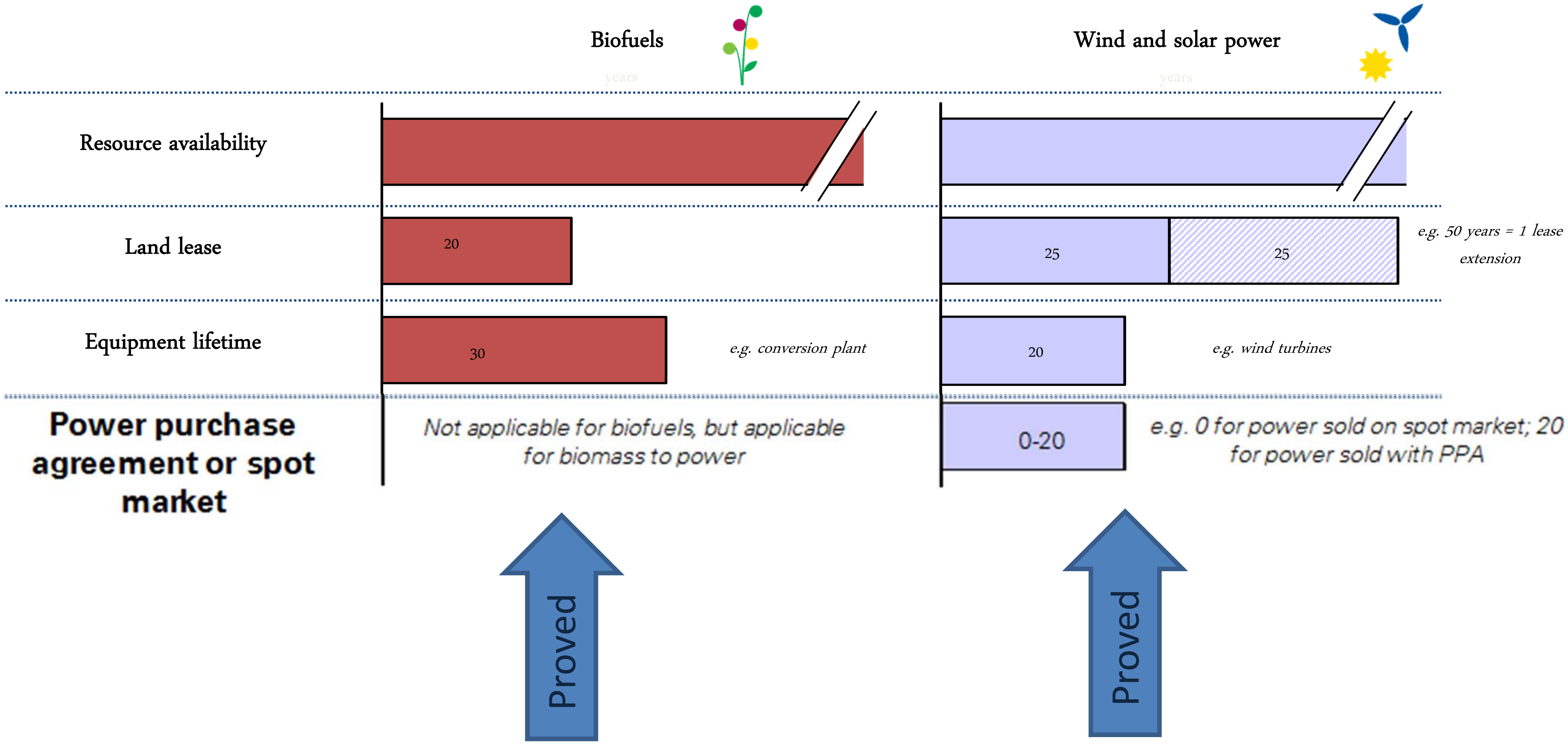
  The entity booking the reserve would need to
  1. **Own the relevant conversion asset**, or
  2. **Have a toll manufacturing agreement (Bioenergy specific) in place.**

The entity also needs to establish for how long the connectivity will exist

- The asset's **techno-economic lifetime** could be a suitable boundary for **Proved Reserves.**
- Extension beyond **Proved Reserves**, e.g. **Contingent** requires a suitable cut-off, either a plant lifetime or multiple or a set number of years?

Access and Entitlement and Market Connectivity must be demonstrated simultaneously

The lifetime of the reserve will be set by all of the factors together, not the technology lifetime alone



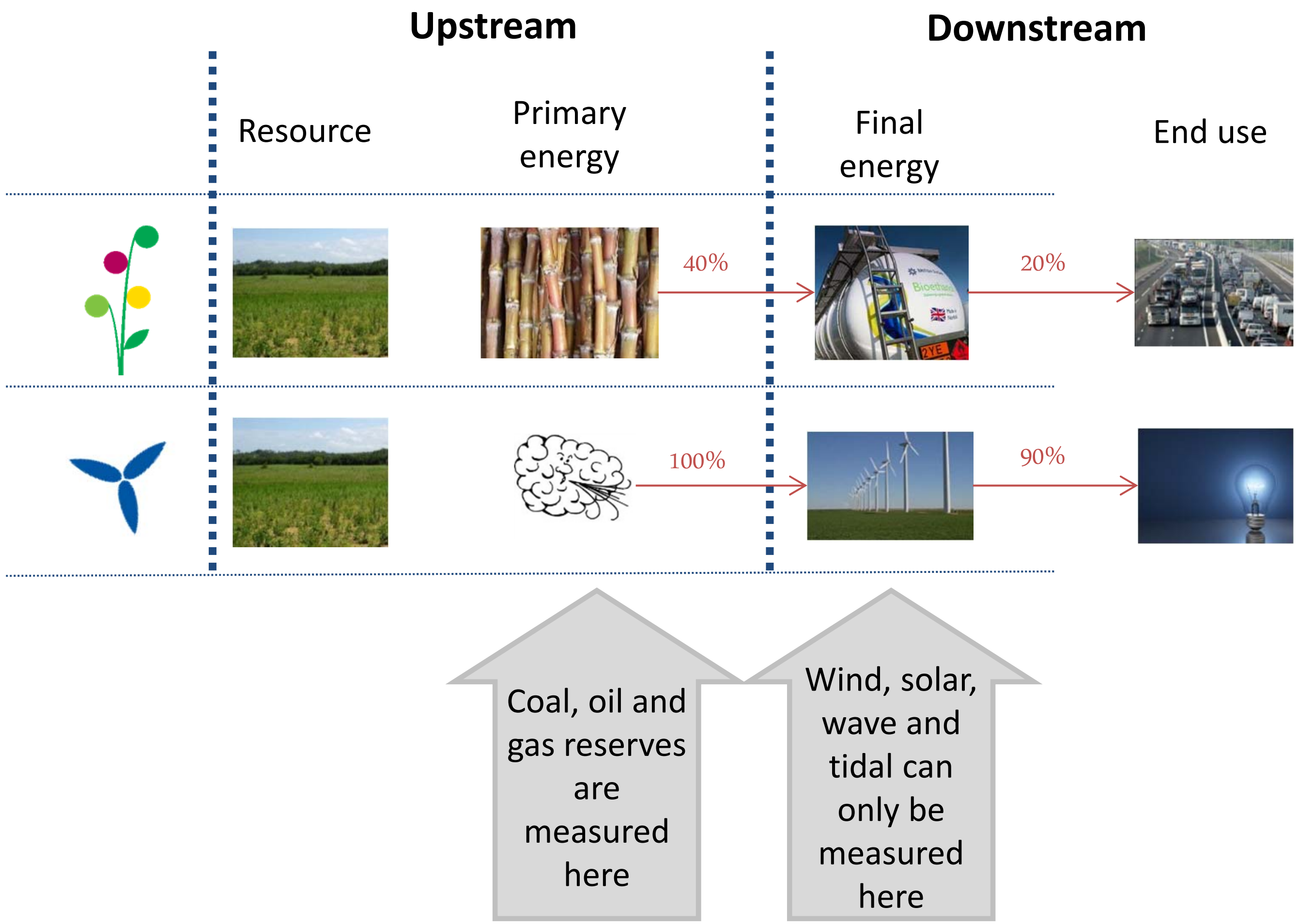
The Commercial Criteria in more detail (2)

- **Authorisation and commitment:**
  - Approval /sanction from the asset owner (or all JV partners)
  - All necessary consents and permits for the asset and the associated infrastructure

- **Economic case validation**
  - Economic model demonstrating commerciality, based on robust assumptions on capex, opex, sales price of energy product etc
  - Can include policy support, e.g. feed in tariffs – but this is valid only for the lifetime of the policy

What is the appropriate point of measurement ?

- Do we measure primary energy in, or final energy out?



Factors to consider:

- For wind and solar, **final energy** is the only meaningful basis
- Should we maintain consistency across RE types? Or with fossil fuels, which are measured in primary energy?

Recommendation:

Final energy out may be a more credible, transparent basis.

Who can book the resource?

Options

- A prescriptive approach? – decide whether it should be the resource owner or the conversion asset owner
- An evidence based approach? - the entity that can demonstrate both resource entitlement/access and market connectivity.

Some Considerations:

- Would a single prescriptive approach work under all circumstances ?
- Would an evidence based approach be better suited to deal with wide variety of business models present in the Renewable Energy Sector ?
- An evidence based approach would be more likely to be consistent with the Technical and Commercial criteria.
- How can multiple booking by different entities be avoided ?

Recommendation

An evidence based approach, but mechanism to avoid multiple booking is required.

In what units should Renewable Reserves be expressed?

Options

- Straight final energy / volume terms (MWh, bbls, m^3) and/or
- In terms of energy equivalence with other types of energy (barrels/tonnes of oil equivalent)? This requires conversion factors to be agreed

Some Considerations:

- Need for common units to allow comparison with conventional equivalents and across renewable energy sectors?
- Require a clear, objective and defensible approach.
- Definition would be captured in UNFC conversion document for all renewables.

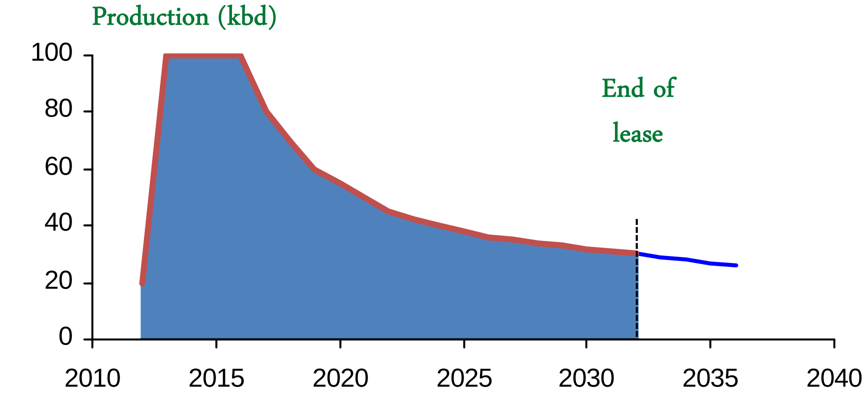
Recommendation

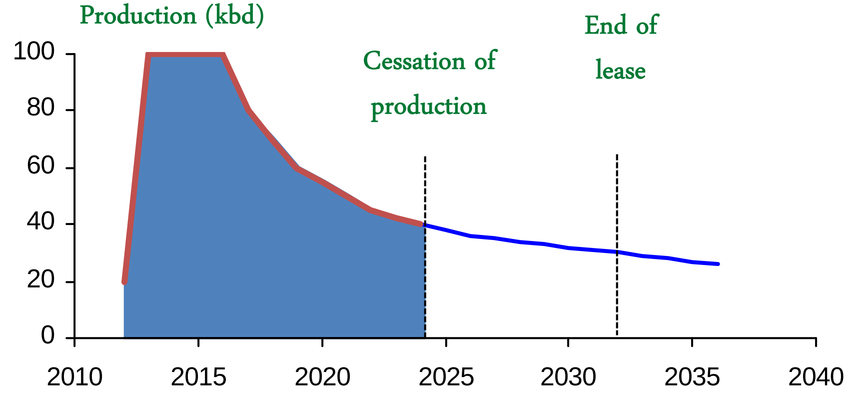
- Start discussion, but park agreement for conversation on conversion document

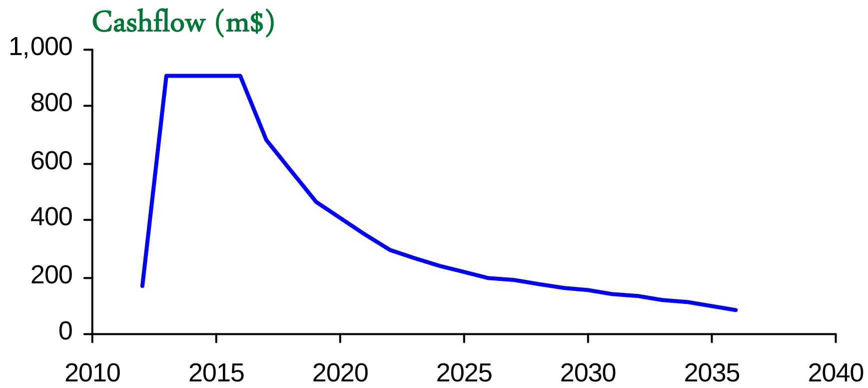
To summarise..

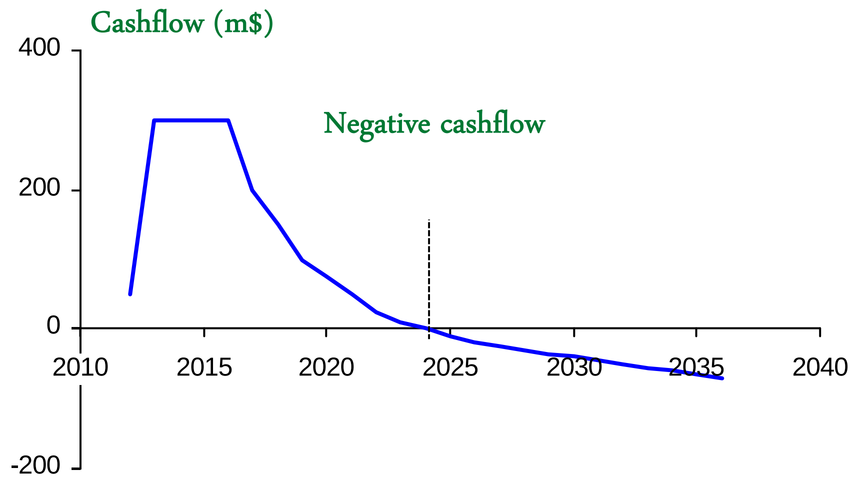
- RE projects can be characterised as Proved, Probable and Contingent.
- Renewables could use analogous technical and commercial criteria to those for conventional reserves.
- Challenges remaining:
  1) Test the approach against real-world RE business models.
  2) Develop a more detailed understanding of the criteria as applied to RE.

Illustration of how price can affect reserves









At **$100/bbl**, cashflow remains positive year on year, so reserves equal sum of production until end of lease

At **$50/bbl**, cashflow becomes negative in 2024; so reserves can only be the sum of production until 2024

The method for determining the price to use vary between technologies

	Biofuels	Wind and solar power	
'Price' / Contract options	High Liquidity. Regional price quotations. Spot and short-term contracts Term contracts typically priced off spot quotations	Local power price (PPA or spot market) + subsidies (e.g. FIT or PTC) PPA 5 – 20 yrs Significant differences can exist between spot and contract prices.	Levelised cost of electricity by technology
Pros	High price / evaluation transparency	• No fluctuation (PPA and FIT) • Small fluctuation (spot and RPS)	• Less subject to local variations • Commonly used methodology
Cons	High volatility / future uncertainty (similar to fossil fuels)	• Prices local and regulated • Not 1 price for all • Lack of clarity of appropriate price to use.	• Underestimate compared to power price • Changes over time with learning
Accounting solutions	• Past average price • Price on 31 Dec (SPE)	Past average local power price (but spot or contract ?)	Current or future levelised cost

Note: In oil and gas, price has direct impact on reserves because it dictates the COP (Cessation of Production); the higher the oil price, the bigger the reserve

Examples of accounting methods used to compare energy sources

	Eurostat/IEA methodology	Substitution methodology
	Primary energy value of power calculated assuming a conversion efficiency factor of 100% for wind and solar power, so primary energy value of 1MWh = 1MWh equivalent	Primary energy value of wind and solar power calculated based on the fossil fuel energy required to produce an equivalent amount of power
Purpose	• Statistical bookkeeping • Political discussions on energy targets	Compares different energy resources or projects at different points in the energy system
Pros	• Straightforward bookkeeping • No conversion to apply for solar and wind because conversion factor 100%	• Compares like for like because of substitution approach • Use of universal conversion factor for fossil fuels to power (38%) simplifies accounting • Widely used (e.g. BP Statistical Review, Shell, REN21)
Cons	• Conversion factor of 100% does not result in a "fair" picture (e.g. 10% for geoth, 33% nuclear) • Does not compare like to like, comparison at different points in the energy system with no conversion • Overvalue upstream energy carriers and undervalue downstream carriers	• Challenging for accounting • No unanimity on conversion factor • Abandoned by Eurostat and IEA