

# Application of UNFC-2009 to Geothermal Energy Resources

Presented by **Ussher & Grant** on behalf of the Task Force  
on the Application of the UNFC-2009 to Renewable Energy  
and the IGA Resources and Reserves Committee



## *“United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources”*

- **Generic, principles-based classification system**

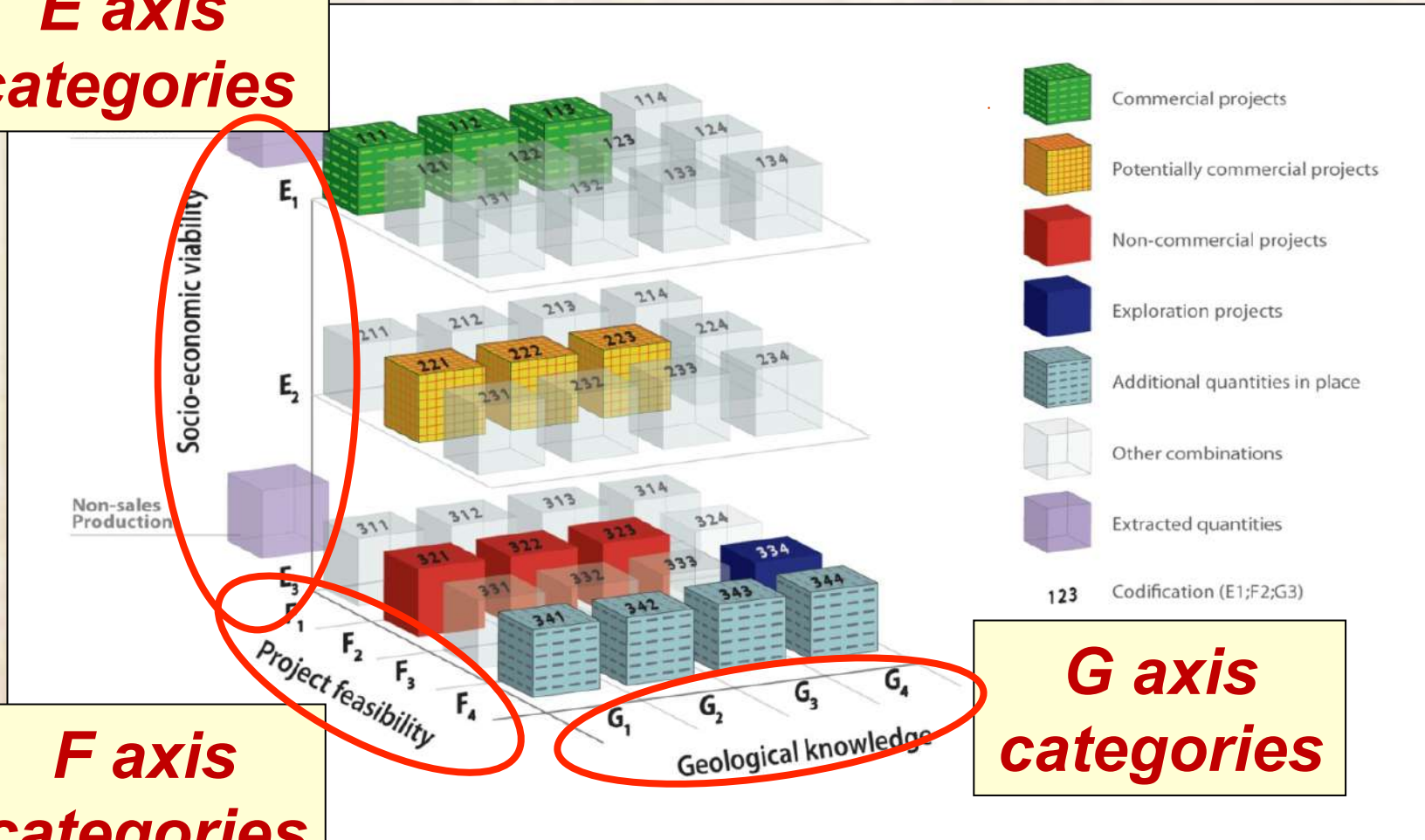
- Now applicable to solid minerals, fossil energy, renewables (geothermal energy) and injection projects

- **Based on three criteria**

- ‘**E axis**’ (*degree of favorability of social and economic conditions for establishing commercial viability of project*)
- ‘**F axis**’ (*maturity of studies and commitments necessary to implement project*)
- ‘**G axis**’ (*level of confidence in the estimate of potentially recoverable quantities*)

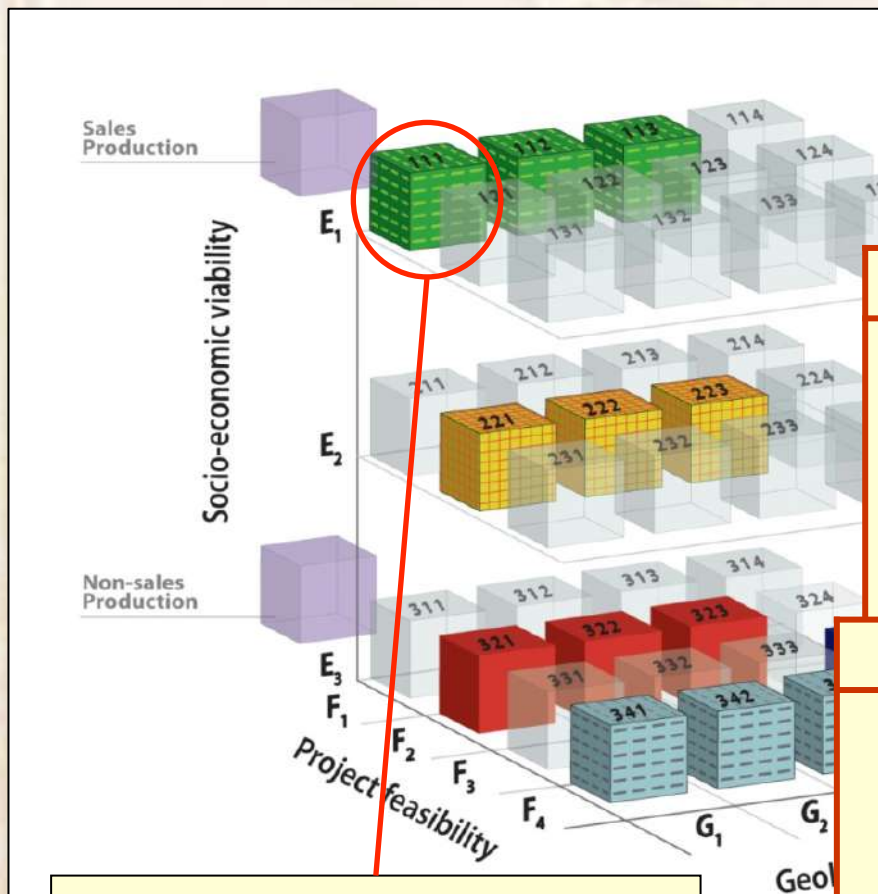


**E axis categories**



**F axis categories**

**G axis categories**



**UNFC Class: 111**

| Category  | Definition  |
|-----------|---|
| <b>E1</b> | Extraction and sale has been confirmed to be economically viable. |

| Category  | Definition   |
|-----------|--|
| <b>F1</b> | Feasibility of extraction by a defined development project or mining operation has been confirmed. |

| Category  | Definition  |
|-----------|---|
| <b>G1</b> | Quantities associated with a known deposit that can be estimated with a high level of confidence. |

## UNFC-2009

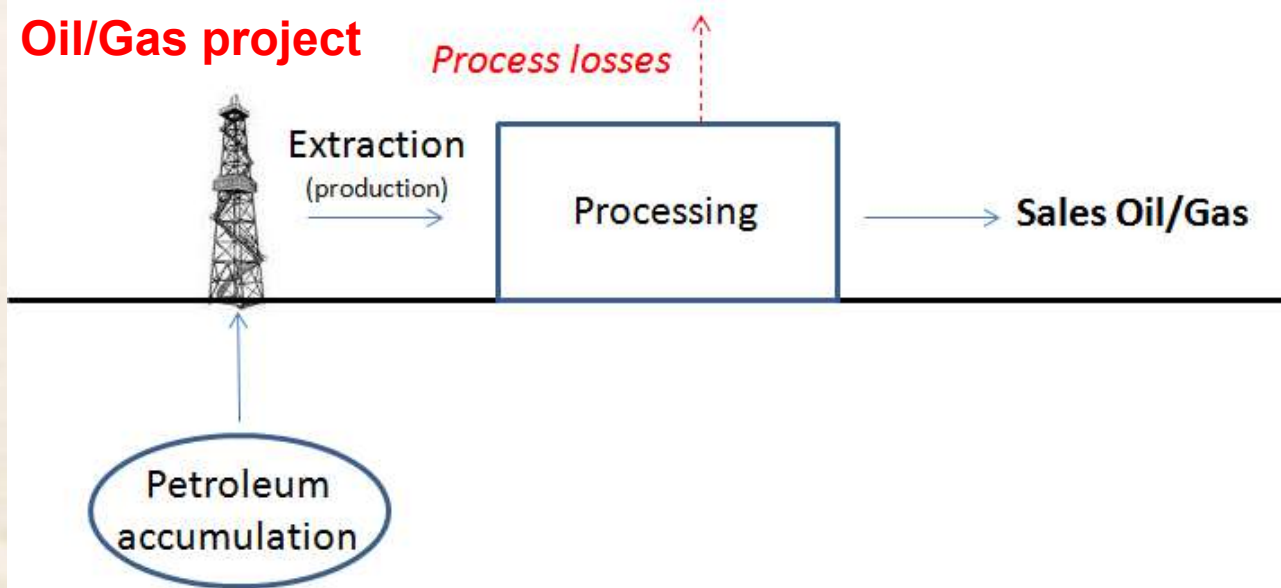
## PRMS

## CRIRSCO

|   |  |                              |                            |
|---|--|------------------------------|----------------------------|
| <b>Total commodity initially in place</b> | <b>Sales Production</b>                | <b>Production</b>            | <b>Extracted</b>           |
|   | <b>Non-sales Production</b>            |                              |                            |
|   | <u><b>Class</b></u>                    | <u><b>Class</b></u>          | <u><b>Class</b></u>        |
|   | <b>Commercial Projects</b>             | <b>Reserves</b>              | <b>Mineral Reserves</b>    |
|   | <b>Potentially Commercial Projects</b> | <b>Contingent Resources</b>  | <b>Mineral Resources</b>   |
|   | <b>Non-Commercial Projects</b>         |                              | Not reported               |
|   | Additional quantities in place         | Unrecoverable                | Not reported               |
|   | <b>Exploration Projects</b>            | <b>Prospective Resources</b> | <b>Exploration Results</b> |
|   | Additional quantities in place         | Unrecoverable                | Not reported               |

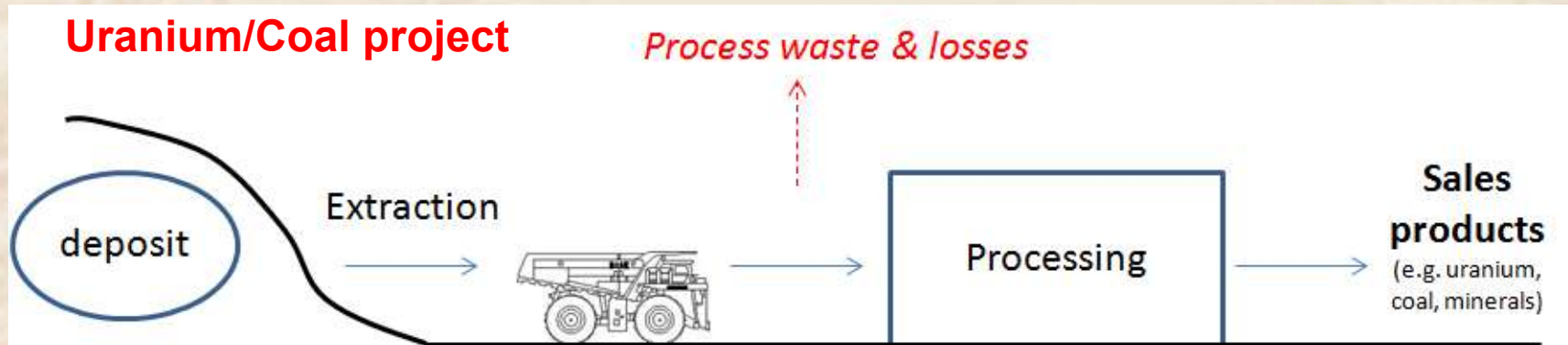


## Oil/Gas project



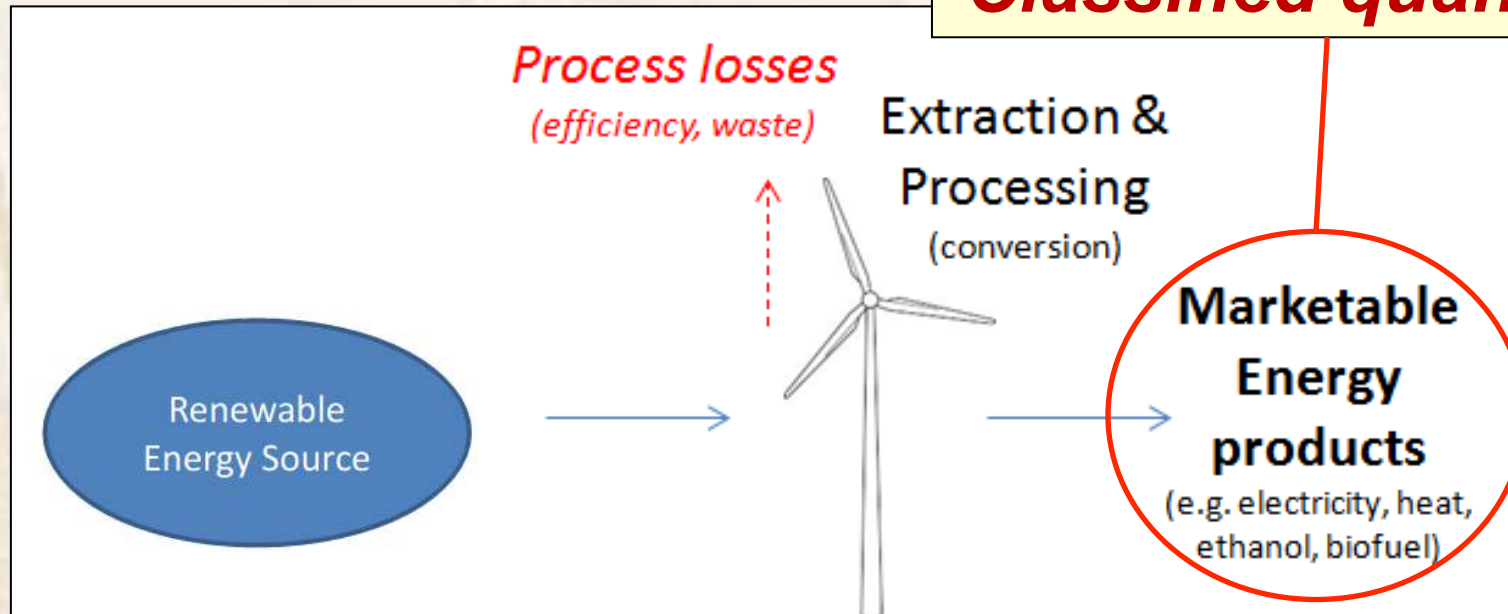
A **Project** is the level at which a decision is made on whether or not to proceed (i.e. spend money or not.)

## Uranium/Coal project





## Classified quantities



A **Project** is the link between the Renewable Energy Source and marketable quantities of Energy Products.

A **Project** provides the basis for economic evaluation and decision-making.



- Known versus Potential Geothermal Energy Sources
  - Critical distinction between Drilled (and tested to be productive)
    - [G1, G2, G3]
  - Or NOT
    - [G4 or G4.1, G4.2, G4.3]
- Probability of Discovery
  - For Potential Geothermal Energy Sources reported using the ‘G’ category G4 or its sub-categories G4.1, G4.2 and G4.3, the Probability of Discovery should also be reported.
  - This probability is the chance that further exploration, drilling and well testing will result in the confirmation of a Known Geothermal Energy Source.
    - temperature, permeability and fluid chemistry or other relevant parameters that are important for the type of energy extraction planned.
  - The quantities reported in the ‘G’ category G4 or its sub-categories G4.1, G4.2 and G4.3 are ‘un-risked’
    - they are the quantities that may be expected to be reported for the project once Known, regardless of the level of Probability of Discovery





- The IGA and the UNECE signed an MoU on 19 Sept 2014 to develop a globally applicable harmonized standard for reporting Geothermal Energy Resources.
  - [http://www.unece.org/fileadmin/DAM/oes/MOU/2014/MoU-UNECE\\_IGA.pdf](http://www.unece.org/fileadmin/DAM/oes/MOU/2014/MoU-UNECE_IGA.pdf)
- The IGA appointed a voluntary Working Group on 15 Jan 2015 to draft ‘Geothermal Specifications’ for the UNFC.
- Subsequent 20-month period of teleconferences, drafting, workshops, presentations, white papers, expert reviews, public comments and refinement of the documents.
- The UNECE Committee on Sustainable Energy endorsed the Geothermal Specifications on 30 Sept 2016.

| <b>Name</b>         | <b>Country of residence</b> | <b>Affiliation</b>                              |
|---------------------|-----------------------------|---|
| Gioia Falcone       | Germany                     | (*)TU Claustal (representing UNECE and IGA R&R) |
| Miklos Antics       | France                      | GPC IP/Geofluid (endorsed by EGEC)              |
| Roy Baria           | UK                          | Mil-Tech UK Ltd.                                |
| Larry Bayrante      | Philippines                 | Energy Development Corporation                  |
| Paolo Conti         | Italy                       | University of Pisa (endorsed by UGI)            |
| Malcolm Grant       | New Zealand                 | MAGAK (endorsed by NZGA)                        |
| Robert Hogarth      | Australia                   | Hogarth Energy Resources                        |
| Egill Juliusson     | Iceland                     | Landsvirkjun                                    |
| Harmen F. Mijnlieff | Netherlands                 | TNO (endorsed by Dutch Geothermal Platform)     |
| Annamaria Nádor     | Hungary                     | Geological and Geophysical Institute of Hungary |
| Greg Ussher         | New Zealand                 | Jacobs  |
| Kate Young          | USA                         | National Renewable Energy Laboratory            |

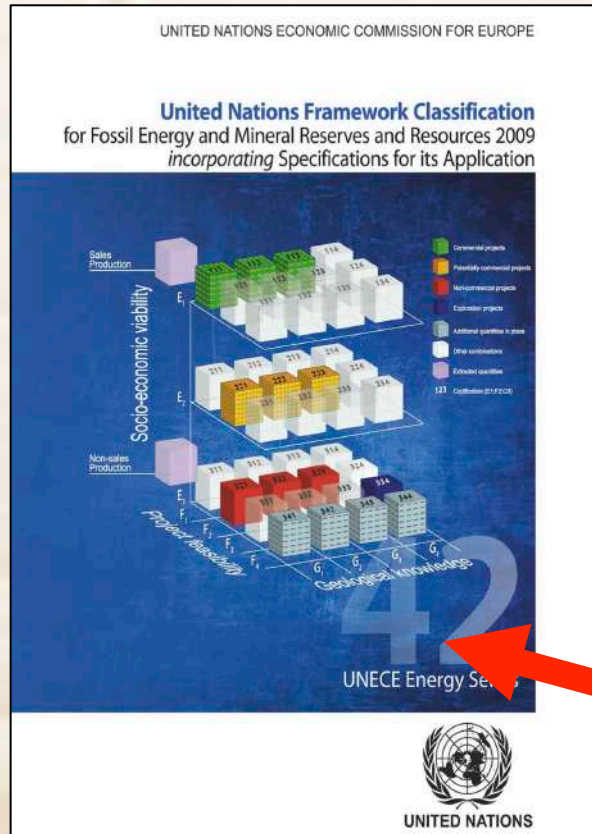
(\*) Now at Cranfield University, UK

**Observers:** Graeme Beardsmore, Chair, IGA R&RC  
Horst Rüter, Director, IGA Service GmbH



UNECE

# UNFC-2009 Hierarchy



**UNECE**

**Specifications**

for the application

of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009

to Renewable Energy Resources

Done in Geneva, 30 September 2016

**UNECE**

**Specifications**

for the application of the

**United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009)**

to

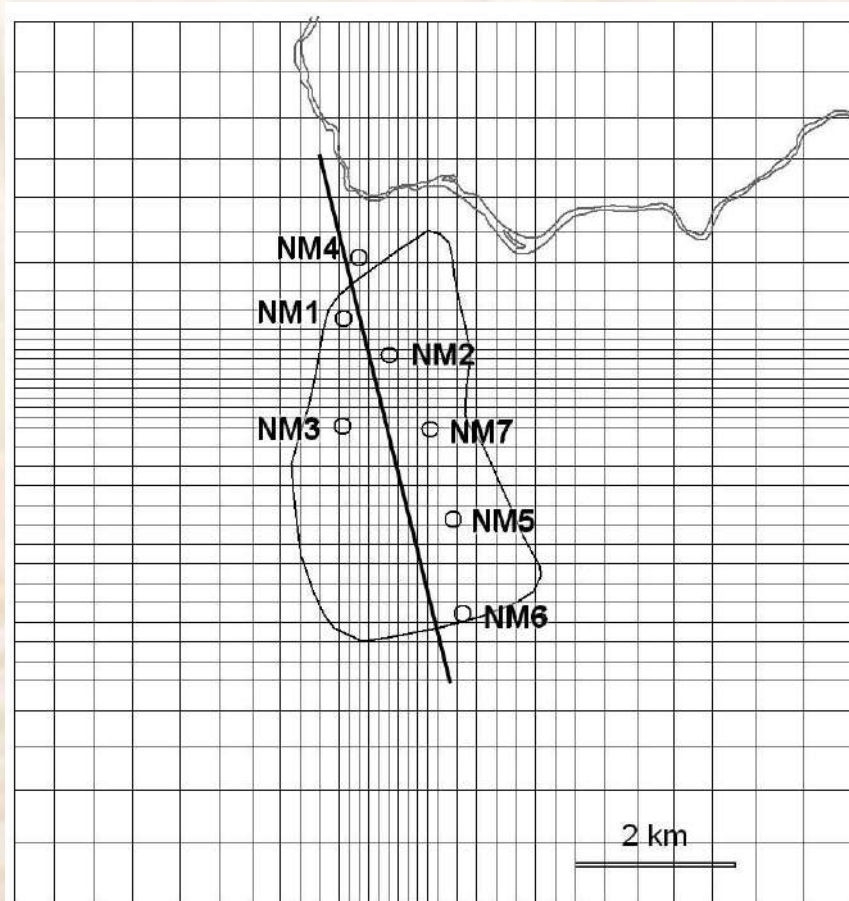
**Geothermal Energy Resources**

Done in Geneva on 30 September 2016

*Geothermal Specifications linked to Renewable Specifications and Generic Specifications*

- On 30 Sept 2016, the Sustainable Energy Committee requested the UNECE Expert Group on Resource Classification (EGRC) to consider changing the name of UNFC-2009 to reflect that it is for energy and mineral resources and not just for fossil energy.
- The UNFC revision process has just started, which will include renaming the system. The intent is for the EGRC to issue revised system end-2018/early-2019.

# Example Ngatamariki



Ngatamariki as at 2011, using only public information.

- 7 wells drilled
- 4 productive plus one permeable but not flowed
- Reservoir temperature up to ~280C
- Reservoir area around 5 km<sup>2</sup>
- Simulation based on known data

- **Ngatamariki**
  - Classification based on consent
    - Project defined in application
    - 82 MW power plant, binary, 100% reinjection
    - Feasibility assessed at level to justify securing resource consent
  - Product
    - Electricity
  - Reference Point
    - Switchyard

## Ngatamariki E category classification and subclassification

| <i>Category</i> | <i>UNFC-2009 Definition</i>   | <i>Reasoning for classification</i>   |
|-----------------|---|---|
| E1              | Extraction and sale has been confirmed to be economically viable  | Well testing and simulation has shown sustained discharge is possible and flow rates are economic.  |
| Sub-category    | <b>UNFC-2009 Definition</b>   | The project has resource consents and final financial approval in 2011.   |
| E1.1            | Extraction and sale is economic on the basis of current market conditions and realistic assumptions of future market conditions | Consents were issued for 35 years, so that the project is defined for this period. The classification of E1.1 applies to the energy to be produced over this period only. |

## Ngatamariki

### F category classification and subclassification

| <i>Category</i>     | <i>UNFC-2009 Definition</i>   | <i>Reasoning for classification</i>   |
|---------------------|---|---|
| <b>F1</b>           | Feasibility of extraction by a defined development project or mining operation has been confirmed   | Exploration, well testing, simulation and development plans are all complete. |
| <b>Sub-category</b> | <b>UNFC-2009 Definition</b>   |   |
| <b>F1.3</b>         | Sufficiently detailed studies have been completed to demonstrate the feasibility of extraction by implementing a defined development project or mining operation. |   |



## Ngatamariki G category classification and subclassification

| <i>Category</i> | <i>UNFC-2009 Definition</i>   | <i>Reasoning for classification</i>   |
|-----------------|---|---|
| G1 *            | Quantities associated with a known deposit that can be estimated with a high level of confidence.     | The combination of the power density method and the simulation give high confidence on the estimate.  |
| G2*             | Quantities associated with a known deposit that can be estimated with a moderate level of confidence. | Wells have been tested and a simulation completed based upon natural state and interference information. There is no production history and consequently no match to that history. Because of the lack of history confidence is moderate. |

\* Note that the classification as G1 and G2 was based on an evaluation of public domain information only and a final classification, including the provision of a G3 estimate, would be required to provide an indication of the full range of uncertainty in the estimate.

- **Ngatamariki**
  - **Energy Assessment**
    - Numerical Model shows 82 MW for 35 years (Deterministic)
    - Areal method indicates 86 MW for 30 years or 82 for 31.5 (Gives P90)
  - **Geothermal Resources:**
    - Low estimate: 80 PJ
    - Best estimate: 89 PJ

# Ngatamariki

## UNFC-2009 Geothermal Energy Resources

| <i>Classification</i> | <i>Energy Quantity</i>                       | <i>Supplemental information</i>   |
|-----------------------|--|---|
| UNFC Class            | Use energy units                             |   |
| E1.1;F1.3;G1          | 80PJ* (2500 <sup>#</sup> MW <sub>e</sub> yr) | 82 MW <sub>e</sub> for 31.5 years;  |
| E1.1;F1.3;G2          | 9PJ* (300* MW <sub>e</sub> yr)               | 82 MW <sub>e</sub> for 3.5 years; incremental to G1, with G1+G2 representing the best estimate. |